State of Vermont
2012 Water Quality Integrated Assessment Report

Vermont Agency of Natural Resources
Department of Environmental Conservation
Watershed Management Division

May 2012

STATE OF VERMONT

2012 WATER QUALITY INTEGRATED ASSESSMENT REPORT

Clean Water Act Section 305B Report

Vermont Agency of Natural Resources
Department of Environmental Conservation
Watershed Management Division
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Vermont Surface Water Management Strategy

This assessment is issued as a reporting element of the Vermont Surface Water Management Strategy

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Executive Summary and Overview

Overall Description

Section 305(b) of the Federal Water Pollution Control Act (also known as the Clean Water Act or CWA) requires each state to submit a report about the quality of the state's surface and ground waters to the US Environmental Protection Agency (EPA) on a biennial basis. This 2012 Water Quality Integrated Assessment Report (*305(b) Report*), prepared by Vermont's Department of Environmental Conservation (DEC) summarizes water quality conditions throughout Vermont with the known conditions as updated with information and data from the 24-month reporting period of January 1, 2010 through December 31, 2011.

Within its borders, Vermont has approximately 7,100 miles of rivers and streams based on 1:100,000 scale maps. Vermont also has 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.

Vermont's water quality policy states that rivers, streams, lakes and ponds should be of high quality, and in most instances, DEC's water quality monitoring programs indicate this to be true. Detailed surface water assessment results are provided in Chapter 4, but aquatic life use support and swimming use support for Vermont's surface waters are summarized in the figure below. Aquatic life and swimming uses are supported on over 89% of assessed rivers and streams and on more than 62% of inland lake acres. In Lake Champlain, although phosphorus pollution impairs swimming uses in the majority of lake acres, aquatic life use is in fact supported on 88% of the lake.

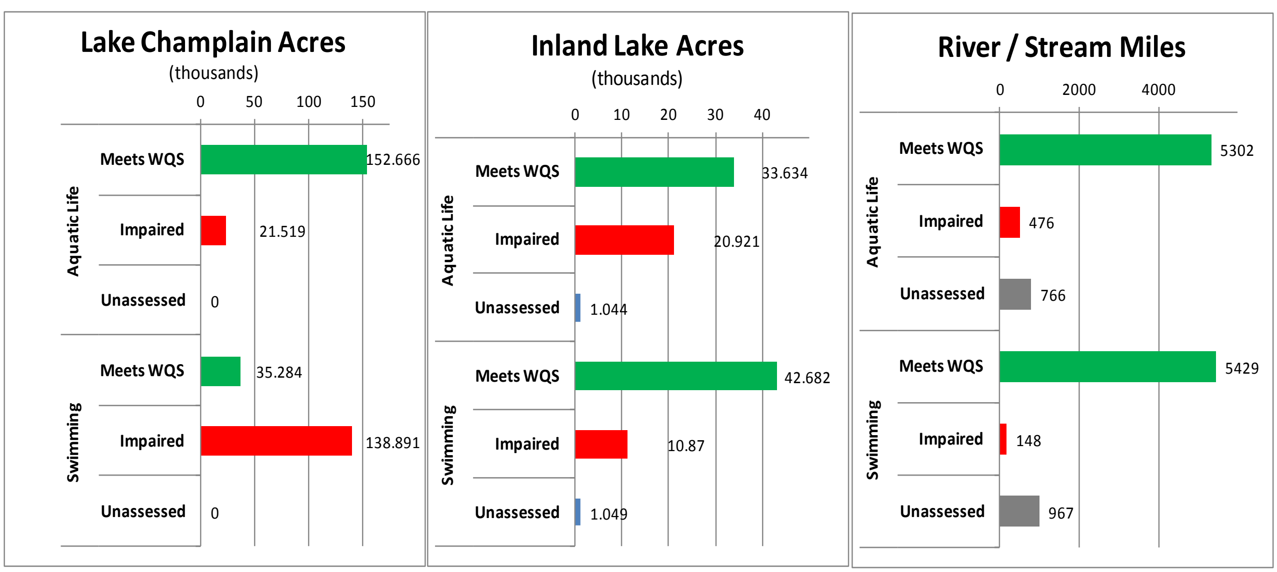

Figure 1. Assessment of Aquatic Life and Swimming Uses in Vermont Lakes and Rivers.

The US Environmental Protection Agency (EPA) has requested that Vermont also assess the attainment of fish consumption use in light of the advisory for mercury issued by the Vermont Department of Health in June 1995, and revised in 2000 and 2007. The advisory was issued as the result of fish tissue sampling that documented the occurrence of mercury in the tissue of all fish, particularly in walleye and lake trout, and also PCBs in lake trout in Lake Champlain. Taking the fish consumption advisory into consideration, the fish consumption use of all the state's waterbodies ranges from stressed to impaired. Deposition of mercury from the atmosphere is the overwhelming source of mercury in fish. The fish consumption advisory is in Appendix A.

The Wetlands Program of DEC's Watershed Management Division (WSMD) has assessed and monitored wetland condition in the state for over ten years. 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. The Vermont Wetland Rules were amended in 2010 through the formal rulemaking process. The new Rules contain a number of provisions that will enhance the protection of Vermont's wetlands.

In 2008, the legislature declared that groundwater in Vermont is a public trust resource. In mid 2011, the Department of Environmental Conservation completed an interim procedure implementing the public trust doctrine for groundwater quality. Groundwater re-classifications in the reporting period include one re-classification from Class III to Class II and one re-classification from Class III to Class IV. A number of permit applications for Underground Injection Control (UIC) wells and numerous inquiries about geothermal wells were received throughout the reporting period.

Assessment Methodology

As described in DEC's Assessment Methodology, miles of rivers and streams, and acres of lakes and ponds are placed into one of four categories by degree of support of designated uses - full support, stressed, altered or impaired. Fully supporting and stressed waters are those that meet the goals of the water quality standards. Impaired waters do not meet goals of the water quality standards because of one or more particular pollutants. Altered waters do not meet water quality standards because of non-pollutant effects (e.g., alteration of flow to generate electricity).

During the two years since the 2010 305(b) Report, the Basin 16 Northern Connecticut River Watershed Assessment Report was completed – the last of the seventeen basins to be comprehensively assessed. Assessment work will now be done in a targeted fashion to assist in providing timely information to the tactical basin planning process. Basin-specific assessment information is always available from DEC upon request and many reports or summaries are located on the DEC Watershed Management Division website.

DEC conducts its monitoring, assessment, and listing of waters consistent with the 2011 Assessment and Listing Methodology. Some additions and revisions to the Assessment and Listing Methodology were made to the earlier 2006 methodology in this reporting period. During 2010 and 2011, DEC conducted a comprehensive review and update of its 2005 Water Quality Monitoring Strategy. The new 2011 WQMS contains a comprehensive mid-stream progress analysis based on the goals and action items put forward in 2005.

Rivers and Streams Assessment

The assessment of Vermont's river and stream surface water quality and aquatic habitat conditions has been updated from the 2010 305(b) assessment with water quality information and data from waters monitored and assessed during the January 1, 2010 to December 31, 2011 reporting period. Using the EPA estimate of 7,100 miles of perennial rivers and streams, approximately 5,788 miles or 81% were assessed for this 2012 305(b) report.

The major causes of impairment and stress to Vermont rivers and streams include sediments, physical habitat alterations, nutrients, temperature, pathogens, flow alterations, metals, and turbidity. The river assessment process attempts to distinguish the relative contributions of sediment from overland runoff from construction sites and other land use activities and from eroding banks due to vegetation removal from streambank de-stabilization related to incising stream channels, resulting changes in channel and bank erosion, and sediment deposition and transport all from the stream system instability.

Lakes and Ponds Assessment

The assessment of Vermont's lake surface water quality and aquatic habitat conditions has also been updated from the 2010 305(b) assessment with water quality information and data from waters monitored and assessed during the 1/1/10 to 12/31/11 reporting period. 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 on the upper Connecticut River, Lake Memphremagog and Wallace Pond are transboundary waters that are reported as "inland lakes."

In Lake Champlain, none of its 174,175 acres found in Vermont fully support designated uses due to the combined effects of mercury and other contamination, nutrient accumulation, and non-native species. No acres in the Vermont portion of Lake Champlain support fish consumption use due to elevated levels of mercury or polychlorinated biphenyls (PCB) in fish tissue. Sedimentation is a stressor in Lake Champlain. In the 55,561 inland lake/pond acres that were assessed for the 2012 305(b) Report, the causes of impacts to those acres include mercury, phosphorus, pH (acidification), water level fluctuations, and invasive exotic species.

Wetlands Assessment

The Wetlands Section of the Watershed Management Division has assessed and monitored wetland condition in the state for over ten years. Prior to 2010, bioassessment and monitoring strategies had been singularly linked with the lakes and rivers sections of the DEC's Watershed Management Division. In many respects the connection between the Wetlands Section Bioassessment Program and the lakes and rivers water quality monitoring programs make sense since many of Vermont's wetlands occur adjacent to lakes and streams. Additionally, the assessment and monitoring programs measure a number of the same water quality parameters. However, while bioassessment efforts are evolving, the opportunities to expand and include findings from the Vermont Natural Heritage Program's work related to wetland communities has not transpired.

The importance of biomonitoring being integrated with wetland community type is that once a specific wetland community type is identified, it should be characterized by a well defined and expected set of ecological parameters. A specific wetland's biological condition and significance can then be measured against the predicted floral and faunal community members, soils, hydrology, bedrock influence, assessed functions, and water quality of the type. Thus, where possible the Vermont Natural Heritage Program wetland community types will be used in tandem with the Cowardin National wetland types, to assess metrics specific to individual wetland communities.

As a practical approach to bioassessment and monitoring efforts, Vermont has developed a new Vermont Rapid Assessment Method (VRAM) that will be used and refined, along with existing level I, II, and III wetland bioassessment methods, thus including the identification of wetland stressors and impacts determining site specific wetland condition. These efforts were facilitated significantly by WSMD's participation in the National Wetlands Condition Assessment.

The recent completion of the National Wetland Inventory (2008) mapping effort increased Vermont's identified wetland acreage by approximately 10 percent statewide, and 34 town-funded wetland mapping initiatives increased those towns' wetland acreage even higher. Given the large increase in known wetland acreage, much of it either forested, adjacent to existing wetlands, or newly identified small isolated wetlands, the benefits to assigning natural heritage community types to wetlands becomes evident as the distinction between impaired, impacted but healthy, or reference conditions become clearer when linked to predicted natural community conditions. Beginning in 2012, wetlands monitoring and assessment will be in synch with the rotational basin assessments.

Groundwater

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. The results of the study on groundwater interference caused by the pumping of Public Community Water Supply (PCWS) sources indicate that, overall, groundwater interference is not a chronic problem in Vermont.

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

Vermont has been active protecting groundwater through the groundwater reclassification process. In St. Albans, a contaminated rail yard has been reclassified as Class IV groundwater and in Brandon, a public community water system has been given the status of Class II groundwater. Furthermore, geothermal wells, a groundwater withdrawal program, along with legislation placing groundwater in the public trust have put a new emphasis on the importance of groundwater. In turn, staff have been engaged in the development of groundwater protection measures to meet these new challenges.

Listings of Waters

Development of Vermont's 2012 303(d) List of Impaired Waters runs concurrently with the development of this 2012 Section 305(b) Integrated Report. Consequently, the final 2012 303(d) List of Impaired Waters has not been included directly in this 305(b) Report. The 303(d) List of Impaired Waters, which needs approval by EPA, will be finalized and made available separately. DEC will also make available separately Vermont's List of Priority Waters that includes waters not on the 303(d) List. This 305(b) report, in combination with Vermont's 303(d) List and List of Priority Waters are considered Vermont's complete Integrated Water Quality Report.

Vermont's 2010 303(d) List of Impaired Waters was approved by the New England regional office of EPA during the 2012 reporting period (June 15, 2011). The 2010 303(d) listing identified a total of 107 waters as being impaired (92 river/stream segments and 15 lakes/ponds). The 2012 303(d) List potentially adds 2 segments, however, 28 segments are proposed for delisting resulting in a total of 87 segments as being impaired.

Vermont's 2010 listing of other priority waters outside the scope of 303(d) was also finalized in 2011. 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 2012 Section 305(b) reporting period, the New England regional office of EPA approved 22 TMDL determinations that had been completed by DEC. This brings to 117 the total number of TMDLs affecting Vermont waters that have been developed by DEC and approved by EPA since 2001. These TMDL waters are in various stages of TMDL implementation, and while many remain impaired, there have been considerable successes as well. The Department is pleased to point out that in New England, Vermont leads the way in the numbers of so-called §319 Success Stories posted to EPA's website (http://www.epa.gov/owow/NPS/Success/).

Major State Water Quality Issues

The year 2011 was the year of flooding and flood-related damage to Vermont's water resources and aquatic habitat. Chapter 3 contains brief updates and links to major topics covered in the 2010 305(b) report and then subsections on the flooding topics as well as several major issues in the list below.

Climate change and water/wetland resources
Dams and hydro-electric facilities
Flooding and channel impacts from Tropical Storm Irene
Flooding of Lake Champlain Spring 2011
Floodplains and surface water protection
Impacts to stream habitat and wild trout populations following Tropical Storm Irene
Invasive exotic plants and animals in surface waters and wetlands
Nutrient criteria
Phosphorus-impaired lakes restoration

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Chapter 1: Introduction

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 about the quality of the state's surface and ground waters to the US Environmental Protection Agency (EPA) on a biennial basis. The Year 2012 Water Quality Integrated Assessment Report (often called the *305b Report*) summarizes water quality conditions throughout Vermont with the known conditions updated with information and data from the 24-month reporting period (January 1, 2010 through December 31, 2011). Also included are brief descriptions of 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.

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 for land use 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 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 those wetlands that are exceptional or irreplaceable in their contribution to Vermont's natural heritage and that merit the highest level of protection. Class Two wetlands are those wetlands, other than Class I wetlands that, are so significant, either taken alone or in conjunction with other wetlands, that they merit protection. Class Three wetlands are those wetlands that have not been determined to be so significant that they merit protection either because they have not been evaluated or because when last evaluated were determined not to be sufficiently significant to merit protection. The majority of wetlands within Vermont are Class Two.

The 2012 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 biota/ habitat have been disturbed to some degree by point or nonpoint sources of pollution of human origin and the water may require some attention to maintain or restore its high quality; the water quality and/or aquatic habitat may be at risk of not supporting uses in the future; or the structure or integrity of the aquatic community has been changed but not to the degree that the standards are not met or uses not supported. 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).

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 is made following the Vermont Surface Water Assessment Methodology and using information gathered and provided to the Department of Environmental Conservation by water resources personnel, fish and wildlife biologists, aquatic biologists, lake and river organization members and other qualified individuals or groups. The 2012 Water Quality Assessment Report identifies the distance in miles of rivers and streams and area in acres of lakes and ponds that were assessed.

For 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, for Section 303d[1] 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, waters reported for 303d

[1] 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.

purposes in the 2012 list of waters are impaired waters that need or would benefit from a pollution budget determination more commonly known as a Total Maximum Daily Load (TMDL) determination. The 2012 303d list of waters is being developed concurrently to the 2012 305b Report. Because the 2012 303d list needs EPA approval, that information is presented separately from the 2012 305b Report. The 305b Report, the 303d list, and the other lists of priority waters when taken together however, represent Vermont integrated reporting because this information is inextricably linked.

A rotating basin schedule is used when assessing the state's waters, assessing roughly one-fifth of the state each year, from the 17 major river basins found in Vermont. The 2012 305b Report contains updated water quality information primarily for basins 9 (the White River), 12 (the Deerfield River), 15 (Passumpsic River), and 16 (Northern Connecticut River) but also contains a summary of the entire state's water quality. For 2012 assessment reporting and listing purposes, DEC used an updated Assessment and Listing Methodology that is dated July 2011. The 2011 Assessment and Listing Methodology can be read on DEC's Watershed Management Division web site (www.vtwaterquality.org). A map illustrating the 17 Vermont river basins and the year in which they are scheduled for monitoring is provided below.

The 305b Report remains an important mechanism for communicating to EPA and Congress, Vermont residents, and Vermont water managers about the progress being 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 Clean Water Act 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 on the internet at http://www.anr.state.vt.us/dec/waterq/WSMDhome.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
- 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.

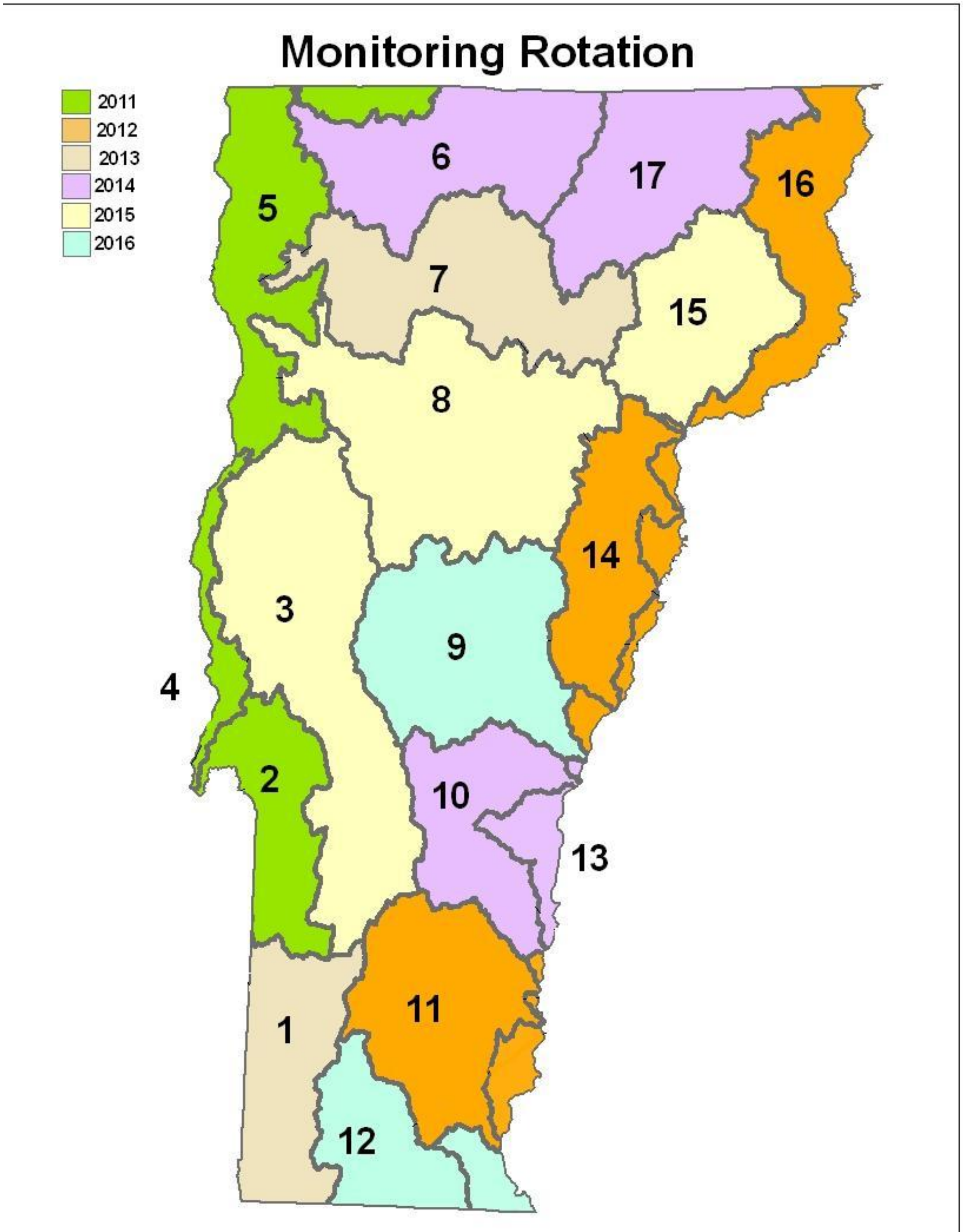

Figure 2. Vermont's seventeen basins and the year in which each will be monitored

Chapter 2: Vermont's Waters and Water Programs

Atlas and Total Waters

The estimates of the number of miles of rivers and streams in Vermont varies depending on the source and the scale of the mapping on which that source draws. Vermont has approximately 7,100 miles of rivers and streams based on EPA's Total Waters Database, which uses 1:100,000 scale maps. However, Vermont has approximately 24,493 miles of river and stream calculated using the National Hydrography Dataset (Version NHD080221, local resolution, schema 1.06) derived by photo-interpretation of 1:5,000 scale aerial orthophotographs. DEC currently uses the 7,100 number as the total on which to base assessed and unassessed miles. Discussion on how to use translate the assessment to the larger 1:5000 scale estimate of stream miles is underway.

Vermont has 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 (partial border with New York). The 17 major river basins of Vermont shown on the earlier map 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 1 below.

Table 1. Atlas

State population (2010 census)	625, 741
State population change (2000-2010)	2.8%
State surface area	9,609 square miles
State population density	65 persons/sq mi
Number of water basins	17
Miles of perennial rivers & streams	7,099 (includes the Conn River)
Border miles of shared rivers/streams (subset)	262 (Conn R. 238, Poultney 24)
Longest river in the state (not including Conn R.)	100 miles (Otter Creek)
Largest river watershed in the state (not including Conn R.)	1080 sq miles (Winooski R watershed)
Number of lakes, reservoirs & ponds over 20 acres	280
Number of lakes, reservoirs & ponds from 10 to 20 acres	190
Number of lakes, reservoirs & ponds (at least 5 acres but less than 10 acres)	148
Number of significant lakes, reservoirs & ponds less than 5 acres(or size unmeasured)	206
Deepest in-land lake (Willoughby)	308 feet
Greatest depth of Lake Champlain (off Thompsons Point)	394 feet
Acres of lakes, reservoirs & ponds[1]	230,927
Acres of freshwater wetlands[2]	300,000

[1] Number 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 CT River impoundments, Moore and Comerford Reservoirs, which are 1,255 and 777 acres in size respectively. The figure also accounts for newly inventoried ponds that were not previously tracked in Vermont's Lake Inventory Database and for some minor lake size changes that were identified via GIS analyses.

2 Number does not include wetlands found on agricultural lands that are actively used for agricultural purposes

There are no coastal waters, estuaries or tidal wetlands in Vermont. However, due to the size of Lake Champlain (approximately 120 miles long and 12 miles wide at its widest), 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.

For the 2012 Section 305(b) Report, DEC continues to use the EPA Total Waters estimate. Before the VHD-based estimate can be incorporated into its various water quality assessment efforts, DEC will need to revise the lengths of rivers and streams throughout the state on a systematic basis involving each waterbody.

Water Pollution Control Programs

DEC is 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. For the purpose of describing program effectiveness, DEC's various water pollution control programs can be summarized into three categories: General, Point Sources and Nonpoint Sources.

General

Water Quality Standards

The Water Quality Standards are the foundation of the state's water pollution control and water quality management and protection efforts. The Water Quality Standards are promulgated by the Vermont Water Resources Panel and provide the specific criteria and policies for the protection and management of Vermont's surface waters. The classification of waters (rivers, streams, lakes and ponds) as Class A, Class B, or Class B with a 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 could fall within one of three water management types (B1, B2 or B3) after consideration by the Water Resources Panel, however, as of the date of this report, no Class B water has been typed. The Standards used when preparing this report were last amended as of December 31, 2011 (www.nrb.state.vt.us/wrp/rules.htm).

The Standards 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. Table 2 lists the designated uses.

Table 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	✓		✓
Water Supplies		✓	✓
Agricultural Uses (Irrigation of Crops ...)			✓

Watershed Planning Process

As of 2011, Vermont has been implementing a revised tactical planning approach to developing water quality/watershed management plans that is considered the core implementation structure for Vermont's new Surface Water Management Strategy (Strategy). This newly minted Strategy sets forth goals and objectives for managing Vermont's surface waters in light of the goals of the federal Clean Water Act and Vermont's state surface water quality policy. The Strategy:

1. Sets forth goals and objectives for managing Vermont's surface waters in light of the goals of the federal Clean Water Act and Vermont's state surface water quality policy;
2. Describes pollutants and stressors that affect the uses and values of Vermont's surface waters, approaches to address stressors, and appendices describing regulations, funding and technical assistance programs;
3. Describes the Division's approach to protecting and improving surface waters by managing stressors rather than individual pollutants;
4. Evaluates program effectiveness in managing stressors, including an identification of regulatory "gaps" that impede effective stressor management;
5. Describes the Division's updated ambient Water Quality Monitoring Strategy that will work hand in hand with watershed management planning at the statewide and basin-specific level to identify and prioritize waters in need of protection, restoration and management; and,
6. Recommends a new more focused approach to watershed management planning that would result in the development of tactical basin plans that provide the geographic specificity necessary to effectively implement this Strategy.

The tactical planning process takes into account current and past assessment, planning, and implementation activities at the state and local levels. Assessments are used internally by the Department to develop nimble basin plans with implementation tables outlining the highest-priority current and envisioned water pollution or water quality management activities. Implementation tables will incorporate actions designed to protect high quality waters, and actions to address impaired, altered, and stressed waters. The Department will, for example, use the tactical plans as vehicles to identify implementation steps and accountability measures for such efforts as the Lake Champlain, Long Island Sound, Lake Memphremagog, and Statewide bacteria TMDLs.

This rotational planning process relies on the Strategy to guide the how of implementation, and focuses on the "what" to implement, and the "where." Extensive public process is conducted with organizational and watershed partners with the goal of arriving at an implementation table with pre-agreed funding and action steps. Further, the Department has re-engineered the process by which state Ecosystem Restoration Funding is administered such that funding is tied to the implementation tables of the tactical plans.

During the reporting period, in addition to the development of the Strategy itself, four new plans have been released for public review. For a detailed look at the tactical planning program, the reader is referred to the 2011 Legislative Report on Basin Planning, which is available at http://www.anr.state.vt.us/dec/waterq/mapp/docs/mp_2012_Basin_Planning_Legislative_Report_Final.pdf.

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 rulemaking procedure before the Water Resources Panel where a public interest determination must be made pursuant to Vermont's Water Pollution Control Statute, Title 10 VSA Section 1253. No streams have been re-classified to Class A since the 1998 305(b) Report. However, during this reporting period, good candidates for Class B to Class A re-classification have been, and are now being, identified in the new Tactical Basin Plans being written by DEC watershed coordinators.

Outstanding Resource Waters

An additional tool to manage and protect Vermont's waters is through the designation of Outstanding Resource Waters (ORWs). ORWs are waters of the State designated by the Vermont Water Resources Panel pursuant to 10 V.S.A. 1424a as having exceptional natural, recreational, cultural or scenic values. To gain an ORW designation, the petitioners must, in a contested case hearing before the Panel, provide evidence and testimony that the waters in question have exceptional natural, cultural, scenic, or recreational values. To date, 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 ORWs have been designated since 1996. However, during this reporting period, good candidates for ORW status have been, and are now being, identified in the new Tactical Basin Plans being written by DEC watershed coordinators.

Point Source Control

Direct Discharge Program

Vermont administers a 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 172 wastewater treatment facilities.

With the construction of the state's last originally identified municipal wastewater treatment facility (WWTF) and completion of the upgrades from primary to secondary, the program now places emphasis on refurbishment of existing WWTFs, the completion of phosphorus reduction upgrades (Appendix B, Table B.1), advanced waste treatment, correction of combined sewer overflows (Appendix B, Table B.2), control of toxics, pollution prevention activities and facility enlargements.

Of the 35 facilities with planned phosphorus reduction projects in the Vermont portion of the Lake Champlain basin, 33 have been or are close to being completed. Of the 34 planned CSO correction projects, 23 have been completed, 6 are partially completed and 5 are pending.

Table 3: Municipal Pollution Control Project Starts from January 1, 2010 to December 31, 2011

Community	Description	Awards to Date ($)
Alburgh Village	WWTF upgrade	42,400.
Barre City	WWTF heating & ventilation improvements construction	370,157.
Barton Village	Wastewater collection & treatment – final design	88,390.
Bellows Falls Village	Headworks – final design & construction	3,071,910.
Brattleboro	WWTF & pump station upgrades	5,264,270.
Bristol	Stormwater improvements construction	1,166,634.
Burlington	Stormwater improvements construction	1,324,000.
Canaan	Wastewater treatment & collection facilities upgrade	33,335.
Castleton	Stormwater improvements construction	260,000.
Enosburg Falls Village	Aeration system construction	115,000.
Essex Town	Pump station upgrade	575,255.
Hartford Town (WRJ)	WWTF upgrade	8,494,900.
Hartford Town (Quechee)	WWTF upgrade	6,020,600.
Hinesburg	WWTF upgrade – final design & construction	1,671,776.
Hinesburg	Mountain View Mobil Home Park wastewater upgrade	36,800.
Johnson Village	Pump station replacement final design engineering and sewer replacement construction	115,121.
Lyndon	WWTF upgrade – preliminary & final design engineering	318,200.
Richmond	Sewer replacement and stormwater improvements	804,560.
Springfield	Combined sewer overflow abatement	1,552,193.
St. Albans City	Biosolids & trickling filter final design & construction	2,528,743.
Troy & Jay	Solar sludge treatment facilities final design & construction	2,315,000
Windsor	Bridge St pump station and Mill Brook siphon	89,000.
TOTAL COST		**36,258,244.**

During the 2010 - 2011 reporting period, approximately 36,258,244 million dollars were committed and construction commenced on wastewater treatment facility upgrades, combined sewer overflow corrections, sewer line rehabilitations and other wastewater treatment system improvements in 22 communities (see Table 3 above).

Illicit Discharge Detection and Elimination (IDDE) Initiative

Many Vermont communities have aging sanitary sewer systems. Cross-connections and leakage from sanitary sewers to stormwater collection systems can be common, even in relatively new sewer lines. As a consequence, pollutants such as phosphorus, toxic substances and pathogenic organisms can bypass the wastewater treatment facility and be discharged at stormwater outfalls.

With support from the Ecosystem Restoration Program (ERP) and the Lake Champlain Basin Program, Stone Environmental, Inc., and VTDEC collaborated on drainage mapping and Illicit Discharge and Detection Elimination (IDDE) projects in the Missisquoi River, St. Albans Bay, Winooski River, and Connecticut River basins. In 2011, studies were ongoing in the Lamoille, Castleton-Hubbardton and Otter Creek river basins. To date, 26 discharges of non-stormwater run-off have been located and have or will be eliminated. These discharges ranged in size from a very large municipal trunk sewer line that was leaking to single-family homes. The collaboration provided 33 urbanized communities with a comprehensive stormwater drainage map identifying sites where installation of additional stormwater treatment measures is feasible. The maps will be used to assist infrastructure maintenance and spill prevention emergencies. In Chittenden County, the twelve regulated communities subject to the Municipal Separate Storm Sewer System (MS4) federal permit have located and eliminated 45 illicit discharges since 2003. The majority of these discharges were from single-family homes.

Stormwater Management

The Stormwater Program issues post-construction, or operational stormwater permits under both a state law program for discharges from impervious surfaces and a federal NPDES based program for discharges from industrial activities (Multi-Sector General Permit). Operational stormwater permits stay in place for the life of the regulated discharge. The Department has been issuing stormwater discharge permits since the late 1970s, and currently administers 2,883 active stormwater permits under these two programs. All permits require regular inspection, maintenance, and renewal.

The Stormwater Management Program issued 257 permits for new developments or redevelopment projects in 2011. The decrease in permit authorizations from 2010 is due to the large number of permit renewals in 2010. Permit activity in 2011 is similar to pre-2010 results and shows the continuing effects of the economic recession on new development. In 2011, Stormwater Program staff conducted 161 operational site visits, of which 85% were generally compliant.

As of November 2009, all 12 of the urban TMDLs for stormwater-impaired watersheds have been approved by EPA. To develop the basis for the implementation plans for these TMDLs, the DEC undertook a multi-year effort to fully characterize these watersheds, and to establish a process for developing the most cost-effective remediation strategies. This process resulted in the November 2009 *Final Report - A Framework for Remediation of Vermont's Stormwater-Impaired Waters:* http://www.vtwaterquality.org/stormwater/docs/swimpairedwatersheds/sw_tmdl_implementation_report_FINAL.pdf.

As outlined in the “Framework”, remediation of the twelve urban stormwater-impaired waters will commence through a combination of permits issued pursuant to Vermont’s federally delegated National Pollutant Discharge Elimination System (NPDES) permitting program. (See below.)

Stormwater MS4 General Permit

On January 22, 2010, the Department issued a draft General Permit (3-9014) for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). This draft permit contains detailed stormwater TMDL implementation requirements, including: within the first three years of the permit, each MS4 permittee, in consultation with the Agency, shall work cooperatively with other MS4 permittees that discharge into the same stormwater-impaired watershed to develop and submit a single, comprehensive Flow Restoration Plan (FRP) for the stormwater-impaired watershed.

The FRP shall contain the following elements: 1) an identification of the suite of necessary stormwater BMPs that will be used to achieve the flow restoration targets; 2) a design and construction schedule for the stormwater BMPs that have been identified as necessary to achieve the flow restoration targets; 3) a financing plan that estimates the costs for implementing the FRP and describes a strategy for financing the FRP; 4) a regulatory analysis that identifies and describes what, if any, additional regulatory authorities, including but not limited to the authority to require low impact development BMPs, the permittee will need in order for the permittee to implement the FRP; and 5) an identification of regulatory assistance that the permittee will need from the Secretary in order to effectively implement the FRP. Within ten years of the effective date of the permit, the permittee shall implement the measures identified in the Flow Restoration Plan as necessary to meet the flow restoration target.

DEC expects to issue a final MS4 permit in early 2012.

Stormwater Residual Designation Authority (RDA) General Permit

The Department has also issued a NPDES RDA permit with TMDL implementation requirements to over 450 individual dischargers to five of the 12 urban stormwater-impaired waters pursuant to the Vermont Environmental Court’s August 28, 2008 Judgment Order which granted CLF’s 2003 “Petition for Determination that Existing Discharges in Potash, Englesby, Morehouse, Centennial and Bartlett Brooks Contribute to Water Quality Standards Violations and Require NPDES Permits.” The Department notified these dischargers of their obligation to apply for permit coverage by December 16, 2009. These identified stormwater discharges go directly to these impaired streams and do not enter or commingle with the stormwater discharges regulated under the MS4 permit. The TMDL implementation requirements in the RDA permit are geared for three categories of discharges, including: Designated Discharges from Property with Existing Impervious Surfaces that are Subject to a Previously Issued State Stormwater Permit; Designated Discharges from Property with Existing Impervious Surfaces Greater than One Acre that do not have a Previously Issued State Stormwater Permit; and Designated Discharges from Property with Existing Impervious Surfaces Less than One Acre that do not have a Previously Issued State Stormwater Permit. The Department has created a “Small Sites Guide for Stormwater Management” to assist small property owners in meeting these requirements.

Nonpoint Source (NPS) Control – DEC Programs

Erosion Control at Construction Sites

Planned construction disturbance of 1,094 acres was permitted in 2011. This is the lowest value since 2007, and reflects the continued downtown in construction activity due to economic conditions. The acreage permitted does not equal the actual extent of regulated construction activity in a given year as authorizations are valid from 2-5 years. The Stormwater Management Program conducted a total of 80 site visits during 2011, including 36 projects authorized under the Construction General Permit and 44 authorized under Individual Construction Permits. Site inspections were skewed towards individual permits and repeat visits of the same site in 2011 due to the oversight necessary on several large projects.

319 Nonpoint Source Management 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 twenty years of Clean Water Act Section 319 NPS implementation funding (1990-2011), Vermont has received a cumulative total of about $25.96 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 NPS 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 305(b) reporting period include watershed restoration efforts carried out in various drainages by the Vermont Youth Conservation Corps, cover cropping demonstrations in northwestern Vermont and in the Winooski River drainage, assistance to farm producers in priority watersheds with management intensive grazing for clean water, strategic riparian planting efforts on streambanks assessed as “stable,” development of a model lakeshore protection ordinance, implementing phosphorus reductions within the Lake Carmi watershed and continuation of agricultural runoff control in the northern watersheds of the Rock River, Saxe Brook and St. Albans Bay. Importantly, the program was able to assist a variety of locally-led efforts to improve water quality and/or habitat conditions (e.g. NPS phosphorus and sediment control in the watersheds of Crosby Brook and Englesby Brook).

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 other elements are conducted outside of DEC. Examples of the former include stream stability assessments and floodplain management, 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 NPS management partner in both forestry and agriculture arenas.

Specific details regarding the NPS program and project activities are available from DEC's Watershed Management Division. DEC has maintained a listing of Section 319-assisted project titles by funding year. Vermont will continue to pursue and apply Clean Water Act 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.

Ecosystem Restoration Program

In 2011, the Vermont Agency of Natural Resources Center for Clean and Clear formally changed its name to the Ecosystem Restoration Program to more accurately describe the mission of the program. The program moved into the Vermont Department of Environmental Conservation Watershed Management Division to increase synergy within the Department. The move also enhances the effectiveness of Division in providing technical, financial, and educational support to local and regional partners to address nonpoint sources of water pollution that are degrading Lake Champlain and other surface waters across the state.

The Ecosystem Restoration Program's work is guided by the *2010 Revised Implementation Plan for the Lake Champlain Phosphorus Total Maximum Daily Load (TMDL)* and *2003 Vermont Clean and Clear Action Plan*. The goals of these plans are to accelerate phosphorus pollution reduction in Lake Champlain and reduce pollutants in waters statewide.

The *2010 Revised Implementation Plan for the Lake Champlain Phosphorus TMDL* indicates that the need to develop benchmarks and account for phosphorus load reductions resulting from program actions will be addressed by the following combination of efforts:

1. Direct monitoring of lake phosphorus concentrations and tributary loading rates;
2. Development and tracking of progress indicators developed specifically for each program (such as number of farms with approved nutrient management plans);
3. Watershed modeling; and,
4. Scientific literature review and field studies on management practice effectiveness.

Stone Environmental, Inc. and the Lake Champlain Basin Program completed a major watershed modeling project during 2011 to identify "critical source areas" of phosphorus in the Missisquoi Bay watershed. This work was funded by the International Joint Commission with oversight participation by staff from VTANR and VAAFM. Key findings of the study are that 74% of the upland sources of phosphorus is generated from only 20% of the watershed area, and in-channel sources of phosphorus (from stream bed and bank erosion generated from channel instability) represent about 40% of the phosphorus load entering the river.

Wetland Protection and Restoration

The U.S. Department of Agriculture (USDA) Natural Resource Conservation Service (NRCS) Wetlands Reserve Program (WRP) enrolled and/or restored 315 acres for wetland restoration projects in 2008, 940 additional acres 57 in 2009, 950 additional acres in 2010, and 283 acres in 2011. All of these lands will be permanently conserved by an easement that is held by NRCS. The DEC Ecosytem Restoration Program assists with WRP project development through a combination of direct staff support and a grant to Ducks Unlimited.

River Management
Analysis of stream geomorphic assessment data collected during the first six years of the Ecosystem Restoration Program is providing important insights regarding the condition of Vermont's streams and rivers. Of the more than 1,700 assessed river miles in Vermont, nearly three-quarters (73%) have become confined to deeper, straighter channels and no longer have access to historic floodplains. Vermont ANR has adopted an avoidance strategy to restore and protect the natural stability of rivers and streams. Multiple river corridor protection activities were underway or completed during 2011 in nearly all of the state's 17 major river basins including Phase 1 and 2 stream geomorphic assessments, river corridor planning, Fluvial Erosion Hazard (FEH) mapping, project development, and project implementation.

In 2011, Vermont DEC released a stream alteration general permit, as a regulatory tool containing reporting and non-reporting categories that removes the 10 square mile jurisdictional threshold for channel management activities in streams. The general permit was designed to to guard against channel management activities that could cause greater channel instability and thus excessive erosion and sedimentation as well as phosphorus transport.

Nonpoint Source Control – Non-DEC Programs

Forest Management
Acceptable Management Practices (AMPs) were developed and adopted as rules to implement Vermont's water quality statutes, and became effective on August 15, 1987. The AMPs are designed to prevent sediment, petroleum products, and logging slash from entering waters of the state. They are also meant to reduce the potential for soil erosion and minimize stream temperature fluctuations. The Vermont Department of Forests and Parks (VTFPR) works with representatives from the Vermont forest industry to help Vermont DEC Compliance and Enforcement Division reduce the number and severity of water quality violations resulting from timber harvesting operations. In 2011, VTFPR staff provided technical assistance to loggers and landowners on 73 AMP cases where water quality was potentially threatened. VTFPR hosts workshops and provides support to Vermont logger education and training programs. During 2011, VTFPR hosted or participated in seven workshops on the topic of Maintaining Forest Water Quality on Timber Harvesting Operations with 77 participants in attendance. The Vermont Portable Skidder Bridge Initiative provides education, outreach and technical assistance and programs for loggers to promote better stream crossing practices to protect water quality on timber harvesting operations

Agricultural Programs and Practices
An important component of nonpoint source pollution control, but under the purview of of the Agency of Agriculture, Food, and Markets (AAFM), are a number of practices, programs, and regulations followed by the agricultural community that provide water quality protection. Following is a list of the programs that serve to protect water quality and good descriptions of each of these can be found in the 2011 Ecosystem Restoration Annual Report located at ***Y:\WQ_ERP\Reports\Clean and Clear Annual Reports\2011 Report\120202 ERP 2011 Annual Report compiled FINAL.pdf***. This report was done by Vermont DEC and Vermont AAFM to describe progress on Lake Champlain restoration efforts.

1) Agricultural Regulatory Programs to Protect Water Quality including Accepted Agricultural Practices, Medium Farm Operations Rules and Large Farm Operations Rules
2) AAFM Best Management Practices Program
3) Conservation Reserve Enhancement Program and Vermont Agricultural Buffer Program
4) Farm Agronomic Practices Program
5) Nutrient Management Plan Incentive Grant Program

Better Backroads

The Better Backroads Program is a partnership with the Vermont Local Roads Program, Vermont Agency of Transportation (VTrans), Vermont Agency of Natural Resources (VTANR), and the Northern Vermont Resource Conservation and Development Council (RC&D that was established in 1997. The program is administered by the Northern Vermont RC&D. The Vermont Better Backroads Program provides grants and technical assistance to towns to correct erosion problems and adopt road maintenance practices that protect water quality while reducing long-term road maintenance costs. Better Backroads financial and technical assistance demonstrates to towns that the proper fixes and maintenance practices are cost-effective: the one-time investment to fix a chronic erosion problem properly (e.g., rock-line a steep roadside ditch) generally pays for itself many times over in reduced long-term maintenance costs as well as providing environmental benefits .

A total of 165 Vermont towns have participated in the Better Backroads Program since 1997 by conducting at least one grant-funded project, including 95 towns in the Lake Champlain Basin. In 2011, three new towns received grants through the program.

Municipal Water Quality Protection Technical Assistance

The Vermont League of Cities and Towns (VLCT) Water Resources Coordinator developed and promoted a Model Lake Shoreland District Protection Bylaw and accompanying technical paper describing water quality benefits of lakeshore protection and illustrating how to create an effective shoreland protection bylaw in 2011. The VLCT mailed 1,266 postcards and 1,129 email messages announcing the new *VLCT Model Lake Shoreland District Protection Bylaw* and technical paper to numerous municipal official positions and to the Vermont Planner's Association and the Vermont Zoning Administrator's list-serves.

The Coordinator also participated in numerous meetings and workshops to support municipalities during the aftermaths of the spring flooding and Tropical Storm Irene in 2011 as well as attended a FEMA-funded week long training course on advance floodplain management. The Coordinator organized and moderated a workshop held in October, 2011 titled "Weathering the Storms - Land, Water and the Local Role," which was attended by 135 municipal officials and other interested parties from state government, nongovernmental organizations and the private sector. In total, water quality protection technical assistance was provided to municipalities and others through eight workshops, twenty-six town meetings, thirteen articles or other information pieces, and nineteen meetings with partners.

Costs and Benefits of Water Pollution Control 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 $729.9 million. These facilities have improved the quality of 59 rivers and 3 lakes for such uses as swimming, fishing, boating and aquatic life. The $729.9 million figure includes the $32.3 million in improvements which started construction during the 2012 305(b) reporting period. Refer to Table 3 for the location and estimated cost of recent improvements.

The money spent on stormwater pollution clean-up has included geomorphic assessments, subwatershed mapping, flow and precipitation monitoring, and modeling work in impaired watersheds in order to develop the best management practices needed to understand the impairment and clean up the streams. To date, at least $1.39 million have been spent on the stormwater impaired streams through grants and contracts for the work described above.

In addition, over $17.1 million have been spent in private and/or public projects in about 16 towns retrofitting existing stormwater systems or enhancing stormwater treatment. Some of this work has provided stormwater offsets for new development by allowing the developers to purchase their offset credits rather than find an appropriate project themselves.

Nonpoint Sources

Unlike point sources, quantifying the financial resources spent on nonpoint source control of pollutants is not as easy to determine or link to specific river miles/lake acres of improvement. This is due to several factors: contributions of resources come from various state, federal and local agencies as well as from landowners, volunteer groups, foundations, businesses; NPS controls take many shapes and forms and can be applied as structural or non-structural measures; some NPS controls may be implemented one year and not applied the following year (e.g. cover crops); some NPS efforts are focused on education as a way to encourage adoption of recommended practices.

During state fiscal year 2011, the Ecosystem Restoration Program received just under $1.9 million for ecosystem restoration grants and 60 grants were awarded to do nonpoint source pollution reduction work.

Funding for the two CWA programs under DEC administration from 1989 through 2011 has amounted to about $1.1 million (604b) and over $25 million (319). The 604b Program’s 40% pass-through has helped the 11 Vermont regional planning commissions (RPC) conduct a wide variety of water quality planning related activities. Section 604b funding was increased by $194,000 for a single year as a result of money arising out of the American Recovery and Reinvestment Act of 2009. Forty percent of that amount was distributed to the RPCs and linked to low impact development planning purposes. A portion of the 319 Program has, year to year, provided varying levels of funding to government and non-profit organizations to carry out a wide variety of NPS implementation efforts.

Another notable state funded water quality and aquatic habitat program (aside from the Ecosytem Restoration Program) is the Vermont Conservation License Plate Program. In the 13 years of its existence (1998-2011), the program has awarded close to $900,000 in state monies to many diverse groups for a wide variety of water quality or aquatic habitat projects. Many of the license plate funded projects provide water quality and/or aquatic habitat benefits that have some connection to NPS management. The program, co-administered by DEC and the Vermont Department of Fish and Wildlife, would not be possible without the assistance and insight of citizens who serve on a committee charged with reviewing the numerous proposals submitted each year.

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Chapter 3. Major State Surface Water Quality Issues

Introduction

This chapter summarizes a number of the significant State surface water quality and aquatic habitat issues in Vermont. In the 2010 Vermont Water Quality Integrated Assessment Report, there were fourteen topics discussed in this chapter. For this 2012 Integrated Report, eight of the topics are updated briefly below and the reader is referred to the 2010 report for background information on the issue and how the Department of Environmental Conservation has been involved in monitoring and assessing the pollutant or problem, its impact and source. To see the 2010 305(b) report, go to: http://www.vtwaterquality.org/mapp/docs/305b/mp_305b-2010.pdf. For the six other topics that were discussed in 2010, they are still presented in separate sections of their own below because there is some substantial information to add from the reporting period. Three sections of this chapter are new – they discuss the impacts from the spring and Tropical Storm Irene flooding in 2011 on Vermont's surface waters as well as post-Irene dredging and channelization impacts.

Atmospheric deposition of pollutants

Deposition of pollutants (mercury, sulfate, nitrous oxides) to the Vermont landscape from the atmosphere has been principally responsible for the impairment of fish consumption uses on 8,165 inland lake acres, all of Lake Champlain, and 66 river and stream miles. Acidity due to atmospheric deposition of pollutants impairs aquatic life uses on 4,468 inland lake acres. This is an important water quality topic that was covered well in the 2010 305(b) report but there is little to report during the 2012 305b period.

Large farms and potential pollution

From a water quality perspective, concerns continue to exist regarding shifts in agricultural production from a large number of smaller farms to growing numbers of larger farms. This topic and changes in rules and permitting were discussed in the 2010 305(b) report and is also addressed somewhat in Chapter 2 of this report under Nonpoint Source Control on page 20.

Chlorides and water quality

Chloride concentrations continue to be monitored in streams through the Ambient Biomonitoring Program and in lakes and ponds through the Spring Phosphorus and Acid Rain Programs. The Champlain monitoring program also routinely measures chloride in the lake and major tributaries. No substantial updates or analysis have been done on the topic, however, since the 2010 305(b) report. However, a link to the study results and analysis to date can be found here: http://www.anr.state.vt.us/dec/waterq/lakes/docs/lp_chloridereport.pdf.

E. coli contamination and microbial source tracking

Results of a study that was done on *E. coli* and microbial source tracking on two Vermont rivers, which was mentioned in the 2010 305(b) report have been presented in a USGS report. A link to the study results can be found: http://pubs.usgs.gov/sir/2011/5113/.

Lack of strategic statewide vegetated buffer requirements

There is still a lack of statewide vegetated buffer requirements to protect lakes and ponds, and rivers and streams in Vermont. Discussion of the need and the issue is in the 2010 305(b) Report.

Lakeshore development and alteration of littoral habitat

The Littoral Habitat Assessment and the Vermont Lakes Survey conducted by the Lakes and Ponds Section from 2005 to 2008 quantified habitat parameters that can be used to evaluate whether the standard, which states "no change from the reference condition that would prevent the full support of aquatic biota, wildlife, or aquatic habitat uses", is being met in the ecologically important littoral zone of lakes. A description of both studies can be found in the 2010 305(b) report.

Since 2009, the data from the Vermont Lakes Survey has been analyzed using methods described by EPA in their state of the nation's lakes 2010 report. This analysis made it possible to compare the condition of Vermont's lakes to the nation and to the Northern Appalachian Ecoregion. Vermont's lakes are in some of the best condition for nutrients but a higher proportion are in fair condition for lakeshore disturbance than the ecoregion or the country.

In 2010, Vermont DEC developed and tested methods for using macroinvertebrates as indicators of biological integrity. The method used at rocky littoral sites showed statistically different metrics at unbuffered developed sites as compared to reference sites further demonstrating that unbuffered lakeshore development results in changes to aquatic biota as well as aquatic habitat.

In 2011, Vermont DEC partnered with Maine DEP to determine if Maine's mandatory Shoreland Protection Act standards are effective at protecting aquatic habitat. No change from reference sites were found in a majority of aquatic habitat parameters measured at sites meeting Maine's standards.

Pharmaceuticals, personal care products, and other contaminants in waters

As part of the National Flowing Waters Survey, EPA expanded investigations of pharmaceuticals in fish tissue to better understand whether pharmaceuticals get into rivers and streams. Field teams began collecting water and composite fish samples at sites that included several urban sites in Vermont in 2008 and 2009. EPA has analyzed the water and fish fillet samples for an expanded list of PPCP chemicals and has also analyzed the fish fillets for persistent contaminants, including mercury, selenium, PCBs, pesticides, and flame retardants (PBDEs). EPA plans to complete this work and report on results in 2012. More on this topic can be found in the 2010 305(b) report.

Stormwater TMDLs Implementation

On January 22, 2010, DEC issued a draft General Permit (3-9014) for Stormwater Discharges from Municipal Separate Storm Sewer Systems (MS4s). This draft permit contains detailed stormwater TMDL implementation requirements, including: that each MS4 permittee, in consultation with the Agency, shall work with other MS4 permittees that discharge into the same stormwater-impaired watershed to develop and submit a single, comprehensive Flow Restoration Plan (FRP) for the stormwater-impaired watershed within three years. The Department has also issued a NPDES RDA permit with TMDL implementation requirements to over 450 individual dischargers in five of the 12 urban stormwater-impaired waters pursuant to the Vermont Environmental Court's August 28, 2008 Judgment Order which granted CLF's 2003 petition. Further discussion on stormwater management issues can be found in Chapter 2 above on page 16.

Climate Change and Vermont's Waters

Scientists have noted some key climate trends in the last few decades, including changes in air and water temperatures and precipitation patterns. In particular, Vermont and the region are expected to experience warming temperatures, increased annual precipitation (by as much as 30%), more extreme rainfall events, altered timing and duration of seasonal floods, less snowpack and lake ice, and more short-term droughts. These changes could have critical consequences for hydrology, water quality and availability, ecological integrity, and human infrastructure.

Flooding

With a warmer, wetter climate and more extreme precipitation events, flooding and erosion concerns are likely to become more pressing. Vermont communities have already experienced an increase in the frequency of damaging floods in recent years including the record setting flows and floods of 2011. This trend is likely exacerbated by greater development in flood-prone areas, as well as chronic instability from historic and current channelization practices, including channel straightening, dredging, bank armoring, and berm construction. These activities can limit a stream's floodplain access and create more runoff, which then increases flood power, velocity, and erosion around infrastructure. With further climate shifts in the coming decades, we could see still more stream channel erosion, lakeshore fluctuation, sedimentation, and loss of human investment.

Water Quality

In addition to flooding, water quality may be threatened as precipitation patterns change and waters warm. Intensified storm water runoff may increase water pollution as flows carry pesticides, fertilizers, road sands, eroded sediments, animal wastes, inundated septic systems, combined sewage overflow and other pollutants into rivers and lakes. Runoff can also increase the amounts of toxics, such as mercury, that end up in rivers and lakes. In turn, higher water temperatures can allow for greater incidence of mercury methylation, resulting in increased mercury accumulation in fish and fish-eating animals, including humans . Wastewater treatment facilities that are not completely disconnected from storm sewers may be overwhelmed by storm water volumes, allowing for the possibility of contamination of lakes or rivers. Warmer, nutrient-rich waters may encourage more frequent cyanobacterial blooms and elevated populations of the bacterium *E.coli.*

Ecosystems

Aquatic life could face severe challenges. Of primary concern is that warmer waters hold less dissolved oxygen. This low-oxygen condition can be detrimental to many aquatic species, especially species such as trout that are already restricted to cold-water habitats because of their oxygen requirements. If low flows become more prevalent in summer, aquatic habitats may become reduced, more isolated, and more oxygen-poor. Changes in the timing and duration of high and low flows could interfere with the life cycles of migratory fish or aquatic insects. Species interactions may be disrupted, as more tolerant species gain competitive advantages, and aquatic communities become less resistant to invasive species. Research from the Great Lakes and Lake Champlain suggests that even minor changes in temperature regime can result in shifts in prevalent lake fish species, away from coldwater spawners such as salmonids, to tolerant species like bass.

Availability
Vermont waters may also have reduced availability for human use, especially during droughts when demand increases and flows are low. For instance, a month-long increase in summer low-flow periods may challenge communities that depend on streams and rivers for their water supply. The timing of precipitation and the form it takes (snow vs. rain) plays a strong role in how much water becomes stored in surface waters and aquifers. Increased runoff caused by soil saturation and impervious surfaces found in developed areas may lead to reductions in aquifer replenishment and in increased risks of waterway contamination as result of flooding. Additionally, many wells in the northeast are drilled into bedrock, and bedrock aquifers may be extremely vulnerable to extended periods of drought (Frumhoff et al., 2007). Water withdrawals or other stream flow alterations may become more common, and human uses may compete with aquatic management needs.

Vulnerability
Vermont is just beginning to identify the water resources most vulnerable to climate change, which is an important step toward planning adaptation efforts. Vulnerabilities may be found in human communities and aquatic ecosystems where the resource is already highly stressed, or in particular species that are rare or highly sensitive due to specialization.

Human communities
In human communities, vulnerabilities may include locations of infrastructure already at risk. For example, flood-prone shorelines and streams with high levels of encroachment may be especially susceptible. Significant and costly structures (e.g., bridges, culverts, roads, ditches, homes, and embankments) could be damaged by erosive flooding, and stormwater systems could be overwhelmed during high rainfall events. Similarly, dams may be subject to changing flow regimes, accelerated sediment buildup behind structures, and elevated risk for catastrophic failure during high flow events. Because of the potential for increased pollution and short-term droughts, drinking water availability and quality may also be at risk, creating additional costs associated with storage and/or treatment.

Aquatic ecosystems
Aquatic ecosystems may be especially vulnerable wherever habitats are already compromised. For example, locations with little or no vegetated buffer will experience higher thermal stress. Also, habitats may be fragmented by barriers to aquatic species movement, such as culverts, berms, or dams. Critical ecosystem processes that have been altered (e.g., where floodplain function is diminished by flow regulation or excessive encroachment) may already limit habitat diversity and availability. Particular species vulnerabilities may include species sensitive to warmer temperatures and oxygen-poor waters (e.g., brook trout), rare species or species sensitive to sedimentation (e.g., freshwater mussels), species with pronounced susceptibility to mercury contamination (e.g., loons), or species that may provide benefits to other species (e.g., tree species important for riparian buffers that may themselves be vulnerable to warming temperatures).

Monitoring and managing water resources in the future

In most cases, the challenges posed by climate change are not new, but are expected to become more intense in the upcoming decades. Therefore, management strategies already used by the Watershed Management Division may become increasingly critical for climate change adaptation and mitigation, now and in the future. Some existing programs important to addressing climate change include:

1. Monitoring biological, chemical, and physical conditions of lakes, rivers, and wetlands, to establish baseline conditions and help maintain the health and quality of local waterways.

2. River corridor, floodplain, and shoreline protection to reduce encroachment, and river, lake, and wetlands vegetated buffer promotion.

3. Stormwater regulation and promotion of low impact development/ best management practices.

4. Improving and protecting existing infrastructure near waterways. This includes upgrading undersized culverts and bridges, regulating uses that alter stream flows, and the strategic removal of obsolete, inoperative dams.

5. Improving the resiliency of wastewater treatment facilities and their collection systems near waterways.

Understanding climate trends and their impacts to Vermont's water resources will be essential to making wise decisions about adaptation. Much of what we know can be refined through planned research efforts:

- Continue to evaluate how precipitation changes may affect stream flow and flooding.
- Analyze buffer characteristics needed for maintaining adequate microclimate over Vermont water bodies, map thermal risks throughout watersheds, and monitor water temperature and dissolved oxygen in lakes, rivers, and wetlands.
- Conduct species vulnerabilities and create monitoring and/or "rescue" plans.
- Assess ecological functions and vulnerabilities by watershed, and prioritize locations for additional protection, buffering, and/or restoration.
- Enhance monitoring programs for toxins in wastewater, ground water, and water bodies.

The original white paper from which this information was taken was prepared by Sacha Pealer and Gwen Dunnington of the WSMD in April 2011. It can be seen at: http://www.anr.state.vt.us/anr/climatechange/Pubs/VTCCAdaptWaterResources.pdf.

Dams and Hydroelectric Facilities

There are over 1,200 inventoried dams on Vermont's rivers, streams and lakes. Recent stream assessments indicate that there are many more that are not included in the state dam inventory. While many of these dams continue to serve one or more useful purposes – such as recreation, flood control, water supply and hydroelectric power generation – many more, literally hundreds, do not.

Most of the dams that are no longer serving a useful purpose were built many years ago, often to provide power for a mill that has long since ceased to operate and may no longer exist. The dams remain, and continue to have significant ecological impacts. Fundamentally, these dams change free-flowing streams to unnatural impoundments, impacting species that depend on river habitat for their survival. Specific impacts include:

- The larger surface area of the impoundment and generally shallower water often results in higher water temperatures in the impoundment and downstream, which can be detrimental or even fatal to species such as brook trout.
- The loss of turbulent flow may reduce the dissolved oxygen concentration. If the impoundment stratifies, the dissolved oxygen level may be further reduced.
- The movement of fish and other organisms both downstream and upstream can be limited or completely blocked.
- Natural sediment transport dynamics are interrupted, so sediment accumulates in the impoundment and the channel downstream is subjected to scour.
- The natural flow regime can be altered.

Since the spring floods of 2011 and the flooding caused by Tropical Storm Irene, there have been calls to use existing dams to manipulate lake levels or river flows to mitigate or eliminate flooding. Only a handful of dams in Vermont were designed for flood control, so the flood control benefit is likely to be limited, while the ecological impacts could be significant. There has also been interest in building new flood control dams, but this is unlikely given the cost (tens or hundreds of millions of dollars) and social and environmental impacts.

In recent years, there has been increasing interest in removing dams to eliminate the ecological impacts of these structures. In addition to the ecological benefits, removal of old, unused dams resolves other issues including public safety (dams may exacerbate upstream flooding and many are poorly or not maintained) and economics (the cost of dam ownership to towns, the state and private individuals can be significant).

There is increasing interest in developing hydroelectric power facilities at existing dams as part of a larger movement to develop new renewable energy sources. The current situation is not dissimilar from that of the early 1980s, when public policy and economic incentives led to the development of 35-40 new hydroelectric projects in Vermont. The good hydropower sites were developed then and the economics of most of those that remain are poor. Many of the remaining sites are only suitable for projects of a few hundred kilowatts, or even less, and are unlikely to be developed without economic incentives such as grants, preferential electric rates and tax incentives. Many sites that are being considered are likely to remain uneconomical even with incentives.

Many small projects are being undertaken by people who are unfamiliar with the technical and regulatory issues associated with developing hydroelectric power. They face the additional challenge of working with very tight financial constraints and they are often unable to engage experienced engineering consultants to help them determine if their project is feasible, and if so, working through the design, permitting and construction process.

Finally, there is a general lack of understanding about the impacts of dams and hydroelectric power development on rivers. As noted earlier, the impacts of dams on river ecology make them one of the most significant alterations humans have wrought on river systems. Depending on the design and operation of a hydroelectric facility added to an existing dam, the impacts can be multiplied by increased flow regulation and dewatering of reaches between the dam and powerhouse. This lack of understanding has resulted in a disconnect between the ecological impacts of a hydroelectric facility and the benefits of renewable energy. Put another way, a small facility does not necessarily mean there will be a small impact, but it does mean that the amount of energy produced will be relatively modest.

What does all this mean for Vermont's water resources? The laudable goal of doing something to reduce the production of greenhouse gases is creating a situation where the process of restoring rivers and streams that began with passage of the Clean Water Act could be undermined as dams that might otherwise have been removed are redeveloped or retained for future development. These dams will continue to fragment our rivers and streams at a time when restoring their continuity so they are more resilient and resistant to the effects of global warming is essential.

Flooding and Channel Impacts from Tropical Storm Irene

Vermont's rivers, streams, lakes, ponds, and associated wetlands suffered substantial damage in 2011. The flooding of Lake Champlain in May and June of 2011 set new records due to its height and duration and amount of damage. The water level rose over a foot above levels recorded since 1827, plus it stayed above the previous record of 102 feet for a month and a half. Numerous streams and rivers flooded at the end of May bringing sediment as well as water to Lake Champlain and causing damage to the aquatic habitat of the rivers and streams themselves.

And then on August 28, 2011, Tropical Storm Irene moved through the state dropping anywhere from 2.25 to 7.80 inches of rain resulting in record flooding in some of Vermont's watersheds. Following the floods themselves, many miles of southern and central Vermont rivers and streams were dredged, channelized, re-channelized and/or bermed. Some of the activity was conducted to obtain material for road rebuilding and to reclaim lands. These activities, whether legitimate emergency measures or not, will have significant and negative short-term impacts on stream habitat. In many of the stream reaches, the habitat alterations may persist for years if not decades. As it is, the post-flood impacts from the 1970s floods can still be seen in parts of rivers and streams today.

There are twenty long-term USGS stream gauging stations in Vermont and New Hampshire and there were new record peak stages and streamflows at 11 of the 20 sites following Irene. The following table shows the Vermont gages that reported record peak flows for Tropical Storm Irene and compares that to the previous historical peak.

Table 4. Record streamflow discharges at Vermont USGS gages during Tropical Storm Irene

USGS station number	Location (USGS name)	Date	Streamflow discharge (ft3/second)	Historic peak discharge (ft3/second)	Year of historic peak
01153550	Williams River near Rockingham	8/28/2011	48,700	11,500	1987
01334000	Walloomsac River near North Bennington	8/28/2011	9,420	8,450	1938
04282000	Otter Creek at Center Rutland	8/29/2011	18,300	13,700	1938
04287000	Dog River at Northfield Falls	8/28/2011	23,500	10,600	1973
04288000	Mad River at Moretown	8/28/2011	23,600	23,000	1927
01142500	Ayers Brook at Randolph	8/28/2011	5,630	3,480	1973
01154000	Saxtons River at Saxtons River	8/28/2011	14,700	9,620	1936
04296000	Black River at Coventry	8/29/2011	4,120	3,740	1976

A number of Vermont watersheds were badly flooded and then were further altered during the post-flood work while others did not have the intensive quantity of rain or fared better due to the nature of the watershed. Following is a brief watershed-by-watershed description of the damage that occurred to rivers and streams as known at the time of this report after Tropical Storm Irene.

Basin 1 – Batten Kill, Walloomsac, Hoosic

The Batten Kill mainstem fared pretty well although the straightened and bermed tributaries did not. Almost all of the tributaries broke through their berms: the worst hit was Roaring Branch but Bourne Brook, White Creek and Mill Brook were also damaged.

The Walloomsac River incised in Woodford and severely aggraded in Bennington where the channel almost completely filled in. The City of Bennington hired a consultant to direct the recovery work and the river was engineered giving it a pattern and floodplain that is designed to better handle future flooding.

Basin 2 – Poultney, Mettawee

Poultney River tributaries such as Lavery Brook, Finel Hollow Brook, and Lewis Brook were affected with roads, bridges, and culverts washed out. The Hubbardton River and the Castleton River as well as Castleton tributaries, Belgo Brook and Brittain Brook, were also severely affected.

The Mettowee River itself as well as tributary Flower Brook flooded and culverts, roads, bridges washed out. The Indian River avulsed and headed through backyards.

Basin 3 - Otter Creek watershed

The Otter Creek itself fared relatively well considering the volume of water coming down from its numerous and large tributaries, and importantly, the extensive floodplains and wetlands in the river corridor served to protect the downstream towns of Middlebury and Vergennes as well as riverside development that has occurred in this valley. There was significant damage to the Mill and Cold Rivers, both of which had been dredged and channelized following the 1970s floods. Mendon

Brook, Neshobe River, Middlebury River, and New Haven River flooded and moved resulting in houses and roads being damaged, which then resulted in the reconstruction of these channels. Homer Stone Brook, a tributary to the upper Otter Creek, was severely dredged out and then bermed.

Basin 8 - Winooski River

The Dog River watershed and the Mad River watershed were the hardest hit subwatersheds to the Winooski River. Cox Brook and Union Brook, tributaries to the Dog River, have been dredged and bermed since the flood.

The whole length of the Mad River was affected by flooding both in May and in August from Tropical Storm Irene. Instream channel work occurred in the Mad River following the flooding. Stetson Brook, High Bridge Brook, and an unnamed tributary to the Mad River near Kenyon's were all hit hard. Some stream alteration work post flooding occurred near the mouth of Pine Brook, in Shepard Brook and in Freeman Brook in Warren village.

Ridley Brook in Duxbury scoured severely and post-flood work was conducted to reestablish a more natural and coarser bed armoring.

Basin 9 - White River watershed

The White River watershed was one of the most damaged watersheds post-Irene: undersized bridges and culverts, unstable riverbanks, rivers and streams historically put into a prescribed location and configuration all exacerbated the damage of the floods, and poorly-executed dredging and re-channelizing following the floods resulted in widespread aquatic habitat impacts. The White River mainstem, especially in the towns of Stockbridge, Bethel, Royalton, Sharon, and West Hartford, was damaged. The following direct tributaries to the White River experienced flooding and some were further altered by post-flood activity: Fay Brook in Sharon, Whitewater Brook in Sharon, Broad Brook in Sharon, Mill Brook in Pomfret, Locus Creek, Lillieville Brook in Stockbridge, Stony Brook and its tributary, Davis Hill Brook, in Stockbridge.

The Third Branch to the White River also suffered substantial impacts. Its tributaries damaged included Camp Brook, Gilead Brook, Thayer Brook, and Riford Brook.

The Tweed River was seriously damaged by the flood and then was extensively dredged following the flood resulting in a braided, overwidened channel. There has been restoration work in the Tweed since the post-flood dredging. Guernsey Brook and the West Branch of the Tweed also were hard hit by the flooding. Guernsey Brook cut around a debris jam formed at its culvert under Route 100 taking out a section of the road as it made its way to the Tweed.

Basin 10 – Ottauquechee Black Rivers

The Ottauquechee River mainstem from the U.S. Army Corps flood control dam upstream through Woodstock to Killington was flooded and then dredged as Route 4 was being repaired. In addition, 200 propane tanks were displaced from West Woodstock and carried down through the Quechee Gorge and deposited in the USACE reservoir (North Hartland Lake).

The following tributaries of the Ottauquechee also had impacts due to flooding and then post-flood work: Roaring Brook from Killington Resort to its mouth; Reservoir Brook from Woodard Reservoir down; Broad Brook from Lynds Hill Road down as well as its tributary Pinney Hollow Brook, Kedron Brook from Noah Wood Road to the Ottauquechee; Gulf Stream from Lakota Road down; Barnard Brook from Line Pond Road to its mouth

The Black River mainstem from the Army Corps flood control dam upstream flooded and the gravel from roads as well as other debris carried by the floodwaters ended up in the river. Extensive post-flood work occurred instream.

Patch Brook, Twenty-Mile Stream, North Branch Black River plus its two tributaries Alder Meadow Brook and Knapp Brook, and Reading Pond Brook were all severely flooded. The North Branch was dredged and channelized extensively after the flood. Mass failures on Money Brook, exacerbated by dredging activity, continue to dump sediment upstream of the lakes.

Basin 11 – West, Williams, Saxtons Rivers

The West River upstream of the two U.S. Army Corps flood control dams was heavily flooded and accumulated the impacts of its steep and powerful tributaries sending floodwaters and eroded material down.

The West River tributaries of Rock River and its tributary Marlboro Branch, Smith Brook and its tributary Wardsboro Brook, Wardsboro Branch, Ball Mountain Brook, Winhall River, Cold Stream Brook all flooded. The Winhall River, Ball Mountain Brook, Wardsboro Brook, Rock River, and Marlboro Branch were all dredged and re-channelized post Irene.

There was severe flooding on the Williams River with the now famous, Bartonsville Covered Bridge, washed downstream (famous because of the YouTube video that was viewed over ½ million times - http://www.youtube.com/watch?v=WyO18one8fU). The South Branch of the Williams River was also hard hit.

The Saxtons River mainstem flooded and cut a new channel. The river was "put back" into its former channel post-Irene. South Branch Saxtons River and its tributary Howe Brook as well as Bull Creek were affected by flooding.

Basin 12 - Deerfield River watershed

The North Branch of the Deerfield River had huge impacts and Wilmington village was one of the most damaged in the state. Beaver Brook, Ellis Brook and other tributaries were also harmed.

Basin 13 – Lower Connecticut River

Whetstone Brook in Marlboro and Brattleboro was affected for its whole length by flooding. Mill Brook in Windsor and West Windsor was damaged by flooding with a bridge gone and the fire station flooded. In the upper portion in Reading, Bailey Brook and Reading Hill Brook suffered substantial impacts. Lulls Brook saw high water but not too much damage.

Basin 16 - Blood Brook Norwich
This brook flooded and then was re-constructed post-flood with the goal that it have access to some floodplain area and have stable dimensions. The brook and the created floodplain went into winter with no vegetation present and no mulching. The Department expects that Japanese knotweed will be a significant issue in Spring 2012.

Flooding of Lake Champlain Spring 2011

The flooding of Lake Champlain in May and June of 2011 set records due to its height and duration, as well as the amount of damage that was caused. The water level rose over a foot above the previous record high of 102 feet where it stayed for a month and a half. Record high lake levels for the date were set on 48 consecutive days during the heavy spring runoff between April and June — and then again for 37 more days in September and October after Tropical Storm Irene.

The high water and wave action eroded lakeshore soils never before exposed to such forces and created unusual plumes of sediment more commonly associated with the mouths of rivers than with lakes. But Lake Champlain's tributary rivers too carried high concentrations of suspended sediment and phosphorus that washed off uplands and eroded from streambanks. Rivers like the Winooski and Missisquoi each delivered about 400 metric tons of phosphorus to Lake Champlain during 2011, more than twice their average annual amounts. About two-thirds of this phosphorus arrived during the runoff of April and May. Tropical Storm Irene accounted for another 9 to 13 percent.

Much of the phosphorus in these rivers came from developed land and farmland — from manure, other fertilizers, and soil exposed to erosion. But recently another important source of phosphorus in our rivers was confirmed: two studies of the Missisquoi River watershed established that erosion of stream banks contributes 40 to 50 percent of all the sediment and phosphorus delivered to the river. This finding has important implications for Lake Champlain cleanup efforts. It means that better ways must be found to achieve long-term stability in our river channels by allowing them to regain their natural shapes and functions. Armoring stream banks with riprap only transfers the erosive power of the water elsewhere in the river system and does little to help the lake.

As expected, the lake's water quality suffered significantly this past year. Average phosphorus concentrations throughout most of the lake were the highest recorded since the Lake Champlain monitoring program began in 1992. Algae flourished during 2011. In fact, sediment and algae suspended in the water made it difficult to peer into the depths of the lake. Out in the middle of the lake, it is normal to be able to see a black and white measurement disk lowered 18 feet deep, but during 2011 water clarity was reduced to only 11 feet.

Despite this degradation, we saw a few encouraging signs elsewhere. As destructive flood waters during Irene poured into the Otter Creek from tributaries like Mendon Brook and the Neshobe River, flow rates measured at the river gauge in Rutland spiked quickly at over 18,000 cubic feet per second. But 40 river miles downstream in Middlebury, this torrent was spread out over many days and barely exceeded 6,000 cubic feet per second at its peak. Extensive wetlands and floodplains along Otter Creek between Brandon and Middlebury soaked up the floodwaters and released them more slowly in a way that lessened the impact on Lake Champlain.

Other rivers like the Winooski and the Missisquoi, which have fewer wetlands and floodplains along their courses, behaved very differently during Irene. Here, flow rates peaked nearly three times higher at downstream gauges, compared with rates measured upstream. Phosphorus concentrations in the Winooski and the Missisquoi measured soon after Irene were considerably higher than levels recorded in Otter Creek.

The floods of 2011 left many streambanks in bare and unstable conditions, vulnerable to further erosion during even moderate storm events. Fortunately, post-Irene sampling has not shown abnormally high phosphorus concentrations at the mouths of the major rivers draining to Lake Champlain. However, sediment and phosphorus levels in these rivers will have to be monitored for any effects from Irene until our streambanks stabilize and regain their protective vegetation cover.

The sediment and phosphorus delivered to Lake Champlain during 2011 will eventually either settle to the bottom or drain out via the Richelieu River. In shallow bays where the water is flushed out fairly quickly, this process is already well underway although some of the phosphorus in the bottom sediments could return to the water to fertilize algae growth next summer. In the deep region of the main lake, it may take another year or two before these pollutants dissipate from the water.

Rivers with adjoining wetlands and access to their natural floodplains are far more resilient to flooding. Such areas moderate the erosive force of rivers during floods and result in cleaner water downstream. Almost certainly, properties in Middlebury were spared damage during Irene because of the wetlands and floodplains along Otter Creek. These natural ecosystems are integral features of all waterways and play a critical role in flood resiliency.

The original article was prepared by Vermont DEC staff as part of an ongoing series sponsored by the Rutland Natural Resources Conservation District for the Rutland Herald. It has been modified for this report.

Floodplains and Water Quality

Stream geomorphic assessment data (2002-2011) are now available in sufficient quantity to help explain the habitat alteration in many rivers in Vermont. Data, including the stage of stream channel evolution, demonstrate vertical and lateral channel adjustment processes that alter aquatic and riparian habitats. Stages II through IV of the Schumm channel evolution model (1984) represent departures from equilibrium conditions that indicate where floodwaters lack access to a floodplain and its attenuation functions. Table 5 below shows that 73.5% of the 1,500 river miles assessed at the “Phase 2 level” in Vermont lack access to a floodplain during the frequent or annual flood. In many of these river miles, channels are deeply incised, and even the large (infrequent) floods are confined within the channel.

In addition to erosion hazards, which dramatically increase when flood energy is unable to reach the floodplain, channelization and incision lead to a loss of sediment storage and an overall export of soil and nutrients from a watershed. Rivers that have down cut and lost access to their floodplains will erode their banks until stream power is reduced through the floodplain formation process.

Table 5. Miles of stream in different evolution stages

Stream Evolution Stage	Stream Evolution Condition	Number of Miles	Percent Length
I	Equilibrium	378	25.2
II	Incised & steepened	333	22.2
III	Incised & widening	549	36.6
IV	Incised & depositional	220.5	14.7
V	Equilibrium w/terraces	19.5	1.3
Total		**1,500**	**100**

The erosion and transport of bed and bank materials and woody debris stored within the channel represents a loss of aquatic and riparian habitat. Excess stream power may result in loss of stream bed undulations and the formation of a plane bed channel morphology. The loss of deposition and convergent flow patterns leads to a loss of pools and therefore a loss of riffles and rock steps. Many river miles in Vermont are in the evolutionary stages that follow channel incision (Stage II), when plane bed channels widen then slowly begin to store the materials that serve as food and cover for aquatic organisms. Reference habitat is restored when flow and sediment regimes are in balance.

Erosion and sedimentation have been listed as the number one cause of stress and impairment of aquatic life use support since Vermont began reporting the impacts of nonpoint source pollution. Sources have been reported to include sediment in overland sheet runoff from cropland and construction sites; the erosion associated with concentrated stormwater; and streambank erosion. While streambank erosion has been associated with the loss of riparian woody vegetation, in most stream networks it is more complex than that with channel incision often being at the heart of the problem (see continued discussion in Chapter 4). Stream geomorphic data collected over the past nine years provide an opportunity to add detail to Vermont's assessment of sedimentation sources.

The Agency is pursuing river corridor protection as the primary tool to restore and protect dynamic equilibrium in rivers. River corridors consist of lands adjacent to, and including, the present channel of the river. Delineations are based primarily on floodplain function, the lateral extent of stable meanders, i.e., the meander belt width, and a wooded riparian buffer to provide streambank stability. The meander belt width is governed by valley landforms, surficial geology, and the length and slope requirements of the river in its most probable stable form.

A River Corridor Easement Program established in 2007 focuses on conserving river reaches identified as high priority sediment and nutrient storage areas. The opportunity to purchase and sell river corridor easements was created to augment Fluvial Erosion Hazard (FEH) zoning which, if adopted, avoids future encroachment and flood damage, but does not restrict channelization.

The Rivers Program works closely with state and federal farm service agencies, the Vermont Housing and Conservation Board (VHCB), and land trust organizations to combine corridor easements with other land conservation programs. The easement ensures that watercourses and wetlands are not manipulated to alter natural water level or flow, or intervene in the natural physical adjustment of the water bodies. To date the program and land trusts have completed easements on 20 miles of river which, when in equilibrium, will have access to more than 783 acres of floodplain.

Table 6. VTDEC Rivers Program Supported River Corridor Easements 2007 - present

River Name	Stream Length (ft)	Easement Area (acres)
Bull Creek (trib to Saxtons)	2200	16
Saxtons River & Bull Creek	2024	70
Nulhegan River	2,000	19
White River	3,618	29.8
Second Branch White River	3,025	6.5
Meadow Brook	1,056	4.5
Little River	2,345	8.4
LaPlatte River	14,900	160
Beecher Hill Brook	1,431	6.3
North Branch Winooski	8,412	76.9
Ayers Brook	19,790	50.8
Browns River	2,800	23.7
Hungerford Brook	1,700	7.3
Tyler Branch	4,405	23.1
Trout River	3,900	22.3
Leach Stream	5,300	22
Middlebury River	1,340	11.7
Mad River	1,563	8.3
Green River (Arlington)	2,300	11.4
Batten Kill	900	8.9
Mettowee River	3,700	7.5
Wanzer Brook	2,050	4
New Haven River	4,318	9.1
Lewis Creek	10,300	175.8
Totals	**105,377 ft**	**783 acres**

During the 2010 project year, Vermont DEC formalized an important funding partnership with the Vermont Agency of Agriculture, the USDA Natural Resource Conservation Service, VHCB, and Vermont Land Trust. These partners agreed that agricultural soils conservation and river corridor conservation (including protection of dynamic equilibrium stream corridors) were compatible easement purposes. This milestone allows Vermont to use state ERP funds to match federal USDA funds to complete conservation projects with both agricultural and river conservation objectives.

Impacts to Stream Habitat and Wild Trout Populations Post Irene

Damage suffered from Tropical Storm Irene required immediate and in some cases extensive stream channel alteration to protect life and property and rebuild critical transportation infrastructure. However, a significant amount of instream activity was also conducted without proper consultation and oversight and for reasons beyond that necessary as an emergency protective measure. Instream activities continued for several months after the flood event and covered a wide area of the central and southern portion of the state.

The flood itself had an impact on aquatic habitat. Some steep, upland reaches were scoured down to glacial till and cover habitats were eroded away. Other reaches were completely filled in with sediments, where the flows subsequently became either braided or sub-surface. When the flood receded, post-flood activities commenced and included large scale removal of stream channel sediments and woody debris, berming to raise streambank elevations, and the straightening (or more likely re-straightening) of stream channels. These activities, whether legitimate emergency measures or not, resulted in homogeneous, often over-widened stream channels comprised of small substrates and lacking the diversity of habitats, flows and depths necessary to support aquatic populations.

As fish population recovery and fisheries management options will be dependent on aquatic habitat quality and complexity, the Vermont Department of Fish and Wildlife conducted an assessment of post-flood aquatic habitats in selected watersheds. This partial assessment estimated a total of 77 miles of stream with major impacts to aquatic habitat where post-flood stream channel alteration activities were conducted.

Long-term monitoring studies in two Vermont rivers indicate that, in the absence of post-flood channel alterations, wild trout populations generally recover within 2-4 years. Where aquatic habitat has been severely altered through streambed dredging, woody debris removal, and channel widening and straightening, complex habitat features will need to re-establish before improvements in fish and aquatic populations can be expected. While relatively short reaches of impacted streams may recover in a matter of years, the recovery of longer reaches may take decades and will depend upon the availability and mobility of upstream sources of coarse streambed material and natural wood, as well as the magnitude and frequency of future flood events.

Introduction

On August 27-28, 2011 Tropical Storm Irene deposited over six inches of rain on several watersheds in central and southern portions of Vermont. The US Geological Survey reported record discharges for eight stream gauges in Vermont including the Saxtons River (Rockingham), Little River (Waterbury), Ayers Brook (Randolph), Williams River (Rockingham), Walloomsac River (North Bennington), Otter Creek (Middlebury), Dog River (Berlin) and Mad River (Moretown).

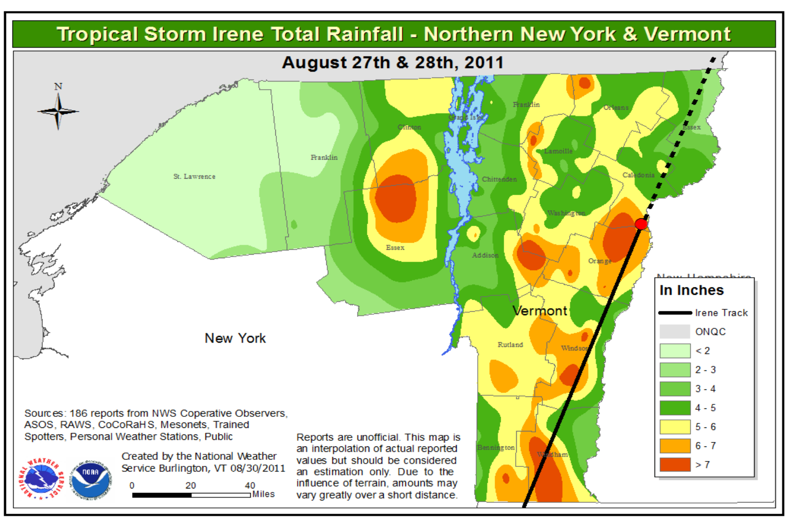

Figure 3. National Weather Service estimates of total rainfall from Tropical Storm Irene

Long Term Impacts of Floods to Wild Trout Populations

Catastrophic flood events can also have profound effects on wild trout and other aquatic populations. Waters (1999) reported floods and sedimentation as the main environmental causes for the variation of wild brook trout populations in a long-term study of a Minnesota stream. Numerous studies have linked the abundance of age-0 trout to the timing and magnitude of flood events. While young fish are often more susceptible to loss during flood events, high mortality of adult trout have been documented as well. The decline and subsequent recovery of fish populations following flood events are directly related to aquatic habitat quality and complexity. Pearsons et. al (1992) reported that following flooding, hydraulically complex reaches lost fewer fish and had higher species diversity than reaches with low complexity. Large floods will often result in large scale movement of stream substrates and may recruit large quantities of natural wood to stream channels resulting in changes in the size and depth of habitat features. Studies by Carline and McCullough (2003) and Dolloff et. al.(1994) indicate that while individual habitat units may have changed, overall habitat composition and complexity did not suffer and in some cases improved.

Long-term monitoring of wild trout populations in Vermont provides direct evidence of population decline and recovery following large flood events. In the examples presented below, catastrophic flood events resulted in widespread damage to private and public infrastructure and caused large scale movement of stream substrate and large wood. However, significant post-flood channel alterations were not conducted and habitat quality remained intact.

Clay Brook, a tributary of the Mad River, supports a fish population consisting exclusively of wild brook trout. Following the June 1998 flood, trout populations dropped to their lowest levels in 11 years, totaling only 41% of the previous low recorded (Figure 4). A further decline occurred in 1999 before recovery in 2000. In subsequent years populationswere sustained at pre-flood levels.

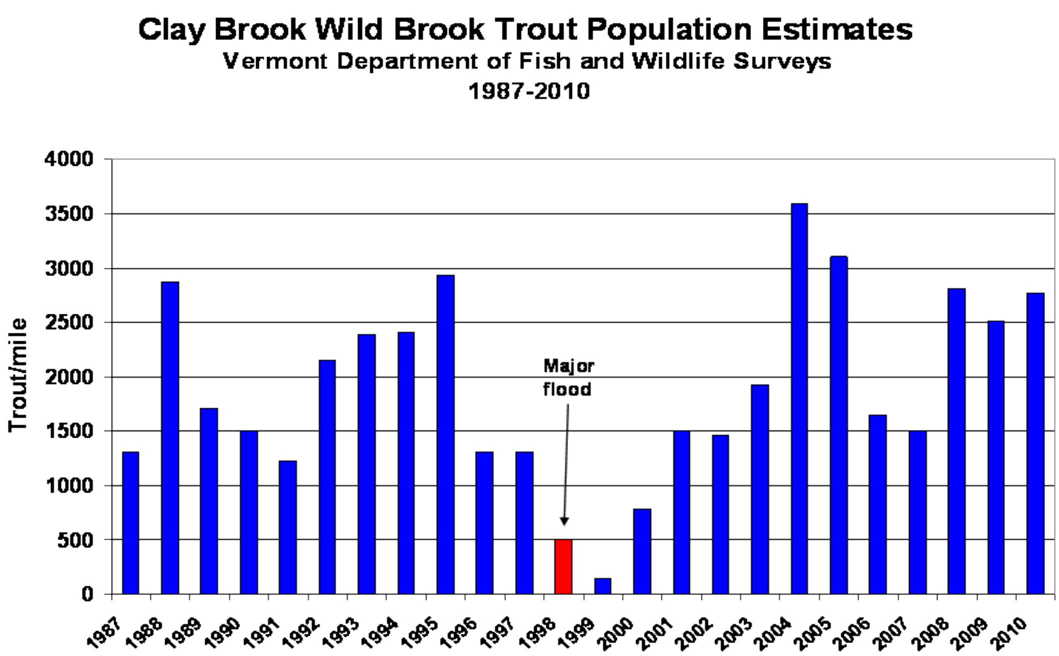

Figure 4. Clay Brook Wild Brook Trout Population 1987-2010

Lilliesville Brook is a tributary of the White River and serves as a spawning and nursery stream for wild rainbow trout, consisting largely of two age classes of trout. Wild brook trout are also present in relatively low numbers. A major flood event in July 2007 reduced wild trout populations to their lowest level in 24 years (Figure 5). However, successful spawning of wild rainbow in 2008 resulted in the rapid recovery of this population.

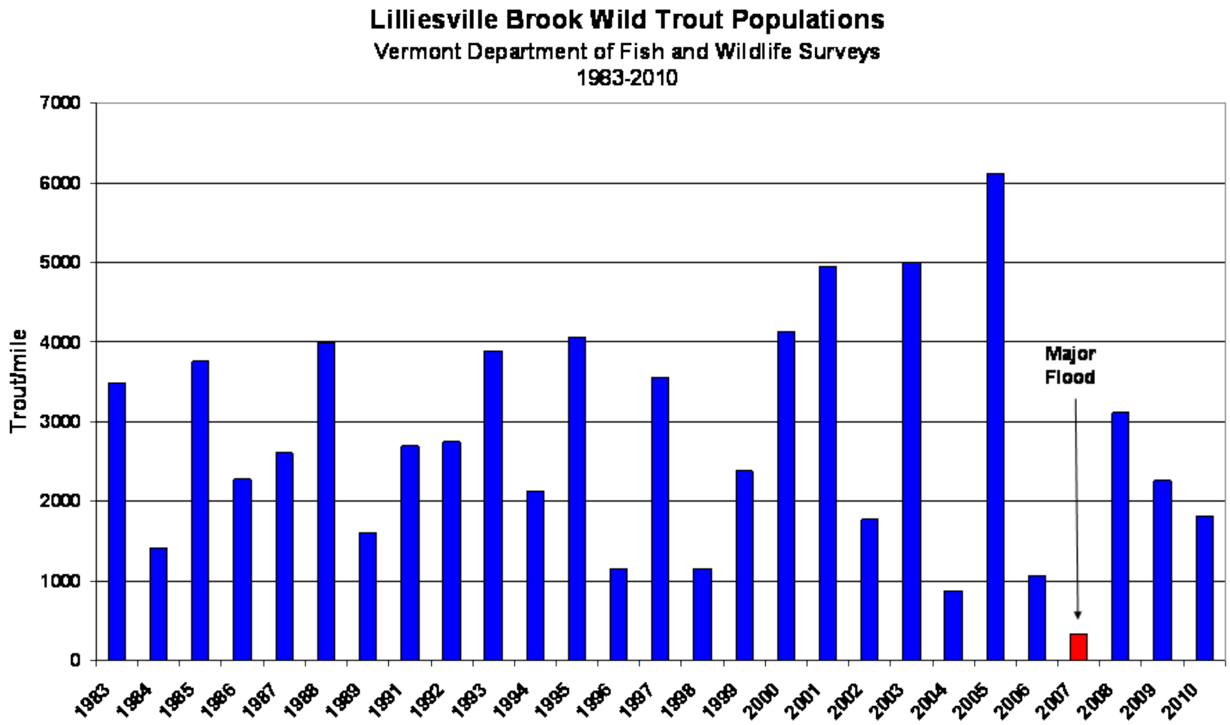

Figure 5. Lilliesville Brook Wild Trout Populations 1983 - 2010

__Impacts of Tropical Storm Irene to Wild Trout Populations__

Several trout population surveys conducted in the Mad River and Dog River watersheds in 2011 prior to Tropical Storm Irene were repeated following the flood. Slide Brook is a tributary of the Mad River and supports wild brook trout. The upper Dog River supports wild brook trout as does its tributary, Union Brook. Stony Brook is also a tributary of the Dog River and supports both wild brook trout and rainbow trout. A comparison of pre- and post-flood population levels provides insight into the impact of flooding on wild trout resources in Vermont. As in previous extreme flood events, wild trout populations declined substantially. In the four streams surveyed, wild total trout population levels were reduced to 33-58% of pre-flood levels (Figure 6). Young fish were particularly affected (0-37% of pre-flood levels) while older trout fared better (41-64% of pre-flood levels). As in the previous examples, there were only limited post-flood channel alterations and despite significant movement of streambed material, these stream reaches maintained diverse and complex habitat conditions following the flood.

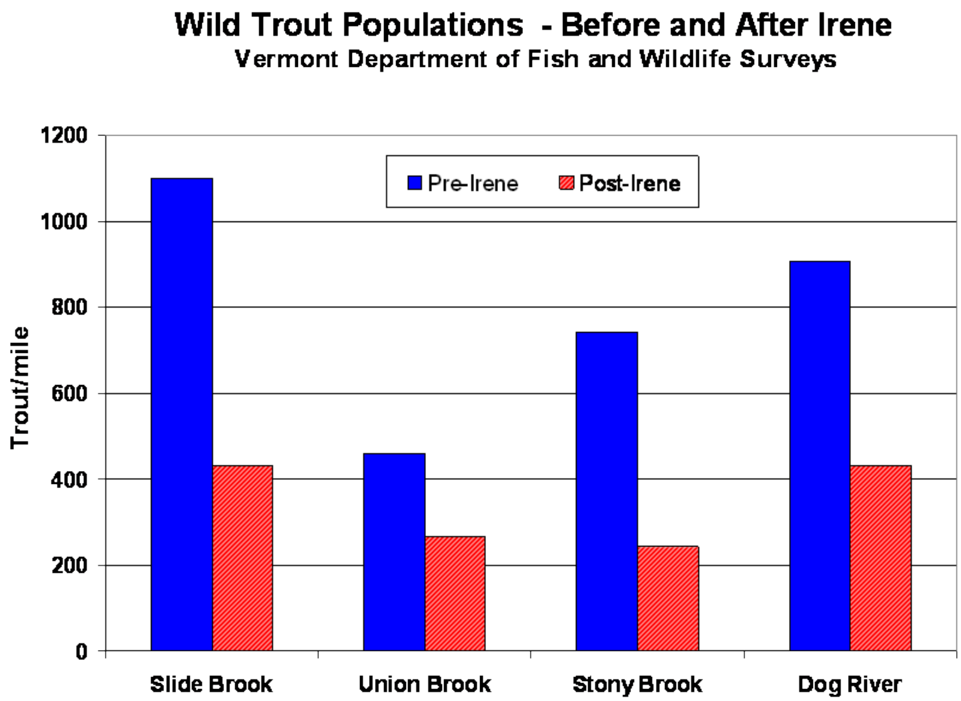

Figure 6. Wild Trout Population on Four Streams Before and After Irene

<u>Post-flood Channel Alteration Impacts to Aquatic Habitat</u>

Vermont Department of Fish and Wildlife staff conducted roadside assessment of instream habitat degradation throughout the central and southern portion of Vermont in the months following Irene. In some instances, assessments were obtained from Agency of Natural Resources and watershed organization staff intimately familiar with specific stream reaches. Field maps were used to demarcate reaches of stream with minor or major instream habitat degradation. Major and minor categories of impacts were defined with major involving significant alterations and minor tending to be more localized with habitat features still in place. Full definition of the methodology is in the original report. The distance of individual stream reaches identified on field maps or with GPS waypoints was estimated using ArcGIS or other topographic mapping software. (See Table 7 for the stream estimates.)

A total estimate of approximately 406,000 feet, or nearly 77 miles, of stream were identified with major impacts to instream habitat from post-flood stream channel alteration activities. An additional 45,000 feet (8.6 miles) of stream channel were estimated with minor impacts. See the original report for definitions.

It should be noted that estimates of instream habitat impacts should be considered conservative for the following reasons:

- Only stream reaches accessible/visible by public roads were assessed.
- Not all watersheds were assessed.
- Not all streams within watersheds were assessed.
- Once an assessment was completed, additional activity may have occurred which would not be captured.

Table 7. Estimated length (feet) of instream habitat impacts from post-flood channel alterations identified in a partial assessment of Vermont watersheds.

Watershed	Subwatershed	Major impact (feet)	Minor impact (feet)
Batten Kill	Roaring Branch	4708	0
	White Creek	500	455
	watershed total	**5208**	**455**
Black River	Mainstem	5064	0
	North Branch	7381	2547
	watershed total	**12445**	**2547**
Hoosic River	Walloomsac River	**25425**	**300**
Mettawee River	Mainstem	750	0
	Indian River	520	50
	watershed total	**1270**	**50**
Mill Brook	Mainstem	859	0
	Bailey Brook	2218	0
	watershed total	**3077**	**0**
Ottauquechee River	Mainstem	1300	850
	Barnard Brook	1030	2620
	Broad Brook	28361	690
	Curtis Hollow Brook	1405	0
	North Branch	11663	0
	Reservoir Brook	3750	0
	Roaring Brook	1000	0
	watershed total	**48509**	**4160**
Otter Creek	Mainstem	300	0
	Clarendon River	350	200
	Cold River	7350	150
	Homer Stone Brook	1350	0
	Sucker Brook	585	0
	Mendon Brook	7750	100
	Middlebury River	4200	0
	Mill Brook	1900	0
	Mill River	1250	4450
	Neshobe River	6150	150
	New Haven River	700	0
	watershed total	**31885**	**5050**

Watershed	Subwatershed	Major impact (feet)	Minor impact (feet)
Poultney River	Castleton River	**2150**	**0**
Saxtons River	Mainstem	**42767**	**0**
West River	Mainstem	2165	1903
	Ball Mountain Brook	21877	1641
	Flood Brook	150	0
	Greendale Brook	225	2000
	Rock River	14000	0
	Turkey Mountain Brook	0	390
	Utley Brook	75	0
	Wardsboro Brook	24332	370
	Winhall River	5795	711
	watershed total	**68619**	**7015**
White River	Mainstem	12550	0
	Alder Meadow Brook	4000	10650
	Broad Brook	1340	0
	First Branch	200	0
	Hancock Branch	12800	0
	Lilliesville Brook	5000	1600
	Locust Creek	10000	0
	Stony Brook	11300	0
	Third Branch	54110	2020
	Tweed River	15050	0
	West Branch	11300	0
	Marshs Brook	1500	0
	Nason Brook	1700	0
	Clark Brook	500	0
	unnamed tributary	1700	
	watershed total	**143050**	**14270**
Williams River	Middle Branch	**6125**	**0**
Winooski River	Mad River	9100	9250
	Dog River	6325	2235
	watershed total	**15425**	**11485**
All Watersheds	***Grand Total (feet)***	***405955***	***45332***
	Grand Total (miles)	***76.9***	***8.6***

The information from the original report has been edited for this 305(b) report by Vermont DEC staff. The original report on this topic is entitled: **Impacts to Stream Habitat and Wild Trout Populations in Vermont Following Tropical Storm Irene** *and is a Vermont Fish and Wildlife Department Annual Report for the period July 1, 2011 to June 30, 2012 written by Rich Kirn, Fisheries Biologist, March 5, 2012. The original report with all photographs and references can be obtained from the Vermont Department of Fish and Wildlife. Rich.kirn@state.vt.us.*

Many of the watersheds and river segments assessed as impacted in the Fish and Wildlife Department report had been dredged and channelization after earlier flood events too. A DEC Rivers Program analysis of the channel straightening, using pre-Irene SGA Phase 1 data collected in ten of the post-Irene assessed watersheds, shows that 176 river miles had been dredged and straightened before. The assessment included Phase 1 data from alluvial, lower gradient reaches in the Battenkill, the Black, Walloomsac, Ottauquechee, Saxtons, West, White, Mad, and Dog rivers and the upper Otter Creek. The total miles of dredged and straightened stream would be much greater if higher gradient streams were included. Six major floods occurred in these watersheds since 1927, where dredging and channelization practices were likely employed. Therefore, it may be inferred that habitat impacts of the nature described above may have occurred at a frequency as high as once every 14 -20 years in Vermont rivers.

Channelization as a method to mitigate future flood damage has not been successful in Vermont. Dredging, berming, and armoring rivers after floods, in attempts to contain flood future floods, has invited new river corridor and floodplain encroachments, and created an escalation of costs, risks, and ecosystem degradation.

Invasive exotic plants and animals in surface waters

Non-native aquatic plants and animals are established in Vermont - at least 49 non-native aquatic species are known – and many of the state's waters, especially lakes, have a history of impacts related to these invasions. Although the number of new introductions of species already known from Vermont increases annually, many of these populations are found early in the invasion, when control efforts can be more successful .

During the 2012 305(b) reporting period, there were a number of invasive species expansions or events:

- Eurasian watermilfoil (*Myriophyllum spicatum*) was discovered in three additional waters bringing the total number of lakes with Eurasian watermilfoil to 68 (in 3 of these lakes watermilfoil has not been found in a number of years) and other waters to 27.

- Water chestnut (*Trapa natans*) was discovered in one more waterbody bringing the total number of waterbodies with water chestnut to 23.

- Blooms of the alga *Didymosphenia geminata* (“didymo” or sometimes called "rock snot"), first discovered in the state in 2007, were confirmed in two new Vermont rivers. The presence of this species has raised significant concerns about the potential impact on the ecology and aesthetic value of Vermont rivers. Although direct impact on fish populations has not been definitively documented in other parts of the world where didymo produces nuisance blooms, it is difficult to predict what the long term impact will be for Vermont waters. Preliminary evidence from macroinvertebrate biomonitoring in fall 2007 at several sites on the White River and one site on the Connecticut River revealed that abundant didymo significantly altered the composition of macroinvertebrate communities. The macroinvertebrate community response in these oligotrophic waters resembled that normally seen in waters with excessive nutrient enrichment, with proportionate increases in Chironomidae species and decreases in EPT (Ephemeroptera, Plecoptera and Trichoptera) taxa. The results suggest that didymo blooms could ultimately result in infested waters failing to meet Vermont's Class B aquatic life biocriteria. However, additional monitoring over the course of one or more seasons will be required to assess the longterm impact. The ability to monitor and investigate impacts in infested waters and to survey for new infestations is likely to be limited by insufficient staff and financial resources. Because there are no management or control options for didymo once it has been introduced, ANR's response has focused on public education and outreach to promote spread prevention practices among anglers and other recreationists.

- A new exotic crayfish species, big water crayfish (*Cambarus robustus*), was confirmed for the first time in Vermont in the White River. Extensive crayfish surveys done in the White River in 2005 did not find this species suggesting that this is a recent introduction. (Extensive monitoring of crayfish in the state has not been performed.)

- Alewives (*Alosa pseudoharaengus*) were first confirmed in Lake Champlain in 2005. Alewives of all age classes have now been documented in the lake, and schooling alewives were observed for the first time during summer 2007 indicating a significant population increase. These fish have the potential to seriously alter trophic conditions and food chain dynamics as they have in the Great Lakes and Finger Lakes. A fish kill of millions of alewives in the winter of 2008 resulted in fouled beaches and shorelines along the entire length of Lake Champlain.

- Zebra mussels (*Dreissenia polymorpha*) are pervasive in Lake Champlain and Lake Bomoseen but have not emerged or become established elsewhere.

Additional aquatic invasive species information for the 2012 reporting period can be found at:
Vermont Aquatic Invasive Species Program 2011 Update, November 2011
Vermont Aquatic Invasive Species Program 2010 Update, November 2010

Nutrient criteria

As reported in the 2010 Integrated Report, the Department has worked consistently to develop numeric nutrient criteria that are empirically shown to support the designated uses established by Vermont Water Quality Standards. During the reporting period, the Department had entered into discussions with the Vermont Water Resources Panel on draft nutrient criteria rule language. During that process, the Department received new comments from USEPA Region 1 staff that caused the Department to suggest tabling further rule promulgation pending additional analyses suggested by Region 1, and in light of Region 1's initial stated position on Independent Applicability of Vermont's proposed nutrient criteria. Despite this, the Department continued work towards the development of numeric nutrient criteria in several ways:

1) Development of a revised criteria development timeline with Region 1;
2) Additional empirical analyses using a logistic regression approach on sensitive direct indicators of use attainment;
3) Development of a case study for a new EPA guidance document on biocriteria showing the relationship between biological attainment and nutrient conditions.
4) Continued participation on the Region 1 Regional Technical Advisory Group (RTAG);
5) Comment and discussion regarding on the "Nancy Stoner" memorandum through RTAG;
6) Participation in a national-level State-EPA workgroup on nutrient criteria to develop a common understanding on the relevance of independent applicability as pertains to nutrients, and on the value of biological criteria programs to detect impairments associated with nutrients;
7) Preparation of programmatic capabilities for the afore-mentioned workshop;
8) Continued consultation with Region 1 and Region 1 states in the current status of numeric criteria package approvals
9) Comment on the content of the new national Nutrient Indicators Database

The Department remains committed to the promulgation of numeric nutrient criteria that are empirically tied to, and protective of, indicators of use attainment, mutually acceptable to the Department, USEPA, and stakeholders, and implementable in a nimble fashion.

Phosphorus- Impaired Lakes Restoration

During the reporting period, the Department developed a feasibility study and treatment option analysis to implement internal nutrient controls on Ticklenaked Pond, an impaired pond in Ryegate that is subject to a phosphorus TMDL. This analysis, which was supported by the Ecosystem Restoration Program, has outlined treatment options that will result in reduction in internal nutrient cycling, and attainment of in-lake TMDL target criteria for a period of a decade (or more). The Department has established the priority to support the implementation of the internal treatment during the coming reporting period, most likely in summer 2013.

The Department continues its fruitful partnership with the Province of Quebec and several watershed partners in Vermont and Quebec on the management of Lake Memphremagog. During the reporting period, Vermont has continued its leadership role in the development of a modeling study to assess watershed contributions of phosphorus to the lake from the Vermont and Quebec portions of the watershed (one example of the model output is shown in Figure 7).

During the reporting period, a field program was implemented to complement the watershed model, the results of which will permit the development of a TMDL that includes a geographically explicit implementation plan. In addition, the Department finalized a new Basin Plan for the Memphremagog, Tomafobia and Coaticook watersheds that contains numerous actions to support reduction of phosphorus to the lake from Vermont sources. That Plan may be found at: http://www.anr.state.vt.us/dec/waterq/mapp/docs/mp_basin17final.pdf.

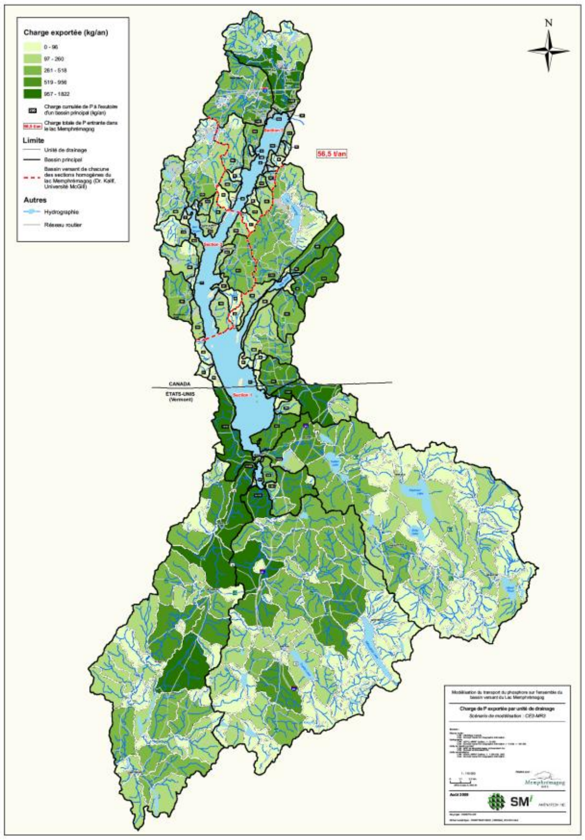

Figure 7. Map of modeled phosphorus export by subwatershed, for the Lake Memphremagog Basin.

The Department is working in partnership with USEPA in their efforts to revise the Lake Champlain Phosphorus TMDL. In 2011, USEPA took action to disapprove the 2002 TMDL, on the grounds that it did not contain sufficient reasonable assurances to ensure non-point source reductions, and did not provide an adequate margin of safety. As a result, the Department is actively working with USEPA staff and contractors in revisions to in-lake and watershed phosphorus models, and on the best approach to provide reasonable assurances in the new TMDL. In this process, the Department will continue to work with USEPA to ensure that the best available science is used to support regulatory and non-regulatory approaches to phosphorus reduction that will result in attainment of water quality criteria in the Lake. Throughout this process, the State is continuing to implement point and nonpoint source phosphorus reduction actions including those described in annual reports and in the 2010 Revised Implementation Plan for the Lake Champlain Phosphorus TMDL, which may be found here: http://www.vtwaterquality.org/erp.htm.

An earlier discussion of eutrophication in lakes and phosphorus-impaired lakes can also be found in the 2010 305(b) report at this link: http://www.vtwaterquality.org/mapp/docs/305b/mp_305b-2010.pdf.

Chapter 4. Surface Water Monitoring & Assessment

Surface Water Quality Monitoring Program

During 2010 and into 2011, DEC conducted a comprehensive review and redesign of its 2005 Water Quality Monitoring Program Strategy (WQMS). This effort was carried out in parallel with a major strategic planning initiative which produced the Vermont Surface Water Management Strategy. This Strategy and the companion 2011 redesigned WQMS were co-developed to enable prioritized protection and restoration activities that are geographically pinpointed as a result of monitoring and assessment data, and that address multiple pollutants through the concept of stressor management. The 2011WQMS provides a comprehensive mid-stream progress analysis of the original 2005 Strategy, which is reported at the bottom of this section.

During 2010, DEC also completed a project to develop automated field data collection methods using handheld field computers, finalized development of a new lake assessment method, completed a probability-based biological assessment of Vermont lakes relying on biological indicators and species loss estimates, continued development of wetlands biocriteria, and updated the rivers Assessment Database.

During 2010, Vermont supported the implementation of the National Wetlands Assessment (NWA) and continued implementation of our rotating basin probability assessment effort for wadeable streams. Using one-time supplemental funding provided under §106 of the Clean Water Act for compliance and enforcement activities, the Department developed a targeted monitoring approach to support determinations of reasonable potential analyses for wastewater treatment facilities in rotation waters (see http://www.vtwaterquality.org/mapp/docs/mp_wwtf2011report.pdf). The Department is now implementing a joint biological and physical habitat assessment approach for lakes that was initially adopted from the 2007 National Lakes Assessment and validated using 2010 supplemental §106 funding. This assessment approach is being deployed on a set of reference lakes that have been selected for sampling under the 2012 National Lakes Assessment (NLA). The Department is preparing for the 2012 field work associated with the NLA, and, with EPA assistance, is developing design alternatives to conduct a full statewide survey associated with the 2013-14 National Rivers Assessment.

The most important component of this workplan is an investment in long-term information technology support for DEC's monitoring program in the form of permanent data management staff. This staff person, recently appointed to DEC's Monitoring, Assessment and Planning Program, has responsibility for all data management and national database uploads, and to commence development of a unified Vermont Integrated Watershed Information System to support the Statewide Strategy. These are top-priority action items in the WQMS and the Statewide Strategy and exemplify how supplemental §106 funds can be used to augment State monitoring program capacity. In brief, during the reporting period, the Department implemented the following:

River Biomonitoring Program:

I) Continued sampling Vermont rivers using a randomized, rotating-basin probability design to produce a statewide probability assessment while contributing to the overall rotational assessment.

II) Incorporated upstream-downstream WWTF sampling on identified facilities in the current year basin rotation.

Lake Monitoring Program:

I) Implemented the new Lakes Assessment procedure on candidate reference lakes for the 2012 National Lakes Assessment, including physical habitat, benthic macroinvertebrate, and sediment diatom indicators.

II) Continued development of a phosphorus TMDL for Lake Memphremagog by coordinating an international sampling initiative on that lake.

III) Finalized a comprehensive probability assessment of lakes based on information acquired from the 2007 NLA, and biological assessments completed on samples archived from the 2007/2008 sampling period on NLA lakes.

Wetlands Monitoring Program:

I) Implemented the National Wetlands Condition Assessment.

Assessment:

I) Worked with EPA to combine the lakes and rivers ADB into a combined assessment database for all Vermont surface waters reported in the Integrated Report. DEC is now submitting 303(d) lists and other assessment findings to EPA for incorporation into ATTAINS using the newly combined ADB.

Data Management:
Invested in data management capacity by hiring a new database manager into the Monitoring, Assessment and Planning Program.

Staff Development:
Supported staff participation at annual regional environmental biologists conferences or other national meetings. Several staff participated in the regional NEAEB meeting, two staff participated in the 2011 NARS training scheduled for October and 4 staff participated in the June 2011 NWA training.

Establishment of a Monitoring Council:
In conjunction with the WQMS, the Department is contemplating the establishment of a Vermont Water Quality Monitoring Council.

Table 8. Mid-stream progress analysis of Water Quality Monitoring Strategy Implementation

Monitoring Program Strategy Recommendation	Achieved by 2010?
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.	Yes, core indicators continue to be monitored but monitoring for supplemental indicators has declined due to the reduction in monitoring staff since 2005.
Continue use of the LaRosa Laboratory annual assessment fee funding model to ensure availability of analytical capacity.	No. Assessment fee model ended in 2009 during State budget crisis. Now the fee for service model is used. Laboratory organizational structure is being re-evaluated as of early 2012.
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.	Yes, cooperative network continue, and systems for establishing new sites has been streamlined.
Evaluate available biomonitoring data from the Lake Champlain Agricultural BMP Monitoring Project to determine the biological response to BMP implementation.	Yes.
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.	No, demonstration project was delayed due to landowner reluctance. A modified project was re-initiated in 2010.
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. (2005 TMDL funding will enable this analysis for the nutrient-impaired Shelburne Pond during 2005/2006).	Yes, performed on Shelburne Pond in 2006.
Develop a program of sediment contaminant screening downstream of sites of concern (e.g., identified hazardous materials sites).	No. Identified as a high priority in the Statewide Management Plan in the toxics stressor chapter. This will involve collaboration between the VTDEC Hazardous Sites Section, the Solid Waste Section and the Watershed Coordinator.
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.	Temporary (¾FTE) monitoring program staff have been supported from 2007 forward using §106 Clean Water Act supplemental monitoring funding. The Department is evaluating mechanisms to create a permanent position for this function.
One additional wetlands staff would be necessary to develop an ambient wetlands monitoring program ($54.5K).	A¾ FTE temporary technician has been maintained since 2007.

Monitoring Program Strategy Recommendation	Achieved by 2010?
New monitoring initiatives or special studies related to water quality threats should address one or more of the threats outlined in the section on Existing and Emerging Threats to the extent practical.	Yes, Supplemental Environmental Project was used to conduct Pharmaceutical and Personal Care Products study on the Winooski in 2008.
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.	No, funding has not been available.
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., PDBEs).	No, funding has not been available. Investigate if EPA has capacity to analyze samples.
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.	Yes
There exists the need for a freeze drier to prepare fish tissue for organic contaminant analysis.	Yes.
There exists a need for a dissecting scope to aid in accurate aquatic plant identification.	Yes.
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.	Yes. The Vermont Department of Health now has analytical capability for microcystin and anatoxin. The service is available for public water suppliers and town health officers at no charge, and to homeowners for a minimal charge. A draft guidance document for towns that wish to implement cyanobacterial monitoring has been developed. Currently, there is no state-supported monitoring outside of Lake Champlain.
Continue to employ Phase I, II, and III geomorphic assessments to assess stream geomorphic condition.	Yes.
Continue to foster monitoring of stream and river water chemistry by volunteer organizations to assess waters of specific interest.	Yes, however a change in the funding mechanism for the LaRosa lab has required a downscaling of laboratory analyses provided to individual projects.
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 in Section 4.B.	Yes, VTDEC continues to report indicators as part of the Performance Partnership Agreement budget narratives.
Continue implementation of monitoring initiatives in stormwater-impaired watersheds, including on-going physical/chemical, biological, and geomorphic assessments.	Yes.

Monitoring Program Strategy Recommendation	Achieved by 2010?
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.	No guidance has been prepared, however morphometry. However morphometry surveys have been completed for Lake Associations by VTDEC.
Prioritize water quality standards and criteria that are not presently measured.	Yes, this is an on-going process.
Develop nutrient criteria for lakes that will satisfy Clean Water Act §304 criteria while being tailored specifically to Vermont.	Yes, see Chapter 3 of this report.
Initiate process to revise the current water quality criterion for *E. coli.*	Yes, initiated in 2009. Pre-rulemaking stakeholder process complete. DEC envisions proposing revised standards to e consistent with new EPA draft criteria issued early 2012.
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.	No. VTDEC is preparing participation in the 2013-2014 National Rivers and Streams Assessment, and envisions implementing the large river component to gain experience in these methods.
Complete lake biocriteria development.	Yes, completed in 2007.
Initiate wetland biocriteria development for lake-margin and stream-laved wetlands.	Initiated in 2007 and continues to include other wetland types.
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.	Yes. Communication will continue to improve under the new tactical basin planning process which implements the Statewide Surface Management Strategy.
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.	No. A 2010 recommendation is to work with USGS to form a Vermont Monitoring Council, a state level branch of the National Water Quality Monitoring Council, which would coordinate such efforts.
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.	Partially. LMP has an additional 0.3 FTE temporary technician support, but not the 0.5 FTE full time staff. Coordination of the program continues with current staff.
Encourage USEPA's New England's monitoring equipment loan concept.	Yes.

Monitoring Program Strategy Recommendation	Achieved by 2010?
Ensure wide distribution of the 2005 Volunteer Guide to Citizen Water Quality Monitoring in Vermont	Distribution of this document continues (online) and the guide is required reading for all recipients of LaRosa partnership grants.
Continue the LaRosa Laboratory Services Partnership Program	Yes.
Continue to support and foster long-term partnership monitoring programs.	Yes.
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.	Yes, updated Watershed Management Division Field Method Manual in 2006 which all WSMD programs except for River Management refer to for monitoring methods.
Waterbody segmentation and database integration	Yes.
Conversion of the Water Quality Data Archive to a more powerful database handling system	Yes, conversion began in 2008 and most WQ data in now in WQX, a SQL based server. Chemistry data from Biomonitoring database completed in 2011.
STORET data submissions	Yes.
Development of pocket computer-based field data entry tools.	Yes, completed in 2010 for Biomonitoring and Spring P.
Vermont's new assessment and listing methods will be standardized for a period of at least three listing cycles	Yes, since 2006. Minor revisions were made to the methodology in 2011 in anticipation of the 2012 listing cycle.
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.	Yes, since 2010.
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.	Yes, begun in 2010 and completed in early 2011.

Surface Water Assessment and Listing

The methods used to derive Vermont's statewide assessment of water quality conditions are found in the *Vermont Surface Water Assessment and Listing Methodology July 2011*. This 2012 305(b) Water Quality Integrated 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*. Definitions of these categories can be found on page 8 of this report.

Water uses include, but are not limited to, aquatic biota/habitat, contact recreation (swimming and wading) and secondary contact recreation (fishing or boating), aesthetics, fish consumption, and agricultural water supply. A determination of use support is made using information gathered and provided to the DEC by many sources including water resources personnel, fish and wildlife biologists, aquatic biologists, lake and river organization members, and other qualified individuals or groups – the sources of data and information are more fully described in the DEC document: 2011 redesigned WQMS.

As in prior years, Vermont is presenting assessment results along with a series of lists that are analogous to EPA's reporting categories. The Vermont Part A list of 303(d) waters impaired by pollutants corresponds to EPA "Category 5" impaired waters. The Vermont Part B list of impaired waters not in need of a TMDL analysis corresponds to EPA "Category 4B." The Vermont Part C list of waters in need of further assessment, partially corresponds to EPA "Category 3," and all are stressed per Vermont's methodology. The Vermont Part D list is a list of waters that have approved TMDLs, which is analogous to EPA "Category 4A." In Vermont, so-called altered waters are those where water quality impairments exist due to non-pollutants. These occur on the Vermont Parts E, F, and G lists (exotic species, flow, and geomorphic alteration, respectively), and all are analogous to EPA "Category 4C." This report also provides a tabular assessment of waters by EPA reporting category.

During the 2012 305(b) reporting period, ANR used EPA's Assessment Database (ADB) application for both lake and stream water quality assessment information. For the lakes database, ANR staff continued to verify ADB entries. For the river and stream ADB, staff used the available fields in a much more comprehensive manner. The goal is to be able to generate the lists reflecting EPA's five categories and Vermont's Priority Lists from the ADB by the 2014 305(b) report.

Assessment Results for Rivers and Streams

Designated Use Support Status

Vermont has approximately 7,100 miles of perennial rivers and streams based 1:100,000-scale maps, of which 6,544 miles are tracked within Vermont's assessment databases. Of the approximately 5,778 river and stream miles assessed for this report, overall about 89% of those miles are in compliance with the state's water quality standards and support designated uses, and 11% do not meet water quality standards or do not fully support the designated uses. Of the 89% meeting standards, approximately 16.5% are considered stressed by some pollutant or activity. These percentage results are the similar to those in the 2010 305(b) Report.

Table 9 is a summary of the number of miles of rivers and streams throughout Vermont that support or do not support 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 support aquatic biota have macroinvertebrate and fish communities in good to excellent health in the sampled reaches based on a number of metrics for each community. River miles that do not support swimming have a seasonal geometric mean of *E. coli* of 77 or more. River uses can be impaired by pollutants or altered by flow reductions or fluctuations and they can be stressed by a pollutant, condition, or direct instream activity.

Table 9. Summary of Use Support for Vermont Rivers & Streams (in miles)

Designated Use	Full support	Stressed	Altered	Impaired	Total Assessed	Total Measured
Overall	4311.3	853.4	283.7	329.9	5778.3	6544.5
Aquatic biota/habitat	4414.3	888.2	285.1	190.7	5778.3	6544.5
Contact recreation	4981.1	447.8	6.5	142.4	5577.8	6544.5
Secondary contact recreation	4878.8	623.6	96.7	45.9	5645.0	6544.5
Aesthetics	4827.6	639.3	172.5	112.8	5752.2	6544.5
Fish consumption	0	6478.0	0	66.5	6544.5	6544.5

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, and fish consumption. 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 10 below provides an ADB-based view of overall use attainment for Vermont rivers and streams.

Table 10. Size of Rivers or Streams in EPA Assessment Categories (as per ADB).

Category	Description	Total size (miles)	Number of stream segments
1	All uses met	971.0	38
2	Some uses met, others indeterminate	4311.7	138
3	Insufficient information to assess any use	638.5	28
4A	Impaired, TMDL approved	89.3	23
4B	Impaired, no TMDL needed	7.2	7
4C	Impaired, but not by pollutant	89.5	8
5	Impaired	214.6	87

Note: Segment is defined as a unique portion of a stream. More than one segment may be present for an individually named stream. Figures are provisional, pending outcome of 2012 303d list approval by EPA.

Causes & Sources of Impairment, Alteration, and Stress for Rivers and Streams

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 11 and 12 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 the tables. 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.

Causes

Sedimentation has been listed as the cause of stress and impairment of aquatic life use support affecting the most river and stream miles since Vermont began reporting the impacts of nonpoint source pollution. Unnatural levels of sediment alter or destroy macroinvertebrate habitat and fish spawning areas and fill in swimming holes among other impacts.

Sources include sediment in overland sheet runoff from construction sites, roads, and cropland; the erosion associated with concentrated stormwater; and streambank erosion. Streambank erosion has been associated with the loss of riparian woody vegetation, which does occur a lot, but in many streams and rivers, it is more complex than that with channel incision often at the heart of the problem. The concept of channels downgrading and thus losing access to their floodplains, as a cause of sedimentation/source of erosion has now been confirmed by studies in Vermont.

A research project with the US Department of Agriculture (USDA) Agriculture Research Service (ARS) National Sedimentation Laboratory wrapped up in 2011. The project evaluated the contribution of sediment and nutrient loading into Lake Champlain from unstable stream channels. A total of 30 sites were evaluated throughout the Missisquoi Basin. Results show that streambank erosion from channel instability contributes approximately 29-42% of the total suspended sediment load, and approximately 50% of total phosphorus at the mouth of the Missisquoi River.

The “cause” that has the second greatest number of miles of impact, impaired and stressed, is one called “physical habitat alterations” (“other habitat alterations”) in earlier 305(b) reports. This cause is different from the others that are more obviously pollutants such as pathogens or metals or sediments. However, dredging, instream mining, channelization, berming (captured in the “Sources” section below), all lead to physical alterations in-channel, which is the direct habitat of the aquatic communities that the standards and Vermont DEC among others strive to protect. In 2010, only 249.9 miles were documented as having impacts from this cause, but this 2012 round identifies 631.3 miles. This much greater number reflects the increased assessment of channel disequilibrium and its impacts on Vermont rivers and streams per the stated goal in the 2010 report.

Table 11. Summary of Causes of Impact to Vermont Rivers & Streams (in miles).

Cause of impairment, alteration or stress	Length impaired or altered by cause	Length stressed due to the cause	Total length on which causes have an impact
Sediments	161.8	845.5	1007.3
Physical habitat alterations*	153.2	478.1	631.3
Nutrients	66.0	521.6	587.6
Temperature	63.2	506.6	569.8
Pathogens	116.3	309.0	425.3
Flow alterations	206.8	69.5	276.3
Turbidity	46.9	230.5	277.4
Metals	108.7	120.7	229.4
Organic enrichment	30.3	48.3	78.6
Stormwater	36.0		

(*) These numbers do not necessarily include the miles of river and stream channelized and dredged post Tropical Storm Irene. The Vermont F&W Department has estimated 77 miles of major impact but also note that they were unable to survey all the streams at the time of their summary and report.

Nutrients are known to impair about 66 miles and stress over 500 more miles. Given the agricultural heritage of Vermont and the fact that villages and towns lie along rivers and streams in Vermont valleys, it has always been a challenge keeping nutrients on the land in the soil and out of surface waters and wetlands.

Temperature increases in surface waters are also a challenge to control due to the removal of riparian vegetation and warm impervious surface runoff affecting coldwater streams. Streams with onstream impoundments and high turbidity also suffer from increased temperatures.

Pathogens get to Vermont rivers and streams in CSOs, from barnyard and pasture runoff, from city and suburban runoff, and from failed waste treatment systems large and small. Elevated *E. coli* also can result from concentrations of wildlife and separating natural from anthropogenic loads is difficult at times.

At the same time that progress is made in dam removal and improving flow through licensed projects, increased development with its impervious surfaces and stormwater runoff especially in areas of steeper slopes causes increased flows that affect aquatic habitat and communities.
The other substantial causes identified include turbidity, metals, organic enrichment and stormwater

in order of the number of miles impaired by these pollutants. Miles labelled as having impacts from metals are slowly increasing as more areas are identified where either old landfills exist or careless development disturbs certain soils or adds fill resulting in iron pollution. Stormwater impacts are underestimated because components of stormwater (flow, sediment, turbidity among others) might currently be the proxies for stormwater itself.

Sources

The five sources of pollution identified as having the greatest impacts, or causing the greatest stresses, on miles of river and stream are streambank erosion/de-stabilization; agricultural land uses and activities; removal of riparian vegetation; developed land runoff, which includes road runoff; flow alteration from hydroelectric facilities, snowmaking water withdrawals and other sources; and channel instability/confined streams. Additional significant sources of impacts include atmospheric deposition, flood impacts resulting from poorly sited or designed human structures or activities, land development (active development as opposed to runoff from existing roads and development), and upstream impoundments. See Table 12 below for sources affecting Vermont rivers and streams.

Table 12. Summary of Sources of Impact to Vermont Rivers & Streams (in miles).

Source of impairment, alteration or stress	Length impaired or altered due to source	Length stressed due to source	Total length on which sources have an impact
Streambank erosion/ de-stabilization	127.5	660.1	787.6
Agriculture	123.1	580.7	703.8
Riparian vegetation removal	98.4	564.8	663.2
Developed land runoff (includes roads)	93.8	328.3	422.1
Flow modification (hydro, snowmaking withdrawals..)	214.6	66.1	280.7
Channel instability/ Confined streams	70.0	195.8	265.8
Atmospheric deposition	119.5	39.6	159.1
Flooding (including infrastructure failures)	45.4	102.1	147.5
Upstream impoundment	34.6	72.5	107.1
Land development	30.7	57.7	88.4

Streambank erosion is described above as a source in and of itself, but this 'source' results from other 'sources' such as riparian vegetation removal and channel instability. In addition, the interrelationship and overlap between several of these sources such as agricultural activities, riparian vegetation loss, streambank erosion, and channel instability 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 of the numbers in the table.

Vermont will continue to use stream geomorphic data and other sources to identify stream erosion/sedimentation as a source of alteration or stress emanating from:

1. Channel instability – associated with disequilibrium (vertical instability), i.e., bed and bank erosion due to an imbalance between sediment load and sediment transport capacity. In the above table this source is correctly listed in the channel instability row, but is also listed along with other sources in the streambank erosion/de-stabilization row.
2. Bank and adjacent land erosion – not associated with disequilibrium, i.e., bank erosion due to sources such as loss of woody vegetation, animal trampling, or construction development too close to banks. This source is currently reflected in the streambank erosion row.

Sedimentation occurs in a stream reach when the capacity to transport a sediment load is exceeded by the actual load. This process may occur when either the load is increased or the transport capacity is decreased. Fluvial geomorphic assessments in Vermont are making it increasingly clear that the full "sedimentation" story involves both actively eroding reaches whereby sediment loads are significantly increased and habitat is directly impacted as well as those streams physically altered into sediment transport reaches where capacity to move sediment out has been increased.

Relating erosion/sedimentation to the equilibrium condition of the stream will be very useful in prioritizing remediation efforts. Typically, BMPs targeted toward the direct treatment of bank erosion (not associated with disequilibrium) are successful at the local scale. On the other hand, remediation plans and treatments to deal with disequilibrium must typically be conceived and carried out over larger scales to deal with channel morphology, hydrology and sediment regimes.

Urban/developed land as a source includes runoff from any urban, suburban, village or other developed areas such as roads, bridges, and driveways. 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. The impact from rapidly developing suburbia and residential sprawl as well as commercial development seems to outpace progress in erosion and runoff control, streamside vegetation re-establishment, and stream stabilization efforts.

Removal of riparian vegetation continues to be a ubiquitous problem in the state. Residential and commercial landowners, developers, utility companies, 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 even in an otherwise stable system.

Atmospheric deposition is primarily responsible for mercury and acidified conditions in Vermont's surface waters. While these conditions are exacerbated in lake systems, stream biological communities do exhibit quantifiable impacts, particularly due to acidification.

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. Channel instability can be a result of flood impacts, flood "repair" work, instream gravel mining, stormwater runoff, and watershed hydrology changes. A variety of human activities can cause channel instability but channel instability is a source of sedimentation and habitat alteration. As discussed above, this source of habitat impact and loss will continue to identified as new physical assessments are done.

Toxic Impacts to Rivers and Streams

Sites of Known Sediment Contamination
During the reporting period of 2010- 2011, sediment characterizations were conducted at several locations. Most of the assessments were conducted behind low-head impoundments that are being considered for remediation or removal in order to restore stream connectivity. These include Dufresne Pond in Manchester, a small impoundment on the Walloomsac River by the former Vermont Tissue Corporation in Bennington, a small impoundment of the Winooski River in Marshfield, an impoundment of the stormwater-impaired Moon Brook in Rutland called Combination Pond, and Sweet Pond in Guilford. Other sites include a small "clay influenced" tributary to Commissary Brook in Westminster, Hobbs Pond in Milton, and Gunner Brook in Barre adjacent to the Farwell Street Dump.

Sediment characterization at these sites includes priority metals and organic compounds. Results are compared to Vermont ANR Sediment Quality Guidelines (SQGs) for protecting aquatic biota. Sediment characterization at the low-head impoundment sites showed slight exceedance of probable effects concentrations for some metals at Dufresne Pond and the Winooski River impoundment. Higher concentrations of metals were noted at Commissary Brook, although these metals are strongly complexed to the clay "varve" that is characteristic of the immediate Connecticut River vicinity, and due to the low bioavailability, therefore likely low risk to the aquatic biota. The highest exceedances of the SQGs were observed at Hobbs Pond with elevated concentrations of benzo (a) pyrene, cadmium, arsenic, chromium, lead and arochlor 1260.

There are also documented contaminated sediments in Stevens Branch in Barre, Stevens Brook in St. Albans, and in a tributary to Muddy Brook in South Burlington.

Lampricide Impacts
During the reporting period, 9.5 miles of the Lewis Creek, 10.5 miles of the Poultney River, and 2 miles of the Hubbardton River were treated with lampricide to kill sea lamprey.

On Lewis Creek, the post treatment survey found the non-target fish mortality was low: one bowfin, one redfin pickerel, two blacknose dace, and one tesselated darter were found dead during the survey. Eight crayfish were also found dead. However, only twenty percent of the treated stretch was surveyed for the non-target mortality results. An estimate of the silver lamprey killed in the course of targeting the sea lamprey has not yet been reported (a post larval QAS survey was planned to be done in summer 2011). Loss of biological diversity in Lewis Creek from this activity is a concern. Following two lampricide treatments in the 1990s in which over 40 dead mudpuppies were found, there were none found following the 2002 and 2006 treatments and it is not clear if they are now gone from this stream.

The non-target mortality for the Poultney River treatment in 2011 has not been reported at this time. Channel darters are endangered and sand darters are threatened in Vermont and so it is important to review the 2011 study results. Pre- and post-treatment sampling for channel, sand, and tessellated darters in 2007 and 2008 on the Poultney found a decrease in the numbers of darters following the 2007 lampricide application: channel darters found were 25 in 2007 and 4 in 2008; sand darters were 81 in 2007 and 53 in 2008; and tessellated darters were 167 in 2007 and 73 in 2008.

Assessment Results for Lakes and Ponds

Designated Use Support Status

In Table 13 below, use support is presented in relation to designated use and is consistent with the reporting the Department provided in the 2010 Integrated Report. Changes in use support from the 2010 report result from changes in modifications to altered acres due to Eurasian watermilfoil and other invasive species infestations, as well as minor adjustments or corrections made to individual waterbody assessments while updating the EPA Assessment Database (ADB). The reader should note that not all uses are assessed at all waters (e.g., swimming and boating uses are sometimes, but not always precluded at drinking water supply reservoirs). Therefore the total sum of acres by use will not necessarily tally to 55,561 acres for inland lakes or 174,175 acres for Lake Champlain.

Table 13. Summary of Use Support for Vermont Lakes & Ponds.

Use Support →		Fully Supporting acres	Stressed acres	Altered acres	Impaired acres	Unassessed acres
Waterbody Type ↓	Use ↓					
Inland Lakes	Aesthetic	32,722	10,107	3,774	7,974	1,022
	Aquatic Biota, Wildlife, and Aquatic Habitat	17,531	16,103	8,479	12,442	1,044
	Boating, Fishing, and Other Recreational Uses	31,483	9,032	5,087	7,974	1,038
	Fish Consumption	1,402	45,975	-	8,165	57
	Public Water Supply	1,196	-	-	-	5
	Swimming and Other Primary Contact Recreation	33,134	9,548	2,896	7,974	1,049
Lake Champlain	Aesthetic	35,290	-	6,832	132,053	-
	Aquatic Biota, Wildlife, and Aquatic Habitat	152,666	-	21,503	6	-
	Boating, Fishing, and Other Recreational Uses	156,974	-	17,195	6	-
	Fish Consumption	-	-	-	174,175	-
	Public Water Supply	148,685	-	15,673	-	-
	Swimming and Other Primary Contact Recreation	35,284	-	6,832	132,059	-

Size of Lakes & Ponds in EPA Assessment Categories

Table 14 below provides an ADB-based view of overall use attainment for Vermont lakes and ponds. By this view, the majority of lake acres are identified as impaired, falling in EPA Category 5, although this is the result of a relatively small number of large lake segments, where the size of Lake Champlain serves to overstate the severity of impaired waters in Vermont. It is important to note that where an impairment exists that is not yet subject to a TMDL, the acres associated with that impairment will be identified as Category 5, even if a TMDL has been completed for another pollutant on the same waters. For example, the existing impairments associated with PCBs cause all Lake Champlain acres to be assessed as impaired, even though TMDLs for phosphorus and mercury have been approved for those same lake segments. According to ADB, there are 54 lake segments that are altered which comprise 7,663 acres. There are 563 lake segments comprising 31,001 acres that support uses. A more detailed display of use support for lakes segregated by use and Champlain/non-Champlain waters is shown in Table 13 above.

Table 14. Size of Lakes & Ponds in EPA Assessment Categories (as per ADB).

Category	Description	Total size (acres)	Number of lake segments
1	All uses met	29,913	449
2	Some uses met, others indeterminate	1,088	114
3	Insufficient information to assess any use	20	1
4A	Impaired, TMDL approved	18,339	54
4B	Impaired, no TMDL needed	-	-
4C	Impaired, but not by pollutant	7,663	54
5	Impaired	172,751	33

Note: Segment is defined as a unique portion of a lake or stream. More than one segment may be present for an individually named stream or lake. Figures are provisional, pending outcome of 2012 303d list approval by EPA.

Summary of Causes & Sources of Impact (Impairment, Alteration, and Stress) - Lakes

Causes of impact to Lake Champlain and Vermont's inland lakes are shown in Table 15, and the related sources of impact are provided in Table 16. For Lake Champlain, the most widespread causes of impairment are mercury and PCB contamination in fish tissue, with atmospheric deposition of toxics and improper waste disposal being the respective sources. The third most widespread cause of impairment for Lake Champlain is phosphorus pollution. The sources of phosphorus vary by lake segment but arise from various categories of nonpoint source pollution, along with minor contributions from municipal wastewater effluents. Toluene and xylenes are the cause of impairment from contaminated sediments at the 6-acre Pine Street Barge Canal site in Burlington Bay. Eurasian watermilfoil, water chestnut, and zebra mussel infestations are the causes of alterations to Lake Champlain, which result from transport of plant fragments and larval zebra mussels through recreational boating and fishing activities.

For the inland lakes of Vermont, mercury in fish tissue impairs the largest number of lake acres, resulting largely from atmospheric deposition. In the case of two reservoirs in the Connecticut River, mercury levels are also attributed to water-level fluctuations. In the case of reservoirs within the Deerfield River drainage, mercury levels are also attributed to natural watershed susceptibility. The cause of the second largest number of impaired acres for inland lakes is phosphorus pollution. For all nutrient-impaired lakes, the sources of phosphorus are largely nonpoint sources of a variety of types, including agriculture, road maintenance, and sediment losses related to development. Acidity due to atmospheric deposition of acid-forming precursors and natural susceptibility also impairs a significant number of lake acres in Vermont. The principal causes of alterations to inland lakes arise from water-level management and Eurasian watermilfoil infestations that originate from the transport of plant fragments through recreational boating and fishing activities.

The observed effects that stress uses on Lake Champlain include Eurasian watermilfoil and other exotic species, sedimentation, native plants, and *E. coli* bacteria. The observed effects that stress uses on inland lakes are more diverse but principally include algae, Eurasian watermilfoil and other exotic species, acidity, flow alteration, phosphorus, and sedimentation.

Table 15. Summary of Causes of Impact to Vermont Lakes & Ponds (in acres).

Waterbody Type ↓	Assessment of waterbody ↓	Cause of Impact ↓ (Use →)	Aesthetic	Aquatic Biota, Wildlife, and Aquatic Habitat	Boating, Fishing, and Other Recreational Uses	Fish Consumption	Public Water Supply	Swimming and Other Primary Contact Recreation
Inland Lakes	Impaired	Mercury in Fish Tissue				8,165		
		Organic Enrichment - DO		700				
		pH		4,468				
		Phosphorus	7,874	7,874	7,874			7,874
		Sedimentation/Siltation	100	100	100			100
	Altered	Eurasian Water Milfoil	2,284	2,284	2,284			2,284
		Exotic Species	118	118	118			118
		Flow Alteration	1,490	6,195	2,803			612
	Fully Supporting but Stressed	Escherichia coli						25
		Eurasian Water Milfoil	6,582	6,076	6,435			6,455
		Excess Algal Growth	27	27	27			
		Exotic Species	1,605	3,017	701			701
		Flow Alteration	193	4,385	193			3
		Mercury in Fish Tissue				45,859		
		Noxious Aquatic Plants - Algae	9,285	9,277	9,647			9,665
		Noxious Aquatic Plants - Native	886	889	1,346			1,346
		Nutrient/Eutrophication Biological Indicators		7				
		Nutrients	3,716	3,874	3,515			3,612
		Oil and Grease	79					
		Organic Enrichment - DO		1,419				
		pH		5,965				
		Phosphorus	3,716	3,874	3,515			3,612
		Salinity		9				
		Sedimentation/Siltation	3,353	3,612	3,166			3,203
		Zebra Mussel		829				829
Lake Champlain	Impaired	Mercury in Fish Tissue				174,175		
		PCB in Fish Tissue				166,171		
		Phosphorus	132,053					132,053
		Toluene		6	6			6
		Xylenes (total) (mixed)		6	6			6
	Altered	Eurasian Water Milfoil	6,832	17,195	17,195			6,832
		Exotic Species		1,101	1,101			
		Zebra mussel		21,503			15,673	6,832
	Fully Supporting but Stressed	Escherichia coli						49
		Eurasian Water Milfoil	10,363					10,363
		Exotic Species	2,701	1,600	1,600			2,701
		Noxious Aquatic Plants - Native			500			500
		Sedimentation/Siltation	5,388	5,388				5,388
		Zebra mussel	5,281					6,162

Table 16. Summary of Sources of Impact to Vermont Lakes & Ponds (in acres).

Waterbody Type ↓	Assessment of waterbody ↓	Use → / Source of Impact ↓	Aesthetic	Aquatic Biota, Wildlife, and Aquatic Habitat	Boating, Fishing, and Other Recreational Uses	Fish Consumption	Public Water Supply	Swimming and Other Primary Contact Recreation
Inland Lakes	Impaired	Agriculture	1,456	2,156	1,456			1,456
		Animal Feeding Operations (NPS)	1,456	2,156	1,456			1,456
		Atmospheric Depositon - Acidity		4,468				
		Atmospheric Depositon - Toxics				8,165		
		Flow Alterations from Water Diversions				2,012		
		Internal Nutrient Recycling	54	506	54			54
		Managed Pasture Grazing	1,854	2,554	1,854			1,854
		Natural Sources		4,468		3,692		
		Non-irrigated Crop Production	1,908	2,608	1,908			1,908
		Non-Point Source	7,422	7,422	7,422			7,422
		Post-development Erosion and Sedimentation	452	452	452			452
		Streambank Modifications/destablization	100	100	100			100
	Altered	Flow Alterations from Water Diversions	1,280	5,985	2,803			612
		Impacts from Hydrostructure Flow Regulation/modification	300	2,198	235			215
		Other Marina/Boating On-vessel Discharges	2,240	2,240	2,402			2,240
Lake Champlain	Impaired	Agriculture	31,859					30,259
		Atmospheric Deposition - Toxics				174,175		
		Combined Sewer Overflows	13,725					13,725
		Contaminated Sediments		12	12			12
		Highway/Road/Bridge Runoff (Non-construction Related)	13,725					13,725
		Inappropriate Waste Disposal				166,171		
		Industrial Point Source Discharge	4,423					4,423
		Natural Sources	5,388			58,184		5,388
		Non-Point Source	132,053					130,453
		Post-development Erosion and Sedimentation	13,725					13,725
	Altered	Other Marina/Boating On-vessel Discharges	6,832	39,799	18,296		15,673	13,664
All Waters	Stressed	Sources are not attributed to stressed waters						

Trophic Status of Lakes

Trophic status can be defined as the level of "primary production," or algal growth that is supported by lakes. As an indicator of primary production, trophic state provides insight into how much overall biological productivity might be expressed in a given lake for all components of the food web. Lakes in higher trophic condition (e.g. eutrophic or hypereutrophic) have more biological productivity, and may exhibit undesirable conditions such as algal scums or the development of blue-green algae blooms. Oligotrophic and mesotrophic lakes are characterized by lower levels of productivity. Dystrophic lakes are those in which productivity is naturally controlled by deeply tannic-colored water, as commonly occurs in high-elevation, forested lakes.

During the reporting period, the Department did not re-evaluate trophic status. The information that follows is from the 2010 reporting cycle. Of the 558 lakes tracked in the assessment, trophic status was determined for 275 lakes, a considerable increase since the last time trophic state was reviewed for all assessed lakes statewide. This number of waterbodies comprises 219,019 acres of the total 229,788 acres assessed for trophic state. Trophic state is determined by evaluating data from a combination of programs: Spring Phosphorus, Lay Monitoring, Lake Champlain Monitoring, and Lake Assessment. Assessment thresholds for the determination of trophic state are used to classify lakes along a gradient of oligotrophic to dystrophic (Table 17). When assessing trophic state, summer monitoring data are prioritized over spring data when available.

Table 17. Trophic State of Assessed Vermont Lakes & Ponds (assessment thresholds also shown).

Trophic State	Secchi Average Summer (m)	Chlorophyll-a Average Summer concentration (ug/L)	TP Spring average concentration (ug/L)	TP Summer photic zone - LMP	Number of lakes in assessment	Acres
Undetermined	--	--	--	--	283	10,769
Hypereutrophic			>100		2	473
Eutrophic	0 - 3.0	> 7.0	> 15	> 15	52	27684
Mesotrophic	3.0 - 5.5	> 3.5 - 7.0	>7 - 15	>7 - 15	151	178,842
Oligotrophic	> 5.5	0 - 3.5	<7	<7	46	11,333
Dystrophic			<20 (and PtCo >50)		24	687

The increased number of assessed lakes, and the tracking of this information within the EPA ADB database system, permits a comparison of the change in trophic state from the 2008 Integrated Report to 2010 (Figure 4). This comparison indicates that the proportion of lakes in the oligotrophic and eutrophic categories has increased, while the proportion of lakes in the mesotrophic category has declined slightly. These changes can be explained in one of two ways. First, there were 42 additional lakes assessed in 2010 for trophic state that were not reported in the 2008 305(b) Integrated Report. Second, some lakes have changed from one trophic status class to another, with 18 lakes moving from a less to a more productive trophic state, and 13 lakes improving from a more productive to less productive trophic state. The movement of lakes from lower to higher trophic condition is cause for concern.

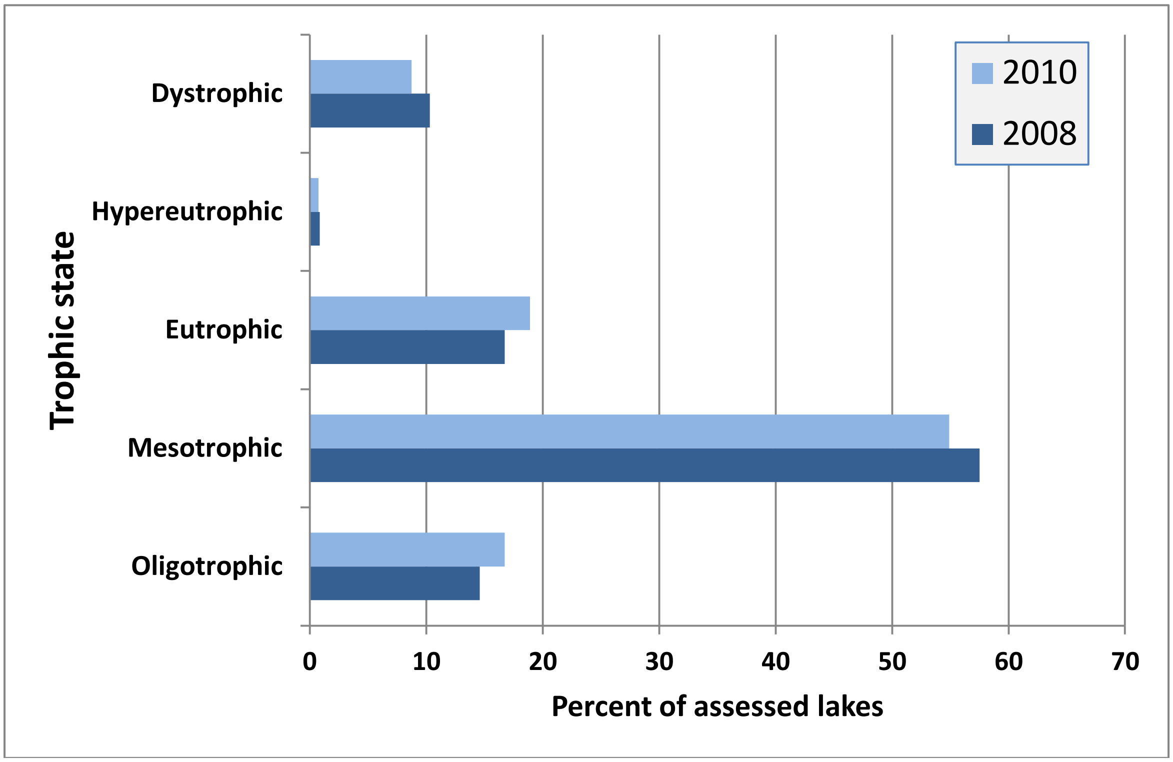

Figure 8. Comparison of the trophic state of Vermont lakes and ponds from 2008 to 2010, based on long-term monitoring data.

Impaired Waters of Vermont – Lakes and Rivers

<u>Total Maximum Daily Load Program & Summary of Impaired Waters</u>

Under Section 303(d) 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 303(d) List of Impaired Waters in Need of a TMDL; Part B List of Impaired Surface Waters - No TMDL Determination Required; and Part D Surface Waters with Completed and Approved TMDLs. 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 are typically accompanied by an implementation plan that articulates the means to achieve 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:

> <u>Problem Identification</u> - 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.
>
> <u>Identification of Target Values</u> - this establishes water quality goals for the TMDL. These may be given directly in the Water Quality Standards or may need to be interpreted.
>
> <u>Source Assessment</u> - all significant sources of the pollutant in question must be identified in the watershed. This often requires additional water quality monitoring.
>
> <u>Linkage Between Targets and Sources</u> - 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.
>
> <u>Allocations</u> - 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.
>
> <u>Public Participation</u> - stakeholder involvement is critical for the successful outcome of TMDLs. Draft TMDLs are also released for public comment prior to their completion.
>
> <u>EPA Approval</u> - EPA approval is needed for all TMDLs as required by the Clean Water Act.
>
> <u>Follow-up Monitoring</u> - additional monitoring may be needed to ensure the TMDL is effective in restoring the waters.

Table 18 identifies the twenty-two stream and river segments that were included as part of the Vermont Statewide Bacteria TMDL that was approved by EPA Region 1 on September 30, 2011. These represent the total number of TMDLs completed and approved since the 2010 305b integrated report was compiled.

Table 18. Waterbody segments associated with the Vermont Statewide Bacteria TMDL

WATERBODY ID	SEGMENT NAME
VT02-05	FLOWER BROOK, MOUTH TO RM 0.5
VT03-01	OTTER CREEK, MOUTH OF MIDDLEBURY RIVER TO PULP MILL BRIDGE (4.0 MI)
VT03-07	LITTLE OTTER CREEK, MOUTH TO RM 7.8
	LITTLE OTTER CREEK, RM 15.4 TO RM 16.4
VT03-08	LEWIS CREEK, FROM LOWER COV'D BRIDGE UPSTRM TO FOOTBRIDGE (12.3 MI)
	POND BROOK, FROM LEWIS CREEK CONFLUENCE UPSTREAM (1.5 MILES)
VT03-12	MIDDLEBURY RIVER, FROM MOUTH UPSTREAM 2 MILES
VT05-09	DIRECT SMALLER DRAINAGES TO INNER MALLETTS BAY
VT05-10	ENGLESBY BROOK
VT05-11	POTASH BROOK
	LAPLATTE RIVER FROM HINESBURG TO MOUTH (10.5 MILES)
	MUD HOLLOW BROOK, FROM MOUTH TO 3 MILES UPSTREAM
VT06-04	BERRY BK, MOUTH UP TO AND INCLUDING NO. TRIB (APPROX. 1 MI)
	GODIN BROOK
	SAMSONVILLE BROOK
VT08-02	ALLEN BROOK
VT08-10	HUNTINGTON RIVER, VICINITY OF BRIDGE STREET IN HUNTINGTON
VT08-18	MAD RIVER, MOUTH TO MORETOWN (6.2 MILES)
VT11-17	WEST RIVER, APPROX 1 MILE BELOW TO 0.5 MILE ABOVE SOUTH LONDONDERRY
VT12-05	NO. BRANCH, DEERFIELD RIVER, VICINITY OF WEST DOVER
VT13-14	WHETSTONE BROOK - BRATTLEBORO
VT14-03	OMPOMPANOOSUC RIVER, USACOE BEACH AREA TO BRIMSTONE CORNER (9.8 MI)

Current and upcoming TMDL projects

Lake Champlain Phosphorus TMDL revision

In response to a federal lawsuit filed by the Conservation Law Foundation, the EPA reconsidered its previous approval of the 2002 Lake Champlain TMDL and disapproved the Vermont portion of the TMDL in January 2011. Under federal law, upon such disapproval, the EPA is responsible for establishing a new TMDL to implement the water quality standards. The EPA initiated the process of developing a new TMDL for Lake Champlain in 2011 in cooperation with the State of Vermont.

Several key steps involved in this process include:

- Review and revision of the in-lake water quality model to update the lake segment loading capacities
- Complete the study of effects that climate change may play on lake loading capacities
- Estimate phosphorus loads from subwatershed areas within tributary watersheds and estimate potentially achievable phosphorus reductions
- Identify programs and requirements to provide sufficient reasonable assurance that nonpoint phosphorus controls are achievable

TMDL completion is expected in 2013.

Lake Memphremagog Phosphorus TMDL

VTDEC has been working to develop a TMDL for Lake Memphremagog, which is listed as impaired for phosphorus, and is a high priority for TMDL development. Initial work has included intensive lake sampling, tributary sampling to estimate watershed loading, and collaboration with partners in Quebec on a watershed phosphorus export model. Current plans are to develop a full lake model (a simple version of what was done for Lake Champlain) in cooperation with partners in Quebec to more accurately represent phosphorus movement in the lake and watershed as a whole. There are technical challenges associated with this that the project team is currently addressing. It is anticipated that the TMDL will be completed in 2013.

Long Island Sound Nitrogen TMDL revision

The original LIS TMDL was finalized in 2001 and developed among NY, CT and EPA and set forth nitrogen reduction goals for point and nonpoint sources in those states. As part of that TMDL, a non-binding reduction of nitrogen from upstream states' treatment plants (VT, NH, MA) of 25% was set as a goal to help meet standards in the Sound.

For the past several years, the LIS TMDL has been under revision, this time with the participation of the upstream states. Several data gathering and monitoring projects have been undertaken to better understand the role of the upper states in their contribution of nitrogen to the LIS. At present, completion of the revised TMDL appears to be a few years off but a framework has been developed that lays out the tasks needed to be completed before the new TMDL can be developed. In the mean time, an interim plan has been developed to address point source permitting and other nonpoint source actions to be completed by all five states (NY, CT, VT, NH, MA).

Agricultural area TMDLs

There are approximately twenty streams impaired for some combination of excess nutrient and sediment loading that occur in predominantly agricultural areas. VTDEC intends to develop a methodology to enable TMDL development for these areas, beginning in 2012. Since many of these streams occur within the Lake Champlain watershed and tools are currently being developed to quantify loading from similar areas as part of the Lake Champlain TMDL, VTDEC envisions using tools developed as part of that process for these TMDLs.

Overview of the Vermont 2012 Priority Waters List including Section 303(d) List of Waters

Development of the 2012 Section 303(d) List of Impaired Waters is a process that is ongoing and concurrent to the development of the 2012 Section 305(b) Report. Consequently, the final 2012 303(d) List is not included in this report. The 2012 303(d) List will be prepared in a format consistent with the EPA-approved 2010 List and will be developed in accordance with DEC's Assessment and Listing Methodology (2011).

The 2010 303(d) List was approved on June 15, 2011 during the 2012 305(b) reporting period and is available separately on the Watershed Management Division's web site: www.vtwaterquality.org. The 2012 draft and ultimately the EPA-approved 303(d) List will also be available on the web site when finalized.

A brief summary of the Vermont Priority Waters List, which identifies and tracks both impaired and non-impaired waters, is given in Table 19. It should be noted that the Section 303(d) List of Impaired Waters is only a portion of the overall Vermont Priority Waters List (Part A) and much of the Priority Waters List process occurs outside the scope of Section 303(d). However, it is important to be aware of the overall listing process because it is indirectly involved with the 303(d) listing process.

Table 19. Overview of Vermont Priority Waters List.

Vermont Priority List Section	Description	Included as Part of 303(d) Listing?
Part A	Impaired Waters in Need of a TMDL	Yes
Interim List	Candidate Waters for Section 303(d) De-listing	Yes, until EPA approval. After approval these waters are removed from 303(d). EPA approved 303(d) 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 & EPA Approved TMDLs	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 2012 draft Lists is given in Table 20. Numbers in the table are tentative as the list is pending approval by EPA.

Table 20. Number of Impaired Segments (taken from DRAFT 2012 listings).

Impaired Segments	Lakes & Ponds	Streams & Rivers	Total
Listed in Part A – impaired waters needing a TMDL (newly listed waters in 2012 in parentheses)	15	71 (1)	86
Listed in Part B – impaired waters not needing a TMDL (no new waters were added in 2012)	1	9 (1)	10
Total number of impaired segments	16	80	96
Total number of segments restored to full support for a use	0	6	6
Total number of segments moved to Part D due to completion of a TMDL	0	22	22

Assessment Results for Wetlands

The 2010 - 2011 wetland monitoring and assessment program builds on the findings of the 2006-2009 wetland bioassessment results, and an initial bioassessment project that involved vernal pools and northern white cedar swamps in Vermont. When appropriate, sampling was coordinated with ongoing streams, rivers, and lakes bioassessment sampling, allowing the wetlands project to incorporate the knowledge of individuals previously engaged in water quality monitoring. Monitoring and assessment staff actively engaged with the Army Corps of Engineers (ACOE), Environmental Protection Agency (EPA), and other regional states involved in wetland assessment to contrast and compare, and refine Vermont's wetland assessment techniques. Also, in 2011 wetland program staff took part in the first National Wetland Condition Assessment (NWCA). This involved a team of 5 persons trained by the Environmental Protection Agency (EPA) to sample wetland vegetation, hydric soils and surface water in wetlands; and to use the USA Rapid Assessment Method (USA RAM). Vermont had 8 sites randomly selected of the 1,000 sites across the country. The data will be tallied by the EPA and the results shared with states in 2013.

The specific objectives of the program are to: conduct assessments of wetlands across a condition gradient; record and gather chemical and physical data at each wetland site including water quality, hydrology and landscape characteristics; sample and describe the vegetation in assessed wetlands to develop vegetation-based metrics of wetland integrity; complete rapid assessments and evaluate the ability of the methods to reflect the overall wetland condition, and begin to expand the use of metrics in assessing the overall ecological health of Vermont's wetlands by wetland type. (As a result of lack of funding, macroinvertebrate samples have not been collected since the 2007 season.) Once data has been collected over a number of seasons, it is expected that results from the wetlands bioassessment program may be used for improving permitting and planning decisions; providing significant information for mitigation and restoration projects; and identifying the effects of environmental and anthropogenic stressors on wetlands over time.

Site Selection

Overall

A total of forty-one wetlands were sampled in 2010 and 2011, including the NWCA wetlands (see Table 21). Sampling was targeted to increase the number and types of wetlands in areas where no wetlands had been monitored or assessed previously.

Table 21. Wetlands sampled in 2010 and 2011

Year	VT Wetland Bioassessment	Town	Region 1	Wetland Type 2
2010	Lake Ninevah Wetland	Plymouth	SGM	PSS1C
2010	Reading Pond Wetland	Reading	SGM	PEM/PSS1
2010	Locus Creek Wetland	Barnard	SVP	PFO1C/PSS1C
2010	East Creek Wetland	Benson	TAM	PEM1E
2010	Podunk Wetland	Strafford	NVP	PUBh/PEM1
2010	Strafford Town Forest Wetland	Strafford	NVP	PSS1C
2010	Cornwall Swamp	Cornwall	CHV	PSS4/FO4Eg
2010	Dragon Brook Wetland	Ripton	NGM	PFO1B
2010	Cookville Brook Wetland	Washington	NVP	PEM1
2010	Second Branch White River Wetland	Brookfield	NVP	PEM/PSS1
2010	Beaver Meadow Wetland	Lincoln	NGM	PSS1/EMC
2010	South Branch Wells River Wetland	Groton	NVP	PFO5/EMFb
2010	East Slang Creek Wetland	Ferrisburg	CHV	PFO1E/PEM
2010	LaPlatte Trib Wetland	Hinesburg	CHV	PSS1/EM1Eh
2010	Bog Brook Wetland	Victory	NEH	PSS1Eb
2010	Bear Swamp	Wolcott	NGM	PSS1/EME
2010	Rogers Brook Wetland	Westford	CHV	PSS1/EM1Eb
2010	West Mtn. Wetland	Maidstone	NEH	PFO5/SS4C
2010	Bean Brook Wetland	Newark	NEH	PFO4C
2010	Lost Pond Wetland	Georgia	CHV	PEM1E
2010	Robert Burns Wetland	North Hero	CHV	PSS/FO1F
2010	Hurricane Bk Wetland	Norton	NEH	PEM1Eb
2010	Berkshire Town Forest Wetland	Berkshire	CHV	PEM1Eb
2010	Kesick Swamp	Sunderland	VV	PEM1Eb
2011	Aitken State Forest	Mendon	NEH	PFO4B
2011	Buczek Marsh WMA	Poultney	NGM	PEM1Eb
2011	St. Johnsbury Watershed Conservation	Waterford	CHV	PSS1/EMC PFO1C
2011	Roy Mountain WMA	Barnet	NGM	PFO4/PSS
2011	Lake Carmi Bog	Franklin	NEH	PEM1/PFO2
2011	Sandbar WMA	Milton	NVP	PFO/PSS1
2011	Waitsfield Town Land Route 100	Waitsfield	CHV	PSS1
2011	Cutler Memorial Forest	Dorset E	CHV	PFO4/1A
2011	Winooski River Stream Mill Brook WMA	Jericho	TAM	PSS1/EME
2011	Green Mountain Nat'l. Forest Rt. 155	Mt Holly	CHV	PEM1Eh
2011	Mud Creek WMA	Alburgh	NGM	PSS1/UBF
2011	State Historic Site PUB/PFO?	Hartford	VV	PUB/PFO?
2011	Howard Community Park	Shaftsbury	SGM	PFO2/4B
2011	Rock River WMA	Highgate	CHV	PSS1F
2011	VLT Land Howe Hill Road	Sharon	SGM	PUB/EME
2011	VLT Emergent Marsh w/Shrubs	Marlboro	CHV	PSS1/EME
2011	Conte Nat. Wildlife Refuge	Lewis	NVP	PSS1/3Ba

[1] Biophysical Regions: NVP = Northern Vermont Piedmont, SVP = Southern Vermont Piedmont, NGM = Northern Green Mountains, SGM = Southern Green Mountains, CV = Champlain Valley, VV = Vermont Valley, TM = Taconic Mountains.
[2] Cowardin Wetland types: AB = Aquatic Bed, E = Emergent Wetland, F = Forested Wetland, ML = Moss-lichen Wetland, SS = Scrub-shrub Wetland, UB = Unconsolidated Bottom.

Sites were selected in an effort to assess wetlands across a range in condition from reference (excellent condition) to highly disturbed (very poor condition) based on landscape characteristics and historical data. Historical data were obtained from the Agency of Natural Resources GIS database, orthophotos, wetland ecologists involved in permitting, and color infrared aerial photos. Sites were remotely analyzed to assess landscape characteristics such as watershed location, average buffer size, and intensity of surrounding land use. In most cases it was possible to identify the approximate wetland type (emergent marsh, scrub-shrub, or forested swamp) using aerial photographs. In addition to wetland type and perceived condition, factors influencing site selection included prior experiences with the wetland or watershed, site location and accessibility, land owner permission and sampling feasibility. Assessments included wetlands where a known change or impact had occurred in order to monitor the effects on wetland condition and species composition. Sites were also selected by considering the sampling histories of the VTDEC Lakes and Ponds Section and the Biomonitoring and Aquatic Studies Section.

Reference Sites

Each sampling season, attempts were made to ensure that at least one-third of the sites sampled had potential as reference wetlands in order to create a solid baseline of expectation for wetland quality. Sites appearing to have a large, natural buffer surrounding the wetland were considered to be of reference condition. Any site meeting the low disturbance level expected from a reference condition site was then assessed for the factors listed in the Sampling and Assessment section.

Disturbed Site Selection

Disturbed sites were selected to inventory the response of wetlands to environmental and anthropogenic stressors including, but not limited to, encroachment, stormwater runoff, point source pollution, filling, nutrient enrichment and farming as indicated from aerial and satellite photography. Non-reference condition sites were selected in an effort to encompass a range of disturbances from minimally disturbed to highly disturbed based on the amount and severity of the anthropogenic and environmental stressors. Site assessment areas also included wetlands undergoing restoration and were selected based upon best professional judgment.

Sentinel Sites for Climate Change

Ten high quality wetlands of exemplary natural community types, believed to be of a minimally disturbed condition, were also selected in 2011 in order to evaluate their potential for future climate change sentinel sites.

Sampling and Assessment

Physical Habitat

Information about the physical environment in and surrounding each wetland site was recorded after the site visit. At each site, wetland community size, maximum water depth, water source, water color and clarity, canopy cover, duration of inundation and saturation, alterations to hydrologic regime, and substrate and habitat were recorded onto the wetland bioassessment field data sheet.

Land use, wetland connectivity, dam presence, horizontal interspersion and invasive species cover were also recorded. Latitude and longitude were determined using a Garmin hand-held GPS unit with an accuracy ranging from 2 to 20 meters based on canopy cover and satellite coverage.

Water Chemistry
Water samples were collected at all but one site (Franklin bog) in 2011, and all sites in 2010. Samples were collected following the protocol outlined in the Vermont Wetlands Bioassessment Program Quality Assurance Project Plan.

Maximum, minimum and average water chemistry results will not be calculated for the 2011 water quality samples due to laboratory loss of data and samples during Hurricane Irene. However, the water quality samples for 2010 were processed for aluminum, alkalinity, sulfate, iron, nitrate+nitrite-water, and total suspended solids, which had results that were measurable to a minimum level. The minimum level was interpreted as the final result when running the mathematical and statistical analysis. Sigma Stat© 3.1 software was used to run the statistical tests. (See Table 22 below for the maximum, minimum, and average values for the 25 parameters sampled at each wetland.

Human Disturbance Assessment
The determination was made after using both the Human Disturbance Ranking (HDR) and the Vermont Rapid Assessment Method (VRAM) adapted from the Ohio Rapid Assessment Method for Wetlands v. 5.0, in 2010. Creating the newest iteration of the VRAM is scheduled to be completed prior to the start of the 2012 wetland assessment season. The VRAM metrics give a score ranging between 0 and 100 based upon characteristics of the wetland measured its assessment. A high score designates a site with little or no anthropogenic impacts; scores decrease with increased levels of human disturbances and lack of vegetation community diversity.

Vegetation Sampling
Vegetation was assessed between June and September at a total of forty-one wetlands during the 2010 and 2011 field seasons. Vascular vegetation was sampled at each site using a transect-quadrat method. Trees and shrubs data were gathered using a 10 meter distance for inclusion of species associated with the transect. Plants were identified to the lowest taxonomic level possible and their presence, by percent, was noted on the field data sheet. Vegetation outside the 1 meter transect was also noted and described to give a more complete picture of the wetland flora.

Site Reports
Forty-one individual site reports for 2010 - 2011 will be included in the final report. The site report includes the physical setting, surrounding landscape condition, vegetation, and physical and chemical characteristics of each wetland site. A map illustrating the assessment location and surrounding landscape is also included with each report.

Results

Water Chemistry
The maximum, minimum, and average values for the 25 parameters sampled at each wetland are presented in Table 22.

Table 22. Water Chemistry Results for 2010 Wetland Sites

Parameter	Max	Site Name	Min	Site Name	Average	n= 1
Alkalinity (mg CaCO3/l)	248	Robert Burns Wetland	1.3	Beaver Meadow Brook	61.52	n= 27
Aluminum (ug/L)	414	South Branch White River	>10	Hurricane Brook Wetland	95.18	n= 27
Chloride (mg/L)	15.2	East Slang Creek	0.21	6 Wetland Sites > 2	1.92	n= 24
Conductivity	551	Robert Burns Wetland	15.5	Beaver Meadow Brook Wetland	130.31	n= 27
Sulfate (mg/L)	15	Robert Burns Wetland	< 0.5	Cornwall Swamp & LaPlatt Wetland	2.75	n= 27
Sodium (mg/L)	13.9	East Slang Creek	0.32	Beaver Meadow Brook	2.41	n= 27
Magnesium (mg/L)	14.4	Laplatt River Tributary Wetland	0.27	Dragon Brook Wetland	3.45	n= 27
Potassium (mg/L)	3.78	Robert Burns Wetland	< 0.1	Beaver Meadow Brook	0.75	n= 27
Calcium (mg/L)	85.3	Robert Burns Wetland	1.38	Beaver Meadow Brook	18.71	n= 27
Total Calculated Hardness (mg/L)	264	Robert Burns Wetland	5.19	Beaver Meadow Brook	60.93	n= 27
Iron (ug/L)	6760	Bear Swamp	30.6	Strafford Town Forest Wetland	1180.8	n= 27
Manganese (ug/L)	2010	Bear Swamp	10	West Mountain WMA Wetland	291.68	n= 27
Nitrate + Nitrite - Water (mg-N/L)	1.36	Robert Burns Wetland	< .05	Twenty Wetland Sites < .05	0.31	n= 27
Nitrogen, Total - Persulfate (mg-N/L)	11	Lake Ninevah Wetland	2.17	Cookville Brook Wetland	0.54	n= 27
Phosphorus (ug P/L)	150	East Slang Creek Wetland	< 5	Beaver Meadow Brook Wetland	33.46	n= 27
Filtered Phos-phorus (ug P/L)	63.3	Robert Burns Wetland	< 5	Beaver Meadow Brook Wetland	17.82	n= 27
Solids, Total Sus-pended (mg/L)	33.4	East Slang Creek Wetland	0.3	West Mountain WMA Wetland	6.85	n= 27
Turbidity (NTU)	18.7	East Slang Creek Wetland	< 0.2	Dragon Brook Wetland	3.18	n= 27
Temp (°C)	29.36	Reading Pond Wetland	11.9	Beaver Meadow Brook	19.58	n= 27
SpCond (µs/m)	545.9	Robert Burns Wetland	14.1	Beaver Meadow Brook	131.96	n= 27
pH	8.09	South Branch White River	5.08	Beaver Meadow Brook	6.74	n= 27
DO (%)	117.8	Reading Pond Wetland	7.7	East Slang Creek Wetland	64.36	n= 27
DO (mg/L)	9.13	Cookville Brook	0.66	East Slang Creek Wetland	5.69	n= 27
Color	400	Bear Swamp	5	Cookville Brook Wetland	97.98	n= 27

Biological
Vegetation, algae, macroinvertebrates and other aquatic biota measurements can provide insight into the overall health of a wetland, and indicate how a site is reacting to the stressors placed upon it. Metrics for these assemblages are still under development for wetlands. The New England Interstate Water Pollution Control Commission (NEIWPCC) grant from EPA to develop a Floristic Quality Assessment Index for the New England states is now complete for Vermont. This new information rating Vermont plant species from 0 to 10 (0 being the lowest site fidelity a plant can meet and 10 being the highest) will be used beginning in 2012 to further assess vegetative species relationship to condition in wetlands sampled.

Vermont Rapid Assessment Method
VRAM score results provided disturbance ranges from 46 to 95 out of a maximum of 100 points. Sites with scores between 95 and 100 are considered to be of excellent reference condition; of very good condition between 85 and 94; of good condition between 70 and 84; and disturbed condition between 0 and 69. Using this scoring regime, eleven sites sampled in 2010 - 2011 were considered to be in poor condition, and 13 sites sampled scored in the very good to excellent range. The VRAM scoring method implies that the more developed and intact the wetland vegetation community, natural buffer, habitat and hydrology is in a site, the better the wetland is able to deal with low impact stressors. As a result, a wetland that has a high condition rating is in likely in a near-to-intact natural setting with an undisturbed or high percentage of undisturbed buffer.

In nearly all instances, water chemistry data supported the conclusions that described wetland condition drawn by the VRAM. For the 2010 and 2011 sampling season further separations in data analysis were made by wetland type due to the hydrologic, vegetative, soil, and chemical differences of various wetland types. Thus, shrub-scrub wetlands, forested wetlands, emergent wetlands, and moss-lichen wetlands have been categorized to each reflect its own range of water quality.

Table 23 . VRAM scoring system

Condition	***Range of Score***	***Table Character***	***Presumption***
Poor Condition	***69 or less***	***Color: Red*** ***Italics***	***Highly disturbed, more than one stressor to condition***
Good Condition	***70 – 84***	***Color: Green***	***Some disturbance, one or more stressors affect condition***
Very Good Condition	***85 – 94***	***Color: Blue*** ***Bolded***	***Low disturbance, stressors have little impact on the wetland***
Excellent Condition	***95 or higher***	***Color: Blue*** ***Bolded***	***Little or no disturbance, no invasive species, wetland is in near or reference condition***

Table 24. Wetland Ranking based on VRAM Score

VRAM Score	VT Wetland Bioassessment	Town	Condition	Year
52	*Kesick Swamp WMA*	*Sunderland*	*Poor*	*2010*
65	*East Slang Creek*	*Ferrisburg*	*Poor*	*2010*
67	*Bear Swamp*	*Wolcott*	*Poor*	*2010*
68	*Second Branch White River Wetland*	*Brookfield*	*Poor*	*2010*
69	*Podunk Wetland*	*Strafford*	*Poor*	*2010*
71	Cornwall Swamp	Cornwall	Good	2010
71	Robert Burns Wetland	North Hero	Good	2010
73	Lake Ninevah Wetland	Plymouth	Good	2010
76	LaPlatte Tributary Wetland	Hinesburg	Good	2010
76	Reading Pond Wetland	Reading	Good	2010
79	Rogers Brook Wetland	Westford	Good	2010
81	Berkshire Town Forest Wetland	Berkshire	Good	2010
83	Cookville Brook Wetland	Washington	Good	2010
83	Strafford Town Forest Wetland	Strafford	Good	2010
83	West Mountain Wetland	Maidstone	Good	2010
85	**South Branch Wells River Wetland**	**Groton**	**Very Good**	**2010**
86	**Beaver Meadow Wetland**	**Lincoln**	**Very Good**	**2010**
86	**Hurricane Brook Wetland**	**Norton**	**Very Good**	**2010**
87	**Bean Brook Wetland**	**Newark**	**Very Good**	**2010**
88	**Locus Creek Wetland**	**Barnard**	**Very Good**	**2010**
89	**Bog Brook Wetland**	**Victory**	**Very Good**	**2010**
93	**East Creek Wetland**	**Benson**	**Very Good**	**2010**
95	**Lost Pond Wetland**	**Georgia**	**Excellent**	**2010**
97	**Dragon Brook Wetland**	**Ripton**	**Excellent**	**2010**
46	*Waitsfield Town Land Route 100*	*Waitsfield*	*Poor*	*2011*
51	*State Historic Site PUB/PFO?*	*Hartford*	*Poor*	*2011*
51	*Howard Community Park*	*Shaftsbury*	*Poor*	*2011*
56	*Rock River WMA*	*Highgate*	*Poor*	*2011*
60	*Green Mountain Nat'l. Forest Rt. 155*	*Mt Holly*	*Poor*	*2011*
62	*Winooski River Stream Mill Brook WMA*	*Jericho*	*Poor*	*2011*
72	VLT Land Howe Hill, White River Trib.	Sharon	Good	2011
73	Mud Creek WMA, Mud Creek	Alburgh	Good	2011
78	Lake Carmi Bog	Franklin	Good	2011
80	Buczek Marsh WMA, Poultney Trib.	Poultney	Good	2011
80	St. Johnsbury Duck Pond Brook	Waterford	Good	2011
81	Aitken State Forest, Cold River Trib.	Mendon	Good	2011
83	Cutler Memorial Forest, Mettawee River	Dorset E	Good	2011
87	**VLT Emergent Marsh w/Shrubs**	**Marlboro**	**Very Good**	**2011**
91	**Roy Mountain WMA, Jewett Brook**	**Barnet**	**Very Good**	**2011**
93	**Sandbar WMA, Lamoille River**	**Milton**	**Very Good**	**2011**
95	**Conte Wildlife Refuge, Yellow River**	**Lewis**	**Excellent**	**2011**

Future Wetland Monitoring and Assessment

Beginning in 2012, the wetland monitoring and assessment program will tie into the Monitoring, Assessment and Planning Sections basin rotation method by working in basins 11, 14, and 16 on the eastern side of Vermont. As well the Wetland Section will continue to refine its assessment methods—borrowing from the USARAM and methods used in the NWCA. The Wetland Section will also evaluate a number of wetlands for climate change sentinel sites, and gathering information to determine which parameters will best determine climate change impacts over the long haul.

The Vermont Bioassessment Planning Map following depicts the location and year of each wetland that has been assessed since 2008.

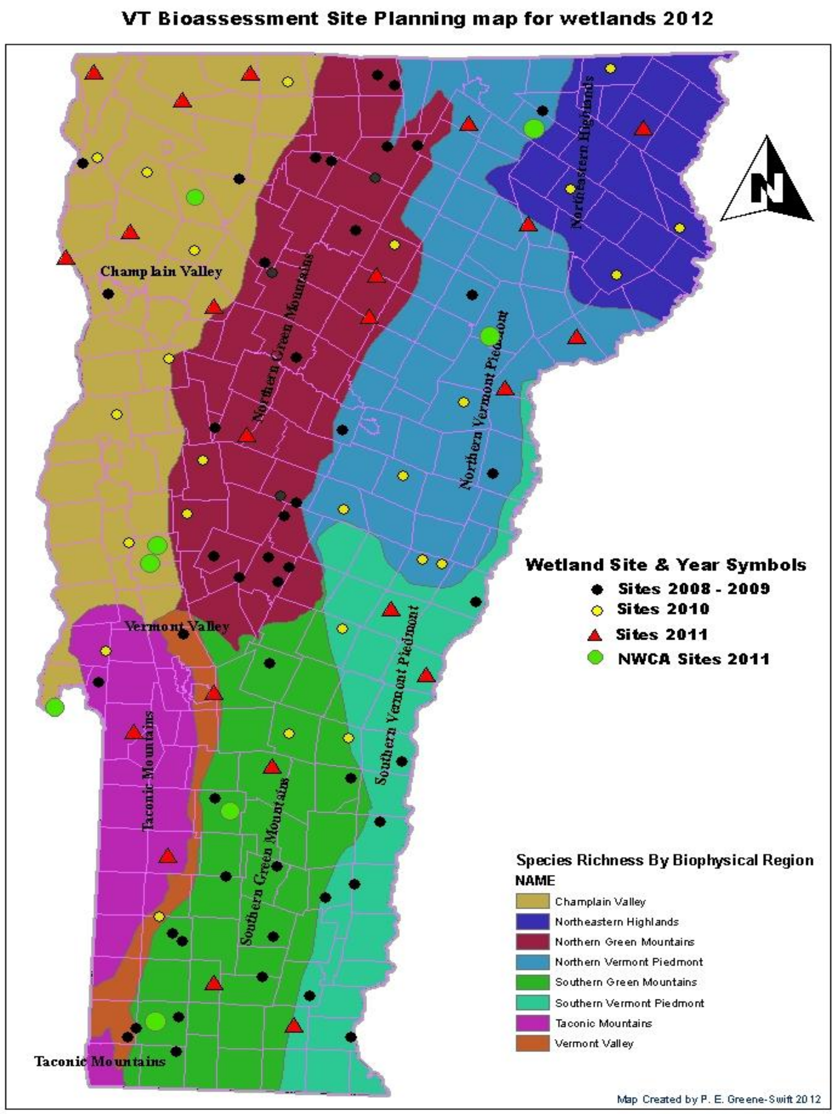

Figure 9. Locations and years of wetlands assessed

Public Health Issues

Size of Water Affected by Toxicants

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

Mercury and Fish Consumption

During the reporting period, the Department did not process fish mercury samples directly. However, during 2011, in partnership with the Lake Champlain Basin Program, a comprehensive reassessment of fish mercury and PCBs in Lake Champlain was conducted. This assessment focused on acquisition of white and yellow perch, smallmouth bass, and lake trout, from seven specific segments of Lake Champlain. The sampling design will provide mercury values for 10 or more specimens of each species from each lake segment where that species exists. The sampling design will also yield PCB measurements in lake trout from five fish, in each of five segments. These important results will be compared to prior mercury and PCB sampling efforts in Lake Champlain to document changes (hopefully reductions) in contamination levels with time.

Cyanobacteria

Monitoring for cyanobacteria continued on Lake Champlain in 2010 and 2011 as a cooperative effort headed by the University of Vermont (UVM) and the Vermont Department of Health (VDH). The Vermont DEC, the Lake Champlain Committee and citizen volunteers were partners in this effort. UVM conducted routine counting and evaluation following the established protocol. Anatoxin-a analyses were undertaken by the VDH. The VDH lab also continues to offer cyanotoxin test kits to the general public, for a low fee, which include both microcystin-LR and anatoxin-a. Results of the monitoring program and any additional cyanobacteria sightings are reported on the VDH web page (http://healthvermont.gov/enviro/bg_algae/bgalgae.aspx) through a weekly status statement and a lake status map color-coded for alert levels. The weekly statement and lake map are routinely viewed by the public and by the members of the Champlain Coalition of Water Suppliers.

Over the next two years, the cyanobacteria monitoring effort on Lake Champlain will transition from a university-coordinated effort to one coordinated by the Vermont DEC and VDH. Additionally, the structure of the program will be modified to a visual assessment system supported by quantitative data gathered at specified core locations. This change will facilitate statewide consistency in responding to cyanobacteria reports while continuing to provide quantitative data at key Champlain locations for which there is nearly a decade of historical information.

In 2010, cyanobacteria were observed in some Lake Champlain locations by late June. In early July, the main portion of the lake was affected by numerous, highly visible blooms along both the Vermont and New York shores. Trace levels of microcystin were detected at the limited number of sites where samples were collected. Blooms were reported to DEC and Health Department by many observers. Outreach efforts on Champlain over the years have clearly been successful as the majority of callers knew who they should contact and that they were observing algae rather chemical or paint spills. Several inland lakes experienced blooms during the same time period, with the same knowledge displayed in most cases by the callers who reported them. Press coverage during the events was well-balanced and informative. The overall public response was mild in comparison with some previous bloom events despite the large area affected, another indication that outreach efforts have been successful. Transient blooms and elevated cell densities were observed on Champlain during the remainder of 2010, however, microcystin levels remained below the 6 µg/L recreational standard. Cyanobacteria reports were received from a total of 12 inland lakes. Microcystin analyses were conducted for only a few lakes and these were all below 6 µg/L.

In 2011, Lake Champlain experienced unusually high spring water levels as a result of heavy winter snowpack and spring rainfall. In late August, Tropical Storm Irene dumped heavy rain across Vermont and many lakes, including Champlain, received large quantities of sediment. An increased frequency of cyanobacterial blooms was expected as a result of the unusually high loading of phosphorus through both tributary flow and shoreline erosion. Cyanobacteria densities and microcystin concentrations on Champlain were similar to past years through early September – blooms occurred in northern areas and low levels of microcystin was detected. In late September, blooms intensified in northern Champlain and microcystin reached 180 µg/L in one location, levels that had not been observed for several years. However, no adverse health effects were reported. By mid-October, cyanobacteria densities were once again at normal low levels. Despite the adverse weather and elevated phosphorus loading during 2011, only a few cyanobacteria blooms were reported on inland lakes (6). Two lakes were tested for microcystin, which was detected in both at levels well below the recreational standard.

When compared to other locations across the country, Vermont has few reported cyanobacteria bloom events and rarely has toxin concentrations of concern. Like many states, Vermont relies on the general public to report blooms and may thus be under-reporting the occurrence of cyanobacteria. The DEC continues to work closely with the VDH when responding to bloom events, providing consistent messages to the public regarding safety and water quality concerns. Utilizing early season press releases, the VDH reminds the public each year to be aware of blooms and scums as part of general recreational safety during the summer. The Community Guidance document developed in 2009 has been provided to communities where blooms have been observed on a consistent basis to assist them in developing an outreach and monitoring effort that suits their needs. Vermont continues to be involved in the ongoing national discussion of public health risk, suitable sampling methods and appropriate response. Drinking water safety is particular interest as Lake Champlain provides drinking water to large numbers of people.

Small Community Untreated Waste Discharges

DEC provides direct funding and technical assistance to small communities without sewers to help them evaluate and plan for their wastewater needs. It is anticipated that there will be a continuing need from small communities for wastewater evaluations and planning in the coming years. Most of 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. 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.

During the 2010 - 2011 reporting period, the Towns of West Windsor (one village), Fairfield (two villages and a recreational camp pond), Huntington (three villages), and Franklin (one village and a large recreational camp lake) began such studies for their village centers. These studies will be completed in calendar year 2012. For the first time, the Department provided funding for combined wastewater and water supply feasibility studies. West Windsor and Huntington took advantage of this integrated and efficient approach.

Restrictions on Bathing Areas During the 2012 Reporting Period

The current Vermont criterion for *E. coli* in Class B swim waters is 77 organisms/100 ml of water for any single sample. This criterion was developed in the 1990s as an interpretation of then-current EPA guidance, which suggested that such a criterion would protect swimmers to somewhat less than 4 expected illnesses per 1000 swimmers. This criterion is significantly more stringent than the current EPA recommended recreational water quality standard for *E. coli* of 235 organisms/100 ml for any single water sample, which corresponds to approximately 8 gastrointestinal illnesses per 1000 swimmers. Other restrictions on bathing areas in Vermont have recently included beach closures due to cyanobacteria blooms and animal fecal waste (e.g. geese and gulls defecating along shoreline), which can be a source of *E. coli* contamination. The reader is cautioned that the occurrence of a beach closure should not be equated with the determination that the beach is impaired due to *E. coli* contamination.

Lake Champlain

The count of beach closures for Lake Champlain public beaches in 2010 and 2011 is shown in Table 25. Some beaches opened late in 2011 due to high water levels from spring flooding.

Table 25. Number of Beach Closures for Vermont Portion of Lake Champlain.

Segment & Beach	**Closures due to *E. coli***		**Other Closures**
NORTHEAST ARM	**2010**	**2011**	**2010-2011**
North Hero State Park	No data	0	
St. Albans Town Beaches	No data	5	
Kill Kare State Park	No data	0	
Burton Island State Park	No data	0	
Knight Point State Park	No data	0	May 24, 2011: high *E. coli* reading, beach not swimmable due to high water
Grand Isle State Park	No data	0	
Sand Bar State Park	No data	2	
MALLETTS BAY	**2010**	**2011**	**2010-2011**
Niquette Bay State Park	No data	4	
Bayside Beach	5	4	
Rossetti Nature Area	2	4	
MAIN LAKE	**2010**	**2011**	**2010-2011**
Leddy Beach	No data	No data	
North Beach	No data	No data	
Blanchard Beach	No data	No data	
Cove Beach (Oakledge Park)	No data	No data	

Red Rocks Park Beach	2	0	June 22 – July 6, 2011: beach closed due to spring damage and clean-up
Shelburne Town Beach	3	1	June 20 – 30, 2011: beach closed due to high water levels
Charlotte Town Beach	No data	7	
Kingsland Bay State Park	No data	5	
Alburg Dunes State Park	No data	0	

Inland Lakes

There were eight inland lakes with State Park beaches that were closed due to an *E. coli* violation during the 2012 305b reporting period (Table 26). In most cases, re-sampling taken the day that high results were received by the beaches revealed *E. coli* concentrations below the Vermont standard. It should be noted that Camp Plymouth State Park on Echo Lake was destroyed by Tropical Storm Irene on August 29, 2011.

Table 26. Number of State Park Beach Closures for Inland Lakes Due to *E. coli*.

Waterbody	2010	2011
Adams Reservoir	No data	1
Lake Carmi	No data	16
Echo Lake (Plymouth)	No data	8
Lake Elmore	No data	2
Lake Groton	No data	2
Ricker Pond	No data	1
Waterbury Reservoir	No data	2

All five inland reservoirs with beaches operated and maintained by the US Army Corps of Engineers had beach closures due to one or more *E. coli* exceedances during this reporting period (Table 27). It should be noted that all beaches were closed early for the 2011 season during the week of August 29 due to flood control from Tropical Storm Irene.

Table 27. Number of Days US Army Corps of Engineers Beaches Closed Due to *E. coli*.

Waterbody	2010	2011
Ball Mountain Lake	0	13
North Hartland Lake	0	12
North Springfield Lake	0	10
Townshend Lake	8	7
Union Village Dam	45	45

Restrictions on Surface Drinking Water Supplies During the 2012 Reporting Period

One surface water system was on a boil water restriction during the reporting period. The Montpelier Water System has a boil water notice for three homes that are not presently connected to the City drinking water distribution system.

Chronic or Recurring Fish Kills

The Vermont Department of Fish and Wildlife (DF&W) maintains a fish pathology laboratory which responds to reports of fish kills and maintains records of the events. The following fish kills were reported in 2010 /2011. These kills are likely due to extremely hot weather conditions leading to high water temperatures/low oxygen levels during this period. The kills were not intensively investigated by the Vermont Fish & Wildlife Department. All kills were judged to be minor in overall significance to total fish population.

Fish Kills in 2010 or 2011:

July 2010 **-** Saxtons River (upstream of Cambridgeport), Sculpins reported dead.
July 2010 **-** Roaring Branch (lower section). Various fish species reported dead.
July 2010 **-** Black River (1/3 mile upstream of Downers Covered Bridge). Trout, salmon parr and longnose dace reported dead**.**
July 2010 **-** Bristol Pond. Northern pike reported dead.
July 2011 - Lake Elmore. Various fish species reported dead.
August 2011- Fern Lake. Various fish species reported dead.
September 2011 - Rock River. Northern pike reported dead.

The following fish kills were investigated by the Vermont Fish & Wildlife Department.

January through April 2011- Lake Champlain. Large alewive die-off due to general immunosuppression caused by low water temperatures.

July 2011 - Lake St. Cartherine (Little Lake Section). Northern pike were documented dead. Prior to fish kill, extremely hot weather conditions were documented. High water temperatures were documented. Fish kill minor in overall significance to the total fish population

August 2011 - Lake Champlain (southern section). Various fish species documented dead. Prior to the fish kill, extremely hot weather conditions were documented. High water temperatures documented. Columnaris disease documented. Fish kill was minor in overall significance to total fish populations.

Chapter 5. Groundwater Monitoring and Assessment

Introduction

The Groundwater Coordinating Committee (GWCC) was active during the 2010 and 2011 biennial. The GWCC was established through legislation (Chapter 48: Groundwater Protection, 1985) with committee representation from the Department of Environmental Conservation, Department of Forests, Parks and Recreation, Agency of Agriculture, Food and Markets, Department of Health, along with representatives of other agencies and the private sector.

The purpose of the GWCC is to advise the Secretary of the Agency of Natural Resources (the Secretary) on the development and implementation of the groundwater management program. This program includes:

- Developing a groundwater strategy and integrating the groundwater management strategy with other regulatory programs administered by the Secretary,
- Cooperating with other government agencies in collecting data on the quantity and quality of groundwater and location of aquifers,
- Investigating and mapping groundwater currently used as public water supply sources and groundwater determined by the Secretary as potential future public water supply sources,
- Providing technical assistance to municipal officials, classifying the groundwater resources and adopting technical criteria and standards for the management of activities that may pose a risk to their beneficial uses,
- Developing public information and education materials, and
- Cooperating with federal agencies in the development of programs for protecting the quality and quantity of the groundwater resources.

Also, the Secretary shall adopt rules for the protection of public water source protection areas (Chapter 56: Public Water Supply). The administrative functions of the Committee are performed by the Drinking Water & Groundwater Protection Division (DW&GWPD) within the Department of Environmental Conservation.

In carrying out these duties the Secretary shall give due consideration to the recommendations of the GWCC. This relationship was most realized through the development of the strategy for the management and protection of groundwater along with the adoption of the Groundwater Protection Rule and Strategy (GWPR&S) Chapter 12 (adopted February 1988 and revised September 2005). The committee's interaction with the Secretary has mostly been involved with the reclassification of ten contaminated groundwater areas to Class IV Groundwater and one groundwater reclassification to Class II Groundwater.

Groundwater Reclassification Issued in this Reporting Period

Class II Groundwater Area, Brandon Fire District #1

The Groundwater Coordinating Committee, with the administrative support of the Drinking Water & Groundwater Division, has completed the process for the Class II Groundwater Area at the Brandon Fire District #1. Reclassifying the groundwater from Class III (suitable as a water source for individual domestic water supply, irrigation, agricultural use, and general industrial and commercial use), which is the current designation, to Class II (suitable for public water supply, character uniformly excellent but exposed to activities which may pose a risk to its current or potential use as a public water supply) helps ensure public health protection for the long term use of this public community water system.

The Brandon Class II Groundwater Area is located in northeastern Brandon on either side of Route 53. The Brandon Fire District #1 (BFD #1) was formed in 1856 to provide fire protection and drinking water to the village of Brandon, eventually expanding its service area to include the Forest Dale area of Brandon where many businesses and residences are located. The BFD #1 public community water system serves an estimated population of 3,865 people through 1,175 service connections. The first gravel well (Well #1) for the water system was constructed in the Forest Dale area in August 1952 approximately 1,000 feet south of the Neshobe River. Well #1 is only 59 feet deep and is within a sand and gravel aquifer with a safe yield of 450 gallons per minute (gpm). The water system discontinued use of its surface water sources and began relying solely on groundwater sources with the installation of its second gravel well (Well #2) in the fall of 1971, also located in the Forest Dale area, approximately 600 feet north of the Neshobe River. Well #2 is 100 feet deep and terminates in sand, gravel, and clay. From production records it is estimated Well #2 has a safe yield of 625 gpm. A third gravel well (Well #3) located proximal to Well #2 was constructed in December 1997 and has a permitted safe yield of 630 gpm.

The Source Protection Area (SPA) for the BFD #1 consists of 3 zones as per the Water Supply Rule, Chapter 21. Zone I is a two hundred foot circle around each well where impacts from potential sources of contamination are likely to be immediate and certain. Zone II is defined by groundwater monitoring of the recharge area where there will be probable impacts from potential sources of contamination. Zone III is the remaining recharge area to the wells where there may be impacts from potential sources of contamination. In addition, as specified in Section VII of the Procedure for Class I and II Groundwater Reclassification, the Class II groundwater boundary is equivalent to the SPA boundary.

The three wells serving BFD #1 and the gravel well serving Brandon Fire District #2 (Forrest Brook development) are all completed in the aquifer system represented by deltaic, lake sand, and kame moraine deposits in the vicinity of the wells. Mapping conducted by the Vermont Geological Survey (VGS) indicates that there is a considerable thickness of ice contact and deltaic sand and gravel to the east of Wells #2 and #3 across the buried Neshobe Valley. This area is likely the most extensive overburden aquifer in Brandon.

Water quality in the aquifer in which the three Brandon FD #1 PCWS gravel wells exist are best represented by the historical water quality testing results. There have been no detections of any of the volatile organic chemicals or synthetic organic chemicals above analytical detection limits. For those analytes detected at BFD #1 above the analytical detection limits, there have been no exceedences of the MCLs specified in Subchapter 21-6 of the Water Supply Rule.

The Class II Groundwater Area, similar to SPAs will add an extra layer of groundwater protection to the public community water sources.

Groundwater Class IV Area, Central Vermont Properties

The Groundwater Coordinating Committee, with the administrative support of the Drinking Water & Groundwater Protection Division, has completed the process for the Class IV Groundwater Area at the Central Vermont Properties, Inc. Engine House Yard located in St. Albans. No comments were received during the reclassification public comment period.

Reclassifying the groundwater from Class III (suitable as a water source for individual domestic water supply, irrigation, agricultural use, and general industrial and commercial use), which is the current designation, to Class IV (not suitable as a source of potable water but suitable for some agricultural, industrial and commercial use) helps ensure public health protection from this area of non-potable water.

The CVPI Engine House Yard is located on approximately 19.75 acres situated on the west side of Route 7 and just north of Route 36 in the downtown area of St. Albans, Franklin County, Vermont.

Topography in the general area gently slopes towards Lake Champlain, located approximately 2.5 miles to the west. The topography on site is essentially flat and highly modified by the historic railroad activities. Stevens Brook runs through the northern section of the subject property, and forms the northwest border of the site. The Brook runs in a northerly direction toward the regional drainage of Jewett Brook, ultimately discharging into St. Albans Bay.

The surficial geology within the majority of the site and surrounding area is mapped as gravelly silt-loam and silty loams. However, continuous use related to the railroad industry has considerably altered the site's surficial geology. Studies indicate that the geology consists of a layer of fill and ballast (cinders, coal, brick, and stone ballast) from the ground surface to 8 to 10 feet below grade, followed by 3 to 5 feet of silty fine sand with interbedded gravel, and dense silty/fine sandy fill at 8 to 18 feet below grade.

The Site has been used as a rail yard since the 1860s. The existing Engine House was constructed in 1923. A 50,000-gallon diesel fuel aboveground storage tank (AST) was installed circa 1961, and the two former ASTs (15,000 gallon waste oil and 10,000 gallon lube oil) were installed 5 years later at north of the Engine House. The yard tracks and fueling area have been located in essentially the same area since the inception of the yard. At some time in the 1960s or 1970s the fueling platform was replaced with a track pan as a spill collection system which discharged to an oil/water separator and was replaced with a groundwater recovery system (GRS).

The site has been studied extensively since 1989. A groundwater recovery system (GRS) was operated from 1997 to 2005 and numerous monitoring wells have been installed. An initial site investigation was performed in 1989. The investigations disclosed the presence of elevated concentrations of total petroleum hydrocarbons (TPH), metals, volatile organic compounds (VOCs), and polynuclear aromatic hydrocarbons in soils and areas of LNAPL on groundwater.

In 1990, containment areas were constructed around the larger diesel fuel tank and two former oil ASTs. Soil excavated from the area of a 50,000-gallon AST was found to be impacted with petroleum. A pool of free product in the vicinity of the fueling station at thicknesses ranging up to 1/8 inch to 1 foot; contaminants in the underlying groundwater were detected at “very low” concentrations, none of which exceeded Vermont groundwater cleanup objectives. The study also identified contamination and visible petroleum seeps in the banks of Stevens Brook. Updated data indicated that the thickness of free product had increased to 2.5 feet since the original study had been conducted, and that concentrations of VOCs and heavy metals in the groundwater in the vicinity of the 50,000-gallon AST and refueling area exceeded applicable groundwater quality standards. In the late 1990s, piping was leaking and additional monitoring wells were installed as well as the GRS and track pan. A second release from piping at the 50,000 AST was discovered in 2002 and in the next year the oil water separator overflowed. In 2005, the GRS that was designed to collect free product was shut down. Of the 1000 gallons of product recovered, about 680 gallons were recovered using the GRS. Recovery wells continued to capture free product. Afterwards the AST containment area was relined. It was discovered that the groundwater was not impacted because the shallow soils at the site were so impermeable. The consultant believes that the contaminants at the site have limited mobility and the plume is not expanding. Natural attenuation appears to provide some benefit. All homes and businesses within the reclassification area have been connected to the municipal water supply.

State Legislation

<u>Groundwater Withdrawal</u>

State legislature passed an act relating to a Groundwater Withdrawal Permit Program in 2008. The new law recognizes that the groundwater of Vermont is a precious, finite, and invaluable resource upon which there is an ever-increasing demand for present, new, and competing uses and that an adequate supply of groundwater for domestic, farming, dairy processing, and industrial uses is essential to the health, safety, and welfare of the people of Vermont. It also recognizes that the withdrawal of groundwater of the State should be regulated in a manner that: benefits the people of the State; is compatible with long-range water resource planning, proper management, and use of the water resources of Vermont; and is consistent with Vermont’s policy of managing groundwater as a public resource for the benefit of all Vermonters.

Groundwater Withdrawal Reporting and Permitting Rules were effective as of December 11, 2009 and amended June 22, 2011. The rules stated that on and after July 1, 2010, no person shall make a new groundwater withdrawal for commercial or industrial uses of more than 57,600 gallons a day from any source on a single tract of land or at a place of business without first receiving a groundwater withdrawal permit.

In the fall of 2010 a biomass electric generation plant with a wood pellet production facility was proposed. The project would obtain potable water from an existing gravel packed water supply well that was previously permitted as a Transient Non-Community (TNC) source. The proposed biomass plant's normal process water consumption rate is 321.6 gpm, and the peak consumption rate is 465.2 gpm.

The rules require two separate informational meetings. At least 30 days before filing an application for a permit under the rule, the applicant shall hold an informational meeting in the municipality in which the withdrawal is proposed. At the informational meeting the applicant shall describe the proposed project and provide attendees with the opportunity to comment on the proposed project. Afterwards the applicant is responsible for drafting a final report. The final report must address safe yield, efficient use of water, effects on existing sources, consistency with the town plan, effects on wetlands or other water resources, and other concern of the Secretary that may adversely impact the environment or human health. Once the report is prepared the applicant must hold the second information meeting. In the case of the biomass facility, both meetings were very well attended and attendees voiced strong opposition to the groundwater withdrawal. In the end, the applicant put the groundwater withdrawal application on hold.

Groundwater in the public trust

In 2008, the legislature declared that groundwater in Vermont is a public trust resource. In mid 2011, the Department of Environmental Conservation completed an interim procedure implementing the public trust doctrine for groundwater quality. Groundwater quantity in regards to the public trust is addressed in the Groundwater Withdrawal Reporting and Permitting Rules. The interim procedure was necessary so that regulated activities could proceed while allowing for thoughtful public discourse regarding the public's interest in groundwater quality along with a comprehensive examination of groundwater science, planning and management. The examination should:

1) Coordinate and strengthen existing data gathering and resource planning programs at the municipal, regional, and state level.
2) Recognize that groundwater and surface water are parts of a single water resource system and to the extent feasible propose changes to regulatory programs to manage groundwater and surface water in a conjunctive manner.
3) Incorporate public trust principles, including revisions to standards and the use of points of compliance, into regulatory programs to ensure the protection of groundwater for present and future generations.
4) Reinforce that a person whose activities result in damage to a public trust resource is responsible to remediate that damage and compensate the public for their losses.

The objective of this examination is a proposal to amend the State's Groundwater Protection Rule and Strategy which incorporates these concepts.

Underground Injection Control Program

During fiscal year 2011, 18 permit applications were received for Underground Injection Control (UIC) wells. Eight permits were issued for new wells and three permits were renewed. Four of the projects were determined not to need a permit. The remaining three permit applications were continued for review into fiscal year 2012. Thus far three additional permit applications have been received in fiscal year 2012. The types of wastewater being permitted for discharge into the Class V injection wells are: sand and gravel processing water; spent filter backwash water from drinking water treatment; geothermal heating and cooling; industrial subsurface discharges including boiler blowdown; and processing waters from slaughterhouse operations. Floor drains are also required to be registered under the UIC Rule.

A bill was introduced into the VT Legislature to prohibit permitting of injection wells for High Volume Hydraulic Fracturing (HVHF) associated with natural gas recovery. HVHF in conjunction with horizontal drilling is a relatively new technology, increasing in use over the past five years. There are a number of negative public health and environmental impacts associated with HVHF, however scientific studies trying to document the cause and effect relationship are just starting. In November 2011, EPA launched a three year study on the Drinking Water Impacts of HVHF. The House approved a three-year moratorium on HVHF. If the bill is approved by the Senate, the moratorium will allow Vermont to obtain the results of the EPA study; and to learn more about the experiences of Pennsylvania and New York in the use of HVHF in natural gas recovery from the Marcellus Shale Formation.

Geothermal Wells

Geothermal Well Language for Water Supply Rule

Staff is receiving numerous calls regarding geothermal wells, especially as they relate to permitting. It is anticipated that there are more than several hundred geothermal wells in the State. Marketing these wells as a "green" energy source has probably increased both interest and appeal of this growing industry.

Types of geothermal wells include:

- Open loop wells that withdraw groundwater, pass it through a heat exchanger and discharge it to septic, surface water, etc.
- Standing column wells withdraw groundwater from the bottom of the well, pass it through a heat exchanger, and return it to the top of the water column,
- Closed loop wells circulate fluid within closed pipes and the well bore is grouted around the pipe and
- Direct exchange systems circulate refrigerant through closed looped copper pipe that is grouted from the bottom up.

In Vermont it is thought that 10% of these wells are closed loop and 90% are standing column.

The Groundwater Coordinating Committee provided language regarding the regulation of geothermal wells. This language may potentially amend Appendix A of the Vermont Water Supply Rule. It addresses both public and private wells and speaks to standing column open loop geothermal wells.

The proposed language allows standing column wells given the following:

- No additive is added to the re-circulated water.
- The heat exchange medium in the system is R-410 or a different medium approved by the Secretary.
- The system has a low pressure safety cutout circuit that will turn off the system when is a pressure leak in the heat exchange medium containment vessel.
- All electronic components of the system are properly grounded to prevent potential electrolysis of metals.

The committee agreed on the above and also added additional language which reads "in the event the heating exchange system source is disconnected as a heating or cooling source it shall be capped labeled or removed." The committee also spent some time discussing whether or not language regarding abandoned geothermal systems was needed. In the end the group decided not to include additional language.

Geothermal Grant

The Department of Energy (DOE) had stimulus money available to states. Vermont is slated to receive $160,000 of this money which will be allocated over a 3 year period. The bulk of the grant will be used for document management. The DOE is also interested in geothermal wells. They would like to use this technology to operate a 160 mega-watt power plant. A small portion of the grant is therefore geared to investigating wells for geothermal use. Finding several existing deep wells located adjacent to power corridors would be ideal.

Issues associated with these wells include heat pollution, groundwater contamination, and construction problems. It also appears that the industry is poorly regulated even though regulations regarding geothermal wells could involve a host of regulations including the Groundwater Rule and Strategy, Underground Injection Control Regulations, regulations regarding Groundwater Withdrawal, along with well construction standards and licensing. Given the complexity of this industry, it has been proposed that stand alone regulations for geothermal wells might be best.

Information & Public Education

Each of the Class II and Class IV Groundwater Areas along with source protection areas (SPA) delineations includes a public notice. The town, residents or property owners in these areas, and officials of the water system are contacted. An opportunity for a hearing regarding the area is also provided. The outcome of both processes includes the identification of the groundwater resources along with the development of a rapport with concerned citizens at the town level. Groundwater planning at the local level can be better applied through such efforts. Such processes will go a long way towards educating the public and protecting the resource. Class II and IV Groundwater Areas as well as SPAs are posted on ANR's GIS website.

The DW&GPD annually sponsors Drinking Water Day at the State House. 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 ANR's Science on the Green is another annual event and has been an additional opportunity for the DW&GWPD to provide educational material to students and the public.

The VDH toll-free phone line and its website have assisted well owners in better understanding the quality of their water. Also, when there is a confirmed exceedance of a water quality standard, whether naturally occurring or due to nearby land activities, there is technical assistance outlining treatment options so as to minimize a family's risk of exposure. VDH has also been present at Home Shows and realtor meetings regarding water quality sampling and testing. Similarly, the DW&GWPD's well driller's database is available on ANR's GIS website providing geographic and geological information to the public.

Recommendation

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. This interconnection of water resources, however, has not had significant attention. Groundwater is also 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.

Appendix A:Vermont Department of Health Fish Consumption Advisory

HEALTH ALERT

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

These advisories are based on tests of fish caught in Vermont waters and 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, PCBs (poly-chlorinated biphenyls).

You can mix and match fish (you catch or buy) with the same limits, but once you meet the lowest limit eat no more fish that month. Do not eat the monthly limit within a single week.

Store bought fresh and canned fish—including tuna—have mercury levels that are about the same as many Vermont-caught fish. Add in store bought fish when you decide how many fish meals to eat each month.

One fish meal = 8 ounces uncooked fish

	Women of childbearing age and children age 6 and under	Everyone else
GENERAL ADVISORY:		
Brown Bullhead Pumpkinseed	No more than 5 meals/month	No Restrictions
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 Yellow Perch (larger than 10 inches)	No more than 2 meals/month	No more than 6 meals/month
Brook Trout Brown Trout Rainbow Trout Yellow Perch (smaller than 10 inches)	No more than 3-4 meals/month	No Restrictions
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 Restrictions
Lake Champlain - Lake Trout (larger than 25 inches)	0 meals (includes all children under 15)	No more than 1 meal/month
Hoosic River - All Fish	0 meals	0 meals
Deerfield Chain (Grout Pond, Somerset Reservoir, Harriman Reservoir, Sherman Reservoir, and Searsburg Reservoir)		
Brown Bullhead Brook Trout	No more than 5 meals/month	No Restrictions
Rainbow Trout Brown Trout (smaller than 14 inches) Rock Bass Rainbow Smelt Yellow Perch	No more than 1 meal/month	No more than 3 meals/month
Brown Trout (larger than 14 inches) All Other Fish	0 meals	No more than 1 meal/month
15 Mile Falls Chain (Comerford Reservoir and Moore Reservoir)		
White Sucker	No more than 1 meal/month	No more than 3 meals/month
All Fish	0 meals	No more than 2 meals/month
15 Mile Falls Chain (McIndoes Reservoir)		
Yellow Perch	No more than 2 meals/month	No more than 6 meals/month
All Other Fish	No more than 1 meal/month	No more than 3 meals/month

VERMONT
DEPARTMENT OF HEALTH

For more information call 1-800-439-8550
healthvermont.gov

June 2007

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	
Hardwick	completed	
Hinesburg	completed	
Johnson	completed	
Middlebury	completed	
Milton	completed	
Montpelier	completed	
Morrisville	completed	
Northfield	completed	
Proctor	completed	
Poultney	completed	
Richford	completed	
Richmond	completed	
Rutland City	completed	
South Burlington (Bartlett Bay)	completed	
South Burlington (Airport Parkway)	completed	

Municipality	Construction Status	Comments
Shelburne (Plant #1)	completed	
Shelburne (Plant #2)	completed	
St. Albans City, NW Correctional Facility	completed	
Stowe	completed	
Swanton	completed	
Troy/Jay	under construction	expected complete in 2013
Vergennes	completed	
Waterbury	under design	
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	partially completed	
Hardwick	completed	
Middlebury	partially completed	
Montpelier (Phase 1)	completed	
Montpelier (Phase 2)	completed	
Northfield	completed	
Poultney	completed	
Richford	partially completed	monitoring 2 CSOs

Municipality	Construction Status	Comments
Rutland City (Phase 1)	completed	
Rutland City (Phase 2A)	completed	
Rutland City (Phase 2B)	pending	monitoring Phase 2A
St Albans	under design	
Swanton	completed	
Vergennes	completed	
****** Lake Memphremagog Drainage ******		
Barton	completed	
Newport City	partially completed	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)	Contract 1 completed Contract 2 under construction Contract 3 completed	Monitoring still needs to be done for Contract 3. There may be another contract as there are a group of small projects the city wants to do.
St. Johnsbury (Phase 1)	complete	
St. Johnsbury (Phase 2)	Phase 2A completed	Phase 2B pending
St. Johnsbury (Phase 3A)	scheduled for 2010	on holding pending study of system status
St. Johnsbury (Phase 3B)	scheduled for 2010	on holding pending study of system status
St. Johnsbury (Phase 4)	scheduled for 2010	on holding pending study of system status
Wilmington	completed	
Windsor	completed	