2006

VERMONT SURFACE WATER ASSESSMENT METHODOLOGY

including

VERMONT LISTING METHODOLOGY

In accordance with
USEPA 2006 Guidance

Prepared by:
Vermont Department of Environmental Conservation
Water Quality Division
103 South Main Street
Building 10 North
Waterbury, VT 05671
802-241-3770 or -3777
www.vtwaterquality.org

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Executive Summary

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

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

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

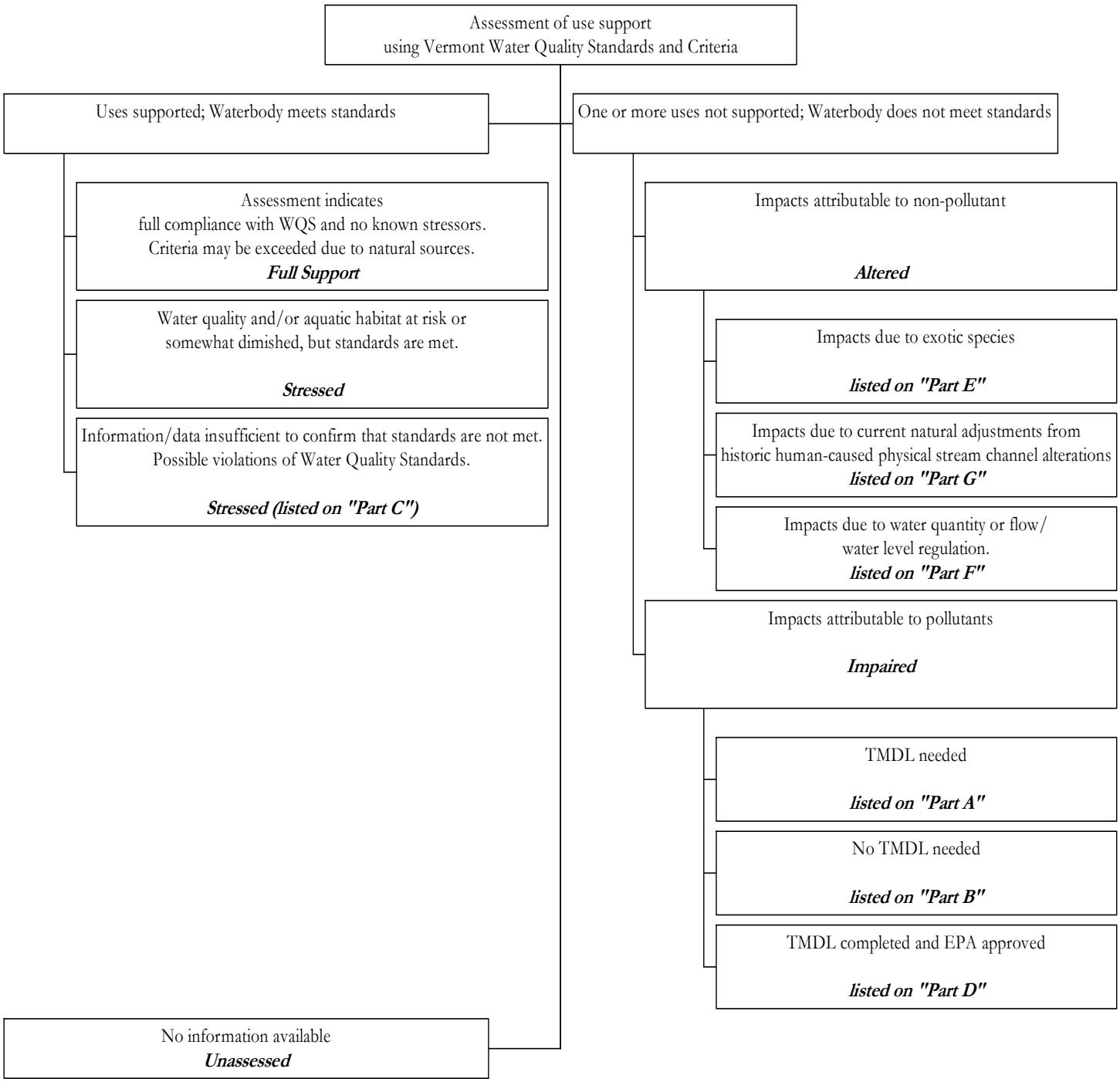
The collection, analysis and evaluation of water quality monitoring data and other information represent the assessment of a water's condition. The assessment of a water is most accurate when judgements about the water's condition are made using chemical, physical and/or biological data of known reliability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

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

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

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

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



Chapter One. Introduction to Surface Water Assessment Methodology

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

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

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

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

Chapter Two. Vermont Water Quality Standards

2.1. Overview

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

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

Table 2.1. Designated Uses for Water Classifications.

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

Existing uses of waters and the level of water quality necessary to protect those uses is to be maintained and protected regardless of the water's classification. Existing water uses are those uses which have actually occurred on or after November 28, 1975 in or on a waterbody whether or not the uses are included in the standard for classification of the particular waterbody and whether or not the use is presently occurring. Determinations of what constitute existing uses of a particular water are made either during the basin planning process or on a case-by-case basis during consideration of an application by the Secretary of the Vermont Agency of Natural Resources (ANR). In making a determination of existing uses, the VTANR shall consider at least the following factors:

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

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

2.2. Surface Water Classification & Typing

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

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

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

Chapter Three. Monitoring Designs for Surface Water Assessment Purposes

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

3.1. Rotational Watershed Assessment Approach

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

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

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

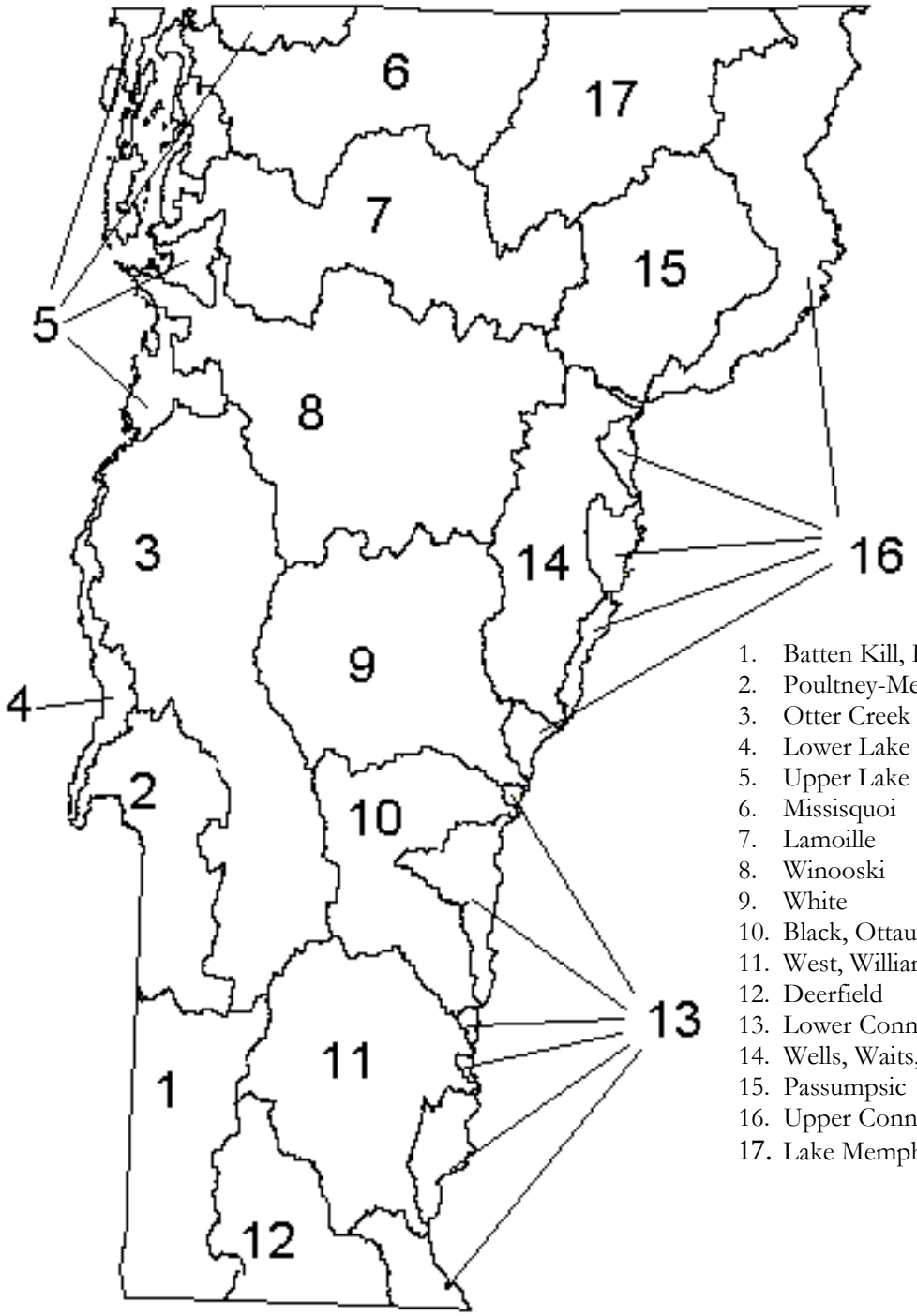
- Basins from more than one of the four regional drainage areas of the state (Lake Champlain, Connecticut River, Lake Memphremagog, Hudson River) are represented each year with special attention to including at least one Lake Champlain basin and one Connecticut River basin in most years;
- The sum of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

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

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

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

Vermont's Major River Basins



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

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

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

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

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

3.2. Fixed Station Monitoring Approach

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

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

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

3.3. Probability-based Monitoring Approach

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

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

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

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

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

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

3.4. Special Studies and TMDL-related Studies

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

Chapter Four. Surface Waters Assessment Methodology

Part I. 2004 Overall Methodology

1. Overview and Data Sources

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

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

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

2. Biological Monitoring and Assessments

Assessment of biological integrity is conducted on the state's rivers and streams for the purpose of trend detection and site-specific impact evaluation. Macroinvertebrate and/or fish populations of rivers and streams considered to be "wadeable" are assessed by comparing a series of biometrics measuring community structure and function to a set of biocriteria that represent the biological potential for the ecoregion/habitat being evaluated. The biomonitoring activities carried out by DEC can be placed into three categories; 1) long-term monitoring of reference level sites, 2) site-specific impact evaluations and 3) statewide probability-based surveys.

Individual site surveys and subsequent processing steps are detailed in *"Methods for Determining Aquatic Life Use Status in Selected Wadeable Streams Pursuant to Applicable Water Quality Management Objectives and Criteria for Aquatic Biota Found in Vermont Water Quality Standards (WQS) Chapter 3, Section 3-01, as well as those specified in Section 3-02(A1 and B3), Section 3-03(A1 and B3), and Section 3-04(A1 and B4, parts a-d)"* (a.k.a. biocriteria procedure). Using the biocriteria procedure, the integrity of the aquatic biota inhabiting the sites in question is attributed a rank of excellent, very good, good, fair or poor. Rankings are indicative of aquatic life use support status for each water quality classification and water management type.

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

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

Where site-specific impact assessments are conducted (including an evaluation of the appropriate chemical and physical data), potential pollution sources that are not of natural origin are spatially bracketed (i.e. above and below) with sample sites to determine effects on the aquatic biota attributable to the pollution source. Either macroinvertebrate or fish populations or both may be sampled. Approximately 50 river sites are assessed each year in the late summer-early fall (September to October 15) on a five-year rotational watershed basis. DEC has evaluated over 1,200 sites since 1990.

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

Until recently, very little biological assessment data has been available for lakes, except for a rather comprehensive, long-term database describing the distribution of aquatic macrophytes in lakes. Past assessments often relied on qualitative observations of habitat conditions, in some cases using the aquatic macrophyte data. DEC, with cooperative funding from EPA, is now finalizing a multi-metric biological index based on phytoplankton communities, and is also developing a multi-metric index to describe the condition of macroinvertebrate communities within lakes. It is anticipated that future aquatic life use assessments will be more directly based on biological data for phytoplankton, macrophyte, and macroinvertebrate assemblages. Where data are available, results of phytoplankton, macrophyte, and macroinvertebrate community assessments are being incorporated into the assessments of individual lakes. As part of the cooperative agreement with EPA, a lake biological criteria implementation procedure should be finalized as early as 2005. Macroinvertebrate and amphibian community indices are

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

3. Stream Geomorphic Assessment

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

The DEC stream geomorphic assessment program objectives are:

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

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

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

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

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

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

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

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

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

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

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

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

4. Data Solicitation

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

5. Data Quality

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

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

6. Statistical Analyses

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

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

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

7. Vermont Surface Water Assessment Categories

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

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

7.1.1. Full Support Waters

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

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

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

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

7.1.2. Stressed Waters

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

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

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

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

7.2.1. Altered Waters

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

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

7.2.2 Impaired Waters

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

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

7.3. Unassessed Waters

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

Part II. Assessment Use Support Determinations

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

1. Aquatic Biota/Habitat (Aquatic Life) Use

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

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

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

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

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

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

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

1.2. Habitat Assessment

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

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

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

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

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

Full Support: Waters that are not stressed or impaired due to conventional pollutants, assessed using the Vermont Water Quality Standards. For example, the total increase from the ambient temperature due to all discharges and activities is not known to exceed 1.0 degree F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities shall not exceed the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery).

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

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

Impaired: Temperatures are too high as a result of human activities to fully support coldwater fish species in waters designated as a coldwater fishery OR the total increase from the ambient temperature due to all discharges and activities exceeds 1.0 F for a coldwater fishery and the total increase from ambient temperature due to all discharges and activities exceeds the temperature criteria derived from tables 1 or 2 in Section 3-01.B.1.c. except as provided for in Section 3-01 B.1.d. of the Vermont Water Quality Standards (pertaining to both a coldwater and warmwater fishery).
Reliable, representative monitoring indicates that pH values repeatedly fall below 6.5 standard units or exceed 8.5 standard units across a range of weather conditions, and values are not due to natural sources.
Reliable, representative monitoring indicates D.O. values or percent saturation repeatedly fall below the standard for the water's classification and type except as noted in section 1.5.1 below.
Reliable, representative monitoring shows that turbidity values are more than occasionally above the standard for the water's classification and type as measured across a range of weather conditions and values are not due to natural sources.
Reliable, representative monitoring shows that nitrate-nitrogen and/or phosphorus repeatedly and/or consistently exceeds the standard for the water's classification, type, and elevation except as noted in section 1.5.1 below.

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

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

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

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

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

1.5. Additional Aquatic Life Use Considerations for Lakes

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

Full Support: Waters that are not stressed or impaired.

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

Stressed: Reliable long-term monitoring data indicates that a lake's alkalinity routinely drops below 12.5 mg/l (as CaCO3) during the spring runoff period.
Reliable long-term monitoring data indicates that a lake's hypolimnetic dissolved oxygen concentration periodically falls to (or near) 0 mg/l or 0% saturation during peak summer stratification, but macroinvertebrates are present. The area designated as stressed, as a result of human disturbance, is limited to the lake acreage underlain by the hypolimnetic oxygen-deficient area.

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

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

1.5.2. Lakes Conventionals (phosphorus)

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

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

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

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

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

1.5.3. Lakes – Non-Native Species

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

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

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

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

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

1.5.4. Lakes - Aquatic Life Use Assessments for Fluctuated Reservoirs

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

1) Can the level of the waterbody be regulated by an artificial structure (e.g. dam, sluice, weir)?
   Answer is NO: no alteration or stress to ALUS due to water level fluctuation. ***Full Support.***
   Answer is YES: go to 2.
2) Is the waterbody connected to a licensed or unlicensed hydroelectric generating system, a flood control system, or subject to promulgated Vermont Water Resources Board rules regulating the fluctuation?
   Answer is NO: a stress or alteration to ALUS could potentially exist, but must be verified by direct assessment before the waterbody can be correctly assessed; go to 4.
   Answer is YES: go to 3.
3) Is the waterbody regulated by a federal Clean Water Act Section 401 water quality certification issued by VTDEC after January 1, 1990?
   Answer is NO: go to 4.
   Answer is YES: ***no alteration or stress to ALUS due to water level fluctuation if operated in accordance with the license.***
4) Is the waterbody in fact subject to periodic fluctuations that are attributable to operation or manipulation of the outflow structure?

Answer is NO: ***a stress to ALUS is presumed to exist***, due to the ability of the outflow operators to fluctuate water levels if the need arises, which can negatively impact littoral zone communities. Such littoral zone impacts have the potential to cause cascading changes within the trophic web of the waterbody but cause no more than a minor change in habitat or moderate change in aquatic biota from the reference condition. The entire waterbody acreage will be assessed as stressed for ALUS.

Answer is YES: Go to 5.

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

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

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

2. Fish Consumption Use

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

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

Full Support: No fish consumption advisory in effect.

Stressed: "Restricted consumption" of fish is in effect (restricted consumption is defined as limits on the number of meals or size of meals consumed per unit time for one or more fish species).

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

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

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

3. Swimming/Contact Recreation Use

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

3.1. Indicator Bacteria

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

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

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

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

sources. Based on calculations using EPA's statistical relationships, 77 *E. coli* /100ml, expressed as a geometric mean of several samples, results in a projected illness rate of 6 in 1,000 swimmers. While this level of risk approaches the EPA minimum recommendation, it is consistent with the intent of current and prior Vermont water quality criteria for bacteria, beginning in 1985. In addition, new EPA guidance (USEPA, 2003b) on the application of water quality criteria for pathogens allows that impairment determinations can be based on geometric seasonal means or some number of single sample exceedances. EPA expresses preference for use of a longer-term indicator (geometric mean) for reporting use attainment. Given these considerations, a common-sense approach must be applied when assessing waters using *E. coli* monitoring data. The following guidelines are applied during the assessment process:

Full Support: Waters are suitable for swimming.

Stressed: Individual samples only occasionally exceed the class-specific single-sample criteria values. The geometric mean does not exceed the criterion value.

Altered: *E. coli* indicator bacteria are considered a pollutant. This assessment category is not applicable.

Impaired: For class B waters in all water management types, the geometric mean of 77 *E. coli* /100 ml is exceeded in a given segment or area and the contamination can be attributed to sources other than natural background. DEC accepts a weight-of-evidence approach to confirm that *E. coli* values are or are not of natural origin. A minimum of five samples collected regularly over the swimming season is needed, and flow and antecedent precipitation are accounted for in this determination. For class A(1) and A(2) waters, the geometric mean of a minimum 3 samples exceeds 18 *E. coli* /100ml, and the contamination can be attributed to sources other than natural background (i.e. human, livestock, domestic animal sources). Generally, data from at least two swimming seasons are needed to assess waters as impaired for swimming.

3.2. Nutrients and Nuisance Aquatic Species

Full Support: Waters are not stressed, altered, or impaired by nuisance aquatic species (includes Eurasian watermilfoil, water chestnut, zebra mussels).

Stressed: Nuisance species are present but not at levels where a nuisance has been documented or in low densities (scattered areas of growth in limited areas of the littoral zone). In the case of Eurasian milfoil, lakes within a 10-mile radius of an infested lake are considered stressed, unless access to the lake is remote or inaccessible by conventional means.

Altered: Nuisance species present in such densities such that swimming uses are not met. For aquatic macrophytes, typically these conditions are characterized by greater than 75% cover of the non-native macrophyte and are designated as "moderate" or "heavy" infestations. For species other than aquatic macrophytes such as zebra mussels, colonies would be present in such densities and at such depths as to impact swimming uses due to potential for injury to bare feet. Nutrients are not applicable in this category.

Impaired: An on-going record of public complaint concerning the algal conditions in the water has been established. For cyanobacteria (blue-green algae), waters display on-going summer blooms of toxin-producing cyanobacteria and have microcystin concentrations at elevated levels in excess of the World Health Organization guideline of 1 ug/l. Nuisance aquatic species are not applicable in this category.

4. Secondary Contact/Non-Contact Recreation Use

For assessment of Secondary Contact/Non-Contact Recreation Use, the DEC Water Quality Division uses information regarding water quantity and water quality, data and other information regarding the game fishery and records of public feedback and complaint to determine levels of support.

Full Support: Water quantity and quality sufficient for boating and fishing.

Stressed: Odor, color, plant growth, low water conditions occasionally discourage boating or fishing.

Altered: Fishing and/or boating are limited due to insufficient or diminished or lack of water, aquatic nuisance species or channel alterations. Boating is not feasible to the degree deemed achievable for the water's Water Management Type.

Impaired: Fishing and/or boating are limited due to water quality or aquatic habitat impairment(s) caused by pollutants from human sources.

5. Drinking Water Supply Use

Drinking water supply use is assessed using data on toxicants and bacteria; information on water treatment plant operation and operating costs; and, data describing cyanobacterial (blue-green algae) toxin concentrations.

Full Support: Water quality suitable as a source of public water supply with disinfection and filtration.

Stressed: This category is not applicable.

Altered: A well-established zebra mussel infestation is known to increase cost or effort to produce water that is suitable for drinking.

Impaired*:* In rivers, streams, brooks and riverine impoundments the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C of the Water Quality Standards (or as otherwise determined by the Natural Resources Agency Secretary in accordance with the Toxic Discharge Control Strategy) at flows equal to or exceeding the median annual flow for toxic substances that are classified as "non-threshold toxicants" or at flows meeting or exceeding the 7Q10 flow for toxic substances that are classified as "threshold toxicants." In all other waters, the exceedance, due to human sources, of any one human health-based toxic pollutant criteria listed in Appendix C (or as otherwise determined by the Secretary in accordance with the Toxic Discharge Control Strategy) at any time. (Note: "non-threshold toxicants" are probable or possible human carcinogens and "threshold toxicants" are not known or probable human carcinogens).
Criteria established by the Federal Safe Drinking Water Act can be met only by employing treatment practices that operationally or financially supercede customary practices that include filtration and disinfection.
Finally, waters display on-going summer blooms of toxin-producing cyanobacteria and have microcystin concentrations in excess of the World Health Organization guideline of 1 μg/l.

6. Aesthetics Use

For assessment of Aesthetic Use, the DEC Water Quality Division uses water quality and water quantity information from field surveys and public feedback and complaints to determine levels of support.

Full Support: Water character, flows, water level, riparian and channel characteristics, all exhibit good to excellent aesthetic value consistent with the waters classification. Water clarity and substrate condition is good. No floating solids, oil, grease or scum. Limited or no record of public concern.

Stressed: Aesthetic quality is compromised somewhat. Water unnaturally turbid at times. Moderate levels of plant growth above the expectation for natural communities. Small or disturbed riparian zone. Some record of public concern or complaint.

Altered: Aesthetic quality is poor due to a diminished amount of water to no water in the channel or lake resulting from human activities or due to moderate or heavy densities of nuisance non-native species.

Impaired: Aesthetic quality of water is poor. Water is frequently and unnaturally turbid. Excessive plant growth above the expectation for natural communities covers the channel or lake bottom, rocks or water surface. Substrate is unnaturally silt-covered, mucky, or otherwise changed so as to adversely affect the aesthetics in an undue manner. Presence of solid waste, floating solids, scum, oil or grease occurs frequently and persistently.

7. Agricultural Water Supply Use

There are no EPA definitions for agricultural water supply. Consequently, this use is unassessed and the four assessment categories are not used.

Chapter Five. Listing and De-Listing Methodology

Following the assessment process where waters are determined to be impaired, altered, stressed, or in full support of existing uses or designated uses associated with class and water quality management type, waters may then be categorized and placed onto one or more listings for tracking purposes. The listing of waters is undertaken for Section 303d of the Federal Clean Water Act and, outside the scope of the Act's requirements, DEC maintains several other lists for tracking and management purposes. The sum of listings maintained by DEC is collectively known as the Vermont Priority Waters List. This chapter describes how waters are assigned to the various lists based on their assessment categorization.

5.1. Impaired Waters

All waters determined to be impaired are placed on one of the following listings: Part A-303d List (impaired waters scheduled for TMDL development), Part B (impaired waters for which TMDLs are not required), and Part D (impaired waters for which TMDLs have been completed).

Determination of Pollutant

An important piece of information required in order for a water to be listed as impaired is the determination that the pollutant(s) causing the condition is a result of human activity and not of natural origin. The pollutant becomes the basis for loading determinations and TMDL development or for the control measures to be implemented. DEC attempts to be as accurate as possible as to causal pollutant determination. Where appropriate, DEC subscribes to EPA's Stressor Identification Methodology (USEPA, 2000b). In the absence of EPA's Stressor Identification Methodology or pollutant data, DEC may use biological assessment indicators (refer to previous chapter on biocriteria and biomonitoring) to identify by inference most probable causal pollutants or stressors.

Where there is monitoring data that identifies a violation of a numeric standard, the pollutant may be identifiable. For example, long-term monitoring data may identify a segment of Lake Champlain as exceeding the numeric criterion for total phosphorus as opposed to measured below standard dissolved oxygen which does not necessarily identify a pollutant. Where there is monitoring data that identifies a violation of a narrative standard, the identification of the causal pollutant is more complex. An example of this would be where biological data taken from a stream indicates non-support of aquatic life.

One of DEC's methods of determining compliance with water quality standards is by assessing the biological integrity of the aquatic biota. The benefits of using biocriteria as a *direct* measure of waterbody health are that the approach takes into account the impact of all stressors on a waterbody and provides an overall assessment of the water's health and its ability to support aquatic life. Biological assessment data provide generalized guidance on the nature and extent of the stressor(s) when a problem is detected. The poor condition of a waterbody's biotic community is often related to several factors. Evaluation of the biological data combined with the implementation of stressor identification methodologies can result in the development of a defensible list of most probable stressor candidates or suites of pollutants/stressors of common origin (e.g. stormwater).

In the 2002 version of the Vermont 303d List, and previous years' iterations, the term "undefined" was used under the "Pollutant(s)" column to either suggest a broad suite of potential pollutants or when there was uncertainty about whether the standards violation was caused by a pollutant. For 2006, DEC will use a more rigorous method to determine the causal pollutant. Using current data, knowledge of the specific situations, and best professional judgment, it will be determined whether there is sufficient evidence that the standards violation is caused by the discharge of a pollutant to the water, and if so, the pollutant will be identified. There remain instances whereby the specific pollutant may not be identifiable but a

particular class of discharge, known to contain pollutants, is still determined to be responsible for the impairment. An example of this instance is the discharge of collected stormwater runoff from impervious surfaces. In this example, if the evidence from an on-site investigation suggested that "stormwater" and its associated pollutants was the cause of the impairment, then "stormwater" would be cited as the pollutant on the 303d List. Often accompanying "stormwater" are the instream effects from the altered hydrology stemming from impervious surface runoff. However, since a discharge of pollutants, not altered hydrology, is the primary factor in a water being listed on Part A, there must be some indication of pollutants being discharged. At this time, since it is unknown to what degree either of the problems (pollutants or hydrology) have on these waters, they are listed as impaired by "stormwater" because of the likelihood of pollutants being discharged and that they contribute to the failure to meet water quality standards. Only when there is sufficient evidence that a Standards violation is the result of pollutants discharged to the water will the water be identified as impaired.

In instances where monitoring data identified a water as impaired based on *E. coli* bacteriological data, the causal pollutant in past versions of the 303d List identified "Pathogens" as the pollutant. This procedure was followed because *E. coli* is used and recognized as an indicator of potential illness-causing pathogens. DEC now identifies *E. coli* as the pollutant if there is no monitoring data identifying the existence of other pathogens. The source(s), however, must be confirmed not to be of natural origin.

Part A - 303d List

Part A of the 2006 List of Waters identifies impaired surface waters that are scheduled for total maximum daily load (TMDL) development. Certain impaired surface waters may have TMDLs developed as a group of waters due to the similarity of problems. Part A of the List has been prepared in accordance with current EPA 2006 Guidance and the Environmental Protection Regulations 40 CFR 130.7 ("Total maximum daily loads (TMDL) and individual water quality-based effluent limitations"). A TMDL is deemed necessary for these waters in order to establish the maximum amount of a pollutant that may be introduced into the water after the application of required pollution controls and to ensure the Water Quality Standards are attained and maintained. Waters appearing in Part A are equivalent to "Category 5" waters described in EPA's 2006 Guidance.

In addition to identifying the waterbody, the 303d list identifies the pollutant(s) causing the impairment, the priority ranking for TMDL development and which water use(s) are impaired. DEC has also described the specific water quality problem.

TMDL Scheduling

Priority ranking for TMDL development was developed considering: (1) health issues, (2) the nature, extent, and severity of the pollutant(s), (3) the use or uses that are impaired, (4) the availability of resources to restore the water, and (5) the degree of public interest in problem abatement.

Public Comment Opportunity, Submittal to EPA and EPA Approval

Upon compilation of the draft Part A-303d List, it is made available to the public for review and comment. Notification of availability is at a level sufficient to allow broad coverage of the general public and may include notices in newspapers, State web sites and direct notification through email or mailing lists. In addition to notification, public meetings are conducted to further the public's understanding of the document and to receive verbal comments. Following receipt of public comments, a responsiveness summary is developed that describes how the comments were addressed. Appropriate changes are made to the list. A final version of the Part A-303d List is then sent to the New England regional office of EPA for review and approval.

De-listing - Interim List

During development of the 2006 Part A-303d List there may arise the need to propose for de-listing water(s) previously identified on the year 2004 Part A-303d List. Waters proposed for de-listing will be presented on the 2006 Interim List. This list is termed "interim" because it only exists during the period of Part A-303d List development - the period between release of the 2006 Part A-303d List for public comment and the list's final approval by EPA. The sole purpose of this interim listing is to notify the public and EPA of the de-listing proposals and to provide the rationale and justification for such proposals.

On the Interim List, each entry contains specific information for that particular waterbody as to why it is being proposed for de-listing. The waterbody-specific rationale is intended to provide "good cause" for de-listing. The three scenarios below cover the broad range of circumstances for which waters may be proposed for de-listing in the 2006 list cycle.

- **Scenario 1. Absence of previously known impairment shown by water quality monitoring data.**

  Where there is water quality data confirming the absence of a previous impairment or where a waterbody has been improperly listed due to a lack of sufficient water quality data, DEC will propose to de-list waters that appeared in the EPA-approved 2004 Part A-303d List. The absence of impairment can be substantiated by data of a comparable quantity and quality as the data that was required to assess the water as impaired (for example, 2 years of biological or chemical data needed to establish impairment generally means 2 years of data needed to establish attainment).

- **Scenario 2. Impaired waters that do not need or require a TMDL determination.**

  Current EPA guidance for the 2006 303d List includes a category of impaired waters whereby a TMDL is not required because existing pollution control requirements are reasonably expected to result in the attainment of the water quality standard in the near future. In light of this, DEC can propose to de-list impaired waters that do not need or require a TMDL. It is important for the reader to understand these waters remain assessed as impaired (until water quality is restored) but will, after EPA approval for de-listing, be shown in Part B of the Vermont Priority Waters List.

  In order to de-list certain impaired waters from Part A (and move them to Part B), DEC must be convinced that other pollution control requirements, such as best management practices, will result in the attainment of Vermont Water Quality Standards. Specifically, DEC needs to show that (1) there are legal requirements in place (e.g. regulations, permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time.

- **Scenario 3. Impaired waters with an EPA approved TMDL.**

  Impaired waters for which an EPA-approved TMDL exists can be de-listed from Part A according to EPA's 2006 Guidance. These waters will then be found in Part D of the Vermont Priority Waters List. Each water covered by an EPA-approved TMDL will continue to be listed in Part D whether the impairment continues to exist or not.

Part B List

All waters listed in Part B are assessed as impaired and do not require development of a TMDL as described in 40 CFR 130.7. Section 303d of the Federal Clean Water Act does not govern these waters. Impaired waters that do not need a TMDL are those where other pollution control requirements (such as best management practices) required by local, state or federal authority are expected to address all water-pollutant combinations and the Water Quality Standards are expected to be attained in a reasonable period

of time. DEC will provide information to show that (1) there are legal requirements in place (e.g. regulations or permits implementing regulations) that apply to the source(s) causing the water quality impairment and (2) that such legally required pollution control practices are specifically applicable to the impairment in question **and** are sufficient to cause the water to meet water quality standards within a reasonable time. Waters shown in Part B are equivalent to "Category 4b" waters of EPA's 2006 Guidance. If, in the future, it is determined that waters are no longer impaired, they will be removed from Part B without formal notice.

Part D List

All waters identified on Part D have appeared on a previous version of the Part A-303d List and also have completed and approved TMDLs in place. If future assessments show the impairment has been eliminated, the waters will remain on Part D as a means of TMDL tracking, however, the current assessment status of the water will be noted. Waters shown in Part D are equivalent to "Category 4a" waters of EPA's 2006 Guidance.

5.2. Altered Waters

All waters determined to be altered are placed on one of several lists that track altered waters. These lists include: Part E List (water altered by exotic species), Part F (waters altered by flow regulation), and Part G (waters altered due to physical channel changes). The listing methodology for each list is given below.

Part E List

Waters appearing in Part E are assessed as "altered." They represent situations to be given priority for management where aquatic habitat and/or other designated uses have been altered to the extent that one or more designated uses are not supported due to the presence of exotic aquatic species. This list currently includes waters altered by the proliferation of Eurasian watermilfoil, water chestnut, zebra mussels or the presence of alewives. Waters shown in Part E are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part E List when the population of the exotic species declines and the water is assessed as either "stressed" or in "full support" of the designated uses.

Part F List

Waters appearing in this part of the Vermont Priority Waters List are assessed as "altered." They represent priority management situations where aquatic habitat and/or other designated uses have been altered by flow regulation to the extent that one or more designated uses are not supported. Alterations arise from flow fluctuation, obstructions, or other manipulations of water levels that originate from hydroelectric facilities or other dam operations or from water withdrawals for industrial or municipal water supply or snowmaking purposes. Waters shown in Part F are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part F List as corrective actions are implemented.

Part G List

Waters appearing in Part G have been assessed as "altered" where the geomorphic assessment condition (derived from Phase 1 and Phase 2 data) is predominantly the result of in-stream human-induced channel management activities. These waters include stream or river reaches with significant impacts due to physical channel alterations, documented channel degradation or a change in stream type that have resulted from human activities such as gravel mining, dredging, channelization, improper bridge or culvert placement, or floodplain encroachments. In these situations, the aquatic habitat is altered from the stable ecological state due to changes in bedload movement and habitat feature loss so that one or

more designated uses are not supported. In these altered reaches, the changes in bedload and habitat features result from an instability of the system itself as streams naturally realign themselves into a new natural equilibrium. Waters shown in Part G are equivalent to "Category 4c" waters of EPA's 2006 Guidance.

Waters will be removed from the Part G List when the aquatic habitat reaches a stable ecological state naturally or as a result of channel management efforts which reduce bedload transport and the water is assessed as either "stressed" or in "full support" of the designated uses.

The Part G listing is not intended for waters that are subject to myriad discharges or multiple stressors or in watersheds subject to unremediated stormwater discharge(s). Part G is inappropriate for waters that are subject to influxes of washload arising from continuing watershed perturbations.

5.3. Stressed Waters

A subset of waters assessed as "stressed" are listed on the Part C List (waters in need of further assessment).

Part C List

All waters appearing in this component of the Vermont Priority Waters List are assessed as "stressed" and have been identified as needing further assessment to confirm the presence of a violation of one or more criteria of the Vermont Water Quality Standards. A violation has not been documented by sufficient data (i.e. there is an insufficient weight of evidence). Part C waters are considered high priority waters for assessment and monitoring.

In the event a violation is substantiated and determined to exist, DEC will assess the water as "impaired" or "altered," depending on whether or not the cause of the violation is a pollutant, and then assign the water to either Part A (impaired needing a TMDL), Part B (impaired not needing a TMDL), Part E (altered by exotic species), Part F (altered by flow regulation), or Part G (altered by physical channel changes). In the event, however, further monitoring is conducted and the weight of evidence becomes sufficient to show compliance with the Vermont Water Quality Standards, the water will be removed from the Part C listing.

5.4. Full Support Waters

Waters that fully support designated uses are not tracked on the Vermont Priority Waters List.

5.5. Comparison to EPA's Listing Categories

The development of this most recent listing methodology relies upon EPA guidance that outlines a consolidated report regarding the status of all the waters in the state. For comparative purposes, the table below shows how the various DEC listing components correspond to EPA listing categories.

Table 5.1. Comparison between Vermont DEC Listing Components and EPA Listing Categories.

Vermont DEC Listing Components	EPA Listing Categories
Full support waters. Not tracked on the Vermont Priority Waters List	Category 1
Part C waters	Category 2
Unassessed waters. Not tracked on Vermont Priority Waters List	Category 3
Part D waters	Category 4a
Part B waters	Category 4b
Part E, Part F and Part G waters	Category 4c
Part A waters	Category 5

Chapter Six. References

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APPENDIX A

Summary Description of
Vermont Water Quality Division Monitoring Programs

Vermont Department of Environmental Conservation

A Descriptive Listing of Water Quality Division Monitoring Programs

The Water Quality Division (WQD) is responsible for conducting much of the Department's ambient surface water quality monitoring activities. WQD efforts in this regard are comprised of numerous discrete projects and programs. The Division's monitoring efforts can be classified as physical/chemical, biological, volunteer and other. Within each of these broad classes, monitoring projects are further described as core, or long-term projects; diagnostic studies, which identify the causes of particular water quality problems; and special studies, which provide information and data on specific water quality issues. There are, in addition, other projects coordinated by close partners of the WQD which tend to broaden the scope and geographic extent of assessment data collection. Analysis of samples for organic and inorganic compounds and heavy metals would not be possible without the analytical services of the R.A. LaRosa Environmental Laboratory.

A. Physical & Chemical Monitoring

1. Core Programs

The Spring Phosphorus Program collects during the spring overturn (typically late March to May 10) nutrient and physical and chemical data on Vermont lakes and ponds that are 20 acres in size or larger. On average, 50 to 60 lakes are sampled each year. Ten lakes are customarily sampled every year. Parameters include total phosphorus, total nitrogen, alkalinity, calcium, magnesium, hardness, Secchi disk transparency, and multi-probe profiles (temperature, dissolved oxygen, conductivity, and pH). Since 1977, 236 lakes have been monitored in conjunction with this program. Forty-eight lakes have 10 or more years of data, and 18 of these have 15 years or more. The Spring Phosphorus Database contains over 1,700 records.

The Lake Assessment Program is designed to rapidly assess the extent to which lakes meet designated uses and to gather information to focus lake management and protection efforts. The sampling intensity for assessment lakes varies with the degree to which impairment is evident or must be documented. Lakes being evaluated under this program are those found in the basins being examined under the rotational watershed assessment approach. In general and during the summer months, lakes are circumnavigated and detailed assessment observations are made regarding in-lake and shoreline conditions with respect to designated uses and threats to water quality. Detailed notes are made regarding the extent and species composition of the macrophyte community. Sampling is performed for total phosphorus, alkalinity, Secchi disk transparency, and multi-probe profiling. Additional sampling may be performed as necessary to determine compliance with Water Quality Standards. Since 1989, 281 comprehensive assessments and 59 cursory assessments have been performed under this program.

The River Assessment Program is designed to assess the extent to which rivers and streams support designated uses to focus management and protection efforts. The assessments themselves involve collecting, compiling, analyzing and evaluating all water quality data and information as well as point and nonpoint source pollution impacts on designated uses specific to the basins being assessed in any given year under the rotational watershed assessment approach. Rivers and streams in the basins of the rotation focus are visited in the spring, summer and fall to look for obvious sources of pollution from the land or indicators of problems or threats in the water such as sedimentation, heavy algae growth, or water with

unnatural color or odor. The Ambient Biomonitoring Program (described on page 5 below) provides most of the information used to determine a waterbody's aquatic life use support and compliance with Vermont Water Quality Standards. Temperature, nutrients, pH, conductivity, and alkalinity are parameters commonly measured concurrently with any biological sampling.

The Water Level Monitoring Program monitors lake surface elevations (June 1 to September 15) to establish mean water levels for a variety of purposes, most notably to determine the jurisdictional boundary of the State's lakes and ponds under the shoreland encroachment permit program and Vermont's Public Trust Doctrine. On average, 40 lakes are visited each year.

The Lake Champlain Long-Term Monitoring Program surveys the quality of Lake Champlain waters on a bi-weekly basis (May to November) at 12 locations throughout the lake. The mouths of eighteen major tributaries are sampled on an event basis as well. The program's large physical and chemical parameter list includes species of phosphorus, nitrogen and organic carbon; chlorophyll-a; base cations; alkalinity; total suspended solids; dissolved oxygen; conductivity; and pH. As of April 2003, this program had assembled a database comprising 6,366 lake and 4,282 tributary sampling events.

The Long-Term Monitoring (LTM) Acid Lakes Program collects chemical and biological data on lakes located in low alkalinity regions (those sensitive to acidification based on the bedrock buffering capacity) to determine the effects of acid deposition on Vermont's lakes. Nearly 200 lakes statewide were surveyed during the winters of 1980 through 1982 to identify the acid sensitive areas of the state. Eleven lakes selected from these areas are now included in the LTM and are sampled at least eight times every year for sixteen chemical parameters related to acidification. This data is used to: 1) classify lakes according to their acidification status; 2) evaluate spatial and temporal variability in measured parameters; 3) track changes in acidification status over time as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen); and 4) evaluate impacts of acidification on aquatic biological communities. As of April 2003, the LTM data archive comprises 1,857 lake and 405 outlet sampling records.

The Stream Geomorphic Assessment Program collects geomorphologic data on streams throughout the state to assess stream geomorphic stability and develop regime relations for Vermont's streams. Stability assessments enable the prediction of expected rates of river adjustment and an evaluation of the effects of various land and river management practices on geomorphic stability and physical habitat quality. Regime relations guide stream protection, management, and restoration projects and assist in the establishment of Vermont-specific physical criteria for water quality classification and use attainment determinations. Parameters measured in this program, typically during low flow periods, include channel dimension (cross section), pattern (meander geometry), longitudinal profile, channel substrate conditions, structure and composition of riparian vegetation, and floodplain and valley morphology.

This Program has also produced a Stream Geomorphic Assessment Handbook containing recommended protocols and procedures for completing such work. The Handbook's protocols, produced in cooperation with Vermont Department of Fish and Wildlife and VTDEC's Geology and Mineral Resources Division, are for Phase 1, Phase 2 and Phase 3 assessments. The Handbook's protocols are being used by VTDEC and by other groups gathering geomorphologic data.

As of August 2003, the Program has obtained or is aware of geomorphic assessments concerning 17 rivers/streams located in 12 of Vermont's 17 river basins. Phase 1 assessments have been conducted for approximately 1,200 reaches. About 200 reaches have a Phase 2 assessment.

2. Lake Diagnostic Studies

Diagnostic studies are typically aimed at identifying the cause of eutrophication in Vermont lakes. Over the past 20 years, VTDEC has performed numerous such monitoring studies, and the results of these studies have led to concrete remediation steps. Lakes on which notable diagnostic studies have been performed include Harveys Lake (Barnet), Lake Morey (Fairlee), Lake Iroquois (Hinesburg), Fairfield Pond (Fairfield), Lake Parker (Glover), Lake Carmi (Franklin), and Lake Champlain. A diagnostic study was recently completed on Ticklenaked Pond (Ryegate).

A wide variety of parameters are sampled throughout the year in conjunction with diagnostic studies, with the actual tests performed being specific to the project's objectives. Standard eutrophication parameters (total phosphorus, Secchi disk transparency, and dissolved oxygen) are always measured. Other parameters from both the sediment and the water column are measured as needed.

3. Special Studies

Special studies are those performed to gain more information about a particular environmental issue of importance to VTDEC and the Agency of Natural Resources. There are three such projects being cooperatively managed by the WQD. A fourth special study project was completed in June 2001.

The EPA-sponsored **REMAP Assessment of Mercury in Sediments, Waters and Biota of Vermont and New Hampshire Lakes Project** is a three-year effort to identify lake types occurring in the two states that have elevated levels of mercury in fish and upper trophic level biota. The parameter list for this integrated collaborative monitoring project is large, and includes standard limnological measurements and mercury in total and methyl phases in sediment, water, and biota. There is also a paleolimnological component that has determined the extent to which atmospherically deposited mercury has entered lakes in the study set. Two peer-reviewed journal articles have been produced from this study.

The Best Management Practices Effectiveness Demonstration Project is a stream monitoring effort designed to assess the efficacy of best management practices in controlling pollutants in nonpoint source runoff. This cooperative VTDEC-USGS project employs an upstream-downstream approach to pinpoint reductions in pollutant runoff attributable to specific installed BMPs. The multi-year project is being carried out in one agricultural stream (Little Otter Creek) and one urban stream (Englesby Brook) in the Lake Champlain basin.

In conjunction with **the Paleolimnology of Vermont Lakes Project**, the WQD is collaborating with the University of Vermont to develop a set of indicators of present and historical trophic status based on the paleolimnology of carbon and nitrogen stable isotopes ($\delta^{13}C$ and $\delta^{15}N$). Using cores from the sediments of several lakes, the WQD is working to identify the extent to which the present trophic condition in these lakes deviates from the historic background. Such information will be instrumental in understanding the extent to which productivity (and thus phosphorus) has been elevated since the lake watersheds were first disturbed.

The Lake Champlain Agricultural Best Management Practices Monitoring Project was a seven-year special water quality monitoring project completed in 2001. This comparative observational study used a three-way paired watershed experimental design using a single control and two treatment watersheds. The goal was to evaluate the efficacy of both low- and high-intensity whole-watershed BMP implementation strategies. Parameters measured included total phosphorus, total and Kjeldahl nitrogen, total suspended solids, and *E. coli*. Biological assessments of fish and macroinvertebrate communities were also performed on each of the three watersheds.

B. Biological Monitoring

1. Core Programs

The Ambient Biomonitoring Program was established in 1982 to: 1) monitor long-term trends in water quality as revealed by changes in ambient aquatic biological communities over time; 2) evaluate potential impacts on aquatic biological communities from permitted direct and indirect discharges, Act 250 projects, nonpoint sources, and spills; and 3) establish a reference database to facilitate the generation of Vermont-specific biological criteria for water quality classification and use attainment determinations. Since 1985, VTDEC has used standardized methods for sampling fish and macroinvertebrate communities, evaluating physical habitat, processing samples, and analyzing and evaluating data. The program has led to the development of two Vermont-specific fish community Indexes of Biotic Integrity (IBI) and several macroinvertebrate metrics. Guidelines have been developed to determine water quality standards attainment using both macroinvertebrate community biological integrity metrics and the IBI. Approximately 75 sites per year are assessed, typically during the fall season, using fish and/or macroinvertebrate assemblages. Alkalinity, pH, conductivity, temperature and such measurements as substrate composition, embeddedness, canopy cover, percent and type of periphyton cover, and approximate velocity are routinely monitored. This program provides much of the biological data used in the rotational watershed assessment program for rivers. From 1985 to April 2003, well over 1,700 stream assessments were completed using macroinvertebrate and/or fish from 1,229 stream reaches.

The Aquatic Macrophyte Monitoring Program collects baseline information on aquatic plant communities in Vermont lakes by conducting descriptive surveys using a pre-established plant cover scale. This program has been active since the late 1970's and information is available from 177 discrete surveys.

The WQD conducts numerous Aquatic Nuisance Species Searches and Surveys each year to search for new populations and monitor existing populations of nuisance aquatic species, primarily Eurasian watermilfoil (*Myriophyllum spicatum*), water chestnut (*Trapa natans),* zebra mussels (*Dreissena polymorpha*), and the wetland invasive purple loosestrife (*Lythrum salicaria*).

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

2. Special Studies

The Biodiversity Monitoring Program evaluates the status of selected biological species and communities in Vermont. Specific activities include: 1) distribution surveys of aquatic plant, fish and macroinvertebrate species listed by the Vermont Endangered Species Committee as rare, threatened, endangered, or of special concern; 2) distribution surveys of communities having species considered likely candidates for future listing (e.g., snails); and 3) monitoring of biological communities or

community types whose diversity is threatened (e.g., Lake Champlain mussel and cobble/shale macroinvertebrate communities threatened by zebra mussels). Data are used to describe species distribution, identify species/communities at risk, and develop management plans for the protection of identified species/communities.

The Vermont Wetlands Bioassessment Project is a coordinated effort between VTDEC and the Vermont Department of Fish and Wildlife's Non-game and Natural Heritage Program to document and understand the biological and physical characteristics associated with seasonal pools (vernal pools) and northern white cedar swamps in Vermont. Since 1999, the project has collected biological, physical and chemical data from 28 seasonal pools throughout the state. Information collected on the invertebrates, amphibians, algae, and plants associated with seasonal pools has been used to assess and monitor the ecological health of seasonal pools in Vermont. Preliminary efforts at using these data to develop vernal pool biocriteria have seen limited success.

The Lake Bioassessment Project was initiated in 1995 to begin developing biological criteria for Vermont lakes. This monitoring effort was launched as a cooperative project with the State of New Hampshire. The goal of the project is to develop numeric measurements of the phytoplankton, macrophyte, and macroinvertebrate communities in reference lakes for use in assessing aquatic life use attainment in lakes. Consistent protocols have been developed to measure these biological assemblages, and to date, 12 New Hampshire and 38 Vermont lakes have been included in the project. Statistically-validated multimetric indices have been developed for the phytoplankton macroinvertebrate communities, and remain under development for macrophytes.

The Lake Champlain Long-Term Monitoring Program (see also above) includes biological sampling, which is primarily aimed at assessing phytoplankton, zooplankton, and macroinvertebrate communities. Data from this element of the project resides in the New York State Natural History Museum, with copies available only in spreadsheet form in Vermont. These data, which have been underanalyzed and underutilized, should provide a baseline for evaluating changes in ecosystem structure anticipated owing to zebra mussel infestation.

The Northern Leopard Frog Surveys in the Lake Champlain Basin Project was initiated in response to reports of malformed frogs in the Vermont portion of the Lake Champlain basin during the summer of 1996. Malformed frogs were reported from 12 sites in five Vermont counties. Systematic field surveys were initiated in 1997, targeting the northern leopard frog (Rana pipiens). These surveys recorded the frequency and morphological characteristics of gross abnormalities among newly metamorphosed northern leopard frog populations at 20 sites within the basin. With subsequent support through the USEPA REMAP program, WQD has examined over 6,000 northern leopard frogs since 1996, and external malformations have been detected in 7.5% of the frogs examined. Data characterizing the gross abnormalities and describing the frequency and occurrence of abnormalities within northern leopard frog populations continues to be gathered at 10 established sites within the lake basin. All findings are reported to the North American Reporting Center for Amphibian Malformations (http://www.npwrc.usgs.gov/narcam/). VTDEC continues to collaborate with the National Institute of Environmental Health and Sciences, the National Wildlife Health Center, and other researchers, providing environmental samples and specimens to help further malformed frog investigations.

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

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

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

C. Volunteer Monitoring

Citizen groups are becoming increasingly involved in monitoring, education, protection, and restoration projects in Vermont. VTDEC provides assistance and training to volunteers whenever possible. Watershed and lake associations are presently active on numerous rivers and lakes in the state. In fact, there are over 100 such associations statewide. The WQD has developed a directory listing various watershed associations and their activities in "Current Programs of Vermont Watershed Associations – 2002," with a lake association addendum listing active lake groups which can be inspected at WQD's web site (www.vtwaterquality.org, click on "lakes and ponds," click on directory).

1. Core programs

The Vermont Lay Monitoring Program equips and trains local lake users to measure the nutrient enrichment of lakes by collecting water quality data following a rigorously documented and quality assured methodology. This citizen monitoring program is based on trophic parameters and monitors approximately 40 lakes and 25 Lake Champlain stations per year. All Lake Champlain stations and many inland lakes in the program are sampled for chlorophyll-a, total phosphorus, and Secchi disk transparency. The remaining inland lakes in the program, from which more limited data are needed, are sampled only for Secchi disk transparency. All sampling occurs on a weekly basis during the summer months. Since development of the Lay Monitoring Program in 1979, data has been generated on 84 inland lakes and 36 Lake Champlain stations. Seventy-two inland lakes and 30 Lake Champlain stations have five or more years of full season data. In addition to their standard monitoring, Vermont's citizen lake monitors also assist in the ANS Watchers Program (see below), and in collecting data for the Lake Bioassessment Project.

The Citizen Lake and Watershed Survey Program provides survey sheets and technical training to volunteers, lake and watershed associations, and other interested groups to enable them to perform screening level assessments to identify potential nonpoint sources of pollution to lakes by conducting in-lake, lakeshore, and lake watershed surveys.

The Aquatic Nuisance Species (ANS) Watchers Program trains citizen volunteers to monitor for the presence of invasive non-native aquatic species. The program is currently focusing on monitoring for Eurasian watermilfoil, water chestnut, and zebra mussels. There are presently 129 ANS Watchers throughout Vermont.

The Volunteer Acid Precipitation Monitoring Program was initiated in 1980 to assess the impact of the 1970 Clean Air Act (and it's 1990 amendments), which mandated nationwide reductions in SO_4 emissions. Dedicated volunteers at six sites around Vermont (Holland, Morrisville, Mt. Mansfield, St. Albans, St. Johnsbury, and Underhill) collect precipitation samples on an event basis. The volume and pH

of each storm event is recorded. Additional parameters such as conductivity and wind direction are recorded at individual stations. The data are used to: 1) assess spatial and temporal variability in the pH of bulk precipitation; and 2) assess changes in the pH of bulk precipitation over time and as related to reductions in atmospheric emissions of acid precursors (e.g., oxides of sulfur and nitrogen).

2. Other volunteer initiatives

In 2003, the WQD and the R.A. LaRosa Environmental Laboratory launched a new initiative to foster volunteer monitoring by providing laboratory analytical services cost-free to volunteer organizations under a competitive grant program. While this program is just beginning, it does provide an opportunity to significantly enhance the monitoring of waters of joint importance to volunteer organizations and WQD. Grantees under this program are required to prepare, submit, and adhere to an USEPA pre-approved 'checkoff' QAPP prepared by USEPA Regions 1 and 2 in collaboration with VTDEC and New York State DEC, for volunteer-based projects funded by the Lake Champlain Basin Program. These projects promise to provide a wide array of data of known quality and reliability to be used for assessment reporting.

D. Other Monitoring Partnerships

1. Federal

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

The US Environmental Protection Agency (EPA) coordinates regional water quality monitoring projects of a wide variety. In recent years, projects that WQD has collaborated on include the REMAP New England Wadeable Streams Project and the National Study of Chemical Residues in Fish. EPA was also the principal sponsor of the REMAP Assessment of Mercury in Waters, Sediments and Biota of Vermont and New Hampshire lakes project and in the survey of pharmaceuticals in certain Vermont waters. WQD plans to participate in the upcoming REMAP New England Lakes Project. Results of these studies are used for a variety of purposes in addition to assessment reporting.

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

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

2. State

The Vermont Department of Forests, Parks, and Recreation (DFP&R) operates a comprehensive beach monitoring program for all public use beaches on State Park lands. Twenty-nine beaches are monitored on a weekly basis during the summer (June – August) following established protocols. Swim advisories are posted by DFP&R based on results of the testing when *E. coli* sample values exceed the Vermont criterion for Class B waters of 77/100ml. These data are openly shared with WQD, who uses the data for the purpose of assessment reporting and for identifying beaches subject to potentially chronic bacterial contamination.

The Vermont Monitoring Cooperative (VMC) is a collaborative organization in which scientists collect and pool information and data for the purpose of improving our understanding, protection, and management of Vermont's forested ecosystems. Participating cooperators from government, academic and private sectors, conduct research projects on a variety of topics including forest health, air quality and meteorology, wildlife, aquatic systems and others. The VMC helps make the data and results from these projects available to other scientists, educators, resource managers and the general public. The VMC was initiated in 1990 as a state, university, and federal partnership, with an envisioned one-hundred year lifespan. The centerpiece of the VMC is the data library and card catalogue system that allow data to be shared, archived, and accessed by scientists and other interested parties via the VMC website. The data archive contains data and ancillary textual material from over 100 projects and is geographically and temporally linked.

The Vermont Geological Survey (VGS), also known as the Geology and Mineral Resources Division of VTDEC, conducts research and surveys related to the geology, mineral and groundwater resources of Vermont. VGS serves as a clearinghouse for the State's topographical information.

3. Local

The Addison County Collaborative (ACC) is a volunteer-based consortium of local volunteer organizations that monitor waters in several watersheds in the vicinity of Addison County. Partial funding is typically allocated through the Addison County Regional Planning Commission. ACC has monitored approximately 45 sites across four watersheds for *E. coli* and eutrophication-related parameters. ACC provides data and summary reports to VTDEC on an annual basis. These data are used to assist development and implementation of the Otter Creek and Lower Direct Champlain Basin Plans and in assessment reporting.

The Lewis Creek Association (LCA) is a private, non-profit organization dedicated to protect, maintain and restore ecological health while promoting social values that support sustainable community development in the six-town watershed region as well as other areas of Vermont. LCA is a member organization of the ACC noted above.

The White River Partnership (WRP) is a private, non-profit organization dedicated to helping local communities balance the long-term cultural, economic and environmental health of the watershed through active citizen participation. The WRP, using US Department of Agriculture funding leveraged by private donations, has established a monitoring program for the watershed, comprised of multiple elements and several volunteer "stream-teams." Activities include geomorphic assessment, priority site mapping, and water quality sampling for a variety of constituents including temperature, turbidity, conductivity, and *E. coli*. WRP's active base of volunteer monitors generate quality-assured data that is used to identify

priority reaches for protection or remediation. VTDEC is periodically provided data summaries for use in implementation of the White River Basin Plan, in assessment Reporting, and in other joint special studies.

The West River Association (WRA) is a newly forming group dedicated to similar goals as the WRP and ACC, for waters in the West River watershed. This organization plans to launch a new monitoring project in partnership with WQD during 2003. Project data will be used for several purposes including assessment reporting.

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

The Watershed Alliance of the University of Vermont and **River Network** have been active in promoting surface water quality monitoring for elementary and high schools. Such monitoring is valuable from an educational and student/community involvement standpoint. When monitoring results are shared with VTDEC, the information can be considered during assessment reporting.