New Hampshire Department of Environmental Services Water Monitoring Strategy

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I. Executive Summary

The Watershed Management Bureau at the New Hampshire Department of Environmental Services (NH DES) is responsible for understanding and assessing the quality of the state's surface waters. In order to fulfill this responsibility, the Bureau gathers many thousands of water quality samples each year. The water monitoring strategy will help to guide that effort to ensure that it is effective in reaching the goals set forth by the Bureau. The strategy addresses the Bureau's monitoring plans from 2014 - 2024.

The goal of the strategy is the collection of high quality data for the purpose of making informed and accurate water management decisions and communication to the public regarding the health and safety of the state's waters. It is designed to fulfill the dual purpose of satisfying the requirements of the 2003 EPA guidance document entitled "Elements of a state water monitoring and assessment program" (EPA 2003); and serving as a "manual" to NH DES in implementing its surface water monitoring programs and use of the data that is gathered through these programs.

The strategy focuses on NH DES' monitoring efforts of the state's inland surface waters, namely lakes/ponds and rivers/streams. With approximately 17,000 miles of rivers/streams and over 1,200 lakes/ponds, these surface waters represent important ecological, recreational and economic resources. The decision to focus on these waterbody types was based on an acknowledged need for a more collaborative approach to data collection and utilization. The revised approach integrates multiple monitoring programs within NH DES and makes full use of volunteer collected data. Collectively, the strategy makes efficient use of limited monitoring resources for sampling New Hampshire's surface waters, sets forth a plan for data usage, and a timetable for reporting.

The strategy is organized around a basic conceptual model designed to achieve specific water quality-based objectives. At the center of the model are three design components:

1) **Probability-based water quality surveys**: a statistical approach to understand overall conditions state-wide;
2) **Trend-based monitoring:** to track the trajectory of important water quality indicators over time, and;
3) **Synoptic (or site specific) monitoring:** collection of summary water quality data in a coordinated fashion from targeted, site-specific locations in order generate a statewide dataset over time.

Probability-based monitoring refers to the random selection of a subset of sample locations that are representative of the entire population of a particular waterbody type. By collecting data from each of the randomly selected sites the overall condition of the waterbody type can be predicted with an known level of confidence. Probability surveys represent a cost effective means for estimating and reporting on the physical, chemical, and biological conditions by waterbody type and the factors that affect these conditions at a particular point in time.

NH DES probability surveys build on the National River/Streams and National Lakes Assessments, used by EPA to periodically report on the quality of the nation's waters. The NH DES strategy will add to, or intensify, the sampling of the national probability sites that fall in New Hampshire once every 10 years for each waterbody type in order to complete a statewide assessment of conditions. State-wide condition reports are planned for 2017 for rivers/streams and 2022 for lakes/ponds.

Trend monitoring is, as the name indicates, an attempt to understand how conditions are changing over time. NH DES trend monitoring is designed to "pick up", or detect, water quality trends in the state through repeated monitoring visits to a set number of sites over the long term. Trend monitoring for rivers and streams will consist of 40 sites that are spread out relatively evenly across large watersheds (HUC8s), include rivers and streams of many sizes, and represent a number of different upstream land use patterns. Data collection, analysis, and reporting will be completed primarily by NH DES staff with assistance from the Volunteer River Assessment Program (VRAP). Trend monitoring for lakes and ponds will consist of 84 waterbodies, include different lake trophic classes (or age), and also be represented across watersheds and land use patterns. Data collection for trend lakes and ponds will be completed exclusively through the Volunteer Lakes Assessment Program (VLAP) with analysis and reporting by NH DES staff. Waterbody-specific trend reports are scheduled for completion every 10 years starting in 2021.

Last, synoptic monitoring is designed to provide a structured framework for short-term, focused water quality monitoring efforts (1-3 years) in surface waters in order to maintain a current statewide catalog of waterbody conditions. In order to generate data from across the state, a state-wide rotating basin approach will be implemented that is based on 81 medium sized watersheds (HUC10s). Annual monitoring efforts be focused in 8 to 10 of these watersheds allowing for a complete statewide rotation within 10 years. Specific sampling locations will be determined by NH DES staff during the winter months preceding the upcoming field season and based on a variety factors including data age, waterbody designated use status, location of permitted facilities, evaluation of restoration efforts, and public use intensity. A data summary report will be issued at ten year intervals. For the period covered in this version of the water monitoring strategy, a synoptic monitoring data summary report will be prepared in 2023 covering the period from 2013 - 2022.

Taken together, these three approaches provide the necessary structure to ensure that the data are collected with specific goal in mind. The strategy relies on the incorporation of surface water data collected across programmatic boundaries to achieve a series of objectives while simultaneously providing a broad view of water quality conditions across New Hampshire.

1. Introduction

The implementation of an effective and efficient surface water quality monitoring program serves as the foundation for informed water management decisions. The collection, analysis, and reporting of water quality data educates resource managers and the public of waterbody conditions, the factors that affect these conditions, and the geographical context where protection or restoration measures are necessary. As part of this foundation, the US Environmental Protection Agency (EPA) requires that states receiving section 106 Clean Water Act (CWA) funding prepare and submit a water monitoring strategy. The strategy is designed to be forward thinking and inclusive of all waterbody types (e.g. lakes, rivers, streams, wetlands, coastal waters).

In order to fulfill this requirement, the New Hampshire Department of Environmental Services (NH DES) developed its surface water monitoring strategy in 2005 (NH DES 2005). NH DES serves as the agency responsible implementing the CWA with a primary goal of restoring and maintaining the chemical, physical, and biological integrity of its water resources. In support of this goal, NH DES monitors its surface waters in order to satisfy federal reporting requirements [CWA section 305(b) and 303(d)], assist in regulatory decisions, and for use in planning activities (TMDLs, Section 319). The standards by which NH DES assesses the quality of its waters are outlined state law RSA 485-A and further clarified in administrative rule Env-Wq 1700. Water quality data collected in support of these efforts are subject to strict quality assurance measures and managed within a comprehensive data management system.

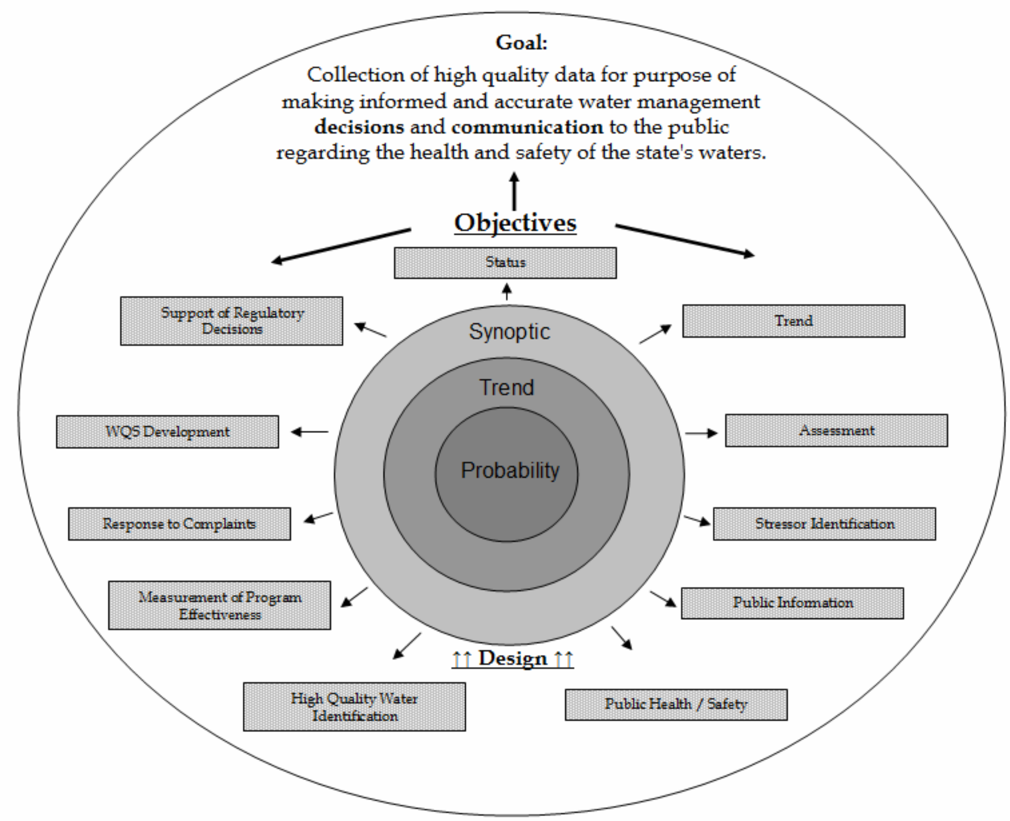
In its 2005 strategy, the NH DES focused on the importance of making data-driven management decisions, clearly stating the purposes for the collection of water quality data, and the value of maintaining a mechanism for managing high quality, well documented, data that is accessible for multiple uses. The 2005 effort accurately recognized NH DES' needs with respect to instituting a basic model for the valuation of current and new surface water monitoring efforts and the subsequent management of the data collected through these programs. The outcome of the strategy has been a gradual movement towards monitoring programs that generate information that is directly linked to measurable environmental outcomes through the quantification of water quality conditions. As evidence of this progress, NH DES now has one of the most advanced processes for evaluating water quality data for its biennial 305(b)/303(d) reporting requirements, dramatically increased its Total Maximum Daily Load (TMDL) productivity, become more efficient in completing Section 401 water quality certifications, and remained current in the development of new or renewal of existing water quality criteria. Further, all of NH DES water quality data is now stored in a single, unified, agency-wide database known as Environmental Monitoring Database (EMD). To date, the EMD houses nearly 25,000 individual monitoring stations from 638 individual projects, and millions of individual results. Data generated by the NH DES and outside organizations are entered through automated lab imports, batch uploads, and manual entry. The data is then flowed directly to EPA's STORET/WQX using a node to node transfer. Thus, clearly the pathway envisioned through NH DES' 2005 monitoring strategy was an important one that benefited the agency.

While the 2005 strategy increased NH DES water quality monitoring effectiveness through a data driven water management process, it provided minimal direction for the collective design, implementation, and ultimate usage of data collected across multiple monitoring programs. The revised strategy herein focuses NH DES' surface water monitoring efforts through the identification of individual programs and the implementation of a unified monitoring design. The design is one that meets the objectives of the CWA and is also used to inform the general public of the conditions of New Hampshire surface waters and the factors affecting them. Further, the design will, to the extent possible, maintain a current catalog of data that can be used for a variety of purposes that include reviewing and developing water quality standards, determining designated use attainment, TMDL development, documenting waterbody restoration efforts, and permitting needs. The revised strategy does not abandon the direction outlined in 2005, but builds upon the concept of maximizing the use of data to evaluate waterbody conditions through quantifiable measures within a structured approach to data collection and evaluation.

2. Overview

The revised strategy covers a 10 year timeframe (2014 - 2024) and is designed to fulfill a dual purpose; 1) satisfy the requirements of the 2003 EPA guidance document entitled "Elements of a state water monitoring and assessment program" (EPA 2003); and 2) serve as a "manual" to NH DES in implementing is surface water monitoring programs and use of the data that is gathered through these programs. The latter, was recognized by NH DES staff as an important need in order to maximize program efficiency and accountability. To this end, the revised strategy is organized around a basic conceptual model (Figure 1). The strategy is based on the goal of the collection and usage of water quality data for water management decisions and communication to the public of waterbody conditions. At the center of the model are three primary monitoring program design components (synoptic, trend, probability) which are intended to feed data directly to a series of objectives. The design components represent the major organizational components of the strategy described below.

Figure 1. Conceptual design of NH DES surface water monitoring strategy.



For each design component a brief description of its purpose is provided including its relation to the specific objectives outlined in the strategy. In addition, individual monitoring programs are identified which will be responsible for data collection, the specific uses of the data, and design implementation. Each design component section identifies indicators that will be used to address the evaluation of water quality conditions and how these data will be reported. Where historical data exists, an evaluation of the basic data qualities (central tendency and variation) has been completed to better understand the capacity for reporting on status and trends. The strategy also defines the expected data sources, data management, quality assurance measures that will be utilized. A basic needs assessment is provided that identifies the resources needed to implement the program. Lastly, a defined schedule is included for reporting on water quality conditions associated with each of the primary components of the strategy. By organizing the strategy in this manner, the final product will serve as a useful document that guides NH DES' surface water monitoring activities.

The strategy focuses primarily on NH DES' monitoring efforts of the state's inland surface waters, namely lakes/ponds and rivers/streams. With approximately 17,000 miles of rivers/streams and over 1,200 lakes/ponds, these surface waters represent important ecological, recreational and economic resources. The decision to focus on these waterbody types was based on an acknowledged need for a more collaborative approach to data collection and utilization. The revised approach integrates multiple monitoring programs within NH DES and makes full use of volunteer collected data. Similarly the necessary quality assurance measures and data management needs also cross programmatic boundaries.

Wetland monitoring is minimally described because NH DES is currently working on developing its monitoring and assessment methods for this waterbody type. Coastal waters, including estuarine and marine waters are also given minimal attention in this strategy as the Piscataqua Regional Estuaries Partnership (PREP), to a large extent, has taken responsibility for monitoring and tracking the conditions of these waters. In addition, NH DES oversees a federally approved (Food and Drug Administration) shellfish program that monitors the availability of shellfish harvesting areas in tidal waters. While these resources are recognized as important for inclusion into NH DES' overall strategy eventually, we decided to focus on inland waters in this iteration of the monitoring strategy.

In developing the strategy it is important to recognize that it is limited to NH DES' current staffing, field, and laboratory resources and assumes that these remain stable for the period of time which this version of the strategy covers. In some cases, a more comprehensive implementation of the monitoring design described below may require NH DES to reach beyond its resources and programs. Partnerships between NH DES and outside entities (NH Fish and Game, USGS, USFS, USFWS, universities, etc.) are viewed as a necessary part of future iterations of the water monitoring strategy in order to make best use of the water quality data that is collected from the state's surface waters and move towards common goals. However, while the strategy recognizes these needs, its current focus is on crafting and implementing a unified monitoring effort that efficiently directs NH DES' limited resources for surface water monitoring.

3. Implementation

NH DES' surface water monitoring strategy, to a large extent, is already being implemented through its existing monitoring programs. The design described below capitalizes on these ongoing efforts, with some modification, through a coordinated approach to make effective use of the data for the purposes of meeting the objectives of the CWA, namely:

- Reporting on waterbody status and trend;
- Establishing, reviewing, and revising water quality standards;

- Determining water quality standards attainment;
- Identifying impaired waters;
- Identifying causes and sources of water quality impairments;
- Supporting the implementation of water management programs; and
- Supporting the evaluation of program effectiveness.

The NH DES Watershed Management Bureau (WMB) is the primary entity responsible for implementing the State of New Hampshire's surface water monitoring programs. Within the Bureau, 15 different programs collect surface water quality data (Table 1). These efforts are diverse in nature and range from of the collection of basic water quality parameters from inland and coastal waters to programs specifically designed to protect public health and safety. These programs collectively generate in excess of 100,000 data points annually and rely on data collected by NH DES staff, as well as data gathered through two citizen-volunteer programs. Many of these programs are dedicated wholly, or in part to satisfying NH DES' CWA Section 106 grant fund obligations with respect the "establishment and operation of appropriate devices, methods, systems, and procedures necessary to monitor, and to compile and analyze data on the quality of navigable waters [CWA Section 106(e)(1)]. NH DES' monitoring strategy is also designed to support the agency's commitments to EPA in implementing water management programs (e.g Sections 303, 305, 319, 402) required by the CWA and evaluating their effectiveness.

Table 1. NH DES Watershed Management Bureau surface water quality monitoring programs.

Program	Description	Effort
Lake Survey	Trophic status determination; primary lake monitoring effort by internal staff	~ 30-50 lakes / ponds per year
VLAP	Lake assessment; volunteer collected data	~170 lakes / ponds 1 – 5x per year
ARMP - trend	Repetitive river sampling; 20+ years of data; NH DES staff	17 stations, 3x per summer
ARMP - rotational	Synoptic surveys; ~15 years of data; NH DES staff	~30 – 40 stations 3x per summer
VRAP	River assessment; volunteer collected data	~ 30 individual groups; ~300 stations, 1 to many x per year
Biomonitoring	Biological assessment wadeable streams	~30 stations / year
Hg in fish	Mercury in fish tissue	~100 – 150 fish / year
Acid outlet	Long term acidification trends	20 lake outlets 2x / year
Acid precipitation	Long term trends in acid precipitation	~50 events / year
Exotic plant tracking	Identify and track exotic plant infestations	40 – 50 waterbodies / year
Beach sampling	Beach openings / postings based on bacteria prevalence	160 freshwater & 16 coastal beaches
Shellfish	Examine sanitary quality of state's tidal waters to ensure molluscan harvest safety	• Shoreline pollution source identification • Water quality sampling- 70-75 stations / month • Paralytic shellfish parasite monitoring
TMDL	Impairment source quantification and reduction	Variable depending on need
Pools/Spas	Construction, design, operation, and safety of artificial bathing facilities	>500 inspections >750 individual water quality results
Complaints	Receive and respond to water quality concerns from public	>50 annually

Where possible, each of these programs are utilized to implement a portion of the design of the monitoring strategy. In some cases, specific programs are not included in the individual design components but are still considered important in tracking water quality for the purposes of public health and safety.

4. Goal and Objectives

The overall goal of NH DES' approach to surface water quality monitoring is:

> **The collection of data for making informed and accurate surface water management decisions and for communication to the public regarding the health of the state's waters and the factors affecting them.**

The goal is based on NH DES' obligation and responsibility in acting as the stewards of its public water resources and satisfying the requirements of the CWA, and is achieved, in part, through the following objectives.

1) ***Report on the status of all surface waterbodies*** **-** Monitoring efforts will be conducted as necessary to report on the statewide condition of the major waterbody types (lakes/ponds, rivers/streams, wetlands, coastal waters). Results of these efforts will become part of the state's 305(b) / 303(d) integrated water quality report to EPA and summarized biennially for communication to the public.

2) ***Determine trends in important surface water quality indicators*****-** Surface water quality monitoring will be completed repetitively at a fixed network of stations in order to report on trends in the most important environmental indicators and to identify emerging indicators that could become important in tracking environmental conditions in the future. The trend monitoring network will be spatially stratified for tracking statewide and regional trends as they relate to local, regional, and global environmental stressors.

3) ***Collect data in support of water quality assessments*** **-** All data produced as a result of NH DES' monitoring programs will be utilized, to the extent possible, in completing water quality assessments for each designated use and serve as the basis for reporting on the status of individual waterbodies, including the identification of impaired waterbodies requiring restorative actions (TMDLs).

4) ***Identify of the stressors that affect water quality*** **-** NH DES will complete surface water monitoring in a manner that relates the condition of its waterbodies to the factors that affect these observations. Where possible, accessory information on environmental conditions such as rainfall, air quality, landscape change, and climatic conditions will be incorporated in the analyses of stressor impacts on surface water quality conditions.

5) ***Provide public information*** **-** Communication of results of water quality monitoring efforts is critically important to NH DES. The monitoring program design will provide high quality data sufficient for producing timely, accurate, and understandable reports to the public regarding the condition of the state's waterbodies. Information produced from this data will include daily advisory or closure updates, reports on overall status and trends, as well as a constantly updated portfolio of data from individual waterbodies to satisfy public inquires.

6) ***Ensure public health and safety*** - NH DES' water monitoring strategy calls for the continuation of its programs designed to track water quality parameters related to public health and safety.

7) ***Identify high quality waters*** **-** Strategic monitoring of its surface water will allow NH DES to identify and describe its high quality waters. These efforts will assist in classifying surface waters based on their natural characteristics, establishing water quality expectations, guiding protection efforts, and setting restoration targets.

8) ***Measure of program effectiveness*** **-** To the extent possible, NH DES' water monitoring strategy will provide assistance to evaluate the success of surface water quality protection and restoration efforts. These include Section 319 projects, TMDL implementation plans, and efforts to control and prevent exotic species introductions.

9) ***Response to complaints*** **-** In order to better serve the public and be responsive to potentially harmful environmental circumstances, surface water monitoring will include the collection of samples based on complaints. Sampling in this realm will be episodic and focused on the nature and location of the complaints.

10) ***Development and implementation of water quality criteria*** **-** The water monitoring strategy is designed to generate high quality data on a statewide basis that can be used to support the development and implementation of new or revised water quality criteria. In some cases, additional special studies may needed to be conducted in order to complete this objective. However, to the extent possible, the strategy will provide the necessary body of evidence to document baseline conditions.

11) ***Support of regulatory decisions / actions*** **-** Water quality data will be collected to assist in making decisions regarding regulatory activities permitted or reviewed by NH DES and be available to other regulatory entities for consideration in permit issuance or renewal. The strategy also supports the collection or use water quality data for enforcement actions.

5. Monitoring Design

In order to meet the overall goal and objectives of the NH DES monitoring strategy three basic design components will be implemented:

1) ***Probability monitoring*** **-** Randomized selection of sample locations by individual waterbody type (e.g. lakes/ponds, rivers/streams, etc.).

2) ***Trend monitoring*** **-** Repetitive monitoring of fixed stations.

3) ***Synoptic monitoring*** **-** Short-term (e.g single year) targeted monitoring of individual waterbodies or waterbody segments based on a standardized statewide selection process and/or specific issues related to a waterbody in order to obtain a basic "snap-shot" of water quality conditions at a single point in time.

NH DES will complete probability-based monitoring projects, to the extent possible, for each of its waterbody types (lakes/ponds, rivers/streams, coastal waters, wetlands). Probability-based monitoring will serve, to a large extent, for reporting on the statewide status of each waterbody type and the factors that relate to overall waterbody condition. Trend monitoring will track important water quality parameters over the long term from a representative set of waterbodies that are distributed across the landscape and range the spectrum of natural and anthropogenic conditions. Synoptic monitoring will be completed to determine the condition of individual waterbodies for a variety of purposes, including assessment, regulatory, or planning purposes. The relation of each of the design components to the strategies objectives are outlined in Table 2.

Table 2. NH DES monitoring objectives and relation to monitoring design components.

Monitoring Strategy Objectives	Monitoring Design		
	Probability-Based	Trend	Synoptic
Status	x		
Trend		x	
Assessment		x	x
Stressor Identification	x	x	
Public Information	x	x	x
Public Health / Safety	x		x
High Quality Water Identification		x	x
Measurement of Program Effectiveness			x
Response to Complaints			x
WQS Development		x	x
Support of Regulatory Decisions			x

Taken together, these three approaches will be inclusive of multiple surface sampling programs at NH DES. The design components define each program's individual contribution to the overall monitoring strategy and provide a unified approach for NH DES in the collection and reporting of surface water quality data. The following sections describe specifically how each approach in the monitoring design will be implemented. It is important to recognize, however, that there are important monitoring efforts that occur specifically for programmatic purposes that do not necessary fit neatly within the monitoring design as described below.

6. Probability-based monitoring

Probability monitoring refers to the randomized selection of a set of sample locations that are representative of the entire population of a particular waterbody type. By collecting data from each of the randomly selected sites the overall condition of the waterbody type can be predicted with an known level of confidence. Probability surveys represent a cost effective means for estimating and reporting on the physical, chemical, and biological conditions by waterbody type and the factors that affect these conditions at a particular point in time.

Probability-based surveys have been utilized by the EPA since 2004 to evaluate the overall condition of the nation's surface waters (fresh and marine). These surveys are completed on a 5-year rotating schedule by waterbody type (Table 3). To date NH DES has participated in the national wadeable streams assessment (2004-05), national lakes assessment (2007, 2012), national rivers and stream assessment (2009-10, 2013-14), and the national wetland condition assessment (2011). NH DES remains committed to our future participation in these surveys at the national level.

6.1 Statewide Intensifications

NH DES will also complete, to the extent possible, statewide probability-based surveys of its individual waterbody types. Statewide probability surveys will include the collection of data from additional randomly selected sites in conjunction with those included in the national surveys. In this manner, a statewide survey for each waterbody type will be an extension of the

national survey but at an intensified level of sampling. In general, it is expected that the statewide intensification will include approximately 50 randomly selected sampling locations per waterbody type. Based on past experiences, this represents 30 to 35 additional sites above and beyond the national survey and a significant investment of state resources to complete. For this reason, statewide intensifications are planned to occur over a multiple years within single EPA "round" and once every 10 years (Table 3). As currently planned, NH DES' statewide intensification responsibilities are limited to lakes/ponds and rivers/streams. A statewide probability survey of wetlands will eventually be added once NH DES fully develops its wetland sampling and assessment methodology. In the past, probability-based assessments of coastal waters were conducted through a cooperative effort between NH DES, University of New Hampshire and the Piscataqua Regional Estuaries Partnership (PREP). It is unclear, at this time, whether the necessary funds or staff resources will be available to carry out this effort in the future.

Table 3. Schedule (2007 - 2021) of national and state-scale probability surveys.

Waterbody type	Year														
	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Lakes/ponds-EPA	X					X					X				
Lakes/ponds-Intensification		X	X									X	X	X	
Rivers/streams-EPA		X	X				X	X				X	X		
Rivers/streams-Intensification			X	X				X	X	X					
Coastal-EPA				X					X					X	
Wetlands-EPA					X					X					X
	ROUND 1					ROUND 2					ROUND 3				
	COMPLETE							UPCOMING							

For statewide probability surveys, a series of water quality parameters have been identified in table 4 that will serve as the primary indicators for reporting on water quality conditions with respect to designated uses. The table below also identifies the expected reporting units for each waterbody type. Analysis of the condition outcomes to estimate statewide conditions for individual waterbody types will follow the tools developed and made available through the EPA's Office of Research and Development, National Health Environmental Effects Research Laboratory, Western Ecology Division (http://www.epa.gov/nheerl/arm/analysispages/monitanalysisinfo.htm).

Table 4. Statewide probability-based survey reporting units, designated uses, and potential indicators.

Waterbody Type	Reporting Units	Designated Uses for Reporting	Potential Indicators
Rivers / Streams	Percent of total number of river / stream miles (1:24,000 NHD)	Primary Contact Recreation	Bacteria (*E. coli*)
		Aquatic Life Use	Invertebrates, Fish, pH, Dissolved oxygen, Habitat, Nutrients (Total phosphorus / Total nitrogen)
Lakes / Ponds	Percent of total number of lakes / ponds ≥ 10 acres (1:24,000 NHD)	Primary Contact Recreation	Bacteria (*E. coli*), Chlorophyll *a*, Presence of cyanobacteria scum
		Aquatic Life Use	Chlorophyll *a*, Total phosphorus, pH, Dissolved oxygen, Exotic plants, Acid neutralizing capacity

6.2 Data Sources, Quality Assurance, and Data Management

Data collection for probabilistic field surveys will be completed by NH DES staff using standardized procedures that are either documented in an EPA approved quality assurance project plan (QAPP) or a standard operating procedure (SOP). Prior to any data analysis, all data will be reviewed for completeness, accuracy, and precision. Once data verification is complete, the NH DES Environmental Monitoring Database (EMD) will serve as the primary data repository. Subsequently, raw data will be flowed EPA's STORET/WQX using a node to node transfer.

6.3 Project Costs / Needs

The completion of probability-based monitoring surveys will rely of staff from the NH DES Watershed Management Bureau and not linked to particular monitoring program(s). For each waterbody type where an intensification is to be completed, a project manager will be appointed and the field staff identified. Overall estimated lab costs and staffing needs for the rivers/streams and lakes/ponds are detailed in Tables 5 and 6, respectfully.

Table 5. Estimated Costs and needs associated with a statewide probability-based survey for rivers and streams.

Rivers / Streams Statewide Probability-based Estimated Costs / Needs				
Estimated Laboratory Costs				
	Single Event Parameter Cost*	E. coli costs**	Nutrient costs**	Invertebrate costs
Per site	$225	$60	$171	$270
Number of sites	30	50	50	30
QC cost estimate	$675	$300	$855	
Total cost by category	$7,425	$3,300	$9,405	$8,100
Total cost / site (no inverts)				$456
Total cost / site (includes inverts)				$726
Total lab costs				$28,230
* Single event parameters include total suspended solids (TSS), alkalinity, hardness, total organic carbon, calcium, sodium, magnesium, potassium, sulfate. ** Assumes samples collected 3x per year during summer months. Additional parameters collected 3x per year will include chloride, specific conductance, pH, dissolved oxygen, water temperature.				
Staffing Needs				
1 field crew (6 staff) @ 1 site / day x 50 sites = 50 days over multiple years Total number staff days = 300 (once / 10 years)				

Table 6. Estimated Costs and needs associated with a statewide probability-based survey for lakes and ponds.

Lakes / Ponds Statewide Probability-based Estimated Costs / Needs			
Estimated Laboratory Costs			
	Single Event Parameter Cost*	E. coli costs**	Nutrient costs**
Per site	$160	$60	$171
Number of sites	36	36	36
QC cost estimate	$640	$240	$700
Total cost by category	$6,400	$2,400	$6,856
Total lab costs			$15,656
* Single event parameters include total suspended solids (TSS), alkalinity, hardness, total organic carbon, calcium, sodium, magnesium, potassium, sulfate ** Assumes samples collected 3x per year during summer months Additional parameters collected 1x per year will include chloride, specific conductance, pH, dissolved oxygen / water temperature profile			
Staffing Needs			
1 field crew (4 staff) @ 1 site / day x 50 sites = 50 days over 2 years Total number staff days = 200 (once / 10 years)			

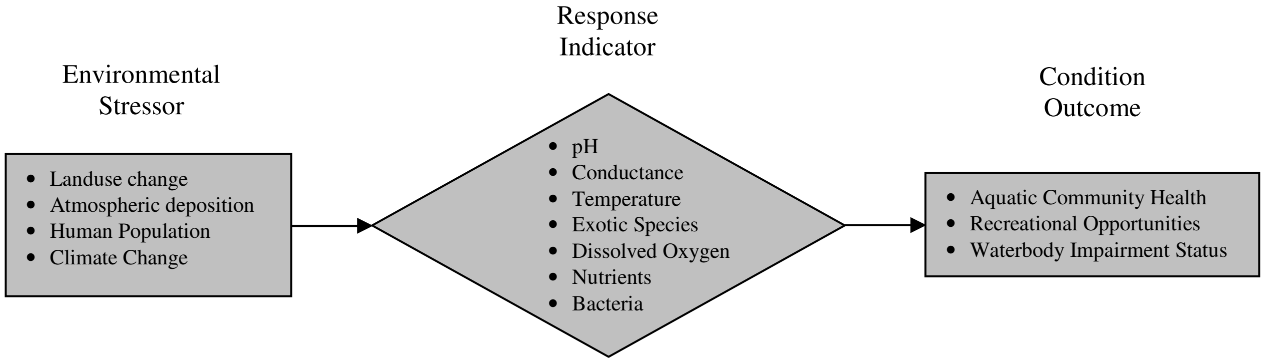
6.4 Reporting

Probability surveys will be used to communicate the status of conditions for individual waterbody types on a statewide basis in a succinct and understandable format to the public. Specifically, statewide probability survey designs and reporting will be completed with a known margin of error. The results of probability-based surveys will be utilized, in part, to understand the stressors that are most prevalent and their overall impact on waterbody condition. Reports of study results will be completed approximately 2 years following the termination of sampling. However, based on previous experience, report timing will, in large part, depend on the availability of data collected through the national surveys. These data are managed by EPA and must undergo a thorough review process prior to becoming available to the states. Once these data are made available and the final "condition" ratings are released by EPA, NH DES will prepare a statewide waterbody-specific status report. Currently, NH DES plans on statewide condition reports being drafted and available for review in 2017 for rivers and streams and 2022 for lakes and ponds (Appendix A).

7. Trend Monitoring Network

Trends in quality of New Hampshire's surface waters will be determined from fixed network of monitoring stations that are repetitively sampled over the long term. At this time, trend monitoring efforts are focused on lakes/ponds and rivers/streams, but will incorporate wetlands in the future. Trends in New Hampshire's coastal waters are monitored and reported through the Piscataqua Regional Estuaries Partnership (PREP; See 2012 State of Estuaries Report).
The design of the trend monitoring network is partially based on a stressor - response - condition conceptual model (Figure 2). Under this model, environmental stressors will be identified and related to the observed responses in water quality indicators. In turn, responses in water quality indicators will be related to surface water condition outcomes. To the extent possible, trend monitoring will incorporate data collected from sites across a range of environmental stressors in order to track trends and make comparisons to the response indicators and overall condition outcomes.

Figure 2. Surface water trend monitoring conceptual model for tracking stressor - response - condition outcomes.



In order for the trend network to be effective, the data it produces must capable of answering specific questions. Only in this manner will a trend network serve to satisfy the objectives outlined in the strategy. The three general questions of interest for the trend network are:

1) ***Are surface water quality conditions in New Hampshire improving, deteriorating, or remaining constant over time?***

2) ***At what rate are trends changing over time?***

3) ***Are trends related to suspected environmental stressors?***

In order to answer these questions, quantifiable measures were developed for each indicator. The data source feeding individual indicators was identified and evaluated for its relevance (relation to environmental stressors and condition outcomes), methods of collection, explanation of data qualities, and the timeframe for which trends are reported.

The design of the trend network is described separately for rivers/streams and lakes/ponds. The description includes a review of the primary monitoring programs responsible for data generation, a spatial framework that establishes a geographically diverse register of sample stations, the identification of waterbody descriptors (size, trophic status) that are built into the design, and the environmental stressors considered for site selection.

7.1 Rivers and Streams

For the timeframe covered by the strategy trend monitoring in New Hampshire rivers and streams will be accomplished by the integration of data collected from three current monitoring programs administered by NH DES; the Ambient Rivers Monitoring Program (ARMP), the Biomonitoring program, and the Volunteer Rivers Assessment Program (VRAP). NH DES recognizes that there are additional sources of data outside the agency that could be considered in tracking surface water quality trends, but has decided to focus on its own data here to ensure it is collected and used in the most effective and efficient manner. By integrating three programs, NH DES is committed to collecting and analyzing data from 40 stations statewide for its trend monitoring efforts. To accomplish this goal, NH DES will rely on its own staff and citizen volunteer water quality monitors.

Historically, NH DES had repetitive surface water quality records from 17 rivers stations monitored through the ARMP dating back to 1990. Traditionally, ARMP trend stations were focused in central and southern portions of that state and represented exclusively by large rivers. Typically, these stations were visited 3 times during the summer months and samples analyzed for 20 separate water quality parameters (Table 7). Since its inception, the trend stations monitored through the ARMP have generated over 20,000 data records. Thus, past data from the ARMP will serve as an important component of NH DES' trend monitoring for large rivers (>4th order). As in the past, the focus of trend monitoring at a limited number of historic ARMP stations will continue to be on physical and chemical parameters. In addition, future monitoring at these stations will include the use of continuous data loggers to ensure that sufficient data is gathered in order make a full assessment of the applicable designated uses at least once within a five year period.

Table 7. Historic ARMP water quality parameters.

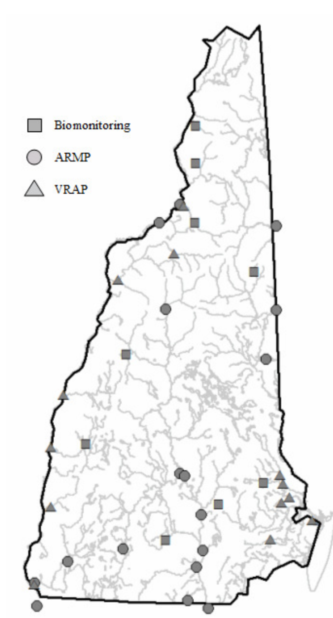
Parameter	Abbreviation	Units
Dissolved Oxygen	DO	Percent saturation (%); Concentration (mg/L)
pH	pH	Units
Specific Conductance	Sp. Cond.	µg/L
Chlorophyll *a*	Chl *a*	mg/L
Chloride	Cl	mg/L
Escherichia coli	E. coli	counts/100 mls
Nitrate / Nitrite	NO2 / NO3	mg/L
Total Kjeldahl Nitrogen	TKN	mg/L
Total Phophorus	TP	mg/L
Total Solids	TS	mg/L
Total Suspended Solids	TSS	mg/L
5-day Biochemical Oxygen Demand	BOD5	mg/L
Alkalinity	Alk	mg/L CaCO3
Hardness	Hard	mg/L CaCO3
Aluminum	Al	mg/L
Total Organic Carbon	TOC	mg/L
Calcium	Ca	mg/L
Magnesium	Mg	mg/L
Sodium	Na	mg/L
Postassium	K	mg/L
Sulfate	SO4	mg/L

The biomonitoring program was established by NH DES in 1997 to assess the condition of biological communities. Since that time, the biomonitoring program focused on gathering data that resulted in the development of mature biological indices for fish and macroinvertebrates for most wadeable streams. To date, the biomonitoring program has physical, chemical, and biological data from nearly 400 unique stations. Through these efforts the biomonitoring program has developed the capacity to effectively sample up to 30 - 40 stations a year for a full suite of parameters. The biomonitoring program's role in the trend monitoring network is to utilize a portion of this capacity to repetitively sample a fixed set of stations that are representative of the natural biological assemblage types that occur in wadeable streams. The data produced from these efforts will be used to track the trends in similar physical and chemical water quality parameters with an added ability to track annual aquatic community condition estimates through the use of biological indices. Repetitive sampling of the biological communities at trend sites will also be used calibrate and revise biological indices when necessary. Lastly, full assessments of the applicable designated uses will be possible annually at trend sites where biological samples are collected.

The Volunteer River Assessment Program (VRAP) was established in 1999 and has grown to include approximately 30 active groups. The program relies on over 200 volunteers to collect water quality data from approximately 250 stations on an annual basis. Of these groups, at least eight have 10 or more years of data and additional eight have five or more years of data. Thus, the efforts of these dedicated volunteers provide an important source of data for tracking trends on New Hampshire's rivers and streams while simultaneously reducing the efforts required by NH DES staff to collect water quality data. Since many of the rivers and streams sampled under the VRAP program are wadeable, the biological indices developed under the biomonitoring program are also applicable and will be used in conjunction with physical and chemical parameters to track trends in water quality. Designated use assessments at trend stations collected through the VRAP program will be completed either annually (wadeable streams) or once every five years (non-wadeable rivers or streams).

Taken collectively, 39 river monitoring stations were established as of 2012 that can be considered to be long term monitoring stations (Map 1). Of these, as noted above, 17 have were monitored by the ARMP for over 20 years. In addition, in 2012, the biomonitoring program established 9 new stations as a demonstration of its ability to dedicate a portion of its efforts towards trend monitoring. Similarly, the VRAP program established long term monitoring stations at 13 locations to assist volunteer groups in tracking the water quality characteristics in their river of interest over the long term. In total this comes close to the goal of 40 river or stream trend monitoring stations. However, moving forward, 7 of the historic ARMP stations were discontinued and 8 new stations added in order to establish a trend network that is more geographically diverse, representative of small, medium, and large rivers, and includes streams across a range of human development intensity. The sections below describe, in detail, how these stratification requirements are met and the revised roster of trend monitoring stations.

Map 1. 2012 river and stream long term monitoring stations.



7.1.1 Spatial Framework

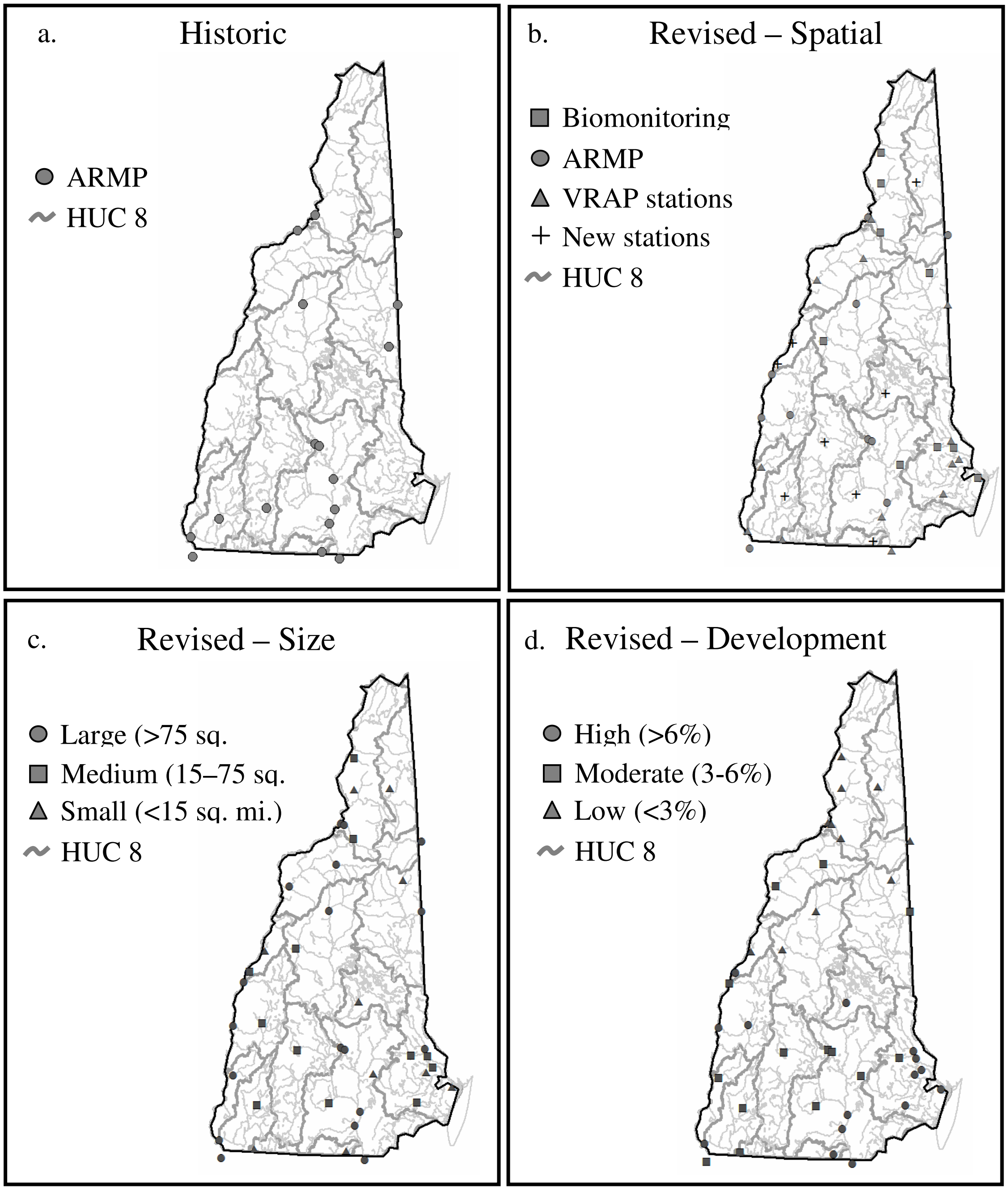
The 8-digit hydrologic unit code (HUC8) was used as the basic framework to evaluate the past and future extent of trend monitoring stations. HUC8s in New Hampshire range in size from 186 to 1,673 square miles and include watersheds located in the largely undeveloped, less populated, forested northern sections of New Hampshire to the more urban and suburban southern and eastern sections of the state with higher population densities. The state's HUC8 watersheds also represent differences in natural environmental factors across the state such as climate, geology, soils, and hydrology. Thus, a geographically diverse trend network will capture these natural and anthropomorphic differences that occur across the New Hampshire landscape.

The revised trend monitoring network for rivers and streams reflects the goal of establishing at least one station in each HUC8 (Table 8, Map 2a). The occurrence of several sample stations within a single HUC8s, in some instances, serves to meet the stratification goals outlined below based on stream size and the percentage of developed lands. A full roster of the sample locations by HUC8 is provided in Appendix B.

Table 8. 8-digit hydrologic unit code (HUC8) breakdown of historic and revised river / stream trend monitoring sites.

HUC_8	HUC_8 Name	Number of Sites		Explanation of change
		Historic	Revised	
1040001	Upper Androscoggin	0	1	Add 1 new station.
1040002	Lower Androscoggin	1	1	No change.
1060002	Saco	2	2	Discontinue 1 ARMP (03-OSS). Add 1 new station.
1060003	Piscataqua-Salmon Falls	0	7	Add 7 new stations.
1070001	Pemigewasset	1	2	Add 1 new station.
1070002	Winnipesaukee River	0	1	Add 1 new station.
1070003	Contoocook	2	2	Discontinue 1 ARMP (25J-CTC). Add 1 new station.
1070004	Nashua	1	1	Discontinue 1 ARMP (06-NSH). Add 1 new station.
1070006	Merrimack River	5	6	Discontinue 1 ARMP (16-MER). Add 2 new stations.
1080101	Upper Connecticut	1	5	Add 4 new stations.
1080103	Waits	1	2	Discontinue 1 ARMP (53-CNT). Add 2 new stations.
1080104	Upper Connecticut-Mascoma	0	2	Add 2 new stations.
1080106	Black-Ottauquechee	0	3	Add 3 new stations.
1080107	West	0	1	Add 1 new station.
1080201	Middle Connecticut	3	3	Discontinue 2 ARMP (16-ASH, 02-ASH). Add 2 new stations.
1080202	Miller	0	1	Add 1 new station.

Map 2. Historic and revised rivers and streams trend monitoring network.



7.1.2 Stream size

Size was chosen as an important characteristic to stratify the river and stream trend monitoring network. Stream size is generally represented either by stream order or upstream drainage area and is an important variable to consider when describing the natural variability in the physical, chemical, hydrological, and biological characteristics that are observed.

Based on the 1:24,000 National Hydrography Dataset (NHD), New Hampshire contains nearly 16,000 miles of rivers and streams with approximately 89% of these miles distributed in smaller streams (≤ 3rd order), 9% in medium-sized rivers (4th & 5th order), and just 2% from large rivers (6th and 7th orders) (Table 9).

Table 9. Miles of streams and rivers by stream order in New Hampshire.

Stream Order	1	2	3	4	5	6	7	Total
Miles	8,804	3,399	1,869	860	513	266	121	15,832

For the trend monitoring network, sampling locations were placed in one of three categories (small, medium, large). The boundaries for these categories were selected based on known natural differences in biological communities and the observed transitions in the physical characters that structure these communities. Specifically, NH DES utilizes an upstream drainage area of 15 square miles as an important transition point in differentiating among wadeable streams when applying both its fish and macroinvertebrate indices of biotic integrity. In general, wadeable streams with drainage areas less than 15 square miles (small) in New Hampshire, with some exception in southern sections of the state or at low elevations, are dominated by coldwater taxa. In contrast, wadeable streams with drainage greater than square miles (medium) can contain both cold and warmwater taxa depending on their geographic location and elevation.

In order to discriminate medium from large streams, a second size-based boundary was identified based on 394 unique sample locations contained in the NH DES biomonitoring unit's database as of 2011. Of these, 349 (89%) had drainage areas less than 75 square miles and serve as a reasonable boundary to separate medium-sized wadeable streams (≤4th order) from non-wadeable rivers (large). Further, most rivers with drainage areas greater than 75 square miles in New Hamsphire tend to be dominated by warmwater taxa.

In application, the revised trend monitoring network for rivers and streams represents a departure from previous efforts that were exclusively centered on large rivers through the ARMP. Instead, it emphasizes the collection of data from more small to medium sized rivers and more accurately represents the true distribution of river and stream miles in New Hampshire (Table 10). In this manner, NH DES is will be able to interpret the immediate affects of the stressors affecting water quality at smaller scales while also depicting the integrative affect of multiple stressors at larger scales. Overall, the resultant impacts of the stressors will be tracked through condition outcomes such as benthic macroinvertebrate community condition, as well as trends in pH and dissolve oxygen. A full roster of the sample locations by stream size category is provided in Appendix B.

Table 10. Stratification of the historic and revised river and stream trend monitoring network based on upstream watershed drainage area.

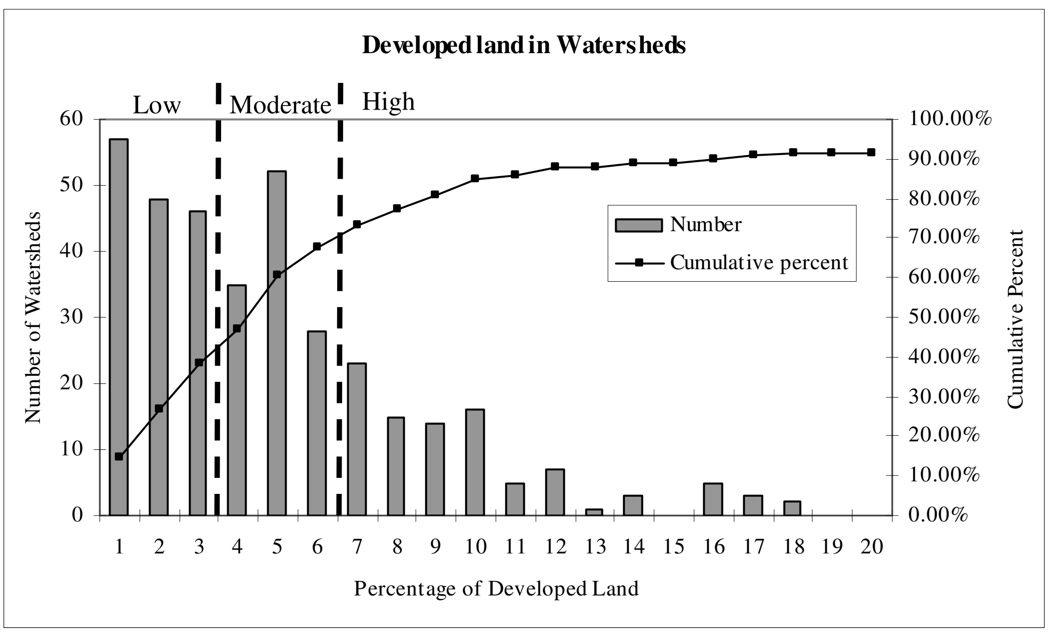
Category	Program	Number of Sites	
		Historic	Revised
Small <15 sq. mi. drainage area	ARMP	0	0
	VRAP	0	2
	Biomonitoring	0	8
	Total	**0**	**10**
Medium 15-75 sq. mi. drainage area	ARMP	0	0
	VRAP	0	3
	Biomonitoring	0	9
	Total	**0**	**12**
Large >75 sq. mi. drainage area	ARMP	17	10
	VRAP	0	8
	Biomonitoring	0	0
	Total	**17**	**18**

7.1.3 Environmental stressors

The percentage of developed land, as estimated through the 2006 National Land Cover Database (NLCD), was used as the primary means for stratifying sample locations for the river and stream trend monitoring network in order to track trends in water quality conditions with respect to potential anthropogenic stressors. Developed lands are associated with higher population densities, more intensive road networks, higher percentages of impervious cover, point source discharges of pollution sources, and more frequent modifications to the natural hydrologic regime. Collectively, the prevalence of these stressors is important to consider and can negatively impact water quality conditions. While other environmental stressors, such as atmospheric deposition and climate change are also important factors that may affect water quality, the extent of developed land within a given watershed was chosen because of the potential to observe changes in environmental quality based on local activities.

Breakpoints to stratify river and stream trend monitoring stations were based on the cumulative distribution properties of the population of biomonitoring stations that have been sampled to date under the assumption that they are generally representative of the development patterns across New Hampshire. According to a 2010 report from the Society for the Protection of New Hampshire Forests (SPNHF), 82% of the land in New Hampshire is forested (Sundquist 2010). Of the nearly 400 locations previously sampled by the biomonitoring program, the median percentage of forested lands, based on the 2006 NLCD, within the each watershed was identical (82%). Conversely, the median percentage of developed lands from watersheds previously sampled by the biomonitoring program was 4% with 90% of these watersheds having developed land percentages less than 16% (Figure 3). Based on these findings low, moderately, and highly developed watershed categories were established from the percentage of developed lands using 3% and 6% as the categorical breakpoints.

Figure 3. Culmulative frequency distribution of percentage of developed land within watersheds previously sampled by the NH DES biomonitoring program. Vertical dashed lines are development category thresholds.



The revised trend monitoring network for rivers and streams is specifically designed with the intent of tracking and reporting on the trajectory of important water quality indicators over time with respect to land use. The revised design is more equally balanced across the range the percentage of developed land observed in New Hampshire (Table 11). The end result is that the revised river and stream trend monitoring network will provide the necessary long term data for tracking baseline water quality conditions in relatively undeveloped watersheds in comparison to watersheds where development is more prevalent. A full roster of the sample locations by development category is provided in Appendix B.

Table 11. Stratification of the historic and revised river and stream trend monitoring network based on percentage of developed land in the upstream watershed.

Category	Program	Number of sites	
		Historic	Revised
Low (<3% development)	ARMP	2	2
	VRAP	0	1
	Biomon	0	8
	Total	**2**	**10**
Moderate (3-6% development)	ARMP	8	5
	VRAP	0	5
	Biomon	0	5
	Total	**8**	**15**
High (>6% development)	ARMP	7	3
	VRAP	0	8
	Biomon	0	3
	Total	**7**	**15**

7.1.4 Indicators

Trend monitoring in rivers and streams will be focused on the collection of data records for meaningful water quality parameters in order to track changes in water quality conditions over time. A full list of water quality parameters scheduled for collection is provided in table 12. A select set of these parameters will serve as primary "indicators" of water quality conditions. The sections below provide a description these indicators, why they were included, and the expected frequency of collection. For each parameter, specific questions have been identified for which the data will be utilized along with the anticipated analytical procedures for answering these questions. A brief summary of the data qualities is provided in order to establish a basic understanding of trend detection expectations. Lastly, for each parameter, the means by which the data will be obtained and stored is identified.

Table 12. Water quality parameters collected as part of the NH DES river and stream trend monitoring network.

Parameter	Analysis Location	Primary (P) or Accessory (A) Indicator
Water Temperature	Field	P
pH	Field	P
Dissolved Oxygen	Field	P
Specific Conductance	Field	P
Macroinvertebrates	Field	P
Nitrate + Nitrite Nitrogen	DHHS PHL-WAL	P
Total Kjldahl Nitrogen	DHHS PHL-WAL	P
Total Phosphorus	DHHS PHL-WAL	P
Calcium	DHHS PHL-WAL	A
Magnesium	DHHS PHL_WAL	A
Sodium	DHHS PHL-WAL	A
Potassium	DHHS PHL-WAL	A
Total Organic Carbon	DHHS PHL-WAL	A

Parameter	Analysis Location	Primary (P) or Accessory (A) Indicator
Sulfate	DHHS PHL-WAL	A
Hardness	DHHS PHL-WAL	A
Acid Neutralizing Capacity	DHHS PHL-WAL	A
Bacteria	DHHS PHL-WAL	A
Chloride	JCLC	A

7.1.4.1 Specific Conductance

Specific conductance is a measure of the water's ability to carry an electrical current and reflects the concentration of dissolved solids. Ions such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum all contribute to specific conductance levels. These ions originate from natural (bedrock) and unnatural (fertilizers, road salt, stormwater, septic systems, agricultural practices) sources.

In New Hampshire, in-stream specific conductance levels are typically low (median = 137 µmhos / cm; D. Neils, Unpublished data) and reflective of the mineral poor rock formations (granite) over which most streams flow. Higher in-stream specific conductance levels have been associated with urbanized watersheds that have a greater percentage of impervious cover and greater road density (Deacon et al. 2005). Impervious cover and more specifically, road density, in turn, are linked to greater inputs of sodium and chloride ions as a result of road deicing (Trowbridge et al. 2010, Daley et al. 2009).

For the rivers and streams trend network, specific conductance will be measured using data sondes fitted with a calibrated probe. Data will be collected a minimum of 3 - 5 times as discrete, one-time measures during individual site visits. In some cases, annual median specific conductance levels may also include a representative sub-sample of a continuous data record produced from a data logger deployment.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in specific conductance statewide?***

   <u>Measure:</u> Number of trend sites with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be determined.

   <u>Data analysis:</u> Linear regression or the Mann-Kendall test of specific conductance levels by year for individual trend sites. Data will be limited to the defined index period (June - September) and include all data points reported within the respective river segment (=AUID) for each trend station. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 15 or more points to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean.

2) ***What is the percentage of trend locations that have higher (lower or similar) level of specific conductance in the last five years compared to the previous five year interval?***

   <u>Measure:</u> Number of trend sites with mean specific conductance levels that are significantly different in the current 5-year period than the previous 5-year period divided by the total number of trend sites.

   <u>Data analysis:</u> Analysis of variance (ANOVA) or an equivalent non-parametric test of specific conductance levels between current and previous reporting period. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported within the respective river segment (=AUID) for each trend station. A significant difference in mean specific

conductance levels between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of trend sites are in the upper 75th percentile of the statewide distribution of specific conductance levels?***

   Measure: Number of trend sites in the upper 75th percentile of the statewide frequency distribution divided by the total number of trend sites.

   Data analysis: Answering this question includes 2 components: 1) a statewide frequency distribution of specific conductance measures from all river segments where data is available; and 2) a 5-year mean computation for individual trend stations. The statewide frequency distribution will be computed from specific conductance measures from all "RIV" AUIDs (river segments) from 1990 through the last year included in the reporting period. Individual station measures will be consolidated by AUID. All AUIDs with 10 or more specific conductance measures will be used to create the statewide frequency distribution and computation of the mean, 25th, and 75th percentiles. The 5-year mean specific conductance level at individual trend sites will be computed from the current year going back 5 years.

Data Qualities:

Specific conductance data in NH DES' records are abundant and show a moderate level of variability (Table 13). Based these data, within station variability is approximately 30% (Mean coefficient of variation) and a power analysis of simulated data indicated that trends using linear regression will be detectable within 10 years if levels double over that same time period at a given site. More subtle trends may be detectable at sites where specific conductance measures are more consistent or numerous.

Table 13. NH DES surface water specific conductance data record summary and expected ability to detect trends.

Number of Observations	Median (µmhos / cm)	Mean of Standard Deviations*	Mean Coefficients of Variation*	Variability Category	Expected trend detection capacity (10 year doubling)	Expected trend detection capacity (25 year doubling)
31,091	137	49.4	0.30	Medium	Yes	No

* Statistics are based on repeated measures within the same river segment (e.g. assessment unit)

7.1.4.2 Nutrients

Nutrients, namely nitrogen and phosphorus, are vital components to ecosystem primary production. However, in aquatic systems, when nutrient levels are increased beyond those that naturally occur, plant and algal growth can become excessive. The resulting effects can lead to water quality impairment as measured by the ability of a waterbody to support aquatic life and recreational uses. The EPA recognizes nutrients as the leading cause of water quality impairment in the United States and reported that approximately 30 percent of the stream miles in the "most disturbed condition" could be attributed to either phosphorus or nitrogen (EPA 2007). Nutrients from instream water samples originate naturally from soil, rocks, and rainwater. Unnatural nutrient sources are primarily fertilizers, sewage, animal waste, and erosion.

Median total nitrogen (TN) and total phosphorus (TP) concentrations of all water samples analyzed from New Hampshire rivers and streams from 1990 - 2009 were 0.539 and 0.015 mg/L, respectively (D. Neils, Unpublished data). However, when the data was limited to samples collected from sites with minimal human disturbance, the natural, background concentrations of TN and TP were 0.345 and 0.010 mg/L, respectively.

The primary factors contributing to instream nutrient concentrations beyond the natural background are related to point and non-point source contributions. In a study of the watersheds draining to New Hampshire's Great Bay by the Piscataqua Regional Estuaries Partnership (PREP), approximately 30% of the nitrogen load was attributed to point sources and 70% to non-point sources (PREP 2013). For the river and stream trend network, in-stream nutrient concentrations will be expressed through concentrations of TN and TP measured from June through September. Discrete samples will be collected and submitted for laboratory analysis 3 - 5 times annually.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in nutrient concentrations statewide?***

   Measure: Number of trend sites with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or Mann-Kendall test of nutrient concentrations (TP and TN) by year for individual trend sites. Data will be limited to the defined index period (June - September) and include all data points reported within the respective river segment (=AUID) for each trend station. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 15 or more points to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean.

2) ***What is the percentage of trend locations that have higher (lower or similar) nutrient concentrations in the current five years compared to each of the previous reporting periods?***

   Measure: Number of trend sites with mean nutrient concentrations (TP and TN) that are significantly different in the current 5-year period than the previous 5-year period divided by the total number of trend sites.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of nutrient concentrations (TP and TN) between the current and previous reporting period. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported within the respective river segment (=AUID) for each trend station. A significant difference in mean nutrient concentrations between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the upper 75th percentile of the statewide distribution of nutrient (TP and TN) concentrations?***

   Measure: Number of trend sites in the upper 75th percentile of the statewide frequency distribution divided by the total number of trend sites.

   Data analysis: Answering this question includes 2 components: a statewide frequency distribution of nutrient concentrations from all river segments where data is available and a 5-year mean computation for individual trend stations. The statewide frequency distribution will be computed separately for TN and TP from all "RIV" AUIDs (river segments) from 1990 through the last year included in the reporting period. Individual station measures will be consolidated by AUID. All AUIDs with 10 or more measures will be used to create the statewide frequency distribution and computation of the mean, 25th, and 75th percentiles. The mean TN and TP concentration at individual trend sites will be computed from the current year going back 5 years.

Data Qualities:

TP data in NH DES' records are abundant and show a high level of variability (Table 14). Based these data within station variability is approximately 73% (Mean coefficient of variation) and a power analysis of simulated data indicated that trends may not be detectable within 10 years if levels double over that same time period at a given site. However, if data variability is lower, then trend detection may be possible.

TN data in NH DES' records are moderately abundant and show a moderate level of variability (Table 14). Based these data, within station variability is approximately 38% (Mean coefficient of variation) and a power analysis of simulated data indicated that trends will be detectable within 10 years if levels double over that same time period at a given site. More subtle trends may be detectable at sites where TN measures are less variable.

Table 14. NH DES surface water total phosphorus and total nitrogen concentration data record summary and expected ability to detect trends.

Parameter	Number of Observations	Median (µmhos/cm)	Mean of Standard Deviations	Mean Coefficients of Variation	Variability Category	Expected trend detection capacity (10 year doubling)	Expected trend detection capacity (25 year doubling)
TP (mg/L)	27,818	.018	.023	.73	High	No	No
TN (mg/L)	4,041	.451	.185	.38	Medium	Yes	No

7.1.4.3 Acidification

The acidic qualities of surface water, as measured through pH, influence the types and abundances of aquatic organisms that are able to persist over time in a given waterbody. Surface waters with a pH below 5 are considered highly acidified resulting in significant negative impacts to the aquatic community. However, deleterious chronic impacts to aquatic communities occur in waters with pH levels less than 6.5 (reference). Conversely, excessively high pH levels, above 8.0, are also outside the range considered to be supportive of a healthy biological community.

The pH of surface water is influenced by the geologic, soil, vegetative, and physical landscape characteristics within the watershed, as well as local landuse history and atmospheric deposition patterns. The ability to resist acidification, measured as a water's acid neutralizing capacity (ANC) is a key component to protecting a waterbody from becoming acidified and in allowing it to recover once it becomes acidified. Waters that have a low ANC concentrations are particularly susceptible to, and lack the ability to be resilient from acidification.

Acid precipitation, as a result of fossil fuel combustion, is a well documented phenomena in the northeastern United States that causes significant negative impacts to surface waters. For New Hampshire, the draft 2012 305(b) report of surface water quality indicates that approximately 20% of the state's river miles were listed as impaired for pH. An approximately 50% reduction in the emission of the pre-cursors [sulfur dioxide (SO2); nitric oxides (NOX)] to acid precipitation has occurred in the northeast since the 1990 Clean Air Act amendments, thus water quality improvements are expected, but are likely to take years to be realized due to naturally low ANC values (EPA 2010, NH DES 2004).

A summary of NH DES pH water quality data records from 1990 through 2012 indicates the median pH from 720 river segments with 5 or more records was 6.49 (D. Neils, Unpublished data). Similarly, records of alkalinity from the same time period for 107 river segments, regardless of the number of records per segment, indicated the median alkalinity was 6.20 mg/L.

For the rivers and streams trend network, pH will be measured using data sondes fitted with a calibrated probe. Data will be collected a minimum of 3 - 5 times as discrete, one-time measures during individual site visits. In some cases, annual median pH levels may also include a representative sub-sample of a continuous data record produced from a data logger deployment. Measures of alkalinity concentrations will occur one to two times per year through water samples collected during individual site visits. For pH, data used trend analyses will be collected from June through September. Alkalinity data will be plotted annually as a secondary indicator of acidification.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in pH levels statewide?***

   Measure: Number of trend sites with a significant trend (increasing / decreasing) or no detectable trend in pH. If a significant trend is detected, the rate of change will be determined.

   Data analysis: Linear regression of pH (units) or the Mann-Kendall test for individual trend sites. Data will be limited to the defined index period (June - September) and include all data points reported within the respective river segment (=AUID) for each trend station. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). At each site, a reporting period will add 15 or more points to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean.

2) ***What is the percentage of trend locations that have higher (lower or similar) pH levels in the current five years compared to each of the previous reporting periods?***

   Measure: Number of trend sites with mean pH levels that are significantly different in the current 5-year reporting period than the previous 5-year reporting period divided by the total number of trend sites.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of pH levels between the current and previous reporting period. Data for the analysis will include all data points reported within the respective river segment (=AUID) for each trend station. A significant difference in means between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the lower 25th percentile of the statewide distribution of pH levels?***

   Measure: Number of trend sites in the lower 25th percentile of the statewide frequency distribution for pH levels divided by the total number of trend sites.

   Data analysis: Answering this question includes 2 components: a statewide frequency distribution of the means from all river segments where data is available and a 5-year mean for individual trend stations for each parameter. The statewide frequency distribution will be computed from pH measures from all "RIV" AUIDs (river segments) from 1990 through the last year included in the reporting period. Individual station measures will be consolidated by AUID. All AUIDs with 10 or more pH measures will be used to create a statewide frequency distribution and computation of the mean, 25th, and 75th percentiles. The mean pH level at individual trend sites will be computed from data ending in the year of the current reporting cycle going back 5 years.

Data Qualities:

Data in NH DES' records indicated that pH measures are abundant and show a low level of variability (Table 15). Based these data, within station variability is approximately 4% (Mean coefficient of variation) and a power analysis of simulated data indicated that trends will be detectable within 10 years if levels double over that same time period at a given site. More subtle trends may be detectable at sites where pH measures are less variable.

Table 15. NH DES rivers and streams pH data record summary and expected ability to detect trends.

Number of Observations	Median (µmhos/cm)	Mean of Standard Deviations	Mean Coefficients of Variation	Variability Category	Expected trend detection capacity (10 year doubling)	Expected trend detection capacity (25 year doubling)
29,133	6.43	0.28	0.04	Low	Yes	Yes

7.1.4.4 Biological Condition

The biological condition of aquatic systems can be measured directly through the use of biotic indices or indirectly through surrogate water quality measures, such as dissolved oxygen, that affect an organism's health, likelihood of successful propagation, or survival. A decline in biotic condition is reflective of the waterbody's inability to support a natural, adaptive and integrated community of aquatic organisms. The biological condition of individual sites can be affected by a single or multiple stressors that include stormwater, excessive nutrients, degraded habitat, acidification, and toxics. In New Hampshire, NH DES has developed biological indices for macroinvertebrates and fish in wadeable streams (typically ≤4th order) and uses dissolved oxygen as a surrogate indicator of aquatic life use support for larger rivers (typically ≥5th order).

For wadeable streams, the trend monitoring network will utilize NH DES' benthic index of biotic integrity (B-IBI) to track trends in aquatic community condition. The B-IBI is based on benthic macroinvertebrates and is comprised of 7 measures of biotic condition. These measures are combined into a single index score that ranges from 0 to 100 with 100 indicating the best condition. B-IBI score ratios reflect the ratio of a site's score to its applicable condition threshold. Score ratios of <1.0 indicate that an individual site's macroinvertebrate community condition was lower than that of samples collected from un-impacted (e.g. reference) streams with similar characteristics. Sites with B-IBI score ratios ≥ 1.0 are considered to be supportive of aquatic life use. For trend monitoring sites where the B-IBI is applicable, three replicate macroinvertebrate samples will be collected from each site annually and used to compute a single overall site-specific B-IBI score.

For larger rivers, dissolved oxygen will be used to represent the ability of the water body to support an aquatic community that is representative of un-impacted biological condition. Low dissolved oxygen levels are typically reflective rivers with of an overabundance of aquatic life resulting from elevated nutrient loads (eutrophication) or have sluggish flows and higher water temperatures in or below impounded areas.

Low dissolved oxygen concentration events are cyclical in most New Hampshire rivers and streams occurring usually during the early morning hours. Therefore, these events are best captured by means of a continuous data loggers deployed over a set period of time. For this reason, within a given reporting period (5-years), two continuous 7 - 10 day data records will be collected for each trend monitoring site. For each continuous record, DO readings (concentration and percent saturation) will be taken at 15-minute increments resulting in between 672 - 960 data records per parameter.

Benthic Index of Biotic Integrity (B-IBI):

1) ***What is the incidence of increasing, decreasing, and stable trends in B-IBI scores statewide?***

   Measure: Number of trend sites with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of the annual B-IBI score by year for individual trend sites. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 15 points (3 replicates / year x 5 years) to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean.

2) ***What is the percentage of trend locations that have higher (lower or similar) B-IBI scores in the current five years compared to each of the previous reporting periods?***

   Measure: Number of trend sites with mean B-IBI scores that are significantly different in the current 5-year reporting period than the previous 5-year reporting period divided by the total number of trend sites.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of B-IBI scores between current and previous reporting period. A significant difference in mean B-IBI scores between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the upper 75th percentile (lower 25th) of the statewide distribution of B-IBI score ratios?***

   Measure: Number of trend sites in the upper 75th percentile (lower 25th) of the statewide B-IBI score ratio frequency distribution divided by the total number of trend sites. Plot of percentage of sites in upper and lower percentile categories over time and record of individual trend site percentiles.

   Data analysis: Answering this question includes 2 components: a statewide frequency distribution of B-IBI scores from all river segments where data is available and a 5-year median computation for individual trend stations. The statewide frequency distribution will be computed from all applicable "RIV" AUIDs (river segments) from 1997 through the last year included in the reporting period. Where multiple benthic samples occur within the same AUID, the respective B-IBI score ratios will be consolidated into a single median B-IBI score ratio. All AUIDs with B-IBI score ratios will be used to create the statewide frequency distribution and computation of the median, 25th, and 75th percentiles. The median B-IBI score ratio at individual trend sites will be computed from data ending in the year of the current reporting cycle going back 5 years.

Data Qualities:

B-IBI scores represent single measures within a given year. To date, NH DES has minimal data from repeat visits to sample stations over time. However, the data used to generate B-IBI scores are result of three replicate samples that can be compared to estimate the variation at a sample location within a given year. The variation replicate B-IBI scores was relatively low (mean standard deviation = 4.62, coefficient of variation = 7%) (Table 16). It is expected that the year-to-year variation in B-IBI scores at individual sites will be higher than those observed within a given year, and that these differences will be partially attributable to natural environmental conditions. However without inter-annual estimates of variation, the ability to detect trends in B-IBI scores is unknown.

Table 16. NH DES macroinvertebrate benthic IBI data record summary.

Number of Observations	Median (B-IBI score)	Mean of Standard Deviations*	Mean Coefficients of Variation*	Variability Category	Expected trend detection capacity (10 year doubling)	Expected trend detection capacity (25 year doubling)
1,023	65.4	4.62	0.07	-----	-----	-----

* Statistics computed from three replicate samples at individual sampling locations. Means are averages across all sample locations.

Dissolved Oxygen:

1) ***Is the frequency of exceedences of the instantaneous dissolved oxygen criteria increasing, decreasing, or remaining stable?***

   Measure: The frequency of exceedence at individual sites will be the percentage of the total number of days that have a 1-hour minimum instantaneous dissolved oxygen concentration below the applicable water quality criteria.

   Data analysis: The percentage will be computed as the number of hours where the mean hourly concentration is less than 5.0 mg/L divided by the total number of hours for which continuous data records exist within given reporting period. Frequencies will be reported for individual sites and used to qualitatively characterize the occurrences of exceedence over time.

2) ***Is the frequency of exceedences of the daily average dissolved oxygen criteria increasing, decreasing, or remaining stable?***

   Measure: The frequency of exceedence at individual sites will be the percentage of the total number of days that do not meet the applicable daily average water quality criteria.

   Data analysis: The percentage will be computed as the number of days where the mean daily dissolved oxygen percent saturation is less than 75% divided by the total number of days for which continuous data records exist within given reporting period. Frequencies will be reported for individual sites and used to qualitatively characterize the extent of exceedence over time.

3) ***Is the frequency of exceedence of the daily average dissolved oxygen standard from discrete samples increasing, decreasing, or remaining stable?***

   Measure: The frequency of exceedence will be the percentage of the total number of measures that do no meet the applicable daily average criteria for individual sites.

   Data analysis: The percentage will be computed as the sum of the number of data points that are less than the applicable criteria divided by the total numbers of measures . Applicable measures are those collected within the critical timeframe defined by NH DES when dissolved oxygen saturation is most apt to be lowest due to high temperatures and low flows. Frequencies will be reported for individual sites and used to qualitatively characterize the extent of exceedence over time.

Data Qualities:

Data in NH DES' records indicated that dissolved oxygen measures are abundant and show a low level of variability (Table 17). Based these data, within station variability is approximately 12% (Mean coefficient of variation) for percent saturation measures and 19% for concentration measures. A power analysis of simulated data indicated that trends will be detectable within 10 years if levels are reduced in half over that same time period at a given site. More subtle trends may be detectable at sites where dissolved oxygen measures are less variable.

Table 17. NH DES rivers and streams dissolved data record summary and expected ability to detect trends.

Parameter	Number of Observations	Median	Mean of Standard Deviations	Mean Coefficients of Variation	Variability Category	Expected trend detection capacity (10 year doubling)	Expected trend detection capacity (25 year doubling)
DO (% saturation)	5,021	88.5%	9.09	0.12	Low	Yes	Yes
DO (mg/L)	5,229	9.14 mg/L	1.65	0.19		Yes	Yes

7.1.4.5 Water Temperature

Aquatic organisms have a wide variety of thermal requirements. Some species of animals or plants prefer cool water temperatures while others flourish in warmer waters. In addition, some species can exist across a wide range of water temperatures whereas others have a more restrictive thermal range. In New Hampshire, a majority of wadeable streams are supportive of cold water species, such as trout, while large rivers, with some exceptions, tend to be more commonly dominated by warmwater species.

A number of local factors can have an impact on water temperature including latitude, elevation, stream size, quantity and maturity of riparian vegetation, rate of flow, percent of impervious surfaces contributing stormwater, thermal discharges, impoundments, and groundwater. Climate change represents a global threat to the natural distribution of aquatic communities as well (Isaak and Rieman 2012; Staudinger et al. 2012). An increase in water temperatures will likely reduce habitat available to coldwater species (Isaak et al. 2012).

NH DES has collected 139 continuous water temperature records since 2006 from 87 unique locations. The records include hourly water temperature readings from June through September in most instances. In a recent analyses of these data, preliminary findings indicate that there are distinct differences between in the median water temperatures supportive of three basic fish assemblage types; coldwater, transitional water, and warmwater. Further, these data provide a baseline by which to track long term changes in water temperature moving forward.

For the rivers and streams trend network, water temperature will be measured at each site using continuous water temperature data loggers. The data loggers will be deployed in early summer and retrieved in early fall and include approximately 2,880 data records per site (120 days x 24 hourly readings).

1) ***What is the incidence of increasing, decreasing, and stable trends in maximum water temperatures statewide?***

   Measure: Number of trend sites with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of the median water temperature for warmest 7-day period for each trend site within the annual data record. The warmest 7-day period is defined as 7 consecutive days that have the highest 7-day running mean water temperature. The reported value will be the median of the 7-day period. Data for the computation of an annual median will be limited to the defined index period (June - September). A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis.

2) What is the percentage of trend locations that have a higher (lower or similar) water temperature in the current reporting period compared to previous reporting periods?

Measure: Number of trend sites with summer water temperatures that are significantly different in the current 5-year reporting period than the previous 5-year reporting period divided by the total number of trend sites.

Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of temperatures between current and previous reporting period. For each reporting period the median 7-day running mean water temperature will be computed for each year. The median will be computed from the 7-day running mean values for each respective date within a given reporting period (5 annual measures / period). The reporting period will be from June 15 - August 31. A significant difference in water temperature between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$).

3) What is the duration of exceedence of water temperature benchmarks?

Measure: The percentage of the consecutive days temperature benchmarks are exceeded for individual trend sites.

Data analysis: For each trend site, the percentage will be computed as the greatest number of consecutive days fish assemblage water temperature benchmarks are exceeded divided by the total number of days of the annual continuous water temperature record. The daily 7-day running mean water temperature will represent the daily measure to compare against water temperature benchmarks. The expected fish assemblage type for each site will be identified according to NH DES (NH DES 2011). Water temperature benchmarks for expected fish assemblage type are as follows as indicated in Table 17.

Table 17. Water temperature benchmarks for expected fish assmeblage types.

Expected fish assemblage type	Water temperature benchmark (°C)*
Coldwater	18
Transitional water	20
Warmwater	24

* Water temperature benchmarks DO NOT represent NH water quality criteria. They are a consolidation of known thermal limits and analysis of existing data records.

The duration of exceedance will be reported for individual sites and used to qualitatively characterize if water temperature benchmark exceedance durations are changing over time.

Data Qualities:

NH DES water temperature data of the warmest 7-day consecutive period indicate a low level data variability. However, the magnitude of water temperature increases a 10 - 25 year period are likely to be low. If a 5°C increase over 25 years were to occur, significant trends in water temperature have a 52%, 91%, and 98% chance of being detected at coldwater, transitional water, and warmwater streams, respectively (Table 18). Higher trend detection percentages are reflective of lower variability in the observed data collected to date. More subtle trends may be detected if data variability is lower.

Table 18. NH DES rivers and streams water temperature data record summary and expected ability to detect trends.

Expected fish assemblage type	Number of Records	Median (°C)	Standard Deviation	Coefficient of Variation	Variability Category	Expected trend detection capacity (5°C increase over 25 yrs)*
Coldwater	49	19.5	2.78	0.14	Low	52%
Transitional water	49	21.2	1.69	0.08		91%
Warmwater	37	23.8	1.57	0.07		98%

* Trend detection capacity is based on the percentage of significant linear regressions (p=0.95) obtained from 250 simulated iterations based on a synthetic dataset.

7.1.4.6 Accessory Indicators

Several additional water quality parameters will be collected at each of the river and stream trend monitoring stations (Table 19). These parameters were selected as accessory indicators since they are of common interest for a variety of reasons in determining water quality conditions, but are known to be either highly variable or regularly occur at low concentrations. Data for these parameters will be collected primarily by NH DES staff or VRAP volunteers, but may, in some instances, include data collected by other sources. Sampling frequency for these parameters will generally be once during the summer months (June - September), but may include additional samples during other times of the year. Results for each of the parameters will be obtained through the collection of discrete water samples that are submitted for laboratory analysis. Although no formal trend analyses will be completed for these parameters, standard descriptive statistics (mean, median, etc.) will be tabulated for each reporting period. As with the primary trend indicators, raw data for the accessory indicators will be quality assured and stored in the NH DES EMD.

Table 19. Accessory water quality indicators for the NH DES rivers and streams trend network.

Parameter	Symbol
Dissolved organic carbon	DOC
Total Suspended Solids	TSS
Hardness	Hard
Calcium	Ca^{+2}
Magnesium	Mg^{+2}
Sodium	Na^{+1}
Potassium	K^{+1}
Chloride	Cl^{-1}
Sulfate	$SO4^{-2}$

7.1.5 Data Sources, Quality Assurance, and Data Management

River and streams trend monitoring data will be generated primarily by NH DES staff and citizen volunteers (VRAP) using field instruments, collection of discrete samples for laboratory analysis, by means of continuous data loggers, or through the capture of biological organisms for laboratory identification. Data collection for all trend monitoring activities will be completed under EPA approved quality assurance project plans (QAPP) or a NH DES standard operating procedures (SOP). All data will be stored in the NH DES EMD. Prior to acceptance, all data will be reviewed for completeness, accuracy, and precision. Once data verification is complete, raw data will be flowed from NH DES' EMD to EPA's STORET/WQX using a node to node transfer.

In some cases, trend data may be collected and submitted to NH DES by alternative sources for a variety of unknown purposes. The quantity of data submitted by alternative sources cannot be determined at this time but is likely to account for a small percentage of the overall data. In these instances, a full review of the submitting entities quality assurance measures will be completed prior to data acceptance and inclusion in trend reporting. Any data included in trend reporting that is generated by outside sources will also be stored in the EMD and subsequently flowed to EPA's STORET/WQX. Only data marked as "valid" in the EMD will be utilized in the trend analysis and reporting phase.

7.1.6 Project costs / needs

The completion of river and stream trend monitoring surveys will rely primarily on staff from the NH DES Watershed Management Bureau. A total of 40 sites will be sampled annually 3 times during the summer months. Data collection will rely on two 2-person field crews. Overall estimated lab costs and staffing needs for the rivers/streams trend monitoring are detailed in Table 20.

Table 20. Estimated costs and needs associated with rivers and streams trend monitoring.

Rivers / Streams Trend Monitoring Estimated Costs / Needs				
Estimated Laboratory Costs				
	Single Event Parameter Cost*	E. coli costs**	Nutrient costs**	Invertebrate costs
Per site	$225	$60	$171	$270
Number of sites	40	40	50	30
QC cost estimate	$900	$240	$684	
Total cost by category	$9,900	$2,640	$7,524	$8,100
Total cost / site (no inverts)				$456
Total cost / site (includes inverts)				$726
Total lab costs				$28,164
* Single event parameters include total suspended solids (TSS), alkalinity, hardness, total organic carbon, calcium, sodium, magnesium, potassium, sulfate. ** Assumes samples collected 3x per year during summer months. Additional parameters collected 3x per year will include chloride, specific conductance, pH, dissolved oxygen, water temperature.				
Staffing Needs				
2 field crews (2 staff / crew) @ 3 sites / day x 40 sites = ~7 days / sample round 3 rounds of sampling = ~21 days total / year 21 days x 4 staff = 84 staff days / year				

7.1.7 Reporting

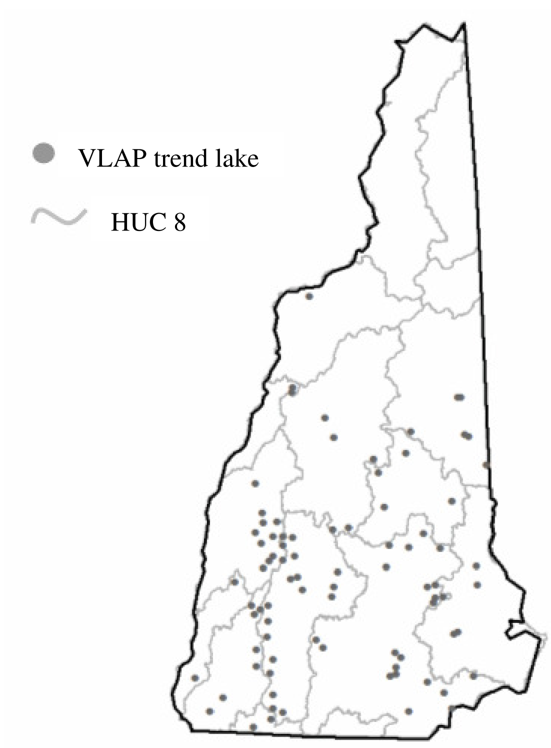
A summary report will be issued at five year intervals based on the schedule in Appendix A. For the period covered in this version of the water monitoring strategy the first river and stream trend report will be drafted and available for review by 2018. The report will cover the trend monitoring period from 2013 - 2017. A second river and stream trend report will be completed in 2023 that covers the monitoring period from 2018 - 2022. Both reports will document, to the extent possible, the outcome of each of the primary indicators detailed above and provide a general summary of the accessory indicators.

7.2 Lakes and Ponds

Trend monitoring in New Hampshire lakes and ponds will be accomplished by utilizing data collected through the Volunteer Lake Assessment Program (VLAP). The VLAP program was initiated in 1985 and has grown to produce annual water quality data from approximately 175 lakes and ponds. VLAP data is collected by citizen volunteers following an EPA approved (QAPP) and submitted to NH DES for analysis. NH DES biologists also visit the volunteer groups to ensure the use of proper field techniques. Thus, the data collected through the VLAP program is high quality and continuously available for data analysis. The utilization of VLAP data for trend analysis and reporting will build upon the individual and regional summary reports that are currently prepared by NH DES staff for organizations that collect the data.

A total of 83 VLAP lakes and ponds have collected data for 10 or more years at a frequency of 3 - 5 times per summer (Map 3). These waterbodies will serve as the primary basis for monitoring trends in water quality conditions of New Hamsphire's lakes and ponds. In addition, bacteria (*e. coli, cyanobacteria*) data from up to 160 freshwater beaches will be utilized to report on trends in the condition of popular bathing locations including. NH DES will also draw upon aquatic plant surveys to report on trends in the frequency and extent of exotic aquatic plant infestations.

Map 3. Lakes and ponds included in the NH DES trend monitoring network.



Similar to rivers and streams trend network, lake and pond trend reporting will include a select number of important physical, chemical and biological indicators of water quality. Along with trend reporting, sufficient monitoring will be completed in order make a full assessment of the applicable designated uses at least once within a five year period for each waterbody. The lake and pond trend network is described, in detail, below with respect to its geographic distribution, waterbody trophic status, and land use characters. The following sections also include a description of the trend indicators chosen for reporting and the specific analyses expected to be used for measuring these outputs.

7.2.1 Spatial Framework

The 8-digit hydrologic unit code (HUC 8) was used as the basic framework to evaluate the extent of VLAP waterbodies included in the lake and pond trend monitoring network. In total there are over 1,200 lakes and ponds that are part of the NH DES waterbody catalog. The number of lakes and ponds in each HUC 8 ranges from 7 to 245 (Table 21). There are between 2 and 22 VLAP waterbodies per HUC 8 included in the lake and pond trend monitoring network. Four HUC 8s are without a waterbody in the lake and pond trend monitoring network. In general, the highest concentration of lakes and ponds in the trend monitoring network are in the Dartmouth-Lake Sunapee region of the state, with the remaining watebodies distributed relatively equally in the southern two-thirds of the state. Northern sections of New Hampshire are lacking lakes and ponds in the trend monitoring network. Additional waterbodies could be added in these regions in the future if volunteer groups are interested in participating in VLAP. A full roster of the lakes, ponds, and freshwater beaches included in the trend monitoring network is provided in appendices C and D.

Table 21. Frequency of New Hampshire lakes and ponds by HUC8 and the respective number of VLAP lakes included in the lakes and pond trend monitoring network.

VLAP Trend Lakes and Ponds			
HUC 8		Total Number	VLAP Trend Count
1040001	Upper Androscoggin	43	0
1040002	Lower Androscoggin	7	0
1060002	Saco	105	6
1060003	Piscataqua-Salmon Falls	127	3
1070001	Pemigewasset	110	5
1070002	Winnipesaukee River	64	4
1070003	Contoocook	147	17
1070004	Nashua	9	0
1070006	Merrimack River	245	22
1080101	Upper Connecticut	59	0
1080103	Waits	44	1
1080104	Upper Connecticut-Mascoma	21	2
1080106	Black-Ottauquechee	88	12
1080107	West	38	2
1080201	Middle Connecticut	101	7
1080202	Miller	27	2
TOTAL		1,235	83

7.2.2 Trophic Class

Trophic status is a statement of a lake's level of biological productivity. Lakes with differing levels of biological production often exhibit different water quality characteristics, such as nutrient concentrations, water clarity, or dissolved oxygen levels. Lake productivity is a reflection of the natural characters of the landscape and the human activities that alter land use patterns. Understanding and analyzing the trends in water quality conditions with respect the frequency of lakes and ponds within the major trophic classes is necessary to evaluate changes based on those human activities.

Over the course of the past 35 years, NH DES has sampled and produced trophic ratings for 760 waterbodies, with the largest percentage of those falling in the mesotrophic class and nearly equal percentages in the oligo- and mesotrophic classes (Table 22). The population of lakes and ponds included in the trend monitoring network is broken down similarly, but with slightly less representation by eutrophic lakes.

Table 22. Trophic class ratings for lakes and ponds previously sampled by NH DES and the respective number of VLAP lakes and ponds included in the trend monitoring network.

VLAP Trend Lakes and Ponds		
Trophic Class	Total Number	VLAP Trend Count
Oligotrophic	199 (26%)	31 (37%)
Mesotrophic	395 (52%)	46 (55%)
Eutrophic	166 (22%)	6 (7%)
Total	760	83

A comparison of trend results by trophic class will be completed in a attempt to draw inferences about their relative susceptibility and resiliency to water quality stressors, such as local land use alteration, regional acidification patterns, or global climate change.

7.2.3 Environmental stressors

The percentage of developed land, as estimated through the 2006 National Land Cover Database (NLCD), was used as the primary means for stratifying lakes and ponds included in the trend monitoring network in order to track trends in water quality conditions with respect to potential anthropogenic stressors. As noted above in the river and stream trend network section, land development can be associated with multiple stressors that can, collectively, affect water quality conditions. Further, these stressors are typically local in nature, and thus, are best managed by local activities and decisions.

Categorical breakpoints in the percentage of developed land for lakes and ponds included in the trend monitoring network were the same as those utilized for rivers and streams and follow the same overall justification. That is, they provide a generalized representation of the current landuse patterns across the state. Table 23 provides the breakdown of VLAP lakes and ponds by development class categories.

Table 23. Development class frequency for VLAP lakes included in the lake and pond trend network.

VLAP Trend Lakes	
Development Class	Count
Low (<3%)	16
Moderate (3 - 6%)	32
High (>6%)	35

7.2.4 Indicators

Trend monitoring for lakes and ponds will be focused on the collection of data records for meaningful water quality parameters in order to track changes in water quality conditions over time. The parameters selected for trend monitoring will serve as "indicators" of water quality conditions (Table 24). The sections below provide a description of parameters selected to serve as indicators of water quality conditions, why they were included, and scheduled frequency of collection. For each parameter, specific questions have been identified for which the data will be utilized to answer along with the anticipated analysis procedures for answering these questions. A brief summary the data qualities is provided in order to establish a basic understanding of the data and the trend detection expectations.

Table 24. Water quality parameters collected as part of the NH DES lake and pond trend monitoring network.

Parameter	Analysis Location	Primary (P) or Accessory (A) Indicator
Chlorophyll *a*	JCLC	P
pH	JCLC	P
Specific Conductance	JCLC	P
Cyanobacteria	JCLC	P
Total Phosphorus	DHHS PHL-WAL	P
Bacteria	DHHS PHL-WAL	P
Secchi Disc Transparency	Field	P
Exotic aquatic plants	Field	P
Dissolved Oxygen	Field	A
Alkalinity	DHHS PHL-WAL	A
Ice in/out records	Field	A
Water Temperature	Field	A

7.2.4.1 Specific Conductance

Specific conductance is a measure water's ability to carry an electrical current and reflects the concentration of dissolved solids. Ions such as chloride, nitrate, sulfate, phosphate, sodium, magnesium, calcium, iron, and aluminum all contribute to specific conductance levels. These ions originate from natural (bedrock) and unnatural (fertilizers, road salt, stormwater, septic systems, agricultural practices) sources.

In New Hampshire, in-lake specific conductance levels are typically low (median 1976 - 2008 = 40 µmhos / cm; N=768; NH DES 2008) and reflective of the mineral poor rock formations (granite) over which most of the lakes lie. Higher in-lake specific conductance levels are typically associated with urbanized watersheds that have a greater percentage of impervious cover and greater road density (Deacon et al. 2005). Impervious cover and more specifically, road density, in turn, are linked to greater inputs of sodium and chloride ions as a result of road deicing (Trowbridge et al. 2010, Daley et al. 2009).

For the VLAP lakes and ponds included in the trend network, specific conductance levels will be based on summer epilimnetic samples submitted to NH DES and measured using laboratory benchtop meters. Data will be collected a minimum of 3 - 5 times as discrete, one-time measures from samples collected and submitted by VLAP volunteers. In some cases, annual median specific conductance levels may include additional data collected by others sources but deemed acceptable by NH DES.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in specific conductance statewide?***

   Measure: Number of lakes and ponds with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of annual specific conductance levels by year for individual trend waterbodies. Data will be limited to the defined index period (June - September) and include all data points for the given "deep spot" sample location for each respective trend lake or pond . A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add between 3 - 5 data points per year to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean of the site.

2) ***What is the percentage of lakes and ponds that have higher (lower or similar) level of specific conductance in the current five years compared to each of the previous reporting period?***

   Measure: Number of trend waterbodies with mean specific conductance levels that are significantly different in the current 5-year reporting period than each previous 5-year reporting period divided by the total number of trend sites. Percentages will be computed individually for each current vs. previous reporting period.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of specific conductance levels between current and previous reporting periods. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported for the given "deep spot" sample location for each respective trend lake and pond. A significant difference in mean specific conductance levels between reporting periods is defined as one that has a 5% chance of occurring at random ($\alpha \leq 0.05$). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of lakes and ponds are in the upper 75th percentile (lower 25th) of the statewide distribution of specific conductance levels?***

   Measure: Number of trend waterbodies in the upper 75th percentile (lower 25th) of the statewide frequency distribution divided by the total number of trend sites. Plot of percentage of sites in upper and lower percentile categories over time and record of individual trend site percentiles.

   Data analysis: Answering this question includes 2 components: a statewide frequency distribution of specific conductance measures from all lakes and ponds where data is available and a 5-year median computation for individual trend waterbodies. The statewide frequency distribution will be computed from the median specific conductance level of individual lake and ponds from the respective water samples collected from the corresponding layer (epilimnion) and location (deep spot) as is utilized for the trend waterbodies. Data included in the statewide frequency distribution will be from all lakes and ponds for which data exists from 1990 through the last year included in the reporting period.
   Only waterbodies with two or more specific conductance measures will be used to create the statewide frequency distribution and computation of the median, 25th, and 75th percentiles. The 5-year median specific conductance level at trend waterbodies will be computed from data ending in the year of the current reporting cycle going back 5 years.

Data Qualities:

VLAP specific conductance data indicate a low to moderate level of variability (18-25%) (Table 25). Based historic data, the mean rates of change in specific conductance for waterbodies with significant linear regressions range from 0.80 - 9.3 µmhos/cm/yr depending on trophic class. If specific conductance levels were to change (increase or decrease) by 20 µmhos/cm over the next 20 years, it is estimated that significant trends would be detectable for oligotrophic lake and ponds, but not for meso- or eutrophic lakes and ponds. If however, changes in specific conductance were greater than 20 µmhos/cm then is it likely that the ability to detect trends for meso- and eutrophic lakes would be greater. Similarly, for waterbodies where the data variability is low, more subtle changes in specific conductance may be detectable.

Table 25. NH DES lakes and ponds specific conductance data record summary and expected ability to detect trends.

Trophic Class	Number of Lakes	Number with Sig. Linear Trend	Number of Records	Median (µmhos/cm)	Mean of Standard Deviations	Mean of Coefficients of Variation	Mean rate of change*	Future Trend detection capacity**
Oligotrophic	31	15	1,887	54.70	14.50	0.25	0.80	Y
Mesotrophic	46	19	2,892	52.90	19.41	0.18	1.42	N
Eutrophic	6	4	292	125.80	66.56	0.22	9.30	N

* Mean rate of change is average line slope of VLAP waterbodies with a minimum of 10 years of data that have significant linear regressions.

** Future trend detection capacity is based on a increase in specific conductance of 20 µmhos/cm over a 20 years.

7.2.4.2 Nutrients

Nutrients are vital parts to ecosystem primary production. However, in aquatic systems, when nutrient levels are increased beyond those that naturally occur, plant and algal growth can become excessive. The resulting affects can lead to water quality impairment as measured by the ability of waterbodies to support aquatic life and recreational uses. In lakes and ponds, phosphorus is widely accepted as the limiting nutrient and thus most important in controlling the growth of plants and algae.

The median total phosphorus (TP) concentration from 772 lake surveys completed from 1976 through 2008 through the Lake Survey Program was 0.012 mg/L (NH DES 2008). However, these data were wide ranging depending on lake trophic state. Typically, waterbodies that experience excessive plant or algal growth have total phosphorus concentrations in excess of 0.020 mg/L.

For the lake and pond network, nutrient levels will be expressed through TP concentrations measured during from June through September. Discrete samples will be collected by VLAP volunteers and submitted for laboratory analysis 3 - 5 times annually.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in nutrient concentrations statewide?***

   Measure: Number of trend waterbodies with a significant trend (increasing / decreasing) or no detectable trend. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of annual median TP concentrations by year for individual trend waterbodies. Data will be limited to the defined index period (June - September) and include all data points for the given "deep spot" sample location for each respective trend lake or pond . A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$).

Each reporting period will add 3 to 5 points per year to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean.

2) ***What is the percentage of trend locations that have higher (lower or similar) nutrient concentrations in the current five years compared to the previous reporting period?***

   Measure: Number of trend waterbodies with mean TP concentrations that are significantly different in the current 5-year reporting period than the previous 5-year reporting period divided by the total number of trend sites. Percentages will be computed individually for each current vs. previous reporting period.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of TP concentrations between current and previous reporting periods. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported for the given "deep spot" sample location for each respective trend lake and pond. A significant difference in mean TP concentrations between reporting periods is defined as one that has a 5% chance of occurring at random (($\alpha \leq 0.05$)). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the upper 75th percentile (lower 25th) of the statewide distribution of nutrient concentrations?***

   Measure: Number of trend lakes and ponds in the upper 75th percentile (lower 25th) of the statewide frequency distribution of TP divided by the total number of trend lakes and ponds. Plot of percentage of sites in upper and lower percentile categories over time and record of individual trend site percentiles.

   Data analysis: Answering this question includes 2 components: a statewide frequency distribution of TP concentrations from all lakes and ponds where data is available and a 5-year TP median concentration for individual trend waterbodies. Data included in the statewide frequency distribution will be from all lakes and ponds for which data exists from 1990 through the last year included in the reporting period. Only waterbodies with two or more TP concentration data points will be used to create the statewide frequency distribution and computation of the median, 25th, and 75th percentiles. The 5-year median TP concentration at trend waterbodies will be computed from data ending in the year of the current reporting cycle going back 5 years.

Data Qualities:

VLAP total phosphorus data indicate a moderate level of variability (25 - 36%) (Table 26). Based historic data, the mean rates of change in total phosphorus for waterbodies with significant linear regressions ranged from 13 - 19 µg/L/yr depending on trophic class. If total phosphorus concentrations were to double (or half) over the next 20 years, it is estimated that significant trends would be detectable for oligotrophic and mesotrophic lakes and ponds. At this time, trends in total phosphorus have not been detected in any of the eutrophic lakes and ponds. For all trophic classes, subtle trends in total phosphorus will have the greatest likelihood of being detected where the data variability is low.

Table 26. NH DES lakes and ponds total phosphorus data record summary and expected ability to detect trends.

Trophic Class	Number of Lakes	Number with Sig. Linear Trend	Number of Records	Median (µg/L)	Mean of Standard Deviations	Mean of Coefficients of Variation	Mean rate of change*	Future Trend detection capacity**
Oligotrophic	31	7	1,887	6.0	3.32	0.32	0.13	Y
Mesotrophic	46	10	2,856	10.0	4.18	0.25	0.19	Y
Eutrophic	6	0	288	18.0	13.5	0.36	----	----

* Mean rate of change is average line slope of VLAP waterbodies with a minimum of 10 years of data that have significant linear regressions in total phosphorus.

** Future trend detection capacity is based on a doubling or halving of total phosphorus concentrations over a 20 years.

7.2.4.3 Acidification

The pH of surface water is influenced by the geologic, soil, vegetative, and physical landscape characteristics within the watershed, as well as local landuse history and atmospheric deposition patterns. The ability to resist acidification, measured as a water's acid neutralizing capacity (ANC) is a key component to protecting a waterbody from becoming acidified and in allowing it to recover once it becomes acidified. Waters that have a low ANC concentrations are particularly susceptible to, and lack the ability to be resilient from acidification.

The draft 2012 305(b) report for New Hampshire's surface water quality indicates that approximately 37% of the state's lake and pond assessment units were listed as impaired for pH. A summary of pH water quality data records from 1976 through 2008 from the Lake Survey Program indicates the median pH from 780 lakes and pond was 6.5 (NH DES 2008). Similarly, records of alkalinity from the same time period for 781 lakes and ponds, indicated that the median alkalinity was 4.9 mg/L (R. Estabrook; summer, epilimnion samples).

For the lakes and ponds included in the trend network, pH will serve as the primary indicator of acidification. The data will be based on summer epilimnetic samples submitted to NH DES and measured using laboratory benchtop meters. Data will be generated 3 - 5 times per year as discrete, one-time measures from samples collected by VLAP volunteers. In some cases, annual pH measures may include additional data collected by others sources but deemed acceptable by NH DES.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in pH levels statewide?***

Measure: Number of trend lakes and ponds with a significant trend (increasing / decreasing) or no detectable trend in pH. If a significant trend is detected, the rate of change will be computed.

Data analysis: Linear regression or the Mann-Kendall test of annual median pH by year for individual waterbodies. Data for the computation of annual medians will be limited to the defined index period (June - September) and include all data points for the given "deep spot" sample location for each respective trend lake or pond . A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis. Rates of change for significant trends will computed by dividing the slope of the trend line by the overall mean of the site computed by taking the mean of the annual medians.

2) What in the percentage of trend locations that have higher (lower or similar) pH levels in the current five years compared to each of the previous reporting periods?

Measure: Number of trend lakes and ponds with mean pH levels, respectively that are significantly different in the current 5-year reporting period than each previous 5-year reporting period divided by the total number of trend sites.

Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of pH levels between current and previous reporting periods. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported for the given "deep spot" sample location for each respective trend lake and pond. A significant difference between reporting periods is defined as one that has a 5% chance of occurring at random (($\alpha \leq 0.05$)). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) What percentage of sites are in the upper 75th percentile (lower 25th) of the statewide distribution of pH levels?

Measure: Number of trend lakes and ponds in the upper 75th percentile (lower 25th) of the statewide frequency distribution for pH divided by the total number of trend sites. Plot of percentage of sites in upper and lower percentile categories over time and record of individual trend site percentiles.

Data analysis: Answering this question includes 2 components: a statewide frequency distribution of median measures from all lakes and ponds where data is available and the 5-year median measure for individual trend waterbodies. The statewide frequency distribution will be computed from the median pH of individual lakes and ponds collected from the corresponding layer (epilimnion) and location (deep spot) that is utilized for the trend waterbodies. Data included in the statewide frequency distribution will be from all lakes and ponds for which data exists from 1990 through the last year included in the reporting period. Only waterbodies with two or more pH measures will be used to create the each respective statewide frequency distribution and computations of the median, 25th, and 75th percentiles. The 5-year median pH level at trend waterbodies will be computed from data ending in the year of the current reporting cycle going back 5 years.

Data Qualities:

VLAP pH data indicate a low level of variability (4%) (Table 27). Based historic data, the mean rates of change in pH for waterbodies with significant linear regressions ranged from 0.014 - 0.017 units/yr depending on trophic class. If pH concentrations were to change (increase or decrease) by 0.05 units over the next 20 years, it is estimated that significant trends would be detectable for all lake and pond trophic classes. For all trophic classes, more subtle trends in pH may be detected where the data variability is low within years and exhibits a consistent increase (or decrease) over time.

Table 27. NH DES VLAP lake and pond pH data record summary and expected ability to detect trends.

Trophic Class	Number of Lakes	Number with Sig. Trend	Number of Records	Median (units)	Mean of Standard Deviations	Mean of Coefficients of Variation	Mean rate of change*	Future Trend detection capacity**
Oligotrophic	31	8	1,897	6.66	0.24	0.04	0.016	Y
Mesotrophic	46	9	2,843	6.70	0.27	0.04	0.014	Y
Eutrophic	6	1	291	6.86	0.25	0.04	0.017	Y

* Mean rate of change is average line slope of VLAP waterbodies with a minimum of 10 years of data that have significant linear regressions in pH.

** Future trend detection capacity is based on a 0.5 unit change in pH over a 20 years.

7.2.4.4 Water Clarity

Water clarity is directly related to the amount of suspended material in the water column. Variation in water clarity is expected based a waterbody's productivity (concentration of suspended algae), underlying geology, and type and quantity of sediment deposits. Waterbodies with unnaturally high production levels, due to excessive nutrient concentrations, will have lower water clarity than unproductive lakes. Similarly, waterbodies with an abundant supply of fine sediments that remain suspended have poorer clarity than those with fewer fine sediments. Poor water clarity can impede the growth of macrophytes, inhibit the success of visual predators, and be indicative of excessive deposition of organic matter and sediment. In cases where excessive deposition of organic matter or sediment occur, secondary water quality impacts, such as low dissolved oxygen levels or high nutrient concentrations may result.

In New Hampshire lakes and ponds water clarity is most commonly measured by way of Secchi disc transparency to the nearest tenth of a meter. The median secchi disc transparency reading of 663 lakes and ponds sampled from 1976 - 2008 through the Lake Survey Program is 3.2 meters, with readings ranging from 0.4 to 13 meters (NH DES 2008). In general, water clarity measures that exceed 4.5 meters are considered exceptional, those between 2 and 4.5 meters are considered good, while measures less than 2 meters are poor.

For the lakes and ponds included in the trend network, water clarity will be based on summer Secchi disc readings reported to NH DES through the VLAP program. Data will be collected a minimum of 3 - 5 times as discrete, one-time measures made by VLAP volunteers. In some cases, the annual median Secchi disc readings may include additional data collected by other sources but deemed acceptable by NH DES.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in water clarity statewide?***

   Measure: Number of trend lakes and ponds with a significant trend (increasing / decreasing) or no detectable trend water clarity. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of annual median water clarity by year for individual waterbodies. Data for the computation of annual medians will be limited to the defined index period (June - September) and include all data points for the given "deep spot" sample location for each respective trend lake or pond . A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis. Rates of change for significant trends will be computed by dividing the slope of the trend line by the overall mean of the site computed by taking the mean of the annual medians.

2) ***What is the percentage of trend locations that have lower (high or similar) water clarity measures in the current five years compared to each of the previous reporting periods?***

   Measure: Number of trend lakes and ponds with mean water clarity measures that are significantly different in the current 5-year reporting period than each previous 5-year reporting period divided by the total number of trend sites.

   Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of water clarity measures between current and previous reporting periods. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported for the given "deep spot" sample location for each respective trend lake and pond. A significant difference between reporting periods is defined as one that has a 5% chance of occurring at random (($\alpha \leq 0.05$)). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the lower 25th percentile (upper 75th) of the statewide distribution of water clarity measures?***

Measure: Number of trend lakes and ponds in the lower 25th percentile (upper 75th) of the statewide frequency distribution for water clarity divided by the total number of trend sites. Plot of percentage of sites in lower and upper percentile categories over time and record of individual trend site percentiles. Placement of trend waterbodies on a statewide frequency distribution curve will be done with respect to trophic class (See data analysis).

Data analysis: Answering this question includes 2 components: a statewide frequency distribution of median Secchi disc transparency from all lakes and ponds where data is available and the 5-year median measure for individual trend waterbodies. The statewide frequency distribution will be computed for each trophic class from the median Secchi disc transparency of individual lakes and ponds collected from the corresponding location (deep spot) that is utilized for the trend waterbodies. Data included in the statewide frequency distribution will be from all lakes and ponds for which data exists from 1990 through the last year included in the reporting period. Only waterbodies with 2 or more Secchi disc transparency readings will be used to create the each respective statewide frequency distribution and computations of the median, 25th, and 75th percentiles. The 5-year median Secchi disc transparency at trend waterbodies will be computed from data ending in the year of the current reporting cycle going back 5 years. Placement of trend lakes and ponds on the statewide frequency distribution will be according the each trend waterbody's respective trophic class. Trophic class assignments will be according to the "best" historic rating recorded by NH DES.

Data Qualities:

VLAP Secchi disc transparency data indicate a low level of variability (13-17%) (Table 28). Based historic data, the mean rates of change in Secchi disc transparency for waterbodies with significant linear regressions ranged from 0.045 - 0.078 m/yr depending on trophic class. If Secchi disc transparencies were to be reduce in half (or double) over the next 20 years, it is estimated that significant trends would be detectable for all lake and pond trophic classes. For all trophic classes, more subtle trends in Secchi disc transparency may be detected where the data variability is low within years and exhibits a consistent increase (or decrease) over time.

Table 28. NH DES VLAP lake and pond Secchi disc transparency data record summary and expected ability to detect trends.

Trophic Class	Number of Lakes	Number with Sig. Trend	Number of Records	Median (m)	Mean of Standard Deviations	Mean of Coefficients of Variation	Mean rate of change*	Future Trend detection capacity**
Oligotrophic	31	11	1,862	6.00	1.27	0.13	0.078	Y
Mesotrophic	46	11	2,890	3.40	0.66	0.15	0.045	Y
Eutrophic	6	3	289	2.44	0.64	0.17	0.05	Y

* Mean rate of change is average line slope of VLAP waterbodies with a minimum of 10 years of data that have significant linear regressions in Secchi disc transparency.

** Future trend detection capacity is based on a doubling or halving in Secchi disc transparency over a 20 years.

7.2.4.5 Biological Production

The productivity of a waterbody is a measure of the rate of biomass accumulation. Natural production rates are affected by the various factors such as light availability, temperature, and the underlying geology and soil characteristics that supply nutrients. Unnatural increases in production rates are most often associated with nutrient loading from fertilizers, excessive soil erosion, or waste disposal. Where waterbody productivity is increased beyond its natural rate, water quality conditions often decline, specifically with respect algae blooms that, in turn, can result in decreased dissolved oxygen concentrations due to increased microbial decomposition of organic material.

In lakes and ponds primary production is most often measured through estimates of chlorophyll *a* concentrations. Chlorophyll-*a* is a pigment found in plants and serves as an indicator of the abundance of suspended algae. For New Hampshire lakes and ponds, chlorophyll-*a* concentrations less than 5 µg/L are considered good, between 5 and 15 µg/L as fair, and greater than 15 µg/L poor. Water quality records of 776 New Hampshire lakes and pond from 1976 - 2008 indicate the meadian chlrorophyll-a concentration of "deep spot" epilimnion water samples was 4.58 µg/L (NH DES 2008). The draft 2012 305(b) report for New Hampshire's surface water quality indicates that 90 assessment units were above the thresholds assigned to lakes and ponds (~6% of lake and pond assessment units).

For the VLAP lakes and ponds included in the trend network, chlorophyll-*a* concentrations will be based on summer epilimnetic samples submitted to NH DES using standard spectrophotomic analysis methods. Data will be collected a minimum of 3 - 5 times as discrete, one-time measures from samples collected and submitted by VLAP volunteers. In some cases, annual median chlorophyll-a concentrations may include additional data collected by others sources but deemed acceptable by NH DES.

Question(s) parameter will be used to answer:

1) ***What is the incidence of increasing, decreasing, and stable trends in chlorophyll-a statewide?***

   Measure: Number of trend lakes and ponds with a significant trend (increasing / decreasing) or no detectable trend chlorophyll-a concentrations. If a significant trend is detected, the rate of change will be computed.

   Data analysis: Linear regression or the Mann-Kendall test of annual median chlorophyll-*a* concentration by year for individual waterbodies. Data for the computation of annual medians will be limited to the defined index period (June - September) and include all data points for the given "deep spot" sample location for each respective trend lake or pond . A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis. Rates of change for significant trends will be computed by dividing the slope of the trend line by the overall mean of the site computed by taking the mean of the annual medians.

2) ***What is the percentage of trend locations that have lower (high or similar) chlorophyll-a concentrations in the current five years compared to each of the previous reporting periods?***

   Measure: Number of trend lakes and ponds with mean chlorophyll-*a* concentrations that are significantly different in the current 5-year reporting period than each previous 5-year reporting period divided by the total number of trend sites.

Data analysis: Analysis of variance (ANOVA) or an equivalent non-parametric test of chlorophyll-*a* concentrations between current and previous reporting periods. Data for the analysis will be limited to a defined index period (June - September) and include all data points reported for the given "deep spot" sample location for each respective trend lake and pond. A significant difference between reporting periods is defined as one that has a 5% chance of occurring at random (($\alpha \leq 0.05$)). Data from an entire reporting period will be consolidated for the computation of summary statistics and used in completing each analysis.

3) ***What percentage of sites are in the upper 75th percentile (lower 25th) of the statewide distribution of chlorophyll-a concentrations?***

Measure: Number of trend lakes and ponds in the upper 75th percentile (lower 25th) of the statewide frequency distribution for chlorophyll-*a* divided by the total number of trend sites. Plot of percentage of sites in lower and upper percentile categories over time and record of individual trend site percentiles. Placement of trend waterbodies on a statewide frequency distribution curve will be done with respect to trophic class (See data analysis).

Data analysis: Answering this question includes 2 components: a statewide frequency distribution of median chlorophyll-*a* concentrations from all lakes and ponds where data is available and the 5-year median measure for individual trend waterbodies. The statewide frequency distribution will be computed for each trophic class from the median chlorophyll-*a* concentration of individual lakes and ponds collected from the corresponding location (deep spot) that is utilized for the trend waterbodies. Data included in the statewide frequency distribution will be from all lakes and ponds for which data exists from 1990 through the last year included in the reporting period. Only waterbodies with 2 or more chlorophyll-*a* concentrations will be used to create the each respective statewide frequency distribution and computations of the median, 25th, and 75th percentiles. The 5-year median chlorophyll-*a* concentration at trend waterbodies will be computed from data ending in the year of the current reporting cycle going back 5 years. Placement of trend lakes and ponds on the statewide frequency distribution will be according the each trend waterbody's respective trophic class. Trophic class assignments will be according to the "best" historic rating recorded by NH DES.

Data Qualities:

VLAP chlorophyll *a* data indicate a low to moderate level of variability (17-35%) (Table xx). Based historic data, the mean rates of change in chlorophyll *a* concentrations for waterbodies with significant linear regressions ranged from 0.045 - 0.071 µg/L/yr depending on trophic class. If chlorophyll *a* concentrations were to double (or reduce by half) over the next 20 years, it is estimated that significant trends would be detectable for all lake and pond trophic classes. More subtle trends in chlorophyll *a* concentrations may be detected where the data variability is low within years and exhibits a consistent increase (or decrease) over time.

Table 29. NH DES VLAP lake and pond chlorophyll *a* data record summary and expected ability to detect trends.

Trophic Class	Number of Lakes	Number with Sig. Linear Trend	Number of Records	Median (µg/L)	Mean of Standard Deviations	Mean of Coefficients of Variation	Mean rate of change*	Future Trend detection capacity**
Oligotrophic	31	3	1,889	2.35	1.38	0.35	0.071	Y
Mesotrophic	46	10	2,885	4.35	3.51	0.36	0.37	N
Eutrophic	6	1	288	7.67	8.49	0.49	0.614	N

* Mean rate of change is average line slope of VLAP waterbodies with a minimum of 10 years of data that have significant linear regressions in chlorophyll *a* concentrations.

** Future trend detection capacity is based on a doubling or halving in the concentration of chlorophyll *a* over 20 years.

7.2.4.6 Primary Contact Recreation

Primary contact recreation refers to suitability of our waters for swimming with respect to pathogen concentrations. Waters with high pathogen inputs can be a human health risk. Pathogens that cause diseases such as gastroenteritis or *Giardiasis*, can be carried in the feces of humans, waterfowl, livestock and domestic animals. The pathogens are transferred to public bathing areas when the feces from an infected warm-blooded animal enters a waterbody from nearby farms, septic systems, wildlife, storm drains or unknown sources.

In New Hampshire freshwater beach areas are assessed for primary contact recreation by measuring the concentration of *E. coli*, a common bacterium that is present in the fecal material of warm-blooded animals. If a beach area exceeds state water quality criteria (2 or more samples ≥ 88 counts / 100 mL or 1 sample ≥ 158 counts / 100 mL), then an advisory is posted. In 2012, NH DES personnel performed 710 beach inspections at 160 freshwater beaches in 11 weeks (June - August). A total of 176 *E. coli* samples exceeded the state standards, resulting in the issuance of 56 advisories (S. Carlson, Pers. Comm).

Trends in primary contact recreation conditions at freshwater beaches will tracked through the NH DES Beach Program. Beaches used for trend analysis will include some, but not all of the VLAP waterbodies that are to be used for the lake and pond trend monitoring network. Only beaches that have been sampled at least twice per summer (June - August) in 8 out of the last 10 years will be utilized for trend analysis. A total of 160 beaches have been identified that meet this criteria (Appendix D).

Question(s) parameter will be used to answer:

1) ***Is the percentage of the total number of beaches with advisories issued in a given year increasing, decreasing, or remaining stable?***

   Measure: The percentage of the total number of freshwater beaches sampled annually where an advisory is issued during the bathing season (June 1 - August 31).

   Data analysis: Linear regression or the Mann-Kendall test of the percentage of freshwater beaches where an advisory has been issued by year. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis. The percentage will be computed by summing number of beaches where an advisory is issued one or more times during the bathing season divided by the total number of beaches sampled in the respective bathing season.

2) ***Is the percentage of the total number of beach advisory days increasing, decreasing, or remaining stable?***

   Measure: The percentage of the total number of available bathing days annually when beach advisories are in place.

   Data analysis: Linear regression or the Mann-Kendall test of the percentage of available bathing days when an advisory was is place by year. A significant trend is defined as one that has ≤ 5% chance of occurring at random ($\alpha \leq 0.05$). Each reporting period will add 5 points (5 years) to the trend analysis. The percentage will be computed by summing number of bathing days for all freshwater beaches when an advisory is in place and dividing this number by the sum of all potential bathing days (normally 92 x total number of beaches; June 1 - August 31).

3) Is the number of beaches with advisories in the current reporting period greater than, less than, or equal to the overall mean over the entire reporting period?

Measure: Comparison of the number of beaches in each year within the reporting period as in (1) above to the mean number of beaches with advisories issued annually up to the beginning of the current reporting period.

Data analysis: No formal data analysis is required as the single number (total number advisories) in each given year will be compared to the long term mean. Improving conditions will be interpreted as fewer advisories, declining conditions as more advisories, stable conditions as an equal number of advisories. A running 10-year tally of the frequency of improving, declining, and stable conditions will also be reported.

Data Qualities:

The frequency of beach advisories indicate a moderate level of variability (27%) based on 10 years of data and average approximately 20% of all beaches sampled annually (Table 30). Based an these data if the percentage of beach advisories increase (or decrease) 5% each year for 20 years, trend detection is highly likely (100% based on 250 simulated linear regression iterations). Trends with a lower rate of change may be detected if data variability remains stable or is reduced.

Table 30. NH DES beach advisory data record summary and expected ability to detect trends.

Number of Records	Mean (%)	Standard Deviation	Coefficient of Variation	Variability Category	Expected trend detection capacity*
1,540	19.9	5.39	27.1	Moderate	100%

* Trend detection capacity is based on the percentage of significant regressions (p=0.95) obtained from 250 simulated iterations based on a synthetic dataset with a 5% annual increase in the percentage of beach advisories.

7.2.4.7 Exotic Aquatic Plant Infestations

Exotic aquatic plants pose a threat to the ecological, aesthetic, recreational, and economic values of freshwater resources (lakes, ponds, rivers and streams) primarily by forming dense growths or monocultures in critical areas of waterbodies that are important for aquatic habitat and recreational use. These dense stands can reduce the natural diversity of plant and animal species, alter water chemistry, modify dissolved oxygen concentrations, and impact the aquatic habitat structure that is native to the system.

Infestations of exotic aquatic plants occur commonly by way of plant fragments that become attached to aquatic recreational equipment, such as boats, motors, and trailers and can spread from waterbody to waterbody through transient boating activities. Once infested, these plants can rapidly spread to areas with suitable conditions through seed dispersal and fragment rooting.

Since the first exotic aquatic plant infestation in New Hampshire was discovered in 1965 in Lake Winnipesaukee, a total of 87 infestations in 78 waterbodies have been documented (NH DES 2013). Species present include variable milfoil (70 waterbodies), Eurasian milfoil (6 waterbodies), fanwort (9 waterbodies), water chestnut (1 waterbody), Brazilian elodea (1 waterbody), Curly-Leaf Pondweed (3 waterbodies), European Naiad (3 waterbodies), and Didymo (4 waterbodies).

NH DES takes an active role in monitoring the incidence and extent of exotic aquatic plant infestations through its Exotic Species Program. freshwaters are assessed for the presence and extent of exotic aquatic plants, and where found, the locations of occurrence are mapped and tracked regularly with geographic positioning systems (GPS) and geographic informational systems (GIS). Each year, roughly 80 surveys are performed across New Hampshire's waterbodies to identify new infestations or track existing infestations.

Question(s) parameter will be used to answer:

1) Is the number of infested waterbodies in New Hampshire increasing or remaining stable?

Measure: Total number of infested waterbodies over time.

Data analysis: No formal data analysis is required other than graphing and evaluating the trend in total number of infestations annually. Based on experience, infestation frequency (e.g. number of waterbodies) will either increase or remain stable (eradication of established infestations are uncommon). Thus, an increase will simply be determined by comparison to the number of infestations in the prior year. Likewise a stable trend will be reported when the number of infestations is the same as the prior year.

2) What is the area infested by exotic aquatic plants in each of the years within the current reporting period and how does it compare to the long-term annual mean?

Measure: Comparison of the total area (acres) documented as being infested with exotic aquatic plants in each year of the current reporting period to the mean annual infestation area annually up to the beginning of the current reporting period.

Data analysis: No formal data analysis is required as the single number (total area infested) in each given year will be compared to the long term mean. Improving conditions will be interpreted as a decrease in the mean area of infestation within the reporting period and declining conditions as an increase in the mean area of infestation with the reporting period compared to the long term mean area of infestation. The total number of waterbodies surveyed for infestation within a given year will be reported as a scaling factor.

3) Is the use of herbicides for the control of exotic aquatic plants in the current reporting period greater than, less than, or equal to the overall annual mean?

Measure: Comparison of the total area (acres) treated by herbicides for the control of exotic aquatic plants annually for each year of the current reporting period to the mean area treated annually up to the beginning of the current reporting period.

Data analysis: No formal data analysis is required as the single number (total acreage treated) in each given year will be compared to the long term mean. A reduction in use will be interpreted as less acreage treated by herbicides and an increase in use as more acreage treated. A running 10-year tally of the frequency of increased or decreased use of herbicides will also be reported.

4) Is the use of alternative control measures (e.g. suction harvesting, hand pulling, benthic barrier) for the control of exotic aquatic plants in the current reporting period greater than, less than, or equal to the overall annual mean?

Measure: Comparison of the total area (acres) treated by alternative measures for the control of exotic aquatic plants annually for each year of the current reporting period to the mean area treated annually up to the beginning of the current reporting period..

Data analysis: No formal data analysis is required as the single number (total acreage of control) in each given year will be compared to the long term mean. A increase in the use of alternative measures will be interpreted as an increase in acreage and vice-versa for a reduction in use the use of alternative measures. A running 10-year tally of the frequency of increased or decreased use of alternative control measures will also be reported.

Data Qualities:

A review of the data to date with respect to tracking the extent of exotic aquatic plant infestations includes records back as far as 1992. These records, however, were generated using a variety of inconsistent methods up until 2000. From 2000 to 2013, geo-referenced data were used to pinpoint to infested areas on individual waterbodies using GPS and GIS technologies.

Records indicate that the extent of exotic aquatic plant infestations has ranged from 382 to 1,169 acres with a mean area of infestation over this time of 793 acres (Table 31). These data, however, were highly positively correlated with the number of surveys conducted. Since 2000, the number of areas surveyed has consistently increased from 10 in 2000 to 41 in 2013. In 2013, of the areas surveyed, the cumulative area of infestation was 1,158 acres.

Treatment of areas infested with exotic aquatic plants from 2000 to 2013 included the use of herbicides and alternative methods (hand harvesting, suction harvesting, benthic barriers). Herbicides were used to treat between 12 and 41 areas covering from 279 to 1,110 acres over this time period with a mean of 264 acres (Table 31). Herbicide use has increased over the past 13 years as new infestations are discovered. In 2013, 41 areas were treated with herbicide covering approximately 1,110 acres in total.

Records of alternative control methods are limited to the number of alternative control methods per waterbody. From 2000 to 2013, the cumulative number of alternative control methods ranged from 17 to 87 with a mean of 36 (Table 31). Since 2000, the use of alternative control methods has increased consistently and is the preferred method of treatment whenever possible. In 2013, alternative control methods were used on 87 occasions in 46 waterbodies.

Table 31. Summary of exotic aquatic plant survey results and treatments from 2000 - 2013.

Metric	Range	Mean	Standard Deviation	Survey / Treatment Frequency
Infested Acres	382 - 1169	793	303	10-41 waterbodies surveyed
Acres treated w/ Herbicide	279 - 1110	264	296	12-41 sites treated
Use of alternative control methods	17 - 87	36	23	8 - 46 waterbodies treated

7.2.4.8 Cyanobacteria Occurrence

Cyanobacteria are photosynthetic bacteria found naturally in lakes, streams and ponds. Cyanobacteria do not usually cause recreational or aesthetic problems. However, unsightly and potentially harmful blooms can form when excess nutrients find a way into a lake. Most cyanobacteria species exist on the lake bottom during the winter months. In the spring, increased water temperature and light cause cyanobacteria to move toward the lake surface.

Some cyanobacteria produce toxins that can adversely affect livestock, domestic animals, and humans when critical levels are reached. According to the World Health Organization (WHO), toxic cyanobacteria are found worldwide in both inland and coastal waters. The first reports of

toxic cyanobacteria in New Hampshire occurred in the 1960s and 1970s. Regionally, several dogs died in 1999 after ingesting toxic cyanobacteria from a bloom in Lake Champlain. The WHO has documented acute impacts to humans from cyanobacteria from the US and around the world as far back as 1931. While most human health impacts have resulted from ingestion of contaminated drinking water, cases of illnesses have also been attributed to swimming in cyanobacteria infested waters.

Cyanobacteria beach advisories are issued by NH DES when greater than 50% of an algal bloom is identified to be cyanobacteria. NH DES has issued 88 cyanobacteria beach advisories since 2000 (S. Carlson Pers. Comm.). To alert lake users of cyanobacteria blooms on lakes without designated beaches or in areas of a lake far from a designated beach, NH DES developed cyanobacteria lake warnings. Cyanobacteria lake warnings are issued when blooms cover a significant portion of a lake with a large concentration of cyanobacteria. NH DES has issued 44 lake warnings since 2008.

NH DES takes an active role in monitoring the incidence and extent of cyanobacteria blooms in lakes through its beach inspection program. During the summer months, approximately 160 freshwater beaches are sampled three times for signs of cyanobacteria blooms. As biology staff visit lakes throughout the state, any suspect bloom is sampled and recorded. Additionally, citizen complaints of suspect cyanobacteria occurrences submitted to the department are investigated.

Question(s) parameter will be used to answer:

1) ***Is incidence of lake-wide cyanobacteria warnings increasing, decreasing, or remaining stable over time?***

   Measure: Total number lake-wide warnings issued within each year of the current reporting period.

   Data analysis: No formal data analysis is required other than graphing and evaluating the trend in total number of warnings issued on an annual basis within the current reporting period and comparing these data to previous years and the long term mean.

2) ***Is incidence of swimming beach-related cyanobacteria advisories increasing, decreasing, or remaining stable over time?***

   Measure: Total number swimming beach-related cyanobacteria advisories issued within each year of the current reporting period.

   Data analysis: No formal data analysis is required other than graphing and evaluating the trend in total number of advisories issued on an annually basis within the current reporting period and comparing these data to previous years and the long term mean.

Data Qualities:

Cyanobacteria beach advisory records date back to 2003. Since 2003, a total of 92 advisories have been issued. Annually the number of advisories has ranged from 1 to 15 with a mean of 8 advisories per year (Table 32). Lake-wide cyanobacteria warnings were first issued in 2008 and have ranged from 1 to 15 per year with a mean of 7. In total, 44 lake-wide cyanobacteria warnings have been issued.

Table 32. Incidence of NH DES issued cyanobacteria beach advisories and lake-wide warnings from 2003 - 2013.

Warning Type	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Mean	Standard Deviation	Cumulative Total
Beach Advisory	1	3	5	6	11	14	15	10	10	9	8	8.4	4.34	92
Lake Warning	--	--	--	--	--	15	10	12	4	1	2	7.3	5.79	44

7.2.4.9 Accessory Indicators:

Additional water quality parameters will be collected at each of the lakes and pond included in the trend monitoring network (See Table 24, above). These parameters were selected as accessory indicators since they are of common interest for a variety of reasons in determining water quality conditions and may prove a useful indicators in the future. Data for these parameters will be collected primarily by NH DES staff or VLAP volunteers, but may, in some instances, include data collected by other sources. Sampling for these parameters will be during the summer months (June - September), primarily, but may include additional samples during other times of the year. Results for each of the parameters will be obtained through the collection of discrete water samples that are submitted for laboratory analysis, field collection, or observation. Although no formal trend analyses will be completed for these parameters, standard descriptive statistics (mean, median, etc.) will be tabulated for each reporting period. As with the primary trend indicators, raw data for the accessory indicators will be quality assured and stored in the NH DES EMD.

7.2.5 Data Sources, Quality Assurance, and Data Management

Lakes and ponds trend monitoring data will be generated citizen volunteers (VLAP) and NH DES using field instruments, collection of discrete samples for laboratory analysis, or through the capture of biological organisms for laboratory identification. Data collection for all trend monitoring activities will be completed under EPA approved quality assurance project plans (QAPP) or a NH DES standard operating procedures (SOP). All data will be stored in the NH DES EMD. Prior to acceptance, all data will be reviewed for completeness, accuracy, and precision. Once data verification is complete, raw data will be flowed from NH DES' EMD to EPA's STORET/WQX using a node to node transfer.

In some cases, trend data may be collected and submitted to NH DES by alternative sources for a variety of unknown purposes. The quantity of data submitted by alternative sources cannot be determined at this time but is likely to account for a small percentage of the overall data. In these instances, a full review of the submitting entities quality assurance measures will be completed prior to data acceptance and inclusion in trend reporting. Any data included in trend reporting that is generated by outside sources will also be stored in the EMD and subsequently flowed to EPA's STORET/WQX. Only data marked as "valid" in the EMD will be utilized in the trend analysis and reporting phase.

7.2.6 Project costs / needs

Data utilized for the analysis of water quality trends in lakes and ponds will be produced primarily through NH DES' volunteer lake assessment program. Laboratory costs to process these samples are split between volunteers and NH DES. Sampling events will occur 3 or more times per summer at 83 or more lakes. Costs associated with the production of data to track bathing beach conditions will be NH DES' responsibility through its BEACH program and based on bacterial samples collected 2 - 3 times per summer at 150 freshwater beaches. Costs associated with tracking exotic aquatic plant species infestations are tied field activities of the Exotic Species Program.

Collectively, the implementation of these programs are reliant of 3 full time staff people and 5 interns. Their tasks include the coordination and completion of the field activities necessary to produce the data required to assess the indicators. Since these activities do not occur on a set schedule it is not possible to provide a detailed estimate of staffing needs as with the other monitoring programs. In most instances some phase of lakes and ponds trend monitoring will occur everyday during the field season (May - September). Table 33 provides a estimate of laboratory costs and staffing needs.

Table 33. Lakes and ponds trend monitoring estimated costs and needs.

Lakes / Ponds Trend Monitoring Estimated Costs / Needs			
Estimated Laboratory Costs			
	VLAP Program related lab services costs*	BEACH program related lab services costs**	Totals***
Per sample event cost estimate	$80	$20	
Number of samples	1	3	
Number of events	3	2	
Number of sites	83	150	
Total lab costs	$19,920	$18,000	$37,920
* VLAP costs include total phosphorus, sp. conductance, pH, alkalinity, and Chlorophyll a ** BEACH costs are for E. coli *** Total costs exclude field parameters and microscopic identification			
Staffing Needs			
VLAP - 1 full time staff (coordinate volunteer field activities); 2 interns (complete quality assurance visits; process laboratory samples). BEACH - 1 full time staff (coordinate field activities, process advisories); 2 interns (complete sample collection and submission). Exotic - 1 full time staff, 1 intern (complete field surveys).			

7.2.7 Reporting

A summary report will be issued at five year intervals based on the schedule in Appendix A. For the period covered in this version of the water monitoring strategy the first lake and pond trend report will be drafted and available for review by 2019. The report will cover the trend monitoring period from 2013 - 2017. A second lake and pond trend report will be completed for review in 2024 and cover the monitoring period from 2018 - 2022. Both reports will document, to the extent possible, the outcome of each of the primary indicators detailed above and provide a general summary of the accessory indicators.

8. Synoptic Monitoring

Synoptic water quality monitoring is a general term defined as a systematic approach to monitoring.. The benefits of NH DES' synoptic monitoring program are that they provide an opportunity to collect and disseminate information from waterbodies that are not otherwise monitored, yet are important recreational or ecological resources of the state. More specifically, synoptic monitoring will included a targeted selection of waterbodies based on a systematic statewide watershed rotation and include waterbody visitations for the purposes of designated use assessment, regulatory investigation, restoration documentation, lake or pond trophic status determination, or water quality data cataloging of public waterbodies.

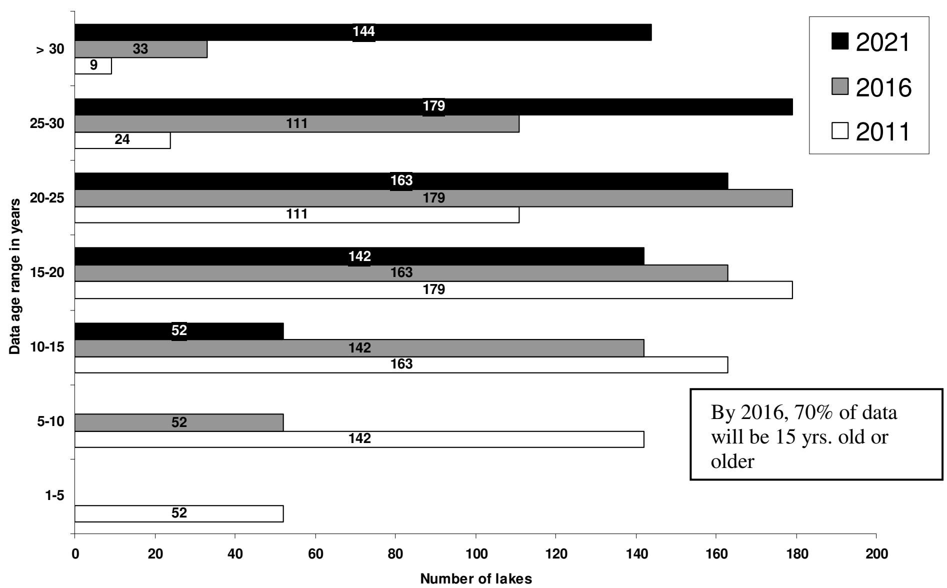
Up until 2007 targeted monitoring accounted for the majority of the surface water quality monitoring efforts by NH DES. For lakes and ponds, beginning in 1975, 40 - 50 waterbodies were sampled annually as part of its Lake Survey Program and resulted in a catalog of data for nearly 800 lakes and ponds. Similarly, starting in the mid-1980s, 50 or more river and stream sampling stations were visited annually as part of the Ambient River Monitoring Program resulting in nearly 900 stations on individual river or stream segments. While these data continue to be valuable, there has been a general reduction in the generation of more recent data.

Since this approximately 2005, targeted surface water quality monitoring efforts have been completed almost entirely through NH DES' volunteer monitoring programs; the Volunteer Lake Assessment Program (VLAP) and the Volunteer River Assessment Program (VRAP). To the credit of these two popular and extremely valuable programs, a core body of water quality data has been maintained for the waterbodies where these groups exist.

However, for those waterbodies without volunteer groups or that are not part of the trend monitoring network, the are no current programs dedicated to completing targeted monitoring of surface water quality. If unchanged, over the long term the result will be a plethora of data from a select set of waterbodies, but little to no current information from many of the state's water resources.

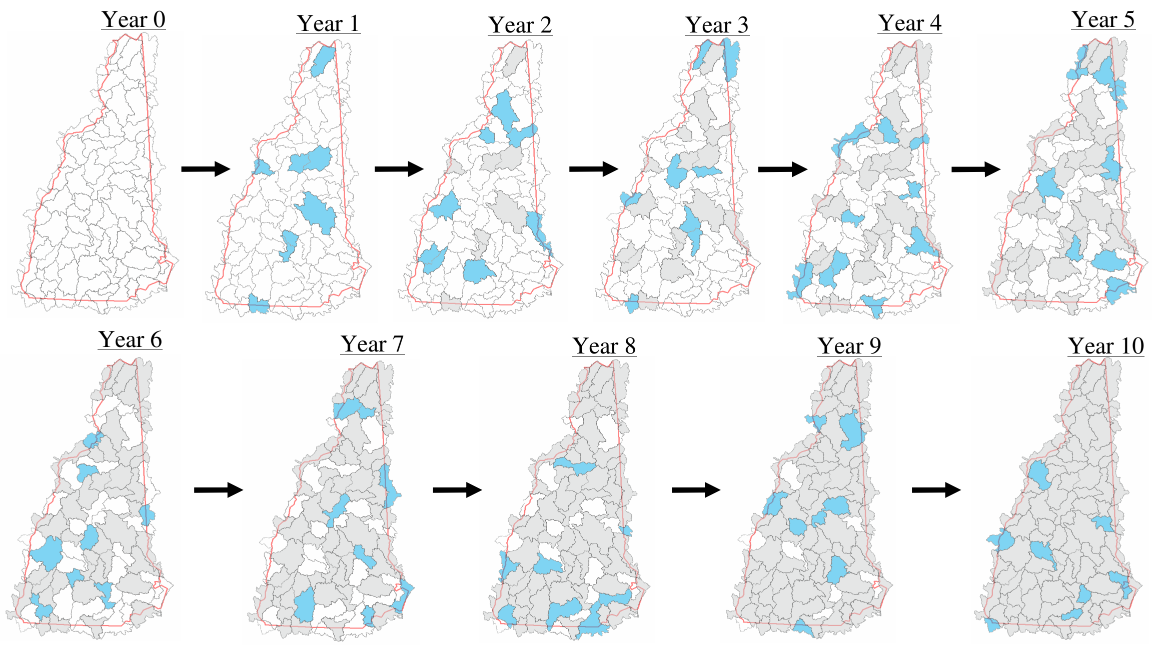
As an example, based on a review of the data collected through the Lake Survey Program, without a renewed monitoring effort, approximately 70% of the data will be 15 years or older by 2016 (Figure 4). As a result, NH DES will not be able to update the trophic status of individual lakes, an important determinant in quantifying the cumulative impacts of anthropogenic influences such as stormwater inputs, excessive nutrient loading, and shoreline development. A similar situation would also occur for the rivers and streams without a refocused effort to collect data from targeted sample locations.

Figure 4. Data age by year for the NH DES lake survey program.



To address this need, NH DES will institute a renewed, limited, effort to collect targeted water quality data from surface waters where data is needed but might otherwise go unsampled. Synoptic monitoring by NH DES in this manner will be rooted in the use of a stratified rotating basin approach centered around the 10-digit hydrologic unit code (HUC 10; n=81) as a way to systematically generate statewide data on a watershed basis. At a minimum, the new approach would include sampling of a least one representative lake or pond and one representative river segment in 8 to 10 HUC 10s every year. In this manner, a full statewide rotation of each HUC 10 watershed would be completed on a 10-year cycle. HUC 10s designated for sampling by NH DES staff in any given year will be spatially distributed throughout the state (Figure 5) and based on a predetermined schedule (Appendix E). A spatially balanced approach is preferred to track the effects of widespread uncontrollable environmental events (e.g. drought) throughout the state and not incorrectly associating them with a particular region as is possible with a geographically focused rotating sampling design. The statewide rotational design is made possible by the relatively small geographic area of New Hampshire allowing field personnel to easily travel to and from most locations in the state on any given day or sampling multiple watersheds within a pre-planned timeframe.

Figure 5. Geographic representation of scheduled rotation of HUC 10 target watersheds for synoptic monitoring. White (unsampled), blue (sampled in respective year), grey (sampled in previous years).



Unlike probability and trend monitoring, synoptic monitoring based on the rotational design is meant to be flexible in order to satisfy a specific water quality data needs. For this reason, the selection of waterbodies slated for sampling will be done annually, based on the rotational schedule, but through input from NH DES staff and others where possible. In this manner, NH DES staff responsible for planning water quality monitoring efforts will provide communication of the targeted HUC 10 watersheds to be sampled within any given year and hold a series of pre-field season meetings to determine monitoring needs and make final selections for sampling in the upcoming field season. Monitoring will be focused on lakes/ponds or river/stream segments where water quality data is determined to be unavailable, unreliable, or out-of-date. Targets for data needs will also include a review of water quality assessment outcomes. These will identify where additional data would be beneficial in updating the designated use status of individual assessment units for 305(b) reporting requirement.

The flexibility of NH DES' targeted synoptic monitoring also efforts excludes it from the requirement of developing predetermined measures centered around specific water quality indicators. Instead, the parameters selected for monitoring will be those most suited to fulfill the needs of the investigations. However, the ability of NH DES to satisfy the needs that are identified will be balanced with available resources. In most cases, monitoring will be limited to the collection of data for standard physical, chemical, and biological parameters at a frequency of one to three times during the summer months. In some cases, specialized surveys may be completed that include standard or unique parameters that are monitored at a increased frequency, over extended temporal period, or at an intensified spatial distribution where needs are identified and new or expanded funding sources exist.

8.1 Lakes and Ponds

As currently planned, targeted synoptic monitoring for lakes and ponds will occur through a renewed Lake Survey Program. The Lake Survey Program draws heavily from the field protocols and trophic rating processes used in the past by the NH DES to maintain a consistent data collection and analysis process moving forward. In total, 23 different physical, chemical, and biological parameters are proposed for collection and analysis (Table 34). In addition, limnological characters, such as flushing rate, mean depth, and shoreline configuration will also be calculated.

Table 34. Lake and ponds synoptic monitoring parameters.

Parameter	Analysis Location
Plant Community Assessment *	Field
Secchi Disk Depth**	Field
Oxygen Profile**	Field
Temperature Profile**	Field
Bathymetry *	Field
Nitrate + Nitrite Nitrogen**	DHHS PHL-WAL
Total Kjldahl Nitrogen**	DHHS PHL-WAL
Total Phosphorus**	DHHS PHL-WAL
Calcium*	DHHS PHL-WAL
Magnesium*	DHHS PHL_WAL
Sodium*	DHHS PHL-WAL
Potassium*	DHHS PHL-WAL
Organic carbon*	DHHS PHL-WAL
Sulfate*	DHHS PHL-WAL
pH**	JCLC
Acid Neutralizing Capacity**	JCLC
Conductivity**	JCLC
Apparent Color**	JCLC
Turbidity**	JCLC
Chloride**	JCLC
Phytoplankton*	JCLC
Zooplankton*	JCLC
Chlorophyll-a**	JCLC
* Parameters sampled only during first year; ** Parameters to be sampled once annually over 3 year period; see below.	

The Lake Survey Program will produce data over three years during the summer months (Table 35). Repeat visits over the course of three summers is recommended in effort provide a more accurate representation of average water quality conditions. In addition, summer sampling will produce data during the growing season when lakes and ponds are most heavily used and likely to demonstrate water quality problems.

In total, the program will sample up to 10 new lakes per year and up to 30 total lakes within any given year once the program has been in place for three years (Table 35). In the first year of sampling for a given selection of lakes, field efforts would be focused in August and include the most intensive sampling. Sampling in the second and third years would be more rapid, completed in July the seconed year and June the third year, and focused only on water quality parameters that are quick and easy to collect.

Table 35. Lake trophic survey program sampling schedule 2013 - 2022.

Month of Sampling → Year of Sampling ↓	August	July	June	Maximum number to be sampled
2013	2013 selection*	x	x	10
2014	2014 selection*	2013 selection	x	20
2015	2015 selection*	2014 selection	2013 selection	30
2016	2016 selection*	2015 selection	2014 selection	30
2017	2017 selection*	2016 selection	2015 selection	30
2018	2018 selection*	2017 selection	2016 selection	30
2019	2019 selection*	2018 selection	2017 selection	30
2020	2020 selection*	2019 selection	2018 selection	30
2021	2021 selection*	2020 selection	2019 selection	30
2022	2022 selection*	2021 selection	2020 selection	30
* Each year of selection represents up to 10 lakes				

8.1.1 Project costs / needs

Field efforts for the Lake Survey Program are estimated to be up to 20 days within any given year, with 10 days of sampling in August and 5 days of sampling in each of June and July. The completion of lake/pond synoptic monitoring surveys will rely of staff from the NH DES Watershed Management Bureau within the Biology Section. Overall estimated lab costs and staffing needs are detailed in Table 36.

Table 36. Lakes and Ponds synoptic monitoring estimated costs and needs.

Lakes / Ponds Synoptic Monitoring Estimated Costs / Needs			
Estimated Laboratory Costs			
	1st year cost	2nd year cost	3rd year cost
Per site	$197	$57	$571
Number of sites	10	10	10
QC cost estimate	$197	$57	$57
Total cost by category	$2,167	$627	$627
Total cost / site			$311
Total cost / cycle*			$3,421
Total cost / year			$3,421
* Cycle is one set of 10 lakes sampled over 3 consecutive years ** Total lab costs / years assumes 30 lakes per year are sampled			
Staffing Needs			
Year 1: 1 field crew (2 staff) @ 1 site / day x 10 sites = 20 staff days Year 2 & 3: 1 field crew (2 staff) @ 2 sites / day x 20 sites x 2 years = 20 staff days Total number of staff days = 40 / year			

8.2 Rivers and Streams

For rivers and streams, synoptic monitoring will be flexible and rely on NH DES staff input to plann where, when, and how to carry out these efforts. Monitoring needs may shift from year-to-year depending on programmatic needs, particularly with respect to documentation of restorative measures, designated use attainment determination, and anticipated data needs with respect to permitting. Data collection may include single or multiple visits within a year, or spread across

multiple years, if necessary. In some cases, the collection of continuous data over the course of multiple days may also be required. As with lakes and ponds 10 to 12 sample locations will be dedicated towards targeted synoptic monitoring for rivers and streams annually. If no particular needs are identified within a given watershed, the downstream-most point within the watershed will be selected for monitoring in order to be representative of the cumulative water quality conditions of the watershed. For each site selected for monitoring a final list of parameters as well as sampling frequency and duration will be prepared for review and approval. A standard list water quality parameters that may be collected is provided in Table 37.

Table 37. Typical river and stream synoptic monitoring parameters.

Parameter	Analysis Location
Water Temperature	Field
pH	Field
Dissolved Oxygen	Field
Specific Conductance	Field
Nitrate + Nitrite Nitrogen	DHHS PHL-WAL
Total Kjldahl Nitrogen	DHHS PHL-WAL
Total Phosphorus	DHHS PHL-WAL
Calcium	DHHS PHL-WAL
Magnesium	DHHS PHL_WAL
Sodium	DHHS PHL-WAL
Potassium	DHHS PHL-WAL
Total Organic Carbon	DHHS PHL-WAL
Sulfate	DHHS PHL-WAL
Hardness	DHHS PHL-WAL
Acid Neutralizing Capacity	DHHS PHL-WAL
Bacteria	DHHS PHL-WAL
Chloride	JCLC
Chlorophyll-a	JCLC

NH DES recognizes that there will be specific monitoring needs that do not coincide with the standard HUC10 rotation schedule, and thus, plans to accommodate these needs when they arise. Specifically, these needs will include monitoring to confirm designated use determinations, undertake or participate in special studies that are of high priority to the department, investigate water quality complaints, and assist in the collection of data towards regulatory actions. Consideration for the "special" monitoring needs will be included in annual surface water monitoring activity planning meetings.

8.2.1 Project costs / needs

Field efforts for river and stream synoptic monitoring are estimated to be between 9 - 12 days within any given year and utilize 2 staff people. The completion of river and stream synoptic monitoring will rely on staff from the NH DES Watershed Management Bureau . Overall estimated lab costs and staffing needs are detailed in Table 38.

Table 38. Rivers and stream synoptic monitoring estimated costs and needs.

Rivers / Streams Synoptic Monitoring Estimated Costs / Needs				
Estimated Laboratory Costs				
	Single Event Parameter Cost*	E. coli costs**	Nutrient costs**	Invertebrate costs
Per site	$225	$60	$171	$270
Number of sites	10	10	10	30
QC cost estimate	$225	$60	$171	
Total cost by category	$2,475	$660	$1,881	$2,700
Total cost / site (no inverts)				$456
Total cost / site (includes inverts)				$726
Total lab costs				$7,716
* Single event parameters include total suspended solids (TSS), alkalinity, hardness, total organic carbon, calcium, sodium, magnesium, potassium, sulfate. ** Assumes samples collected 3x per year during summer months. Additional parameters collected 3x per year will include chloride, specific conductance, pH, dissolved oxygen, water temperature.				
Staffing Needs				
1 field crew (2 staff) @ 3 sites / day x 10 sites = 6 - 8 staff days / round 3 rounds of sampling = 18 - 24 staff days total / year				

8.3 Reporting

An overall (lakes/pond and rivers/streams) synoptic monitoring data summary report will be issued at ten year intervals based on the schedule in Appendix A. For the period covered in this version of the water monitoring strategy a synoptic monitoring data summary report will be prepared in 2023. The report will cover the synoptic monitoring period from 2013 - 2022. The reports will provide a listing of the sites sampled, a data summary, watershed characteristics, trophic status ratings (lakes and ponds only) and where possible, the designated use outcomes.

9. Data Quality Assurance and Control (QA/QC)

All federally funded programs conducting surface water monitoring are required to maintain a Quality Assurance Project Plan (QAPP). These plans spell out the project's organizational components, data generation and acquisition methods, project assessment techniques, and data quality verification requirements. NH DES maintains current QAPPs for all federally funded, and several state funded surface water monitoring programs. For those state funded programs or activities where a formal QAPP has not been developed, a detailed project management plan (QMP) or standard operating procedure (SOP) has been developed. The surface water monitoring programs described above are covered primarily under 5 state-developed QAPPs, 2 federal QAPPs, and 1 state-level QMP (Table XX).

Table 39. Quality assurance / quality control documents associated with NH DES probability, trend, and synoptic monitoring efforts.

Monitoring Design Component	Waterbody Type	QC/QC document
Probability	River/Stream	Ambient River QAPP
		National River and Stream Assessment (NRSA) QAPP
	Lake/Pond	Lake Trophic Survey QMP
		National Lake Assessment (NLA) QAPP
Trend	River/Stream	Ambient River QAPP
		Volunteer River Assessment Program (VRAP) QAPP
	Lake/Pond	Volunteer Lake Assessment Program (VLAP) QAPP
		BEACH Program QAPP
		Exotic Species Program QAPP (Pending EPA approval)
Synoptic	River/Stream	Ambient River QAPP
		VRAP QAPP
	Lake/Pond	Lake Trophic Survey QMP
		VLAP QAPP

Within each of these documents there are standardized procedures associated with each field protocol, operation and calibration of water quality instruments, and sample preservation and tracking to ensure and maintain a high quality of data. Subsequent to data collection, a formal process for data review prior is required prior to acceptance into NH DES data management tools.

In addition, NH DES operates a laboratory, the Jody Conner Limnology Center (JCLC) in order to service is citizen volunteer surface water quality programs and process samples collected by its field staff. The successful operation of the JCLC relies on a continuously updated laboratory manual that details all of the procedures for the generation of high quality data. The manual includes details regarding water or specimen sample acceptance and tracking procedures and the use of bench top instruments, basic wet chemistry procedures, and microscopic analysis. The JCLC produces an annual workload report that details the number of analysis preformed by the laboratory and to track its QA/QC performance measures. In 2012, the JCLC completed 10,453 analyses and met its QA/QC performance measures. A copy of the JCLC workload report is submitted to EPA and NH DES' commissioner's office for review. The report is also on file within the watershed management bureau for public review if desired.

10. Data Management

Prior to 2003, monitoring data was stored in a variety of spreadsheets and databases. There was no common format and much of the metadata (analytical method, fraction type, sample collection method etc.) was missing. In 2003, the Environmental Monitoring Database (EMD) was built in Oracle in-house to handle the physical/chemical data. The EMD was designed with federal reporting to EPA's STORET database in mind. The data stored in the miscellaneous spreadsheets and other databases was imported into the EMD and metadata was researched and added. Since the EMD's original creation, it has been expanded to include biological, habitat, tissue, and toxicity data.

Currently the EMD has an Oracle 10 back end and an Oracle Forms 6 front end. In the next few years, the front end will be redone in .NET since Oracle Forms 6 is no longer supported.

Surface water data is primarily hand entered or batch uploaded to the EMD via the web or historically via customized programs created by the Oracle developer. Data is generated by staff and also supplied by volunteers and other organizations.

The EMD has hundreds of projects (groupings of data) which contain thousands of stations. The stations have thousands of activities, which can be samples, measurements, or observations. Some stations also have related data logger installations and their records.

During manual entry of data, the EMD does enforce the entry of a minimum set of data elements. The batch upload process through the web enforces the same rules as the database itself – in some cases even more. Several QA/QC reports are run monthly or quarterly to look for a variety of errors such as unreasonable values, missing metadata, and other issues. Staff also have their own QA/QC mechanisms with many programs having one person enter the data and another person review the data for accuracy against the paper field forms.

Using our Exchange Network node, data is extracted from the EMD and formatted to meet the Water Quality Exchange (WQX) requirements in an XML file. Our node sends the XML file to the EPA's node where the file is validated and interrogated for completeness and structure. The data is sent as needed such as monthly for beach data during the beach season or at the end of the year for other projects after the data has been QA/QC'd by the program. To date, of the 11,512 surface water stations in the EMD, 3,030 (26%) and of the 379,800 activities, 70,183 (18%) have been sent to EPA.

Finalized data is available to the public via the NHDES OneStop web site: http://www2.des.state.nh.us/OneStop/Environmental_Monitoring_Menu.aspx. If other data is needed and the request is approved by the program staff, customized reports can be created by the Data Management staff. The EMD will continue to serve as the primary data repository for surface water quality data in the future.

11. Data Analysis and Assessment

Biennial surface water quality assessments are required under the Federal Water Pollution Control Act [PL92-500, commonly called the Clean Water Act (CWA)]. The CWA requires each state to submit two surface water quality documents to the U.S. Environmental Protection Agency (EPA) by April 1st of even numbered years. Section 305(b) of the CWA requires submittal of a report (commonly called the "305(b) Report"), that describes the quality of its surface waters and an analysis of the extent to which all such waters provide for the protection and propagation of a balanced population of shellfish, fish, and wildlife, and allow recreational activities in and on the water. The second document is typically called the "303(d) List " which is so named because it is a requirement of Section 303(d) of the CWA. The 303(d) List includes surface waters impaired by a pollutant that need a Total Maximum Daily Load (TMDL). The 303(d) List is not 'final' until approved by EPA.

In most cycles, the Draft 303(d) is sent out for public comments in February of the even numbered year to allow time for comment, response, and the finalization of the 303(d) by April 1st. In several of the recent cycles, a combination of submittal dates and the approval time by EPA was extended the overall assessment timeline such that the Final 303(d) approval did not occur until the next cycle was actively in its assessment phase.

Water quality assessments are made using all readily available data. How data/information is used in the assessment depends largely on the quality and completeness of the submission. In general, scientifically sound and defensible evidence is needed to determine if a waterbody is meeting water quality standards or is impaired. Evidence that does not meet these criteria, however, is still useful as it provides a preliminary sense of water quality that can be used to guide future monitoring efforts/investigations designed to fill data gaps needed to make a final assessment. NH DES encourages anyone who has surface water data/information, to submit it to NH DES electronically at any time.

The Comprehensive Assessment and Listing Methodology (CALM) describes how the department uses all data to make comparisons to Env-Wq 1700 and RSA 485-A:8. The CALM describes, in detail, the process used to make surface water quality attainment decisions in accordance with state water quality standards. The CALM is intended as a translator document to bridge the gap between water quality criteria and actual sample data. However, nothing in the CALM precludes the department from using provisions of the water quality standards that are not specifically addressed. The current CALM document can be found at http://des.nh.gov/organization/divisions/water/wmb/swqa/documents/calm.pdf.

In order to complete, track, and store assessment outcomes NH DES built a Supplemental-Assessment Database (SADB) in 2005 for the 2006 assessment cycle in ORACLE. The SADB and is biennially populated with data from the Environmental Monitoring Database (EMD).

The level of use of data in the SADB for the assessment process is driven by the source of the data (collection entity) and the associated QA/QC requirement of the collection entity. All data is run through the assessment process but the data from the sources with lower QA/QC requirements may be valuable for screening only. Conversely, data with rigorous QA/QC requirements can be used for final assessment outcome determinations. After final assessment determinations are made, cross check queries between the SADB and EPA's Assessment Database (EPA-ADB) are used to populate the EPA-ADB including the addition of probable source and Total Maximum Daily Load (TMDL) target date information which is not built into the SADB.

Assessments are based on surface waters shown on the 1:24,000 National Hydrography Dataset (NHD), which is consistent with EPA's national coverage. Surface waters for which data was available to make an assessment, but which were not shown on the base NHD coverage, were added to this coverage on a case-by-case basis and linked to the NHD. Within the waterbody catalog, each waterbody type is divided into smaller segments called assessment units (AUs) (Table 40). In general, AUs are the basic unit of record for conducting and reporting the results of all water quality assessments. AUs are intended to be representative of homogenous segments; consequently, sampling stations within an AU can be assumed to be representative of the segment. In general, the size of AUs should not be so small that they result in an unmanageable number of AUs for reporting. On the other hand, AUs should not be so large that they result in grossly inaccurate assessments.

Table 40. Assessment Units included in the NH DES waterbody catalog during the 2012 305(b)/303(d) reporting.

Waterbody Type	Total Size		Total Number of Assessment Units
Rivers and Streams	16,963	Miles	5,923
Impoundments	22,435	Acres	1,235
Lakes and Ponds	162,743	Acres	1,558
Estuaries	17.98	Square Miles	72
Ocean	81.48	Square Miles	26
Wetland	286,696	Acres	52,313
Total			61,131 (8,818 without wetlands)

The Surface Water Quality website (http://des.nh.gov/organization/divisions/water/wmb/swqa/index.htm) is the main clearinghouse for current assessment information with new tools and information added as they are developed and needed. Watershed report cards cover each 12 digit Hydrologic Unit Code (HUC12), on average a 34 square mile area. Watershed Report Cards have three components: 1) REPORT CARD - A one-page summary of the overall use support for aquatic life, primary contact (e.g., swimming), secondary contact (e.g., boating), and fish consumption designated uses on every AU identification number (AUID); 2) HUC12 MAP - A map of the watershed with abbreviated labels for each AUID; 3) ASSESSMENT DETAILS - Anywhere from one to 40 pages with the detailed assessment information for every AUID in the report card and map. Watershed report cards have been built for the 2008, 2010, and 2012 assessments (http://des.nh.gov/organization/divisions/water/wmb/swqa/report_cards.htm). Access to GIS layers for the assessment units are located at the "cycle specific pages" (e.g. 2010) of the main assessment website. The process for accessing the 2012 GIS layers are described at http://des.nh.gov/organization/divisions/water/wmb/swqa/2012/documents/2012-gis-layers-aus.pdf.

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Appendix A. NH DES surface water monitoring summary sampling and reporting schedule for probability-based, trend, and synoptic monitoring efforts, 2013 - 2024. Grey boxes are reporting years.

Reporting Summary by Year												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Reports					Rivers and Streams Probability Survey Report	Lakes and Ponds Trend Report			Rivers and Streams Trend Report	Lakes and Ponds Probability Survey Report		Rivers, Streams, Lakes, Ponds Synoptic Report
					Rivers and Streams Trend Report					Lakes and Ponds Trend Report		
Design component: Probability Monitoring												
Waterbody Type: Rivers and Streams												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Cycle	1	1	1	1	2	2	2	2	2	3	3	3
Sampling	x	x	x	x (if needed)		x	x					
Reporting					x (cycle 1)							
Waterbody Type: Lakes and Pond												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Cycle	1	1	1	1	2	2	2	2	2	3	3	3
Sampling					x	x	x	x				
Reporting										x (cycle 2)		
Design component: Trend Monitoring												
Waterbody Type: Rivers and Streams												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Cycle	1	1	1	1	2	2	2	2	2	3	3	3
Sampling	x	x	x	x	x	x	x	x	x	x	x	x
Reporting					x (cycle 1)				x (cycle 2)			
Waterbody Type: Lakes and Ponds												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Cycle	1	1	1	1	2	2	2	2	2	3	3	3
Sampling	x	x	x	x	x	x	x	x	x	x	x	x
Reporting						x (cycle 1)				x (cycle 2)		
Design component: Synoptic Monitoring												
Waterbody Type: Rivers, Streams, Lakes, Ponds												
Year	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024
Cycle	1	1	1	1	1	1	1	1	1	1	2	2
Sampling	x	x	x	x	x	x	x	x	x	x	x	x
Reporting												x (cycle 1)

Appendix B. Rivers and stream sampling locations included in the NH DES trend monitoring network.

Station ID	River	Town	Waterbody ID	HUC8	HUC8 Name	Elevation (ft)	Latitude	Longitude	Drainage Area (sq. mi.)	Size Category	% developed	Development Category
01-AND	Androscoggin River	GILEAD	MERIV400020103-06	01040002	Lower Androscoggin	674	44.3973	-70.9884		large	1.6%	low
02-ASH	Ashuelot River	HINSDALE	NHRIV802010403-20	01080201	Middle Connecticut	202	42.7861	-72.4865		large	6.4%	high
01-CNT	Connecticut River	NORTHFIELD	MARIV802010501-05	01080201	Middle Connecticut	173	42.6836	-72.4714		large	5.7%	moderate
01K-HOB	Hodgson Brook	PORTSMOUTH	NHRIV600031001-04	01060003	Piscataqua-Salmon Falls	21	43.0693	-70.7785		small	81.4%	high
01-MER	Merrimack River	TYNGSBOROUGH	MARIV700061206-24	01070006	Merrimack River	92	42.6760	-71.4213		large	10.1%	high
01-MSC	Mascoma River	LEBANON	NHRIV801060106-20	01080106	Black-Ottauquechee	358	43.6338	-72.3174		large	5.4%	moderate
01-SAC	Saco River	FRYEBURG	MERIV600020305-02	01060002	Saco	391	44.0169	-70.9899		large	4.2%	moderate
01-SGR	Sugar River	CLAREMONT	NHRIV801060407-16	01080106	Black-Ottauquechee	298	43.3983	-72.3939		large	7.1%	high
01T-SOP	South Branch Piscataquog R	NEW BOSTON	NHRIV700060606-05	01070006	Merrimack River	392	42.9823	-71.6826		medium	6.0%	moderate
01-TYB	Tully Brook	RICHMOND	NHRIV802020203-05	01080202	Miller	940	42.7365	-72.2322		small	3.4%	moderate
01X-OTB	Otter Brook	ROXBURY	NHRIV802010201-19	01080201	Middle Connecticut	826	42.9713	-72.2162		medium	4.7%	moderate
02-BBO	Bear Brook	ALLENSTOWN	NHRIV700060503-16	01070006	Merrimack River	369	43.1452	-71.3552		small	4.3%	moderate
02-CLD	Cold River	WALPOLE	NHRIV801070203-09	01080107	West	396	43.1321	-72.3904		large	4.6%	moderate
02-CTC	Contoocook River	BOSCAWEN	NHIMP700030507-07	01070003	Contoocook	271	43.2849	-71.5966		large	5.9%	moderate
02E-NSR	North Branch Sugar River	CROYDON	NHRIV801060404-11	01080106	Black-Ottauquechee	826	43.4154	-72.1804		medium	6.1%	high
02-ISG	Isinglass River	ROCHESTER	NHRIV600030607-10	01060003	Piscataqua-Salmon Falls	113	43.2334	-70.9554		medium	7.7%	high
02-ISR	Israel River	LANCASTER	NHRIV801010806-09	01080101	Upper Connecticut	865	44.4879	-71.5696		large	2.9%	low
02-SHG	Souhegan River	MERRIMACK	NHRIV700060906-18	01070006	Merrimack River	95	42.8606	-71.4930		large	12.1%	high
03-AMM	Ammonoosuc River	BATH	NHRIV801030506-10	01080103	Waits	466	44.1548	-71.9819		large	4.9%	moderate
03-JWT	Jewett Brook	LACONIA	NHRIV700020201-16	01070002	Winnipesaukee River	512	43.5317	-71.4631		small	27.3%	high
04-SBB	Stratford Bog Brook	STRATFORD	NHRIV801010602-02	01080101	Upper Connecticut	1530	44.6817	-71.4958		small	0.0%	low
05-NWL	Newell Brook	DUMMER	NHRIV400010602-10	01040001	Upper Androscoggin	1276	44.6863	-71.2254		small	0.0%	low
05-SMS	Simms Stream	COLUMBIA	NHRIV801010403-02	01080101	Upper Connecticut	1263	44.8492	-71.4931		medium	1.2%	low
06-SBR	South Branch Baker River	WENTWORTH	NHRIV700010304-12	01070001	Pemigewasset	793	43.8187	-71.9305		medium	1.6%	low
07-BLM	Bellamy River	MADBURY	NHRIV600030903-08	01060003	Piscataqua-Salmon Falls	93	43.1744	-70.9178		medium	9.5%	high
07-FLT	Flints Brook	HOLLIS	NHRIV700040402-03	01070004	Nashua	178	42.7266	-71.5562		small	15.2%	high
07T-ISG	Isinglass River	BARRINGTON	NHRIV600030607-01	01060003	Piscataqua-Salmon Falls	235	43.2388	-71.0766		medium	5.6%	moderate
08-MER	Merrimack River	MANCHESTER	NHRIV700060803-14-02	01070006	Merrimack River	110	42.9360	-71.4565		large	7.0%	high
09-OYS	Oyster River	LEE	NHRIV600030902-04	01060003	Piscataqua-Salmon Falls	69	43.1483	-70.9657		small	11.2%	high
06-EBS	East Branch Saco River	JACKSON	NHRIV600020301-01	01060002	Saco	1701	44.1219	-71.1303		small	0.3%	low
14-ISR	Israel River	JEFFERSON	NHRIV801010806-06	01080101	Upper Connecticut	1052	44.4119	-71.4978		medium	2.7%	low
15-EXT	Exter River	BRENTWOOD	NHRIV600030803-05	01060003	Piscataqua-Salmon Falls	65	42.9847	-71.0384		medium	10.2%	high
18-CCH	Cocheco River	ROCHESTER	NHIMP600030607-02	01060003	Piscataqua-Salmon Falls	160	43.2743	-70.9772		large	14.0%	high
22-AMM	Ammonoosuc River	BETHLEHEM	NHRIV801030403-01	01080103	Waits	1183	44.2716	-71.6316		large	4.0%	moderate
23-PMI	Pemigewasset River	WOODSTOCK	NHRIV700010203-01	01070001	Pemigewasset	704	44.0221	-71.6820		large	2.4%	low
27-MER	Merrimack River	CONCORD	NHRIV700060302-24	01070006	Merrimack River	240	43.2710	-71.5645		large	5.3%	moderate
58-CNT	Connecticut River	LANCASTER	NHRIV801010902-03	01080101	Upper Connecticut	815	44.4961	-71.5944		large	5.4%	moderate
02-GNB	Grant Brook	LYME	NHRIV801040204-02	01080104	Upper Connecticut-Mascoma	489	43.8075	-72.1636		small	2.1%	low
01T-MKB	Mink Brook	HANOVER	NHRIV801040401-05	01080104	Upper Connecticut-Mascoma	502	43.6928	-72.2748		medium	6.4%	high
10-WNR	Warner River	BRADFORD	NHRIV700030302-12	01070003	Contoocook	610	43.2675	-71.9188		medium	4.4%	moderate

Appendix C. Lakes and Ponds included in the NH DES trend monitoring network.

Waterbody	Town	HUC 8	HUC 8 Name	Year Span	Total Years	Waterbody ID	Trophic Class	Year of Trophic Class	% developed	Development Category
Armington Lake	Piermont	1080104	Upper Connecticut River - Mascoma River	1990-2012	23	NHLAK801040201-01	Oligo	2007	2.0	low
Ashuelot Pond	Washington	1080201	Middle Connecticut River	1989-2012	24	NHLAK802010101-01	Meso	2004	3.1	moderate
Ayers Lake	Barrington	1060003	Piscataqua River - Salmon Falls River	1987-2012	26	NHLAK600030607-01	Oligo	1995	7.1	high
Baxter Lake	Farmington	1060003	Piscataqua River - Salmon Falls River	1999-2012	14	NHLAK600030602-01	Meso	1995	3.5	moderate
Bearcamp Pond	Sandwich	1060002	Saco River	1991-2012	22	NHLAK600020601-01-01	Meso	1998	0.9	low
Beaver Lake	Derry	1070006	Merrimack River	1993-2012	20	NHLAK700061203-02-01	Meso	1999	20.6	high
Blaisdell Lake	Sutton	1070003	Contoocook River	1986-2012	27	NHLAK700030302-02	Meso	2005	7.7	high
Broad Bay	Ossipee	1060002	Saco River	1990-2012	23	NHLAK600020804-01-03	Oligo	2003	3.9	moderate
Captains Pond	Salem	1070006	Merrimack River	2001-2012	12	NHLAK700061102-03-01	Meso	2002	33.8	high
Chalk Pond	Newbury	1080106	Black River - Ottauquechee River	1986-2012	27	NHLAK801060402-03	Meso	2006	3.7	moderate
Chestnut Pond	Epsom	1070006	Merrimack River	2002-2012	11	NHLAK700060502-03	Meso	2006	4.1	moderate
Clement Pond	Hopkinton	1070003	Contoocook River	1991-2012	22	NHLAK700030505-01	Meso	1990	3.4	moderate
Clough Pond	Loudon	1070006	Merrimack River	2002-2012	11	NHLAK700060202-03-01	Meso	2002	3.5	moderate
Contoocook Lake	Jaffrey	1070003	Contoocook River	1994-2012	19	NHLAK700030101-03-01	Meso	2006	5.8	moderate
Crescent Lake	Acworth	1080107	West River	1990-2012	23	NHLAK801070201-01	Meso	1992	4.1	moderate
Crystal Lake	Gilmanton	1070006	Merrimack River	1989-2012	24	NHLAK700060401-02-01	Oligo	2003	1.4	low
Deering Lake	Deering	1070006	Merrimack River	1987-2012	26	NHLAK700060601-01	Oligo	1997	5.0	moderate
Dorrs Pond	Manchester	1070006	Merrimack River	2000-2012	13	NHLAK700060802-01	Meso	1997	76.0	high
Eastman Pond	Grantham	1080106	Black River - Ottauquechee River	1987-2012	26	NHLAK801060401-06	Meso	1999	9.7	high
Forest Lake	Winchester	1080201	Middle Connecticut River	1991-2012	22	NHLAK802010401-01-01	Eutro	2005	2.4	low
Gilmore Pond	Jaffrey	1070003	Contoocook River	1990-2012	23	NHLAK700030101-05	Oligo	2006	6.4	high
Granite Lake	Stoddard	1080201	Middle Connecticut River	1989-2012	24	NHLAK802010201-05	Oligo	2006	7.4	high
Great Pond, North	Kingston	1070006	Merrimack River	1995-2012	18	NHLAK700061403-06-01	Meso	2004	13.4	high
Halfmoon Lake	Barnstead	1070006	Merrimack River	1989-2012	24	NHLAK700060402-03	Meso	1992	7.2	high
Halfmoon Pond	Washington	1070003	Contoocook River	1992-2012	21	NHLAK700030201-02	Meso	2001	1.6	low
Harvey Lake	Northwood	1070006	Merrimack River	1995-2012	18	NHLAK700060502-05	Eutro	2006	14.1	high
Highland Lake	Andover	1070001	Pemigewasset River	1987-2012	26	NHLAK700010804-01-01	Meso	1994	3.6	moderate
Highland Lake, North	Stoddard	1070003	Contoocook River	2001-2012	12	NHLAK700030201-03	Meso	2007	3.2	moderate
Island Pond	Stoddard	1070003	Contoocook River	1988-2012	25	NHLAK700030202-02-01	Meso	2004	3.3	moderate
Island Pond, Big	Derry	1070006	Merrimack River	1990-2012	23	NHLAK700061101-01-01	Eutro	2002	19.7	high
Jenness Pond	Northwood	1070006	Merrimack River	1994-2012	19	NHLAK700060502-06	Meso	1991	6.2	high
Kezar Lake	North Sutton	1070003	Contoocook River	1988-2012	25	NHLAK700030303-03-01	Meso	2003	13.6	high
Kolelemook Lake	Springfield	1080106	Black River - Ottauquechee River	1987-2012	26	NHLAK801060401-08-01	Oligo	1996	4.6	moderate
Lake Skatuatakee	Harrisville	1070003	Contoocook River	1989-2012	24	NHLAK700030103-08	Meso	2006	2.5	low
Lake Sunapee, Stn 200	Sunapee	1080106	Black River - Ottauquechee River	1990-2012	23	NHLAK801060402-05-01	Oligo	2006	7.7	high
Lake Waukewan, Mayo Stn	Meredith	1070002	Winnipesaukee River	1993-2012	20	NHLAK700020108-02-01	Oligo	1994	5.0	moderate
Lake Winnisquam, Pot Island	Laconia	1070002	Winnipesaukee River	1987-2012	26	NHLAK700020201-05-01	Oligo	2007	7.4	high
Laurel Lake	Fitzwilliam	1080202	Miller River	1989-2012	24	NHLAK802020202-02-01	Oligo	2006	5.4	moderate
Leavitt Bay	Ossipee	1060002	Saco River	1990-2012	23	NHLAK600020804-01-02	Oligo	2003	4.0	moderate
Lees Pond	Moultonborough	1070002	Winnipesaukee River	1991-2012	22	NHLAK700020103-05	Meso	1992	3.5	moderate
Little Lake Sunapee	New London	1080106	Black River - Ottauquechee River	1999-2012	14	NHLAK801060402-04-01	Oligo	2008	4.5	moderate
Loon Lake	Plymouth	1070001	Pemigewasset River	1989-2012	24	NHLAK700010307-01	Meso	1999	1.6	low
Loon Pond	Gilmanton	1070006	Merrimack River	1996-2012	17	NHLAK700060201-01-01	Meso	1996	3.8	moderate
Mascoma Lake, Stn. 1	Enfield	1080106	Black River - Ottauquechee River	1991-2012	22	NHLAK801060105-04-01	Oligo	2008	3.1	moderate
Massasecum Lake	Bradford	1070003	Contoocook River	1986-2012	27	NHLAK700030302-04-01	Meso	2005	3.9	moderate

Waterbody	Town	HUC 8	HUC 8 Name	Year Span	Total Years	Waterbody ID	Trophic Class	Year of Trophic Class	% developed	Development Category
Messer Pond	New London	1070003	Contoocook River	1996-2012	17	NHLAK700030303-04	Meso	1996	12.3	high
Millen Pond	Washington	1080201	Middle Connecticut River	1995-2012	18	NHLAK802010101-06-01	Oligo	1997	6.1	high
Mountainview Lake	Sunapee	1080106	Black River - Ottauquechee River	1985-2012	28	NHLAK801060402-11	Oligo	1992	9.4	high
New Pond	Canterbury	1070006	Merrimack River	2002-2012	11	NHLAK700060201-03	Meso	1997	1.8	low
Northwood Lake	Northwood	1070006	Merrimack River	1998-2012	15	NHLAK700060502-08-01	Meso	2000	8.1	high
Nubanusit Lake	Nelson	1070003	Contoocook River	1991-2012	22	NHLAK700030103-07	Oligo	2003	0.7	low
Nutts Pond	Manchester	1070006	Merrimack River	2000-2012	13	NHLAK700060803-01	Meso	1995	94.7	high
Otter Pond	Sunapee	1080106	Black River - Ottauquechee River	1986-2012	27	NHLAK801060402-12-01	Meso	2008	7.4	high
Partridge Lake	Littleton	1080103	Waits River	1989-2012	24	NHLAK801030502-03	Meso	2006	4.4	moderate
Pawtuckaway Lake, North Stn	Nottingham	1060003	Piscataqua River - Salmon Falls River	1988-2012	25	NHLAK600030704-02-01	Meso	1998	4.4	moderate
Pea Porridge Ponds (Big)	Madison	1060002	Saco River	1995-2012	18	NHLAK600020303-05	Oligo	2001	5.5	moderate
Pea Porridge Ponds (Middle)	Madison	1060002	Saco River	1995-2012	18	NHLAK600020303-06	Meso	2001	6.4	high
Pearly Pond	Rindge	1080202	Miller River	1992-2012	21	NHLAK802020103-08	Eutro	2004	6.1	high
Perkins Pond	Sunapee	1080106	Black River - Ottauquechee River	1987-2012	26	NHLAK801060405-03	Meso	2003	7.4	high
Pine Island Pond	Manchester	1070006	Merrimack River	2000-2012	13	NHLAK700060703-04	Eutro	1997	22.1	high
Pleasant Lake	New London	1070003	Contoocook River	1997-2012	16	NHLAK700030402-02-01	Oligo	1993	2.9	low
Pleasant Lake	Deerfield	1070006	Merrimack River	1989-2012	24	NHLAK700060502-09-01	Oligo	1996	6.5	high
Pleasant Pond	Francestown	1070006	Merrimack River	2000-2012	13	NHLAK700060604-01	Meso	2004	3.9	moderate
Province Lake	Effingham	1060002	Saco River	1991-2012	22	NHLAK600020902-01	Meso	2006	8.2	high
Rand Pond	Goshen	1080106	Black River - Ottauquechee River	1994-2012	19	NHLAK801060403-04-01	Oligo	1994	6.9	high
Robinson Pond	Hudson	1070006	Merrimack River	2000-2012	13	NHLAK700061203-06-01	Meso	1998	18.8	high
Rockybound Pond	Croydon	1080106	Black River - Ottauquechee River	1990-2012	23	NHLAK801060404-01	Meso	2006	2.3	low
Rust Pond	Wolfeboro	1070002	Winnipesaukee River	1988-2012	25	NHLAK700020101-07-01	Oligo	2000	5.7	moderate
Sand Pond	Marlow	1080201	Middle Connecticut River	2000-2012	13	NHLAK802010101-08	Oligo	2008	3.8	moderate
Sebbins Pond	Bedford	1070006	Merrimack River	1987-2012	26	NHLAK700060804-02	Meso	1999	48.5	high
Silver Lake	Harrisville	1080201	Middle Connecticut River	1991-2012	22	NHLAK802010202-09	Oligo	1998	2.9	low
Spofford Lake	Chesterfield	1080107	West River	1990-2012	23	NHLAK801070503-01-01	Oligo	1995	9.0	high
Stevens Pond	Manchester	1070006	Merrimack River	2000-2012	13	NHLAK700060803-02	Eutro	1997	88.2	high
Stinson Lake	Rumney	1070001	Pemigewasset River	1988-2012	25	NHLAK700010306-01	Oligo	2002	1.3	low
Stocker Pond	Grantham	1080106	Black River - Ottauquechee River	1988-2012	25	NHLAK801060401-02	Meso	2001	12.0	high
Swanzey Lake	Swanzey	1080201	Middle Connecticut River	1990-2012	23	NHLAK802010302-01-01	Meso	2005	3.8	moderate
Tarleton Lake	Piermont	1080104	Upper Connecticut River - Mascoma River	2002-2012	11	NHLAK801040201-03	Oligo	1992	1.5	low
Thorndike Pond	Jaffrey	1070003	Contoocook River	1990-2012	23	NHLAK700030102-01-01	Oligo	1998	3.2	moderate
Todd Lake	Newbury	1070003	Contoocook River	1987-2012	26	NHLAK700030301-02	Meso	1991	3.9	moderate
Tom Pond	Warner	1070003	Contoocook River	1987-2012	26	NHLAK700030304-05	Meso	2006	9.4	high
Webster Lake	Franklin	1070001	Pemigewasset River	1986-2012	27	NHLAK700010804-02-01	Oligo	1992	3.5	moderate
White Oak Pond	Holderness	1070001	Pemigewasset River	1989-2012	24	NHLAK700010501-05	Meso	1990	1.7	low
Winnepocket Lake	Webster	1070003	Contoocook River	1995-2012	18	NHLAK700030304-08	Oligo	1998	1.9	low

Appendix D. Beaches included in the NH DES lake and pond trend monitoring network.

Beach Name	Waterbody ID	Waterbody Name	Town	Sample Total	Advisory Total (days)
AHERN STATE PARK	NHLAK700020201-05-05	LAKE WINNISQUAM - AHERN STATE PARK	LACONIA	175	5
ANGLE POND GROVE	NHLAK700061403-01-02	ANGLE POND - ANGLE POND GROVE BEACH	SANDOWN	59	19
BABOOSIC LAKE PARK TB	NHLAK700060905-01-02	BABOOSIC LAKE - TOWN BEACH	AMHERST	87	25
BEARCAMP POND TB	NHLAK600020601-01-02	BEARCAMP POND - TOWN BEACH	SANDWICH	66	5
BEARDS BROOK TB	NHRIV700030204-15-02	BEARDS BROOK - TOWN BEACH	HILLSBOROUGH	88	0
BEAVER LAKE GALLIEN'S BEACH	NHLAK700061203-02-02	BEAVER LAKE - GALLIEN'S BEACH	DERRY	104	10
BOW LAKE BENNETT BRIDGE TB	NHLAK600030604-01-04	BOW LAKE - BENNETT BRIDGE BEACH	NORTHWOOD	67	11
BOW LAKE MARY WALDRON TB	NHLAK600030604-01-03	BOW LAKE - MARY WALDRON BEACH	NORTHWOOD	89	8
BOW LAKE TB	NHLAK600030604-01-02	BOW LAKE - TOWN BEACH	STRAFFORD	88	0
BURNS POND PB	NHLAK801030101-01-02	BURNS POND - PUBLIC BEACH	WHITEFIELD	63	10
CAMPER BEACH ON BEAVER POND AT BEAR BROOK STATE PARK	NHIMP600030702-01-02	BEAVER POND - BEAVER POND BEACH	ALLENSTOWN	69	0
CANAAN STREET LAKE TB	NHLAK801060101-01-02	CANAAN STREET LAKE - TOWN BEACH	CANAAN	79	0
CHESHAM BEACH	NHLAK802010202-07-02	RUSSEL RESERVOIR - CHESHAM BEACH	HARRISVILLE	65	0
CHOCURUA LAKE PB	NHLAK600020604-01-04	LAKE CHOCORUA - PUBLIC BEACH	TAMWORTH	92	0
CHOCURUA LAKE TB	NHLAK600020604-01-03	LAKE CHOCORUA - TOWN BEACH	TAMWORTH	92	6
CLARK POND FB ARGUE REC AREA	NHIMP700060501-03-02	CLARKS POND - TOWN BEACH	PITTSFIELD	87	0
CLOUGH SP	NHLAK700060602-01-02	EVERETT LAKE - CLOUGH STATE PARK BEACH	WEARE	68	9
COBBETTS POND TB	NHLAK700061204-01-03	COBBETTS POND - TOWN BEACH	WINDHAM	71	0
COLD RIVER POT HOLE TB	NHRIV600020602-04-02	COLD RIVER - POT HOLE TOWN BEACH	SANDWICH	56	137
CONWAY LAKE TB	NHLAK600020304-01-02	CONWAY LAKE - TOWN BEACH	CONWAY	81	13
CORCORANS POND TB	NHIMP700010401-01-02	SNOWS BROOK - CORCORAN POND TOWN BEACH	WATERVILLE VALLEY	64	0
COUNTRY POND TB	NHLAK700061403-03-02	COUNTRY POND - TOWN BEACH	NEWTON	67	0
CRYSTAL LAKE TB	NHLAK700060703-02-02	CRYSTAL LAKE-TOWN BEACH	MANCHESTER	249	0
CRYSTAL LAKE TB	NHLAK700060401-02-02	CRYSTAL LAKE-TOWN BEACH	GILMANTON	110	9
CRYSTAL LAKE TB	NHLAK600020304-02-02	CRYSTAL LAKE-TOWN BEACH	EATON	84	2
CUNNINGHAM POND TB	NHLAK700030104-02-02	CUNNINGHAM POND - TOWN BEACH	PETERBOROUGH	60	25
DARRAH POND BEACH	NHLAK700061002-01-02	DARRAH POND - TOWN BEACH	LITCHFIELD	66	6
DAY-USE BEACH ON CATAMOUNT POND AT BEAR BROOK SP	NHLAK700060503-02-02	CATAMOUNT POND - BEAR BROOK STATE PARK BEACH	ALLENSTOWN	162	0
DUNCAN LAKE TB	NHLAK600020703-01-02	DUNCAN LAKE - TOWN BEACH	OSSIPEE	57	0
ECHO LAKE SP	NHLAK600020302-01-02	ECHO LAKE - STATE PARK BEACH	CONWAY	96	11
ELLACOYA SP	NHLAK700020110-02-12	LAKE WINNIPESAUKEE - ELACOYA STATE PARK BEACH	GILFORD	166	4
ELM BROOK PARK	NHIMP700030503-01-02	ELM BROOK - ELM BROOK PARK BEACH	HOPKINTON	437	11
FOREST LAKE SP	NHLAK801030101-02-02	FOREST LAKE - FOREST LAKE STATE PARK	DALTON	73	0
FOREST LAKE TB	NHLAK802010401-01-02	FOREST LAKE - TOWN BEACH	WINCHESTER	58	3
FRANCONIA SP	NHLAK801030302-01-02	ECHO LAKE - FRANCONIA STATE PARK BEACH	FRANCONIA	103	13
FRENCH POND BEACH	NHLAK700030504-02-02	FRENCH POND - PUBLIC ACCESS	HENNIKER	61	0
GREGG LAKE TB	NHLAK700030108-02-02	GREGG LAKE - TOWN BEACH	ANTRIM	97	1
HARRISVILLE LAKE TB	NHLAK700030103-05-02	HARRISVILLE LAKE - SUNSET TOWN BEACH	HARRISVILLE	56	25
HAUNTED LAKE TB	NHLAK700060605-04-02	HAUNTED LAKE - TOWN BEACH	FRANCESTOWN	58	1
HERMIT LAKE TB	NHLAK700010802-03-02	HERMIT LAKE - TOWN BEACH	SANBORNTON	81	0
HIGHLAND LAKE TB	NHLAK700010804-01-02	HIGHLAND LAKE - TOWN BEACH	ANDOVER	58	19
HOOD POND TB	NHLAK700061203-03-02	HOODS POND - TOWN BEACH	DERRY	99	53
HORACE LAKE CHASE PARK TB	NHLAK700060601-05-02	WEARE RESERVOIR - CHASE PARK TOWN BEACH	WEARE	85	0
INDIAN POND TB	NHLAK801040205-01-02	INDIAN POND - TOWN BEACH	ORFORD	63	5
ISLAND POND CHASE'S GROVE	NHLAK700061101-01-02	ISLAND POND - CHASE'S GROVE	DERRY	75	43
ISLAND POND PB	NHLAK700030202-02-02	ISLAND POND - PUBLIC BEACH	STODDARD	59	12
ISLAND POND SANBORN SHORE ACRES	NHLAK700061101-01-03	ISLAND POND - SANBORN SHORE ACRES	HAMPSTEAD	57	2
KILTON POND HUFF BEACH	NHLAK700010701-02-02	KILTON POND - HUFF BEACH	GRAFTON	58	0

Beach Name	Waterbody ID	Waterbody Name	Town	Sample Total	Advisory Total (days)
KIMBALL POND TB	NHIMP700030507-01-02	KIMBALL POND - KIMBALL POND TOWN BEACH	HOPKINTON	58	6
KINGSTON SP	NHLAK700061403-06-02	GREAT POND - KINGSTON STATE PARK BEACH	KINGSTON	104	2
KOLELEMOOK LAKE TB	NHLAK801060401-08-02	KOLEMOOK LAKE - TOWN BEACH	SPRINGFIELD	66	4
LAKE CONTOOCOOK TB	NHLAK700030101-03-02	CONTOOCOOK LAKE - TOWN BEACH	JAFFREY	101	0
LAKE NATICOOK WASSERMAN PARK	NHLAK700061002-04-02	NATICOOK LAKE - WASSERMAN PARK BEACH	MERRIMACK	125	0
LAKE POTANIPO TB	NHLAK700040401-02-02	LAKE POTANIPO - TOWN BEACH	BROOKLINE	62	9
LAKE SUNAPEE BLODGETTS LANDING	NHLAK801060402-05-04	SUNAPEE LAKE - BLODGETT'S LANDING BEACH	NEWBURY	40	0
LAKE SUNAPEE DEPOT BEACH	NHLAK801060402-05-06	SUNAPEE LAKE - DEPOT BEACH	NEWBURY	64	48
LAKE SUNAPEE GEORGES MILL TB	NHLAK801060402-05-02	SUNAPEE LAKE - GEORGES MILL TOWN BEACH	SUNAPEE	60	3
LAKE TARLETON STATE PARK	NHLAK801040201-03-03	LAKE TARLETON - LAKE TARLETON STATE PARK BEACH	PIERMONT	52	0
LAKE WENTWORTH ALBEE BEACH	NHLAK700020101-05-02	LAKE WENTWORTH - ALBEE BEACH	WOLFEBORO	128	17
LAKE WENTWORTH SP	NHLAK700020101-05-03	LAKE WENTWORTH - WENTWORTH STATE PARK BEACH	WOLFEBORO	125	0
LAKE WINNIPESAUKEE ALTON BAY TB	NHLAK700020110-02-10	LAKE WINNIPESAUKEE - ALTON BAY TOWN BEACH	ALTON	97	1
LAKE WINNIPESAUKEE BREWSTER BEACH	NHLAK700020110-02-09	LAKE WINNIPESAUKEE - BREWSTER BEACH	WOLFEBORO	115	0
LAKE WINNIPESAUKEE CARRY BEACH	NHLAK700020110-02-08	LAKE WINNIPESAUKEE - CARRY BEACH	WOLFEBORO	100	4
LAKE WINNIPESAUKEE ENDICOTT PARK	NHLAK700020110-02-14	LAKE WINNIPESAUKEE - ENDICOTT PARK WEIRS BEACH	LACONIA	245	1
LAKE WINNIPESAUKEE LEAVITT PARK	NHLAK700020110-02-15	LAKE WINNIPESAUKEE - LEAVITT PARK BEACH	MEREDITH	89	4
LAKE WINNIPESAUKEE PB	NHLAK700020110-02-07	LAKE WINNIPESAUKEE - PUBLIC BEACH	TUFTONBORO	105	8
LAKE WINNIPESAUKEE PUBLIC DOCK TB	NHLAK700020110-02-11	LAKE WINNIPESAUKEE - PUBLIC DOCK TOWN BEACH	ALTON	90	12
LAKE WINNIPESAUKEE STATES LANDING TB	NHLAK700020110-02-17	LAKE WINNIPESAUKEE - STATES LANDING TOWN BEACH	MOULTONBOROUGH	61	4
LAKE WINNIPESAUKEE TB	NHLAK700020110-02-13	LAKE WINNIPESAUKEE - GILFORD TOWN BEACH	GILFORD	126	8
LAKE WINNIPESAUKEE TB	NHLAK700020110-02-16	LAKE WINNIPESAUKEE - TOWN BEACH (CENTER HARBOR)	CENTER HARBOR	56	0
LAKE WINNIPESAUKEE TB	NHLAK700020110-02-05	LAKE WINNIPESAUKEE - MOULTONBOROUGH TOWN BEACH	MOULTONBOROUGH	65	8
LAKE WINNIPESAUKEE WAWBEEK CONDO ASSOC BEACH	NHLAK700020110-02-37	LAKE WINNIPESAUKEE - WAWBEEK CONDO ASSOC BEACH	TUFTONBORO	49	7
LAKE WINNISQUAM BARTLETT TB	NHLAK700020201-05-03	LAKE WINNISQUAM - BARTLETTS BEACH	LACONIA	221	7
LAKE WINNISQUAM TB	NHLAK700020201-05-02	LAKE WINNISQUAM - TOWN BEACH	SANBORNTON	66	20
LAUREL LAKE TB	NHLAK802020202-02-02	LAUREL LAKE - TOWN BEACH	FITZWILLIAM	62	8
LITTLE SQUAM LAKE TB	NHLAK700010502-01-02	LITTLE SQUAM LAKE - TOWN BEACH	ASHLAND	134	9
LITTLE SUNAPEE LAKE BUCKLIN TB	NHLAK801060402-04-02	LITTLE SUNAPEE LAKE - BUCKLIN TOWN BEACH	NEW LONDON	110	0
LONG POND TB	NHLAK700061205-02-02	LONG POND - TOWN BEACH	PELHAM	96	59
LOVELL POND TB	NHLAK600030401-01-02	LOVELL POND - TOWN BEACH	WAKEFIELD	69	1
MACDOWELL RESERVOIR BEACH	NHLAK700030103-06-02	MACDOWELL RESERVOIR - MACDOWELL RESERVOIR BEACH	PETERBOROUGH	457	8
MASCOMA LAKE DARTMOUTH COLLEGE YACHT CLUB	NHLAK801060105-04-04	MASCOMA LAKE - DARTMOUTH COLLEGE BEACH	ENFIELD	48	0
MASCOMA LAKE SHAKOMA TB	NHLAK801060105-04-02	MASCOMA LAKE - SHAKOMA BEACH	ENFIELD	58	3
MASSASECUM CASINO	NHLAK700030302-04-02	LAKE MASSASECUM - MASSASECUM CASINO BEACH	BRADFORD	87	33
MASSASECUM LAKE FRENCH'S PARK TB	NHLAK700030302-04-03	LAKE MASSASECUM - FRENCH'S PARK TOWN BEACH	BRADFORD	100	0
MELENDY POND TB	NHLAK700040401-01-02	MELENDY POND - TOWN BEACH	BROOKLINE	61	0
MELVIN VILLAGE TOWN PIER	NHLAK700020110-02-04	LAKE WINNIPESAUKEE - MELVIN VILLAGE LAKE TOWN PIER BEACH	TUFTONBORO	68	2
MILL POND BEACH	NHIMP600020702-01-02	DAN HOLE RIVER - MILL POND TOWN BEACH	OSSIPEE	64	97
MILL POND TB	NHIMP700030204-05-02	BEARDS BROOK - MILL POND TOWN BEACH	WASHINGTON	119	2
MILLEN POND TB	NHLAK802010101-06-02	MILLEN POND - TOWN BEACH	WASHINGTON	101	7
MILTON POND REC AREA	NHLAK600030404-01-03	MILTON THREE PONDS - MILTON POND REC AREA BEACH	MILTON	123	12
MIRROR LAKE BEACH	NHLAK700020106-02-02	MIRROR LAKE - MIRROR LAKE BEACH	TUFTONBORO	65	0
MOORES POND ASSOCIATION BEACH	NHLAK600020604-03-03	MOORES POND - ASSOCIATION BEACH	TAMWORTH	61	1
MOORES POND SKI AND BEACH	NHLAK600020604-03-02	MOORES POND - MOORES POND SKI AND BEACH	TAMWORTH	175	7
MOOSE BROOK SP	NHIMP400020101-02-02	MOOSE BROOK - MOOSE BROOK STATE PARK BEACH	GORHAM	81	6
MOOSE BROOK TP	NHIMP400020101-01-02	MOOSE BROOK - TOWN POOL-RAVINE BEACH	RANDOLPH	56	0
NEWFOUND LAKE CUMMINGS BEACH	NHLAK700010603-02-04	NEWFOUND LAKE - CUMMINGS BEACH	BRISTOL	91	4
NEWFOUND LAKE HEBRON TOWN BEACH	NHLAK700010603-02-14	NEWFOUND LAKE - HEBRON TOWN BEACH	HEBRON	70	2

Beach Name	Waterbody ID	Waterbody Name	Town	Sample Total	Advisory Total (days)
NEWFOUND LAKE-AVERY-CROUSE BEACH	NHLAK700010603-02-02	NEWFOUND LAKE - TOWN BEACH	BRISTOL	87	2
NORTHWOOD LAKE TB	NHLAK700060502-08-02	NORTHWOOD LAKE - TOWN BEACH	NORTHWOOD	183	2
NORTHWOOD LAKE-LYNN GROVE ASSOC	NHLAK700060502-08-04	NORTHWOOD LAKE - LYNN GROVE ASSOCIATION BEACH	NORTHWOOD	60	13
NORWAY POND TB	NHLAK700030107-02-02	NORWAY POND - TOWN BEACH	HANCOCK	64	14
OPECHEE BAY BOND BEACH	NHLAK700020201-06-02	OPECHEE BAY - BOND BEACH	LACONIA	83	102
OPECHEE BAY OPECHEE PARK COVE	NHLAK700020201-06-04	OPECHEE BAY - OPECHEE PARK COVE BEACH	LACONIA	174	8
OPECHEE BAY OPECHEE POINT	NHLAK700020201-06-03	OPECHEE BAY - OPECHEE POINT BEACH	LACONIA	128	27
OTTER BROOK PARK	NHLAK802010201-06-02	OTTER BROOK LAKE - OTTER BROOK PK BEACH	KEENE	464	3
OTTER LK GREENFIELD SP-CAMPING BCH	NHLAK700030105-02-05	OTTER LAKE - GREENFIELD SP CAMPING BEACH	GREENFIELD	107	4
OTTER LK GREENFIELD SP-MIDDLE BCH	NHLAK700030105-02-04	OTTER LAKE - GREENFIELD SP MIDDLE BEACH	GREENFIELD	121	11
OTTER LK GREENFIELD SP-PICNIC BCH	NHLAK700030105-02-03	OTTER LAKE - GREENFIELD SP PICNIC BEACH	GREENFIELD	126	14
PAWTUCKAWAY LAKE TB	NHLAK600030704-02-03	PAWTUCKAWAY LAKE - TOWN BEACH	NOTTINGHAM	62	3
PAWTUCKAWAY SP	NHLAK600030704-02-02	PAWTUCKAWAY LAKE - PAWTUCKAWAY STATE PARK BEACH	NOTTINGHAM	307	4
PEABODY RIVER LIBBY TOWN POOL	NHLAK400020102-01	PEABODY RIVER - LIBBY TOWN POOL	GORHAM	92	0
PHILLIPS POND SEELEY TB	NHLAK600030802-03-02	PHILLIPS POND - SEELEY TOWN BEACH	SANDOWN	72	0
PIERCE LAKE MANAHAN PARK	NHLAK700030202-03-02	JACKMAN RESERVOIR - MANAHAN PARK TOWN BEACH	HILLSBOROUGH	112	111
PLEASANT LAKE ELKINS BEACH	NHLAK700030402-02-02	PLEASANT LAKE - ELKINS BEACH	NEW LONDON	114	2
PLEASANT LAKE TB	NHLAK700060601-03-02	PLEASANT LAKE - PUBLIC ACCESS BEACH	HENNIKER	62	5
PLEASANT LAKE VEASEY PARK	NHLAK700060502-09-02	PLEASANT LAKE - VEASEY PARK BEACH	DEERFIELD	75	9
POST POND CHASE TB	NHLAK801040203-01-02	POST POND - CHASE TOWN BEACH	LYME	70	146
RAINBOW LAKE KAREN-GENA BEACH ASSOC	NHLAK700061203-05-02	RAINBOW LAKE - KAREN-GENA BEACH	DERRY	31	25
RAND POND PUBLIC WAY	NHLAK801060403-04-02	RAND POND - PUBLIC WAY BEACH	GOSHEN	63	9
ROBINSON POND TB	NHLAK700061203-06-02	ROBINSON POND - TOWN BEACH	HUDSON	223	11
SACO RIVER DAVIS PARK REC AREA	NHRIV600020304-01-02	SACO RIVER - DAVIS PARK REC AREA BEACH	CONWAY	56	29
SACO RIVER FIRST BRIDGE REC AREA	NHRIV600020302-02-02	SACO RIVER - FIRST BRIDGE REC AREA BEACH	CONWAY	57	26
SANDY BEACH CAMPGROUND	NHLAK700030505-04-01	ROLF POND - SANDY BEACH CAMPGROUND BEACH	HOPKINTON	70	3
SILVER LAKE FOOT OF THE LAKE BEACH	NHLAK600020801-06-03	SILVER LAKE - FOOT OF THE LAKE BEACH	MADISON	61	110
SILVER LAKE KENNETT PARK BEACH	NHLAK600020801-06-05	SILVER LAKE - KENNETT PARK BEACH	MADISON	40	13
SILVER LAKE MONUMENT BEACH	NHLAK600020801-06-02	SILVER LAKE - MONUMENT BEACH	MADISON	60	0
SILVER LAKE NICHOLS BEACH	NHLAK600020801-06-04	SILVER LAKE - NICHOLS BEACH	MADISON	58	28
SILVER LAKE RESERVOIR	NHIMP700030304-04-02	SILVER BROOK - SILVER LAKE RESERVOIR BEACH	WARNER	69	4
SILVER LAKE SP	NHLAK700061001-02-02	SILVER LAKE - STATE PARK BEACH	HOLLIS	111	5
SONDOGARDY POND GLINES PARK	NHLAK700060101-02-02	SONDOGARDY POND - GLINES PARK BEACH	NORTHFIELD	225	2
SOUTH POND REC AREA	NHLAK801010707-04-02	SOUTH POND - REC AREA BEACH	STARK	90	9
SPOFFORD LAKE N SHORE RD TB	NHLAK801070503-01-03	SPOFFORD LAKE - N SHORE RD TOWN BEACH	CHESTERFIELD	71	16
SPOFFORD LAKE WARES GROVE TB	NHLAK801070503-01-04	SPOFFORD LAKE - WARES GROVE TOWN BEACH	CHESTERFIELD	93	4
SQUAM LAKE LIVERMORE BEACH	NHLAK700010501-04-02	SQUAM LAKE - LIVERMORE BEACH	HOLDERNESS	52	67
SQUAM LAKE TB	NHLAK700010501-04-03	SQUAM LAKE-TOWN BEACH	SANDWICH	55	2
STONE POND TB	NHLAK802010303-05-02	STONE POND - TOWN BEACH	MARLBOROUGH	62	9
STONY BROOK GOSS PARK TB	NHRIV700060903-16-02	STONY BROOK - TOWN BEACH (GOSS PARK)	WILTON	86	0
STORRS POND ADULT BEACH	NHLAK801040402-02-03	STORRS POND - ADULT BEACH	HANOVER	65	0
STORRS POND REC AREA	NHLAK801040402-02-02	STORRS POND - RECREATION AREA BEACH	HANOVER	75	0
SUNAPEE LAKE DEWEY TB	NHLAK801060402-05-03	SUNAPEE LAKE - DEWEY (TOWN) BEACH	SUNAPEE	98	13
SUNAPEE SP	NHLAK801060402-05-05	SUNAPEE LAKE - SUNAPEE STATE PARK BEACH	NEWBURY	109	0
SUNCOOK LAKE TB	NHLAK700060402-10-04	UPPER SUNCOOK LAKE - TOWN BEACH	BARNSTEAD	57	17
SUNSET LAKE SUNSET PARK	NHLAK700061101-03-03	SUNSET LAKE - SUNSET PARK BEACH	HAMPSTEAD	92	19
SUNSET LAKE TB	NHLAK700030105-03-02	SUNSET LAKE - TOWN BEACH	GREENFIELD	61	14
SUNSET LAKE TB	NHLAK700061101-03-02	WASH POND - TOWN BEACH	HAMPSTEAD	176	0
SURRY MTN REC	NHLAK802010104-02-02	SURRY MOUNTAIN RESERVOIR - REC AREA BEACH	SURRY	406	0

Beach Name	Waterbody ID	Waterbody Name	Town	Sample Total	Advisory Total (days)
SWANZEY LAKE RICHARDSON PARK TB	NHLAK802010302-01-02	SWANZEY LAKE - RICHARDSON PARK TOWN BEACH	SWANZEY	109	0
TANNERY POND BEACH	NHLAK700030402-03-02	TANNERY POND - BEACH	WILMOT	66	0
THORNDIKE POND TB	NHLAK700030102-01-02	THORNDIKE POND - TOWN BEACH	JAFFREY	59	0
TUTTLE BROOK TWIN MTN REC AREA	NHRIV801030402-07-02	TUTTLE BROOK - TWIN MTN REC AREA BEACH	CARROLL	70	0
VILLAGE POND SAND DAM TB	NHIMP802010303-04-02	VILLAGE POND DAM - SAND DAM VILLAGE POND TOWN BEACH	TROY	143	21
WADLEIGH SP	NHLAK700030303-03-02	KEZAR LAKE - WADLEIGH STATE PARK BEACH	SUTTON	91	0
WAUKEWAN LAKE TB	NHLAK700020108-02-03	LAKE WAUKEWAN - TOWN BEACH	MEREDITH	81	5
WEBSTER LAKE GRIFFIN TB	NHLAK700010804-02-02	WEBSTER LAKE - GRIFFIN TOWN BEACH	FRANKLIN	345	21
WEBSTER LAKE LAGACE TB	NHLAK700010804-02-03	WEBSTER LAKE - LEGACE TOWN BEACH	FRANKLIN	326	3
WELLINGTON SP	NHLAK700010603-02-05	NEWFOUND LAKE - WELLINGTON STATE PARK BEACH	BRISTOL	100	2
WHITE LAKE SP	NHLAK600020605-02-02	WHITE LAKE - STATE PARK BEACH	TAMWORTH	96	6
WHITTEMORE POND TB	NHLAK700030108-01-02	WHITTEMORE LAKE - TOWN BEACH	BENNINGTON	58	2
WINNISQUAM LAKE TB	NHLAK700020201-05-04	LAKE WINNISQUAM - BELMONT TOWN BEACH	BELMONT	99	15
ZEPHYR LAKE TB	NHLAK700030105-01-02	ZEPHYR LAKE - TOWN BEACH	GREENFIELD	67	4

Appendix E. Synoptic rotational watershed sampling design based on New Hampshire 10-digit hydrologic unit codes (HUC 10s) and suggested year designated for sampling of at least one lake/pond and one river/stream segment. Schedule corresponds to Figure 5 and is based on sampling 8 - 10 HUC 10s within a given year.

HUC 10	HUC 10 Name	Year									
		1	2	3	4	5	6	7	8	9	10
104000102	Umbagog Lake Drainage					x					
104000103	Aziscohos Lake Drainage			x							
104000104	Magalloway River					x					
104000105	Clear Stream							x			
104000106	Middle Androscoggin River									x	
104000201	Gorham-Shelburne Tributaries		x								
104000202	Androscoggin River (2) at Rumford Point				x						
106000201	Upper Saco River	x									
106000202	Swift River			x							
106000203	Conway Tributaries					x					
106000204	Saco River-Lovewell Pond							x			
106000206	Bearcamp River									x	
106000207	Pine River										x
106000208	Ossipee Lake Drainage				x						
106000209	Ossipee River						x				
106000210	Little Ossipee River								x		
106000305	Salmon Falls River		x								
106000306	Cocheco River				x						
106000307	Lamprey River					x					
106000308	Exeter River								x		
106000309	Great Bay Drainage										x
106000310	Coastal Drainage							x			
107000101	East Branch Pemigewasset River	x									
107000102	Upper Pemigewasset River			x							
107000103	Baker River					x					
107000104	Middle Pemigewasset River							x			
107000105	Squam River									x	
107000106	Newfound River									x	
107000107	Smith River				x						
107000108	Lower Pemigewasset River						x				
107000201	Lake Winnipesaukee Drainage	x									
107000202	Winnipesaukee River			x							
107000301	Upper Contoocook River							x			
107000302	North Branch				x						
107000303	Lower Contoocook River						x				
107000304	Warner River								x		
107000305	Blackwater River										x
107000306	Lower Contoocook River	x									
107000403	Squannacook River									x	
107000404	Nashua River-Squannacook River to mouth				x						
107000601	Upper Merrimack River	x									
107000602	Soucook River			x							
107000603	Concord Tributaries					x					
107000604	Upper Suncook River							x			
107000605	Suncook River									x	
107000606	Piscataquog River		x								
107000607	Cohas Brook										x
107000608	Manchester Tributaries						x				
107000609	Souhegan River								x		
107000610	Litchfield-Hudson Tributaries										x

HUC 10	HUC 10 Name	Year									
		1	2	3	4	5	6	7	8	9	10
107000611	Spickett River							x			
107000612	Merrimack River-Nashua River to Shawsheen River								x		
107000614	Merrimack River-Shawsheen River to mouth					x					
108010101	Connecticut Lakes Drainage	x									
108010102	Headwater Tributaries			x							
108010103	Mohawk River-Stewartstown Tributaries					x					
108010104	Connecticut River-Mohawk River to Nulhegan River							x			
108010106	Connecticut River-Nulhegan River to Upper Ammonoosuc River									x	
108010107	Upper Ammonoosuc River		x								
108010108	Israel River				x						
108010109	Connecticut River-Upper Ammonoosuc River to Johns River						x				
108010301	Johns River		x								
108010302	Connecticut River-Johns River to Ammonoosuc River				x						
108010303	Gale River						x				
108010304	Ammonoosuc River								x		
108010305	Lower Ammonoosuc River										x
108010307	Connecticut River-Ammonoosuc River to Waits River	x									
108010402	Connecticut River-Waits River to Hewes Brook									x	
108010404	Connecticut River-Ompompanoosuc River to White River			x							
108010601	Mascoma River		x								
108010603	Connecticut River-White River to Sugar River										x
108010604	Sugar River						x				
108010607	Connecticut River-Sugar River to Bellows Falls								x		
108010702	Cold River		x								
108010705	Connecticut River-Bellows Falls to Vernon Dam				x						
108020101	Upper Ashuelot River		x								
108020102	The Branch				x						
108020103	Middle Ashuelot River						x				
108020104	Lower Ashuelot River								x		
108020105	Connecticut River-Vernon Dam to Deerfield River										x
108020201	Upper Millers River	x									
108020202	Lower Millers River			x							
	Count of Stations / Year	8	8	8	10	8	8	8	8	8	8