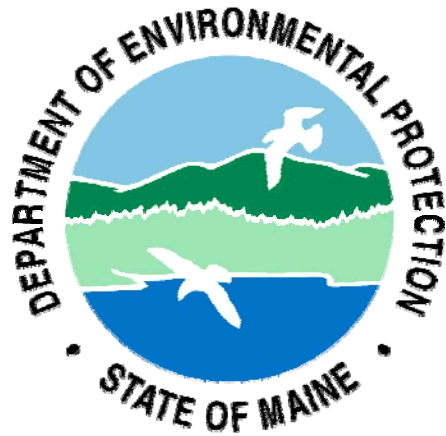


State of Maine
Department of Environmental Protection

Comprehensive Surface Water Ambient Water Quality
Monitoring and Assessment Strategy

2005-2015



September 2005

Table of Contents

Table of Contents	2
Table of Figures	3
Executive Summary	4
Executive Summary	4
1. Strategy Introduction	5
2. Monitoring Goals and Objectives	6
3. Monitoring Design	8
<i>A. Monitoring and Assessment Approaches</i>	<i>8</i>
i) Identification Tier	8
ii) Screening Tier.....	8
iii) Intensive Tier.....	10
iv) Other Monitoring.....	10
<i>B. Water Quality Monitoring Projects</i>	<i>10</i>
i) Rivers and Streams.....	10
ii) Biomonitoring (Rivers, Streams, Wetlands).....	11
iii) Lake Assessment	11
iv) Marine.....	12
<i>C. Emerging Issues</i>	<i>18</i>
<i>D. Program Development</i>	<i>18</i>
4. Indicators	22
<i>A. Maine Water Quality Standards Program</i>	<i>22</i>
<i>B. Assessment Indicators</i>	<i>22</i>
<i>C. Indicator Needs</i>	<i>24</i>
5. Quality Assurance	24
<i>A. Quality Management Plan</i>	<i>24</i>
<i>B. Quality Assurance Program/Project Plans (QAPPs), Sampling and Analysis Plans (SAPs) & Standard Operating Procedures (SOPS)</i>	<i>25</i>
6. Data Management	25
<i>A. Water Quality and Biological Data</i>	<i>25</i>
<i>B. Geographic Information System</i>	<i>25</i>
<i>C. Assessment Data</i>	<i>26</i>
7. Data Analysis	26
8. Reporting	28
<i>A. Integrated Assessment Reporting</i>	<i>28</i>
<i>B. TMDL Reports</i>	<i>28</i>
<i>C. Surface Water Ambient Toxic (SWAT) and Dioxin Reports</i>	<i>28</i>
<i>D. Other Reports</i>	<i>29</i>
i) Rivers and Streams.....	29
ii) Biomonitoring & Wetlands.....	29
iii) Lakes.....	29
iv) Estuarine and Marine	29
9. Program Evaluation	29
<i>A. Annual Review</i>	<i>29</i>
<i>B. Biennial Review</i>	<i>29</i>
<i>C. Annual Workplans</i>	<i>30</i>

10. General Support and Infrastructure Planning	30
<i>A. Current Program Support</i>	<i>30</i>
i) Field Monitoring	30
ii) Laboratory Services.....	30
iii) Assessment, Listing, and Reporting.....	30
iv) Information Management.....	30
v) Monitoring and Assessment Program Planning and Other Functions	31
<i>B. Projected Needs.....</i>	<i>31</i>
i) Staffing	31
ii) Equipment	31
iii) Laboratory Resources	31
iv) Information Technology Resources	32
References	33

Table of Figures

Figure 1. Map of Maine indicating Rotating Basin approach used by the Biomonitoring Section.	9
Figure 2. Monitoring Designs Used for Assessment of Rivers and Streams.	14
Figure 3. Monitoring Designs Used for Biomonitoring Assessment of Rivers, Streams, and Wetlands.	15
Figure 4. Monitoring Designs Used for Assessment of Lakes.	16
Figure 5. Monitoring Designs used for Assessment of Estuarine and Marine Waters.....	17
Figure 6. Emerging Issues.	18
Figure 7. Rivers & Streams: Projected Program and Monitoring Elements.	19
Figure 8. Biomonitoring (Rivers, Streams& Wetlands): Projected Program and Monitoring Elements.	20
Figure 9. Lakes: Projected Program and Monitoring Elements.	21
Figure 10. Estuarine & Marine: Projected Program and Monitoring Elements.	21
Figure 11. Other Division-wide Elements not Directly Supported.	22
Figure 12. Assessment Indicators for Rivers and Streams.	23
Figure 13. Assessment Indicators for Lakes and Ponds.....	23
Figure 14. Assessment Indicators for Estuarine and Marine Waters.....	24
Figure 15. Numerical Guidelines for Evaluation of Trophic Status in Maine.....	26

Executive Summary

This Comprehensive Surface Water Ambient Water Quality Monitoring and Assessment Strategy provides a framework describing existing monitoring and assessment efforts by the Maine Department of Environmental Protection (MEDEP) and other monitoring partners, and describes elements of an ideal monitoring program to meet objectives set forth by the Department. The strategy describes specific monitoring goals and objectives, and the types of monitoring designs and methods used to achieve these goals. Included are sections that characterize all aspects of this process, from monitoring to final reporting.

Although it is difficult to predict what the future may hold, this document attempts to illustrate anticipated monitoring and program development milestones over the next 10 years. These milestones will only be realized if adequate resources are available to meet the challenge. Thus projected needs are summarized by infrastructure element within the document as well. The document also attempts to capture emerging issues.

This strategy is intended to be a dynamic document that is referred to and updated on a somewhat continuous basis to meet the needs of the department. By updating our strategy as often as needed, we hope to be in a better position to seek the resources needed to accomplish the goals and objectives set forth in our state and federal mandates.

1. Strategy Introduction

This ambient surface water quality monitoring program strategy provides a framework describing existing monitoring and assessment efforts by the Maine Department of Environmental Protection (MEDEP) and other monitoring partners, and describes elements of an ideal monitoring program to meet objectives set forth by the Department. The strategy:

- describes specific monitoring goals and objectives;
- describes the types of monitoring designs and methods used in Maine;
- provides a list of anticipated monitoring and program development milestones,
- recommends core and supplemental water quality indicators;
- provides detail and references on quality assurance procedures;
- provides information on data management methods and protocols;
- provides general data analysis and assessment procedures;
- describes required federal and state reporting and provides recent references;
- recommends methods for periodic review of this monitoring program;
- provides estimates of current resources and necessary resources for full program implementation.

The needs to acquire monitoring information are varied. A monitoring program is required by various state and federal directives, notably the Clean Water Act that requires states to characterize the baseline quality or status of waters, understand the trends or direction in which water quality is moving, and determine what factors or stressors may be influencing water quality. This is critical information for planning water quality management. Significant emphasis is currently being placed on determining whether waters are in compliance with applicable water quality standards and criteria. Such decisions carry significant regulatory consequences, hence the need for a robust and scientifically defensible framework. While the current water quality management demands force scientists and managers to think about monitoring in the framework of use support, impaired water listings/de-listings, and TMDL preparation, there are other, equally important goals that must be met by monitoring activities. Among these are the understanding of what is unique about a waterbody and how the monitoring information fits within the context that it is acquired, and the understanding of how waterbodies respond to management actions. These two objectives provide for protection and efficient remediation of waters. Additionally, the monitoring program provides the means of discovering new, or previously unknown, water quality problems. Finally, the monitoring program provides tangible documentation about water quality that can be used by the public for a wide variety of personal and societal decisions.

The general design of a water quality monitoring program must take into account expected variability: spatially, temporally, and analytically. A primary objective of any monitoring design is to describe, control, or reduce the bias that is inherent in any monitoring program, thus to describe, control, and reduce the uncertainty in the information generated. Water quality assessments generally require comparative analysis, either to a water quality standard, to a reference condition, to a trend, or some other defined management objective.

Maine's water quality monitoring program has evolved in recent years to direct the greater amount of our monitoring resources toward impact and fate measures [e.g. invertebrate biomonitoring in rivers, plankton (phytoplankton and zooplankton) assessment in lakes, tissue contamination]. We find that the best means to assess and prioritize environmental problems is by quantifying the biological effects that various stressors impose on a system rather than indirectly assessing water quality by measuring the stressors (e.g. water chemistry). Maine's Biomonitoring Program, including the development of numerical biocriteria for rivers, and the Surface Water Ambient Toxics Program exemplify this approach to monitoring.

Throughout this document, the terms “waters” and “water resources,” refer to surface waters including rivers & streams, lakes & ponds, marine & estuarine waters, and inundated wetlands. The term “monitoring” is intended to address measurement or estimation of ambient water quality conditions. Groundwater is not presently addressed in this strategy, nor is monitoring activity related to permit compliance or in-facility monitoring. This strategy is intended to be a dynamic document, reflecting the ever-improving methods available for water quality monitoring and changing program needs. It describes a range of activities that are currently used and identifies other monitoring activities that could be implemented based on availability of resources. This strategy is intended to have a lifespan of ten years, and allows for (even encourages) annual and mid-year changes that reflect new and immediate demands on the monitoring program.

While this is a Department strategy, clearly ambient monitoring responsibilities extend to other government agencies, tribes, non-governmental, and volunteer groups. This strategy takes into account their current and projected involvement (see Figures 2-5) but does not assess specific resources that these other groups have or specifically assign any roles. The goals and objectives encompass many of the same general goals and objectives that these other monitoring groups share, although they may not share the same priorities as the Department, and are often more single-issue oriented and geographically focused. The Department has been successful in engaging these other groups through various means: (1) financial support through grants or contracts that allow for maintaining staff, acquisition of equipment, and training, (2) training and other logistical support (e.g. quality assurance project plan development) provided by Department staff, (3) data management, analysis, and utilization, and (4) cooperative agreements to partition workloads on various projects. The Department maintains continuous involvement with these groups and could not maintain our monitoring program without this accompanying support.

This Monitoring Strategy makes no attempt to address monitoring of waters outside of those identified as current state priorities. For example, the state GIS system has identified approximately 32,000 polygons as being lakes or ponds. Of these, approximately 29,000 are less than one acre in surface area, few if any which have been monitored. Similarly, intermittent streams are not routinely monitored by the Department. Soft bottom (muck) streams may be monitored by the Rivers & Streams section but not by the Biomonitoring section. Wetland monitoring has yet to focus on certain types of wetlands (e.g., forested wetlands and wetlands having very little standing water). Vernal pools have yet to be monitored for water quality although other organizations may focus volunteer efforts on species enumeration. Coastal wetlands have been the subject of research within the state but are not routinely targeted for monitoring. Given the current levels of support and personnel, it is unlikely that these waters will be directly monitored in the foreseeable future. It is more likely that other issues/contaminants would become higher priority in currently monitored waters before the ‘smaller’ somewhat ephemeral waters. It should be noted that if a contaminant were to be traced up-gradient to a source associated with an ephemeral water, that water would be indirectly identified in the TMDL process due to its location in the watershed.

2. Monitoring Goals and Objectives

General goals of Maine’s surface water program include documentation of the condition of Maine’s waters and protection of these resources in collaboration with other entities through cooperative studies and the fostering of community stewardship at local and statewide levels. Specific goals and objectives are listed in the following bulleted lists.

Goal 1: Monitor and predict the condition of Maine’s water resources to:

- Provide information essential to protecting, maintaining and/or restoring the physical, chemical and biological integrity of Maine’s water resources;
- Provide information on the quality of waters in relation to water quality standards, reference conditions, or other measures of comparison;

- Identify water quality conditions, impairments, causes, and sources;
- Provide information on the trends observed in water quality;
- Identify new or emerging problems before they become widespread or irreversible;
- Evaluate the success of current policies and programs.

Objectives for Goal 1:

- Identify the status of Maine’s water resources, including high-quality waters in need of protection;
- Identify trends in the condition of Maine’s water resources;
- Identify existing and emerging threats to Maine’s water resources and the ability to prioritize the management of these threats and problems;
- Identify contamination sources or other activities at the waterbody and watershed level that impact water resources;
- Provide information to support and evaluate Department planning, management and regulatory programs (including air and hazardous waste programs), and the development of environmental indicators;
- Provide information to support and evaluate Department planning and management of non-regulatory and volunteer programs (including non-point source control);
- Determine environmental and public health effectiveness of pollution control programs, or other agency or voluntary programs;
- Provide necessary monitoring support involving citizen complaints and emergency situations;
- Determine and report compliance with Maine’s Water Quality Standards, and identify where standards are exceeded and warrant protection through anti-degradation, or where they may need to be modified to account for natural conditions;
- Develop methods that increase the capacity and efficiency to address the aforementioned objectives.

Goal 2: Communicate, collaborate and coordinate with organizations, agencies, and the general public to:

- Increase public knowledge of and involvement in water resource monitoring and assessment (and water resource management);
- Promote efficient and effective monitoring and assessment programs;
- Develop effective and timely reporting;
- Collect and disseminate useful data, of standardized quality, to supplement state monitoring and assessment programs;
- Advise water resource management bodies (e.g. Maine legislature, natural resource agencies, regulated community) on water quality status and trends.

Objectives for Goal 2:

- Develop a comprehensive and inclusive monitoring and assessment program in Maine;
- Identify water resource data needs and develop mechanisms to enable volunteer monitoring and assessment programs and other partners (e.g. tribes) to collect data that are of high quality and relevant to those needs;
- Communicate with other state and federal agencies to assure complementary monitoring programs;
- Support volunteer monitoring programs.

3. Monitoring Design

A. Monitoring and Assessment Approaches

Maine can be characterized as a water-rich, heavily forested state that is relatively unpopulated for the northeast region of the country. These three characteristics present a challenge in the design of an assessment strategy that is both comprehensive and cost effective. Aerial estimates of the proportion of Maine covered by surface water, including wetland, river/stream, lake/pond and estuarine environs, ranges between 20 – 30%. The Maine GAP Land Cover and Vegetation Dataset, a GIS based characterization of land cover derived from Landsat imagery, indicates that the predominant land cover is forest (89%). Despite inherent resolution errors in these estimates, this information is considered to be reasonably representative of general conditions within the state. Much of Maine's population occurs along the Interstate 95 corridor, particularly in south and eastern areas. DEP's assessment strategy is tailored to meet the challenges presented by these conditions.

i) Identification Tier

In general, assessment of classification attainment status in Maine waters is approached using a 'tiered' approach. A first tier examination is generally a risk-based identification of waters most likely to be influenced by a stressor or set of stressors. For example, Maine's GPA classification of lakes allows for variation in trophic state ("as naturally occurs") but requires trophic trend to be stable or improving and 'free from culturally induced algal blooms'. An appropriate first tier screening for this classification attribute is population in the watershed or township. Townships/watersheds having 0 persons per square mile (2000 Census) are not necessarily included in screening for attainment status, although they may be monitored to establish 'Reference' conditions.

Similarly, Geographic Information System spatial data may be used as a first tier tool to identify watersheds having a % impervious surface greater than a specific threshold and thus identify streams most at risk for effects from non-point stressors associated with urban development. Such waters may be targeted for further screening. Such waters may be screened using a census based, targeted approach or be included in a stratified probability design.

ii) Screening Tier

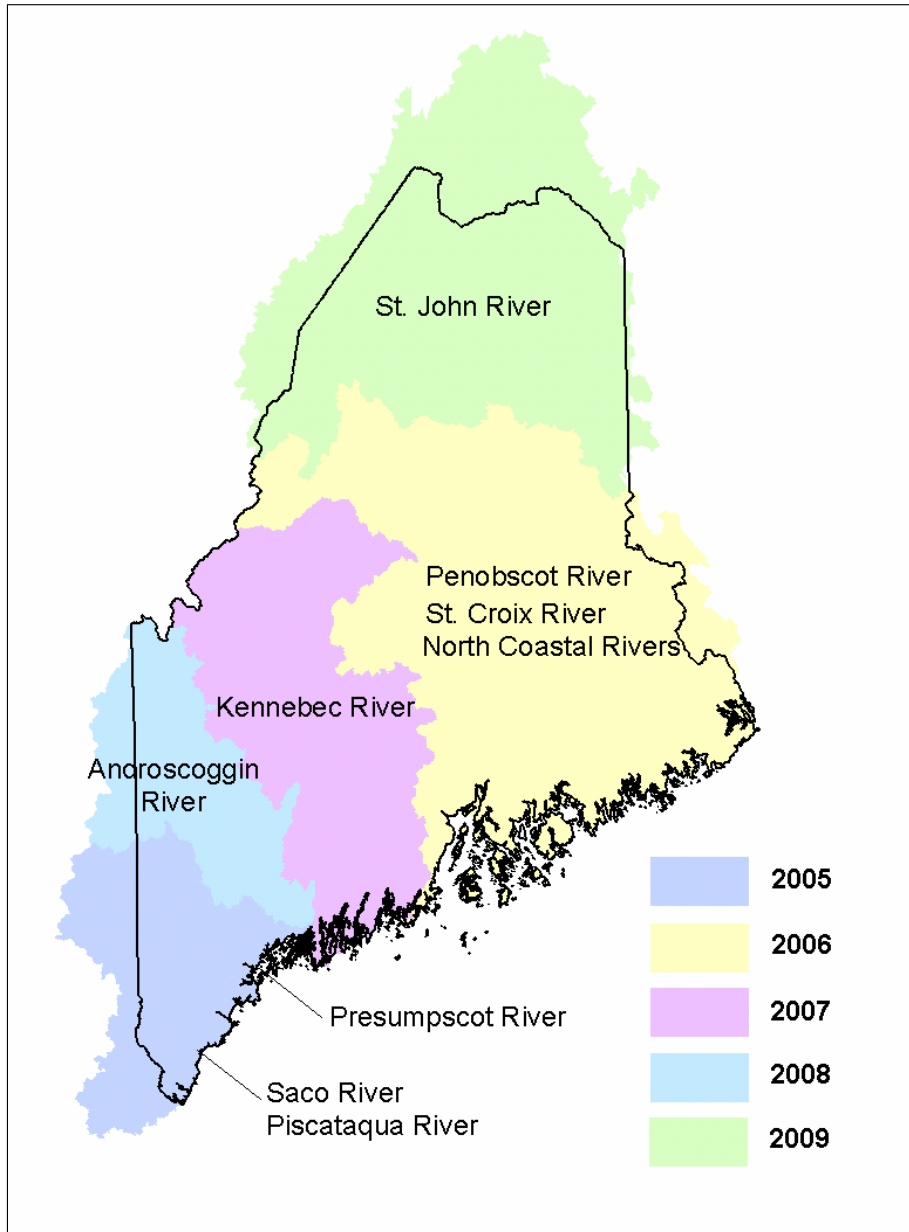
Second tier screenings are conducted by volunteers and/or by professionals often using screening approaches using simple measures at limited frequency or other rapid assessment techniques. If attainment status is in question, more specific monitoring is warranted. When results from additional monitoring reveal that the water is in non-attainment due to a pollutant (impaired and listed under Section 303(d) – requiring a TMDL study) intensive monitoring will become more frequent, focusing on specific stressors and associated sources.

Screening level assessments are conducted using a number of approaches. Origin and persistence of a stressor are paramount considerations in determining where to allocate monitoring resources. For example, airborne stressors (e.g., mercury) are likely to be found across the entire state regardless of local population densities and land uses. In the mid 1990s, Maine undertook a fish tissue assessment to determine extent and magnitude of mercury contamination Maine lakes (Regional EMAP project, Fish Tissue Contamination in Maine Lakes). A probability based (stratified random) approach was chosen to assess fish tissue statewide in a randomly chosen subset of lakes determined by the Department of Inland Fisheries and Wildlife to have a significant game fishery. Fish collections were obtained from 125 lakes in addition to routinely collected water quality data. Results allowed conclusions to be drawn regarding the population of approximately 1800 lakes that support game fish across the state. Results also indicated that 'hot spots' existed downwind of waste to energy facilities. Additional lakes were targeted in the vicinity of these areas to confirm local depositional sources. Further examination of the data revealed that warmwater species typically had greater concentrations of mercury. This insight allowed researchers to target warmwater species in subsequent

sampling designs. One unforeseen benefit from this study was that the statistically valid design allowed results to be used as a 'yardstick' in the evaluation of monitoring effectiveness of other approaches to the collection of water quality data.

On the other hand, stressors associated with specific point source discharges are most likely to be found downstream of such discharges (e.g., dioxin associated with paper mills, pharmaceuticals with municipal treatment plant discharges, bacteria with CSOs). Thus waters downstream of discharges are targeted for monitoring. A rotating basin approach (Figure 1) assures screening evaluation of a statewide resource on a regular frequency. The Biomonitoring section utilizes this approach in many of their projects.

Figure 1. Map of Maine indicating Rotating Basin approach used by the Biomonitoring Section.



Stressors associated with non-point sources generally transported to surface waters by stormwater runoff are most often found in the developed areas of the state (e.g., nutrients & pesticides from agricultural and urban/suburban areas; a ‘soup’ of assorted contaminants from heavily urbanized or industrialized neighborhoods). Screening may be accomplished in these situations using a number of approaches. Citizen monitoring activity has the inherent bias of being most likely to occur in heavily populated regions of the state, and thus in areas most likely for non-attainment issues. Citizen monitoring in Maine is thus categorized as statewide screening, targeted with respect to population, yet opportunistic in that a certain percent of stations (estimated 20%) may be in flux in any given year.

iii) Intensive Tier

Third tier or intensive monitoring approaches are generally implemented when screening results indicate that a water may not be attaining classification standards for one or more designated uses. Intense monitoring may include multiple parameter evaluations to identify stressor(s) and/or increased monitoring frequency of parameters identified as or associated with stressor(s). A combination of is generally used when monitoring an impaired water in conjunction with the development of a TMDL. Restoration effectiveness is often evaluated using a similar approach.

iv) Other Monitoring

The Department engages in a variety of other monitoring activities more or less directly related to water quality assessments. These may include, as examples, monitoring of water quality in the Maine’s Ecological Reserve network, assisting with projects conducted by other State agencies (e.g. Inland Fisheries and Wildlife, Marine Resources), monitoring in cooperation with hazardous waste remediation sites (e.g. RCRA, SARA), or in support of water research associated with the state academic institutions. These are normally not part of a regular monitoring plan but may account for significant additional monitoring resources.

B. Water Quality Monitoring Projects

i) Rivers and Streams

Overview - The Rivers and Streams unit is responsible for the statewide Water Quality assessment of classified rivers and streams. Non-attainment waters are addressed through the TMDL process.

These tasks are accomplished through various programs and involve data collection/compilation/analysis, technical review and modeling.

Brief Project Descriptions

- Point source TMDL studies – Data collected for purposes of developing wasteload models (e.g. QUAL2E) applicable to TMDL reports for Category 5 listed impaired waters.
- Surface Water Ambient Toxics (SWAT) – statewide program assesses toxic contaminants in surface waters using fish tissue, sediment and biomonitoring. Program also supports method development. Information used for fish consumption advisories.
- Dioxin Monitoring Program – Fish tissue (other surrogate methods) collected for dioxin and dioxin – like compounds in waters receiving waste from known dioxin dischargers. Information used for fish consumption advisories.
- Non-point source TMDL – Data collected for purposes of developing load allocations for TMDL reports for Category 5 listed impaired waters.
- Atlantic salmon conservation plan – monitoring directed at characterizing and assessing waters that are listed as threatened “distinct salmon populations”.
- River/stream nutrient criteria – statewide monitoring of reference quality and affected waters to develop nutrient criteria.

- Urban stream restoration projects – follow-up monitoring on urban impaired waters with completed TMDLs.
- Classification assessment – traditional water quality analysis (e.g. dissolved oxygen, pH, conductivity, enteric bacteria) used for water classification assessment.

ii) Biomonitoring (Rivers, Streams, Wetlands)

Overview – Maine DEP has a Biomonitoring Unit which employs biological assessment of the resident biological community in rivers streams and wetlands. Biological criteria are already developed using macroinvertebrates in rivers and streams. Techniques for periphyton and wetlands are in development.

Brief Project Descriptions

- Classification assessment – Statewide monitoring to assess attainment of water classification.
- Non-point source TMDL – Macroinvertebrate data collected to determine stressors involved in NPS TMDL reports.
- Periphyton – Development of statewide criteria using periphyton in cooperation with development of nutrient criteria.
- Surface Water Ambient Toxics (SWAT) – Macroinvertebrate data collected for identification and assessment of toxics problems.
- Wetlands – Development of statewide biocriteria applicable to freshwater wetlands, assessment of condition.
- Ecological Reserves – Biological characterization and baseline documentation of protected reference quality waters in the state.
- NE Wadeable Streams project – Cooperative project with EPA and NE states to development mutual biological assessment methods.

iii) Lake Assessment

Overview – The Lake Assessment Section is responsible for the statewide water quality assessment of classified lakes and ponds. Non-attainment waters are addressed through the TMDL process. Additionally, the section mission is “To promote the protection of Maine's lakes through research, collection and management of sound scientific data, identification of threats to lake ecosystems and dissemination of information to those concerned with lake water quality.” The Invasive Aquatic Species (IAS) Program, spawned by the discovery of invasive aquatic macrophytes in our lakes over the past decade, is also part of the Lake Assessment program.

Brief Project Descriptions

- Maine Volunteer Lake Monitoring Program – The Lake assessment section (LAS) partially funds this private, non-profit entity, provides quality assurance oversight, data management and reporting assistance, and, utilizes data collected on over 400 lakes for prioritization of resources and reporting to state and federal entities.
- Special Study Lakes – The LAS examines a small number of lake systems annually with respect to water level issues, possible impairment, and other lake specific investigations.
- Lake Baseline Sampling – The LAS acquires water quality data and samples for analyses from approximately 100 lakes over a three week period in late August of each year. These data are used to help interpret data collected by the volunteers and cooperators, to make determinations regarding attainment status and to document conditions on reference waters.
- Special Studies with University of Maine – The LAS supports graduate level research through the University of Maine on topics of interest and/or the development of educational resources. Past projects have included analysis of the economic value of lakes, investigations into lake sediment aluminum/iron/phosphorus dynamics, and development

of techniques to assess riparian and littoral attributes on developed and undeveloped shorelines.

- Ecological Reserve Monitoring – For the past five years, the LAS has been documenting water quality conditions and planktonic biota in lakes located on state-owned public lands designated as Ecological Reserves; in 2005 the documentation has expanded to include littoral habitat, aquatic plant communities, minnows, crayfish and macroinvertebrates.
- REMAP/NELAP – The LAS has participated in earlier probabilistic lake surveys in conjunction with EPA (REMAP) and expects to participate in a similar survey, the New England Lakes and Ponds study, in upcoming years.
- Invasive Aquatic Species Program(IAS), Maine Center for Invasive Plants – The IAS supports the center in the development of citizen based monitoring tools to screen Maine lakes for invasive aquatic plants.
- IAS, Population Control – The IAS oversees the development of various control tools to manage or eradicate invasive aquatic plants.
- IAS, Plant Community Surveys – The IAS supports plant community survey projects designed to document aquatic plant habitat communities and species while screening for invasive and threatened/rare/endangered species.
- IAS, Screening – The IAS conducts screening of infested lakes, and lakes hydrologically connected or in close geographic proximity to infested lakes.

iv) Marine

Overview – The Maine Department of Environmental Protection’s (DEP) monitoring strategy for marine and estuarine water has three basic approaches based on the multi-agency, multi-jurisdictional Gulf of Maine Council on the Marine Environment Habitat Monitoring Subcommittee workshop deliberations. The initial monitoring focus is on areas most threatened by human activities and of high management priority. Monitoring must answer questions at multiple scales while addressing multiple pressures on coastal resources and environmental processes. This monitoring strategy adopts a nested, three-tiered approach designed to document State status and trends as well as diagnose causes of environmental change. This conceptual framework is modeled after strategies developed by the National Science and Technology Council for an integrated national monitoring program (NSTC 1997, Integrating the Nation’s Environmental Monitoring and Research, <http://www.epa.gov/cludygxb/Pubs/framework.pdf>) and the Coastal Research and Monitoring Strategy Workgroup of the Clean Water Action Plan (2000, Clean Water Action Plan: Coastal Research and Monitoring Strategy, <http://www.cleanwater.gov/coastalresearch>).

Brief Project Descriptions

- The National Coastal Assessment (NCA) <http://www.epa.gov/emap/nca/> estimates the current status of the condition of the nation's coastal resources on a regional and national basis using the following ecological indicators: dissolved oxygen, chlorophyll, nutrients, community and trophic structure, toxics in sediments, and lobster, and amphipod sediment bioassay. Development of marine biocriteria based on benthic infauna is part of the NCA program.
- GoMOOS uses moored buoys to monitor wind, waves, temperature, fog, currents, temperature, salinity, color, turbidity, and dissolved oxygen above and below the ocean surface off the Maine coast.
- The Surface Water Ambient Toxics Monitoring Program (SWAT) monitors toxic contaminants in mussel tissue, lobster tomalley and meat, clam tissue, and sediments. There have also been special SWAT projects on toxics in cormorants and seals.

- The Gulfwatch Program is part of the Gulf of Maine Council on the Marine Environment program and monitors toxic contaminants in mussel tissue around the Gulf of Maine. SWAT uses the same methods for sampling as Gulfwatch.
- The Shore Stewards program includes the Maine DEP, the Coastal Program of the Maine State Planning Office, the Department of Marine Resources, and Sea Grant/Cooperative Extension. The program provides assistance to Maine coastal groups for monitoring. The Clean Water/Partners in Monitoring program works with community-based groups to monitor temperature, dissolved oxygen, pH, salinity, and fecal coliform using field test kits and equipment in community laboratories.
- Casco Bay Estuary Partnership (CBEP) monitoring program includes monitoring with partners for many indicators including toxics in sediments, lobsters and mussels. The monitoring strategy is available from the CBEP. Lobsters and mussels sampled as part of the SWAT and the Gulfwatch programs use the same sampling protocols.
- The Friends of Casco Bay have been monitoring the water quality in Casco Bay for 12 years. Volunteer monitors and professional staff conduct sampling for dissolved oxygen, temperature, salinity, pH, Secchi depth, chlorophyll and nutrients.
- The Maine Department of Marine Resources (DMR) Shellfish Sanitation Water Quality Monitoring uses volunteers to collect water samples in shellfish growing areas for analysis of fecal coliform at state laboratories. The data is used by the DMR to decide whether shellfish areas have water quality acceptable for harvesting.
- Maine Phytoplankton Monitoring program is part of the Shore Stewards Program and provides assistance to community-based groups monitoring toxic phytoplankton species in coastal waters. The data is incorporated into a database at the Maine Department of Marine Resources (DMR) and is compared to toxins monitoring data generated by DMR's shellfish sanitation program.
- The Maine Healthy Beaches program includes a public education program and a water quality assessment and measurement of Enterococcus bacteria, an indicator of recreational water-borne illnesses. This is a voluntary program. The data are used by municipalities, state agencies and the U.S. Environmental Protection Agency in their efforts to promote public safety. The Maine State Planning Office Coastal Program is the lead agency administering the program at present and the University of Maine Cooperative Extension/Sea Grant coordinates the program.

The following four tables (Figures 2 – 5) summarize specific attributes for monitoring projects conducted by each program. Various cooperators are indicated under the group of columns identified as “Collaborators”. For the purposes of these tables, a collaborator is defined as a group of active participants rather than a source of funding for the project. “Geographic Extent” includes choices that characterize the spatial extent of a project. Attributes listed under “Focus” indicate the general purpose of each project. “Approach” refers to aspects of the project design that address sample site selection. “Frequency” attributes characterize how often a site or set of sites are visited. Selections included under “Parameters” indicate the breadth of the monitoring design. Not included in these tables is an indication of the project duration. Most monitoring occurs as long as needed; however in certain studies the duration is appropriate to accomplish a specific short-term task.

Nearly all water quality data collected is used for attainment assessment and reporting under state and federal mandates, the exception being data which do not meet the program or project quality assurance standards. Biological data collected from rivers and streams are also used to assess attainment status for reporting purposes. Biological data from wetlands and lakes are currently collected for the purpose of developing assessment tools to be used in future attainment assessments. See Section 8 for further information regarding reporting of results.

Figure 2. Monitoring Designs Used for Assessment of Rivers and Streams.

Project Name	Collaborators*						Geographic Extent			Focus			Approach						Frequency						Parameters											
	Federal	Interstate	State & Tribal Gov't	Univ. or College	Local Organizations	Citizen	Statewide	Major Drainage Basin	Specific Waters	# Stations/year	Screening	Trend	Intensive	Probability based	Stratified	Census	Fixed Station	Targeted	Opportunistic	Weekly	Bi-weekly	Monthly	Quarterly	Seasonally	Annual	Opportunistic	Rotating Basin (# yrs)	Physical	Chemical	Biological	Microbiological	Priority Organics	Tissue	Sediment	Toxics	Other
Point Source TMDL Studies			X	X ¹	X	X	X	X	25			X				X	X						S			P	X	X	X							TMDL Depen
Surface Water Ambient Toxics (~26 sub-projects)			X	X			X	X		X		X	X	X	X	X	X					X		X	X		X	X	X	X	X	X	X	X	X	X
Dioxin Monit. Prg			X				X	X		X	X					X	X							X								X				
NonPoint Source TMDL		X ²	X				X	X	12		1	X				X	X				X	X	X		S		X	X	X	X				X		M
Atlantic Salmon Conserv. Plan Water Quality Monit.			X		X		X	X		X	X	X			X	X	X			X	X	X	X	X			X	X								
River/Stream Nutrient Criteria (incl. Ref. sites)		X ²	X				X	X		X							X						X				X	X	X				X			
Urban Stream Restoration Project	X		X		X	X		X				X			X	X						X					X	X	X							W
Ecological Reserves			X				X	X			X	X			X	X	X						S			X	X	X	X							
Data used in Assessment (QA & Priority)	All data used in Assessments.																																			
Emerging Issues	See Figure 6																																			
Comments	River/Stream Nutrient Criteria Development uses nutrient data collect from all projects listed in this table and collected from Rivers/Stream sites monitored by the Biomonitoring Section. Seasonally: S=stormwater; Other: M=metals, W=watershed ¹ Help of Tribes, River groups, treatment plant operators whenever possible; ² Tool Development *Includes active participation, not funding sources																																			

Figure 3. Monitoring Designs Used for Biomonitoring Assessment of Rivers, Streams, and Wetlands.

Project Name	Collaborators*						Geographic Extent			Focus			Approach						Frequency								Parameters												
	Federal	Interstate	State & Tribal Gov't	Univ. or College	Local Organizations	Citizen	Statewide	Major Drainage Basin	Specific Waters	# Stations/year	Screening	Trend	Intensive	Probability based	Stratified	Census	Fixed Station	Targeted	Opportunistic	Weekly	Bi-weekly	Monthly	Quarterly	Seasonally	Annual	Opportunistic	Rotating Basin (# yrs)	Physical	Chemical	Biological	Microbiological	Priority Organics	Tissue	Sediment	Toxics	Other			
Biomonitoring Section – WSA Project (w/EPA)	X	X	X				X		5				X				X								2			X	X	X							X		
Biomonitoring Section – MacroInvert. From NPS (Agricultural&Urban			X				X	X	15	X						X	X									5	X	X	M		Ag								
Biomonitoring Section – Periphyton From NPS (Agricultural&Urban			X	X			X	X	54	X						X	X									5	X	X	P								M		
Biomonitoring Section – Surface Water Ambient Toxics (SWAT)			X				X	X	40		X					X	X							X		5	X	X	M		X			X	X				
Biomonitoring Section – Biological Monitoring of Wetlands			x	X			X		25																	5	X	X	X										
Ecological Reserve Biomonitoring																																							
Data used in Assessment (QA & Priority)	All data used in Assessments.																																						
Emerging Issues	See Figure 6																																						
Comments	Biological: M=macroinvertebrates, P=periphyton; Other: M=metals *Includes active participation, not funding sources																																						

Figure 4. Monitoring Designs Used for Assessment of Lakes.

Project Name	Collaborators*						Geographic Extent			Focus			Approach						Frequency						Parameters													
	Federal	Interstate	State & Tribal Gov't	Univ. or College	Local Organizations	Citizen	Statewide	Major Drainage Basin	Specific Waters	# Stations/year	Screening	Trend	Intensive	Probability based	Stratified	Census	Fixed Station	Targeted	Opportunistic	Weekly	Bi-weekly	Monthly	Quarterly	Seasonally	Annual	Opportunistic	Rotating Basin (# yrs)	Physical	Chemical	Biological	Microbiological	Priority Organics	Tissue	Sediment	Toxics	Other		
Maine Volunteer Lake Monitoring Program (VLMP)	X	X		X	X	X		x	400	X								X		X							X	X										
DEP Lake TMDL Studies			X	X	X	X		X	10			X				X	X				X						X	X	X								H	
DEP Lake Special Studies			X	X	X	X		X	15			X				X	X				X						X	X	X					X				
DEP Baseline Sampling			X	X		X	X	X	100	X		X				X	X	X							Aug		X	X	X					X			H	
Univ. of Me, Special Studies		X	X	X			X	X	V	X	X	X	X	X	X									Ov			X	X										
Ecological Reserves			X					X	15		X	X			X	X	X							S		3-5	X	X	X					X				
REMAP – NELAP	X	X	X	X			X						X	X			X								Aug		X	X	X		X	X	X	X	X	X	X	
Maine Center for Invasive Aquatic Plants (VLMP)			X		X	X			50	X							X	X							X				X								I	
Invasive Aquatic Species (IAS) Prg.: Pop. Control			X					X	2		X	X				X	X				X						X	X	X						X			
IAS Prg.: NAP Plant Community Surveys			X				X		15	X							X								X				X								B	
IAS Prg.: Inv. Plant Screening (infested & hydrologically connected lakes)			X	X					10	X	X						X								X				X								I	
Data used in Assessment (QA & Priority)	Data collected through the VLMP, TMDL Studies, Special Studies, Baseline & Ecological Reserve Sampling are used for assessment.																																					
Emerging Issues	See Figure 6																																					
Comments	*Includes active participation, not funding sources																																					

Figure 5. Monitoring Designs used for Assessment of Estuarine and Marine Waters.

Project Name	Collaborators*					Geographic Extent			Focus			Approach					Frequency						Parameters														
	Federal	Interstate	State & Tribal Gov't	Univ. or College	Local Organizations	Citizen	Statewide	Major Drainage Basin	Specific Waters	# Stations/year	Screening	Trend	Intensive	Probability based	Stratified	Census	Fixed Station	Targeted	Opportunistic	Weekly	Bi-weekly	Monthly	Quarterly	Seasonally	Annual	Opportunistic	Rotating Basin (# yrs)	Physical	Chemical	Biological	Microbiological	Priority Organics	Tissue	Sediment	Toxics	Other	
National Coastal Assessment	X		X		X	X							X	X												3	X	X	X	X		X					
GOMOOS		X	X				X								X	X											X	X									
SWAT			X														X							X								X					
Gulfwatch	X	X	X			X					X				X									X				X			X		X				
Shore Stewards Prg					X	X	X											X	X					X			X	X		X							
Casco Bay Mon. Prg.					X	X		X		X	X	X			X									6/yr				X				X	X	X			
Friends of Casco Bay					X	X		X							X	X			S	W				X		X	X		X								
Shellfish Sanitation (DMR)			X			X	X												X	X										X							
Maine Phytoplankton Monitoring (DMR)					X	X	X												X					X					X								
Healthy Beaches					X	X	X	X												X										X							
Data used in Assessment (QA & Priority)	All data used in Assessments.																																				
Emerging Issues	See Figure 6																																				
Comments	Frequency: W=winter, S=Summer *Includes active participation, not funding sources																																				

C. Emerging Issues

Overview: Emerging issues are not listed in Figures 2 - 5. Such issues could be considered as being on a program’s radar, yet to be elevated to a status requiring the development of a specific monitoring design. Figure 6 indicates which monitoring programs are likely to be impacted by each issue.

Brief Issue Description

- **Water Use:** As the State of Maine Water Use Rules are finalized, there is likely to be the need for some monitoring to evaluate their effectiveness, particularly with respect to protection Aquatic Life Support.
- **Pharmaceuticals and Personal Care Products (PPCPs)** have been identified as potential contaminants below municipal point sources particularly in low dilution scenarios, and possibly in smaller lakes having low flushing rates and many septic systems located on permeable soils or fractured bedrock with their watershed.
- **Persistent Bioaccumulating Toxins (PBTs)** other than those routinely monitored are likely to be targeted for monitoring at some time in the future.
- **Invasive Organisms:** The recently established Invasive Aquatic Species section has been focusing its resources on invasive aquatic plants in lakes and streams. It is apparent that fauna invasive to lakes and streams, and invasive flora and fauna in wetland and marine environs are likely to require future resources at this and/or other state agencies.
- **Green Algae/Marine Nutrient Enrichment:** Green macroalgae (Ulva, Microstoma, and Enteromorpha) tend absorb nitrogen quickly. Later in the summer/fall the gametes and spores are released into the water. This may appear to be a phytoplankton bloom and the elevated chlorophyll A in samples is often mistaken for a phytoplankton bloom. Another problem is that if there is an oxygen problem or a “bloom” then these plants end up dying and washing ashore.
- **Coastal Wetlands including fringing marsh:** Coastal marshes, particularly fringing marshes, are being lost by fragmentation due to shoreline development (dock, piers, etc). Monitoring of this resource has been limited and needs to be expanded. The Gulf of Maine program monitoring subgroup has identified this habitat as a priority habitat to monitor.

Figure 6. Emerging Issues.

Resource or Section	Rivers & Streams	Biomonitoring of Rivers, Streams & Wetlands	Lakes – Water Quality	Lakes – Invasive Aquatic Species	Estuaries and Marine
Emerging Issue					
Water Use	X	X	X		
PPCPs	X	X	X		X
PBTs	X	X	X		X
Invasive Organisms				X	X
Green Algae/Marine Nutrient Enrichment					X
Coastal Wetlands including fringing marsh					X

D. Program Development

Monitoring is expected to continue at some level in association with most of the projects listed in Figures 2 – 5 above, however the reality of unpredictable funding makes it extremely difficult if not nearly impossible to predict how quickly new parameters will be added to existing projects, or how quickly program development

progresses. The following tables (Figures 7 – 11) illustrate anticipated monitoring and program development milestones along a 10-year timeline.

Figure 7. Rivers & Streams: Projected Program and Monitoring Elements.

Program / Project Element	YEAR									
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Development of TMDLs on Impaired Waters (2006 listings)		X	X	X						
Nutrient Criteria Development										
Reference site monitoring – largely complete										
Data Analysis	X									
First Draft	X	X								
Rule Updates		?	?	?						
Final Draft		?	?	?						
Identification of Water Quality Response Vars [Nut.&physical]										
Data Analysis	X									
Diurnal D.O. Study (define fluctuations d/t 'Natural' factors)	?	?	?							
Stream Volunteer Monitoring										
Planning (recommendations, proposal, QAPP&SOP Devel.)	X	X								
Pilot Project		?	?	?						
Full Implementation			?	?	?	?				
Toxics										
Toxics Rule (adoption pending) Evaluation		?	?	?						
PPCPs & PBTs	X	X	X							

Figure 8. Biomonitoring (Rivers, Streams& Wetlands): Projected Program and Monitoring Elements.

Program / Project Element	YEAR										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
River & Stream Biological Cond. Gradient Development											
<i>Periphyton Indicator Development</i>											
Monitoring / Database Develop (ongoing)	X	X	X	X	X	X	X	X	X	X	
Metric Development	X	X									
Metric Testing	X	X									
Multivariate Model Development	X	X									
Model Testing	X	X	X	?							
Incorporation into Existing Biocriteria (if appropriate)					?	?	?				
Wetland Biological Condition Gradient											
Monitoring / Database Develop (ongoing)	X	X	X	X	X	X	X	X	X	X	
Metric Development/Refinement	X	X									
Metric Testing	X	X									
Multivariate Model Development	X	X									
Model Testing, Revisions, Maintenance (ongoing)	X	X	X	X	X	X	X	X	X	X	
Rulemaking (applicability of existing standards/narrative criteria)	X										
Rulemaking (wetland specific criteria)					?	?	?				
Education/Public Assess											
Biomonitoring Internet Mapping Project (BioIMP)											
Software Development (GIS based webpages)	X										
Product Testing	X										
Product deployment	X										
Product Maintenance (revisions & data updates)	X	X	X	X	X	X	X	X	X	X	
National Biological Condition Gradient Integration											
Monitoring (largely done)	X										
New England Data Analysis	X										
National Data Analysis	X	X									
Tiered Use Model Development	X	X	X								
Testing, Revisions, Maintenance		X	X	X	X	X	X	X	X	X	

Figure 9. Lakes: Projected Program and Monitoring Elements.

Program / Project Element	YEAR										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Lakes Biological Condition Gradient											
<i>Pelagic Index Development (zooplankton & phytoplankton)</i>											
Taxonomic Analyses	X	X	X	X	X	X	X	X	X	X	
Database Development	X	X	?	?	?						
Metric Development	X	X	?								
Metric Testing	X	X	X	?							
Multivariate Model Development		X	X	X	?	?					
Model Testing & Refinements		X	X	X	X	X	?	?	?		
<i>Littoral Index Develop. (macroinver., habitat, fish, plants)</i>											
Taxonomic Analyses (Macroinvertebrates, fish)	X	X	X	X	X	X	X	X	X	X	
Database Development	X	X	X								
Metric Development	X	X									
Metric Testing	X	X	X								
Model Development & Scorecard Development	X	X	X	X							
Model Testing		X	X	X	X	X					
<i>Merging of Pelagic and Littoral Model Results – BCG</i>						X	X	?	?	?	
Lake Internship Program											
Draft program model	X										
Contact Institutions of Higher Learning	X										
Pilot (1-2 individuals)	X										
Expansion		X									
Toxics Screening (PPCPs & PBTs in high risk lakes)	?	?	?	?	?						

Figure 10. Estuarine & Marine: Projected Program and Monitoring Elements.

Program / Project Element	YEAR										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Biocriteria Development											
Methods Testing	X	X	X	X							
Implementation Monitoring					X	X	X	X	X	X	
PPCP_s	X	X	X	X	X						
PBTs	X	X	X	X	X						
Invasive Organisms	X	X	X	X	X	X	X	X	X	X	
Green Algae/Nutrient Enrichment											
Methods Testing	X	X	X								
Implementation Monitoring				X	X	X	X	X	X	X	
Coastal Wetlands	X	X	X	X	X	*	*	*	*	*	

* Program may continue in future years

Figure 11. Other Division-wide Elements not Directly Supported.

Program / Project Element	YEAR										
	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	
Environmental Surface Water Ambient Database Development including data uploads to STORET	X	?	?	?	?	?					
Development of Landscape Level Disturbance Variables (GIS)	X	X									
Technical Support to Indian Nations, Conservation Entities, Volunteer Groups (ongoing need)	X	X	X	X	X	X	X	X	X	X	
Ecological Reserve Monit. (monitoring, taxonomy, data anal., reports);	X	X	X	X	X	X	X	X	X	X	
Watershed Level Integration of BCGs for all Surface Waters			?	?	X	X	X	X	X	X	

4. Indicators

A. Maine Water Quality Standards Program

The water quality of Maine is described in terms of physical, chemical and biological characteristics associated with the state's water classification program. As established in Maine statute (38 MRSA Sections 464-470), the classification program consists of designated uses (e.g. drinking water supply, recreation in and on the water, habitat for fish and other aquatic life), criteria (e.g. bacteria, dissolved oxygen and aquatic life), and characteristics (e.g. natural, free flowing) that specify levels of water quality necessary to maintain the designated uses. All State waters have a classification assignment (Lakes: GPA. Rivers and streams: AA, A, B, C. Marine and estuarine: SA, SB, SC).

In some cases, specific limitations are established on certain activities that can occur within a classification, such as types of discharges. Maine's classification system is goal based, that is, it may not necessarily reflect current water quality conditions but rather establishes the level of quality directed by the State to achieve. Maine's classification system should be characterized as more risk-based than quality-based. In a risk-based classification system the difference in water quality between the various classes is not large, however, different restrictions placed on activities associated with each class establishes varying levels of risk that water quality could be degraded and designated uses threatened by allowed activities.

In addition to the Maine water quality classification system, the requirements of the Federal Clean Water Act (CWA) establish national goals (designated uses) and interim goals of swimmable-fishable ("wherever attainable ... of ... the protection and propagation of fish, shellfish and wildlife ... [and] recreation in and on the water"). All waters that attain State standards also attain the interim goals of the Clean Water Act.

B. Assessment Indicators

The following tables (Figures 12 – 14) provide the designated use categories and the criteria (with references) used to assess a water's attainment of the use. A determination of non-attainment is only made when there is documented evidence (e.g. monitoring data) indicating that one or more criteria are not attained. Such data are also weighed against evidence that there are plausible human-caused factors that may contribute to the violation of criteria (38 MRSA Section 464.4.C).

Maine places its highest emphasis for monitoring on impact and fate types of measures. Impact measures are those that measure the outcome of conditions affecting a system. Biomonitoring provides such a measure of impact and is effective at identifying a wide array of stressors (chemical, physical and biological). Maine also invests a higher proportion of its monitoring resources in fate measurements (tissue contamination) which assesses biological uptake and transfer of contaminants.

Figure 12. Assessment Indicators for Rivers and Streams.

Designated Use	Criteria for Attainment	
Drinking water supply after disinfection / treatment	Ambient Water Quality Criteria (Maine DEP Chapter 530.5) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Aquatic life use support	Biomonitoring criteria (Maine DEP Chapter 579) Dissolved oxygen (38 MRSA Section 464.13, 465.1-4) Ambient Water Quality Criteria (Maine DEP Chapter 530.5) Support of indigenous species Wetted habitat (Maine DEP Chapter 581) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Fishing	Support of indigenous fish species No consumption advisory (established by Maine DHS) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Recreation in and on the water	E. coli bacteria (38 MRSA Section 465, geometric mean) Water color (38 MRSA Section 414-C) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Navigation, hydropower, agriculture / industrial supply	General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering

Figure 13. Assessment Indicators for Lakes and Ponds.

Designated Use	Criteria for Attainment	
Drinking water supply after disinfection / treatment	Ambient Water Quality Criteria (Maine DEP Chapter 530.5) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Aquatic life use support	Trophic state (38 MRSA Section 465-A, DEP Chapter 581) Ambient Water Quality Criteria (Maine DEP Chapter 530.5) Aquatic life (38 MRSA Section 465-A, 464.9) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Fishing	Support of indigenous fish species No consumption advisory (established by Maine DHS) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Recreation in and on the water	E. coli bacteria (38 MRSA Section 465-A, geometric mean) Trophic state (38 MRSA Section 465-A, DEP Chapter 581) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering
Navigation, hydropower, agriculture / industrial supply	General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)	Formatted: Bullets and Numbering

Figure 14. Assessment Indicators for Estuarine and Marine Waters.

Designated Use	Criteria for Attainment
Marine life use support	Ambient Water Quality Criteria (Maine DEP Chapter 530.5) Dissolved oxygen (38 MRSA Section 465-B) Narrative biological standards (38 MRSA Section 465-B) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)
Shellfish propagation and harvest	National Shellfish Sanitation Program (as assessed by DMR) No consumption advisory (Maine DHS) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)
Aquaculture	General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)
Fishing	Support of indigenous fish species No consumption advisory (Maine DHS) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)
Recreation in and on the water	<i>Enterococcus</i> bacteria (38 MRSA Section 465-B, geometric mean) General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)
Navigation, hydropower, industrial supply	General provisions: floating/settleable solids, pH, radioactive substances, (38 MRSA Section 464.4.A)

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C. Indicator Needs

The department recognizes the need to move toward the establishment of biological endpoints indicative of structure and function at the community level and position along the Biological Condition Gradient. The Biomonitoring Section has successfully completed this with the establishment of Biological Criteria using evaluation of macroinvertebrates in rivers and streams. Additional biological metrics are currently under development in all waters. The Biomonitoring Section is also developing periphyton-based criteria for Rivers and Streams. The Wetlands unit is also developing periphyton-based and macroinvertebrate –based criteria. The Lake Assessment Section is working on pelagic planktonic indicators (phytoplankton & zooplankton) and is beginning to explore the feasibility of incorporating littoral habitat and biota into their program. The Marine Program is developing an invertebrate-based indicator in conjunction with EPA and will be using chlorophyll as an indicator as they develop nutrient criteria.

5. Quality Assurance

A. Quality Management Plan

Maine DEP operates under a Quality Management Plan (QMP) that establishes the flow of information used in the environmental decision making process. The current plan, dated June 2003, is updated periodically as required under performance partnership agreements with EPA. The QMP is the foundation on which monitoring and assessment projects are implemented, each with their specific Quality Assurance Program or Project Plan which is reviewed annually, updated as needed and revised every five years. Standard Operating Procedures (SOPs), generally forming an appendix in each QAPP, provide documentation of methodology utilized by a program or within a project. Annual Sampling and Analysis Plans (SAPs) document specifics for monitoring done and can be thought of as the project level ‘metadata’. All current and ‘retired’ QMPs, QAPPs, SOPs, and SAPs are kept on file to enable verification of data quality at any time.

B. Quality Assurance Program/Project Plans (QAPPs), Sampling and Analysis Plans (SAPs) & Standard Operating Procedures (SOPS)

Quality Assurance Plans are developed at either the Program or Project level, depending on which avenue provides the best fit for the monitoring effort. Sampling and Analysis Plans are developed as needed to complement QAPPs when any of the elements planned for a specific project deviates from the contents of the QAPP. A SAP template is included in the Lake Assessment QAPP to assure that elements are addressed as completely as effectively as possible. Standard Operating Procedures for monitoring specific waters generally exist at the program level and often are included in the appendices of QAPPs. These documents may be found on the department's network in subdirectories under H:\L&W\Watershed\Monitoring & Assessment\QAPP SOPs, are distributed as necessary and are generally posted on the Department's website. Development of QAPPs and SOPs under the current departmental QMP is largely complete. Distribution of the Lake Assessment QAPP should occur in the near future. The list of references includes examples of both Program and Project QAPPs.

6. Data Management

A. Water Quality and Biological Data

Data collected in conjunction with Maine DEP monitoring programs and quality assured volunteer-based programs, are stored in a variety of electronic formats including Foxpro, Access, Excel, and Oracle. The department is in the process of developing an Environmental Surface Water Assessment Database (ESWAD) which will handle data storage, electronic laboratory result imports, Web-based data input, data analysis, STORET uploads, and will also interface with the state GIS system to facilitate spatial analysis. Much of the migration of data has been or will be a two step process. Older systems (Foxpro) have been or are being replaced with Oracle/Access systems. BIOME, the River/Stream/Wetland biomonitoring database was originally built in Foxpro and was migrated over the past 3-5 years into a modern, relational system. A similar system design is being tested for migration of lake data from another set of Foxpro based tables (36 megabytes of raw data); data normalization during the migration process will improve data integrity and associated queries and reports will be rebuilt in the new system.

Data storage and back-up routines are the responsibility of the Department's Computer Services Division, a group considered to be a state leader in the implementation and maintenance of the DEP's computer network. Maine DEP maintains a series of standard operating procedures for field collections made by all staff, cooperators and laboratories with which we contract. These are updated regularly and are linked to either program level QAPPs or Project QAPPs. Annual SAPs are required under our QMP and QAPPs. Individual SOPs are available on request. Data is evaluated according to data validation specifications included in these documents. Data that do not meet these specifications are either flagged or never entered in the systems.

The department is in the process of establishing standardized formats for electronic transfer of data results from laboratories to departmental data systems. These standards will eliminate data entry redundancies and one error vector. The standardized format will assure that all electronically acquired data are compatible with the data system. Verification/validation steps are included in uploading subroutines.

B. Geographic Information System

Maine Department of Environmental Protection is considered a GIS leader within state government. DEP embraced this technology nearly two decades ago and has made the development of spatial layers pertinent to environmental monitoring and protection a priority. The ESWAD database and the EPA's Assessment Database will be linked to the GIS system as they are developed. Some data is received in GIS coverage format, complete with metadata (e.g., shellfish closure data from the Department of Marine Resources),

allowing the department immediate spatial access to the information. Continued development of spatial data and applications that link water quality data and/or attainment status to spatial layers remains a priority.

C. Assessment Data

This is an area of Maine’s program that is in redevelopment at this time. Previously, assessment data has been cataloged in a variety of sites and controlled by a number of individuals. The Department is presently implementing use of EPA’s Assessment Database (ADB) to document and track assessment determinations. Metadata is requested for all data that will be used to make attainment determinations using the ADB. Attainment decisions are made using only data collected under an approved QAPP, SAP or equivalent.

7. Data Analysis

A complete and consistent water quality data set is uncommon; therefore, some interpretation of data is required in making a final assessment. Data from unique events such as a spill, an accident, a short-duration license exceedance, or a flood are not used in an assessment determination. The following general principles for each criteria type are used in making an assessment:

Biomonitoring Criteria: Assessment based on probability results of the biocriteria models, attainment >0.6. Professional judgment may be used in accordance with the procedures in Maine DEP Chapter 579.

Lake Trophic State: Assessment is based on measures of transparency, chlorophyll a, total phosphorus and color (see Figure 15). When lakes lack this information, a trophic determination made by the Department of Inland Fisheries & Wildlife (DIF&W) is used, if available. DIF&W determinations are more subjective and generally apply to the lake system as a whole including adjacent wetlands and fisheries productivity. Trophic determination is tracked by source (DEP or DIF&W) in the assessment database.

Figure 15. Numerical Guidelines for Evaluation of Trophic Status in Maine (note: dystrophy is rarely evaluated separately from the trophic categories below).

Parameter ¹	Trophic Status ³		
	Oligotrophic	Mesotrophic ²	Eutrophic
Secchi Disk Transparency ³	> 8 meters	4-8 meters	< 4 meters
Chlorophyll_a	< 1.5 ppb	1.5 – 7 ppb	> 7 ppb
Total Phosphorus ³	< 4.5 ppb	4.5 – 20 ppb	>20 ppb
Trophic State Index ^{3,4}	0-25	25-60	>60 and/or repeated algal blooms

¹ Secchi Disk Transparency, Chlorophyll_a, and Total Phosphorus based on long-term means.
² No repeated nuisance algal blooms.
³ When color is > 30 Standard Platinum Units (SPU) or is unknown, best professional judgment is used to assign trophic category in conjunction with chlorophyll_a concentration and dissolved oxygen data.
⁴ Trophic State Indices are calculated when adequate data exists and other criteria are met.

Support of Indigenous Species: Assessment based on the known absence of a species that previously was documented as indigenous to a waterbody (ME Department of Inland Fisheries and Wildlife records).

Dissolved Oxygen: Assessment is based on the results of repeated measurements. Single excursions below the criteria or excursions within the range of sampling or instrument error (as established in a Quality Assurance Project Plan) are generally disregarded. Assessment may also be based on the use of water quality models (e.g. QUAL2E) based on present or expected loadings. New legislation provides that dissolved oxygen in the thermocline and deeper waters of a riverine impoundment will not be used for measurement of water quality attainment.

Ambient Water Quality Criteria: Assessment is based on repeated measurements. Single excursions above the criteria or excursions within the range of sampling or instrument error (as established in a Quality Assurance

Project Plan) are generally disregarded. Assessment may also be based on the use of water quality models (e.g. dilution models) based on present or expected loadings.

Bacteria: Assessment is based on repeated measurements to establish an annual geometric mean. Instantaneous (single sample) criteria are not used for water quality assessment due to the high variability associated with a single measurement. There must be a plausible human source of the bacteria for an impairment determination to be made (38 M.R.S.A Section 465, 465-A, 465-B). The DEP has used various evidence to determine “human source” (e.g. presence of wastewater discharge, OBD, non-compliant septic systems). The prospect of bacteria ribo-typing may offer a new analytical capability that can more effectively determine the proportion of contamination due to human (potentially pathogenic) sources. This would also require enhanced laboratory capability to make these analyses. EPA is also pursuing research to identify a different set of indicator organisms.

Water Color: Assessment based on repeated measurements of discharge performance data (pulp and paper discharges only).

General Provisions: pH based on repeated measurement (between 6.0 and 8.5 for freshwaters; 7.0 and 8.5 for marine waters), however, certain naturally occurring waterbody types (e.g. bogs, aquifer lakes, high elevation lakes) or events may naturally have low pH and affect downstream waters. Use impairment from solids is subjectively determined. Radioactivity is not presently monitored.

Specific procedures used to analyze project data are beyond the scope of this strategy. Project-specific data analysis approaches are commonly spelled out in QAPPs, although data analysis is often an adaptive task, where results of one analysis lead to subsequent analyses. For the purposes of use support assessment or enforcement, however, the following considerations regarding data quality and statistical analyses are relevant.

When used for assessment or enforcement, data employed must be of known quality and should be representative of the water’s condition. All data generated in conjunction with any active and/or approved QAPP are considered readily available and reliable data, and are considered in determining use support. Data can be rejected from consideration in the event that it does not meet data quality objectives established by individual QAPPs. Guidance and assistance regarding quality assurance is also provided from the EPA Region 1 Laboratory.

For data provided by organizations other than Maine DEP, a QAPP is required or the DEP must approve methods prior to considering using data in the determination of use support. The DEP also provides training and data management in some cases. Data of unknown or unquantifiable quality are only used as general information until data of known quality can be obtained.

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

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

In general, DEP believes waters must be proven to be impaired, and thus statistical hypothesis tests, when necessary, are most often structured in that fashion. Nonetheless, in the interest of maintaining solidly defensible and repeatable use support decisions, where the cost of erroneous decisions is high, a decision call of impairment will be accorded to the null or alternate, depending on which test provides the greatest statistical power while maintaining the type-I error rate to a pre-established level (typically 5% to 10%).

8. Reporting

Monitoring data is used for many purposes including the preparation of numerous reports including those submitted to satisfy federal or state mandates covering all surface waters (i.e., Integrated Water Quality Assessment Report, Surface Water Ambient Toxics Report). Topic or program specific reports are also prepared as needed. Report drafts requiring public comment are posted on the departmental website; final reports are also available via the worldwide web. Maps that provide a visual display of attainment status and other pertinent information are included in such reports. Most of these reports are available on the department's web site. The References section provides a list of numerous examples of recent reports typical of Maine's program.

A. Integrated Assessment Reporting

i) Integrated Water Quality Assessment Report (CWA Section 305(b), 303(d) and 314)
Maine DEP prepares a biennial Integrated Water Quality Assessment Report in fulfillment of Sections 305(b), 303(d) and 314 of the Clean Water Act (CWA). Maine's draft reports are generally submitted to USEPA every April of even-numbered years. These reports also serve to fulfill the DEP's mandate to summarize water quality status for the State of Maine Legislature. Drafts are available on the DEP website for review by EPA and Maine citizens prior to being finalized and reposted on the website (<http://www.maine.gov/dep/blwq/docmonitoring/impairedwaters/index.htm>). Quality assured data used in preparation of these reports comes from state agencies, volunteer organizations and Tribal Nations. Waters assessed as 'Impaired' and requiring a TMDL under CWA Section 303(d) are included in these integrated reports .

B. TMDL Reports

Impaired waters listed under Section 303(d) of the Clean Water Act are required to have TMDL developed for them if the impairment is caused by a pollutant. Maine DEP provides a schedule for TMDL development that is accepted by USEPA Region I. Draft TMDLs are posted on the department website during the review period and when complete, final TMDL reports replace the drafts (<http://www.maine.gov/dep/blwq/docmonitoring/impairedwaters/index.htm>).

C. Surface Water Ambient Toxic (SWAT) and Dioxin Reports

The SWAT report is issued annually and includes a data report for all data gathered and analyzed by the SWAT program in the past year. The SWAT program includes biomonitoring, fish tissue, and tissue and sediments from estuarine and marine waters. The reports are available on the DEP website <http://www.maine.gov/dep/blwq/docmonitoring/swat/index.htm> .

The Dioxin Monitoring Program report (Including data on Dioxin-like PCBs collected under the Surface Water Ambient Toxics Monitoring Program for fish consumption advisories) is issued annually and is available on the DEP website <http://www.maine.gov/dep/blwq/docmonitoring/dioxin/index.htm> .

D. Other Reports

i) Rivers and Streams

Numerous non-TMDL river study reports have been prepared from data collected by the agency and cooperators. Refer to the list of References for specific recent reports.

ii) Biomonitoring & Wetlands

In addition to the numerous recent biomonitoring reports listed in the References section, the Biomonitoring unit is in the process of implementing GIS based search capability that will be accessible via the department's website. This site, the Biomonitoring Internet Mapping Project (BioIMP), provides the locations of biomonitoring sampling stations on a map. It allows the user to select locations from the map and displays monitoring results in a data table. It will help the public answer questions like "Wondering if the Biomonitoring unit has sampled a water body in your town?" and "Interested in finding out where samples were collected during a certain year?". The project is expected to be fully implemented within the year.

iii) Lakes

The Lake Assessment Section prepares an Annual Lake Water Quality Report (approximately 3000 pages) that provides data summaries for each monitoring station and when adequate data exists, a narrative interpretation of the data. The raw data and summary data included in these reports are posted on the worldwide web along with the narrative interpretations (<http://pearl.maine.edu/>). The Section also extracts many of the summary data elements that are included in the Maine Volunteer Lake Monitoring Program Annual Report; this report can be accessed on the worldwide web at (<http://mainevolunteerlakemonitors.org/index2.htm>). Reports are also prepared as needed to summarize results from specific studies, or to provide lake specific additional information for citizen training. Educational resources that utilize lake data are also developed.

iv) Estuarine and Marine

The NCA program produces periodic Coastal Condition reports that are available on EPA's website <http://www.epa.gov/emap/nca/>. Raw data that have been QA'd are also available on this website. The Casco Bay Estuary Partnership issues periodic reports that are available on the CBEP website <http://www.cascobay.usm.maine.edu/>.

9. Program Evaluation

A. Annual Review

Initially, the Maine DEP will annually review progress in monitoring waters in light of the recommendations contained in the present strategy. At that time, priorities for the coming year may be readjusted based on availability of resources and/or competing needs for monitoring information. The changes will be incorporated into the annual workplans, and the Performance Partnership agreements. As part of ongoing Quality Management Planning, the quality assurance project plan archive is updated annually, and individual QAPPs are scheduled for revision at that time. Individual SOP's for monitoring are updated annually as needed.

B. Biennial Review

In the process of writing the Integrated Water Quality Monitoring and Assessment Report, data gaps and monitoring needs become apparent. After the report draft has been submitted to EPA, the DEP will review the monitoring strategy and reassess the effectiveness of the monitoring strategy in assessing the condition of all waters. At that time the monitoring strategy may be readjusted if resources are available.

C. Annual Workplans

The monitoring strategy is revisited annually as part of the development of annual workplans for each of the units (e.g. lakes, marine, rivers and streams, etc.). Progress in meeting the milestones will be determined by resources and/or competing needs.

10. General Support and Infrastructure Planning

A. Current Program Support

This report provides support information based on present (FY05) DEP staff and funding resources. Since Maine is a small state with limited staff resources, many staff fulfill multiple functions such as field monitoring, assessment, reporting, and information management. Presently, monitoring is supported by the State General Fund (10.5 FTE), State Surface Water Fund (1 FTE), State dedicated revenue funds (3.5), Federal Section 106 (7.5 FTE), Section 104(b)(3) (1 FTE), Section 319 (1 FTE), and Section 604(b) (0.5 FTE).

The following description addresses only the DEP FTEs supporting ambient monitoring. The FTEs cited are approximations.

i) Field Monitoring

The current field monitoring program requires approximately 12 full time equivalents (FTE) of staff time. At this level of support, the monitoring program is functional, but limited. Unanticipated high-priority monitoring needs and/or underfunded participation in larger-scale monitoring projects (e.g. USEPA sponsored regional studies) can result in loss of core program functionality at this staffing level. Complete implementation of an array of monitoring designs, such as probabilistic studies, long term monitoring projects, waterbody and watershed scale studies along with high-profile event-based monitoring is beyond the scope of monitoring staff resources.

ii) Laboratory Services

Laboratory services are provided on a fee-for-test basis mostly from two facilities, the Department of Human and Health Services, Health and Environmental Testing Lab and the University of Maine's Sawyer Environmental Lab. The Department does maintain some basic lab facilities in Augusta in the Division of Environmental Assessment and at the three regional offices. Additionally, the Department contracts with an outside private laboratory for specialized analysis (e.g. dioxin, PCBs in fish tissue) associated with the Dioxin Monitoring Program and the Surface Water Ambient Toxics Program.

iii) Assessment, Listing, and Reporting

The current assessment, listing and reporting functions are supported provided by the Division of Environmental Assessment. These functions are supported at approximately 8 FTE. These levels are sufficient to support the basic assessment and reporting requirements required for such reports and lists as the 305(b), 303(d), TMDLs, river modeling, annual lake and biomonitoring assessments. However analysis is not always as extensive as the data might allow. The shortfall in assessment resources is partly attributable to increasing requirements within continually-updating federal guidance on minimally acceptable assessment practices, listing and reporting requirements. Fulfillment of all guidance elements regarding the Integrated Reporting method and monitoring program strategy development have imposed numerous unanticipated tasks. Development of new and expanded reporting skills such as the use of GIS will only continue to increase need.

iv) Information Management

Information management of ambient surface water data is presently inconsistent, lacking in standardization, central access and consistent support. There is currently approximately 3 FTE allocated to information

technology and database maintenance for needs associated with monitoring activities defined in this strategy; a level which is likely to decrease significantly in response to changes in information technology management changes within the Department. This will result in database maintenance and design activities being pushed down to the project-level and controlled in a separate bureau. In terms of proper data management and metadata qualification there will be increased uncertainty, as database skills vary very widely among individuals at the project management level. Maine is pursuing the development of a completely new comprehensive surface water data system (ESWAD) which should begin functioning in 2006. The need for rigorous data management approaches and tools will only increase as the level of scrutiny over data used to make environmental management decisions increases.

v) Monitoring and Assessment Program Planning and Other Functions

Planning for future years monitoring and assessment priorities and program development is supported by 2 FTE, including in-house staffing for TMDL pollution planning. Quality assurance and water quality standards planning also requires significant staff-time.

B. Projected Needs

i) Staffing

In order to continue the core monitoring program, stable support is necessary. A particular need exists for temporary technical staff to fulfill field-season monitoring activities, and funding for short-term field staff has been unpredictable and limited in recent years. Often times when funding is available restrictions on hiring prevent the acquisition of staff to work on a project and new projects and funding have been routinely turned down for that reason. Maine has also had to refuse or severely restrict participation in USEPA-sponsored regional studies when such participation would disrupt core monitoring program needs. In the near term, additional support of 5 FTEs is recommended. (High priority)

The DEP needs to modernize its data management capacity (see information resources below). Additional staff need to be dedicated to this function (2 FTEs). (High priority)

If assessment and reporting functions are to proceed at the pace envisioned by this strategy and grow over the long-term. One additional FTE will be required in the near -term. (Medium priority)

ii) Equipment

The DEP is modestly equipped to complete its present monitoring projects. Much of the field equipment is older and while still functional, requires additional maintenance and is prone to more frequent breakdowns. Since back-up equipment is often limited this can lead to program delays. The DEP needs to replace existing equipment over the next few years. These include various field meters, sondes, sampling devices, integrative samplers, snowmobile, boats, motors and trailers. In addition to updating equipment, the DEP needs additional units of this same equipment that it can use as equipment backup and also as "loaners" for volunteer groups to use. Lack of additional equipment is a limiting factor for using additional volunteer support. (High priority)

The DEP would like to build capacity for long-term deployment of sampling devices, sondes or fixed station monitors. This could be accomplished in cooperation with the USGS. (Medium priority)

iii) Laboratory Resources

Laboratory services currently support the needs of the present monitoring program strategy well. A long-term commitment to implementation of this strategy will necessitate increased funding to support rising costs of analysis associated with advances in laboratory technology.

With the loss of the organic analysis section at the University of Maine's Environmental Chemistry Laboratory, there is no in-state capability to do high resolution organic analysis. As emphasis on PBT chemicals, polar organics (e.g. pharmaceuticals), and other emerging contaminants increases, the state needs to establish capacity for this kind of analysis. (High priority)

The DEP identifies a pending lack of taxonomic services in the future as other states build biomonitoring capacity. Presently, the DEP relies on two contractors for macroinvertebrates and one contractor for algae who have gone through extensive quality assurance checks and cross-checks to assure taxonomic standardization. Other available taxonomic services appear limited if one or more of these contractors became unavailable. As EPA promotes biomonitoring approaches, there needs to be coinciding support to develop taxonomic expertise either within agencies or by outside contract. (High priority)

iv) Information Technology Resources

Information technology resources are presently insufficient to meet the needs of this strategy. Investment in new software development for a comprehensive surface water database (ESWAD database) is ongoing. The DEP has only one dedicated position to this project during the development phase with most of the work being accomplished by a contractor. Funding has been pulled together from a variety of sources but is uncertain for the fulfillment of this project. Additional funds of \$100,000-200,000 will probably be required. This database will be designed to merge with STORET (transfer data) and with the DEP's EGAD database for groundwater. Additional staff resources (see above) also need to be dedicated to this project especially when it gets to the final data population phase. Advanced skill training for all staff will also be required to allow staff full use of the system. (High priority)

Site licenses for functional GIS software should be available to each staff member working on assessment of water quality data. (High priority)

Over the years, the USGS has reduced the number of flow gauge sites in the state. There is an increasing demand for flow information for TMDLs, wastewater licensing, water withdrawal, and habitat assessments related to biomonitoring. Support for USGS to provide this data should be increased either through cooperative agreements or fund transfer. Data on small unregulated streams is particularly needed as well as water level measurements on lakes. (High priority)

The DEP would like to build a system of in-place monitors with real-time data feed capability particularly for high profile water quality situations. The recent TMDL for the Androscoggin River points to a need to be able to intensively monitor certain waterbodies to display data that provides feedback to the regulated community so they can more finely tune their treatment and the supplemental oxygen system, provide assurance that water quality standards are being attained, and provide the interested public with a demonstration. Such systems might also be deployed where intensive or complex management is required. (Medium priority)

Toward the future, the DEP would also like to develop new monitoring strategies that could include remote sensing (aerial photography) or satellite imagery. The DEP has made modest use of these types of resources in the past but have never been incorporated beyond specific project needs. Strategies such as this would probably necessitate implementation at least at a regional scale with EPA and neighboring states to build technical capacity and expertise, and gain economies of scale. These strategies may be attractive for monitoring large water resources over large geographic areas (e.g. marine, lakes). (Medium priority requiring cooperative partners)

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