STATE OF MAINE

1994 WATER QUALITY ASSESSMENT

A Report to Congress
Prepared Pursuant to Section 305(b) of the
Federal Water Pollution Control Act, as Amended

Prepared by the
Maine Department of Environmental Protection
Bureau of Land and Water Quality

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* - The Appendices are in a separate volume

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COMMONLY-USED MEASUREMENT UNITS:

ppb	= parts per billion
ppm	= parts per million
g/L	= grams per liter
mg/L	= milligrams per liter (1000 mg/L = 1 g/L)
ug/L	= micrograms per liter (1000 ug/L = 1 mg/L)
M	= meter
cm	= centimeter
mm	= millimeter
um	= micrometer (1000 um = 1 mm)
pH	= a measure of the acid/base status of waters

COMMONLY-USED ACRONYMS:

BHMSWC	= Bureau of Hazardous Material and Solid Waste Control
BLWQ	= Bureau of Land and Water Quality (the bureau of Maine DEP responsible for water quality assessment and protection)
BMP	= Best Management Practice
BOD	= Biochemical Oxygen Demand
CFR	= Code of Federal Regulations
CSO	= Combined Sewer Overflow
CWA	= Clean Water Act or the Federal Water Pollution Control Act
DAFFR	= the Maine Department of Agriculture, Food and Rural Resources
DEP	= the Maine Department of Environmental Protection
DHS	= the Maine Department of Human Services
DIFW	= the Maine Department of Inland Fisheries and Wildlife
DMR	= the Maine Department of Marine Resources
D.O.	= Dissolved Oxygen
EPA	= Environmental Protection Agency, also USEPA
GIS	= Geographic Information System
HUD	= the federal Housing and Urban Development agency
MDOT	= the Maine Department of Transportation
MGS	= the Maine Geological Survey
NPS	= Nonpoint Source, as opposed to point source pollution
PAH	= polycyclic aromatic hydrocarbon
PCB	= polychlorinated biphenyl
SCS	= Soil Conservation Service, a part of the USDA
SWCD	= Soil & Water Conservation District
USDA	= United States Department of Agriculture
USEPA	= United States Environmental Protection Agency
USF&WS	= United States Fish & Wildlife Service
USGS	= United States Geological Survey

PART I: EXECUTIVE SUMMARY

The best way to assess the condition of Maine's rivers, lakes and coastal waters is from a small boat or canoe. Paddling a rushing brook or a major river gets you personally familiar with water quality.

For people like me who have enjoyed our rivers and lakes for over twenty years, the improvements have been quite remarkable. It is also clear that our efforts are not yet complete, and more needs to be done.

Dean C. Marriott
former Commissioner,
Department of Environmental Protection

The State of Maine is known for the beauty and abundance of its natural environment, especially its waters. The first settlers and their descendants relied on Maine waters for food, transportation, and power. Fishermen made their living from Maine waters. Rivers were used to transport logs to lumber and paper mills. Industries flourished where hydropower was available. Cities developed on the coast and along the shores of major rivers. With development and industrial growth, however, the quality of Maine waters suffered.

When the people of Maine recognized pollution as a threat to their future, they took actions to improve the environment. These actions began in the late 1960's and placed Maine at the forefront of the national effort to protect the environment. The Federal Water Pollution Control Act of 1972 provided the framework for significant improvements in the quality of Maine waters that have been achieved in the past 20 years. Federal, State and local funds were spent to construct municipal wastewater treatment facilities. Many Maine industries also constructed facilities to treat their process wastewater. Maine people became more aware of issues affecting water quality and changed their actions appropriately.

The results are dramatic. Atlantic salmon and other fish now return to Maine rivers, waters that were once open sewers are now clean enough to swim in, and the water quality decline in many Maine lakes has been halted or reversed.

Unfortunately, Maine people are still not able to use all their waters. Toxic chemicals in fish tissues limit the use of some Maine waters. Several wastewater treatment plants remain to be built, many existing facilities need to be upgraded to meet tighter standards, the ground water, wetlands and lakes of Maine must be better protected, contaminated ground water supplies must be identified and cleansed, and pollution sources causing closures of many shellfish areas must be abated. We must also continue to invest in our existing infrastructure to maintain its environmental protection value.

The most important water quality initiatives for the future are to move aggressively into pollution prevention, nonpoint source management, watershed-based assessment and planning, coordinated land-use management and water quality monitoring. As we approach the 21st century, the cumulative environmental effects of human activity are increasingly evident. It is also evident that point source control and end-of-pipe treatment will not suffice to achieve the next increment of water quality improvement. We must work with industries, municipalities and individuals to change the activities that cause the pollution.

The Quality of Maine Waters

The designated uses under Maine State law and Federal regulations are: fish consumption, aquatic life support, swimming, secondary contact, drinking water supply, and agriculture. Maine State law also sets forth additional designated uses: industrial process and cooling water, hydroelectric power generation, navigation, and, only for lakes and ponds, trophic stability.

- **Rivers and streams**. The total length of rivers, streams and brooks in the State of Maine is estimated as 31,672 miles. Designated uses are fully supported in 98.7% of the total length of Maine streams, partially supported in 0.1% and not supported in 1.2%. The old "fishable" and "swimmable" goals of the Clean Water Act are fully supported in 98.8% and 99.1%, respectively, of the length of Maine rivers and streams. The uses not fully supported are: Fish consumption - 0.7%, Aquatic Life Support - 0.5%, Swimming and Secondary Contact - 0.3%.

- **Lakes and Ponds**: The total area of "significant" Maine Lakes and Ponds is estimated as 958,886 acres. Of this area, 70.3% of Maine lakes fully support designated uses, 5.3% fully support those uses but are threatened, and 24.4% partially support the uses. There are no Maine lakes assessed as not supporting designated uses. GPA classification requirements established by State law are met in 75.6% of the total acreage of Maine lakes. The uses not fully supported are: Aquatic Life Support - 18.6%, Swimming - 5.4%, and Trophic Stability - 0.9%.

- **Estuarine and Marine Waters**: The total area of marine and estuarine waters in Maine is estimated as 1,633 square miles. Of this total area, 90.2% fully support designated uses, 2.2% partially support those uses and, 7.6% do not support the designated uses. 65.5% of the Maine coast with shellfish harvesting potential is open to harvesting.

- **Ground Water**: No estimate exists for the percentage of ground water not attaining its designated uses. Costs, technical requirements, and Maine's complex hydrogeologic setting make statewide assessments difficult to obtain.

Causes and Sources Affecting Use Support

- In Maine, dioxin contamination in fish tissue is the most significant cause of non-attainment of uses in major rivers.

- The most significant causes of non-attainment of uses in other riverine waters are dissolved oxygen deficit (organic enrichment) and bacteria (pathogenic indicators).

- The source of organic enrichment in riverine waters is predominantly nonpoint source pollution, while the sources of pathogenic indicators are usually municipal point sources (including combined sewer overflows), inadequate on-site wastewater treatment systems or untreated discharges.

- The most significant cause of non-attainment of uses for Maine lakes is organic enrichment from nonpoint sources of pollution such as urban runoff, agriculture and silviculture.

- The most significant cause for non-attainment of uses for marine and estuarine waters is pathogenic indicators, mostly from municipal and small discharge point sources.

- The most significant causes for non-attainment of ground water classification are: petroleum compounds from leaking underground and above ground storage tanks, other organic

chemicals from leaking storage tanks or disposal practices, and bacteria from subsurface disposal systems or other sources.

Trends in Water Quality

- Fish consumption advisories have been issued for three Maine rivers and for lobsters, due to elevated levels of dioxin discovered in fish tissue and lobster tomalley. Maine has been working with the Kraft pulp and paper mills to reduce the levels of dioxin in their discharges. As a result, Maine has abated dioxin contamination in 20 river miles which were previously impaired, thereby restoring them to "fully supporting" the designated uses of the Clean Water Act. Recent data has shown a downward trend in contamination for some rivers.

- There has been a small overall decline in the number of river and stream miles in non-attainment. All of these improvements can be attributed to construction of small waste treatment systems which have eliminated some bacteria and dissolved oxygen problems from point source discharges. Some new river and stream segments have been added to the list of non-attainment waters, most of these are waters affected by nonpoint source pollution. The trend is for continued progress toward cleanup of point sources tempered by the discovery of new nonpoint source problems.

- The water quality of the majority of Maine lakes has remained stable, thereby providing consistently clean water for all to appreciate. However, threats to lake water quality increase with development pressures, making lake protection the preferred approach to lake water quality management than restoration. Analyses of Maine lakes, however, demonstrate that the decline in quality of some lakes has been reduced and that preventative measures are working in other watersheds.

- Trends in lake water quality are difficult to assess due to the time lag between cause and observed effect. Maine is in the process of evaluating lake water quality trends. Data for 671 lakes (29.0% of "significant" Maine lakes) have been evaluated the Department of Environmental Protection (DEP). Of the 671 lakes, 382 (57%) had inadequate data to determine trends, 24 (4%) have a possible decline in water quality, 241 (36%) appear to have stable water quality, and 24 (4%) show a possible improvement in water quality.

- Marine and estuarine waters have not been comprehensively assessed. Shellfish growing and harvesting areas have been the focus of pathogen indicator sampling, and the status of these areas has remained essentially unchanged within the last two years. Casco Bay has been sampled for toxic organics, heavy metals and pesticides. Analyses of these samples show that, while pollutants are detectable throughout Casco Bay, only the Inner Bay adjacent to the greater Portland metropolitan area is seriously affected by toxic pollution.

- Regulations regarding underground storage tank installation have begun to show progress in ground water protection by decreasing the likelihood of new leaks. Closure of landfills and installation of covers over sand/salt piles will also protect the quality of ground water in the future. An recently initiated effort to prioritize ground water will provide a means to rank the relative vulnerability of ground water and thereby direct protection efforts.

Specifics

- The control of nonpoint source pollution is crucial to protecting Maine lakes, ground water, wetlands, coastal bays and restricted estuaries, smaller riverine waterbodies and selected larger rivers. Lake restoration efforts are addressing the results of nonpoint source pollution, while educational efforts are addressing the causes. Numerous best management practices have been or are being developed to control nonpoint source pollution throughout Maine.

- According to the US Fish & Wildlife Service, Maine is estimated to have lost about 20% of its wetlands since colonial times. New regulations have been adopted to better protect wetlands. A system to track wetlands losses has been developed and is in the beginning stages of implementation. A recent grant proposal, if funded, would allow the data to be incorporated into Maine's Geographic Information System.

- The greatest threat to Maine ground water is leaking underground storage tanks. Maine requires that all underground tanks be registered, and those tanks not sufficiently protective be removed according to a set schedule. Under this program, 38,600 tanks have been registered, and 1,500 to 2,500 tanks have not yet been registered. About 23,000 tanks in Maine have been removed since 1986.

- All Maine people must take an active role in protecting their water resources. State, federal and regional agencies must continue to 1) do more to inform the public about environmental issues, 2) provide more and better technical assistance to municipalities, and 3) take an active role in introducing environmental issues to school curricula.

- The DEP has begun a pilot pollution prevention program within the Androscoggin River basin, linking pollution prevention with the watershed approach to water quality management. The goal is to involve local officials and citizen groups within the watershed in establishing programs which will reduce pollutant generation and thereby improve the quality of waters within the entire watershed. DEP staff are working with the towns to establish local teams and to provide them with the knowledge and focus to identify problem areas and develop solutions.

- A recent change that will improve the State's efforts to restore and protect its waters is the merger of two bureaus within the Department of Environmental Protection. The Bureau of Water Quality Control was merged with the Bureau of Land Quality Control to form the Bureau of Land & Water Quality (BLWQ). The creation of a Watershed Management Division will engender a more holistic approach to water quality assessment, pollution prevention and abatement, and restoration. The creation of a data management unit will increase the efficiency, productivity and depth of analyses conducted by the staff, as well as facilitate a more pro-active and systematic strategy for water quality improvement and preservation.

PART II: BACKGROUND

Summary Statistics

Maine is the largest and least densely populated state in New England. Most of the population is concentrated in the southern and coastal portions of the State and in a broad band on either side of Interstate 95. Maine's 5,785 lakes and ponds cover an area somewhat larger than the State of Rhode Island. There are over 7,000 brooks, streams and rivers in Maine, ranging in length from less than two miles to nearly 200 miles with an estimated total length of 31,672 miles. The St. Croix, St. John, St. Francis and Southwest Branch of the St. John make up part of the U.S./Canada boundary while the Salmon Falls River lies on the Maine/New Hampshire boundary. Numerous lakes lie on the New Hampshire and Canadian boundaries. Inland and coastal wetlands and marshes in Maine are estimated to exceed 5,000,000 acres in area. At least 1,315 square miles are underlain by significant sand and gravel aquifers.

Over 400 river and stream systems, ranging in size from a few hundred acres to over 1,850 square miles, empty into Maine's estuarine and near shore waters. For most reporting purposes, Maine is divided by the U.S. Geological Survey into 6 major drainage basins. Two of these (the Western Coastal Basin and Eastern Coastal Basin) are, in fact, made up of dozens of smaller basins that empty into the Atlantic Ocean. Large portions of 4 river basins are located in New Hampshire, Quebec and New Brunswick. Table 2-1 presents this information in summary form. Figure 1 shows the location and extent of Maine's major river basins.

The number of lakes, reservoirs and ponds, and the acres of lakes, reservoirs and ponds used in this report are taken from the Maine Department of Inland Fisheries and Wildlife (DIFW) Lake Index file rather than from USEPA RF3/DLG estimates. The Maine DEP believes that the DIFW Lake Index file (determined from 15' USGS topographic maps; 1:62,500 scale) provides a more accurate estimate of lake numbers and acres than the USEPA RF3/DLG estimates (based on maps having 1:100,000 scale).

In addition, all of our lake data is referenced by a lake identification number, as is the DIFW database containing lake acreage. It would be a monumental task to link the USEPA RF3/DLG acreage estimates to our database, and this could potentially introduce error due to map scale differences.

Under the auspices of the Casco Bay National Estuary Project, the entire coastline of the State of Maine has been digitized as a data layer on the State's Geographic Information System. The information was taken from USGS maps at a resolution of 1:24,000, which provides a much higher level of detail than the DLG estimates. With this higher level of detail and the inclusion of Maine island shoreline miles, this report now estimates that there are 5,249 coastal miles of shoreline.

Classified Uses

The water quality of Maine can be described in terms of physical, chemical and biological characteristics. Public interest in water quality is centered on the uses which can be made of water. Questions such as, "Is that water safe for swimming?", "Are fish caught there safe to eat?" and "Does the water in that lake turn green in the summer?" make up a large portion of the inquiries from the public received by the Department of Environmental Protection (DEP) Bureau of Land and Water Quality. To answer such questions, Maine waters are managed under a use-based classification system.

Table 2-1. State of Maine: Population and Natural Resource Statistics.

Population (Mid-1990 estimate)	1,227,928	
State Surface Area	33,265	mi^2(100.0%)
Forested Upland	21,262	mi^2 (63.9%)
Forested Wetland	4,688	mi^2 (14.1%)
Other Fresh Wetland	3,190	mi^2 (9.6%)
Brackish/Saline Wetland	246	mi^2 (0.7%)
Cropland	924	mi^2 (2.8%)
Pasture	216	mi^2 (0.6%)
All Lakes and Ponds(5,785/986,776 acres)	1,542	mi^2 (4.6%)
Significant Lakes and Ponds(2,314/958,886 acres)		
Other land	1197	mi^2 (3.6%)
Area Underlain by Significant Sand/Gravel Aquifers	1,315	mi^2
Total Area of Estuarine/Marine Waters	1,633	mi^2
Linear miles of Ocean Coast	5,249	miles
Number of Major Drainage Basins	6	
Total lengths of rivers, streams, etc.	31,672	miles
Total length of rivers	3,704	miles
Total length of streams	3,909	miles
Total length of brooks	22,829	miles
Total length of creeks, etc.	1,230	miles
Names and mileages of inland border waters (total miles = 272)		
Monument Brook (U.S. - Canada)	11	miles
Saint Croix R. (U.S. - Canada)	52	miles
Saint Francis R. (U.S. - Canada)	27	miles
Saint John R. (U.S. - Canada)	45	miles
SW. Branch of the St. John R. (U.S. - Canada)	50	miles
Salmon Falls R. (ME - NH)	30	miles
North Lake, Grand Lake, Mud Lake, Spruce Mountain Lake, Spednik Lake, Grand Falls Flowage and Woodland Lake (U.S. - Canada)	42	miles
Umbagog Lake, Lower Kimball Pond, Province Lake, Stump Pond, Balch Pond, Great East Lake, Horn Pond, Northeast Pond, Milton Pond and Spaulding Pond (ME - NH)	15	miles

Table 2-2. Summary of Surface Waters in Maine Classified for Designated Uses

Type of Water	Total Waters	Waters Classified Fishable[1]	Waters Classified Swimmable[2]	Waters Unclassified
Rivers (miles)	31,672	31,672	31,672	0
Lakes (acres)[3]	986,776	986,776	986,776	0
Estuaries[4] (square miles)	1,633	1,633	1,633	0

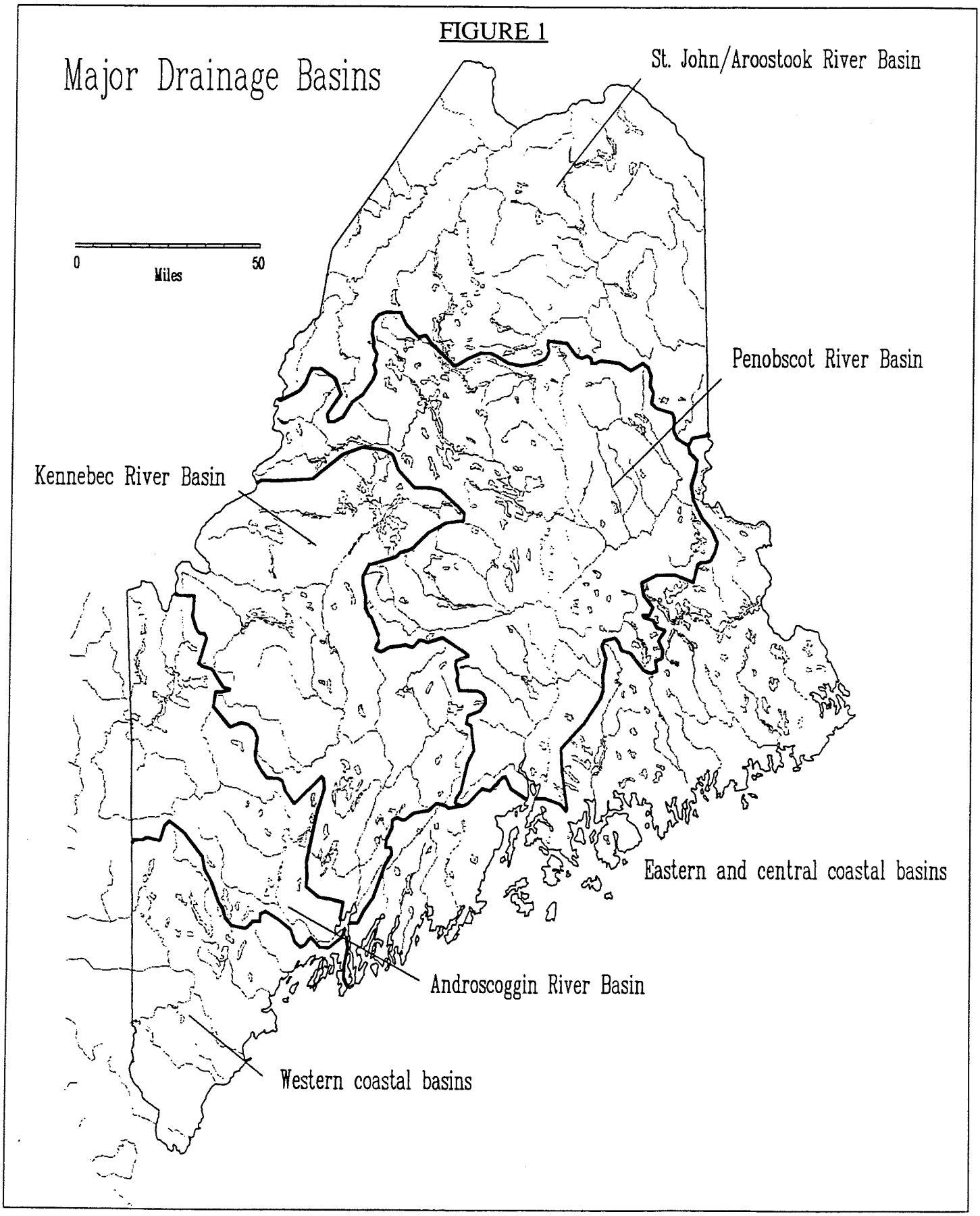
[1] The fishable CWA goal is defined as protection and propagation of fish, shellfish, and wildlife.
[2] The swimmable CWA goal is defined as providing for recreation in and on the water.
[3] Total lake acres is based on State of Maine Department of Inland Fisheries Lake Index file and determined from 15' USGS topographic maps (scale 1:62,500).
[4] Includes all marine waters within Maine's three mile territorial limit.

As established in Maine statute, a classification consists of designated uses (such as swimming or aquatic life habitat), criteria (such as bacteria or dissolved oxygen levels) which specify levels of water quality necessary to maintain the designated uses, and in some cases, specific limitations on certain uses such as types of discharges. Thus, to answer a question about swimming, one might reply, "Yes, that river is classified as suitable for water contact recreation and the data collected show that bacteria criteria are being met." If a water body is meeting all its classification standards, it can be described as "attaining its classification." If a water body is not attaining its classification, Maine statutes direct the DEP to take actions to improve water quality.

In addition to the Maine water quality classification system are the requirements of the Federal Clean Water Act (CWA) which establish the national interim goals (designated uses) "wherever attainable ... of ... the protection and propagation of fish, shellfish and wildlife ... [and] recreation in and on the water." As presented in Table 2-2, Maine's water classification system contains no classifications with designated uses lower than the nation's interim goals.

Guidance from EPA on 305(b) reports requires that ambient water quality be described in two ways: 1) in terms of attaining the designated uses assigned under State law and, 2) in terms of attaining the interim goals of the CWA. **All waters which meet State standards also meet the interim goals of the Clean Water Act.**

FIGURE 1


Major Drainage Basins
St. John/Aroostook River Basin
0
50
Miles
Penobscot River Basin
Kennebec River Basin
Eastern and central coastal basins
Androscoggin River Basin
Western coastal basins

PART III: SURFACE WATER ASSESSMENT

Chapter 1 - Surface Water Monitoring Program

Background

The water sampling programs of the DEP Bureau of Land & Water Quality are conducted to administer two portions of environmental law: the Water Classification Program (38 MRSA, Article 4-A); and Protection and Improvement of Waters (38 MRSA, Chapter 3). Although the Bureau of Land & Water Quality works under the authority of numerous other statutes and regulations, for the water resources and water quality programs, they can be considered as secondary and supportive of the Water Classification Program and Protection and Improvement of Waters statutes.

The following description of the entire water sampling program of the Bureau of Land & Water Quality illustrates activities included under ambient water quality monitoring. Due to budgetary constraints, however, some of these activities are much more limited in scope than is desirable for accurately characterizing water quality conditions in Maine.

I. **Ambient Water Quality Monitoring**

A. **Attainment of Classification.** Assess attainment of present and proposed standards for the classification of surface waters.

1. Bacteria
2. Dissolved oxygen
3. Aquatic/marine life (ambient biomonitoring)
4. Trophic state (for lakes)
5. Other parameters (e.g. priority pollutants at selected sites)

B. **Assimilative Capacity and Wasteload Allocation Studies.** Assess whether present and proposed discharges and/or impoundments would violate the classification standards for dissolved oxygen, temperature, toxics, etc. during 7Q10 (the minimum seven day low flow which occurs once in ten years).

1. Ambient monitoring
   a. Flow monitoring
   b. Time-of-travel studies
   c. Intensive sampling of discharges and ambient waters during preselected flow regimes
2. Modeling to predict assimilative capacity of waterbodies at 7Q10.

C. **Diagnostic Studies.** Assess lake problems through analysis of in-lake and lake watershed parameters.

D. **Tissue Monitoring.** Assessment of contamination levels of metals and organics in fish and shellfish tissues.

E. **Sediment Monitoring.** Assessment of contamination levels in sediments for metals and organics.

F. **Special Studies.** Sampling programs supportive of scientific research necessary for the resolution of difficult, hypothetical and/or unusual water quality problems.

II. **Treatment Plant Compliance Monitoring**

A. **Compliance Sampling.** Assess compliance with wastewater discharge licenses by sampling effluents.

B. **Bioassay Monitoring.** Assess toxic effects of whole or mixed effluents.

C. **Diagnostic Evaluations.** Aid municipal treatment plant compliance through intensive diagnostic evaluations.

III. **Investigations**

A. **Complaint Investigations.** Respond to allegations of unlicensed discharges by sampling suspected discharges and ambient water quality above and below suspected discharges.

B. **Sanitary Surveys.**

Although the above descriptions define the sampling programs fairly well, there is some overlap between ambient water quality monitoring and compliance monitoring. An example of this overlap is how ambient water quality monitoring serves as a double-check on the license compliance of major discharges, especially with reference to cumulative impact. The ambient water quality monitoring program results in the following products:

1. a biennial report - 305(b) - to Congress and the Maine Legislature which describes the attainment status of all State waters sampled;

2. recommendations on license conditions for wastewater discharges;

3. special reports evaluating the attainment impacts that would result from proposed changes in classification standards and/or assignments of classification; and,

4. reports, articles and news releases for local officials and the general public describing the suitability of various State waters for swimming and fishing.

Selection of Waterbodies To Be Sampled

The steps necessary for generation of the products described above include: selection of waterbodies to be sampled, selection of appropriate sampling locations on those water bodies, setting up sampling stations, scheduling of sampling at these stations, sampling by well-trained, qualified personnel and, last, data entry, processing and analysis.

Water quality is the cumulative result of multiple factors. The Maine ambient water quality monitoring program is biased toward waters in the more populated areas of the State and specifically toward those waters impacted by people.

Table 3-1 serves as a general guide for selection of waters to be sampled (high priority). This guide is not restrictive and much is left to professional judgment.

Table 3-1. Priorities for Water Quality Sampling.

HIGH PRIORITY

Fresh	Marine
1. Lakes with extremely vulnerable or highly vulnerable characteristics.	1. Commercially harvested shellfish areas.
2. River mainstems which receive multiple major discharges.	2. Swimming areas.
3. Streams and brooks which drain population centers.	3. Harbors and other confined waters adjacent to population centers.
4. Swimming areas.	4. Select pristine waters which are considered to be representative of similarly situated waters.
5. Select pristine waters representative of similarly situated waters.	

MEDIUM PRIORITY

Fresh	Marine
1. Waters (other than lakes) impacted by nonpoint source pollution.	1. Shellfish areas which are occasionally harvested.
2. Waters with threatened quality due to proposed discharges and/or activities.	2. Waters with threatened quality due to proposed discharges and/or activities
3. Lakes with moderately vulnerable characteristics.	

LOW PRIORITY

Fresh	Marine
1. Most pristine/unthreatened waters.	1. Most pristine/unthreatened waters.

A specific sampling schedule is dependent on the type of information required and the statistical, scientific and environmental considerations necessary to ensure the validity of information generated. For the parameters of bacteria, dissolved oxygen (D.O.) concentration and temperature, DEP uses the following types of sampling programs for rivers, streams and brooks:

I. **Preliminary Water Quality Assessment.** This program provides a low-intensity approach which results in a limited evaluation of water quality. This program identifies pristine waters which may not require additional sampling as well as culturally impacted waters which may require a more intensive sampling program. To complete this assessment for a station, a minimum of five sample sets are collected between May 15 and September 30 with one of the sample sets being collected during runoff conditions. Data collected are D.O., temperature, bacteria and river stage.

A. **Assessment of Attainment for Bacterial Water Quality Standards.** To produce a valid assessment of attainment for human contact water quality criteria, a minimum of 12 samples must be collected between May 15 and September 30 at regular intervals (usually weekly). The samples are then analyzed for the most probable number of *Escherichia coli* bacteria. Sampling for fecal coliform bacteria in non-tidal Maine waters has been discontinued because of the lack of specificity of the test.

B. **Assessment of Attainment for Dissolved Oxygen Water Quality Standards in Rivers, Streams and Brooks.** Although the Preliminary Water Quality Assessment Program will identify some waters which do not attain their D.O. standards of classification, sampling at moderate or average low flows will result in a large number of waters where nonattainment at extreme low flows is suspected but not proven. For this reason, D.O. samplings are scheduled for "worst case" conditions as regards D.O. levels. Sampling is focused on flows which approximate 7Q10 when available.

II. **Annual Assessment of Attainment.** This program results in a five-year plan that identifies stations which should be sampled every year and other stations which should be sampled one year out of every five years. The stations that are sampled each year are referred to as The Maine Primary Monitoring Network, or PMN, (synonymous with what EPA refers to as a Fixed Station Network). Stations that are sampled with less than annual frequency are referred to as the Maine Secondary Monitoring Network. This results in 80 to 160 stations being sampled each year. Of these, 22 are sampled each year and 60 to 140 are sampled once every five years (the total number of stations is about 1000 including discontinued ones). This effort has been substantially reduced in the last two years.

Stations in the Maine PMN are located in major waterbodies, especially those which have documented water quality problems or which are suspected to have problems. The Maine Secondary Monitoring Network consists of other high or medium priority stations that fit into an efficient sampling route and provide information for annual assessments of attainment regarding suitability for swimming and other aspects of water quality. Hence the procedures outlined in "Assessment of Attainment for Bacterial Water Quality Standards", above, and in the next Chapter (Part III, Chapter 2, I.A. "Bacteria") are also incorporated into this program. Because this program also serves as a double-check on license compliance for wastewater treatment plants, the parameters of D.O., temperature, turbidity, etc. are also determined during some weeks at selected stations.

III. **Biological Monitoring of Rivers, Streams and Brooks.** Maine conducts an extensive sampling program for assessing the overall health of aquatic communities. This program is based on determining the numbers of each genus or species of aquatic animals (benthic macroinvertebrates) in a standardized sampling unit. The program uses introduced substrates (wire baskets filled with rocks) to enhance the comparability of samples collected from a variety of sites.

Over 200 sites on Maine's rivers and streams have been monitored. Sample stations have been established below all significant inland discharges of wastewater in Maine. Reference stations have been established upstream of most of these discharges, as well as on pristine rivers.

Biological monitoring techniques have identified some problem waters in Maine which, through collection of dissolved oxygen data, were thought to have acceptable water quality. The DEP plans to expand its use of biological monitoring for the regulation of wastewater discharges as well as for control of nonpoint source pollution. Studies conducted thus far have proven biological monitoring to be important in determining whether water quality "provides for the protection and propagation of fish...and wildlife."

IV. **Assimilative Capacity Studies.** The DEP conducts assimilative capacity studies for toxic compounds and for oxygen-demanding substances. The results of these studies are used to establish license conditions for point source dischargers to these waters.

A. **Assimilative Capacity for Toxics.** Maine has adopted, by regulation, the EPA "Ambient Water Quality Criteria..." to avoid the occurrence of toxic effects in State waters. The DEP Toxic Pollution Control Strategy, sent to EPA Region I in April 1985, details how Maine seeks to avoid the discharge of "toxic materials in toxic amounts" into State waters. In general the process is two-tiered.

Initially, the Ambient Water Quality Criteria are used to calculate effluent limitations. These are compared to Best Practical Technology (BPT)-based effluent limits and the more stringent of the two limits is proposed in the draft wastewater discharge license. The license applicant may accept the proposed effluent limitations or go to the second tier and submit toxicity testing data in support of alternate limits. Toxicity testing protocols generally follow EPA acute and chronic methods manuals with a few modifications required by DEP. Toxicity testing methods must be approved by the Toxics and Permits Section if prior to initiation the results are intended for use in applying for a wastewater discharge license. This effluent-specific approach is added insurance that the goal of the EPA toxics criteria are met.

The major deviation from EPA testing protocol is the DEP requirement that a salmonid be used for testing toxicity to fish. This is required because salmonids are indigenous to almost all Maine waters. This method of analysis has been used in developing the State toxics control strategy and for other special studies. The DEP also analyzes fish tissues for priority pollutants as part of Maine's program for control of toxics.

B. **Assimilative capacity for oxygen-demanding substances.** The following situations precipitate studies of assimilative capacity:

1. For rivers where D.O. has been found to be lower than the requirements of classification, a study is conducted to determine how much reduction in pollutant loading is required to attain classification standards for D.O.

2. For rivers where a new BOD discharge is proposed, the river is modeled to ensure that the new discharge will not violate the D.O. requirements of classification.

3. For rivers where construction of a new dam is proposed, Section 401 of the Clean Water Act prohibits federal licensing of any dam which would violate the standards of State water quality classification. Assimilative capacity analysis ensures that the decreased aeration and increased time-of-travel caused by the dam will not violate the D.O. requirements of classification.

An assimilative capacity study for D.O. begins with field surveys designed for the calibration and verification of a water quality model. At least two data sets are collected during river conditions of low flow and high temperature. These conditions, because of the low D.O. levels which occur then, are considered to be the most critical for river habitats. The field surveys include hydraulic, physical and chemical analysis of the river including time-of-travel as determined by dye injection, measurement of cross sectional area, dissolved oxygen, temperature, salinity, sediment oxygen demand, chlorophyll a, nitrogen series, phosphorus series, BOD_5 and ultimate BOD. Extensive analysis of effluents entering the river is also done during field surveys. Nonpoint sources of water pollution are also estimated if they are thought to be significantly affecting the river's water quality.

The next step involves utilizing the data sets to calibrate and verify a computerized water quality model. Model calibration is accomplished by varying parameter factors until the model output matches the field survey results for BOD, temperature, D.O. and other parameters. The computerized river model is considered verified when the model which was calibrated by use of the first data set is run under the flow and temperature conditions of the second data set and the model output matches the BOD and D.O. data collected during the second field survey. The models most often used are QUAL-2E and WASP4. The modeling sometimes shows a need for additional data. This results in a third and, occasionally, a fourth field survey to collect the necessary data.

Once a model is calibrated and verified, it can then be used for predictive purposes. When applied to the three situations specified above, assimilative capacity studies can be the basis to formulate management options.

V. **Lake Monitoring.** The Water Resource Survey Section of the DEP Division of Environmental Assessment coordinates the lake monitoring program. Data is stored in Foxpro databases and is available to staff on the departmental computer network in read-only format.

The Maine lake monitoring program includes the following components:

A. **Volunteer Monitoring Program (VMP)**

The purpose of the Voluntary Monitoring Program is two-fold. It provides data (transparency) on a large number of lakes which is used to identify trends of improving or declining water quality. In addition, over 25 lakes are currently being sampled for dissolved oxygen. Education has also become a major goal of the program. The program also provides a unique opportunity for communication since monitors often end up functioning as a liaison between the DEP and the local lake community, keeping the DEP informed on local concerns and vice-versa.

In 1992, the State Legislature zero-funded the Lakes Restoration and Protection Fund, the sole source of State funding for the VMP. In response to this event, the DEP entered into an agreement with the Congress of Lake Associations (COLA), a non-profit organization to assist in the management of the VMP. The DEP will maintain control of data management and provide technical assistance to the program, while COLA will take over the administration of the program.

In recent years the program has included 300^{+} monitors, but the quality of data received has been highly variable. Largely because of quality problems, a new focus on quality assurance quality control is being implemented. In 1992 the DEP contracted with a local consultant to hold QA\QC workshops. Every monitor will be required to attend. The DEP has also developed a booklet entitled "Standard Field Methods for Lake Water Quality Monitoring" to assist groups wanting to perform additional testing.

Several private monitoring programs have been started particularly in small coastal watersheds. The DEP has been assisting these efforts with training and data support. The Penobscot Indian Nation has signed a cooperative agreement with the State to pool our collective monitoring resources in the Penobscot watershed. The Penobscot Nation contributed a significant amount of data from their studies in the Penobscot River basin. Additionally, data from the United States Geological Survey has been used to supplement data collected by the DEP.

Expansion of the program and development of the monitors is continuing. This includes the training of volunteers to act as regional coordinators and data entry personnel. Training was completed in the fall of 1993 with 1994 being the first year volunteers will participate in the administration of the program.

A new pilot project to test the viability of expanded testing by volunteers will also be started in 1994. Five lakes have been chosen for the program, which entails monthly sampling of dissolved oxygen, color, alkalinity and transparency. In addition, total phosphorus and chlorophyll a samples will be collected at least twice during the year. This project is slated to expand as more funds become available.

B. Federal Clean Lakes (Section 314) Projects

There are currently active Section 314 projects on two lakes in the State. They include Chickawaukie Lake phase II (initiated 1990) and China Lake phase II (initiated 1989). Lakes where 314 projects have been completed but where monitoring continues include Cochnewagon Lake phase III (initiated 1986), Madawaska Lake (initiated 1990), Threemile Pond, Salmon Lake, Sebasticook Lake and Webber Pond. All of these lakes are monitored on a regular basis for transparency, chlorophyll-a, phosphorus, dissolved oxygen and temperature. Additional parameters are included in specific projects. Improvements in water quality have occurred on most lake restoration projects.

C. Diagnostic Study Lakes

The vulnerability index, in combination with the volunteer monitoring program, has identified lakes with potential need of diagnostic analysis. Due to a lack of Federal funds (CWA Section 314), the State has not undertaken any new diagnostic studies. Some limited, privately-funded partial diagnoses have been performed on such lakes as Pattee and East Ponds. Trends of declining water quality have been evident on several lakes in Maine, such as Mousam Lake. Diagnostic studies would allow determination of the nature of problems, external sources of phosphorus loading, the extent of internal loading and the feasibility of potential solutions.

D. Special Study Lakes

The DEP monitors a number of lakes to provide answers to specific questions. For example, the DMR has a program to re-establish historical alewife runs. They plan to stock alewives in several productive lakes in Central Maine as part of their program. The Lake Studies Section is monitoring zooplankton and phytoplankton populations at Lake George in Canaan to determine if this stocking of efficient planktivores will encourage development of colonial blue-green algal blooms through depletion of the zooplankton community.

A study on the efficiency of wetland-wet pond systems in the removal of phosphorus from agricultural runoff has been completed in Aroostook County. Long and Cross Lakes have historically received large amounts of high phosphorus runoff from agricultural lands. The study entailed monitoring runoff entering and exiting the wet ponds and determining efficiencies of phosphorus, organic matter, and suspended solids removal. The wet ponds proved to be both highly effective in solids and phosphorus removal, and cost effective when combined with agricultural BMPs for water quality protection.

E. **Environmental Monitoring and Assessment Program (EMAP) and Regional Monitoring and Assessment Program (REMAP**

Maine is part of EPA's EMAP, with 64 lakes included in the sampling effort. The samples have been analyzed, but the interpretation of the data is not included in this assessment. Maine also received a special grant (REMAP) to study toxic contamination in 120 randomly selected lakes. Field sampling is complete, but only a small part of the data is presently available.

VI. **Estuarine/Marine Monitoring.** Most Maine sampling of salt waters is conducted by DMR, which is concerned with bacteria levels in shellfish propagation areas and with marine biotoxins. Marine bacteriology is conducted in accordance with the protocols of the National Shellfish Sanitation Program to protect public health. Although most of the bacteria sampling is done to verify acceptable conditions at open shellfishing areas, some of the sampling is also done in connection with pollution abatement projects.

Sampling for D.O., conductivity and temperature has determined that dissolved oxygen levels are very near the saturation point in Maine's off-shore waters. Although, D.O. depressions have been documented in harbors with restricted water circulation, no sampling has been done to assess duration or cause(s).

The DEP has begun monitoring toxic contamination along Maine's coast, focusing on tissue contamination in blue mussels and sediment monitoring. This work is being done cooperatively with the Gulf of Maine Project.

Tools Needed to Improve Assessment Abilities

The DEP is in desperate need of a data management system for both ambient water quality data and permit compliance data that is user friendly, automatically calculates and displays summary data, has useful report retrievals and statistical analysis capabilities, has built in logic to determine attainment status at both the Federal and State levels, and is linked to the state Geographic Information System. It would be even more useful to have such a system available to all agencies in the state to facilitate data sharing. The former would require staff devoted not only to design and implement the system but to get all historic data entered and maintain the system in the future. Some of the historic data is already in databases or spreadsheets and could be reformatted and transferred electronically to a new system, however, the bulk of data collected on rivers and streams resides only on paper. A system such as this would allow resource management decisions to be made in a timely fashion with the support of the best available data. Also, such a system could then be linked to EPA's WaterBody System to facilitate production of the 305(b) report.

The DEP could also use additional personnel whose sole responsibility would be to coordinate water quality assessment activities and data acquisition with other state entities, thus eliminating duplication of efforts, maximizing assessment effort and facilitating data sharing . At this point, there may be as many as 30 entities in the state doing this type of work, some of which submit copies of the data to us and some of which we probably don't even know about. Increased inter-agency coordination and efficient data management will allow us to better assess the status of our waters.

Development of regional methods for lakes bioassessment will be necessary for states to fulfill EPA's expectations for bio-criteria development and adoption. This will require a number of multi-year projects supported at the State and Regional level to field test reliable metrics and biological indicators. Without such a progam, biocriteria for lakes will not become a truly useful tool for state management of waters.

Assessment abilities should extend to watershed evaluations. EPA should restructure program criteria for CWA Sections 319 and 314 (at a minimum) to allow watershed surveys, thus ensuring that 319 and TMDL projects are adequately designed, major watershed problems are targeted and statewide prioritization of projects is facilitated.

Chapter 2 - Assessment Methodology and Summary Data

Methodology

For the assessment of many surface waters, the DEP accepts the EPA protocol of using only data collected within the last five years. However, for waters impacted only by nonpoint sources of pollution (particularly lakes), all existing data are utilized unless there have been significant land use changes in the watershed.

As described in the previous chapter (Part III, Chapter 1), Maine has an extensive sampling program to assess water quality conditions. This section of the report describes the methodology used to analyze the data produced by those monitoring efforts.

I. **Rivers, Streams and Marine Waters.** To assess what portion of Maine's rivers, streams and brooks meet the goals of the Clean Water Act (CWA), this report uses bacteriological, dissolved oxygen, and aquatic life criteria contained in the Maine water quality standards.

   A. **Bacteria.** The criteria used to determine the suitability for recreation in and on the water are based on bacteriological data. The interpretation of bacteriological data has required the establishment of several protocols.

      1. The standards for determining attainment of the CWA goals are geometric means of 142 *Escherichia coli*/100 milliliters (mL) and 14 enterococci/100 mL of human origin for freshwater and marine estuarine waters respectively. The geometric mean standards for *E. coli* and enterococci are based on a 90% confidence limit (log standard deviation = 0.5) with a sample size of n=12. If necessary, different sample sizes may be interpreted using the appropriate value for a 90% confidence limit. Since Maine has higher classifications with more stringent requirements than the interim goals of the CWA, waters can sometimes not attain their Maine classification standard but still attain the interim goals of the CWA.

      2. Maine has adopted instantaneous bacteria standards (949 *E. coli*/100 mL for Class C rivers and streams and 94 enterococci/100 mL for Class SC) which correspond to the 90% confidence limit for n=1.

      3. All indicator bacteria are assumed to be of human origin unless there are no known sources of human waste affecting bacteria levels. This protocol has led to some livestock-impacted waters being assessed as attaining bacteria standards despite high bacteria levels.

   B. **Dissolved Oxygen.** To assess what Maine rivers, streams and brooks provide for the protection and propagation of fish and wildlife, the DEP uses an adaptation of the dissolved oxygen (D.O.) criteria proposed by EPA (Federal Register, Vol. 50, No. 76, p. 15634, 4/19/85), as well as the dissolved oxygen standards specified in the Maine classification system. For waters receiving point source discharges, use of computer modeling is the preferred method for assessing D.O. attainment. Riverine waterbodies which are predicted to have a seven-day minimum D.O. greater than 5.0 mg/L at flows equal to or greater than 7Q10 (the lowest seven-day flow occurring once in ten years) and 6.5 mg/L at 30Q10 are considered to be providing for the interim CWA goals of protection and propagation of fish and wildlife. A D.O. criterion of 70% of saturation is used to assess whether D.O. in Maine estuarine and marine waters are meeting the interim goals of the CWA.

C. **Aquatic Life Support.** To assess the impact of toxics and other nonconventional pollutants, Maine uses dilution modeling of discharges based on EPA "Quality Criteria For Water - 1986," and ambient biomonitoring of benthic macroinvertebrates. The macroinvertebrates are quantitatively analyzed using a multivariate model developed by the State which assesses the sample communities in comparison to a reference condition for Maine waters (Maine Biological Monitoring and Biocriteria Development Program, DEP 1993). These methods are more sophisticated, sensitive and stringent than the "balanced population" criteria provided in the EPA 305(b) guidance. For biota, Maine riverine waters "of sufficient quality to support all species of fish indigenous to the receiving waters and maintain the structure and function of the resident biological community" and where the fish are also safe for unrestricted human consumption are considered to be providing for the protection and propagation of fish and wildlife.

D. **Fish Consumption.** In addition to the criteria discussed above under Aquatic Life Support, fish and shellfish must also be suitable for human consumption as determined by the State Toxicologist, of the Maine Department of Human Services.

E. **Assessment of Attainment for Rivers, Streams and Brooks:** Attainment of designated uses common to both State and Federal programs in lakes, based on chemical data and other indicators, has been assessed as follows:

1. **Fish Consumption**

   Supporting: No fish consumption advisories in effect.

   Partially Supporting: "Restricted Consumption" fish advisory or ban in effect during the reporting period for the general population or a subpopulation that could be at potentially greater risk (e.g., pregnant or nursing women, children). Restricted consumption is defined as limits on the number of fish of one or more species consumed per unit time. The limit on number consumed often varies with fish size.

2. **Aquatic Life Support**

   Supporting: Rivers, streams or brooks that meet Maine's Class C standards for oxygen content and toxicity, and exhibit no other impairments that would reduce the viability of an indigenous fishery or other aquatic life, as defined in Maine's draft biocriteria.

   Not Supporting: Rivers, streams or brooks that exhibit dissolved oxygen depression, turbidity, extreme water level fluctuations, toxic contamination, thermal modifications, or other impacts that would reduce the viability of an indigenous fishery or other aquatic life.

3. **Recreation In and On the Water**

   Supporting: Rivers streams and brooks that meet or exceed Maine's Class C standards for bacteria of human origin (see I.A., above).

   Not Supporting: Rivers, streams or brooks that fail to meet either the instantaneous or geometric mean standards for Class C waters. If sampling indicates the instantaneous bacteria standard has been exceeded due to combined sewer overflows (CSOs), the affected waters are considered to be in non-attainment for the entire year.

II. **Lakes.** Attainment of Clean Water Act goals and designated use support in lakes has been assessed using chemical data and other indicators. Detailed descriptions of use assessment can be found in Part III, Chapter 4: Water Quality Assessment of Lakes. A summary of the tools used to assess designated uses follows:

Fish consumption during the reporting period, is assessed using fish advisories or bans. Shellfishing and agriculture are not designated uses for Maine lakes and therefore, are not assessed. Attainment of aquatic life support is primarily based on dissolved oxygen levels in the bottom waters of a lake, but may also be based on turbidity, or extreme water level fluctuations. The designated use of swimming is primarily assessed using trophic information (presence or absence of algal blooms). Secondary contact is assumed to be fully supported in all Maine lakes: therefore no specific assessment criterion has been developed. The designated use of drinking water is fully supported as there have been no water supply closures or advisories during the reporting period.

The state designated use trophic stability (condition) is assessed by professional examination of the dataset for trends. The state designated uses of lake water for industrial process and cooling water, hydroelectric power generation, and navigation are all assumed to be fully supported in Maine, thus no assessment criteria have been developed.

Water Quality Summary

In general, Maine water quality is very good. Many of the rivers and lakes that were grossly polluted earlier in the century have recovered since the enactment of the Clean Water Act in 1972. Most of the eastern and northern portions of Maine contain waters that are relatively pristine.

In the more populated areas of Maine, water quality is affected by a combination of point sources such as industrial and municipal effluents including combined sewer overflows, and nonpoint sources such as urban and suburban stormwater runoff, agriculture, silviculture, construction-related runoff, and waste disposal practices. All of the larger municipal and industrial effluents now receive the equivalent of best practicable treatment; hence the huge improvement in the water quality of major rivers in the last twenty years. Given the difficulties of controlling nonpoint sources, the low number of remaining untreated point sources and the emergence of ground water quality as major concerns, the rate of water quality improvement will diminish over time.

This report includes an assessment of water quality conditions for all Maine water resources, except wetlands. Maine has not yet assessed wetlands in terms of designated uses (see Part III, Chapter 6: Assessment of Maine Wetlands for further information). The assessment of other Maine waters is based upon a combination of physical, chemical and biological data for waters which were actually monitored and upon the professional judgment of DEP water quality evaluation staff for waters which were not monitored.

Almost 1.4% of Maine riverine waters are not fully supporting their designated uses. The length of rivers, streams and brooks not attaining full use is 423 miles. This is slightly less than the 472 miles reported in the 1992 Water Quality Assessment report. River miles with fish consumption advisories have remained the same, and the number of pollution-related fish kills in this reporting cycle has declined. This consistent gradual improvement of riverine water quality is the type of progress Maine hopes to continue to make in the future.

Based on area, 70.3% (1992-73.3%) of Maine lakes fully support designated uses, 24.4% (1992-21%) partially support the uses, and 5.3% are fully supporting, but threatened. Of Maine lakes, 75.6% (1992-78.9%) meet the GPA classification requirements established by State law, 24.4%

(1992-21.1%) do not. The Lake Water Quality Assessment chapter (Part III, Chapter 4) details GPA classification requirements and use support status with respect to "Significant" lakes. The Waterbody System (WBS) is not used to track attainment status for lakes at this time due to the difficulty of extracting information from our master databases and raw data files and then entering it into the WBS. We currently use a number of Foxpro databases and extraction programs to store data and obtain the necessary attainment statistics to compile this report.

The Maine DEP has not undertaken any new marine monitoring projects. As in 1992, approximately 160 square miles of estuarine and marine waters are not fully supporting their designated uses. The Maine Department of Marine Resources estimates that 98,000 acres of Maine coast capable of supporting shellfish harvesting do not fully support the designated use of shellfish harvesting.

The DEP, in implementing the Maine Clean Water Strategy, will solicit the input of local government, special interest groups and Maine people in general, in formulating future water quality evaluation activities. The needs of Maine people will be better met and the coverage of Maine waters will increase by involving more Maine people in the management of their waters.

A summary of the extent to which designated uses of Maine water quality classifications are not being supported is presented in Table 3-2.1. The apparent decrease in riverine waters listed as not supporting the designated uses and the subsequent increase in those partially supporting does not necessarily indicate an increase in the quality of Maine rivers over those represented in the 1992 assessment report. In 1992 riverine waters affected by dioxin were categorized as not supporting. For the 1994 report, Maine believes these waters more appropriately partially support their designated uses since limitations are on consumption rather than fishing.

Table 3-2.2 summarizes attainment of the designated uses of State Law and the Clean Water Act. Because some Maine classifications are more stringent than those of the CWA, the sizes of water bodies indicated as attaining classifications in Table 3-2.2 may be larger than those indicated in Table 3-2.1.

Causes and Sources of Non-attainment of Designated Uses

The causes and sources of non-attainment of water quality standards vary significantly depending on the type of water resource considered. The total sizes of waters not fully supporting uses is broken down by cause categories (Table 3-2.3) and source categories (Table 3-2.4).

The most significant cause of non-attainment in larger Maine rivers is the presence of priority pollutants, specifically dioxin. Non-attainment in smaller rivers, streams and brooks is most often caused by high levels of nutrients (organic enrichment) which results in the depletion of dissolved oxygen. Organic enrichment is also the most significant cause of non-attainment of Maine lakes. Estuaries and marine waters are most heavily affected by indicators of pathogen contamination, but the presence of small overboard discharges is the primary reason for many closures regardless of water quality. Several areas are currently closed due to the lack of sufficient water quality information.

The assignment of source magnitudes is relative and based on the number of sources present in a particular lake watershed. A source magnitude of "High" is assigned when there is only one known source category in a watershed. Source magnitudes of "Moderate" and "Slight" are assigned when multiple source categories exist in a watershed. Occasionally, if multiple source categories exist and a predominant source category exists, then the predominant category would be assigned a "High" magnitude and subsequent source categories would be assigned "Moderate" and "Slight" magnitudes.

Table 3-2.1 Overall Use Support in Assessed Surface Waters in Maine.

Type of Waterbody: Rivers, Streams, and Brooks (linear miles)

Degree of Use Support	Evaluated	Monitored	Total
Size fully supporting	24,930	6,319	31,249
Size fully supporting, but threatened	0	0	0
Size partially supporting	0	29	29
Size not supporting	11	383	394
TOTAL	24,941	6,731	31,672

Type of Waterbody: Significant Lakes and Ponds (acres)

Degree of Use Support	Evaluated	Monitored	Total
Size fully supporting	140,881	533,070	673,951
Size fully supporting, but threatened	9,566	41,540	51,106
Size partially supporting	26,748	206,971	233,719
Size not supporting	0	0	0
TOTAL	177,195	781,581	958,776

Type of Waterbody: Estuarine and Marine Waters (square miles)

Degree of Use Support	Evaluated	Monitored	Total
Size fully supporting	1,423.1	50.0[1]	1,473.1
Size fully supporting, but threatened	0.0	0.0	0.0
Size partially supporting	0.0	35.7	35.7
Size not supporting	6.7	117.5	124.2
TOTAL	1,429.8	203.2	1,633.0

[1]The area of monitored estuarine and marine waters fully supporting designated uses is estimated.

Table 3-2.2 Individual Use Support Summary for Surface Waters in Maine

Type of Waterbody: Rivers, Streams and Brooks (linear miles)

Use	Supporting	Supporting, but Threatened[1]	Partially Supporting	Not Supporting	Not Attainable	Unassessed[2]
Fish Consumption	31,461	0	236	0	0	0
Aquatic Life Support	31,508	0	0	148	0	0
Swimming	31,597	0	0	94	0	0
Secondary Contact	31,597	0	0	94	0	0
Drinking Water Supply	0	0	0	0	0	31,672
Agriculture	31,672	0	0	0	0	0

Type of Waterbody: Significant Lakes and Ponds (acres)

Use	Supporting	Supporting, but Threatened[1]	Partially Supporting	Not Supporting	Not Attainable	Unassessed[2]
Fish Consumption	958,776	0		0	0	110
Aquatic Life Support	723,112	57,589	178,075	0	0	110
Swimming	807,399	99,871	51,506	0	0	110
Secondary Contact	958,776	0	0	0	0	110
Drinking Water Supply[3]	958,776	0	0	0	0	110
ADDITIONAL STATE USES:						
Trophic Stability	849,146	101,023	8,607	0	0	110
Industrial Process & Cooling Water, Hydropower, Navigation	958,776	0	0	0	0	110

Type of Waterbody: Estuarine and Marine Waters (estimated acres and square miles)

Use	Supporting	Supporting, but Threatened[1]	Partially Supporting	Not Supporting	Not Attainable	Unassessed
Shellfish (Acres)[4]	180,000	0	2,000	89,000	7,000	
Aquatic Life Support (Square Miles)[5]	1,475	0	36	122	0	
Swimming (Square Miles)[6]	1,630	0	0	3	0	

[1] Size Threatened is not a sub-category of size fully supporting.
[2] Unassessed areas are assumed to fully support the designated use.
[3] Waterbody can be used as drinking water source with reasonable treatment ranging from chlorination to filtration and chlorination.
[4] Acreage estimated by the Maine Department of Marine Resources.
[5] Use category includes propagation of fish, shellfish and wildlife.
[6] Use category includes recreation in and on the water

Table 3-2.3 Causes of Surface Water Non-attainment in Maine.[1]

Rivers, Streams and Brooks (linear miles)

Cause Categories	Major Impact	Moderate/Minor Impact
Unknown Toxicity		2.0
Priority Organics	236.4	
Metals	2.9	3.0
Total toxics	3.6	
Organic Enrichment	86.9	21.5
Hydrologic modification	4.6	8.5
Pathogen Indicators	81.0	18.0
Thermal modification	3.0	
Taste and Odor	174.4	26.0
Habitat Alteration		4.0
pH	1.0	

Significant Lakes and Ponds (acres)

Cause Categories	Major Impact	Moderate/Minor Impact
Nutrients	2,463	63,564
Siltation		42,181
Organic Enrichment	133,096	58,604
Flow Alteration		30
Other Habitat Alterations	26,748	7,865
Taste and Odor		3,845

Estuarine and Marine Waters (square miles)[1]

Cause Categories	Major Impact	Moderate/Minor Impact
Priority Pollutants	3	
Organic Enrichment	1	
Pathogen Indicators	38	

[1]Does not signify that DEP has data to support non-attainment or adverse impact. Monitoring must be coupled with standards development before any conclusions can be drawn.

Table 3-2.4 Sources of Surface Water Non-attainment in Maine.

Type of Water Body: Rivers, Streams and Brooks (linear miles)

Source Categories	Major Impact	Moderate/Minor Impact
Unknown	1.5	
Industrial Point Sources	233.4	37.0
Municipal Point Sources	16.5	8.0
Combined Sewer Overflows	29.5	8.0
Agriculture	66.5	2.0
Land Development		6.0
Urban Runoff/Storm Sewers	16.2	
Resource extraction	2.4	
Habitat Modification	1.5	
Onsite Waste Treatment (domestic)	36.0	1.0
Flow Regulation	5.6	6.5
In-place Contamination	3.7	
Upstream Impoundment		0.2

Type of Water Body: Significant Lakes and Ponds (acres)

Source Categories	Major Impact	Moderate/Minor Impact
Industrial Point Sources		4,288
Municipal Point Sources	76	4,458
Agriculture[1]	1,827	68,635
Aquaculture	30	
Silviculture	5,730	47,501
Construction	32	1,344
Urban Runoff/Storm Sewers [1]	35,105	102,663
Shoreline Development	35,105	82,658
Residential Development		13,706
General Development		3,972
Urban Runoff		3,327
Land Disposal [1]		1,999
Hazardous Waste		1,420
Hydro-modification	26,748	7,865
Other [1]	23	29,222
In-Place Contaminants		18,080
Internal P Recycling		18,080
Source Unknown	70,827	827

Type of Water Body: Marine and Estuarine Waters (square miles)

Source Categories	Major Impact	Moderate/Minor Impact
Municipal Point Source	117.0	6.2
Combined Sewer Overflows		0.5
Flow Regulation		0.4

[1]General category acreage is inclusive of subcategory acreages.

The percentage of watercourse miles suitable for fishing and swimming in Maine is highest for small watercourses and lowest for major rivers (Table 3-3.1). This is due to patterns of settlement and industrialization in Maine and the rest of New England being directed by the availability of water power. Because of the greater potential for development of major Maine rivers, water pollution problems eventually became most severe there.

Table 3-3.1. Rivers, Streams and Brooks Evaluated for the Interim Goals of the Clean Water Act.

Waterbody Type	Miles in Maine	Miles "Fishable"		Miles "Swimmable"	
Major Rivers[1]	1141	891	(78.1%)	922	(80.8%)
Minor Rivers, Streams, and Brooks	30,531	30,407	(99.6%)	30,479	(99.8%)
TOTAL	31,672	31,298	(98.8%)	31,401	(99.1%)

[1] Major: Those with a drainage area greater than 500 square miles.

Main Stems of Major Rivers

Maine rivers with a drainage area greater than 500 square miles deserve special consideration in assessing ambient water quality. This is due to settlement patterns as well as the potentially greater opportunities for recreation and habitat on these 19 major rivers. Eleven of these 19 rivers are tributaries of still larger rivers. Five of the 19 rivers (the Allagash, Dead, East Branch of the Penobscot, Fish and West Branch of the Penobscot) lie in remote areas and can be characterized as pristine. Seven of these 19 rivers (the Mattawamkeag, Moose, Piscataquis, Saco, Sandy, Sebasticook and Union) are less densely settled and industrialized than the following group but historically had segments with pollution problems.

The remaining seven of the 19 rivers (the Androscoggin, Aroostook, Kennebec, Penobscot, Presumpscot, Saint Croix, and Saint John) are pristine in their upper watersheds but pass through urbanized, industrialized areas in their lower reaches. Prior to the treatment of industrial and municipal wastewater, these seven rivers had serious pollution problems in their lower reaches. The Androscoggin River was once characterized as one of the ten most polluted rivers in the nation. With Lewiston, Maine's second largest city, located on the banks of the Androscoggin, the pollution of the past generated widespread public concern for water quality. Similar situations in other cities and towns along the lower reaches of these seven rivers have resulted in unequivocal public support for clean water in this State.

Table 3-3.2. Maine Attainment Status: Major Rivers.

River Name	Maine Length (miles)	Fishable[1] miles	Swimmable[2] miles	Fishable/ Swimmable miles	
Androscoggin[3]	124	0	29	0	(0%)
Kennebec[3]	145	89	89	89	(61%)
Dead	22	22	22	22	(100%)
Moose	13	13	13	13	(100%)
Sandy	86	86	86	86	(100%)
Sebasticook	50	48	50	48	(96%)
Penobscot[3]	80	24	24	24	(29%)
East Branch	46	46	46	46	(100%)
Mattawamkeag	48	48	48	48	(100%)
Piscataquis	47	47	47	47	(100%)
West Branch	36	31	33	28	(78%)
Presumpscot	23	16	15	15	(70%)
Saco	81	81	80	80	(99%)
Saint Croix	30	30	30	30	(100%)
Saint John[4]	161	161	161	161	(100%)
Allagash	64	64	64	64	(100%)
Aroostook	69	69	69	69	(100%)
Fish	13	13	13	13	(100%)
Union	3	3	3	3	(100%)
TOTAL MILES	1141	891	922	886	
PERCENT OF TOTAL		(78%)	(81%)	(78%)	

[1] Those which attain the criteria for protection and propagation of fish and wildlife.
[2] Those which attain the criteria for recreation in and on the water.
[3] Segments of the Androscoggin (124 miles), Kennebec (56 miles) and Penobscot (57 miles) Rivers do not fully attain the interim goal of fishable due to the presence of dioxin in fish tissues. The State Toxicologist has issued an advisory to limit consumption of fish from these rivers.
[4] That portion of the basin upstream of the Hamlin, Maine - Grand Falls, New Brunswick boundary.

As shown in Table 3-3.2, 891 of 1,141 miles of major river main stems in Maine attain the interim goals of the Clean Water Act. As previously stated, the most significant cause for not fully supporting the uses of the main stem rivers is the presence of dioxin from industrial point sources. Additional problems are caused by discharges of untreated municipal wastewater, inadequate sewers or treatment facilities not yet built. Each stream segment in Maine which does not attain classification standards is identified in Chapter 4 of Appendix I along with a description of the cause(s) of non-attainment.

Building wastewater treatment facilities will not solve all of the water quality problems on Maine's major rivers. Maine cities and larger towns also have problems with their wastewater collection systems. A serious problem is combined sewer overflows (CSOs). During spring as well as during summer rain storms, the carrying capacity of sewers can be exceeded, thereby discharging untreated sewage to nearby streams. A detailed discussion of point and nonpoint control programs may be found in Part V, Chapters 1 and 2, of this report.

Small Streams

Thirteen percent of the segments that were reported as non-attainment segments in the 1992 assessment report have been brought into attainment within the last two years. These segments were mostly streams with high bacteria counts or low D.O. from untreated domestic wastewater. Many of these segments were in the Piscataquis River basin. During the same period, a number of other segments were identified in non-attainment, mostly associated with nonpoint source pollution. The net effect was a reduction of 6% in the number of segments in non-attainment for this report.

Water Quality Trends

The trend projected for coming years will be a slow but steady improvement in the water quality of Maine. As attainment nears 100% in the years ahead, it is likely that the rate of improvement will slow even more due to the increasing incremental costs of water cleanup described in the section on the quality of minor rivers, streams and brooks. In addition, as Maine addresses nonpoint source (NPS) pollution, it will become important to develop assessment criteria applicable to the wide range of NPS pollutants and impacts.

The period of water cleanup in Maine which produced the most dramatic gains in ambient water quality was from 1975 to 1985. This was a direct result of the amendments made to the Clean Water Act in 1972. The major rivers had the most severe water quality problems, caused largely by the discharge of untreated and inadequately treated wastewater from 22 pulp and/or paper manufacturing facilities located within Maine and from two facilities located outside the State. Although construction of numerous municipal wastewater treatment facilities was also accomplished during this period, it was the reduction of BOD loading from pulp and paper mills which caused the dramatic improvement in Maine rivers. Large potential targets for water quality gains no longer exist.

During this reporting period, there was a net decrease in reaches which were not attaining minimum standards in 1992. Most of these gains are attributable to the construction of waste treatment facilities. Detracting from this achievement, however, are a number of new reaches identified as non-attainment waters. Nonpoint source pollution, particularly from agriculture and urban runoff, is the primary reason for waters being added to the non-attainment list. This leaves a picture of continued improvement where point sources are detected, but an increasing need for the control of nonpoint source pollution. Overall, nonpoint source pollution is probably not increasing in the state, and the non-attainment waters added to this year's list probably reflect new discoveries of existing problems. However, reductions in nonpoint source loading does not yet

seem to be having an effect in reducing the number of non-attainment waters. Most of these problems involve small waterways.

The Maine DEP has taken an active role in the relicensing of hydroelectric facilities in the state. New certifications have required re-adjusting flows, usually increasing minimum flows to benefit aquatic life in and below many impoundments. Maine has many more hydroelectric facilities scheduled for relicensing in the next few years and will pursue similar agreements with the operators.

Toxic contamination appears to be a significant concern for the state in coming years. With the repopulation of fisheries on many rivers following waste removal in the 1970's, we are finding that some populations carry significant contaminant burdens. Recent sampling for dioxin has shown some decline of this contaminant in fish tissues, however advisories are still continuing for this contaminant. Additional monitoring planned for the next few years may reveal other contamination problems. Mercury contamination is of primary concern.

Summary statistics for use support and causes or sources of impairment in Maine lakes can be found in Tables 3-2.1 through 3-2.4 in Part III, Chapter Two: Methodology and Summary Data. Of the 237 lakes (233,719 acres) not fully supporting uses, 1 lake (76 acres) has its major contribution from a point source and 236 lakes (233,643 acres) have major contributions from nonpoint source pollution.

Background

To improve consistency in 305(b) reports nationally, EPA restricted "significant" lakes to publicly-owned lakes with public access in 1992. In the State of Maine, all Great Ponds are defined by Statute to be publicly-owned (Title 17 M.R.S.A., Section 3860). The Great Ponds definition includes inland bodies of water in excess of 10 acres or, if artificially impounded, in excess of 30 acres (Title 38 M.R.S.A., Section 480-B). For the purposes of this assessment, "significant" lakes are publicly-owned lakes for which bathymetric/morphometric surveys exist, vulnerability modeling has been performed, or for which some trophic data has been gathered. This is a functional definition only and not intended to define relative value or need for protection. The water quality statistics presented in this chapter, except those under the topic, **Acid Effects on Lakes**, are based on the acreage of "significant" lakes rather than the acreage of all lakes.

Table 3-4.1 illustrates how the lake population considered in this report compares to the 1992 report and to the total lake population.

Table 3-4.1. Maine Lake Population Statistics.

	Number(%)	Acreage(%)
Total Lakes	5,785 (100%)	986,776 (100%)
1992 Significant Lakes	2,312 (40%)	958,499 (97.1%)
1994 Significant Lakes	2,314 (40%)	958,886 (97.2%)

Maine employs several tools to assess lake water quality and potential for change. Some of these, such as the Vulnerability Index (VI), focus on planning for the inevitable fact that Maine watersheds are going to change over the next several decades. Others, such as Trophic State Index, are primarily used for generic classification of productivity and trend detection. Maine also uses basic trophic state indicators (transparency, dissolved oxygen depletion) to assess the degree of impairment in human use potential and habitat degradation as well as trend detection.

The Maine statutory goals for the management of lakes and ponds (Class GPA) include: stable or decreasing trophic state, freedom from culturally-induced algal blooms which impair their use and enjoyment, and no impairment of aquatic habitat. While Maine statute defines this condition as acceptable water quality, it does not mandate natural or pristine conditions where lake watersheds already had extensive agricultural or residential development. The Maine management goal for lakes recognizes the existing diversity of trophic state.

Trophic Status

The trophic state of a Maine lake is determined using measurements of transparency, and chlorophyll and phosphorus concentrations. It may also be assigned subjectively to lakes that are not monitored. Since 1979, Maine has calculated a Trophic State Index (TSI) for monitored lakes having sufficient data. This numerical index is valuable in that it integrates a substantial amount of data to yield a relatively unbiased evaluation of overall water quality. This metric also allows an objective method of ranking lakes and detecting trends which may be masked by reliance on transparency readings alone. TSI statistics are calculated for lakes on which trophic data exists for only one parameter (usually transparency) but the most reliable TSI indicator of overall conditions is based on all three parameters.

Assignment of trophic status based on subjective evaluation or on limited data such as minimum Secchi disk transparency (SDT) readings does not directly equate to the numerical TSI. It does, however, allow some assessment of trophic status on the largest possible number of Maine lakes and is particularly useful for planning purposes. Many lakes have been assigned one of the three trophic ratings based on the professional judgment of DEP staff or Maine Department of Inland Fisheries and Wildlife (DIFW) staff. Trophic status ratings were made by the DIFW on almost all of the significant lakes included in the Maine Lakes Survey (approximately 1900). These determinations were based primarily on the subjective assessment of a staff biologist as to the potential fisheries productivity and morphometry of a lake. DEP staff have assigned trophic status to some lakes not evaluated by the DIFW when specific knowledge, including public reports of repeated blooms or related nuisance conditions, provided a basis for evaluation.

For the purposes of this report, trophic status has been assigned to lakes under criteria which reflect both professional judgment and numerical data. Table 3-4.2 illustrates how numerical criteria relate to trophic status. Oligotrophic lakes are characterized by low productivity and above average transparency, mesotrophic lakes have moderate productivity and average transparency, and eutrophic lakes are highly productive, have below average transparency, and may support nuisance algal blooms.

Table 3-4.2. Numerical Criteria for Evaluation of Trophic Status in Maine.

Parameter	Oligotrophic	Mesotrophic[1]	Eutrophic
TSI[2]	0-25	25-60	>60 &/or repeated algal blooms
SDT[2]	> 8 M.	4-8 M	< 4 M.
CHL a	< 1.5 ppb	1.5 - 7 ppb	> 7 ppb
Total Phosphorus[2]	< 4.5 ppb	4.5 - 20 ppb	>20 ppb

[1] No repeated algal blooms (SDT minimum < 2.0 M.)

[2] If color is > 25 Standard Platinum Units (SPU) or not known, chlorophyll a concentration (CHL a) and professional judgement must be used to assign trophic category.

Table 3-4.3 summarizes trophic status of significant Maine lakes regardless of trophic assignment source (DEP or DIFW). Of significant lake acres, 79% have been assigned trophic status by DEP, 17.6 % have been assigned trophic status by DIFW and 3.4% remain unassigned. Table 3-4.4 displays the DEP-assigned trophic rating for 695 monitored lakes broken down by major drainage basin. The remaining 1038 significant lakes, as evaluated by DIFW, are described in Table 3-4.5.

Table 3-4.3. Trophic Status of Significant Publicly-Owned Maine Lakes.

Status	Number of Lakes	Acreage of Lakes
Total	2,314	958,886
Assessed	1,733	926,878
Oligotrophic	142	121,801
Mesotrophic	989	625,616
Eutrophic	602	179,461
Hypereutrophic	0	0
Dystrophic	n/a	n/a
Unknown	581	32,008

As noted earlier, DEP and DIFW trophic assignments are not equivalent. For example, it is likely that a large number of the 518 lakes rated "eutrophic" by DIFW would be assigned a mesotrophic status by DEP, if sufficient monitoring data were available. This is primarily because DIFW considered the productivity, not only of the water, but of the entire ecosystem, thus lakes with extensive natural macrophyte beds but with clear water were often evaluated by DIFW biologists as eutrophic.

By definition, dystrophic implies that a lake has high color [>45 Standard Platinum Units (SPU)] due to humic acids and depressed dissolved oxygen concentration as a result. Lakes in this category can be shallow or deep but often have a substantial adjacent wetland area as the source of humic enrichment. No lakes have been assigned to the "dystrophic" category. There are a number of reasons for this. First, there are many lakes for which we have no color data and no simple way to characterize adjacent wetland areas in the watersheds of all significant lakes. Second, dystrophy is not truly exclusive of the other three classifications. For example, it is valid to call Threecornered Pond eutrophic as well as dystrophic, however it is described as eutrophic in this report.

Of the significant lakes, 3.4% of the surface area remains unclassified for trophic status because data or evaluations do not exist, despite having vulnerability modeling or morphometric surveys done. Trophic status is not included for 2.8% of the total lake acreage because is these lakes did not meet the "significant" criteria.

Table 3-4.4. Trophic Status of 695 Significant Maine Lakes by River Basin (DEP-Monitored lakes).

Basin	Oligotrophic acres	Mesotrophic acres	Eutrophic acres
Saint John	2,840	57,888	14,361
Penobscot	23,146	144,413	3,626
Kennebec	7,439	153,722	24,902
Androscoggin	4,680	71,664	2,711
Eastern Coastal	30,845	122,083	26,481
Western Coastal	31,927	33,922	1,387
All Basins	100,877	583,692	73,468
Number of Lakes	**63**	**548**	**84**
% of Significant Lake Area (958,886 acres)	**10.5%**	**60.9%**	**7.7%**
% of Total Lake Area (986,776 acres)	**10.2%**	**59.2%**	**7.4%**

Table 3-4.5. Trophic Status of 1,038 Significant Maine Lakes (DIFW Evaluation).

Class	Number of Lakes	Acres
Oligotrophic	79	20,924
Mesotrophic	441	41,924
Eutrophic	518	105,993
Total	1,038	168,841

Control Methods

Existing State programs for controlling pollution of lakes generally fall into three categories: Regulation, Planning, and, Technical Assistance and Guidelines. The DEP has abated many of the major sources of pollution to numerous Maine lakes through statutes, regulations, permit review, and lake restoration projects. The major threat to maintaining the present water quality of lakes is changing land uses. The greatest change has been the transition from predominantly forested land to numerous small residential developments, with significant cumulative impacts on water quality. A heightened public awareness of the vulnerability of lake water quality has resulted in recognition of nonpoint sources (NPS) of pollution, primarily nutrients and sediments, as a priority for action.

Control methods include installation and maintenance of agricultural conservation practices, erosion control on private and commercial properties, and reduction of shoreland zone groundwater pollution. Awareness of the need for effective silvicultural management is also increasing in Maine, not only as it affects water quality of Maine lakes and streams, but also for habitat diversity and maintenance of long-term productivity. State agencies have begun to place more emphasis on training and education. Agriculture continues to be a major source of enrichment to lakes. Despite a general decline in the agricultural sector of the Maine economy, it can still be the catalyst for new lake water quality problems.

The EPA Clean Lakes Program is instrumental in furthering the Maine goal of eliminating culturally-induced algal blooms from Maine lakes. The Federal CWA, Section 319 Nonpoint Source Control Program enhances the effectiveness of the Section 314 Clean Lakes Program and other lake protection activities. Emphasis on water quality protection, including the implementation of Best Management Practices (BMPs) to reduce nutrient loading, complements the Maine Phosphorus Control Program. Section 319 implementation projects have been completed on Sebago Lake and Unity Pond (Twenty-five Mile Stream). Projects are currently underway on Taylor Pond, Damariscotta Lake and China Lake. Range Pond is also targeted for a future implementation project.

I. Regulation

A. **Water Classification**: The Maine statutory classification of lakes and ponds, Class GPA, includes a stable or decreasing trophic state, freedom from culturally induced algal blooms which impair use and enjoyment, and no impairment of aquatic habitat (38 M.R.S.A., Article 4-A). The statute also prohibits new point source discharges of pollutants to lakes or tributaries of lakes. Existing licensed sources are allowed to remain only as long as no practical alternative exists. At this time there are five municipal discharges to lakes. Two of these municipal discharges (Rangeley and Sanford) receive tertiary treatment for phosphorus removal. The Town of Rangely has developed engineering proposals for removal of its discharge to Haley Pond, tentatively scheduled for 1995. The St. Agatha discharge to Long Lake will be removed in 1994.

B. **Subsurface Wastewater Disposal**: During the last twenty years, substantial numbers of domestic wastewater discharges to lakes have been removed through application of the Maine Subsurface Wastewater Disposal Rules and the statutory prohibition against discharges. A proposed Section 314 Phase I study on Mousam Lake was not funded. This project would have examined the migration of phosphorus from substandard leachfields, and the potential effects on lake water quality.

C. **Natural Resources Protection Act**: In 1988, the Maine Legislature consolidated a number of resource protection statutes and regulations under the Natural Resources Protection Act (NRPA). The act requires that alterations to shorelines of lakes, streams

and wetlands must not have adverse impacts on water quality or aquatic habitat. Wetlands which are hydraulically connected to lakes are considered by DEP to be part of the lakes themselves in terms of protection of habitat and water quality. Development of residential and commercial projects, and other activities above certain thresholds, are regulated not only by local governments, but also by the DEP. One of the objectives of review is to require stormwater management and erosion control so as to minimize new sources of sediment and phosphorus to lakes, especially to impaired lakes. Consideration is also given to the potential cumulative impact of proposed developments in the watershed.

D. **Shoreland Zoning**: Maine requires local adoption and enforcement of shoreland zoning. In a defined area around lakes and major rivers, municipalities must impose at least minimum standards for setbacks, lot clearing, and permitted types of land use. While of substantial benefit to lake water quality protection, these ordinances usually do not affect the entire watershed and usually reflect only minimum protection standards for lakes. The 1991 mandatory inclusion of zoning on freshwater wetlands and all second order or larger streams will help considerably in focusing attention on other areas of sensitive lake watersheds.

E. **Municipal Land Use Ordinances**: Municipal land use ordinances vary widely across the State in terms of their detail and application concerning lake protection. Adoption of comprehensive plans under the Maine Growth Management Act allows municipalities to set water quality protection goals which form the basis for adoption of specific local programs and regulations. The most common features of these ordinances revolve around local planning board review of subdivisions and standards for road construction. A number of municipalities have also adopted general land use ordinances, which control (or at least set guidelines for) such activities as timber harvesting and general erosion control. An increasing number of ordinances incorporate references to specific lake watersheds with special standards for water quality protection. Municipalities are being encouraged to adopt aerial phosphorus allocations for their lake watersheds according to Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development, Revised September 1992.

F. **Regulation in Unorganized Areas**: In approximately 52% of Maine's land area (and thus for fully half its lakes) the Land Use Regulation Commission (LURC) is the planning and zoning agency regulating development. Permit application reviews specifically consider water quality impacts and are often done on a cooperative basis with DEP, particularly in lake watersheds.

G. **Forestry Practices**: The Forestry Practices Act of 1989 and corresponding rules regulate the size of clear-cuts and regeneration standards for these cuts. Most timber is grown and harvested in unincorporated townships of the state under the jurisdiction of LURC. Standards for stream crossings, road and ditch construction and general erosion control are enforced by LURC and are vital to reducing nutrient and sediment impacts on lakes and streams in the northern part of the state. In June 1991, the Maine Forest Service, at the request and with the support of the Department of Environmental Protection, published BMPs for erosion and sediment control in logging operations as part of the State's Section 319 program. These guidelines are adapted from LURC standards and the DEP encourages their use throughout the state in workshops, demonstrations and training sessions. Maine does not require training of timber harvesters in resource protection, but the BMPs are being incorporated into a new certified loggers program sponsored by the timber harvesting industry.

II. Planning

The management of Maine lakes revolves around maintenance and improvement of water quality. The section on Control Methods details many of the tools used to achieve these twin goals, but DEP is currently emphasizing several aspects which hold the most promise for long-term benefits.

A. **Great Pond Task Force**: The Commission on Maine Lakes was directed by the Maine Legislature to assess the threats to lake water quality and make recommendations to combat these. As a result of the Commission's report, legislation created a Great Pond Task Force. This task force will develop a new management strategy and guidelines governing surface uses of lakes, and will improve public education concerning lake protection. Several other specific actions were directed, including a phosphorus control limitation on domestic detergents. Special emphasis is placed on identification of actions needed to prioritize watersheds for phosphorus loading management.

B. **State and Local Coordination**: Regulations are applied at two levels: State and local (municipal). Because of the geographical extent of the state and the varied nature of threats to water quality, limited state staff must concentrate on high priority problems, compliance inspections and enforcement. In the case of lakes, ensuring compliance with current state regulations to control nonpoint source pollution often receives lower priority than major point source discharges to rivers and marine waters. However, watersheds of lakes which have restoration projects or histories of water quality problems receive substantial attention from DEP staff.

Because the majority of land use decisions affecting lake water quality are regulated locally, the DEP relies on the application of municipal ordinances to be the first line of defense. DEP provides guidance to towns and landowners for individual land use decisions. DEP experiences have shown that the effectiveness of ordinances and regulations rely on two things: the availability of technical information to town officials, developers, and individual landowners, and the education of the public in general. Because of these observations, we have emphasized planning for watershed management (particularly phosphorus control) over the long term - usually a ten to fifty year period.

In addition to the above, the Land Use Regulatory Commission currently operates under a comprehensive plan which places lakes in its jurisdiction into one of five categories. These categories define the goals for managing development, and set standards for density and compatible uses which reflect sensitivity to water quality changes.

C. **Comprehensive Planning Legislation**: In 1991, the Maine Legislature repealed the comprehensive planning mandate and related funding. This mandate has been replaced with a voluntary comprehensive planning bill. Towns that receive funds under the voluntary program are required to protect water quality in great pond watersheds from long-term and cumulative increases in phosphorus related to development. These towns must also develop management goals for great ponds with regard to shoreline character, surface water use, public access and protection of resources of State significance. The DEP technical assistance unit is available to towns interested in the comprehensive planning process. The DEP provides planning manuals, watershed maps, and the water quality data needed for towns to pursue the planning process for their lakes. The staff stresses inter-community communications in this process, especially where towns share lake watersheds.

A number of towns not currently experiencing high growth rates which may not be currently revising their plans have or will soon adopt the technical methodology for phosphorus control in development review. Some of these towns are considering adopting model ordinances aimed at a variety of land uses in an effort at long-range preservation of water quality.

D. **Lake Watershed Management In Unorganized Territories**: In 1990, LURC implemented a new lake management program by adopting an "Amendment to the Comprehensive Land Use Plan Regarding the Development and Conservation of Lakes in Maine's Unorganized Areas" and associated rule changes. This program includes more explicit consideration of lake water quality protection and focuses on limiting phosphorus loading to lakes from future development. The lake management program also enables development of "Lake Concept Plans". These plans provide a cooperative and integrated view of landowners' future development plans. The overall goal of concept plans is to encourage long-range planning, based on resource characteristics and suitability, thereby providing an opportunity to manage the cumulative impacts of development, including water quality, while also enabling expedited permitting of approved components of the Plan. Several lake concept plans are currently being developed with different landowners.

III. Technical Assistance and Guidelines

Almost every State agency with natural resources program responsibility has one or more technical assistance functions which directly or indirectly protect lake water quality.

A. **Best Management Practices**: In addition to standards for development review, Maine has developed a variety of BMPs under the Nonpoint Source Management Program which will be of substantial benefit to lake water quality. Complete BMPs include: 1) Erosion and Sediment Control Handbook for Maine Timber Harvesting Operations, 2) Best Management Practices, Strategy for Managing Nonpoint Source Pollution from Agricultural Sources and Best Management System Guidelines, 3) Best Management Practices for Maine Agricultural Producers, Protecting Groundwater from Nutrients and Pesticides, and 4) Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices. BMPs currently being developed include those for Stormwater Quality, Environmental Management for Erosion and Sedimentation Control: Transportation, and Marine (marinas/boating). Many of these BMPs will be initially developed as technical guidance but may eventually be incorporated into regulations and ordinances.

B. **Pollution Prevention**: The DEP is currently conducting a Pollution Prevention pilot project within the Androscoggin River Basin. The goal of the Androscoggin River Watershed Project is to reduce pollution through coordination among agencies and towns. Key to this effort is the 15 member DEP Watershed Management Team, which assists communitiy teams in the identification and resolution of local pollution problems.

C. **Education and Outreach**: The future of Maine lake water quality depends in great measure on how well DEP promotes evolving guidance for protection. Recognizing that public outreach and education are the cornerstones of water quality protection, an educational campaign begun in 1989 emphasizes lake related issues. Completed brochures include: Protecting Maine Lakes; An Overview, Controlling Lake Phosphorus from Existing Sources; Protecting Maine Lakes from Phosphorus Pollution; A new planning guide for Cities and Towns, Comprehensive Planning for Lake Protection, Town Ordinances for Protecting Maine Lakes, and Acid Rain and Maine Lakes. In addition, brochures on aquatic plants/nuisance species, septic systems and detergents, and an overview of how Maine's Phosphorus Control Method works have recently been

completed . This ambitious brochure production program has already reached thousands of people.

Cooperative projects with Maine Soil and Water Conservation Districts (SWCDs) for education and landowner contacts in lake watersheds are increasingly important. Recently, one such project with the Cumberland County SWCD produced a very popular and useful series of 12 Fact sheets on erosion and sedimentation control and BMPs. Included in the series are the following: 1) Water Quality: How it works, 2) Erosion on Shorefront Property, 3) Erosion Control for Homeowners, 4) Vegetative Streambank Stabilization, 5) Vegetated Phosphorus Buffer Strips, 6) Trees, Shrubs, Vines and Groundcovers, 7) Fertilizer Basics, 8) Riprap for Shoreline Protection, 9) Riprap for Streambank Protection, 10) Temporary Check Dams, 11) Silt Fencing and Hay Bale Barriers, and 12) Vegetative Stabilization for Sand Dunes and Tidal Areas. Other SWCDs have also produced special purpose pamphlets aimed at water quality protection.

Water quality videos and curriculum materials are also distributed to schools across the State. DEP has formed a coalition with 27 other non-profit organizations, state agencies, university faculty and businesses to promote environmental education in Maine, and to develop better delivery systems to teachers and schools. In addition to educational work, a technical assistance unit has been formed to work with municipalities and developers to ensure future developments are designed to limit negative effects on lake water quality. Several interactive television workshops for teachers on environmental issues have been aired through the University of Maine. Topics for this series, which is entitled "Earthminders", have included lake related elements and nonpoint source pollution control.

D. **Phosphorus Control**: Methods to control phosphorus export from development, such as installation of phosphorus control wet-ponds, infiltration systems and vegetated buffer strips, are gaining acceptance. Maine has developed a method for addressing phosphorus loading impacts to lakes (Phosphorus Control in Lake Watersheds: A Technical Guide to Evaluating New Development, Revised September 1992). This method is utilized for reviewing development projects under the Site Location of Development Law, and is also being used by a number of towns. The technology has been developed by the DEP into a workable system for adoption by municipalities and developers in all lake watersheds. A unique feature is the ability of this system to target the necessary level of nutrient control in individual developments by incorporating long-term water quality protection goals for each waterbody. The methods manual and technical training program are available on a state-wide basis through the DEP, participating Regional Planning Agencies and SWCDs.

A pilot project was carried out in the Town of Dedham using the phosphorus method from the planning stage to tracking implementation of phosphorus controls. The project is detailed in a report entitled "Lake Watershed Evaluation and Tracking system, Dedham, Maine" (May 1992). The report includes recommendations on projecting and planning for growth, tracking and analyzing patterns of development, incorporation of the phosphorus method into ordinances, and long-term maintenance of phosphorus controls.

Effective control of pollutant sources in lake watersheds requires the exercise of local governmental authority. Small developments and cumulative land use changes which are not under State jurisdiction comprise the majority of new nonpoint impacts on lakes. DEP has developed a comprehensive lake vulnerability database and corresponding watershed maps to assist municipalities, developers, and other agencies in the implementation of the phosphorus control methodology. A packet of information is available for most of the lakes in the state, and is provided to towns along with technical assistance on request. In addition to the above mentioned phosphorus control design standards, a comprehensive

planning manual for lake watersheds and model ordinances have been designed to aid in local phosphorus control efforts and to complement the Maine municipal comprehensive planning process.

E. **Stream Assessment Methodology**: The DEP recently completed a proposal for the development of a new assessment method for small streams and embayments to estimate potential risks from nonpoint source pollution. The method will be used as a screening tool to focus limited resources on those watersheds which are most at risk. The nonpoint source pollution potential index will make use of existing Geographic Information System (GIS) data layers supplemented by field data and an estimate of resource value. The first pilot project using the index is proposed in the Casco Bay Watershed.

F. **Erosion Control for Road Construction and Maintenance**: The Maine Department of Transportation (MDOT), Office of Environmental Services now emphasizes project planning for erosion control in sensitive lake watersheds. The Rural Roads Center offers training and information to municipal officials, not only in the traditional areas of road construction and maintenance, but also in planning for erosion control and resource protection. Current work by the MDOT on alternative seed mixes, application techniques and application timing is an example of changes in customary procedures needed to safeguard water quality in sensitive watersheds. The MDOT recently funded a study to determine the phosphorus export coefficient for runoff from rural Maine highways, and to compare run-off from paved/medium use roads and gravel/low use roads. The study was conducted by the United States Geological Survey in conjunction with DEP.

G. **Agricultural Management**: The Agricultural Stabilization and Conservation Service (ASCS) of the United States Department of Agriculture (USDA) manages Federal financial assistance to private landowners through the Agricultural Conservation Program. Funds are available for erosion and sediment control practices, and nutrient and agricultural waste management systems related to NPS threats to surface and groundwater, water management and water conservation. Technical assistance is supplied by USDA Soil Conservation Service (SCS) personnel in cooperation with each local Soil and Water Conservation District.

   The 1985 Farm Bill contained provisions known as the Food Security Act. The bill required landowners receiving USDA money to develop a conservation plan for erosion control on highly erodible land by 1992, and to implement that plan by January 1, 1995. Noncompliance with this bill meant a loss of all USDA funds. In 1990, the Farm Bill was amended by the Food, Agriculture, Conservation and Trade Act to update various requirements, especially those related to wetlands. In Maine, management practices to control soil erosion and manure, nutrient and pesticide runoff are included in every conservation plan. Planning is emphasized in heavily farmed lake watersheds.

   Examples of agricultural controls in lake watersheds include advanced management systems for collecting, storing and spreading manure. The management and spreading of nutrients is done according to a specific management plan in such a way and at times that the crop can make maximum use of the nutrients applied. Manure, soil and crop tissue tests are used to monitor the status of the soil, and to update the management plan if necessary. These integrated crop management practices are being demonstrated in many counties. Additional practices, such as pasture management and livestock exclusion from streams, have been added to the host of established erosion control methods. Economical alternative livestock watering sources need to accompany pasture management proposals to be viable to farmers.

Through the Conservation Reserve Program, a substantial acreage of highly erodible land has been removed from potato production for ten year periods. Most of these ten year contracts were signed between 1986 and 1990. In addition, crop rotations with oats and other grains, along with runoff management practices such as nutrient control basins, have resulted in significant decreases in the discharge of silt, nutrients and pesticides.

It is a continuing challenge to find innovative and economical ways to control nonpoint source pollution in the farm community, and to increase the number of farmers cooperating with their local SWCDs. Effective new or revised practices need to be constantly demonstrated on real farms under today's conditions to overcome the deep reluctance of farmers to abandon practices passed down through generations. This is the objective of CWA Section 319 demonstration grants.

H. **Watershed Protection Grants**: Additional projects bearing on lake water quality are funded under Section 604(b) of the CWA through the competitive grants program of DEP. Projects funded in 1993 included the Range Ponds Watershed NPS/BMP Project, Norway Lakes Special Assessment Protection District, Lake Christopher Watershed Survey, Long Pond NPS Assessment Network, Lincolnville Lakes Evaluation Project, and vegetated buffer strip educational material. Projects selected for 1994 include the Thompson Lake Watershed NPS Survey and Assessment, and the Volunteer Lake Monitoring Program.

I. **Maine Lake Restoration and Protection Fund**: In the past, the Maine Lake Restoration and Protection Fund has supported nonpoint source inventories in the Damariscotta Lake, Canton Lake, North Pond and Forest Lake watersheds, utilizing methods and experience gained in the China Lake and Taylor Pond projects. The fund also provided partial support for two current NPS inventories in Rangeley and Island Falls. While still authorized, the Maine Lake Restoration and Protection Fund has been zero funded. If fiscal support is restored, the Maine Lake Restoration and Protection Fund will be an excellent vehicle to support small watershed assessment projects. This is especially true because it can promote local matching and is flexible as a funding mechanism. It also could provide assessment work needed to plan nonpoint source projects which are not supported under current Section 319 program policy.

Restoration and Rehabilitation Efforts

The DEP selects restoration projects based on the severity of problems, feasibility (technical and financial) of alternatives and on local support. This last element has been increasingly important as projects become more complex, require more volunteer effort, focus on nonpoint source control, and involve the development of municipal policies. Each of the current projects has an active lake association working on education and fund raising. Recent projects have included nonpoint source surveys carried out by volunteers under the direction of the DEP. Agricultural NPS control has been the focus of the SCS and SWCDs in several restorations. Increasingly, District staff expertise has been utilized for non-agricultural technical assistance, as in the case of the current China Lake project, in close cooperation with the NPS Control Program.

Table 3-4.6 summarizes rehabilitation techniques used in past and current restoration project lakes. It should be noted that both "Watershed Treatments" and "Other Lake Protection/Restoration Controls" include practices used to abate pollution in many lake watersheds before water quality declines to such a point where restoration is initiated. For example, a property owner may obtain a permit under the State's Natural Resources Protecton Act - Permit by Rule program to apply riprap to 100 feet of shoreline. Over the past five years, 515 such permits have been issued for properties on a total of 139 lakes.

Table 3-4.6. Lake Rehabilitation Techniques*.

Rehabilitation Technique	# Lakes	Acres
In-lake Treatments		
Phosphorus Precipitation/Inactivation (alum treatment)	4	3,344
Dilution/Flushing	3	7,451
Watershed Treatments		
Sediment Traps/Detention Basins	2	8515
Shoreline Erosion Control/Bank Stabilization	4	6,868
Conservation Tillage Used	2	8515
Animal Waste Management Practices Installed	10	17,832
Road or Skid Trail Management	3	5,359
Land Surface Roughening for Erosion Control	1	3,845
Riprapping Installed	3	5,359
Unspecified Type of BMP	13	29,768
Other Lake Protection/Restoration Controls		
Local Lake Management Program in Place	9	22,793
Public Information/Education Program/Activities	7	12,982
Local Ordinances/Zoning/Regs to Protect Lake	7	13,478
Point Source Controls	4	10,845

*techniques used in restoration project lakes listed in Tables 3-4.7 and 3-4.8.

Table 3-4.7 lists completed restoration projects and Table 3-4.8 lists current restoration projects. It should be noted that completion of restoration projects is only meant to imply that the tasks originally envisioned in the Maine workplan have been carried out. Our experiences, however, have illustrated that lake restoration is not a permanent, complete or irreversible process. In a number of instances (ie., Annabessacook Lake, Lovejoy Pond, and Threemile Pond), refinements in assessment techniques or changes in watershed conditions may prompt re-examination of these projects for future additional work. Under "Type", Phase I projects are Diagnostic Feasibility Studies, Phase II projects are Restoration Implementation Projects and Phase III projects are Post Restoration Monitoring Projects.

Also of note is the primary emphasis Maine now places on lake protection and technical assistance rather than restoration. With limited support from either State funds or the CWA Section 314, major restoration efforts which benefit one or two lakes will divert resources from more vital work. The use of NPS funds for expensive in-lake projects is also difficult to justify given the statewide need for nonpoint source projects. Maine continues to promote and support watershed remediation and local planning/pollution prevention for lakes as a restoration tool.

Table 3-4.7. Completed Maine Lake Restoration Projects.

Annabessacook Lake, Cobbossee Lake and Pleasant Pond (Litchfield, Manchester, Monmouth, West Gardiner & Winthrop)

Type: Phases I and II

Funding: EPA Clean Lakes Program, Local contributions, Cobbossee Watershed District and DEP in-kind services.

Problems: Agricultural runoff, algal blooms, internal phosphorus recycling

Management Measures: Restoration of these three lakes in 1976-79 involved control of agricultural sources of phosphorus in their watersheds. Annabessacook, which drains to Cobbossee and Pleasant, also received a phosphorus precipitation/inactivation treatment (alum) of its sediments in 1978 to control internal recycling of phosphorus. The alum treatment reduced internal recycling of phosphorus by 70-80%, although recent data suggest that internal recycling is rising. Though Annabessacook Lake still supports annual algal blooms, the duration and intensity of these blooms has been much less than before restoration. Both Cobbossee and Pleasant have had occasional (not every year), mild algal blooms, but these blooms are much less frequent than before restoration. Substantial local interest is evident for a follow-up restoration project. The Watershed District recently completed a land use/phosphorus inventory for the Annabessacook watershed, and is investigating ways to support NPS inventories in the Cobbossee watershed.

Cochnewagon Lake (Monmouth)

Type: Phases I, II and III

Funding: EPA Clean Lakes Program ($68,348 for Phase III), State Lake Restoration and Protection Fund, local contributions, Cobbossee Watershed District and DEP in-kind services.

Problems: Algae blooms, internal phosphorus recycling

Management Measures: Restoration involved a successful phosphorus precipitation/inactivation alum treatment of the lake sediments in 1986 to control internal recycling of phosphorus. Algal blooms have been eliminated and the lake's water quality apparently restored to its former condition. An EPA Phase III, Post-restoration monitoring program has recently been conducted to assess alum treatment effects and nonpoint source loading.

Estes Lake (Alfred & Sanford)

Type: Other

Funding: Federal and State Municipal Construction Grants and local match

Problems: Sewage treatment plant discharge, algal blooms

Management Measures: In 1982, tertiary treatment for phosphorus removal was installed at the Sanford wastewater treatment plant at a cost of approx. $9 million. Results were dramatic. Annual blooms were almost completely eliminated except following periods when the sewage treatment plant discharge approached or exceeded license limits. In 1988, the license limit for total phosphorus was reduced for the summer period in attempt to eliminate remaining problems. As a result, Estes Lake has been removed from the Impaired lakes list and is now listed as Threatened.

Table 3-4.7 (continued). Completed Maine Lake Restoration Projects.

Haley Pond (Dallas Plantation & Rangeley)

Type: Other

Funding: Federal and State Municipal Construction Grants.

Problems: Sewage treatment plant discharge, development, algal blooms

Management Measures: Construction in 1975 of a tertiary treatment unit at the Rangeley Sewage Treatment Plant reduced phosphorus loading to the lake from the plant by 97%. This immediately resulted in elimination of the blue-green algal blooms in the lake. Blooms have only occurred three times since 1975, and these blooms were associated with breakdowns in the tertiary treatment system. However, substantial concern exists about development in the area and growth of associated nonpoint sources and increased loading from the treatment plant. Recent relicensing of the treatment plant resulted in phosphorus discharge limitations and planning for alternative waste disposal for Rangeley.

Lovejoy Pond (Albion)

Type: Other

Funding: State in-kind services, USDA Watershed Protection and Flood Prevention Act and local farmer contributions.

Problems: External phosphorus loading from agriculture, algal blooms

Management Measures: Agricultural Best Management Practices were implemented in the watershed. Monitoring has indicated that phosphorus loading was reduced at least 25% and perhaps 50%. Due to the large percentage of the watershed devoted to agriculture, total loading is still sufficient to cause algal blooms. No in-lake treatment is planned due to continuing external phosphorus loading.

Madawaska Lake (Westmanland & T16 R4 WELS)

Type: Phase I

Funding: Maine Soil and Water Conservation Commission, EPA 314 programs ($88,830) and local sources.

Problems: Nonpoint source pollution, forestry and other land use practices

Management Measures: A diagnostic/feasibility study has been completed which included State funds and EPA Clean Lakes Program Phase I support, along with DEP and local in-kind services. Internal recycling does not appear to play a dominant role in yearly in-lake phosphorus increases, but could be keeping the productivity of Madawaska Lake high. In-lake treatment should not be pursued until external sources are controlled. Several land based recommendations have been made for the major land uses including forestry, agriculture, camp and home lots, shoreline erosion, commercial property, public property, and roads and associated ditches. This was a coordinated effort between DEP, the Soil and Water Conservation District, major landowners and volunteers.

Table 3-4.7 (continued). Completed Maine Lake Restoration Projects.

Sabattus Pond (Greene, Sabattus & Wales)

Type: Phases I and II

Funding: EPA Clean Lakes Program, ASCS, local farmer contribution, State and local in-kind services.

Problems: Agricultural runoff, internal phosphorus recycling

Management Measures: The Sabattus Pond Restoration project included enhanced seasonal flushing to reduce internal recycling of phosphorus from the lake sediment and installation of Best Management Practices on farms in the watershed to reduce nonpoint sources of phosphorus. Results were a 20% improvement in water quality measurement, and a general perception of improvement among lakeshore residents. The seasonal drawdown program has been turned over to the Salmon McGrath Pond Lake Association.

Salmon Lake (Belgrade & Oakland)

Type: Phases I and II

Funding: EPA and ASCS with in-kind services from DEP and landowners.

Problems: Nonpoint source pollution, including agricultural runoff, algal blooms

Management Measures: BMPs were implemented on two farms in the watershed. No in-lake treatment has been proposed so recovery depends on natural flushing. While no statistically significant change has been noted, residents claim that algal blooms are less frequent and less dense, and the lake Association has begun an intensive monitoring program. The Association has also initiated reduction of several acute nonpoint sources in the watershed.

Sebasticook Lake (Newport)

Type: Phases I and II

Funding: EPA Clean Lake Program, USDA Act, Local Funding, State and Federal Municipal Construction Grants and DEP in-kind services.

Problems: Point sources of phosphorus, agricultural runoff, internal phosphorus recycling, algal blooms

Management Measures: This restoration project addressed four points: (1) elimination of point sources at Dexter, (2) reduction of point sources at Corinna (ongoing), (3) reduction of agricultural nonpoint sources of phosphorus in cooperation with USDA and local farms and, (4) control of internal recycling of phosphorus through enhanced seasonal drawdown. The project began in 1979 and as of 1990 has resulted in an approximate 61% reduction in mid-summer lake phosphorus concentrations. These reductions in phosphorus loading have resulted in decreased incidence, duration and intensity of algal blooms. The elimination of the Dexter sewage discharge in 1988 and the annual drawdowns continue to reduce phosphorus levels in the lake.

Table 3-4.7 (continued). Completed Maine Lake Restoration Projects.

Togus Pond (Augusta)

Type: Phase I

Funding: Property owners and State in-kind services for technical assistance.

Problems: Nonpoint source pollution, failing septic systems, internal phosphorus recycling

Management Measures: Shorefront homeowners have independently and voluntarily cooperated by correcting their own problems. For example, over 20 new septic systems were installed at home-owners' expense despite the fact that they were not required by law to do so. Future treatment to control internal recycling may be appropriate but is not currently proposed. Residents conducted a limited nonpoint source survey and are attempting to reduce pollution from roadways.

Webber Pond (Vassalboro)

Type: Phases I and II

Funding: EPA Clean Lake Program ($89,625), State Lake Restoration and Protection Fund, USDA Watershed Protection and Flood Prevention Act, Local contributions and DEP in-kind services.

Problems: Agricultural nonpoint source pollution, shoreline erosion, internal phosphorus recycling, algal blooms

Management Measures: Restoration project included control of agricultural nonpoint sources of phosphorus, reduction of shoreline erosion problems and control of internal recycling of phosphorus by enhanced seasonal drawdown, (requiring dam reconstruction). Since dam reconstruction in 1985, the lake has exhibited reduced duration, frequency and intensity of algal blooms. Continued annual drawdown by the Lake Association should result in further improvement of water quality.

Threemile Pond (China, Vassalboro & Windsor)

Type: Phases I and II

Funding: EPA Clean Lakes Program ($130,000), State Lake Restoration and Protection Program, USDA Watershed Protection and Flood Prevention Act, local contributions and DEP in-kind services.

Problems: Agricultural nonpoint source pollution, road erosion, internal phosphorus recycling

Management Measures: This restoration project involved control of nonpoint sources of phosphorus and a phosphorus precipitation/inactivation alum treatment of the lake sediments in 1988 to control internal recycling of phosphorus. DEP continues to work with the towns and the lake association to resolve remaining major non-agricultural sources of phosphorus in the watershed, particularly from road erosion problems. Though water quality in the summer of 1989, following the alum treatment was very good, evidence suggests that internal recycling has returned to pre-treatment levels. The long-term effectiveness of the treatment was assessed in the final project report (January 1993), and additional analysis of the alum treatment was provided in a progress report on the China Lake project (November 1993). Monitoring will continue in 1994.

Table 3-4.8. Current Maine Lake Restoration Projects.

Chickawaukie Lake (Rockland & Rockport)

Type: Phases I and II

Funding: EPA Clean Lakes Program ($141,190), along with State and local funds (including in-kind services) and substantial volunteer effort.

Problems: Nonpoint source pollution related to development, algal blooms

Management Measures: This is a two-phase project including nonpoint source reduction and education coupled with long-term protection planning followed by phosphorus precipitation. The project began in 1991 under an EPA Clean Lakes Program grant. A nonpoint source inventory has been completed and a cost-share program has resulted in remediation of several high-priority NPS problems. Work on the remaining high priority sites is expected to be completed by August 1994. The Town of Rockport has adopted the Phosphorus Control Ordinance and the City of Rockland has expressed interest in applying the state phosphorus control method should the need arise. The DEP has assisted the Town of Rockport in the review of one subdivision under the new ordinance and will continue to provide technical assistance as requested. The alum treatment was completed in June 1992 and has provided much-improved water clarity. Frequent monitoring will continue for at least one more year.

China Lake (China & Vassalboro)

Type: Phases I and II

Funding: EPA Clean Lakes Program ($313,375), Maine Lake Restoration and Protection Fund, USDA/ASCS cost-sharing, Town and local contributions, including the China Lake Association, Maine Soil and Water Conservation Commission (Challenge Grant), MDOT (ISTEA), CWA Section 319, Maine State Board of Education, HUD Community Block Grant, NSF/Crest Program and in-kind services by the DEP, Kennecec County Sheriff's Department, the local Soil and Water Conservation District, and by volunteers.

Problems: Nonpoint source pollution related to development and land use practices, shoreline and streambank erosion, internal phosphorus recycling, algal blooms

Management Measures: This project, as designed in 1988, consisted of three phases: reduction of major nonpoint sources of erosion (and resultant phosphorus loading), adoption of a long-term lake protection strategy and the reduction of internal phosphorus loading through nutrient precipitation/inactivation. The first phase incorporates the results of a citizen survey followed up by professionals contacting landowners to offer technical assistance and cost-sharing to reduce external nutrient loading. The second phase stresses public awareness and analysis of local land use practices including Town policies on code enforcement, road maintenance, etc., for long-term water quality protection. Substantial progress has been made in remediation of nonpoint sources in the watershed. A large number of sources have been corrected by means of innovative labor sources (Town Conservation Corps., Kennebec County Sheriff's Dept use of short-term prisoners etc.) and a variety of funding sources multiplying local dollars to complement CWA Section 314 funding support. The Town was recently awarded a $250,000 MDOT/ISTEA grant for road-related phosphorus control and a CWA Section 319 grant for innovative stream stabilization technique demonstrations. The Town of China has adopted a Phosphorus Control Ordinance and the Town of Vassalboro Comprehensive Plan calls for the implementation of an ordinance in the near future. The sediment phosphorus precipitation/inactivation portion of the project will be removed from the workplan due to the very high cost and uncertain long term effectiveness. In addition, several questions regarding the technical feasibility were raised in a recent project review by DEP staff.

Table 3-4.8 (continued). Current Maine Lake Restoration Projects.

Long Lake and Cross Lake (St. Agatha, T16 R5 WELS, T17 R3 WELS, T17 R4 WELS, & T17 R5 WELS)

Type: Other

Funding: USDA/ASCS Special Watershed Project, EPA 319 Nonpoint Source Control Program, Maine Lake Restoration and Protection Fund, the University of Maine, the St. John Valley SWCD, the Fish River Lakes Water Quality Association, the Aroostook County RC&D, and USGS.

Problems: Agricultural NPS pollution, shoreline development, Town of St. Agatha wastewater discharge

Management Measures: Agricultural and shoreline development nonpoint sources have been identified as primary sources of water quality problems in these watersheds. The Conservation District has designated more than 40 high priority agricultural sites in the watersheds. These agricultural sites are targeted for installation of innovative nutrient control wetland/pond systems along with a research project assessing their design and effectiveness. To date, ten of these have been constructed. An aggressive educational campaign by the area lakes association has been conducted over the last three years. The DEP has designated staff with nonpoint source pollution control expertise to work in these watersheds. Water quality of Long Lake has been stable or slightly improved over that last several years, and Cross Lake, although still impaired, appears stable. NPS technical support continues to be provided by DEP, and selected NPS projects will be supported.

The Conservation District will continue building nutrient control structures, although at a slower pace than the 1990-92 seasons due to technical difficulties with several sites and limited staff resources. Lake monitoring has been curtailed for several years due to fiscal constraints and pending a re-evaluation of the project needs. The Town of St. Agatha plans to construct a diversion to eliminate wastewater discharge into Long Lake. This project is scheduled for completion in 1994.

Assessment of Attainment Status

A determination of impairment is based on failure to attain Clean Water Act goals or State Statutory goals (Class GPA and support of designated uses). Assessment for the Clean Water Act interim goals of fishable and swimmable has been combined with assessment of designated uses. The fishable goal is now reported under the designated uses of fish consumption, shellfishing, and aquatic life support. Likewise, the swimmable goal is reported under swimming and secondary contact. Other designated uses assessed in this report include drinking water supply and agriculture. The Maine Water Classification Law specifically designates all of these uses for lakes except shellfishing and agriculture. State standards also specify suitability for the designated uses of industrial process and cooling water, hydroelectric power generation, and navigation. All significant lakes are assumed to support these designated uses because there has been no indication of impairment or potential impairment. Therefore, no specific assessment has been pursued with respect to these last three uses.

The State of Maine lake classification standards indicate that lakes "shall have a stable or decreasing trophic state". Thus, we are including 'Trophic Stability' under State-defined uses. Although this category is technically a condition rather than a designated use, lakes failing to support this condition are considered impaired and are treated the same as lakes having designated use impairments.

Attainment of designated uses common to both State and Federal programs in lakes, based on chemical data and other indicators, has been assessed as follows:

I. Fish Consumption

Supporting: No fish consumption advisories in effect.

Supporting but threatened: Statistical modelling predicts that a particular type of lake or geographical area is more likely than other types of lakes or lakes in other areas, to have a fish consumption advisory in the future.

Partially Supporting: "Restricted Consumption" fish advisory or ban in effect during the reporting period for the general population or a subpopulation that could be at potentially greater risk (e.g., pregnant women, children). Restricted consumption is defined as limits on the number of fish of one or more species consumed per unit time. The limit on number consumed often varies with fish size.

Not Supporting: "No Consumption" advisory or ban in effect for the general population, or a subpopulation that could be at potentially greater risk, for one or more fish species.

Not Attainable: "No Consumption" advisory or ban in effect for the entire human population and all fish species; no practical remediation for the source of contamination in the foreseeable future.

II. Aquatic Life Support

Supporting: Lakes that exhibit no dissolved oxygen (D.O.) impairment, turbidity or extreme water level fluctuations that would reduce the viability of an indigenous fishery or other aquatic life.

Supporting but Threatened: Lakes indicated by vulnerability modeling to be at risk for phosphorus enrichment, and thus an increasing trophic trend, are also considered at risk for dissolved oxygen impairment if the lakes are sufficiently deep.

Partially Supporting: Lakes that exhibit oxygen impairment that would reduce the viability of an indigenous fishery or other aquatic life. D.O. impairment is defined as greater than 50% of the metalimnion/hypolimnion (total depth of > 5 meters) having D.O. concentrations of less than 3 parts per million (ppm) during a monitored period. Further work needs to be done to identify lakes that naturally develop anoxic profiles, such as highly colored lakes, kettle hole ponds or moderately productive lakes with a small metalimnion/hypolimnion volume and little watershed disturbance. Regardless of whether these lakes experience natural or culturally induced oxygen deficits, this condition can promote internal phosphorus recycling, making such lakes particularly sensitive to increased nutrient loading. Also considered partially supporting are lakes having severe turbidity and lakes that experience extreme water level fluctuations.

Not Supporting: Lakes that have experienced complete loss of an indigenous species due to severe D.O. depletion, severe turbidity, or extreme water level fluctuations.

Not Attainable: Lakes that have experienced complete loss of all indigenous species due to severe D.O. depletion, severe turbidity, or extreme water level fluctuations where remediation is not practicable.

III. **Swimming**

Supporting: Lakes that do not exhibit repeated (at least two seasons) intense algal blooms.

Supporting but Threatened: Lakes indicated by vulnerability modeling to be at risk for algal blooms due to anthropogenic activity, and, lakes that have experienced one recorded algal bloom.

Partially Supporting: Lakes in which swimming is impaired during part of the recreational season due to culturally induced algal blooms. Bloom conditions are defined as Secchi Disk Transparency measurements of less than 2 meters in lakes having color less than 30 Standard Platinum Units (SPU). Lakes having color of 30 SPUs or greater are considered impaired if other trophic data or professional judgment indicates that elevated productivity is due to anthropogenic alterations.

Not Supporting: Lakes in which the use of swimming is totally lost due to culturally induced algal blooms.

Not Attainable: Lakes having algal blooms that are so severe that remediation is not practicable.

IV. **Secondary Contact**

Secondary Contact is considered to be fully supported as a designated use in all Maine lakes. There has not been any evidence to the contrary, therefore no specific attainment criterion for assessment exists.

V. **Drinking Water Supply**

Maine lakes fully support the designated use of drinking water supply. No drinking water supply closures or advisories have been in effect during the reporting period and no treatment beyond "reasonable levels" has been necessary.

Additional State Designated Uses:

VI. **Trophic Stability**

Supporting: Lakes exhibiting stable or decreasing trends in trophic state.

Supporting but Threatened: Lakes whose trophic stability is indicated by vulnerability modeling to be at risk due to anthropogenic activities.

Partially Supporting: Lakes exhibiting an increasing trend in trophic state.

Not Supporting: N/A

Not Attainable: N/A

VII. **Industrial Process and Cooling Water, Hydroelectric Power Generation, Navigation**

The suitability of lake water for the designated uses of industrial process and cooling water, hydroelectric power generation (quality not quantity) and navigation is considered to be fully supported in all Maine lakes. Because there has not been any reason to assume otherwise, no specific attainment criterion for assessment of these uses exists.

Impaired Lakes

Evaluation of attainment status is based on occurrence of repeated algal blooms, evidence of hypolimnetic D.O. depletion, increasing trophic trend, or habitat alteration. Lakes which have bloomed during only one season have not shown a definite decline in water quality and thus are not considered impaired due to algal blooms. To date, 24.41% of the total lake surface area does not fully attain Maine classification standards. The total number of impaired lakes has increased by 19 over the 1992-1993 period. Two have been added as a result of habitat modification due to hydropower draw-down. One was added because it supported an algal bloom for the second time. The remaining sixteen lakes were added because of low hypolimnetic dissolved oxygen. Fourteen of the latter were discovered during water quality sampling under the EPA-sponsored Regional Environmental Monitoring and Assessment Project (REMAP). These lakes had not been sampled previously by DEP and probably had low hypolimnetic dissolved oxygen in previous years.

Table 3-4.9. Attainment Status for Significant Lakes by Basin: number (acreage).

Basin	**Fully Supporting Designated Uses**	Impaired Lakes listed by Designated Use[1]		
		Swimming[2]	Aquatic Life Support	Increasing Trophic Trend
St. John	224 (65,320) 2 (85)[3]	11 (10,986)	19 (23,088)	1 (1,526)
Penobscot	700 (238,114) 6 (1,370)[3]	5 (2,351)	24 (16,184)	0 (0)
Kennebec	384 (148,057) 7 (1,095)[3]	22 (27,291)	47 (47,807)	1 (3,845)
Androscoggin	165 (62,025) 4 (413)[3]	4 (2,348)	27 (20,975)	0 (0)
E. Coastal	423 (160,401) 5 (562)[3]	6 (8,390)	37 (45,892)	1 (1,702)
W. Coastal	177 (51,189) 5 (586)[3]	4 (140)	49 (24,129)	2 (1,534)
All Basins	**2,077 (725,167)[4]** **29 (4,111)[3]**	**52 (51,506)**	**203 (178,075)**	**5 (8,607)**

[1] Lakes assessed as partially supporting any designated use are considered Impaired. This includes lakes with multiple impairments, but does not include lakes impaired due to habitat alteration.
[2] Lakes that have experienced two or more seasons with algal blooms.
[3] Subset of lakes that have experienced only one season of algal bloom(s) is included in parentheses.
[4] Four lakes not currently assigned to any drainage basin are included in the total.

Table 3-4.9 summarizes attainment status of significant lakes by major drainage basin. Lakes are considered Impaired if they are assessed as partially supporting for any designated use. Lakes with multiple impairments may be listed in more than one column in Table 3-4.9, therefore the three columns listing Impaired lakes are not additive. Lakes Impaired by habitat modification are not included in Table 3-4.9.

Table 3-4.10 includes detail on current water quality trends for the 5.41% of lake acreage supporting repeated algal blooms (trend analysis does not include D.O. evaluations). Assignment of trends is done by professional inspection and evaluations of the data set. Previous statistical trend analyses of changes in transparency have not been significant, in part due to the large variability of seasonal/yearly data and, in some cases, due to small data sets. At this time, it is not possible to separate out those lakes which are highly productive by nature and would not necessarily violate Maine designated use standards. However, given the location of many of the 53 lakes having repeated algal blooms, and the degree to which their watersheds have been disturbed, it is likely that relatively few of these lakes are naturally eutrophic.

Table 3-4.10. Detailed Breakdown of Designated Use Attainment Status in Maine.

Category	Trend	Number of Lakes	Acreage	% of Total Acreage
Repeated Algal Blooms	Deteriorating	2	2,582	0.27%
	Stable	35	36,321	3.79%
	Improving	3	1,531	0.16%
	Unknown	13	11,459	1.2%
	Subtotal	53	51,893	5.41%
Hypolimnetic D.O. Depletion[1]		181	152,863	15.94%
Increasing Trophic Trend[2]		2	2,602	0.27%
Habitat Alteration/ Hydropower Drawdown		2	26,748	2.79%
Subtotal Partially Attaining GPA		238	234,106	24.41%
Subtotal Attaining GPA[3]		2,076	724,780	75.59%
Total Assessed for GPA Attainment		**2,314**	**958,886**	**100.00%**

[1] Trends for lakes having D.O. depletions are not enumerated; lakes having algal blooms as well as D.O. depletion are included in "Repeated Algal Blooms".

[2] Lakes exhibiting an increasing trophic trend in addition to algal blooms or D.O. depletion are included in either "Repeated Algal Blooms" or "Hypolimnetic D.O. Depletion", rather than here.

[3]. Number and acreage from Table 3-4.9, above.

The largest percentage of lake acreage classified as non-attainment, 15.94%, is attributed to anoxic conditions, presumably due to allochthonous organic loading or algal productivity. It is important to note that this group may contain a substantial number of lakes which, due to morphometry or natural watershed characteristics, develop hypolimnetic anoxia in late summer. Further analysis is needed to distinguish these lakes from those in watersheds significantly altered by cultural activity. Of the 204 lakes assessed as partially attaining use support for fisheries due to summertime hypolimnetic anoxia (including those supporting algal blooms), 60 (25,048 acres) are managed by DIFW for warm water fisheries only. DEP has not determined to what extent these lakes might support cold water fisheries if D.O. depletion were not a factor, however, it is assumed that habitat for benthic invertebrates has been reduced.

An analysis of the causes and sources of water quality impairment of these lakes is summarized in Part III, Chapter 2 of this report and by waterbody in Chapter 6, Table 5, of Appendix I. It should be noted that in most cases this is based on personal knowledge of staff and as such does not reflect detailed evaluations of each lake or waterbody. Furthermore, assignment of nonpoint source categories to "high" or "moderate" status can obscure the true level of impact of a particular source category. This is especially true for those lakes for which several sources, including natural ones, are unknown at this time. In several watersheds, notably those having diagnostic studies or restoration projects conducted, fairly detailed assessments have revealed the diverse nature of nonpoint source impacts and their changing nature through time. A number of non-attainment lakes are substantially affected by internal nutrient recycling which may be the result of historic, but not necessarily current, land use effects.

Of all significant lakes, six (110 acres) have not been assessed for designated use support due to lack of data and four lakes (61 acres) are not currently assigned to any major drainage basin. Of the 5,785 lakes in the state, 3,471 have not been assessed in this report, regardless of significance. Despite the large number, the "unassessed" lakes make up only 2.8% of the 986,776 acres of Maine lakes. Most of the lakes which have not been assessed are very likely to fully attain GPA standards and fully support their designated uses. This is due to low rates and densities of development in many of the watersheds, especially those of the more remote lakes. The extent to which water quality is altered by transient land use changes (e.g., clear-cut forestry practices) has not been assessed, particularly in remote areas. Most of the 5,785 lakes are believed to attain bacteriological standards for the protection of swimmers and biological standards for the protection of habitat with the possible exception of low dissolved oxygen due to natural causes.

Threatened Lakes

Threatened Maine lakes are listed by major drainage basins in Table 3-4.11. Threatened status is applied to lakes that have experienced one algal bloom or are categorized as Threatened by use of the Vulnerability Index. There is one lake, Jewett Pond, with a first-time recorded bloom in 1992-1993. That lake was visited by DEP staff for the first time in 1993 and has numerous shallow areas with extensive macrophyte growth. DIFW fisheries biologists indicate that there is extensive moose activity in those areas. The lake is now included on the Threatened list. This is the first lake known to have an algal bloom that may be due to natural factors.

The Vulnerability Index is a broad-based predictive model which uses the hydrological characteristics of a lake and rate of watershed development to predict the rate at which mean lake phosphorus concentration will increase over time as a result of watershed development. Since the index relies on many broad assumptions, its information is of limited value on a lake-specific basis. It does, however, evaluate a large number of lakes with a limited database. Since its assumptions are consistent, it gives a valuable relative indication of how significant the future cumulative impact of development on Maine lakes may be.

Maine uses the VI to identify, for the purposes of this assessment, a subset of lakes where water quality is most threatened. The lakes which are assigned Threatened status are those for which the index predicts a "perceivable" increase in trophic state over a 50 year period, and hence potential for violation of class GPA standards. In past assessments, DEP had defined "perceivable" increase in trophic state as a 1 ppb increase in mean lake phosphorus concentration. Since 1990, that definition has expanded to consider current water quality and morphometry of each lake.

Table 3-4.11. Threatened Lakes by Major Drainage Basin: number(acreage).

Basin	All Threatened Lakes	Significant Threatened Lakes	Significant Unimpaired Threatened Lakes
Unknown[1]	4 (42)	2 (37)	2(37)
Saint John	3 (164)	3 (164)	0 (0)
Penobscot	57 (13,116)	51 (13,089)	39 (10,444)
Kennebec	85 (18,922)	76 (18,869)	52 (5,880)
Androscoggin	50 (17,564)	46 (17,538)	29 (10,179)
East Coastal	124 (25,532)	113 (25,466)	88 (8,918)
West Coastal	170 (29,602)	137 (29,448)	94 (8,546)
All Basins	**493 (104,942)**	**428 (104,611)**	**304 (44,004)**

[1] not currently assigned to any drainage basin.

Maine lakes have been classified into one of six water quality categories based on both current water quality and sensitivity to change (Table 3-4.12). The sensitivity of the trophic state of a lake to absolute increments in lake phosphorus concentration is assumed to be different for each of these categories. For example, Moderate/Sensitive lakes are considered more sensitive than Moderate/Stable because of their high potential for internal recycling of phosphorus and hence, the higher risk of an algal bloom. Lakes with inadequate data were assigned the default category of "Moderate/Sensitive". Lakes in each of these categories are considered threatened if the predicted increase in mean phosphorus concentration over a 50 year period is equal to or greater than the following:

Outstanding	0.50 ppb
Good	1.50 ppb
Moderate/Stable	1.25 ppb
Moderate/Sensitive	1.00 ppb
Poor/Restorable	0.50 ppb
Poor/Non-restorable	---

Table 3-4.12. Water Quality Categories of Maine Lakes for Planning Purposes.

Outstanding: Lakes in this category are very clear with an average secchi disk transparency (SDT) greater than 9.1 meters (30 feet), have very low algae levels (chlorophyll a < 2 ppb) and have very low phosphorus concentrations (2 to 5 ppb). These lakes are rare and unique resources which are particularly sensitive to small increases in phosphorus concentration.

Good: Lakes in this category are clear with average SDT of 6.1 to 9.1 meters (20 to 30 feet) with relatively low algae levels (chlorophyll a of 2 to 4 ppb) and phosphorus concentrations ranging from 5 to 10 ppb. This water quality type is common, particularly among the larger lakes in the state.

Moderate/Stable: These lakes are less clear with average SDT of 3.1 to 6.1 meters (10 to 20 ft.) but do not have summer algal blooms (minimum SDT is greater than 6.6 feet). Algae levels are moderate (chlorophyll a of 4 to 7 ppb) as are phosphorus concentrations (10 to 20 ppb). Despite their relatively high nutrient and algae levels, lakes in this category do not appear to have a high risk of developing algal blooms because of (1) high water color (>30 SPU), (2) consistently high summer oxygen levels in the metalimnion, and/or (3) very stable algae and nutrient levels with little seasonal variation.

Moderate/Sensitive: These lakes exhibit clarity, algae and nutrient levels similar to the moderate/stable lakes, but have a high potential for developing algal blooms because of significant summertime depletion of dissolved oxygen levels in the hypolimnion and/or large seasonal fluctuations in algae and nutrient levels. Many lakes fall into this category because of their high risk of having significant water quality changes due to small increases in phosphorus concentration.

Poor/Restorable: Lakes in this category support obnoxious summer algal blooms, have minimum SDT less than 2 meters (6.6 feet) and are candidates for restoration. Land use practices in their watersheds should be treated very conservatively because any additional phosphorus loading will reduce the feasibility of restoration. There are 20 to 30 lakes in the state which fall into this category.

Poor/Non-restorable: These lakes have a long history of obnoxious summer algal blooms and little public interest in recreation. Restoration is not considered feasible because they are small lakes with very large, highly agricultural watersheds where the only possibility for restoration would require elimination of agricultural activities throughout much of the watershed. To date, no lakes have been placed in this category and assignment to this group of any lake would require significant study.

The Vulnerability Index, as currently structured, does not assess rates of change in nutrient loading attributable to land use alterations other than development, because the index is based on the rate of increase of tax-assessed structures during the 1984-86 period. Recently, the greatest change in many Maine watersheds has been in cottage lot and residential development. Lack of an adequate, accessible data base on land use changes in such categories as agriculture and silviculture makes modeling nutrient budgets for these components difficult on a per-watershed basis and virtually impossible on a statewide basis. Future model refinements may include these and other land use categories as well as non-cultural watershed features. In addition, the local planning process will frequently incorporate new information which will refine the status of a number of lakes. This, coupled with a re-evaluation of post-1986 development, will result in continuing revision of the Threatened category.

Of the 42 lakes (13,773 acres) with only one recorded season of algal bloom(s), 21 are rated as Threatened by either the VI criterion (16 lakes) or are impaired by hypolimnetic anoxia (11 lakes). The remaining 21 lakes (8,452 acres) were documented through the volunteer monitoring system.

Of the 238 lakes listed as Impaired, only 98 (41%) are also assessed as Threatened under the vulnerability criteria detailed above. This is an indication that, while rates of development and attendant nutrient loading may be important predictors of future eutrophication, more detailed knowledge of the watershed of each lake is necessary to predict the occurrence of such problems. It is also recognized that current conditions often reflect historic land use patterns. Time lags in lake response make vulnerability assessments extremely valuable as a general planning tool. Lake-specific information concerning Threatened lakes is listed in Chapter 6, Table 6, of Appendix I.

Acid Effects on Lakes

Estimates place the number of non-dystrophic Maine lakes which are currently acidic (Acid Neutralizing Capacity or ANC < 0 microequivalents $CaCO_3/l$) at less than 100. Although all Maine surface waters that have had their acid-base chemistry analyzed show increased non-marine sulfate concentrations resulting from acidic deposition, only a portion of known acidic lakes can be considered as having been predominantly affected by atmospheric deposition.

During the 1980s, the effects of acidic deposition were the focus of numerous projects. The 1984 EPA Eastern Lake Survey (ELS) population (225 lakes) was chosen such that statistical inferences about the extent of acidic deposition effects could be made for lakes throughout the state. ELS projected that between 8 and 21 Great Ponds were acidic in the State of Maine. The DEP has evaluated lake populations (pH and ANC) potentially susceptible to the effects of acidic precipitation: 91 high elevation lakes in chemically resistant bedrock were assessed in the High Elevation Lakes Monitoring (HELM) project, and 128 seepage lakes in or associated with mapped aquifers were assessed in the Aquifer Lakes Pilot Survey (ALPS) project. Data have also been obtained from the EPA Long Term Monitoring (LTM) lakes at the University of Maine/DEP Tunk Watershed Site (8 lakes including lakes in adjacent sites) and from numerous University of Maine projects focusing on effects of acidic precipitation (188 lakes). In addition, the DEP has evaluated alkalinity data on 520 lakes as part of routine sampling to assess trophic status.

It is important to note that assessment of lakes for acidity has not been a priority for this state's limnological investigations over the past 4 years. Data collected from investigations done in the past reside in numerous files at various locations across the state, so it is difficult to report any numbers or acreages that are better than estimates. We have not made any effort to enumerate lakes vulnerable to acidity other than focusing the HELM and ALPS studies on lake populations at high risk. It is likely, however, that we would categorize all lakes situated in areas of bedrock and surficial geology having low to no acid neutralizing capacity, as being vulnerable to acidity.

Approximately 1,005 lakes (an estimated 713,397 acres) have been assessed for acidity, predominantly by using measures of pH and ANC. There are about 60 acidic lakes (ANC < 0) comprising a total surface area of 707 acres (1.0% of the lakes and 0.06% of the lake surface area in the state). Twenty acidic lakes are at least ten acres or greater in size and are considered "significant"; the remainder are at least 1 acre in size. According to the Eastern Lake Survey, there are probably only a few unsampled acidic lakes greater than ten acres in size. There are likely some (probably less than 50) additional non-dystrophic acidic drainage and seepage lakes in the 1 to 10 acre size range. Table 3-4.13 summarizes acid effects on lakes.

Sources of acidity include acidic deposition, naturally occurring organic acids and a combination thereof, as determined by an assessment of dissolved organic carbon (DOC) and non-marine sulfate concentrations. Acidic, low DOC (< 5 mg/L) drainage and seepage lakes are acidic largely due to acidic deposition and account for approximately 60% of acidic lakes. Acidic, high DOC drainage lakes are acidic due to a combination of naturally occurring organic acids and acidic deposition, and account for approximately 10% of acidic lakes. Acidic, high DOC seepage lakes

(approximately 30%) are acidic primarily due to naturally occurring organic acids. No low DOC lakes are known with a pH less than 4.9 suggesting that organic acidity is necessary to depress pH to values of less than 5.0. Table 3-4.14 illustrates source estimates for high acidity in Maine lakes.

Table 3-4.13. Acid Effects on Maine Lakes*.

	Number of Lakes	Acreage of Lakes
Assessed for Acidity	1005	713,397
Impacted by High Acidity	60	707
Vulnerable to Acidity	unknown	unknown

*Totals include all lakes in the state, not only 'significant' lakes.

Table 3-4.14. Sources of High Acidity in Maine Lakes*.

Source	Lakes Impacted Number	Percent
Acid Deposition	36	(60%)
Natural Sources	18	(30%)
Combination of Acid Deposition and Natural Sources	6	(10%)

* Totals include all lakes in the state, not only 'significant' lakes; total area impacted is estimated as 707 acres - we have not attempted to determine acreage for each source category due to the unavailability of data.

The extent of aluminum mobilization due to increased acidity is dependent on the presence or absence of substances which bind aluminum such as, DOC and fluorine. Greatest aluminum toxicity has been observed between a pH of 5 and 6 and only a few of the numerous ionic species are biologically toxic. Table 3-4.15 lists 58 acidic lakes categorized by the total aluminum concentration in ug/l.

Table 3-4.15. Aluminum Distribution in Acidic Lakes in Maine.

Total Aluminum (ug/l)	Number of Acidic Lakes
< 100	39
100 - 200	4
200 - 300	5
> 300	10

Total aluminum was determined on filtered (0.4 um), acidified samples according to EPA protocols established for the ELS/LTM projects. No consideration is given to the form of aluminum, however, and a significantly lesser amount would be considered biologically available. Since 40% of the acidic lakes have high levels of DOC, it can be inferred that biologically available aluminum is less likely to attain toxic levels in those lakes.

Historical data on fisheries is limited for all but a handful of the acidic lakes. Temporal shifts in fish populations have been observed in some lakes, but there is no clear association between these shifts and acidic deposition. Although a number of the acidic lakes are fishless, none have been shown to have lost their fish due to acidification. Thus all are considered to be fully supporting uses. Many of the fishless lakes are small and isolated, or exist at high elevations, with poor breeding habitat.

Paleolimnological investigations in New England have shown that some lakes apparently have become acidified within the past 20 to 50 years. Most are inferred to have had a pH of less than 6 in prehistoric times. Therefore, only lakes that currently have a pH less than 6 are considered to be at risk. Existing data suggest that at current levels of acidic deposition, fewer than 100 Maine lakes are potentially at risk of further acidification. However, the only long-term data from lakes with a pH between 5 and 6 suggests that their acid neutralizing capacity has increased since 1982. Thus it is possible that even fewer than 100 lakes are at risk.

A comprehensive treatise on the effects of acidic deposition on Maine's waters can be found in the EPA-sponsored text: "Acid Deposition and Aquatic Ecosystems: Regional Case Studies", edited by Donald Charles and published in 1991 by Springer-Verlag (ISBN 3-540-97316-8).

No attempt has been made to mitigate the effects of acidic deposition or potential toxic mobilization for the following reasons: 1) only a small percentage of surface water has been acidified by acidic deposition, 2) lakes affected by acidic deposition are typically small in surface area, 3) paleological evidence suggests that those lakes with depressed pH attributable to acidic deposition were historically low in pH as a result of inherent watershed characteristics, 4) no alteration of fish populations can be attributed to acidic deposition at this time, and 5) since a significant number of the acidic lakes are dominated by organic acidity, alteration of the buffering system (e.g., by the addition of lime) would drastically change the natural ecosystem.

Toxics

During calendar years 1992 and 1993, there were no lakes in Maine known to be affected by levels of toxics which warranted the issuance of any health advisories. However, concerns have been raised regarding the presence of mercury and other toxic pollutants in Maine fish and predatory birds. The REMAP project ("Fish Tissue Contamination in the State of Maine", Sept. 1992), is currently assessing a number of toxics in fish tissue and lake sediments such as mercury, lead, cadmium and organics, including polychlorinated biphenyls (PCBs) and approximately 20 pesticides. A interim data report on the project is due to EPA in early summer of 1994.

Trends

The entire lakes data set has been evaluated for trends in water quality based on best professional judgement. Based on the quality, quantity and duration of data collected (primarily Secchi Depth Transparency), a trend statement was assigned to each of the 671 lakes in the data set. Table 3-4.16 summarizes the trend statement assignments. The trend statements categories are described as follows:

1. Inadequate data to determine trends

2. Improving trend:
   a. inadequate data/indication of improvement
   b. reasonable data/possible improvement
   c. strong data/probable improvement

3. Stable water quality:
   a. inadequate data/indication of stability
   b. reasonable data/possible stability
   c. strong data/probable stability

4. Declining trend:
   a. inadequate data/indication of decline
   b. reasonable data/possible decline
   c. strong data/probable decline

Table 3-4.16. Water Quality Trend Determinations for 671 Significant Maine Lakes.

Category	Number(%)	Acres	% Significant Lake Area
Data inadequate to determine trends	382(56.9)	304,581	16.5%
Improving trend	24(3.6)	19,148	1.0%
Stable water quality	241(35.9)	418,587	10.4%
Declining trend	24(3.6)	11,863	1.0%
Total Assessed for Trends	**671(100)**	**754,179**	**38.9%**

The "strong data/probable decline" category (increase in trophic state) includes 5 lakes which are considered as not attaining Class GPA standards. This number has not changed since the previous reporting cycle. The DEP staff is confident that trends exhibited by lakes in this category are real and these lakes appear on the 1994 Impaired list. Three of the five would have been on the Impaired list regardless of their trend; the remaining 2 still support their designated uses yet would otherwise have been on the threatened list. Nine lakes were categorized as having "reasonable data possible decline". Six of these are on the 1994 Impaired list, the remaining 3 are on the 1994 threatened list.

Summary

The percent of lake acreage partially supporting designated uses has increased from 21.1% in 1992 to 24.4%. Two lakes, Estes Lake and Chickawaukie Lake have been moved from the Partially Supporting list to the Fully Supporting but Threatened list as a result of successful restoration projects. Of the 19 lakes added to the Impaired list, one was added due to a second algal bloom, two were added because of habitat alterations due to hydromodification, and the remainder were added because of low hypolimnetic dissolved oxygen.

It is important to note that 14 of these lakes were sampled for the first time in 1993, but probably had low dissolved oxygen during previous reporting cycles. Another 2 were also previously impaired due to hydromodification alterations of habitat, but were included for the first time during this reporting cycle. The 3 other lakes added to the Partially Supporting list were removed from the Threatened list concurrently. All three were predicted by the Vulnerability Index to have enrichment problems.

Chapter 5 - Estuary and Coastal Assessment

Background

In 1988, the Maine Legislature established a State program within DEP to monitor and research toxic pollution within the 5,500 miles of near-coastal waters. The program was funded for 1989, but since that time no State money has been dedicated to ambient toxics monitoring in Maine's coastal waters. As a result, sampling of estuarine and marine water quality is done primarily by the Department of Marine Resources (DMR) for the purpose of assessing pathogen indicators and phytotoxins which could cause human health problems upon consumption of contaminated fish or shellfish. Two other projects, the Casco Bay Estuary Project and the Gulf of Maine's Gulfwatch, have collected limited data on toxic contamination in Maine's coastal waters.

The five coastal health topics: eutrophication, habitat modification, changes in living resources, toxics contamination and pathogen contamination, are discussed below.

Eutrophication

Information regarding nutrient enrichment is needed throughout the state before intelligent decisions can be made with respect to nutrient management. No new information has been collected since the 1992 305b report. Anecdotal evidence continues to suggest that Maine should be placing more emphasis in this area of research.

A complete shellfish kill occurred during 1988 in Maquoit Bay, Brunswick, which was coincident with a noxious phytoplankton bloom. In adjacent Freeport, phytoplankton blooms in the Harraseeket Estuary have also been noted. Quantitative documentation for blooms, however, is lacking. In 1990, Saco Bay experienced a hypoxia event resulting in lobster mortality. Although nutrient loads to the bay are significant, no cause has been identified in this incident. The status of Maquoit and Saco Bays remains unknown due to lack of monitoring data. A moored array system, such as that being developed for Chesapeake Bay, is the only cost-effective means of understanding these phenomena.

Habitat Modification

Assessment of habitat alteration is virtually non-existent. Although Maine law strictly regulates habitat modification in all coastal wetlands, there has been no known attempt to assess the habitat modification information gathered through the regulatory process. Follow-up monitoring efforts are inadequate for compliance assessment and make no effort to measure actual habitat loss.

Changes in Living Resources

The only known area of non-attainment is in the Inner Fore River (between Portland and South Portland), upstream of the "Million Dollar Bridge". Species composition data show that crustaceans are absent from a substantial area, mollusks are absent from an intermediate area and a small area is inhabited only by two species of worms. Therefore this area does not meet Class SC standards which allow changes, but still require that the structure and function of the resident biological community be maintained. While the DMR assesses commercial fish stocks, assessments of non-commercial species along the Maine coast do not exist.

Toxics Contamination

Since the 1992 305b report, toxic contamination monitoring has consisted of that done by the Gulf of Maine Council on the Marine Environment (the "Council"), the Dioxin Monitoring Program, the Casco Bay Estuary Project (CBEP), and the Maine Coastal Program.

The National Estuary Program section later in this chapter includes a more thorough discussion of the Casco Bay Sediment Study sponsored by the CBEP during 1991. The results of the CBEP Sediment Study are consistent with previous studies showing significant contamination from polycyclic aromatic hydrocarbons (PAHs) and polychlorinated biphenyls (PCBs) in the sediments near the greater Portland area. The general picture that emerges from these efforts is that, as one would expect, while pollutants could be detected throughout Casco Bay, most of the Bay is free of serious contamination by toxics, except for the areas near Portland.

Animal tissues have been monitored through support from three programs. Results of Council activities are limited to 6 mussel tissue monitoring stations in 1992 and 1993. Maine Coastal Program funds supported tissue analyses from 14 sites during 1992. The addition of these results to past work does not change the general assessment that the Maine coast continues to have localized areas of toxic contamination.

Dioxin monitoring was conducted in coastal waters in 1992 (3 sites for softshell clams) and in 1993 (3 sites, for lobster). Results are published in the department report, "Dioxin Monitoring Program, 1993". The softshell clams were found to contain measurable amounts of dioxin (2,3,7,8 TCDD) but not in amounts sufficient to recommend an advisory on consumption. The lobsters were found to have measurable amounts of dioxin in separate analysis of the muscle tissue and "tomalley" (hepato-pancreas). The concentration in the muscle tissue was below that which would require an advisory, however the concentrations in the tomalley were substantially higher and an advisory has been issued regarding the consumption of this part of the lobster.

To date, DEP has identified six areas of concern based on sediment and/or blue mussel tissue analyses (Table 3-5.1).

Table 3-5.1 Marine and Estuarine Areas of Concern for Toxic Contamination.[1]

Location	Area
Piscataqua River Estuary	2,560 acres
Fore River	1,230 acres
Back Cove	460 acres
Presumpscot River Estuary	620 acres
Boothbay Harbor	410 acres
Cape Rosier	80 acres

[1] Does not signify that DEP has data to support notion of non-attainment or adverse impact. Monitoring will be required to be coupled with standards development before any conclusions can be drawn.

Pathogen Contamination

The DEP estimates that 90.2% of Maine estuaries, bays and near shore waters fully support the uses of recreation in and on the water and the protection and propagation of fish, shellfish and wildlife. Of this total, there are 124 square miles (7.6%) of near shore waters which do not fully support these uses due to high bacteria levels.

The Department of Marine Resources is responsible for ensuring the safety of harvested shellfish. They are responsible for closing areas of shoreline which have been determined to be contaminated with elevated levels of bacteria or toxics. These closings are based on water samples collected in shallow water along the shore. As of February 1994, there were 238 closed shellfish areas, which is a net increase in number from the 1992 report. The Maine Coastal Nonpoint Program estimates that 41 of the total 238 closures are all or in part due to non-point sources rather than human sewage sources. Twenty-four areas closed at the time of the 1992 report are now open, while 29 new areas have been closed. During calendar year 1993, the DMR mandated 28 new closures and 16 new openings.

The DMR estimates that there are 434 square miles of Maine shoreline with shellfish harvesting resources. DMR has closed an estimated total of 151 square miles of these. Approximately 71 square miles of intertidal mudflats are productive enough for commercial harvesting of softshell clams. About 19 square miles (27%) of these "prime habitat" mudflats are closed to shellfish harvesting due to discharges of untreated or inadequately treated wastewater. See Table 4, Appendix II for more information on estuarine and marine waters with shellfishing impaired uses.

National Estuary Program

In April 1990, President Bush designated Casco Bay as part of the EPA National Estuary Program. The Casco Bay Estuary Project is involved in a broad spectrum of activities relating to the bay and to its watershed. These activities include watershed management and planning, public involvement, public education and outreach, and support for technical assistance, volunteer monitoring, restoration projects and scientific research. Much of the support is in the form of grants, ranging from "mini-grants" awarded mostly for educational efforts, to demonstration or planning grants, to larger grants for scientific research or development of environmental models.

In the context of this water quality assessment report, the CBEP activities can be divided into two distinct areas: those that increase our knowledge of the current water quality and ecology of Casco Bay (e.g., sampling, modeling, mapping), and those that will help the condition of the Bay in the longer term (e.g., planning, public education, restoration).

Water Quality and Ecology

Casco Bay Sediment Study:

The largest sampling effort funded by the CBEP to date is the Casco Bay Sediment Study, conducted by Texas A&M during 1991. Sixty-five sites representing the major sub-areas within Casco Bay were sampled for toxic organic compounds and metals. The pollutants of greatest concern were PAHs, PCBs, pesticides, and heavy metals.

The Inner Casco Bay area, which lies between the urban areas of greater Portland and the larger Casco Bay Islands, included the most highly contaminated individual sites, as well as the highest average levels of all pollutants. The rest of Casco Bay sample sites contained low levels of the pollutants measured, except for a few scattered "hot spots" located in the East Bay and Cape Small areas, in or near the New Meadows River. Although these "hot spots"

were high compared to the other nearby samples their levels of contaminants were near the averages for the Inner Bay samples.

Contamination levels of PCBs, DDT, chlordane and trace metals were low when compared to other sites along the East Coast. However, one sample site within the Fore River, which includes Portland Harbor, contained total PCBs at 485 parts per billion (ppb). Total PCB concentration above 400 ppb was reported by Long & Morgan (1990)[1] to elicit toxic responses in marine organisms.

PAHs found in the sediments were combustion-derived, rather than from spilled oil, except for two sites; one in the Fore River and one in the New Meadows River, which separates Harpswell from Phippsburg and West Bath. Within the Inner Casco Bay area adjacent to the urbanized portions of the watershed, PAH levels were comparable to other contaminated estuaries in the country.

CBEP is supporting a volunteer monitoring effort headed by the Friends of Casco Bay to regularly sample for standard water quality parameters, such as dissolved oxygen, salinity, pH and bacteria, at 66 locations across Casco Bay. The goal is to monitor the water quality status of the Bay, especially where the volunteer monitoring effort may help open shellfishing areas.

Three additional projects supported by CBEP warrant mention here, not for direct water quality sampling, but because they will increase our understanding of or ability to use scientific data regarding the quality of the Bay. The University of Maine is developing a circulation model for Casco Bay. The circulation model will describe the general circulation of the Bay, as well as determine the effect of the Kennebec River on the Bay. A private consultant is developing a nutrient and pathogen indicator loading model for Maquoit Bay (which, in 1988 suffered a shellfish kill thought to have resulted from an algal bloom). Although the Maquoit Bay model will be based largely on engineering evaluations and assumptions rather than actual data, a limited level of sampling is proposed for model verification. Grant support has also been provided for an effort to create Geographic Information System (GIS) maps and layers for significant features of the natural environment and locations of significant human activities, especially locations of point sources of pollution or known contaminated sites. As GIS systems become more accessible and comprehensive, scientists, government officials, planners and other interested people will be able to make better judgments of existing data and needs for additional data.

A request for proposals was published in March 1994 for further study of dioxin and organotins in Casco Bay sediments to augment the 1991 CBEP sediment toxics study. Dioxin is a chemical by-product of manufacturing processes that use chlorine, while tributyl tin is an organotin used in some marine paints to retard growth of bio-fouling organisms.

Watershed Planning, Public Education, Technical Assistance, Restoration

The Preliminary Comprehensive Conservation and Management Plan was completed in October 1992, with the final Plan due in September 1995. The CBEP funded a thorough review of comprehensive plans for the towns (24) in the lower portion of the Casco bay watershed. Included in the report were recommendations for improving or providing better protection of water quality in the Bay or its contributory streams. In November 1992, the CBEP produced a discussion paper detailing the options for a Casco Bay watershed management system.

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[1] Long, E. R. and L. G. Morgan. 1990. The Potential for Biological Effects of Sediment-Sorbed Contaminants Tested in the National Status and Trends Program. NOAA Technical Memorandum NOS OMA 52. NOAA Office of Oceanographic and Marine Assessment, Ocean Assessment Division, Seattle WA. 175pp and appendices.

The CBEP has awarded a total of $130,654 in local government grants to 12 towns, for projects mostly involving planning, ordinances, BMP development & implementation, or restoration projects.

Public Education and Outreach mini-grants totaling $33,003 have been awarded to non-profit organizations, high schools, governmental organizations and private consultants to produce educational materials, such as videos, computer programs, maps and various types of written information. The CBEP has produced: four fact sheets on Casco Bay, effects of pollution on the Bay and ways to eliminate or reduce pollution; a State of the Bay report to highlight the need for knowledge and actions to clean up or control pollution in the Bay; and other publications such as bibliographies.

Chapter 6 - Assessment of Maine Wetlands

Background

The Maine Wetlands Conservation Priority Plan, prepared by the Maine Department of Conservation, Bureau of Parks and Recreation and the Maine State Planning Office, estimates that Maine is 25% wetland.

Maine wetlands may be grouped into three major categories: palustrine (freshwater) wetlands, including marshes, swamps and peatlands; saline (salt water) wetlands, including salt marshes, most rocky shores and a significant percentage of tidal marshes; and; brackish wetlands including many tidal flats and fringing brackish marshes, especially on tidal rivers.

Wetlands serve many useful purposes. They mitigate the effects of flooding by storing flood water and slowly discharging the excess water after the flood peak. Upland wetlands may recharge ground water while many wetlands serve as areas of ground water discharge. Wetlands associated with water bodies control shoreline erosion. Wetlands cleanse water of sediments and waterborne nutrients. Wetlands provide habitat for plants (some of them rare), fish and wildlife. Many wetlands (e.g., peat bogs) have potential resource value. Wetlands are also becoming more important to society for their recreational value.

This report uses the United States Fish and Wildlife Service (USF&WS) definition of wetlands which requires one or more of the following three attributes: at least periodically, the land supports predominantly hydrophytes (plants adapted to saturated soils); the substrate is predominantly hydric soil; or the substrate is non-soil and is saturated with water at some time during the growing season.

Five categories of Maine wetlands include those attributes:

1. areas such as marshes, swamps or bogs that possess both hydric soils and hydrophytes;

2. flats with hydric soils, but where drastic water level fluctuations, wave action, turbidity or salinity may preclude hydrophytes;

3. shore areas of new impoundments where hydrophytes exist, but hydric soils have not yet developed;

4. areas lacking soils but with hydrophytes, such as seaweed covered rocky shores; and,

5. areas such as gravel beaches and rocky shores with neither soil nor hydrophytes.

Table 3-6.1 details the areas of wetlands, by type, presented in the Maine Wetlands Conservation Priority Plan. Five different sources of data were used to create that table: the National Wetland Inventory (NWI) completed by the USF&WS; the Salt Marsh Inventory (SMI) completed by the University of Maine, Orono and the Maine Geological Survey; Maine Wetland Inventory (MWI), a ten year survey begun in 1963 by the Maine Department of Inland Fisheries and Wildlife; United States Department of Agriculture, Soil Conservation Service (SCS) mapping of Maine soils; and, estimates of peatland ecosystems from work done by the Maine Office of Energy Resources (OER) and the DEP.

Table 3-6.1. Acres of Wetlands by Type in Maine.

Wetland Types	Acres	Source	State Estimate
Saline Wetlands			
Tidal Flat	28,837	NWI	35,000
Rocky Shore	21,521	NWI	22,000
Beach/Bar	2,897	NWI	4,000
Reef	108	NWI	500
Aquatic Bed	6,202	NWI	7,000
Salt Marsh	18,960	SMI	19,000
Total			**87,500**
Brackish Wetlands			
Tidal Flat	41,700	NWI	45,000
Rocky Shore	2,911	NWI	3,000
Beach/Bar	1,089	NWI	2,500
Reef	138	NWI	500
Aquatic Bed	2,729	NWI	4,000
Fresh/Brackish Marsh	12,861	NWI	15,000
Total			**70,000**
Palustrine Wetlands			
Floodplains/Flats	10,249	MWI	27,700
Inland Fresh Meadows	58,772	MWI	158,843
Inland Fresh Marsh	57,602	MWI	155,140
Shrub Swamp		SCS	1,000,000
Wooded Swamp		SCS	3,000,000
Bog	700,000	OER/DEP	700,000
Total			**5,041,683**
Total Estimated Wetlands			**5,199,183**

Five sources of data were needed to create Table 3-6.1 because no single inventory provides an accurate estimate of acres or numbers of all Maine wetlands by type. All previous inventories were either conducted for different purposes; used dissimilar wetland classifications and definitions; covered different geographic regions; used different map scales and considered wetlands above different threshold areas; were conducted at different times; did not provide a mechanism for updating data (with the exception of the MWI); or, failed to evaluate biological diversity in the wetlands (i.e., the inventory did not evaluate endangered or threatened species due to the large scale of resolution used).

Trends in Wetlands Loss

Maine, like the rest of the United States, has experienced a loss of wetlands since colonial times. The Draft Wetlands Loss Report in the National Wetlands Inventory, estimates that Maine has lost 20% of its wetlands since about 1780 (Table 3-6.2).

Table 3-6.2. Maine Wetlands Loss Since circa 1780s.[1]

Estimate of Original Wetlands circa 1780s	% of State Surface Area[2]	Wetlands Estimate of Existing Wetlands circa 1980s	% of State Surface Area	% Loss of Wetland
6,460,000	30.4%	5,199,183	24.5%	- 20%

[1] From Draft Wetland Loss Report, National Wetlands Inventory, USF&WS.
[2] Based on an estimate of 21,257,600 acres total State surface area

The history of Maine has evolved around the state's plentiful water resources. The first settlers and their descendants established their homes on Maine seashores and major rivers to take advantage of the plentiful fishery resource. Maine waters were also used for transportation and hydropower.

As the small settlements grew to towns and cities, wetlands were filled and converted to farm land or property for development and residences. Cities such as Gardiner, Hallowell and Augusta developed on the floodplain of the Kennebec River.

The Maine Wetlands Conservation Priority Plan listed the following types of wetland alteration as contributors to wetland loss.

1. **Commercial, Residential and Urban Development:** These types of development cause wetland loss as "wastelands" are "improved" for construction; and perhaps even more importantly by such secondary impacts as stormwater runoff, industrial or agricultural pollution and habitat degradation.

2. **Transportation and Roads:** There has been and continues to be a need for development and growth in Maine which requires transportation systems and roads that will conflict with wetland protection efforts. Currently, there are about 22,000 miles of publicly owned roads in Maine. Most of the road construction in Maine during the last 40-50 years has been through the upgrading of dirt roads.

3. **Floodplain Development:** Historically, urban development centered on floodplains. Federal floodplain management guidelines and state shoreland protection amendments now discourage floodplain development.

4. **Navigation:** Dredging activities in Maine marine and estuarine waters resulted in disruption of wetlands when dredge spoils were placed on salt marshes. Dredging also disrupted intertidal or subtidal shellfish habitat, or curbed the accretion rate of salt marsh relative to sea level rise.
5. **Hydropower Development/Water Storage:** The construction of dams for hydropower and water storage may have contributed to some of the most extensive wetland losses in the state.

6. **Pollution:** The discharge of pollutants to wetlands may not necessarily destroy the wetland, but may have a harmful effect on the use of the wetland. As an example, the

potential discharge of pathogenic microorganisms to shellfish harvesting areas from wastewater treatment facilities has resulted in closure of numerous shellfishing areas.

Landfills and hazardous waste disposal in or near wetlands have also adversely affected wetlands. There are many documented cases in Maine of hazardous waste disposal in or near wetlands. With this kind of impact, the wetland itself may remain, but its vital functions can be lost or irrevocably degraded. Such effects may require the destruction or filling of the wetland to contain the contaminants or to remove them to a safe disposal site. Maine has six sites on the EPA National Priority List of Hazardous Waste Sites, "Superfund" sites. Several other sites have been designated as "Uncontrolled Hazardous Substance Sites" by the DEP, and numerous other potential hazardous waste sites are under investigation.

Of the Superfund sites, two are known to include some wetlands - the Saco Tannery Pits and the Winthrop Landfill. Other state-designated or potential sites which have affected wetlands include: the Brunswick Naval Air Station, the North Berwick Municipal Garage, the Portsmouth Naval Shipyard, the Dauphin Dump (Bath), the Callahan Mine (Cape Rosier), Southern Maine Metal Finishing (Waterboro) and Maine Oil Recycling (Buckfield). About one quarter of Maine's hazardous waste sites contain wetlands which have been impacted by these materials, although the total acreage impacted is rather small.

7. **Peat Mining:** At least ten sites in Maine have been or are now being harvested for peat.

8. **Timber Harvesting:** Timber harvesting in Maine wetlands is usually done during the winter months when access is favorable. Habitat loss is the immediate effect of timber harvesting in Maine, but perhaps more importantly, timber harvesting is often a prelude to the conversion of forested wetlands to other uses.

9. **Agriculture:** Many farms are located along river valleys to make use of rich floodplain soils. Additionally, some wetland soils have been drained to create farmland.

Numerous studies of Maine wetlands have been completed. The following five case studies are quoted from the Wetlands Conservation Priority Plan:

USF&WS 1965 Coastal Wetlands Inventory of Maine

A re-survey of coastal wetlands was undertaken by the USF&WS in 1964 as a follow up to their 1953 wetlands inventory in Maine. The 1953 inventory attempted to determine the location, quality and acreage of the wetlands (over 40 acres in size) used by wildlife. Inventory efforts focused on regions containing 90% of the wetlands of importance to waterfowl. The re-survey attempted to determine acreage of coastal wetlands physically lost since the first survey. Only 50 acres of loss was documented (half in marshes and half in mudflats) representing 1% of their original surveyed areas in the coastal zone of which 84% are mudflats. The study was designed primarily to document losses of marshlands, resulting in a more conservative estimate of losses of mudflats or permanent water areas.

The clear trends from this study are:

1. All of the documented wetland losses were in York and Cumberland Counties. Other counties have also experienced wetland losses, but these were not quantified.

2. Although most of the loses were in coastal marshes, there was some loss in mudflats or open fresh water. Losses or disturbance of submerged wetlands (via dredging, etc.) was not documented.

3. Deterioration of the quality of many marshes and declines in their productivity were documented and included these causes:

   a) siltation from adjacent fill;
   b) deliberate or incidental diking;
   c) drainage;
   d) mosquito control;
   e) pollution effects were not measured but were noted; and
   f) increased development in marsh areas placing stress on resident waterfowl populations.

4. Population growth and industrialization were the major causes of wetland loss. Half of the loss was due to fill derived from dredging for channel and harbor maintenance or improvement or from marina and dock construction. Most of the fill was ultimately used for housing, industry or similar activities.

5. More wetlands were considered vulnerable to destruction. Specific, identifiable threats (power projects impoundments) affected the vulnerability of wetlands in certain counties more than others.

USF&WS Report on Unauthorized Wetland Filling in Wells, Maine

A 1974 Army Corps of Engineers (the Corps) permit to Wells Sanitary District to install and maintain four sewer line crossings of waters and wetlands in Wells was approved with the stipulation that dredge or fill material not be deposited on regularly and irregularly flooded marshlands. A series of small unauthorized fill violations ensued in Wells, all of which were linked to the installation of a sewage treatment plant and related sewer lines and interceptors in the town, permitted by the Corps in 1974. At least 30 violations were documented, all of which included placement of fill on salt marsh or freshwater wetland habitats, and many of which caused direct disturbance to the edges of the Rachel Carson National Wildlife Refuge. In most cases, it was recommended that illegal fill be removed and restorative measures be taken. In some cases, the fill was grandfathered, or permitted after the fact. These violations alone probably directly affected approximately 10 acres of salt marsh habitat.

A Study of Habitat Changes in Five Coastal Towns (Arbuckle and Lee, 1987)

For the towns of Scarborough, Damariscotta, Rockport, Trenton and Machias, a comparative study of the cumulative impacts of development on five different land types including fresh and saltwater wetlands was done via aerial photo analysis for the time period from the 1950s to the present. Wetland acreage losses could not be precisely measured in this study, but certain important trends were documented. The report states: "Although wetlands have not been substantially altered over the past three decades, riparian areas surrounding them are rapidly being developed". Quite often, the edges of coastal marshes or other wetlands were developed, cleared or filled, reducing the availability of these areas for wildlife, often resulting in secondary negative impacts to wetlands such as nonpoint source pollution. Where losses occurred, they were generally small and incremental, and usually did not require coastal wetland permits.

Permits reviewed by the Wetland Control Board, 1967 - 1973

The Wetlands Control Board, administered by the Department of Marine Resources , was the body which issued permits for regulated activities in the coastal plain prior to the adoption of the core laws of the Maine Coastal Program. Activities which received permits ranged from filling of a wetland area for the construction of the Maine Yankee nuclear power plant, to ditching for mosquito control. Other approved activities were: filling for parking areas, marina expansion, wharf and pier construction; construction of sewage treatment systems; dredging of rivers and harbors; the construction of bulkheads, rip rap and embankments; fill over dump areas or miscellaneous debris; and various fills to prevent erosion.

Most of the permitted activities were for bulkheads, seawalls, rip rap, retaining walls and piers. Filling strictly for the construction of housing sites was generally denied. The actual extent of marsh, intertidal flats or wetland types altered was not recorded, but generally involved salt marsh, intertidal flats and sand beach/dune systems.

Review of Recent Coastal Wetland Fills under the Alteration of Coastal Wetlands Act (Giffen, 1988)

Giffen reviewed approximately 10% of the coastal wetlands cases decided in the last five years, as well as all cases involving large areas of wetland fill. He found that the Board and Department of Environmental Protection "approached the wetland fill cases quite consistently and rigorously": that request for filling was the most commonly denied activity; that "among wetland types, marshes were less likely to be affected by proposed alterations than rocky shorelines or flats"; and, that "very few substantial coastal wetland fills have been approved". According to DEP staff, only six cases in the 20 years since the enactment of the law had filling greater than one acre approved. Four of these six "were for highway improvements or public port facilities", and " where substantial fills were allowed, mitigation was generally required." Finally, "persons who violated the law by illegally filling coastal wetlands have been subject to stiff penalties."

Wetlands Management Program

Numerous State and local statutes, regulations and performance standards protect Maine wetlands, including the following:

I. The Natural Resources Protection Act (NRPA)

The intent of the NRPA is to prevent the degradation or destruction and to encourage the enhancement of protected natural resource areas. In recognition of the important roles of wetlands in our natural environment, the DEP supports the nation-wide goal of no net loss of wetland functions and values. In some cases, however, the level of mitigation necessary to achieve this goal will not be practicable, or will not have a significant effect on protecting wetland resources. In other cases, the preservation of unprotected wetlands or adjacent uplands may achieve a greater level of protection to the environment. Therefore, the DEP recognizes that a loss in wetland functions and values may not be avoided in every instance.

Permits are required for: dredging, bulldozing, removing, or displacing soil, sand, vegetation, or other materials; draining or otherwise dewatering; filling; and constructing, repairing, or altering a permanent structure in a protected wetland area.

The NRPA requires that any proposed activity must not: unreasonably interfere with existing scenic, aesthetic, recreational, or navigational uses; cause unreasonable erosion of soil or

sediment, or prevent naturally occurring erosion; unreasonably harm any wildlife or aquatic habitat; unreasonably interfere with the natural flow of any surface or subsurface waters; lower water quality; cause or increase flooding; unreasonably interfere with sand supply or movement or increase erosion on sand dunes; or, establish any permanent structure that crosses a river segment identified in the law as "outstanding", unless no other alternative exists that would have less adverse impact on the river.

Maine's Wetland Protection Regulations became effective June 30, 1990. They apply to coastal wetlands, great ponds, freshwater wetlands, and floodplain wetlands of any river, stream, or brook. Wetlands are classified as follows:

"D. Classification of Wetlands

For the purposes of this chapter, wetlands shall be classified by the Department as Class I, Class II, or Class III as follows:

1. Class I. A Class I wetland has one or more of the following characteristics:

a. Is a coastal wetland or great pond;

b. Contains endangered or threatened plant species on the Official List of Endangered and Threatened Plants of the State of Maine, based on documentation of current or past observations of occurrence;

c. Contains a palustrine (freshwater wetland) natural community listed on the Maine Natural Community Classification and ranked S1 or S2 (20 or fewer documented occurrences in Maine); or

d. Contains any of the following areas, whether or not mapped: Habitat for species appearing on the official state or federal lists of endangered or threatened species where there has been evidence of the occurrence of the species; high and moderate value deer wintering areas and travel corridors as defined by the Department of Inland Fisheries and Wildlife; high and moderate value waterfowl and wading bird habitat, including nesting and feeding areas as defined by the Department of Inland Fisheries & Wildlife; critical spawning and nursery areas for Atlantic sea run salmon as defined by the Atlantic Sea Run Salmon Commission; and shorebird nesting, feeding, and staging areas and seabird nesting islands as defined by the Department of Inland Fisheries and Wildlife.

NOTE: the above list is consistent with the definition of Significant Wildlife Habitat in 38 M.R.S.A. Sec. 480-B(10), except that the areas do not have to be mapped. This provision to not require mapping is consistent with PL 1990, c. 838, Sec. 4. since the habitat areas must all be contained within another protected resource; i.e., wetlands.

2. Class II. A Class II wetland does not contain any characteristics of a Class I wetland, but does contain one or more of the following characteristics:

a. Is located within 250 feet of a coastal wetland;

b. Is located within 250 feet of the normal high water line, and within the same watershed, of any lake or pond classified as GPA under 38 M.R.S.A. Sec. 465-A;

c. Is located within 250 feet of the normal high water line, and is contiguous to a river, stream, or brook, including any impoundments not classified as GPA;

NOTE: More than one classification may apply to the same wetland, depending on the distance to a water body. As an example, only that portion of a wetland that is within 250 feet of the normal high water line of a coastal wetland shall be treated as Class II wetland, unless it contains other Class I or Class II attributes.

d. Contains at least 20,000 square feet of aquatic vegetation, emergent marsh vegetation or open water during most of the growing season in most years;

e. Is a bog consisting of peatland dominated by ericaceous shrubs (heath family), sedges, and sphagnum moss and usually having a saturated water regime; or,

f. Is a floodplain wetland.

3. Class III. A Class III wetland does not contain any characteristics of a Class I or Class II wetland.

NOTE: Examples of typical Class III wetlands include wet meadows and wooded swamps which are not contiguous to any protected natural resource."

Wetland boundaries are identified based on vegetation and hydrology, which in many cases requires technical expertise. Wetlands mapping in the state is currently being done by the USF&WS for the Maine Wetlands inventory and is nearly complete. Maine does not require municipalities to complete wetland resource inventories. DEP is available to provide technical assistance to any municipality willing to complete an inventory.

II. Mandatory Shoreland Zoning Act

The Mandatory Shoreland Zoning Act, amended in 1989, requires municipalities to establish land use controls for all land areas within 250 feet of ponds and freshwater wetlands that are 10 acres or larger, rivers with watersheds of at least 25 square miles in drainage area, coastal wetlands, and tidal waters, as well as all land areas within 75 feet of certain streams.

The intent of the law is to protect water quality, wildlife habitat, wetlands, archaeological sites and historic resources, and commercial fishing and maritime industries, and to conserve shore cover, public access, natural beauty, and open space. Local shoreland zoning ordinances (which meet or exceed the State model ordinance) and maps serve to implement the law. Municipalities are empowered to adopt, administer, and enforce a shoreland zoning ordinance and map for their areas of jurisdiction. The state's primary role, through the DEP, is to provide technical assistance in the adoption, administration, and enforcement of local ordinances.

If a municipality has not adopted its own shoreland zoning ordinance, the state will impose the model ordinance. The model ordinance divides the shoreland zone into six land use districts: resource protection, limited residential, limited commercial, general development, commercial fisheries/maritime activities, and stream protection. The model ordinance contains numerous standards for shoreland development activities including: minimum lot area and frontage; structure setbacks; clearing limitations; timber harvesting limitations; erosion and sedimentation control; sewage disposal; and, provisions for non-conforming uses. All land use activities -- even those not requiring a permit -- must comply with all the applicable land use standards described in the ordinance.

III. Dam Registration, Abandonment and Water Level Act

In 1983, the Legislature passed the Dam Inspection, Registration, and Abandonment Act, which updated and consolidated Maine laws dealing with the inspection of dams and abandoned and neglected dams. In 1989, the safety provisions of the law were transferred to a different agency, and the remaining law was renamed the Dam Registration, Abandonment, and Water Level Act (the "Act"). In October 1993, the Act was again changed, by repeal of the dam registration requirement and the provision for award of abandoned dams to new owners.

The remaining purpose of the Act is establish procedures for setting water levels and minimum flows at dams. Under the Act, a water level regime and minimum flow requirement may be set by a municipality, or upon petition, by the Board of Environmental Protection to: maintain public rights of access to and use of state waters; protect the safety of shoreline landowners and the general public; maintain fish and wildlife habitat and water quality; prevent excessive shoreline erosion; accommodate rainfall and runoff; maintain public and private water supplies; and, maintain any use of the dam in power generation.

IV. Site Location of Development Law

The Site Location of Development Law regulates large developments and activities which may "substantially affect the environment". Applications for approval of projects are evaluated to ensure performance standards are met.

Water Quality Standards

Maine has not been delegated authority to approve permits for the disposal of dredged fill material under Section 404 of the Clean Water Act (CWA). Water Quality Certificates for the alteration of wetlands are issued only if the standards outlined in Section 401 of the CWA are met. Regulations have not been promulgated to specify how Water Quality Certifications are processed.

Maine is in the process of developing State wetland water quality standards. When complete, these standards will provide the same level of regulatory protection to wetlands as other state waters. The process is in the beginning stages. Table 3-6.3 summarizes what Maine has accomplished in developing the wetland water quality standards.

Table 3-6.3. Development of Wetland Water Quality Standards for Maine.

Use Classification:	In Place	Under Development	Proposed
Narrative Biocriteria		X	
Numeric Biocriteria		X	
Anti-degradation		X	
Implementation Method		X	

The long-term success of the Maine wetlands protection program will depend on the extent to which wetlands protection efforts are incorporated into existing and new environmental programs. As previously stated, wetland protection authority exists at the state and local levels. Other existing regulatory programs are adopting wetland protection components in their work plans. For example, the Maine nonpoint source pollution control program proposes to evaluate the impacts of non-point source pollution on wetlands and determine the effectiveness of using engineered wetlands (i.e., wet ponds/nutrient-sediment basins) to treat nutrient runoff from agricultural fields.

Waters Affected by Toxics

The extent of waters in Maine thought to be affected by toxics is presented in Table 3-7.1.

Table 3-7.1. Extent of Surface Waters Affected by Toxics in Maine.

Waterbody Type	Extent of Waters Monitored for Toxics	Extent of Waters With Elevated Levels of Toxics
Rivers (miles)	865	223
Lakes[1] (acres)	38,106	400
Estuaries (miles^2)	10	10
Coastal waters (miles)	0	0
Great Lakes (miles)	N/A	N/A
Freshwater wetlands (acres)	3	0
Tidal wetlands (acres)	0	0

[1] Lake acres currently have no advisories issued.

In 1989, the Natural Resources Council of Maine introduced a toxics bill to the Maine Legislature which proposed to adopt the EPA numeric criteria for in-stream priority pollutants. In 1990 the Maine Legislature adopted this bill. In addition to adopting EPA water quality criteria for toxic pollutants, the bill also allowed for the use of site-specific criteria.

Public Health Impacts

The most important public health concern regarding toxic pollutants in surface waters is their possible presence in public drinking water supplies. In 1987, Maine had its first closure of a public surface water supplier due to toxics. The Town of Howland has traditionally used the Piscataquis River as its drinking water supply. Chemical analysis of the river water determined that levels of TRIS (1,3-dichloroisopropylphosphate) exceeded drinking water standards, and the water supply was closed. During 1990, Howland discontinued all use of Piscataquis River water and tied in with the town of Lincoln for drinking water. The safety of swimming and consumption of fish and shellfish are two other major public health concerns of surface waters in Maine. The revision of Maine water quality standards in 1986 included health-effects based standards for recreational water quality as recommended by EPA.

Implementation of these standards has several components: 1) water quality monitoring, 2) data analysis and identification of waters unsafe for swimming, 3) establishment of area closures and/or advisories, 4) public education, and 5) development of action plans for reduction of bacteria levels, where necessary. Even if Maine fully attains the interim goals of the Clean Water Act through the construction of more facilities for the collection and treatment of wastewater, occasional facility malfunctions will still cause some waters to be temporarily unsafe for swimming.

Waterbodies in Maine with sediments known to be contaminated by toxics are listed in Table 3-7.2. Although the sediments of these waterbodies are known to be contaminated with hazardous

materials, the DEP is unsure of how this relates to the overall water quality of each. For this reason, the list of waterbodies contaminated by sediments is not reflected in the Water Quality Designations (Chapter 4) of Appendix I. Maine anticipates that each site will undergo remediation.

Table 3-7.2. Waterbodies in Maine with Sediments Contaminated by Toxics.

Date	Waterbody	Extent	Pollutant	Source
1988	Annabessacook Lake[1]	400 Acres	Dimethyl formamide Toluene & TCE	Winthrop Landfill (Superfund site)
1987	Dennys River	0.1 Mile	PCBs	Salvage yard
1987	Cooks Brook	2 Miles	Cadmium	Metal finishing and plating facility
1989	Piscataquis River	1.5 Miles	TRIS & other organics	Textile mill
1988	Quiggle Brook	6 Miles	Chlorinated solvents	"Recycling" facility (Superfund site)
1985	Riggs Brook	0.5 Mile	PCBs	Salvage yard
1977	Silver Lake[1]	16 Acres	Copper	Copper sulfate program
1991	Androscoggin River	124 Miles	Dioxin	Bleached Kraft Mills

[1] Lakes currently have no advisories in effect.

Since 1982, the DEP has been conducting fish tissue analyses to determine whether fish are safe for human consumption. The compound of greatest concern in Maine surface waters is dioxin. In 1984 through 1986 as part of the EPA National Dioxin Study, fish from several Maine rivers below industries were found to be contaminated with dioxin and furan (2367-TCDD and 2378-TCDF). Based on these limited data, fish consumption advisories were issued by the Department of Human Services. In 1988, the Maine Legislature established the Maine Dioxin Monitoring Program to collect more data to assess the extent of the problem in Maine. This program required DEP to collect sludge and fish below no more than 12 industrial or municipal wastewater discharges to be monitored for dioxin and furan.

In past years, state toxicologists have warned that as a result of elevated dioxin levels pregnant women should avoid eating fish from the Androscoggin, Kennebec below Skowhegan, Penobscot below Lincoln, Presumpscot below Westbrook, and the West Branch of the Sebasticook below Hartland. The general public was advised to eat no more than two meals of fish per year from the Androscoggin and five from that section of the Kennebec.

Fish tissue analysis in 1993 for dioxin and furan showed a decline from earlier levels at all stations. Advisories have subsequently been lifted from the Presumpscot River (7 miles), and the West Branch of the Sebasticook River (13 miles). The recommended consumption rates for the general public were increased on the affected sections of the Androscoggin, Kennebec, and Penobscot Rivers. The US. Fish and Wildlife Service also monitors fish in Maine for contaminants, but data from these studies are not yet available. Presently, there are no other state agencies monitoring toxics in fish tissue. The DEP plans to continue its dioxin monitoring program until 1995.

In 1992 the Maine Legislature passed a bill which requires the DEP, with the help of a special advisory group, to collate available toxics information and recommend additional programs which may be necessary to address toxics issues. This was completed and a report, "Implementation of a Comprehensive Surface Water Ambient Toxic Monitoring Program" was presented to the Legislature in 1993. Legislation to implement the findings of this study was presented to the legislature and will be considered in its second session in 1994.

Table 3-7.3 lists fish consumption advisories presently in effect in Maine.

Table 3-7.3. Fish Consumption Advisories in Effect in Maine.

Name of Waterbody	Pollutant(s) of Concern	Source(s) of Pollutants	Size Affected
Androscoggin River	Dioxin	Kraft Pulp & Paper Mills	124 miles
Kennebec River	Dioxin	Kraft Pulp & Paper Mill	56 miles
Penobscot River	Dioxin	Kraft Pulp & Paper Mills	56 miles

Occasional samples of fish from Maine inland waters have had levels of mercury in excess of FDA standards. These have been reported from lake trout in northern Maine collected from watersheds without point source discharges. Mercury in two chain pickerel from Annabessacook Lake, a Superfund site, exceeded the FDA level however, since the sample size was small this data was not considered sufficient for an advisory. Mean values for all fish collected have traditionally been less than FDA action levels. Recent studies of Maine bald eagles have shown very high levels of mercury. Because of the mercury data and other information about toxics in Maine fish and wildlife (e.g. lead in loons, PCB's in fish), the DEP was successful in securing a research grant through the Regional Environmental Monitoring and Assessment Program (REMAP) to assess contamination of fish and sediments in Maine lakes. This study is proceeding but only preliminary results are available at this time. It is expected that Maine will issue an advisory in 1994 regarding consumption of fish from Maine lakes due to mercury contamination.

Another public health concern associated with surface waters are the health-effects of shellfish consumption. The Maine Department of Marine Resources (DMR) regularly determines bacteria levels in shellfish harvesting areas as required by the National Shellfish Sanitation Program. Harvesting areas which are closed due to pollution are patrolled by State and local marine wardens to prevent illegal harvesting of shellfish, thereby protecting consumers.

There were two swimming advisories issued in 1993 due to pollution. An advisory was issued at Old Orchard Beach when the sewage treatment plant had a malfunction. In Casco Bay, Peaks Island beach was also closed during the summer months due to the discharge of raw sewage. There were no reported cases of waterborne disease in this reporting cycle.

Aquatic Life Impacts

Maine has developed a multivariate model for assessing aquatic life standards using benthic macroinvertebrates for the analysis. This has led to the documentation of a number of waters in the state which do not attain their classification standard but which were not detectable using traditional chemical measurements. Several sites have been identified where contaminated ground water was affecting the benthic communities. The most notable finding using these techniques has been the identification of segments below certain hydroelectric impoundments where aquatic life standards are not met. The most affected sites are those which operate for peaking power, thus causing significant daily flow alteration. These findings have led to the imposition of minimum (and sometimes maximum) flow requirements at some facilities as part of water quality certification in FERC relicensing activities.

Fish kills in Maine have been on the decline for many years as treatment has been imposed and BMPs implemented for agricultural practices. In 1992, Maine finally achieved a perfect record with no pollution-related fish kills occurring in the state for that year. This is the first time in memory that this has been achieved and represents an important milestone in the State's water quality program. Unfortunately, the record could not be sustained in 1993 and two small kills were documented. Table 3-7.4 provides a report of fish kills and their causes for 1992-1993.

Table 3-7.4. Pollution-Related Fish Kills in Maine: 1992 and 1993.

Waterbody	Town	Date	Species	Estimated Number	Cause
Rocky Brook	Mars Hill	8/3/93	brook trout	<50	Pesticides
Mattanawcook Stream	Lincoln	8/24/93	Mixed	<50	Caustic wastewater

Section 303(d) Waters

Section 303(d) of the Clean Water Act requires that Maine identify waterbody segments which do not or will not meet state water quality standards even after the implementation of technology based controls for both point sources and non-point sources of pollution. This list should include, not only waterbody segments which do not attain water quality standards, but also those which are in attainment but are considered to be threatened. The identification process will subsequently require the establishment of Total Maximum Daily Loads (TMDLs) in order to assure the attainment of water quality standards.

Maine must identify priority waters for which it will develop TMDLs within the next two years. Considerations will be primarily target geographically, but pending NPDES permits and treatment plant construction proposals will also be considered. TMDLs for point sources may consist of discharge limitations, while those for non-point sources may include activities that control factors causing non-attainment.

In the development of the 303(d) list, the 1992 305(b) Water Quality Assessment report, including the 304(l) lists, the 314(a) Clean Lakes list and the 319 State Non-Point Source Assessment were all reviewed. Some waterbodies included on these lists generally do not attain water quality standards because of activities that have no technology-based controls. Lakes selected for the list include those lakes identified on the water quality assessment as failing to meet GPA standards due to repeated blue-green algal blooms or a demonstrated trend of increasing trophic state. Also included are several lakes which are viewed as particularly threatened and for which a TMDL-type process may be appropriate.

Tables 1, 2 and 3 of Appendix II contain the lists of waterbodies needing TMDLs. These draft lists will be posted for public comment, after which final lists will be submitted to EPA for review. The priority waterbodies are also identified. In addition to the listed lakes, TMDL-type areal phosphorus allocations for new development sources will be generated for a number of other lakes as part of the state technical assistance program. Many of these lakes will not be on the 303(d) list, but will be prioritized for action based on the need for protection and demonstrated local interest.

PART IV: GROUND WATER ASSESSMENT

Chapter 1 - Overview

Public interest in ground water focuses primarily on its use as a drinking water supply for humans and livestock and as a source of process water for industry. More than 60% of Maine households draw their drinking water from ground water supplied from private wells, public wells, or springs. Ground water is the source of approximately 98% of all the water used by households with individual supplies. In addition, approximately 60% of the water needed for Maine livestock is met by ground water. Industrial ground water use is slightly less than the volume withdrawn for drinking water. Additional federal requirements for surface water treatment are increasing the shift to ground water use for public water supplies.

Generally, the ground water supply in Maine is adequate. The total withdrawal of ground water by all water users is less than one percent of the annual ground water recharge each year. The remaining annual ground water recharge is lost through evapotranspiration or discharges to ponds, lakes, rivers, and streams.

Ground water in significant areas of the 11% of Maine that is not forested may be threatened by contamination. During the last decade, numerous wells in Maine have been made unpotable by nonpoint source pollution. As public concern about ground water quality increases, more widespread detection of contamination can be expected as efforts to monitor known and potential problems increase. Because of slow ground water flow rates and low biological activity, ground water contaminants are extremely persistent. Centuries may be required for natural processes to restore some contaminated ground water to potable standards.

In 1989, the State adopted the Maine Ground Water Management Strategy to articulate its ground water protection policy. In 1990, the State also formulated its Nonpoint Source Pollution Management Plan. This identifies the major sources of nonpoint source pollution to Maine ground water and surface water and proposes to implement pollution prevention programs during the next four years of the program.

Major impediments to effective ground water protection in Maine are (1) absence of an accurate ground water quality database to assess the extent of degradation, (2) lack of data to quantify the impact of some nonpoint pollution sources, (3) inadequate State and Federal funding for ground water research and ground water protection programs and (4) general public unfamiliarity with key ground water concepts and issues. Public misconception about ground water is probably the major factor contributing to degradation of this resource. The State of Maine will continue to work with EPA to address these issues through Maine's comprehensive Ground Water Protection Program.

Chapter 2 - Assessment of Ground Water Quality

Ground water in Maine is classified by its suitability for drinking water purposes. According to current Maine Statute, ground water is classified as either potable (GW-A) or unpotable (GW-B). Water is unpotable when the concentrations of chemical compounds detected exceed either the Maximum Contaminant Levels (MCL) or the Maximum Exposure Guidelines (MEG) as defined by the Maine Department of Human Services (DHS). Although there are many localities where ground water is unpotable and highly contaminated, no ground water is currently classified GW-B. The state is not currently attempting to designate non-attainment areas. An attempt in 1993 to identify areas of degraded water quality in the town of Brunswick in preparation for a GW-B designation was postponed due to legal considerations.

Detailed quantitative estimates of the statewide extent of ground water contamination are not now, and may never be available. In addition, current information about ground water contamination in Maine does not necessarily portray the situation accurately. This information reflects contaminants that have been looked for, where they have been looked for, and where they have been found. Further, the number of wells contaminated by a specific pollution activity does not necessarily reflect its overall ground water pollution potential since some activities (e.g., agriculture) occur in sparsely populated areas with few available wells to monitor.

Ground Water Monitoring

As elsewhere, monitoring of ground water in Maine is either site-specific or generalized. Monitoring at a particular site is generally done to gather data on water quality impacts of particular activities, and may or may not be research-related. The collection of ground water data in Maine is the result of permit conditions, enforcement agreements or impact assessments. This information is scattered in a number of state agencies including the DEP, Bureaus of Land and Water Quality, and Hazardous Materials and Solid Waste Control, the Department of Transportation, Well Claims Unit, the Department of Human Services, Division of Health Engineering, the DHS Environmental Health Unit, and the Department of Agriculture, Food and Rural Resources, Board of Pesticide Control. The data is stored on paper or in computer files. Much of these data are potentially useful for research purposes but not easily accessed by either the public or by other agencies. This problem is the subject of a three-phase study of ground water data management in Maine, the first two parts of which are completed. Phase II resulted in specific and detailed recommendations for a more efficient and accessible system. This effort is concurrent with the EPA-Maine data management pilot study aimed at improving data communication between the EPA, Maine and other state or federal agencies.

The term "generalized monitoring" is intended here to refer to large area, long-term monitoring conducted to obtain trend information on ground water quality or quantity. Such monitoring is generally carried out by the Maine Geological Survey and the U.S. Geological Survey (USGS) under one or another of several cooperative agreements. USGS maintains a statewide network of ground water observation wells to track changes in water quality and quantity. The data thus derived are incorporated into the maps and reports generated by the program and have proven invaluable to town planning boards and State efforts such as the registration of underground oil storage tanks and site reviews of various land use proposals.

Within the DEP, ground water data are obtained by sampling done either by Department staff, permit-holders or as the result of enforcement agreements. The Bureau of Land and Water Quality requires ground water monitoring by operators of some quarries, gravel pits, metallic mines, wood waste and fuel storage areas, infiltration basins and other permittees on a case-by-case basis. Similarly, the DEP Bureau of Hazardous Materials and Solid Waste Control (BHMSWC) requires periodic sampling and reporting various businesses or industries classified as hazardous waste storage facilities or under the terms of enforcement agreements. The samples

are generally tested in commercial laboratories according to EPA standards. BHMSWC field staff sample ground water to determine ground water quality impacts associated with uncontrolled hazardous waste sites, oil or fuel spills from stationary or mobile sources and from approved hazardous waste or hazardous materials storage facilities. BHMSWC also requires operators of landfills to sample ground water and report their findings to the DEP on a periodic basis. Some BHMSWC ground water monitoring is intended to help locate new water supplies to replace those polluted by gasoline.

Major Sources of Contamination

Almost all ground water contamination in Maine originates from nonpoint source pollution rather than point source pollution. Table 4-2.1 lists the major contaminants to ground water. Table 4-2.2 lists the major sources of ground water contamination in Maine.

Table 4-2.1. Ground Water Contaminants Detected in Maine.

Contaminant Category	Check	Relative Priority	Factors[1]
Organic Contaminants			
Pesticides	X	L	1,4,5
Petroleum Compounds	X	M-H	4
Other Organic Chemicals:			
Volatile	X	L	1,4,5
Semi-volatile	X	L	1,4,5
Microbial Contaminants			
Bacteria	X	L	
Protozoa			
Viruses			
Inorganic Contaminants			
Pesticides	X	L	1,4,5
Nitrate	X	M	2,4
Fluorides			
Brine/Salinity	X	L-M	5
Metals			
Arsenic	X	H	1
Radionuclides	X	H	1

[1]Factors for Establishing Relative Priority
1 areal extent of contamination
2 location of contamination relative to ground water used as drinking water
3 size of the population at risk from drinking water threatened by this contaminant
4 risk posed to human health and/or the environment from this contaminant
5 high priority in localized areas of the State, but not over majority of State
6 hydrogeologic sensitivity to this contaminant
7 findings of the Maine ground water protection strategy or other reports

Table 4-2.2. Major Potential Sources of Ground Water Contamination in Maine.

Source	Check	Relative Priority	Factors[1]
Animal Feedlots	X	L	5
Containers			
Deep Injection Wells	N/A		
De-Icing Salt Storage Piles	X	L	3
Fertilizer Applications	X	H	5
Irrigation Practices (return flow)			
Land Application			
Landfills (permitted)	X	H	4
Landfills (unpermitted)	X	H	4
Material Transfer Operations			
Material Stockpiles	X	L	1,5
Mining and Mine Drainage			
Pesticide Applications	X	M	1,4,5
Pipelines and Sewer Lines			
Radioactive Disposal Sites	X	L	1,4
Salt Water Intrusion	X	L	5
Septic Tanks	X	H	1,2,3
Shallow Injection Wells	X	M	1,2,4
Storage Tanks (above ground)	X	M	1,2,4
Storage Tanks (below ground)	X	H	1,2,4
Storm Water Drainage Wells	X	L	5
Surface Impoundments			
Transportation of Materials	X	L	1
Urban Runoff			
Waste Tailings			
Waste Piles (Manure Stockpiles)	X	L	3,5

[1]Factors for Establishing Relative Priority

(1) number of sources
(2) location of sources relative to ground water used as drinking water
(3) size of the population at risk from contaminated drinking water
(4) risk posed to human health and/or the environment from released substances
(5) high to very high priority in localized areas of Maine, but not over majority of State
(6) hydrogeologic sensitivity
(7) findings of the State ground water protection strategy or other reports

The following discussion focuses primarily on nonpoint contamination sources that appear to be responsible for most ground water contamination in the State: agriculture, hazardous waste spill sites, landfills, petroleum products and leaking underground storage tanks, road-salt storage and application, septic systems, saltwater intrusion, shallow well injection, and waste lagoons. In addition to these major sources, diverse land uses such as golf courses, cemeteries, dry cleaners, burned buildings, and automobile service stations are potential threats to ground water.

Petroleum Products and Leaking Underground Storage Tanks (LUST)

Currently, 470 petroleum LUST or spill sites are on DEP's priority list. Two hundred and fifty wells are contaminated by petroleum products at these sites. The DEP, BHMSWC responded to approximately 18,000 spill incidents and investigations between 1984 and 1992. Over 60% of these responses involved discharges of petroleum products to soil and ground water. Between 1990 and 1992, petroleum-related discharges contaminated over 200 private wells. Sources of petroleum discharges range from overturned tanker trailers to tank overfills. For the years 1990 through 1992, most of the discharges were from industrial sources (34%), and leaking underground storage tanks and associated piping (38%). LUST are viewed as the biggest threat to ground water quality in Maine. Home heating oil storage tanks are a significant contributor to ground water contamination due the leakage of stored petroleum products. The most common petroleum product stored in underground storage tanks is fuel oil followed by gasoline. Although fuel oil and gasoline are not classified as hazardous substances, many of their constituent compounds, such as benzene, are carcinogens at very low concentrations.

To control the LUST threat, in 1985 the Maine Legislature passed a law to regulate underground petroleum storage tanks. This law required registration with DEP of all tanks by May 1, 1986, regardless of size, use, or contents. The law also established procedures for abandonment of tanks and prohibits the operation, maintenance, or storage of petroleum in any storage facility or tank that is not constructed of fiberglass, cathodically protected steel, or other non-corrosive material after:

A. October 1, 1989, if that facility or tank is more than 15 years old and is located in a sensitive geological area;

B. October 1, 1991, if that facility or tank is more than 25 years old, or if that facility or tank is more than 15 years old and is located in a sensitive geological area;

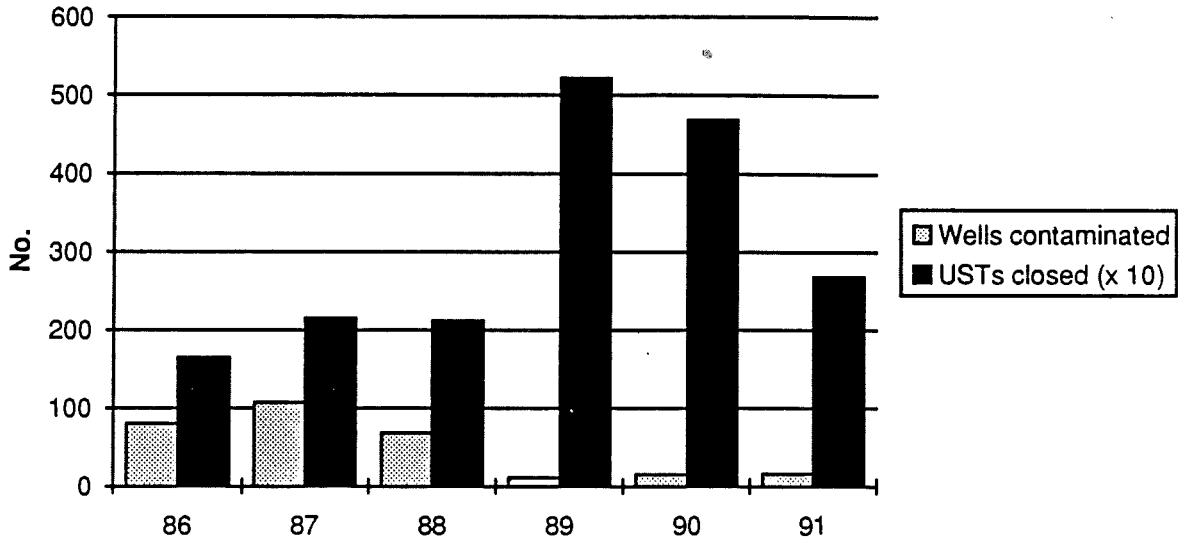
C. October 1, 1994, if that facility or tank is more than 20 years old, or if that facility or tank is more than 15 years old and is located in a sensitive geological area; and,

D. October 1, 1998, for all remaining unprotected facilities or tanks.

If the age of the underground tank(s) cannot be determined, it is presumed to be 20 years old as of October 1, 1989.

To date, approximately 38,600 tanks have been registered and an estimated 1,500 to 2,500 tanks remain unregistered. Since 1986, approximately 23,000 inactive or old tanks have been removed. Figure 2 shows that as the cumulative UST closures increased, the number of drinking water wells contaminated dropped to low levels. At present, it is not clear whether this apparent correlation is real or merely coincidence. A new database is currently being created. When the database is operational in 1995, data on current ground water contamination caused by LUSTs will be accessible by computer.

Figure 2. A Comparison of the Number of Drinking Water Wells Contaminated to the Number of USTs Closed Annually



Federal Facilities Petroleum Spills. The U.S. Government operates two major fuel pipelines in the State of Maine. One extends from Searsport to Limestone, serving Loring Air Force Base (Loring AFB) and the second runs from Harpswell to Brunswick serving Brunswick Naval Air Station (Brunswick NAS). Both pipelines will be decommissioned in 1994, as Loring AFB is closing in September and Brunswick NAS is already trucking its jet fuel. Fuel spills or leaks occurred on twenty-nine occasions at five different federal facilities during 1991, 1992 and 1993. All but eight of the spills were less than 100 gallons and probably didn't cause significant surface or ground water contamination. Two of the spills at Loring AFB were large, 5,000 and 10,000 gallons. Either of the spills may have caused ground water contamination, however these sites have not been studied to date. The largest spill during this three year period occurred at Brunswick NAS in March of 1993. Approximately 63,000 gallons of JP-5 jet fuel leaked through an open valve at an above ground tank farm. Much of the fuel ran across the ground into a storm drain system and exited into a freshwater wetland. Most of this fuel was recovered or burned off in the wetland. The Brunswick Water District wells are a short distance away but have not been affected by the spill. Ground water contamination is present under the tank farm where the spill originated, and is currently under investigation.

Agriculture

The total estimated cropland and pasture land in Maine is 700,000 acres. Agricultural chemicals and manure are estimated to be the second biggest potential source of ground water quality degradation in the state. The agricultural community uses chemicals for pest control, weed eradication, and fertilization. In addition, many farmers also use manure as fertilizer. The major areas of chemical application include potato fields in Aroostook County, blueberry barrens in Hancock and Washington County, and apple orchards and forage cropland in Central Maine. Pesticides and nitrates are the main agricultural ground water contaminants.

Pesticides. Although at high concentrations pesticides have known acute health effects, because they are generally present in low concentrations in ground water most of the concern has been focused on their chronic health effects such as cancer and birth defects. In Maine, increased concern about the health effects of agricultural pesticides in ground water began in 1980 when the Rhone-Polenc Ag company (formerly Union Carbide) found the pesticide aldicarb (Temik) in private wells near potato fields. Forty-seven percent of the 304 wells sampled showed detectable amounts of the pesticide and its toxic derivatives. Subsequently, a study by researchers at the University of Maine at Orono detected traces of the pesticide azinphos methyl (Guthion) in ground water from blueberry regions in Washington and Hancock County.

In 1985, the Maine Geological Survey (MGS) and the Maine Department of Agriculture, Food and Rural Resources (DAFRR) began a three-year evaluation of the effects of agricultural pesticides on ground water quality. The researchers collected 229 samples from 95 wells in potato, orchard, blueberry, and market garden/forage cropland areas and tested them for pesticides and nitrate. The study results suggest that bedrock wells overlain by till in potato regions have the highest incidence of contamination by agricultural pesticides.

Fourteen percent of these samples tested positive (mostly at trace levels) for various pesticides. Seven different pesticides were detected in 19 out of 68 wells sampled in potato regions; these include methamidophos, metribuzin, dinoseb, endosulfan, chlorothalonil, dicamba, and picloram (ethylene thiorea was also detected, but the results are questionable). This study did not analyze for Temik. Trace concentrations of hexazinone were detected in 2 out 21 samples in blueberry areas. Organic pesticides were not detected in nine samples collected from orchard areas; low arsenic concentration was detected in one well. Fifteen samples from market garden/forage crop areas showed two positive results, one each for the herbicides atrazine and alachlor.

A study initiated in 1989 by MGS, DAFRR, and USEPA tested 51 private wells near potato fields in Aroostook County to assess ground water contamination vulnerability from agricultural chemicals. Twenty-two of these wells (42%) had pesticide traces as follows:

1. One sample had parent aldicarb present.
2. Eighteen samples had aldicarb sulfoxide/sulfone present.
3. One sample had atrazine at very low concentrations.
4. One sample had chlorothalonil at trace concentrations.
5. Four samples had metribuzin in low concentrations.
6. Two wells had two pesticide compounds reported.
7. One well had three pesticide compounds reported.

In 1990, the University of Maine and the Board of Pesticides Control conducted a study to evaluate the effectiveness of immunoassay testing for monitoring pesticides in ground water samples. Study test results for 58 wells showed the following:

1. Eighteen wells (31%) had detectable concentrations of atrazine at least once during three sample events. Most of these wells had less than 0.60 ug/L atrazine; only two wells demonstrated concentrations of atrazine higher than the MCL of 3.0 ug/L.

2. Seven wells (12%) had detectable concentrations of alachlor at least once during three sample events. Concentrations in each of these wells exceeded the maximum contaminant goal level (MCGL) of 0 ug/L.

3. Three wells (5%) had detectable concentrations of carbofuran in one of the three sample events. None of these were near the MCL of 40 ug/L.

In 1992 the Board of Pesticides Control and the University of Maine joined forces for the Maine Triazine Survey. The purpose of the study was two-fold. First, the Board working with the University of Maine, Department of Food Science set out to verify the reliability and accuracy of immunoassay tests for the triazine pesticides. Second, data gathered during the project would provide the Board with insight into the quality of Maine's ground water and would aid in the development of Maine's Ground Water Management Plan.

One hundred and fifty-two samples were collected and analyzed for the triazine herbicides. Because a majority of atrazine use in Maine is related to forage corn production, approximately half of the samples were allocated to sites near tilled corn fields. The remaining samples were allocated to three non-tilled triazine use areas: orchards, Christmas tree plantations, and railroad rights of way. Samples were allocated on a county basis, proportionate to the acres in production for those crops as listed in the 1987 U.S. Agricultural Census. Candidate wells were also within 1/4 mile of an active field and downgradient of the application area.

Of the 152 samples subjected to immunoassay tests, 32 (21%) tested positive for the triazine immunoassay (which reacts to both atrazine and simazine). Only one sample (<1%) tested positive for the cyanazine immunoassay. Because resources were available, all samples were verified and individual pesticides quantified by high performance liquid chromatography (HPLC). HPLC analysis yielded 33 (22%) of samples with a pesticide concentration above the 0.04 ppb HPLC detection limit. In summary:

1. Thirty-one sites sampled (20%) had confirmed atrazine detections. Of the 31 sites, 25 were near forage corn, 3 were near railroad rights of way and 3 were near Christmas tree plantations.

2. Only 5 of the sites sampled (3%) had confirmed simazine detections and only 1 sample (<1%) had a confirmed cyanazine detection.

None of the sample results exceeded the health advisories for any of the pesticides tested. The highest atrazine sample results were 1.2 parts per billion (ppb), only 40% of the 3 ppb health advisory level.

In 1993, studies conducted by the University of Maine began to find numerous detections of hexazinone (Velpar, herbicide) in ground water from Maine's blueberry growing regions. During 1994, these detections will be more thoroughly investigated and the scope of the problem defined. The Board of Pesticides Control used 1993 to prepare for the statewide pesticides in ground water monitoring program that will be conducted in February and March of 1994. This program will be a statistically-based, stratified-random survey of drinking water wells near both agricultural and non-agricultural use sites. It is anticipated that over 150 sites will be sampled in this much needed follow-up to the Maine Geological Survey's 1985-87 study.

Nitrates. The documented adverse health effects of nitrate (potential for causing methemoglobinemia in infants and complicity in producing carcinogenic nitrosamines) and its mobility in ground water, may make it the most significant agricultural contaminant in Maine ground water. Nitrate in agricultural areas results primarily from application of chemical fertilizers and manure to cropland. Farmers apply over 58,000 tons of chemical fertilizers and 2.1 million tons of manure to agricultural land in Maine each year. Most of the chemical fertilizer is used on potato cropland. Manure is spread primarily on corn and hay fields. The vast majority of manure is produced by dairy farming (71.6%) followed by poultry production (17.1%), and by beef cattle production (6.8%). Horses, hogs, and sheep combined produce only 4.5% of the total tonnage.

Twenty-one out of 100 wells tested for nitrate in the MGS/DAFRR three-year study cited above had nitrate concentrations exceeding the 10 mg/L drinking water standard. The percentage of wells in each crop type exceeding the drinking water standard was greatest in market garden/forage crop regions (40%) and potato regions (23%). Wells in orchard and blueberry areas did not exceed the standard. Mean nitrate concentrations were highest in market garden/forage crop regions (8.6 mg/L) followed by potato regions (6.7 mg/L), orchards (1.1 mg/L), and blueberry areas (0.1 mg/L). Results of the MGS, DAFRR, and USEPA study conducted in 1989 in the potato growing regions of Aroostook County showed a similar trend. Nineteen percent of the 211 wells (40 wells) exceeded the 10 mg/L primary drinking water standard for nitrate-N. It is important to note that the nitrate contribution from non-agricultural sources, such as septic systems, has not been evaluated at any of the sites.

The impact of typical manure storage and spreading practices on ground water quality is not well known but merits greater investigation. Documentation of nitrate ground water contamination from manure storage and spreading currently is limited to DEP and DAFRR case files; these probably represent 'worst case scenarios'. Some 'worst case' examples include a poultry farm in Turner where poultry manure disposal has caused extensive nitrate-N ground water contamination (nitrate-N above 600 mg/L locally) in both the overburden and bedrock aquifers; and domestic wells in Clinton and Charleston where leachate from nearby uncovered manure piles is alleged to have contaminated domestic wells with nitrate-N concentrations exceeding 100 mg/L.

In 1990, the Maine Legislature gave DAFRR primary responsibility for investigating complaints related to manure storage and spreading. Between 1991 and 1992, 69 manure complaints were investigated by DAFRR. Of 32 complaints in 1992 six complaints concerned elevated nitrate in drinking water wells and three complaints concerned elevated bacteria.

The extent of nitrate ground water contamination from manure is unknown but may be significant. The Maine Soil and Water Conservation Districts 1988 Manure Management Project found that the plow layer in approximately one-half of the 249 corn fields sampled had more than twice the level of soil nitrate needed to produce a normal 25 ton/acre crop yield. Although not all of the excess nitrate will leach into ground water i.e., some will be bound by soil organic matter, the data show a very high potential for ground water quality degradation exists beneath these fields. The Maine Cooperative Extension Service developed non-regulatory guidelines for manure utilization in 1990. The key elements of these guidelines are, testing soil and plant nitrate levels prior to fertilizer application, and fertilizing according to realistic crop uptake rates.

DAFRR statistics for 1992 indicate that farm land available for manure spreading consists of approximately 239,000 acres of hay and 40,000 acres of corn silage cropland.

According to the agronomic spreading rates recommended in the 1980 Manure Management Project report, available hay and corn cropland can accept all of the manure generated annually in this state. However, because manure production is concentrated regionally, land for spreading may not be available locally. Further complicating manure management is the fact that even when spreading areas are available locally, it is usually economically unfeasible for a farmer to haul manure more than two miles from where it is stored.

Cull Potato Disposal. Due to an unfavorable growing season and harvesting conditions in Aroostook County, approximately one billion pounds of the 1992 potato crop was unmarketable. Disposal of these cull potatoes occurred during the fall of 1992 and the winter and spring of 1993. There were four instances of private water well contamination as a result of cull potato disposal. An additional 24 sites are suspected to have caused ground water contamination. However, since these were not near a drinking water supply, the ground water has not been tested. Water quality problems arising from cull potatoes can include increased nitrate and ammonia levels, odor, color and elevated bacteria counts. Examples of surface water impacted by cull potato disposal include discontinuing use of Silver Spring Brook, the primary drinking water supply for the town of Limestone for three months. Leachate from a cull potato pile is also believed to have reached Presque Isle Stream.

Landfills

Another serious threat to ground water is from leachate generated in landfills. Approximately 1.6 million tons of solid waste were deposited in Maine's landfills in 1991. This waste is generated by residential homeowners, municipalities, and commercial operations. Consequently, the associated landfill leachate may contain a variety of toxic organic and inorganic contaminants that will degrade ground water if the leachate is allowed to migrate beyond the landfill bottom. Most Maine landfills do not have liners or leachate collection systems. Therefore, it seems likely that most Maine landfills are polluting ground water.

Currently, there are 81 active landfills. In addition, there are another 116 landfills that have been closed and capped. One hundred and fifty-four others are inactive. In all:

1. 184 landfill sites are on sand and gravel aquifers and ground water contamination has been documented at 46 of these sites;

2. Sixty other sites have contaminated surface water and/or ground water and are considered to be substandard; 37 of these sites have serious ground water contamination;

3. public water supplies appear to be threatened by hazardous contaminants at 5 sites (Bucksport, Gray, Paris, Pittsfield and Standish); contaminants at eight sites appear to threaten private water supplies;

4. 135 sites have no reported or documented problems with surface water or ground water; and,

5. Nineteen sites are inactive dumps where only demolition debris is still being disposed;

6. There are at least 65 sites where open burning occurred.

In 1987, the Maine Legislature established the Solid Waste Landfill Remediation and Closure Program (the "Program") as part of new, comprehensive solid waste legislation. The objectives of the Program are:

1. to accomplish the prompt closure of solid waste landfills that, through inappropriate siting, inadequate design and construction, or improper operation pose an actual or potential hazard to the environment and public health; and,

2. to accomplish remedial activities to eliminate the existing hazards posed by those landfills.

The Program mandates that the DEP prioritize "open" municipal landfill sites (both active and inactive) for investigation. The basis for the ranking is the hazard each facility poses to the environment and public health. In accordance with the priorities established in the initial ranking, DEP is conducting environmental evaluations of "open" municipal solid waste landfills and in several instances is providing a recommended closure plan for those landfills. The deadline for the cessation of use of municipal landfills unable to meet licensing criteria was December 31, 1993. Investigation of 103 sites is in progress. Thus far, 49 of the assessments revealed the presence of a plume of contaminated ground water.

A total of 51 landfill closing projects were completed under state guidance, using local and state funds, during the 1992-93 reporting cycle. A total of 120 municipalities have received state cost-share funding for past landfill closures or ongoing landfill closure planning activities. Of the $24 million originally approved by Maine voters, about $3.1 million remains to be spent on additional projects. Estimates for additional funds needed to complete capping but not including remediation and evaluation, approach $100 million.

Road Salt

During the winter, more than 100,000 tons of salt are spread on Maine roads for deicing purposes. The salt is stored in over 700 registered sand-salt storage piles, most of which are uncovered. Leaching of sodium and chloride from uncovered sand-salt storage and spreading has caused substantial ground water degradation in Maine. DEP field investigations have documented over 130 drinking water wells in the State that have become unpotable (chloride in excess of 250 mg/L) by contamination from sand-salt storage. Elevated sodium concentrations may pose a health risk for people on sodium-restricted diets, e.g., people with hypertension. For the majority of the population, water will taste salty if the chloride concentration exceeds the State 250 mg/L secondary (aesthetic) standard.

Nearly every uncovered sand-salt storage pile is assumed to contaminate the ground water downgradient. The impacts range from the Maine Department of Transportation (MDOT) site in Dixfield where leachate from a sand-salt pile flows a few hundred feet before discharging to the Androscoggin River where it quickly becomes diluted, to the Town of York's former sand-salt pile and leaky salt storage building that combined to contaminate nine wells and threaten or affect more than 20 others.

An investigation conducted in the Province of New Brunswick, Canada, indicated that as much as 57% of the salt may leach annually from uncovered sand-salt storage piles. A British study estimated that approximately 10% of the salt in a typical uncovered sand-salt pile may be lost in one year.

In 1985, the Maine Legislature directed the DEP to prioritize all known sand-salt storage areas according to the extent of their ground water contamination problems. Documentation of ground water contamination was based primarily on private well testing and terrain conductivity surveys.

The prioritization was completed in 1986, however funds do not exist to continue a monitoring program. DEP assumes the existing uncovered piles have an impact on ground water quality, but investigations are currently carried out on a case-by-case basis in response to complaints.

In 1986, the Legislature passed two laws to protect ground water by dealing with sand-salt storage facilities. One statute established a state cost-share program for construction of municipal sand-salt storage facilities. The other statute established a compliance schedule for commercial sand-salt storage operations to construct sand-salt storage facilities. This bill required that all sand-salt be stored under building cover by January 1, 1996. Recent legislation has extended this date to January 1, 2003, because of state budget shortfalls and the lack of state cost share funds. Through the end of 1993, MDOT has funded the construction of 21 sand/salt storage buildings throughout the state using these funds. Individual towns have also constructed storage facilities using their own funds, without State reimbursement.

MDOT files indicate that since 1969 at least 45 wells have been made unpotable by sand-salt spreading on roadways. Recent investigations of sand/salt applications in Massachusetts and urbanized areas of Canada have raised concerns that a large percentage of salt can be retained in shallow ground water. The potential result is an increase in chloride and sodium concentrations above the drinking water standards that can persist for many years. The likelihood of this occurring in Maine depends on the volume of applications and conditions within specific ground watersheds. To date, comprehensive studies of sand/salt spreading impacts in specific ground watersheds have not been undertaken in Maine.

Hazardous Substance Sites

There are numerous sites in Maine where hazardous substances have allegedly been discharged to the environment. As of January 1994, BHMSWC Division of Site Investigation and Remediation had 104 active uncontrolled hazardous substance sites under investigation. Twenty-five additional locations require further investigation to determine whether they should be listed as uncontrolled sites. The definition of an "uncontrolled hazardous substance site" or "uncontrolled site" is an area or location, whether or not licensed, at which hazardous substances are or were handled or otherwise came to be located. The term includes all contiguous land under the same ownership or control and includes without limitation all structures, appurtenances, improvements, equipment, machinery, containers, tanks and conveyances on the site.

Common hazardous substances found in the ground water at these sites include organic solvents, polychlorinated biphenyls (PCBs), pesticides, and metals. Some of the adverse health effects associated with these chemicals are carcinogenicity, mutagenicity, and teratogenicity. Many of these sites are very small. However, because of the extreme health hazard they present, these sites receive a disproportionately large amount of the funds available for ground water protection, mostly for monitoring and remediation.

Since 1983, 417 active and inactive uncontrolled sites have been or are currently being investigated. Naming a site as inactive meanings the state has determined no action is currently needed, action is pending, or action has been completed. Nine sites are listed on the National Priority List of Superfund Sites, including the Brunswick NAS, McKin disposal site, O'Connor Salvage, Pinette Salvage Yard, Saco Tannery Waste Pits, Union Chemical site, Winthrop Landfill, Loring AFB and the Saco Municipal Landfill. At least 97 drinking water wells have been contaminated above the MCLs or MEGs at 16 uncontrolled sites and numerous other wells are at risk. The database listing wells contaminated at uncontrolled sites has not been updated since 1991, so it likely underestimates the number of wells impacted.

The BHMSWC has 750 active generators of hazardous waste and 500 inactive generators in their tracking system. These facilities store or treat more than 100 kilograms per month of hazardous

waste. Maine DEP currently lists approximately 50 sites with non-interim Resource Conservation & Recovery Act (RCRA) licenses and 60 sites with interim licenses. Over 40 sites with interim licenses will be investigated for possible ground water contamination.

Twenty-three sites licensed under the RCRA have been contaminated by discharges of hazardous substances. Sixteen of these facilities have active remediation. Three of these RCRA sites are thought to be affecting drinking water wells. Five domestic water supply wells became contaminated by solvents from lagoons and discharges to the septic system leachfield at the GTE facility in Standish. An additional 5 to 7 wells were considered to be at risk from contamination, and existing public water supply lines had to be extended to seven homes. Remediation efforts at the lagoon area are in progress, remedial measures at the leachfield will begin in 1994. Solvents from the Maine Electronics Plant in Lisbon have impacted the municipal water supply that serves over 2,000 customers. Several manufacturing facilities at the Sanford Industrial Park are suspected as the source of solvents contaminating the Town well field which serves over 6,500 customers.

Septic Systems

U.S. census data from 1990 indicate that there are in excess of 301,000 septic systems in Maine. The DHS Division of Health Engineering currently regulates septic system design and permitting. Of all the sources known to contribute to ground water contamination, septic systems directly discharge the largest volume of wastewater into the subsurface environment. The major contaminants of concern found in septic system effluent are nitrate, bacteria, and viruses. As discussed previously, high concentrations of nitrate may cause methemoglobinemia ("blue-baby syndrome") in infants. Correlations have also been shown between the incidence of stomach cancer and the concentration of nitrate in drinking water. The potential for disease transmission by the microbes discharged by septic systems is a public health concern.

Nitrates. Major factors affecting the potential of septic systems to contaminate drinking water are (1) the density of the systems per unit area, (2) hydrogeological conditions and, (3) water well construction. Areas with high septic system density may experience substantial ground water quality degradation partly because of the inability of the systems to adequately treat nitrates. Although representative septic system effluent nitrate concentrations vary considerably according to the household lifestyle, diet, and water consumption, researchers estimate that the septic effluent reaching ground water contains approximately 30-40 mg/L nitrate-N. Recent ground water quality monitoring beneath 4 Maine septic system leachfields recorded total nitrogen concentrations (as nitrate-N, nitrite-N, and/or ammonia-N) ranging between 27 mg/L and 93 mg/L.

Examination of test data for nitrate-N from private wells in Maine can help identify the threat of conventional septic systems to ground water quality. The earliest ground water quality study performed in Maine to address water quality problems was done in 1973 and involved 523 private wells in York County. The study found nitrate-N concentrations exceeding the 10 mg/L standard in 2% of the wells tested. Approximately 33% of the wells sampled had nitrate-N concentrations in the 1.0 - 9.6 mg/L range. More recent studies have been conducted to document the impact of nitrate on private wells. Data from these studies are summarized in Table 4-2.3.

The Health and Environmental Testing Laboratory (HETL) database contains the results of water tests done on private wells. These tests are requested by homeowners or state or local officials on behalf of homeowners. This database provides the best representative sample of private well nitrate concentrations in the state and includes sites impacted by a variety of nitrate sources including septic systems and agricultural activities. Assuming that the HETL database for nitrate-N represents Maine ground water quality,

approximately 2% of private wells in Maine are unpotable because they exceed the 10 mg/L drinking water standard for nitrate-N and approximately 91% have concentrations below 5 mg/L, well below the standard.

The 1991 Hancock/Lincoln-Knox County (HLK) study focused on the impact of septic systems, but also examined the influence of agriculture on nitrate concentrations. The HLK study represents rural sites with both modern septic systems (post-1974) and older (pre-1974) septic system designs. The study found that 1.5% of the wells sampled exceeded the 10 mg/L nitrate-N primary drinking water standard. Statistical analysis was performed to identify principal factors affecting nitrate-N concentrations in wells. Results suggest that the highest nitrate-N concentrations would occur in dug wells or driven well points in surficial deposits or bedrock with short casing that are located near agriculture or a short distance from septic systems.

The DEP-MGS study focused on residential subdivisions with modern septic systems and associated well siting criteria. Site selection minimized the potential influence of agricultural practices on the ground water. This study, designed to represent modern residential development, demonstrated that ground water impacts with respect to nitrate-N may be expected to make less than 1% of private wells unpotable. Approximately 94% of the test wells were shown to have concentrations below 5 mg/L.

The HETL data and the data from the HLK study show similar percentages of wells with nitrate concentrations over the MCL (nearly 2%). The DEP-MGS study shows a smaller percentage of wells exceeding the MCL (<1%). The reason for the disparity may be the contribution of agricultural activities to increased nitrate concentrations, a factor in the HETL and HLK studies; the DEP-MGS study was designed to minimize or exclude agricultural impacts on ground water quality and focus on septic system impacts.

Table 4-2.3. Nitrate-N Frequency Distributions.

Nitrate-N (mg/L)	HETL Database[1] %	HLK Study[2] %	DEP-MGS Study[3] %
0.00 to 2.50	-	85.5	83.8
2.51 to 5.00	-	9.2	10.4
5.01 to 7.50	-	2.5	4.1
7.51 to 10.00	-	1.3	1.4
Greater than 10.0	1.9	1.5	0.4
# Analyses	5,340	381	511

[1]HETL database for private well analyses between 1/1/92 and 12/31/93.

[2]Cooperative project between the Maine DEP and the Hancock and Lincoln-Knox County Soil and Water Conservation Districts. Project focused on private well testing for nitrate-N in unsewered regions of four towns.

[3]Cooperative project between the Maine DEP and Maine Geological Survey. Project designed to evaluate ground water/well water quality impact of septic systems in 20 residential subdivisions with respect to nitrate-N.

Bacteria. Private well testing for presence of bacteria identifies a greater contamination potential from bacteria than from nitrate. In public and private drinking water supplies, coliform bacteria are used as the indicator of microbial contamination. The Primary Drinking Water Standard for total coliform bacteria is 0 colonies per 100 ml.

HETL data for wells tested between 1960 and 1990 showed approximately 31% of the wells tested for total coliform exceeded the drinking water standard. Data for the period January 1992 and December 1993 shows that 40% of the well samples analyzed for total coliform tested positive. Twenty-six percent of the wells tested for total coliform bacteria in Hancock County as part of the Hancock/Lincoln-Knox County SWCD study had coliform bacteria. However, only 26% of these wells (7% of the wells tested in Hancock County) also tested positive for fecal coliform bacteria.

Fecal coliform bacteria originate inside the intestinal tract of mammals. The fecal coliform test is a better indicator of septic system contamination than total coliform because the total coliform test results may be affected by input from non-mammalian sources such as decaying vegetation. Surface water infiltration around poorly sealed well casings, especially dug well casings, may contribute to the disparity between detection of total coliform and fecal coliform. Examination of the HETL database for the period between 1960 and 1990 indicates that 52% of dug wells and 24% of drilled wells tested positive for total coliform bacteria; this lends support to the belief that dug wells are more susceptible to total coliform bacteria than drilled wells.

Shallow Well Injection

Discharge of pollutants underground by shallow well injection has been illegal in Maine since 1983 when the State adopted the Federal Underground Injection Control (UIC) regulations. Shallow injection wells are classified as Class IV or Class V wells under the UIC designation. No other classes of UIC wells are documented in Maine. Class V wells are usually gravity feed, low technology systems which include cesspools, septic systems, pits, ponds, and lagoons. Industrial and commercial wastes discharged via shallow injection wells include petroleum products, cleaning solvents and degreasers, industrial and agricultural chemicals, storm water runoff, and a variety of other wastes.

Because of their high ground water contamination potential, the DEP has focused most of the UIC Program efforts on inventorying and eliminating automobile service station, and manufacturing facility floor drains. Since 1988, the DEP has received over 3,276 responses to survey requests mailed to potential Class V facilities. Survey responses show 411 facilities with Class V wells discharging to soil or septic systems. Most of these facilities have been required to seal their floor drains or install oil/water separator systems that are connected to holding tanks. This effluent must be disposed of at a licensed disposal facility. No ground water quality monitoring has been performed at any of the facilities to assess ground water degradation.

Disposal of hazardous substances to the ground water through floor drains has contaminated at least two sites that are currently uncontrolled hazardous waste sites.

In 1992, dry cleaning businesses were surveyed for their waste handling practices and the presence of injection wells. Photoprocessors were surveyed in 1993. Other businesses handling hazardous materials will be targeted for future inspection. These include: funeral homes, auto body shops, rustproofers, boatyards, farms, and various laboratories. Shallow well discharges may not be allowed from these facilities in the future, but implementing this policy may require amending the existing regulations. DEP policy is that there is too great a risk involved to allow floor drains and other shallow injection discharges from businesses dealing with materials that could contaminate ground water.

Surface Impoundments

Storage, treatment, and disposal of liquid and semi-liquid materials in surface impoundments have long been suspected as major sources of ground water contamination. Currently, the DEP has authority under different statutes (e.g., the UIC Program) to regulate a variety of activities and materials related to surface impoundments. In 1979, the DEP conducted a study to characterize and inventory surface impoundments in the State. Although the inventory probably was incomplete, the study identified at least 173 impoundment sites with a total of 453 individual pits, ponds, and lagoons (both active and abandoned). Materials stored at these sites included municipal sewage, industrial wastewater (including hazardous wastes), and animal wastes.

Some of the important facts revealed in the DEP study include the following:

1. surface water and ground water have been contaminated by surface impoundments at many sites in Maine;

2. approximately 75% of the assessed surface impoundments did not have impermeable liners;

3. approximately 45% of the surface impoundments are located on highly permeable soils (sandy gravelly deposits);

4. approximately 50% of the assessed abandoned impoundments have not been closed properly to prevent future waste migration;

5. approximately 18% of the impoundment site operators may generate potentially hazardous wastes which could enter the surface impoundments;

6. site monitoring wells were present at only 14 of the impoundment sites assessed and ground water contamination was detected in six of these; and,

7. most surface impoundments in Maine pose a high potential for ground water and surface water contamination.

Since the 1979 study was completed, no follow-up work has been performed to complete the initial surface impoundment inventory, to update the inventory with new sites, or to assess the degree of ground water contamination at the various sites. Improperly operated and abandoned sites probably continue to degrade ground water quality today, but some may not be a threat. A systematic evaluation of all open and abandoned surface impoundments would facilitate a more comprehensive assessment of their ground water impacts.

Municipal Facilities

Since 1990 the Division of Engineering and Technical Assistance has authorized the construction of 11 wastewater treatment facilities that use lagoons to treat or store treated wastewater before discharging to a surface water or prior to land application. The authorization to fund these treatment facilities with State Grant funds comes from Section 411 MRSA Title 38. In all of these lagoons biological treatment of domestic wastewater occurs. Oxygen, which is necessary for the treatment, is introduced naturally in facultative lagoons or artificially introduced by blowers or high speed mixers.

To minimize lagoon leakage, nine of the eleven facilities were constructed using a hypalon or high-density polyethylene synthetic liner. Two were constructed of compacted native soil materials. All eleven facilities installed monitoring well systems to monitor any future leakage that may result in contamination of the ground or surface water. If contaminants are noted in the monitoring wells, or if excessive leakage is confirmed by other testing, the lagoon is taken off-line as soon as possible and repaired.

Salt-water Intrusion

In coastal areas, excessive ground water withdrawals and well placements too close to the shoreline may lead to saltwater intrusion. This is particularly significant considering that Maine has approximately 3500 miles of coastline and development pressures are great along most of it. Saltwater intrusion is particularly common on coastal peninsulas and off-shore islands that rely primarily on private drilled bedrock wells for drinking water. For example, a 1982 hydrogeologic study conducted in the peninsular town of Harpswell found approximately 70 wells that were being affected by saltwater intrusion. As development pressure along the Maine coast continues, the incidence of saltwater intrusion is expected to increase.

Metallic Mining

Maine does not have any operating metallic mines at this time. In August of 1991, metallic mining rules were adopted by the State of Maine to be administered by the DEP. The purpose of these rules is to protect land and water quality while allowing for metallic mineral exploration and property development. Currently, no new permit applications are pending. One permit was issued in November 1992 to BHP Utah for advanced exploration.

Historical metallic mining sites such as the Kerramerican site in Blue Hill are known to degrade surface water quality by acid rock drainage from tailings ponds. Comprehensive studies of these sites to quantify ground water impacts have not been undertaken.

Gravel Pits

There are currently 157 gravel pits of 5 acres or greater, that have been licensed by the state. The number of unlicensed (illegal) pits and gravel pits falling below licensing thresholds is unknown.

Impacts to ground water from gravel pit operations include ground water contamination by spillage or spraying of petroleum products in or near the pits and dewatering of the local surficial aquifers. Improper use, storage or handling of petroleum products has caused ground water contamination in 3 gravel pits. The State does not have any record of the number of wells adjacent to gravel pits that have been dewatered due to mining activities. Another threat to ground water indirectly related to gravel pits is dumping into pits that do not adequately restrict unauthorized access. Unreclaimed sand and gravel pits are too often host to illegal dumping. At the present time, 16 abandoned gravel pits are listed as uncontrolled hazardous waste sites. These pits contain a variety of pollutants such as solvents and PCBs.

Radioactive Waste Storage and Disposal Sites

All generators of low level radioactive waste store the wastes on-site. The only two generators of high level waste are Maine Yankee nuclear power plant in Wiscasset and Portsmouth Naval Shipyard in Kittery. Both of these facilities store spent nuclear fuel on-site.

In 1993, an agreement with Texas to accept and dispose of Maine's low-level radioactive waste was approved by Maine voters. If this compact is ratified by Congress, Maine will begin sending

its low level radioactive waste to Texas as soon as the disposal facility is built, expected to be 1995 at the earliest.

Maine has one confirmed radioactive waste disposal site in Greenbush, other sites may exist but no others have been located. Ground water monitoring wells have been installed at the Greenbush site and on adjacent property. As of November 1993, no wastes had been detected in the monitoring wells.

Chapter 3 - Public Health and Environmental Concerns

Contaminants found in ground water have numerous adverse human health and environmental impacts. Public health concerns arise because some of the contaminants are individually linked to numerous toxic effects ranging from allergic reactions and respiratory impairment to liver and kidney damage, and damage to the central nervous system. Additional public health concerns also arise because information is not available about the health impacts of many contaminants found in ground water. Because of uncertainties about the relationship between exposure to contaminants and impacts on human health, public health efforts are based on identifying the probabilities of impacts (i.e., risk assessment). Conducting a risk assessment for combinations of contaminants that are commonly found in ground water is difficult because there are no generally accepted protocols for testing the effects of contaminant interactions.

Because ground water generally provides base flow to streams and rivers, environmental impacts include toxic effects on fish, wildlife and aquatic vegetation. This also presents a public health concern if the surface waterbody is a source of food and recreation. Although generally overlooked, in some areas of the State there is probably a link between low-level long-term ground water quality degradation and the water quality of streams and brooks during low-flow conditions.

Radon

Not all ground water public health concerns are related to pollutants caused by human activities. The presence of naturally occurring radioactive radon gas in granite bedrock aquifers and overlying soils has recently raised concerns regarding its effects on ground water that had previously been regarded as safe. The average concentration of radon in private residential water supplies is 5,000 picocuries/liter. Though the radon is entirely from natural sources, its presence in Maine is a source of growing concern. Based on studies of miners, medical researchers have shown that high radon levels in air are associated with increased incidence of lung cancer. The question remaining is whether radon levels found in some Maine homes and in drinking water can have a similar health effect. Future research in Maine should increase understanding of the nature and extent of this water quality problem.

Arsenic

Wells showing high levels of arsenic have been found in a number of areas in Maine, with the primary area of concern in the southern part of the state. In the fall of 1993, occurrences of arsenic concentrations in well water above the 50 ppb MCL came to public attention in York and Cumberland Counties. In this area, approximately 10% of nearly 1,000 well water samples tested greater than the MCL.

A source or sources for the arsenic is unknown. It is also not known if similar distributions of arsenic levels in well water will be found in other parts of the state upon closer inspection. It is possible that agricultural or industrial causes are to blame, although it is also possible that the source is naturally occurring arsenic in soils and bedrock formations. To determine the extent of the problem and discover the sources of the contamination, the Maine Geological Survey, the DHS Drinking Water Program, and the Maine DEP will be testing more wells and conducting detailed geologic mapping in the region. Affected towns in southern Maine are also researching historical land uses to find possible man-made sources.

Ground Water Indicators

The following tables (Tables 4-3.1 through 4-3.3) show data on the number of exceedences of MCLs for public water supplies using ground water and give a relative indication of the condition of the ground water resource used as a drinking water supply.

Table 4-3.1. Number of MCL Exceedences for Ground Water-based or Partial Ground Water-supplied Community Public Water Supplies for Selected Contaminants in Four Contaminant Groups

Contaminant Group	Contaminant	# of MCL Exceedences	# of Samples
Metals	Arsenic	3	1323
VOCs	Trichloroethene	1	527
	Di-(2-Ethylhexyl) phthalate	1	"
Pesticides		0	1997
Nitrate		0	366

Table 4-3.2. Number of Ground Water-based or Partial Ground Water-supplied Community Public Water Supplies with MCL Exceedences

	Total Number	Number with MCL Exceedences
Number of PWSs	345	3
Population Served	255,548	1,000

Table 4-3.3. Number of Ground Water-based or Partial Ground Water-supplied Community Public Water Supplies that have Local Wellhead Protection Programs (WHPPs) in Place

Total Number	Population Served	Number with Local WHPP in Place	Population Served
345	255,548	2	3,717

The DHS Drinking Water Program does not currently have its database configured to be able to provide the number of sampling detections in public drinking water supplies between 50 and 100 percent of the MCLs for metals, volatile organic compounds (VOCs), pesticides or nitrate.

Wellhead Protection Program

The DHS, Division of Health Engineering administers the Maine Wellhead Protection Program. Public water suppliers voluntarily participate in this program. The goals of the program are to educate the public and water suppliers on the need for protecting ground water supplying their drinking water, and to assist water suppliers in preparing a wellhead protection plan. The complexity of a wellhead protection plan depends on the volume of water supplied, the number of people served, duration of service and the known threats to the water system.

Chapter 4 - Ground Water Quality Trends

Detailed quantitative estimates of the statewide extent and effects of ground water contamination are not now, and may never be, available. The time, costs and technical requirements necessary to develop statewide estimates would be prohibitive. In addition, Maine's complex hydrogeologic setting makes representative ground water quality sampling difficult. The hilly topography and complex geology have created numerous localized ground water flow basins, "ground watersheds", which are similar to and often coincide with surface watersheds. As a result, water quality data obtained from monitoring wells indicate only the water quality at a specific location and depth in an aquifer. The data reflect the ground water quality up-gradient, but they are not indicators of ground water quality elsewhere, either inside or outside a particular "ground watershed". Current information about the State ground water contamination problems may not describe the actual situation as much as it reflects the reason for the investigation and the manner in which it is conducted, i.e., the contaminants tested for, where the monitoring occurred, and how it was performed.

New occurrences of ground water contamination are being documented in Maine each year. Although discovery of existing contamination is expected to continue, future reports of contamination are expected to decline substantially as State ground water protection initiatives continue to be implemented. These programs stress contamination prevention rather than remediation. Key aspects of these programs include:

1. Stricter underground storage tank installation and monitoring standards, removal of old and substandard tanks, and registration of all active and abandoned tanks should continue to reduce discharges from underground storage tanks.

2. Continued development and implementation of a strategy to protect ground water from agricultural chemicals will diminish the impact of pesticides and fertilizers on ground water quality. For example, concentrations of aldicarb in Aroostook County wells have dropped since the Maine Board of Pesticides Control imposed restrictions on the use of Temik in 1984. Proliferation of Velpar use has led to detection of this pesticide in ground water. Continuing use of this pesticide is expected to lead to further spread of contamination.

3. Development of new manure application guidelines that reflect agronomic nutrient utilization rates will decrease the adverse impact of the poultry and dairy farms on ground water quality.

4. Investigation and closure of polluting landfills will reduce one of the most prominent sources of contamination in the State. Creation of the Maine Waste Management Agency to deal with solid waste disposal issues ranging from determining the State's landfill needs, to siting new landfills, to waste reduction and recycling should result in more environmentally safe waste disposal. Further emphasis on recycling will reduce the waste stream and decrease landfill capacity needs.

5. Storing sand-salt mixtures for road maintenance in water-tight storage buildings will prevent highly concentrated salty leachate from contaminating ground water. However, this solution is still nearly a decade from full implementation. Elevated concentrations of sodium and chloride will persist in the ground water adjacent to roadsides unless an economical substitute for sodium chloride can be found.

6. The emphasis of the UIC Program on inventory and elimination or control of shallow injection wells will undoubtedly aid ground water protection efforts. Although the extent of contamination from shallow well injection in Maine is unknown, studies in

other states indicate the potential ground water quality impacts resulting from routine and accidental discharges of toxic and hazardous substances is serious.

7. The Maine Nonpoint Source Pollution Program will have the most impact toward reducing ground water contamination. The program will develop best management practices (BMPs) for all activities contributing to nonpoint source pollution. Despite the paucity of data to quantify the extent of ground water contamination from many of those sources, the deleterious ground water quality impacts from many of the activities are well documented. Development of BMPs for those activities may proceed concurrently with ground water monitoring. Developing public awareness of BMPs will be one of the most important aspects of the Nonpoint Source Pollution Program.

PART V: WATER POLLUTION CONTROL PROGRAM

Chapter 1 - Point Source Control Program

Maine uses multiple approaches to ensure that point source discharges of wastes receive adequate treatment prior to their release to waters of the State. Maine law prohibits any discharge of wastes to waters of the State without a license, and to receive a license, an applicant has to demonstrate the ability to provide the appropriate level of treatment. All of the larger municipal and commercial sources of wastewater in the state are licensed and treated, or conveyed to licensed facilities for treatment. A few small towns or villages are only now installing treatment, mostly with Federal or State funding assistance. A number of financial assistance programs support new construction, as well as upgrades or additions to existing facilities.

Many communities in Maine are characterized by low population densities and depend on individual subsurface disposal systems to provide sewage treatment. For areas not served by community collection systems, the Maine Subsurface Wastewater Disposal Rules require that property owners provide adequate means of treating their own wastewater, in accordance with specifications established by the rules. The rules are enforced at the municipal level and administered at the State level by the Department of Human Services.

Most sources of wastewater of all types in Maine, including communities, industrial or commercial businesses, and residences, have either installed treatment facilities or discharge their wastes to facilities managed by other owners. The traditional approach with this group is: license compliance inspection coupled with technical assistance in operations and maintenance; enforcement where necessary; and periodic re-licensing. Recent new directions include expanded technical assistance in all aspects of treatment facility operations & maintenance, and pollution prevention.

Pollution Prevention

Within the last two to three years, the State of Maine, EPA and the regulated community have begun to emphasize pollution prevention as the means to accomplish the next level of water quality improvement. The DEP Bureau of Land & Water Quality, Division of Engineering and Technical Assistance (DETA), as the division name indicates, has long included a section focused upon providing technical assistance to treatment facility operators. With EPA support under section 104(b)(3), the technical assistance group has been expanded to 5 staff, with a major emphasis on pollution prevention.

Industrial Pollution Prevention

During the autumn of 1991, DEP staff and International Paper Company (IP) personnel began a landmark pioneering effort, working closely together to conduct an environmental audit at the IP mill in Jay, Maine. This effort was very successful. Not only did IP realize substantial savings in production, treatment and regulatory costs, but far less pollution is now discharged to the Androscoggin River. For example, the amount of biochemical oxygen demand (BOD) discharged has dropped from approximately 14,000 lb/day in 1991 to 6,000 lb/day in 1993. The success of the IP project has convinced other paper mills to work with us to seek the excellent gains pollution prevention can provide in the industrial wastewater treatment arena.

Additional projects are underway at the IP mill, and guidance teams have begun work with Boise Cascade Corporation in Rumford, Maine and with S. D. Warren in Hinckley, Maine. Some initial work has also been done with Georgia Pacific in Woodland, Maine. DEP staff have visited all the Kraft paper mills in Maine to discuss their pollution prevention programs.

Municipal Pollution Prevention

The initial effort in municipal pollution prevention has been to develop a questionnaire focusing on data necessary to evaluate technical assistance needs, upgrade needs and to facilitate communication between treatment facility operators and town officials. In addition to DETA staff, Division of Water Resource Regulation (DWRR) inspectors will also assist treatment facility personnel in pollution reduction and treatment efficiency improvement efforts.

Androscoggin River Basin Project

DEP has launched another pioneering effort, linking pollution prevention with the watershed approach to water quality management. The goal is to involve local officials and citizen groups within the watershed in establishing programs which will reduce pollutant generation and thereby improve the quality of waters within the entire watershed. After an initial period of heavy involvement, the DEP role should diminish to consultation and advisement, with the lead roles taken by watershed and local organizations.

The program has 5 components: education; watershed management team planning; nonpoint and small point source pollution prevention; municipal pollution prevention; and industrial pollution prevention. DEP staff are being trained as facilitators, in Total Quality Team principles and are being cross-trained in DEP water program activities as well as activities in other DEP programs. These DEP staff are working with the towns to establish local teams and to provide them with the knowledge and focus to identify problem areas and develop solutions. In addition to the benefits within the Androscoggin basin, this project is likely to improve internal coordination and communication within DEP, thereby providing indirect statewide benefits.

Construction of Wastewater Treatment Facilities

During the twenty-one years since the passage of the Clean Water Act (CWA), considerable amounts of grant and loan money have supported a very successful effort to clean up Maine's surface waters. Despite this success, there are still significant needs for continued clean-up efforts, directed less toward initial construction and more toward retrofits, upgrades, control of overflows and a larger number of smaller-scale problems. DEP administers multiple programs to address these remaining areas.

In some communities, existing treatment facilities are not adequately treating sewage, due to age of the facility, design deficiencies or operational problems. In other cases, the sewage collection system is in such poor condition that excessive water enters the system, either through underground infiltration or surface inflow, causing storm-related sewer overflows, ineffective treatment and/or excessive treatment and maintenance costs.

Although most of the larger communities in Maine are served by publicly-owned sewage treatment facilities, there are still some areas where domestic sewage is either inadequately treated or not treated at all. Such areas include entire towns or villages, as well as homes, businesses or seasonal dwellings, either singly or in small groups. Many of these communities include areas in which septic systems are malfunctioning and other areas where treatment systems simply do not exist (straight-pipe discharges).

Municipal Facilities Program

Federal and State cost-sharing funds for the construction of municipally-owned sewage treatment facilities, or planning, design and construction of facility upgrades are administered by DEP through its Municipal Wastewater Facilities Construction Program. In accordance with the

requirements of the Federal Clean Water Act and State law (Title 38 MRSA, Sections 411 and 412), the State program is designed to distribute Federal and State loan and grant funds on a worst-first priority basis to communities with sewage treatment problems.

Although EPA Construction Grants funding ended in 1989, Maine still has fifteen active projects being built with funds from this program. These projects range from construction of new facilities to upgrading equipment for improved process control. During State fiscal years 1992 and 1993, eight new municipal wastewater treatment facilities, built with Construction Grant support, began operating in Maine. Even though Federal grants are no longer being made, Maine can provide grant support for wastewater treatment facility construction under several programs within and outside of DEP. The bond issues that provided the State match for Federal revolving fund capitalization included additional grant funds dedicated for various projects.

The State Revolving Fund (SRF) program began in 1989, also supported by EPA funds, but rather than outright grants to municipalities or quasi-municipal corporations, the State provides low-interest loans (2% below market rates). In some cases, state funds are used to provide grants where the cost of a given project would raise the user charge above 2% of the town's median household income. Since 1989, four bond issues have been passed by Maine voters, for a total of $12.7 million in state share matched by $60.6 million in Federal share to be spent on low-interest loans for wastewater treatment improvement projects. This program supports projects ranging from upgrades of primary facilities to secondary treatment and complete facility upgrades, to upgrades or additions of single treatment components such as pump stations, sludge handling systems or composting facilities, to combined sewer overflow abatement projects. Eight SRF projects have been completed and closed out, fourteen are underway and seven are proposed to start during 1994 or 1995.

The DEP Municipal Priority Point System is the mechanism used to rate individual projects. The system incorporates five priority categories listed in descending order of relative priority as follows: 1) water supply protection, 2) lakes protection, 3) shell-fishery protection, 4) water quality concerns, and 5) other facility needs. Within each of these priority categories, points are assigned depending on whether the severity of the problem is assessed as low, medium or high. The DEP Municipal Priority Point System is described in more detail in the "State of Maine Municipal Wastewater Construction Program," published annually by the Division of Engineering and Technical Assistance. In addition to describing the administrative aspects of the Municipal Wastewater Facilities Construction Program, the above-mentioned document includes the Multi-year SRF Project list and the Additional Needs project list. The Multi-year SRF Project list includes all projects likely to need upgrades, whether major or minor. The Additional Needs list is primarily for areas that presently do not have treatment facilities.

The progress of any municipal treatment or collection system project from planning stage to final construction is determined by a variety of factors including public opinion, availability of funds and changes in the priority rank of the project, relative to other projects.

Maine Combined Sewer Overflow Program

Thirty-nine Maine communities are served by combined sewer systems, which are partially or completely combined (ranging from 5% to 100%). During dry weather, all of the sewage in a combined system is conveyed to the treatment plant, but during rainstorms or snow-melt periods, weather-related flows mix with the sanitary sewage. This results in combined sewer overflows (CSOs), which vary extensively in pollutant types, concentrations and loads, as well as in volume of overflow and severity of impact to the receiving waterbodies. An additional 15 towns with separate storm sewers are being assisted by the CSO program because they experience storm-related overflows from their sanitary sewers which behave and exert effects similar to CSOs.

Maine has established an aggressive program, coordinated with EPA's CSO program, to assist communities in evaluating the design, condition, activity and effects of combined sewer systems and overflows. In 1990, the first CSO-related Maine bond issue was passed, establishing a fund of $ 2.4 million for four specific communities' projects. A second bond issue of $2.4 million was passed in 1990 to establish a fund to provide CSO planning grants at 25% of eligible costs. By the end of 1993, twenty-five communities had been awarded CSO planning grants and eight communities had submitted Sewer System Master Plans. Together these eight master plans propose a total of $150 million in projects to abate or control CSOs.

Maine Small Community Facilities Program

In 1981, the Maine Legislature enacted a law designed to allow the State to help finance small wastewater treatment projects. The law authorizes up to $1 million each year for the construction of waste treatment systems and authorizes the DEP to pay up to 90% of the costs of such systems. Grants are limited to $100,000 per year for each town. Projects are reviewed for priority points under a system very similar to the Municipal Priority List, and then selected from the resulting list in descending numerical order. Funds for this program are provided from bond issues approved by Maine voters. The Small Community Facilities Program was last funded for the 1994 construction season by a bond issue approved in November 1993.

This program fills a need which is largely unmet by the Federal Revolving Fund Program. It allows DEP to clean up scattered small-scale problems by funding installation of individual or cluster treatment systems in a very cost-effective manner. During the eleven year period the Small Community Facilities Program has been in existence, nearly 2300 small systems in 155 towns have been constructed through the expenditure of nearly $12 million in grant funds. As a result of these efforts, significant benefits have accrued, including the elimination of public health threats and reopening a number of shellfish growing areas to harvest.

Licensing of Wastewater Discharges

The Division of Water Resource Regulation, Bureau of Land & Water Quality, is responsible for the licensing and re-licensing of all surface wastewater discharges, whether industrial, commercial, municipal or residential. In Maine, the vast majority of wastewater discharge sources have previously been licensed. Therefore, the licensing program is focused largely upon renewal of existing licenses, rather than development of new licenses. As technology advances, and as our understanding of the effects of human activities upon the environment grows, the limits included in discharge licenses must be refocused. Currently, there are approximately 215 industrial licensees, 135 municipal or quasi-municipal licensees, 58 schools with individual licenses, 2,400 small residential & commercial (res/com) licensees and 50 other licensees not in the above categories (mostly non-sanitary municipal sources or sanitary discharges from Federal or State facilities).

Wastewater discharge limits in the United States are based upon two criteria: 1) a standard of performance of technology or level of treatment provided for a specific wastewater or pollutant, or, 2) the level of treatment required to provide protection for the water quality standards of the receiving water. When developing license limits, the more stringent of these criteria is used in the license.

The Clean Water Act established national "standards of performance" for the control of pollutant discharges from all sources. Section 301 of the CWA required that, by 1977 all point source discharges of "conventional" pollutants be treated by the application of best practicable control technology. The Code of Federal Regulations (CFR) lists conventional pollutants as follows: 1) biochemical oxygen demand, 2) total suspended solids, 3) pH, 4) fecal coliform bacteria and, 5)

oil and grease. CFR, Title 40, Part 400 et seq. establishes technology-based effluent limits for conventional pollutants and some non-conventional pollutants such as metals.

Municipal and industrial dischargers of wastewater containing toxic or hazardous pollutants are required to apply "best available control technology" in order to achieve effluent limitations established pursuant to Sections 301 and 307 of the CWA. The Administrator of the EPA publishes additional guidance in the form of effluent limitations and standards of treatment efficiency for control of specific pollutants from categories of discharge sources. As for discharges of conventional pollutants, effluent limitations for toxic and hazardous pollutants are included in the National Pollutant Discharge Elimination System (NPDES) permits and the Maine Waste Discharge Licenses for industrial or municipal dischargers.

In addition to limits for specific toxic or hazardous pollutants, all dischargers above a minimum flow level will be required to conduct Whole Effluent Toxicity (WET) tests. The number of years and frequency of WET testing will depend upon a combination of criteria such as percent contribution by industrial pre-treaters and dilution ratio.

Municipal Wastewater Treatment

The CWA requires that discharges from municipal treatment systems receive secondary treatment (providing 85% removal of conventional pollutants), except where water quality concerns require more stringent limits. The only exception to this requirement is a variance under Section 301(h) of the CWA, allowing primary treatment where the dilution ratio and depth of the water allows rapid mixing of the effluent into the receiving water. Maine has twelve municipal facilities discharging under primary variances; all discharge into the ocean or into waters with high-volume tidal flows.

Municipal licenses include requirements to disinfect at least seasonally due to the possibility of discharging pathogenic micro-organisms. Because most municipal dischargers use chlorine in some form to disinfect, limits for total residual chlorine are included in many municipal licenses. The deleterious environmental effects of reactive chlorine have led to the recent addition of de-chlorination requirements to many municipal licenses, especially for those that discharge into rivers with anadromous fish migrations. Municipal licenses also include requirements to monitor CSO activity and to develop plans for control of these overflows. Many municipalities accept wastewater from industrial or commercial facilities either with or without pre-treatment. Where an industrial source contributes 10% of the flow to a municipal facility and discharges a pollutant that has a categorical standard, a limit for that pollutant will be added to the municipal license.

Industrial Wastewater Treatment

A wide variety of industries in Maine use processes which result in the generation of contaminated wastewater. The chemical and biological constituents of wastewater from Maine's industrial point sources are as varied as the industries themselves and include everything from wood fiber to shrimp wastes to metallic compounds. Some industrial wastes lower the dissolved oxygen of the receiving waterbodies. Others may alter the pH or add pollutants with potential for toxic effects on aquatic life.

Starting in 1972, Maine and its industries made an intensive effort to provide best practicable treatment for all industrial discharges, many of which were untreated. By 1977, all major industries with individual discharges were providing secondary treatment or its equivalent. Since then, additional small industrial discharges have received treatment as municipal treatment facilities have been constructed, or individually, as additional untreated industrial discharges have been discovered.

Industrial dischargers in Maine are regulated in two ways: 1) the industry discharges to a municipal sewage collection system; or 2) the industry discharges directly to a receiving waterbody. Industries which discharge wastewater to publicly-owned sewage treatment facilities are required to pre-treat wastes which would otherwise interfere with the operation of those treatment facilities, or which would not be adequately treated by the municipal treatment process. The pretreatment program is presently administered as part of the NPDES program by the EPA, but the DEP conducts some of the pretreatment inspections and provides assistance to municipalities in understanding pretreatment issues and in developing local limits.

Industries that do not discharge to publicly-owned treatment facilities are issued NPDES permits by the EPA, as well as Waste Discharge Licenses from the Maine DEP. In all cases, the pollutant reduction required by the Maine license for a particular source of discharge is equal to or more stringent than the level of pollutant reduction required by the NPDES permit. The treatment efficiency required by those regulations is related to the type of wastewater produced by the industry, while the amount of the pollutant allowed to be discharged depends on the quantity of goods being manufactured daily.

Elimination of Licensed Overboard Discharges

From the inception of its waste discharge licensing program, Maine has issued licenses to individual homeowners or businesses, or to small clusters, where existing lots were unsuitable for subsurface disposal and no municipal system was available. This eventually led a large number of licensees (more than 2900 in 1987), which made it impossible for DEP to adequately monitor compliance or evaluate re-licensing applications. The large numbers of small overboard discharges (OBDs) led to closures of a significant number of shellfish growing areas.

Due to concern over the effects of the burgeoning number of licensed small point source discharges, the Maine Legislature passed an act (the "Overboard Discharge Law") in 1987 which prohibited new discharges of non-municipal sanitary wastewater. In 1989, substantial changes were made to the Overboard Discharge Law. These changes prohibited new discharges and expansions of existing, licensed discharges, required DEP to inspect all OBDs each year, established an inspection fee to fund the inspection effort, and established the OBD Removal Grant Program. For any licensed discharge to a shellfish growing area, which causes nuisance conditions, or for which subsurface disposal is a viable alternative, a conditional license is issued which expires 6 months after offer of grant assistance from the DEP. With the goal of reclaiming closed shellfish areas, this law has great significance for the future management of Maine coastal waters.

Since its start in 1989, the OBD Removal Program has been funded by successful bond issues in 1989, 1990, 1992 and 1993, for a total of $3.5 million. For any discharge targeted for removal, DEP grants will pay up to 90% of eligible costs for year-round residential replacements, 50% for commercial replacement systems and 25% for seasonal residential replacement systems. With all of the funds for 1989 and 1990 encumbered, part of the 1992 funds encumbered and the 1993 bond money unused, approximately 135 OBD systems have been eliminated, mostly from shellfish growing areas.

Underground Injection Control Program

Underground injection wells are in reality a specialized form of subsurface wastewater disposal. They are being discussed separately, however, because they are the object of a specific regulatory program established by the Federal Safe Drinking Water Act. The Federal program groups underground injection wells into five classes as described below:

Class I - wells which discharge fluid waste, including hazardous and radioactive wastes, beneath an aquifer;

Class II - wells used to inject fluids associated with enhanced recovery from oil and gas wells;

Class III - wells used for solution mining of minerals;

Class IV - wells used to discharge hazardous or radioactive fluid wastes into or above an aquifer; and,

Class V - all other wastewater disposal wells.

Both the Safe Drinking Water Act and EPA regulations include provisions for delegation of primary enforcement authority (primacy) over the Underground Injection Control (UIC) program to states that demonstrate the necessary legal authority and technical and management capability. The DEP demonstrated the necessary authorities and capabilities and was awarded UIC Primacy for Class V wells effective September 26, 1983. The State UIC Program is established in rules of the Board of Environmental Protection, Chapter 543. The rules provide for review and, if appropriate, permitting of proposed Class I, II, and III wells using the procedures set forth in the Federal regulations cited previously. Class IV wells are prohibited based on statutory authority granted the Board by 38 MRSA Section 420, subsections (2) and (3). Class V wells will be handled in accordance with the Department's wastewater discharge licensing authorities as established by 38 MRSA, Sections 413 and 414.

Under Maine's UIC Program, several major categories of businesses (e.g. service stations, food processors, dry cleaners) were surveyed regarding their floor drains. For those with floor drains discharging only to surface water, the information was passed to the surface water point source control program. Those facilities with floor drains discharging into or onto the ground were sent notices of regulation (NOR), with explanation of the regulations and how to comply. Those failing to comply based on the NOR letter were sent Notices of Violation (NOVs). To date, only one UIC case has gone beyond the NOV stage: in that case, the violator entered into a Consent Agreement with the DEP for discharges, including hazardous wastes to the ground water and surface water. In addition to closing the floor drains and other remedial work, the violator paid a total monetary penalty of $70,000. In addition to this enforcement case, the UIC program has been successful in removing a large number of small, widespread threats to ground water. In some cases, small-scale sources of ongoing contamination of ground water were terminated, but no quantitative measures of these improvements exist.

Compliance Evaluation

DEP uses a three-part program to evaluate compliance of wastewater treatment facilities. The compliance evaluation program involves on-site inspections of wastewater treatment facilities, sampling their effluent quality, and monthly evaluation of the licensees' self-monitoring reports. Discharge licenses also require immediate reporting of any major malfunctions, bypasses or exceedences of license limits to DEP inspectors.

The intent of the inspection program is to foster voluntary self compliance and to encourage licensees to be aggressive in attaining optimal operation and maintenance of their treatment facilities. During inspection, all areas of the treatment facility are inspected to ensure proper operation and maintenance, including treatment equipment, pumping systems, self-monitoring records, process control and laboratory testing procedures. Effluent samples are collected for analysis by DEP to ensure that self-monitoring by the licensees accurately represents the quality of the effluent.

An important part of the inspection & compliance program is monthly Non-Compliance Review (NCR) meetings held by the DWRR. At these meetings, representatives of all regional offices, the licensing section, the enforcement section and DETA discuss specific compliance problems at licensed treatment facilities and decide upon specific courses of action. Possible responses to compliance problems range from monitoring the situation to providing technical assistance, to formal enforcement action. The NCR process has improved consistency in addressing compliance problems, has helped foster voluntary compliance, and has facilitated the referral of appropriate violations to the enforcement section.

Technical assistance is also provided to the operators of wastewater treatment facilities. In addition to responding to requests for help with specific problems such as sludge bulking and odor control, programs are conducted which take a more systematic approach to improving wastewater treatment operations by examining all aspects of treatment plant design and operation.

Operations Management Evaluations (OMEs) are done to diagnose license compliance problems and to provide on-site operator training. OMEs are focused on operation and maintenance problems including process control, personnel and financial management. OMEs result in recommendations for procedural changes as well as follow-up operator training targeted towards improving wastewater treatment. DEP conducts twelve OMEs per year on a worst-first priority basis.

Maine requires that chief wastewater treatment plant operators be certified by the DEP through a certification process that consists of qualifying examinations for five levels of certification for biological facilities and three levels of certification for physical/chemical facilities. The smaller municipal facilities can have a Grade I operator in responsible charge, while the larger and/or more complex facilities must have a Grade V operator in responsible charge.

Investigation of Citizen Complaints

During the past two years, the DEP Bureau of Land & Water Quality has investigated over one thousand citizen complaints concerning discharges to the water. Many of these required field investigations and extensive follow-up work to achieve eventual compliance with discharge laws. A number of complaint investigations have led to lengthy enforcement actions. Overall, a significant portion of the bureau's staff time is devoted to responding to citizen concerns.

Due to program inefficiencies within individual bureaus, as well as to take advantage of the possibilities made available by the information age, the DEP is in the process of evaluating all of the complaint response programs within the agency. Over the next biennium, this effort should result in a more efficient, better coordinated and better managed complaint investigation and response system, both at the departmental level and within each bureau program.

Enforcement of Water Quality Laws

The general philosophy of the DEP, Bureau of Land and Water Quality is to gain compliance and resolve problems at the least formal level appropriate, and to maximize the spirit of cooperation between the DEP and the regulated community. By fostering voluntary compliance with Maine's water pollution control laws, the overall effectiveness of the enforcement program is maximized and unnecessary litigation is avoided.

Formal enforcement actions become necessary when violations of environmental laws are severe enough to warrant action regardless of the remediation effort; or when the violator is not responsive in preventing or remediating environmental damage or refuses to cooperate with DEP. Formal enforcement actions originate both from license or permit violations, and from detection

of unlicensed activities through complaint investigation or other field work. DEP enforcement priorities have generally been based on the size of violations, potential for environmental harm, recurrence of violations and precedents involved.

The Division of Water Resource Regulation (previously the Division of Licensing, Enforcement and Field Services of the Bureau of Water Quality Control) is responsible for all formal enforcement actions regarding wastewater discharges taken by the Bureau of Land and Water Quality. Much of Maine's enforcement action on nonpoint source pollution is conducted by the Division of Land Resource Regulation, also in the Bureau of Land and Water Quality, but the Maine Department of Conservation (DOC) Land Use Regulation Commission, and municipal agencies are also involved. In addition to formal enforcement actions, the enforcement sections assist and confer with other units on violations that do not require formal action.

Chapter 2 - Nonpoint Source Pollution Control Program

Background

As required by Section 319 of the CWA, Maine completed its Nonpoint Source (NPS) Assessment Report during 1989. Since that report, assessment activities have focused on specific projects funded by CWA Section 604(b) Planning Grants, or limited assessment/prioritization done for CWA Section 319 project planning. In addition, the DEP's NPS staff also support lake watershed surveys as reported under the Lake Assessment chapter (Part 3, Chapter 4) in this report.

Recognizing that additional resources should be directed toward NPS assessment and prioritization of waterbodies impacted by NPS pollution, staff of the DEP Bureau of Land & Water Quality, Watershed Management Division have begun work toward these issues. First, a NPS Pollution Potential Index (NPSPPI) is being developed. This index will function as a screening tool to identify watersheds most likely to generate significant nonpoint pollution and will serve as a first cut of priority watersheds to be targeted. This will be Geographic Information System (GIS)-based and will utilize land cover, road and population databases for analysis of watershed sensitivity. Field verification of the NPSPPI will be accomplished through in-field assessment of a subset of streams. A pilot project for the Casco Bay watershed is underway and will be expanded to encompass the entire State.

Maine's "Nonpoint Source Pollution Management Program Annual Progress Report-1992" and "State of Maine Nonpoint Source Program Annual Report, October 1, 1992-September 30, 1993" provide a comprehensive overview of NPS activities, including highlights of the NPS Management Program.

Previous Years' Projects

The projects described in the 1992 305(b) Report were completed. Highlights of those projects and other projects implemented over the 1992-1993 period are as follows:

Best Management Practice (BMP) Manuals. Two manuals are currently being developed which are a Stormwater BMP manual and a Marina BMP manual. The following BMP manuals have been completed:

"Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices," Cumberland County Soil and Water Conservation District and DEP, March 1991.

"State of Maine Strategy for Managing Nonpoint Source Pollution from Agricultural Sources and Best Management System Guidelines," Developed by: NPS Agricultural Task Force, October 1991.

"Best Management Practices for Erosion and Sediment Control," Maine Department of Transportation (MDOT), May 1992. (Manual adapts "Maine Erosion and Sediment Control Handbook for Construction: Best Management Practices" and includes many of the BMPs in the construction manual as well as BMPs specific to transportation projects.

"Erosion and Sediment Control Handbook for Maine Timber Harvesting Operations-Best Management Practices," Maine Forest Service, June 1991.

Demonstration Projects. The Potash Cove demonstration project was done to reduce high sediment loading to Thompson Lake from a poorly designed road. The results of the project were a stabilized road and ditch system and significant reduction of sediment transport.

A demonstration project for erosion and sediment on a town ditch, public parking area and access to Ellis Pond was completed. The site demonstrated culvert outlet stabilization, berm and diversion installation for stormwater control and planting stabilization.

The Kennebec County Watershed Project installed several effective and highly visible demonstration projects, mostly in the China Lake watershed.

There are a number of other demonstration projects in places throughout the State which were installed as part of watershed projects or done by other agencies such as the MDOT and the Soil and Water Conservation Districts (SWCDs). A spreadsheet of these demonstration projects is being prepared and will serve as a reference for agencies and the public on what and where these demonstration projects are.

Forestry Projects. Activity highlights include completion of a pocket field manual which loggers and foresters can easily refer to in the field. A session on BMPs is now incorporated in the Certified Loggers Program, sponsored by the Maine Forest Products Council. During the fall of 1993, a project to determine whether BMPs are being used on logging sites and how the information is getting to the public was done. A random inspection of 25 logging sites was made and an analysis of the site visits will be prepared during the winter of 1994.

Statewide Information and Education. Statewide information and education activities are continued each year. Highlights include; publication of the Nonpoint Source Times Newsletter four times per year (this is an ongoing activity), publication of the "Catalog of Water Quality Information and Education Materials" which is a comprehensive compendium of education materials, videos, etc. available for teachers and educators; publication of a streams booklet, septic system brochure, ground water poster and book cover for schools. Education activities include development of a water quality curriculum for third grade, work with high school students on Envirothon competition, and development of interactive television programs for teachers throughout the State. In October 1993, a conference partially supported by the NPS program, "Nitrogen in the Environment-Sources, Impacts, Management" was held at the University of Maine.

Agricultural Activities. The Unity Pond Project was amended as a ground water nutrient management project with farmers in the Twenty-five Mile Stream and Unity Pond watershed. Through this project, nutrient management plans were prepared for twelve farms covering 5000 acres. Fertilization, crop yield and nitrate-nitrogen in ground water data was collected to determine cost effectiveness of nutrient management and ground water quality benefits.

The liaison position between DEP and the Soil Conservation Service was continued through 1992 and 1993. This staff person was instrumental in facilitating technology transfer and communications between DEP and the SWCDs. Examples of this include working with the DEP Solid Waste Division on sludge guidelines and with the Land Resources Regulation Division on stream bank stabilization standards.

Development Technical Assistance. The NPS program supports four staff positions (two Environmental Engineers and two Environmental Specialists) as well as State-funded positions to provide technical assistance to municipalities, government agencies, water resource organizations, businesses and individuals on NPS abatement issues. Activities include development project review, consultation on local ordinance development, inter- and

intra- agency training, BMP recommendations, watershed surveys, and review/comment on legislation and rules affecting NPS.

During 1992, staff reviewed ten comprehensive plans and provided inventory information for approximately twenty towns. Direct technical support was provided to 35 towns in the form of watershed maps and phosphorus allocation information, which is referred to as "Town Pack". Additionally, 30 towns were provided direct technical assistance in the form of review of development proposals, ordinance review etc.

Technical assistance highlights for 1993 include; completion of watershed surveys in the Range Ponds, Hartford lakes (Canton, Bear, and Little Bear), Worthley Pond, Lake Christopher and Forest Lake watersheds; incorporation of phosphorus control and other NPS water quality considerations in more than 50 comprehensive plans; adoption of phosphorus control ordinances in the towns of China and Naples; and incorporation of BMPs for erosion control, stormwater management and phosphorus control in many proposed developments and highway projects.

Transportation. NPS staff formalized a process for reviewing transportation projects and an NPS engineer now consults on a regular basis with MDOT staff and consultants. A manual "Camp Road Maintenance Manual-A Guide for Landowners" was published by the Kennebec County SWCD and has been very well received. The MDOT Local Roads Center provides technical assistance to municipalities on road issues, including assistance on NPS and BMPs for erosion control.

Casco Bay Project. A workshop on BMPs for local governments in the lower Casco Bay watershed was held for 24 municipalities. In the upper watershed, NPS pollution workshops were held to educate the public on protection of freshwater quality in the watershed. The highly successful "Ditch of the Year" contest was held. This is a contest for town road crews to design and implement effective BMP practices/structures. The Casco Bay National Estuary Project completed the preliminary Comprehensive Conservation and Management Plan. A priority of the plan is minimizing impacts from nonpoint sources.

Sebago Lake Project. This project funded a Resource Specialist, hired by the Portland Water District (PWD), who provided technical assistance and education, including coordination of activities, for watershed residents. The list of technical assistance activities, education activities, and fund-raising is extensive. Because of the accomplishments of the Resource Specialist and other PWD staff, the Resource Specialist is now being funded completely by PWD.

Gleason Cove/ Boyden Lake Project. The goal of this project was to open closed shellfish areas in Perry and Robbinston. Progress was made in working with landowners in the watershed, but efforts are continuing towards elimination of the overboard discharge. This project, as well as the Scarborough River Estuary project, supported the Cooperative Extension Service Coastal Volunteer Water Quality Monitoring program.

Bond Brook Project. The first year of the two-year Bond Brook restoration project in Augusta was completed. Completed work includes contact with 28 landowners with direct technical assistance provided to 4 landowners; technical assistance to the two municipal road departments and to Augusta's code enforcement officer; and technical assistance on two agricultural sites. Demonstration projects were completed for clay mining site stabilization, stream crossings, vegetated rip-rap, and stream bank reconstruction. The second year of the project will continue to focus on technical assistance with particular focus on the roads which are a major source of sediment loading.

Taylor Pond. This project in Auburn was completed with the exception of a few BMPs which are waiting on the spring construction season for installation. A watershed survey prior to implementation of this project identified the erosion problems in the watershed. Through implementation, a total of 30 landowners or road associations were provided technical assistance resulting in BMPs being installed at priority sites. Education activities included workshops with the lake association and homeowners and road crews; classroom visits and field trip; and a 45-hour teacher training workshop on lake ecology and NPS pollution. The NPS program staff have proposed to continue work on this project and focus on training and assistance to the two towns on road maintenance, ordinances, etc.

Scarborough River Estuary Project. The first year of the Scarborough River Estuary project was completed. Activities focused on outreach/education, coordination with the Code Enforcement Officer and the Comprehensive Plan Committee, and continued monitoring through support from the University of Maine Cooperative Extension. This project is unique in that it is being facilitated by the Town-appointed Coastal Pollution Committee, so it is successful in that the Committee is comprised of local people and is supported by the town. Completed activities include: outreach activities such as representation on the local cable television station, development of a script on NPS pollution and the estuary and coastal clean-up activities; inspection of problem sites by the local Code Enforcement Officer; continuation of monitoring activities including working with the Scarborough High School and establishment of a lab within the High School; and incorporation of information, problems, and concerns in the Comprehensive Plan. The second year of the project will focus on technical assistance and demonstration projects.

Current 319 Projects

In October 1993, EPA-Region I approved Maine's FFY93 CWA Section 319 grant workplan. The following is a summary of the projects:

Nonpoint Source Pollution Survey Manual for Coastal Waters. This project will develop a manual, for use by local citizen water quality monitoring groups, which will describe how to do watershed surveys of nonpoint pollution sources in coastal areas. The DEP will produce and distribute the manual.

BMP Manual for Marine-Related Industries. Marine-related industries often are relatively important sources of NPS pollutants to near-shore waters. DEP will prepare a BMP manual for marine-related commercial, recreation and industrial activities. The manual and associated public outreach will help people modify or design their operations to minimize export of NPS pollutants.

Dairy Farm Nutrient Management -BMP Demonstration. The Franklin County Soil and Water Conservation District will demonstrate nutrient management as a BMP on a dairy farm within the Sandy River watershed. The demonstration will show that practical improvements in nutrient management will maintain crop yields, reduce crop production expenses and abate NPS pollution. The plan will be shared among all farms within the watershed to encourage other farmers to adopt nutrient management BMPs.

Erosion Control Demonstrations - China Lake Watershed. This project will demonstrate the applicability and effectiveness of various established erosion control materials and methods installed as BMPs at existing active erosion sites within the watershed of a culturally eutrophic Maine lake. Vegetative soil stabilization techniques will be demonstrated at 5 stream bank and 5 lakeshore sites. The effectiveness of each will be monitored after the installations and documented in a final report. Demonstration elements include a narrated

slide show, a statewide public workshop and long-term use of the sites to demonstrate BMPs to people in Kennebec County . The town of China will conduct the project with technical assistance from Kennebec County SWCD.

Statewide Information & Education Project. This project applies information, education, and technology transfer to help citizens improve and protect water quality throughout Maine. This year's goal is to continue and expand our Information & Education program. Specific actions include:

Continue publishing the Nonpoint Source Times;

Update the Catalog of Water Quality Information & Education Materials;

Develop a nonpoint source display for general audiences;

Develop information & education materials for use by the Land Resource Regulation Division;

Continue to increase agricultural technology transfer opportunities; and

Print the Stormwater Management BMP and Camp Road Maintenance Manuals

Timber Harvest Site BMPs - Technical Assistance. Timber harvest operations are a statewide land use activity that is listed as a minor to highly significant source of NPS water pollution in Maine. Failure to apply BMPs at timber harvest sites can cause long-term destruction of aquatic habitats due to direct physical disturbance and sedimentation of watercourses.

The Maine Forest Service published "Erosion & Sediment Control Handbook for Maine Timber Harvesting Operations - Best Management Practices" in June 1991. Inspections of harvest sites will determine whether BMPs are being used properly. If BMPs are not properly applied, DEP will explain to the landowners or operators why and how BMPs need to be installed. DEP will sponsor 5 workshops to inform landowners and operators about the BMPs.

Technical Assistance Program. The purpose of DEP's Technical Assistance Program (TAP) is to provide to state and regional agencies, town governments, consultants, contractors and individuals the clear guidance and technical support necessary to effectively implement the most appropriate NPS controls. The TAP addresses water quality impacts of nonpoint sources statewide with efforts focused on water resources where water quality is threatened or impaired and sufficient local interest and support exists to make the effort successful. Specific objectives of the TAP include:

1. Develop local support for implementation of NPS controls;

2. Assist in land-use planning and regulation, particularly at the municipal level (Assistance includes comprehensive plan development, ordinance formulation, resource evaluation, watershed allocation and review of specific project proposals);

3. Assist in selection, design, construction oversight and maintenance of BMPs to address specific nonpoint sources;

4. Provide guidance and training for BMP users (e.g., road crews, code enforcement officers, engineering consultants, construction and forestry contractors, farmers);

Damariscotta Lake Watershed. This 2-year watershed project conducted by the Maine Congress of Lakes Associations will improve and provide long-term protection to the water quality of Damariscotta Lake. The lake is listed as a priority waterbody because of decline in water quality and local support to treat the watershed. The project involves implementation of BMPs on priority sites that have been previously identified in a NPS watershed survey. Technical assistance will be made available to any watershed landowner who requests a property review/evaluation. Sites will be evaluated in terms of existing or potential erosion problems, and options for treating phosphorus and sediment-rich runoff from the property. Towns will be offered assistance in training public work crews to use methods and procedures to reduce erosion problems from town roads, ditches and shoulders, and to divert runoff from roads away from direct tributaries to the lake.

Prestile Stream Watershed. This project will show municipal officials and private land owners ways to conduct road construction and maintenance to reduce erosion and sedimentation of streams in this watershed. MDOT, Rural Roads Association, Central Aroostook SWCD and the DEP Northern Maine Regional Office will be working jointly on this project. Direct technical assistance and instructional workshops will be available.

Integrated Crop Management Project. The Androscoggin Valley SWCD will conduct this 2-year project. The SWCD will enroll 20 farms located in Androscoggin county to carry out integrated crop management plans, thereby reducing ground water threats and impacts from over-application of nutrients and agricultural chemicals. Priority farms are those in areas where ground water is the primary source of drinking water. The media outreach, demonstrations and available technical assistance associated with this integrated crop management project will be used to promote the use of other BMPs to protect water quality. Reduced inputs can save the producer money and ensure clean water.

Nitrate Pollution from Subsurface Disposal Project. Although there is widespread use of numerous predictive models to calculate nitrate concentrations at down-gradient site boundaries, very little monitoring data exists to verify the accuracy of those models. The 1989 Maine Ground water Management Strategy identified the need to measure actual ground water nitrate levels. This project evaluated the impact of conventional septic systems (i.e., designed according to the 1974 Maine Subsurface Wastewater Disposal Rules) in residential developments on nitrate concentrations in ground water and private wells. In November 1990, over 500 domestic wells in 19 unsewered residential developments were tested for nitrate-N concentrations to provide a snapshot of ground water and well water quality. In addition, monitoring wells installed near some leachfields were tested quarterly to assess the inorganic chemistry of the septic system effluent. The results of this study are presented on .

The study indicates that less than 0.4% of the wells tested (two wells) exceeded the 10 mg/L Primary Drinking Water Standard for nitrate. Approximately 84% of the wells had nitrate-N concentrations less than or equal to 2.5 mg/L; approximately 94% of the wells had concentrations less than 5.0 mg/L. The mean nitrate-N concentration was 1.25 mg/L and the median was 0.4 mg/L Nitrogen concentrations (calculated as nitrate-N) measured in ground water immediately down-gradient from four septic system leachfields varied widely. Concentration ranges associated with the most impacted monitoring well at each individual leachfield are shown on Table 5-1. These ranges are similar to the ranges for total nitrogen concentrations in septic system effluents from other studies.

Table 5-1: Ground Water Nitrate-N Concentrations Down-Gradient From Septic Leachfields

Site	Range of nitrate-N	Number of Sampling Periods
A	53.1 to 95.1 mg/L	5
B	7.2 to 45.2 mg/L	5
C	4.2 to 33.2 mg/L	6
D	60.1 mg/L	1

Ground Water Protection Planning and Education. This project focused on towns engaged in the comprehensive planning process, addressing their need for ground water education and technical assistance. The one-year project provided education and technical assistance to 34 towns on nonpoint source pollution issues relating to ground water protection planning. The following objectives were accomplished:

1. Conducted regional ground water protection workshops which provided citizens with basic ground water concepts and the rationale for ground water protection. Assisted towns in defining their needs for ground water protection goals.

2. Freshmen high school students at Gray New Gloucester High School investigated ground water planning by studying ground water and speaking with town officials on planning issues related to ground water. Their investigations culminated in a cross-disciplinary project to produce a video on ground water protection entitled "Keep It Clean". The video was distributed to science teachers in Maine.

3. Produced outreach materials for the public and municipal officials consisting of two brochures, "Ground Water Facts for Maine Residents" and "Ground Water Facts for Municipal Officials". Specialized mailings were made to planning boards, well drillers and science teachers.

Chapter 3 - Ground Water Protection Program

Background

The protection of Maine ground water is an issue of increasing concern at the local, regional, state and federal levels. Serious ground water pollution problems that have occurred throughout the State and elsewhere have heightened the need for protecting ground water supplies. A few municipalities and regional planning agencies have conducted ground water quality assessment studies, but programs for effective assessment of the quality of ground water resources are needed in many areas of the State. The EPA Office of Ground Water and Drinking Water has placed emphasis on four major areas of coordination for State ground water programs, including:

1. State interagency coordination of ground water programs;

2. development of Comprehensive State Ground Water Protection Programs (CSGWPPs), and adaptation of the State Ground Water Management Strategy to its CSGWPP;

3. joint EPA/State assessment of ground water protection problems and needed activities for risk reduction; and,

4. building upon implemented state ground water protection programs.

State Interagency Coordination of Ground Water Programs

Unlike the management of surface waters which is centered in the DEP Bureau of Land and Water Quality, the management of ground water quality in Maine is distributed among eight state agencies and 495 municipalities. To effectively coordinate these diverse interests in ground water management, an Executive Order was issued in 1985 which established a Ground Water Standing Committee under the State Land and Water Resources Council. In March 1991, the work of the Ground Water Standing Committee effectively ended with the termination of its staff position.

In April 1991, a new Water Resources Standing Committee assumed the responsibilities of the Ground Water Standing Committee. As with the former Committee, the agencies involved represent a broad range of water quality issues. But, unlike the former, the Water Resources Standing Committee is also involved with surface water quality policies. The Committee has taken responsibility for the following ground water issues:

1. prioritizing ground water management program requirements;

2. scheduling key activities that provided for increased protection and better management of ground water resources;

3. developing and prioritizing draft ground water legislation;

4. coordinating meetings as necessary, but at least quarterly, to discuss mechanisms for better interagency coordination of ground water management programs.

The Maine Ground Water Management Strategy

Maine has made significant progress in developing its Ground Water Management Strategy but still has much to accomplish regarding EPA ground water strategy guidance. The Maine aquifer mapping program, ground water standards, and enforcement provisions are established but poorly funded. The proposed classification system, monitoring, data collection and analysis, ground water use, source control, and ground water/surface water/natural resource coordination programs all require further development. The Maine Ground Water Management Strategy has been updated each biennium by the DEP, coordinating through the Water Resources Standing Committee. The latest two-year action plan was created in the fall of 1992.

In late 1993, EPA provided funds to the New England Interstate Water Pollution Control Commission to help Maine develop a framework for a Comprehensive State Ground Water Protection Program by gathering information on the current status of Maine's ground water-related programs. Development of a CSGWPP is currently underway in Maine. This CSGWPP will incorporate the major elements of the Ground Water Management Strategy. A final report is expected in January of 1995.

Joint EPA/State Assessment of Ground Water Protection Problems and Needed Activities for Risk Reduction

The Maine Ground Water Management Strategy details ground water protection problems. The Maine DEP keeps the EPA Ground Water Program Administrator for Maine fully informed of the progress of ground water strategy implementation and further development. The EPA's role is to assist the State in achieving its ground water program objectives as guided by federal policies.

Most major activities that threaten ground water, such as underground storage tanks, sand-salt piles, and solid waste disposal, have been adequately assessed; and comprehensive programs which should ultimately eliminate these threats have either been adopted or are under serious development. Some further assessment of the potential threat posed by agricultural chemical use and specific types of underground injection is needed. Studies to assess the ground water impacts of fertilizers began in 1990. Studies to determine the impacts of agricultural pesticides are on-going. These assessments will be conducted in conjunction with development of the State Pesticide Management Strategy, the NPS Pollution Control Program, and the Underground Injection Control Program within the next two to five years.

Implementation of State Ground Water Protection Programs

Current program emphasis and the biennial development of two-year action plans have been discussed above. Over the next five years, Maine ground water protection efforts will significantly change and grow. Maine ground water protection policy is completing a phase dominated by retroactive cleanup of pollution and entering a phase that will be dominated by pollution prevention planning. The implementation of Maine ground water programs is geared to this reality. Incorporation of ground water quality data into the GIS database is critical to a successful effort to prioritize ground water basins for protection and management.

The majority of the effort to safely site and operate potential threatening activities will be assumed by the DEP and local governments. The Maine Pesticide Management Strategy under development at the Department of Agriculture, Food and Rural Resources (DAFRR) will provide for monitoring and control of agricultural chemical use. DEP and the Maine Geologic Survey (MGS) will continue to provide the ground water research which serves as the basis for some of the ground water protection initiatives in the State. DEP, Bureau of Land and Water Quality will continue to focus its research on ground water quality and monitoring, whereas MGS will continue to emphasize research to identify and physically characterize sand and gravel aquifers

and high-yield bedrock areas. DEP will continue to manage ground water quality through a combination of education and regulation. Public education to protect ground water will become increasingly important in the future. DEP regulatory responsibilities will increase as many of the nonpoint source pollution activities impacting ground water come under regulatory scrutiny. DEP is currently engaged in efforts to improve ground water data management. Many years of site investigation information currently resides in paper files. Since 1991, DEP has been directing resources to enter this information into the GIS database. The accessibility of information in GIS and the geographical capabilities of this format will allow for prioritization of funds and efforts directed at protecting ground water resources.

Other agencies (MDOT, LURC, DAFRR, DOC) will be responsible for ground water protection by ensuring adoption of BMPs for their related activities that pose a threat to ground water quality. Creation of the Maine Solid Waste Management Agency to deal with all solid waste disposal issues ranging from siting new landfills to recycling should result in more environmentally safe waste disposal. Further emphasis on recycling will reduce the waste stream and decrease landfill capacity needs.

Chapter 4 - Cost/Benefit Analysis

The assessment of costs and benefits of water quality protection is an extremely difficult exercise. Determination of direct economic costs of environmental regulation is complex, but with some effort, financial outlays can be determined. Indirect economic costs of water quality protection, such as jobs lost or gained, effects on competitiveness, productivity, worker satisfaction, etc., are often based on assumptions or subjective evaluations and are difficult to distinguish unequivocally from other economic costs.

Comparison of the benefits of water quality protection to economic costs is difficult at best, and often impossible. Because dollar values cannot be assigned to many of the benefits, the environment would nearly always suffer by restricting the comparison to economic aspects. In fact, such a superficial analysis of water quality protection efforts would undoubtedly have deterred the progress Maine has made over the last three decades. Tourism is an important component of Maine's economy; water quality undeniably is one component of Maine's attraction to tourists, but what is the increment resulting from our efforts to protect and improve our waters?

The direct benefits of the construction of numerous wastewater treatment plants for industrial and municipal facilities were dramatic. Waterbodies that were once polluted, now are supporting their designated uses of swimming, fishing, wildlife habitat, and recreation. Some Maine towns now charge premium taxes for riverfront properties that, only 20 years ago, no one wanted. After cleaning up the severe pollution our focus has now shifted to sources and contaminants that were previously masked by the large-scale problems.

One unusual example of direct economic benefits of water quality protection is the elimination of pollution sources from shellfishing areas. Efforts of State personnel from several Departments, in cooperation with local officials, have resulted in opening shellfish areas that had been closed due to sewage contamination. Sanitary survey work documents the sources of pathogenic indicator bacteria, local code enforcement and State enforcement, coupled with State programs to provide financial assistance for construction of new or replacement systems, and follow-up sampling to document the restored water quality, result in re-opening the affected area to harvest. The re-opened area produces a direct economic benefit to the individual shellfish harvesters and indirectly to others in the shellfish industry.

Costs of the State Water Quality Program

Despite the serious understaffing due to Maine's recent budget problems, approximately 70 staff within the DEP work primarily in the evaluation, protection or regulation of water resources. These staff include administrators, environmental specialists, biologists, geologists and engineers. The programs include licensing, compliance, enforcement, technical assistance & pollution prevention, wastewater engineering, environmental assessment, lake restoration, nonpoint source control and groundwater protection. The annual cost to administer all of these water-related programs is approximately $4.24 million. The State's water licensing-compliance-enforcement program costs nearly $1,400,000, with 17%, or about $238,000, paid directly by fees charged to licensees. There are numerous other programs within and outside of the DEP that control impacts to water quality (i.e. the Subsurface Waste Disposal Rules, Agriculture's Pesticide Control Board and Manure Handling Compliance Program, Marine Resources shellfish program, Soil Conservation Service farming assistance). There is no comprehensive effort to catalog all water quality-related State administrative costs.

New Facility Construction

In 1992 and 1993, 20 projects were completed with assistance from the Maine Construction Grants Program (13), the State Revolving Fund (6) or a combination of Farmers Home Administration grant/loan and State grant money. These projects included new facilities, upgrades, additions and modifications, for a total cost of approximately $61,000,000 to complete. In addition to this list of complete projects, 35 projects are in progress, with an estimated total worth of $155,777,000.

During 1992 and 1993, the Combined Sewer Overflow (CSO) program provided 25% grants to fund four specific large projects and to support development of a number of CSO Master Plans. The State grants amounted to $2,400,000 for the 4 major projects and $2,400,000 for the CSO Master Plans, thereby supporting an overall total of $19,200,000 in CSO projects and planning. Eight communities have submitted CSO Master Plans, which together propose $150,000,000 worth of projects to abate CSO discharges.

The Small Community Program, since 1982, has disbursed $12,000,000 in grant funds to assist municipalities in construction of individual or cluster systems to eliminate discharges to surface waters from malfunctioning systems or straight pipes. This amount of funding has resulted in construction of new treatment facilities worth approximately $14,000,000. Since the 1992 305(b) report, $2,105,533 has been disbursed to fund approximately $2,500,000 in new small facility construction.

The Overboard Discharge Removal Program has disbursed $1,700,000 since its inception, removing 135 systems worth approximately $2,000,000. These systems are often constructed on very limited sites, which results in high system costs to achieve the usual benefit of eliminating the wastewater discharges from commercially valuable shellfishing areas.

Much of Maine is served by private, usually individual sewage disposal systems, rather than by centralized municipal treatment facilities. The estimated number of existing systems is 301,000, with approximately 10,000 new or replacement systems installed in 1993. The average range of cost for a new system with no variances or engineering requirements, is $4,500 to $7,500. Therefore the total value of the new systems in 1993 was $45 to $75 milllion and replacement cost of all the private systems in Maine is in the range of $1.4 to $2.4 billion.

At present, no comprehensive data exist on the total wastewater treatment infrastructure installed by businesses and industries, or on the annual increment.

Nonpoint Source Management

The NPS program, including DEP staff, BMP development and grants, was supported by $927,601 in 1992 and $871,936 in 1993. For 1994, the total proposed funding for the NPS program is $1,220,502. The Nonpoint Source (NPS) Best Management Practices (BMPs) were assembled with funding from several federal grants, state challenge grant money, and University of Maine outreach money. BMPs generally reduce the environmental damage of human activity at the cost of changing the way people conduct their activities. In some cases, these changes are minor and inexpensive, in others they require significant changes to the activity as well as significant capital.

Pollution Prevention

Any costs to implement pollution prevention programs are generally counterbalanced many times over by economic benefits alone, and produce significant environmental benefits as well. By reducing or eliminating the use of toxic chemicals, the environment suffers less contamination, human health is affected less by environmental contamination, businesses reduce their regulatory costs, treatment costs often decline and many industries have actually reduced their production costs as a result of re-evaluating their processes during pollution prevention programs.

Chapter 5 -- Special State Concerns and Strategies

Special State Concerns

Although we have achieved much success in reducing water quality impairment from large single sources, the types of problems facing our water resources today demand new and innovative approaches. As this report illuminates, the most prevalent unaddressed threats to our surface waters are from the cumulative impacts of smaller, more diffuse sources, often from individual land use activities. The Department is pursuing a number of strategies to improve our ability to address these problems.

Strategies

Pollution Prevention

Pollution Prevention (P2) is critical for the future of environmental protection. Regulation based upon waste treatment and end-of-pipe controls has allowed tremendous strides in environmental improvement, and regulatory efforts must not be abandoned. To achieve the next level of environmental improvement, however, we must now invest in preventive measures and implement processes that generate less pollution. P2 offers a non-regulatory approach to environmental protection by focusing on removal of pollution and elimination of toxics from processes. Pollution prevention provides businesses the opportunity to reduce operating costs, reduce future environmental liability and create green marketing strategies. P2 is a cost-effective approach that produces tremendous environmental benefit. Pollution prevention makes good business and environmental sense for Maine.

In its 1994 Agenda For Action, the Department includes pollution prevention as one of five priorities. That documents calls for a pollution prevention program that: encourages the use of nonpolluting technologies and waste minimization; promotes the sustainable use of natural resources and protection of the environment through conservation, recycling and material reuse; and includes environmental considerations when evaluating products and processes.

The DEP has made a substantial commitment to pollution prevention, establishing a central Office of Pollution Prevention (OPP), staffed by five positions within the Office of the Commissioner, as well as specific projects or work units within the program Bureaus. The mission of the OPP is to promote pollution prevention as the preferred method of environmental protection statewide, especially within industry. Toward that end, the OPP conducts training workshops for industry, internal training seminars for DEP staff, acts as a statewide clearinghouse for pollution prevention technology & idea transfer, administers the Small Business Technical Assistance and Maine Environmental Partnership Programs, and publishes a quarterly newsletter and other materials. Starting with the successful effort at International Paper, the on-site technical assistance program has grown to involve 12-15 projects active at any given time. Pollution Prevention teams, consisting of staff from DEP and the industry facility work together intensively to evaluate and improve all areas of the operation from production through waste treatment. The pollution prevention program has already produced notable improvement in the water quality of the Androscoggin River. This effort should continue and expand into the rest of the state.

Ambient Toxics Monitoring of Surface Waters

Good data on the quality of our waters is essential for detecting water quality problems, describing the status and trends of our waters, effectively designing programs to protect water quality, and measuring environmental results. After careful analysis of existing data sources, the Surface Water Ambient Toxics Technical Advisory Committee concluded that Maine lacks good

information on the presence of toxics in our waters. The limited information we do have -- discovered largely by accident while Maine was being used as a source of background data -- raises concern that toxic contamination is prevalent and serious.

Recognizing the critical importance of understanding the quality of our surface waters, the 116th Legislature recently enacted L. D. 1446, which establishes an ambient water toxic monitoring program. Together with other toxic monitoring initiatives, including the REMAP program which will investigate toxic contaminination in Maine lakes and the Dioxin Monitoring Program which focuses on dioxin contamination below major known sources, this program will, over time, present a clearer appraisal of the nature, extent and fate of toxins in Maine's surface waters and provide a basis to evaluate the risk that toxic substances present to humans and the ecosystem.

Watershed Management

The Department supports the watershed approach as a means to comprehensively assess a resource, identify the threats to the resource, and produce solutions that are tailored to the problems. Setting priorities based on impacts to the resource can help target available funds to where they are most needed. A common feature of a watershed approach is regulatory flexibility: regulatory controls are combined with other approaches to produce the best environmental results at the lowest cost. Further, watershed management typically calls on all levels of government, as well as the private sector, to collaborate

- **Androscoggin Project:** One specific example of this approach is the Androscoggin Basin Pollution Prevention Project. This project combines watershed management with pollution prevention, and is fundamentally a cooperative effort between the DEP, the affected towns, and the industries to comprehensively reduce point and nonpoint discharges.

- **Organizational changes:** The Department has also sought to promote the watershed approach through organizational changes. In January 1994 the DEP merged the bureaus of Water Quality Control and Land Quality Control into the Bureau of Land and Water Quality. Within this bureau we created the Watershed Management Division, which includes the nonpoint source program. The focus of this division will be to implement watershed planning and to emphasize the watershed approach to our environmental problems.

- **Watershed-based Licensing:** Beginning in 1994, waste discharge re-licensing will be conducted on a watershed basis. The Androscoggin basin facilities will be re-licensed in 1994, the St. John and Presumpscot in 1995, the southern Maine basins in 1996, the Penobscot and eastern Maine basins in 1997 and the Kennebec and central Maine basins in 1998. This approach will be coordinated with NPDES permitting conducted by USEPA Region I.

Land Use and Growth Management

It has long been recognized that land use practices have direct impacts on water quality. The State of Maine has several programs in place to regulate the environmental effects of land uses that may be adverse to the environment: The Site Location of Development Law, which requires developers of large projects to obtain permits from the Department before beginning construction; the Natural Resources Protection Act , which requires a permit from the Department for any activity in, on or adjacent to a protected natural resource, defined as rivers, streams, brooks, great ponds, coastal wetlands, freshwater wetlands 10 acres or larger, sand dunes, and fragile mountain areas; and the Mandatory Shoreland Zoning Act, which requires towns to control building sites,

land uses, and placement of structures within the shoreland area, to protect water quality, habitat, fishing industries, and conserve shore cover, public access, natural beauty, and open space. The Department's merger of the Land and Water bureaus will facilitate the necessary coordination between the management of these land use programs and the protection of water quality.

Also important to environmental protection, and a key feature of the state's land use programs, is the Growth Management Act, enacted in 1988. This program is based on comprehensive planning and stronger state and local cooperation It is designed with the intent of improving natural resources management, including environmental protection objectives, and to allow more effective consideration of the cumulative impacts of development while avoiding the reactive qualities of the existing regulatory system.

During this past legislative session, the Maine State Legislature, through a study commitee, conducted hearings on a wide range of issues related to Maine's land use and natural resource management system. The resulting recommendations of the committee, codified in L. D. 1487, require greater state and local coordination, and strengthened local capacity for land use management. Thus an important area of emphasis for the Bureau of Land and Water Quality will be to coordinate the water and land quality laws it administers with the goals and objectives of the Growth Management Act, and to find new ways to coordinate State environmental programs and local growth management efforts.

Education and outreach.

Since many of the impacts to the environment come from individual actions, public education is vital. The Department has a responsibility to help each citizen to better understand the environment; the consequences of his or her actions upon it and what can be done to avoid them, and the requirements of environmental laws. Voluntary compliance is the primary means of environmental protection.

Each year the DEP performs many outreach tasks with the intention of informing, educating, and involving Maine citizens interested in water quality-related issues. Five central issues for managing Maine water resources have persisted from previous years. The central issues include: 1) improving the coordination and cooperation of federal, state, regional and local governments; 2) educating and involving the people of Maine in the process of managing their environmental resources; 3) increasing the enforcement of environmental laws; 4) providing technical assistance to municipalities; and 5) increasing the monitoring of water quality.

Volunteer Monitoring

A corollary of the education/outreach program is the support of volunteer monitoring. Maine citizens in many areas of the State, including lake watersheds, rivers and coastal areas are increasingly interested and concerned about the quality of their waters. Many of these people are willing to devote time and effort to monitor the quality of their waters in order to help protect and improve those waters. The Department has helped organize and present the annual Water Quality Monitoring Fair, which provides workshops and seminars on many facets of establishing and running volunteer monitoring programs. Additionally, this fair is an event at which volunteers can share their experiences with other volunteers and establish better lines of communication with the staff of DEP and other state agencies with expertise or responsibilties in the habitats of interest to the volunteers. The State will be well-served to continue support of this program and expand its assistance to volunteer monitors in other ways, such as establishing a statewide database management system for coastal volunteer monitoring data.

Geographic Information System (GIS)

The Maine Geographic Information System will serve as the linchpin for a system of well-coordinated and accurate natural resource management information. The spatial format of GIS greatly enhances the analysis of technical information, leading to better informed planning and regulatory decisions, which also provides greater predictability for the regulated community. The Department has recently established a study group to evaluate how the DEP can make the best and most effective use of GIS in its programs. In addition, the Land and Water Quality Bureau contains a newly created Data Management Unit, which will be able to provide services and support to enhance our ability to use all of our water quality and water impact databases, as well as GIS.

Environmental Indicators

The State of Maine, as well as the rest of the nation, have used a performance-based regulatory approach since the passage of the Clean Water Act. This approach was appropriate and achieved tremendous strides toward reducing discharges of pollutants to the environment, with corresponding dramatic improvement in the quality of our waters. This approach should be maintained in place, but now needs to be augmented by other approaches. One of these is pollution prevention, which is discussed in detail elsewhere in this report. Another is the use of receiving water impact standards. Maine's environmental law incorporates biological community integrity standards, and rules establishing the criteria to determine whether those standards are met have been developed for rivers and streams. The State needs to continue its progress in this arena and expand the use of biological community integrity measures to all types of State waters.

Maine Environmental Priorities Project

The Maine Environmental Priorities Project is part of a national effort initiated, and funded in part by the U.S. Environmental Protection Agency, as a method of setting priorities for environmental protection efforts based on the risks from the array of environmental problems. This project is unique in that it is a collaborative effort between state government, environmental organizations, business and academic institutions, and the public at large. The process follows a path of problem identification, risk analysis and reporting, and priority setting, and should provide a useful guide for future management decisions.

Conclusions

After twenty years of controlling or cleaning up pollution point-by-point and pollutant-by pollutant, it is becoming increasingly apparent that many of the remaining problems cannot be addressed in the same manner. Despite our human tendency to view nature as a collection of separate habitats, everything is interconnected. Cleaner waters have allowed us to discover that many of our activities cause adverse effects, even when not directly involving waterbodies or watercourses. Many of these activities generate non-point source pollution, the cumulative effects of which can cause serious problems, such as algal blooms and accumulation of toxics in sediments or fish, in the affected waterbodies.

Our understanding of the distribution and accumulation of toxic compounds in the Maine environment is very limited. The department stands poised to add to its existing data on toxics. Additional data describing the condition of Maine's lakes, rivers, streams, and tidal waters are needed. The State does not have adequate personnel to accomplish all the necessary sampling. This makes it imperative to provide training and support to the large pool of private citizens who are willing to volunteer their time and efforts to monitor our waters.

Regulation of point sources has gained much for us and must be continued and improved. Construction of new treatment facilities, combined sewer overflow controls and upgrades or retrofits of old facilities must continue. The most important water quality initiatives for the future are to move aggressively into pollution prevention, nonpoint source management, watershed-based assessment and planning, coordinated land-use management and water quality monitoring. We must work with industries, municipalities and individuals to change the activities that cause the pollution.