STATE OF MAINE

1990 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 Water Quality Control

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PART I: EXECUTIVE SUMMARY

In Maine, clean water is more than a resource, it is tradition. It has shaped state history and pride. Yet it has also been compromised by misuse and neglect.

We can undo the damage and restore the tradition by reaffirming our commitment to clean water for Maine. It's a commitment, I believe, to protecting our special way of life.

John R. McKernan
Governor

The State of Maine is known for the beauty and abundance of its natural resources, 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 be made into lumber and paper. 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.

The Federal Water Pollution Control Act of 1972 provided the framework for significant improvements in the quality of Maine waters that have occurred in the past 18 years. Federal, State and local funds were spent to construct municipal wastewater treatment plants. Maine industries also constructed facilities to treat their process wastewaters. Maine people became more aware of issues affecting water quality and changed their actions appropriately.

The results are dramatic. Atlantic salmon now return to Maine rivers, waters that were once open sewers are now clean enough to swim in, and some Maine lakes have seen marked improvement.

Unfortunately, Maine people are still not able to use all their waters. Toxic chemicals, recently discovered in fish from some Maine rivers, must be eliminated. Several wastewater treatment plants remain to be built, the wetlands and lakes of Maine must be better protected. Contaminated groundwater supplies must be cleansed while future contamination is prevented.

This biennial Water Quality Assessment Report (305(b) Report) details the existing quality of Maine waters, reports the major factors affecting the use of those waters, evaluates trends in water quality, describes water quality protection programs, and identifies water quality issues that remain to be addressed.

The Quality of Maine Waters

- 98.2% of all Maine rivers (based on length) fully support the uses designated by State law, 1.8% do not.
- 74.4% of Maine lakes (based on area) fully support designated uses, 6.0% fully support those uses but are threatened, and 19.6% partially support the uses. 80.4% of Maine lakes meet the GPA classification requirements established by State law, 19.6% do not.
- 90.2% of all marine and estuarine waters (based on area) fully support the uses designated by State law, 2.2% partially support those uses and, 7.6% do not support the designated uses.
- An estimated 1% of groundwater in Maine does not fully support the uses designated by State law.
- 98.8% and 99.5% of Maine rivers (based on length) support the "fishable" and "swimmable" goals of the Clean Water Act, respectively.
- All Maine lakes at least partially support the goals of the Clean Water Act - 17% (based on area) partially attain the "fishable" goal, 5% partially attain the "swimmable" goal, the remainder fully attain both goals.
- 90.3% of Maine marine and estuarine waters (based on area) attain the "fishable" goal of the Clean Water Act, 2.2% partially attain that goal, and 7.5% do not. 99.9% of those waters attain the "swimmable" goal of the Clean Water Act, and 0.1% do not.

Major Factors Affecting Use Support

- The most significant cause of nonattainment of uses in major Maine rivers is priority organics, most notably dioxin.
- The most significant causes of nonattainment of uses in other riverine waters are organic enrichment from nonpoint source pollution, and pathogenic indicators from municipal point sources, on-site wastewater treatment or untreated discharges.
- The most significant cause of nonattainment 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 nonattainment of uses for marine and estuarine waters is pathogenic indicators, mainly from municipal point sources.

Trends in Water Quality

- Fish consumption advisories have recently been issued for major Maine rivers due to elevated levels of dioxin discovered in fish tissue. Those advisories have greatly increased the amount of riverine waters not attaining the goals of the Clean Water Act and State law.

- Marine and estuarine water quality is reported to have improved slightly, but Maine is still in the process of gaining a full understanding of the quality of marine waters.

Specifics

- The control of nonpoint source pollution is crucial to protecting Maine lakes, wetlands, smaller riverine waterbodies and selected larger rivers. Lake restoration efforts are addressing the result of nonpoint source pollution, while educational efforts are addressing the cause. Best management practices are being developed to control nonpoint source pollution throughout Maine.

- Maine is estimated to have lost about 20% of its wetlands since colonial times. New regulations are being adopted to better protect wetlands.

- The greatest threat to Maine groundwater is leaking underground storage tanks. Maine requires all underground tanks be registered, and those not sufficiently protected be removed according to a set schedule. About 5,000 of the 36,000 tanks in Maine have already been removed.

- All Maine people must take an active role in protecting their water resources. State, federal and regional agencies must 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.

PART II: BACKGROUND

Chapter 1 - The Section 305(b) Report

Section 305(b) of the Federal Water Pollution Control Act (Clean Water Act) requires each state to submit a biennial report to the U.S. Environmental Protection Agency (EPA) describing the quality of its navigable waters. EPA in turn, is required to transmit the State reports to Congress, along with a summary of these reports describing the quality of the nation's waters.

The objective of the 305(b) information transfer process is to provide the information needed to:

1. determine the status of water quality in Maine;
2. identify water quality problems and trends;
3. evaluate the causes of poor water quality and the relative contributions of pollution sources;
4. report on the activities underway to assess and restore water quality;
5. determine the effectiveness of pollution control programs;
6. ensure pollution control programs are focused on achieving environmental results in an efficient manner; and,
7. determine the workload remaining in restoring waters of poor quality as well as protecting threatened waters.

This 305(b) report is useful as a tool for water quality management and in the development of Maine's continuing planning process and annual work programs. By analyzing information to identify water quality conditions, the quality and completeness of water quality data, program successes or failures, site specific problem areas, emerging problems, information gaps and the reoccurrence of old problems, future decisions affecting Maine's waters can make full use of what is known about water quality.

The Maine 1990 Water Quality Assessment contains a collection of facts dealing with what is happening to the State's surface and ground waters. After assimilating these facts, one should have a good working knowledge of Maine's overall water quality and water quality management programs. This report also provides the reader with an update of the progress made and problems encountered in carrying out the goal of improving the quality of the State's waters since the last (1988) assessment.

The report includes an analysis of the extent to which the State's waters provide for recreation and healthy fish and wildlife populations as well as an analysis of the extent to which pollution control actions have achieved this level of water quality. The Maine 1990 Water Quality Assessment contains revised and expanded sections on groundwater, lakes, estuarine and marine waters, and wetlands. The information on lakes presented in this report was assembled in preparation for the completion of the Maine Lakes Assessment later this year.

Chapter 2 - 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.

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 1 presents this information in summary form. Figure 1 shows the location and extent of Maine's major river basins.

The water quality of Maine can be described in terms of physical, chemical and biological characteristics but such a description is unintelligible if presented as a mass of data. 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 public inquiries received by the Department of Environmental Protection (DEP) Bureau of Water Quality Control. To answer such questions, Maine waters are managed under a use-based classification system.

As established by Maine statute, a classification consists of a designated use (such as swimming or fish habitat) and standards (such as bacteria or dissolved oxygen levels) which specify levels of water quality necessary to maintain the designated uses. Thus, to answer a question about swimming, one might reply, "Yes, that river is classified as suitable for water contact recreation and the data DEP has collected show that bacteria standards 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 measures to improve water quality there. It may take many years, however, to improve water quality due to factors such as availability of federal funds, relative priority of the problem, etc.

Layered on top of 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." Prior to 1986, Maine's classification system contained some classifications which had designated uses lower than those specified by the CWA as the nation's interim goals. As presented in Table 2, Maine's present water classification system contains no classifications with designated uses lower than the nation's interim goals.

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

Population (Mid-1989 estimate)	1,125,043
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%)
Lakes and Ponds(n=5,785)	1,762 mi^2 (5.3%)
Other land	977 mi^2 (2.9%)
Area of Estuarine/Marine Waters	1,633 mi^2
Number of Ocean Coastal Miles	3,500
Number of Major Drainage Basins	6
Total length 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. Summary of Classified Uses.

Type of Water	Total Waters	Waters Classified for Uses Consistent with CWA Goals — Total Waters Classified: Fishable[1]	Swimmable[2]	Total Waters Unclassified
Rivers (miles)	31,672	31,672	31,672	- 0 -
Lakes (acres)	994,560	994,560	994,560	- 0 -
Estuaries[3] (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.

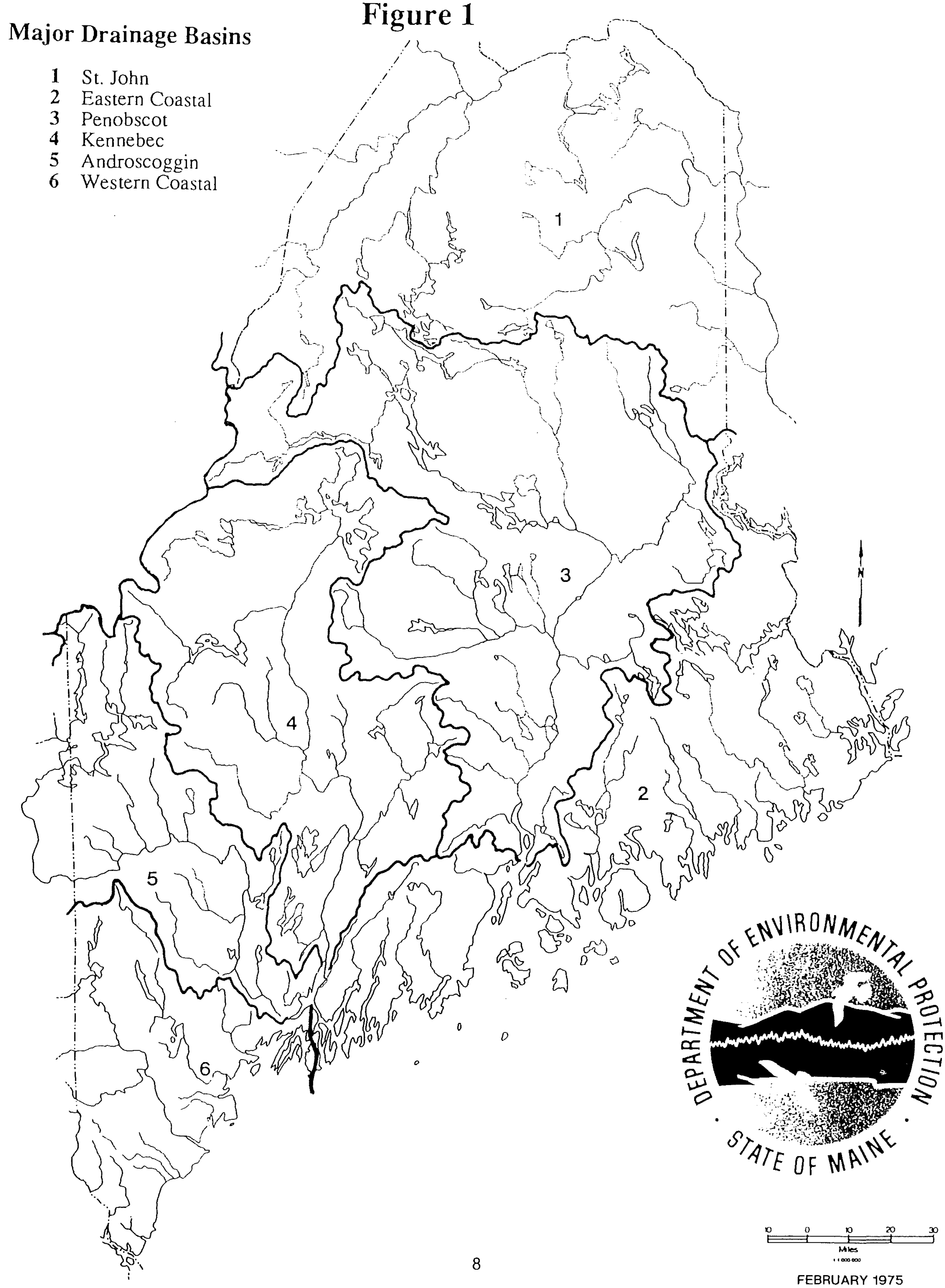
[2] The swimmable CWA goal is defined as providing for recreation in and on the water.

[3] Includes all marine waters within Maine's three mile territorial limit.

The revision of the Maine classification system was only the first step of a two step process. Since 1986, DEP has been examining the appropriateness of the interim classifications assigned to State waters and facilitating many changes in the assignments of classification. This effort resulted in Legislative action during 1989 to update the classifications assigned to waters in the Androscoggin and Kennebec River Basins. During 1990, Legislative action will center on the other four major river basins in Maine as well as marine waters.

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. Again, since the 1986 revision of Maine's classification statute, all waters which meet State standards also meet the interim goals of the CWA.

Figure 1


Major Drainage Basins
1 St. John
2 Eastern Coastal
3 Penobscot
4 Kennebec
5 Androscoggin
6 Western Coastal
1
2
3
4
5
6
N
DEPARTMENT OF ENVIRONMENTAL PROTECTION
STATE OF MAINE
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Miles
FEBRUARY 1975

PART III: SURFACE WATER ASSESSMENT

Chapter 1 - 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, all existing data are utilized unless there have been significant land use changes in the watershed.

As described in the Water Quality Monitoring section of this report, Maine has an extensive sampling program to assess water quality conditions. This section of the report describes the methodology used to analyze the data which monitoring produces.

1. **Rivers, Streams and Marine Waters.** To assess what portion of Maine's rivers, streams and brooks meet the goals of the Clean Water Act, 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 is 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 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 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 and 94 enterococci/100 ml for Class SC) which correspond to the 90% confidence limit (log standard deviation = 0.5) for n=1. If sampling indicates the instantaneous bacteria standard has been exceeded due to combined sewer overflows (CSOs) the affected waters are considered to be in nonattainment for the entire year.

      3. All indicator bacteria are assumed to be of human origin unless a sanitary survey indicates there are no significant 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 portion of Maine rivers, streams and brooks provides for the protection and propagation of fish and wildlife, this report uses an adaptation of the dissolved oxygen (DO) 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 DO attainment. Riverine waterbodies which are predicted to have a seven-day mean minimum DO greater than 5.0 mg/L under conditions of 7Q10 (the lowest seven-day flow which occurs only once in ten years) and 6.5 mg/L at 30Q10 are considered to be providing for the interim Clean Water Act goals of protection and propagation of fish and wildlife. A DO criteria of 70% of saturation is used to assess whether DO in Maine estuarine and marine waters are meeting the interim goals of the Clean Water Act.

C. **Aquatic Life.** To assess the impact of toxics and other nonconventional pollutants, Maine uses dilution modeling of discharges based on EPA "Quality Criteria For Water - 1986," ambient monitoring and biomonitoring of benthic macroinvertebrates. 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. This biological standard is also used to assess the quality of estuarine and marine habitats.

2. **Lakes**. Attainment of Clean Water Act interim goals for significant lakes have been assessed on the basis of the following:

Fishable

Fully meeting: Lakes which exhibit no dissolved oxygen impairment which would reduce the viability of a cold water fishery.

Partially meeting: Lakes which exhibit dissolved oxygen impairment which would reduce the viability of a cold water fishery. Impairment of the fishery (or human ability to fish) by culturally enhanced macrophyte growth. Sediment delivery or other habitat modification has not been assessed, primarily due to lack of current information and the difficulty of data acquisition.

Swimmable

> **Fully meeting**: Lakes which do not exhibit repeated (at least two seasons) of intense algal blooms.
>
> **Partially meeting**: Lakes which exhibit repeated (at least two seasons) of intense algal blooms.

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, and nonpoint sources such as urban and suburban stormwater runoff, combined sewer overflows, agriculture, construction-related runoff, and waste disposal practices. Most 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, it is doubtful future water quality improvements will continue at the same rate as in the past.

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 chapter on Wetlands Information 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 on the considered judgment of DEP water quality evaluation staff for waters which were not monitored. Monitoring data currently exists for about 25% of Maine river, stream and brook miles, 78% of significant lake acreage and an estimated 12% of marine water area. This monitoring coverage is an increase over that reported in 1988 when monitoring data existed for 19% of the river, stream and brook miles, 36% of all lake and pond acreage and 5% of the marine water acreage.

Almost 2% of Maine riverine waters are not fully supporting their designated uses. The length of rivers, streams and brooks not attaining full use is now 565 miles. This is significantly more than the 294 miles reported in 1988 Water Quality Assessment report. However, this reported increase does not necessarily indicate a decrease in the quality of Maine waters since 1988, for two reasons.

First, a significant part of the reported increase in riverine waters not fully supporting all uses is the result of increased information on dioxin levels in fish taken from waters below some Maine industries. Rivers totaling 256.4 miles in length have now been listed as not fully supporting the "fishable" goal of the CWA and State classification due to dioxin contamination that was previously not detected, but possibly present.

Additionally, Maine is now using a new data source for the lengths of rivers that reports different lengths for some riverine waterbodies not fully supporting designated uses.

The data reported for lakes is significantly different from that in 1988, due mainly to changes in how support of uses is determined. The Lake Water Quality Assessment chapter of this reports details the new system for determining support of uses and Appendix I provides information on each significant Maine Lake.

There is an increase of 12.1 square miles of estuarine and marine waters fully supporting the designated uses since the 1988 report.

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. Additional tables and detailed discussions of designated use support and attainment can be found in the sections providing assessments of specific waterbody types.

Table 4 summarizes attainment of the interim goals of the CWA. Table 4 indicates more attainment than Table 3 because the requirements of some Maine classifications are more stringent than those of the CWA.

Assessment of groundwater quality is more difficult than assessing surface waters but it appears that almost 1% of Maine's land area is underlain by groundwater unsafe for drinking water supplies.

Table 3. Designated Use Support.

Type of Waterbody: Rivers, Streams, and Brooks

Degree of Use Support	Assessment Basis (miles) Evaluated	Monitored	Total Assessed
Size fully supporting	23,469	7,638	31,107
Size fully supporting but threatened	0	0	0
Size partially supporting	0	0	0
Size not supporting	176	389	565
TOTAL	23,645	8,027	31,672

Type of Waterbody: Lakes and Ponds

Degree of Use Support	Assessment Basis (acres) Evaluated	Monitored	Total Assessed
Size fully supporting	198,323	515,705	714,028
Size fully supporting but threatened	11,384	46,440	57,824
Size partially supporting	0	188,566	188,566
Size not supporting	0	0	0
TOTAL	209,707	750,711	960,418

Type of Waterbody: Estuarine and Marine Waters

Degree of Use Support	Assessment Basis (square miles) Evaluated	Monitored	Total Assessed
Size fully supporting	1,423.1	50.0[1]	1473.1
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	1633.0

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

Table 4. Attainment of Clean Water Act Goals.

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

Goal Attainment	Fishable Goal[1]	Swimmable Goal[2]
Size attaining	31,282	31,506
Size partially attaining	0	0
Size not attaining	390	166
Size not attainable	0	0

* *

Type of Waterbody: Lakes and Ponds (acres)

Goal Attainment	Fishable Goal	Swimmable Goal
Size attaining	796,394	911,493
Size partially attaining	164,189	49,090
Size not attaining	0	0
Size not attainable	0	0

* *

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

Goal Attainment	Fishable Goal	Swimmable Goal
Size attaining	1,475.0	1,630.7
Size partially attaining	35.7	0
Size not attaining	122.3	2.3
Size not attainable	0	0

[1] Protection and propagation of fish, shellfish and wildlife.
[2] Recreation in and on the water.

Causes and Sources of Nonattainment of Designated Uses

As shown in Tables 5 and 6, the causes and sources of nonattainment 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 5) and magnitudes of impact (Table 6). 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 in a watershed. Source magnitudes of "Moderate" and "Slight" are assigned when multiple sources exist in a watershed. Thus, a source rated as "High" in one watershed can be misinterpreted as being more significant than a source rated as "Slight" or "Moderate" in another watershed. More often than not, multiple sources exist.

The most significant cause of nonattainment in larger Maine rivers is priority organics, specifically dioxin. Nonattainment in smaller rivers, streams and brooks is most often caused by organic enrichment which also is the most significant cause of nonattainment of Maine lakes. Estuaries and marine waters are most affected by pathogenic indicators.

Industrial point sources (especially those discharging dioxin) have a major impact on larger rivers. Nonpoint sources, especially agriculture and malfunctioning or non-existent onsite wastewater treatment systems are significant sources of nonattainment for smaller rivers, streams, and brooks. The most significant source of nonattainment for lakes is nonpoint source pollution. Marine and estuarine waters are reported to be most affected by municipal point source discharges (see Estuarine and Marine Water Quality Assessment for further explanation).

Table 5. Causes of Surface Water Nonattainment in Maine.[1]

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

Cause Categories	Major Impact	Moderate/Minor Impact
Unknown		1.0
Unknown Toxicity		3.2
Priority Organics	99.0	157.4
Metals		19.7
Organic Enrichment	100.2	73.3
Flow Alteration	4.0	
Pathogen Indicators	57.5	83.9
Taste and Odor		36.4
Suspended Solids		36.4

Type of Water Body: Lakes and Ponds (acres)

Cause Categories	Major Impact	Moderate/Minor Impact
Nutrients	2,463	42,156
Siltation		47,779
Organic Enrichment	136,492	36,783
Flow Alteration		30
Other Habitat Alterations		7,865
Taste and Odor		4,197

Type of Water Body: 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 nonattainment or adverse impact. Monitoring must be coupled with standards development before any conclusions can be drawn.

Table 6. Sources of Surface Water Nonattainment in Maine.

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

Cause Categories	Major Impact	Moderate/Minor Impact
Unknown		1.0
Industrial Point Sources	103.0	197.4
Municipal Point Sources	8.0	62.9
Combined Sewer Overflows	1.0	20.7
Agriculture	72.0	46.8
Irrigated Crops		0.5
Land Development		7.0
Runoff/Storm Sewers	3.0	11.7
Mine Tailings		1.4
Landfills		0.7
Onsite Waste Treatment	42.8	12.0
Flow Regulation		4.0
In-place Contamination		1.7
Up-stream Impoundment		23.3

Type of Water Body: Lakes and Ponds (acres)

Cause Categories	Major Impact	Moderate/Minor Impact
Industrial Point Sources		4,288
Municipal Point Sources		4,845
Agriculture [1]	1,794	58,722
Aquaculture	30	
Silviculture	3,442	45,831
Construction	32	1344
Urban Runoff/Storm Sewers [1]	31,613	
Shoreline Development	31,613	67,476
Land Disposal [1]		1,999
Hazardous Waste		1,420
Hydro-modification		7865
Other [1]	19,275	
In Place Contaminants		18,432
Internal P Recycling		18,432
Source Unknown	73,007	

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

Cause 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.

Chapter 2 - Public Health/Aquatic Life Concerns

Waters Affected by Toxics

The extent of waters in Maine thought to be affected by toxics is presented in Table 7.

Table 7. 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	296
Lakes (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

On January 11, 1989, Maine adopted the numeric criteria for 307(a) toxics specified in the EPA Quality Criteria for Water - 1986. Maine was subsequently sued and the suit was stayed. The Natural Resources Council of Maine has introduced a toxics bill to the Maine Legislature, which if passed, would adopt those criteria through statute, making the suit moot.

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. During low-flow conditions, the Town of Howland Piscataquis River water supply was closed following a fish kill. Chemical analysis of the river water determined that levels of TRIS (1,3-dichloroisopropylphosphate) exceeded drinking water standards. During 1990, Howland plans to discontinue all use of Piscataquis River water and rely on groundwater supplies for the town. 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 8.

Table 8. Waterbodies in Maine with Sediments Contaminated by Toxics.

Date	Waterbody	Extent	Pollutant	Source
1988	Annabessacook Lake	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	16 Acres	Copper	Copper sulfate program

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 bleached kraft pulp and paper mills were found to be contaminated with dioxin and furan (2367-TCDD and 2378-TCDF). Based on these limited data, in 1985 and 1987 fish consumption advisories were issued by the Department of Human Services (DHS) after consultation with DEP and the Department of Inland Fisheries and Wildlife (DIFW). Notice of such was printed in DIFW 1988-1989 Open Water Fishing Regulations. The State Toxicologist also determined that dioxin concentrations exceeding 1 ppt in fish fillets constituted a health risk to nursing mothers and pregnant women and therefore, issued an advisory that they should avoid consuming fish from other waters where such concentrations are found.

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 and report the results to the Legislature by the end of December 1990.

Subsequent analyses on bass and trout fillets and whole suckers from Maine rivers showed dioxin concentrations of up to 45.7 ppt (three times what was earlier reported). The State Toxicologist warned in March 1990, that 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. The 1987 amendments to the CWA established new higher priorities for the control of toxic pollutants. DEP and EPA are currently drafting wastewater discharge permits which will control the discharge of dioxin and furan to acceptable levels by June 1992. Levels of dioxin and furan already have been considerably reduced in paper mill effluents, but it is not known how long it will be before levels in fish begin to decline. Monitoring will be required in waste discharge licenses to document any future decline in levels of effluent and fish.

Analysis of sludge samples from various wastewater treatment facilities in the State has also revealed detectable levels of dioxin in some industrially derived sludges. The dioxin contamination of some sludges has raised public health concerns regarding the landspreading of sludge. Since sludge is produced as a result of wastewater treatment; public health concerns related to sludge landspreading are included in this section. The major public health concerns related to landspreading of sludge are contamination of groundwater and food products, rather than of surface water. In 1987, Maine adopted dioxin standards for sludge landspreading.

Table 9 lists fish consumption advisories in effect in Maine.

Table 9. 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	123.9 miles
Kennebec River	Dioxin	Kraft Pulp & Paper Mill	56 miles
Penobscot River	Dioxin	Kraft Pulp & Paper Mills	56.5 miles
Presumpscot River	Dioxin	Kraft Pulp & Paper Mill	7 miles
West Branch Sebasticook River	Dioxin		13 miles

Occasional samples of fish from Maine inland waters have had levels of mercury in excess of FDA standards. These have been reported for older lake trout and since some of these lake trout were collected from watersheds without point source discharges, the source of the mercury seems to be natural. 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. Occasionally, a single fish sample collected from other sites (Androscoggin River, Kennebec River, Little Androscoggin River, Moosehead Lake, and Sebasticook River) has had mercury levels exceeding FDA action levels, but mean values for all fish collected have always been less than FDA action levels. PCB levels in 1 of 3 bluefish sampled in 1983 from the New Meadows River exceeded federal action levels but the mean value was below the FDA level. Bluefish collected from Maine waters in 1985 (n=5) and 1988 (n=13) had PCB concentrations well below federal action levels.

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. Maine waters closed to the taking of shellfish due to bacterial pollution were reported in the Maine 304(l) list. The total area of marine waters closed by DMR to the harvesting of shellfish is 158 square miles and includes more than 120 different geographic areas. The 304(l) list is attached as Appendix II. In 1985, another concern related to shellfish consumption surfaced. Samples of crabs were found to contain elevated concentrations of heavy metals. One possible source of heavy metals contamination is the use of tributyltin as an anti-fouling agent in paints used on boats. The DHS has no record of beach closures, nor reported incidences of waterborne disease in 1988 and 1989.

Aquatic Life Impacts

There are places in Maine where the habitats of freshwater, estuarine and marine organisms are impaired. These situations, which are often the result of toxic contamination, have existed for a long time; prior to the enactment of modern water pollution control laws. Accordingly, the Water Quality Control Act of 1987 places heightened emphasis on control of toxics. Maine is in the process of adopting new legislation that will increase toxicity testing requirements. Those waters of Maine which do not fully support the uses of protection and propagation of fish, shellfish and wildlife are listed in Appendix I.

Table 10 provides a report of catastrophic fish kills and their causes for 1988-1989.

Section 304(l) Waters

Since submittal of the final revised 304(l) list (Appendix II) in May 1989, DEP has noted some changes in discharges which may require revision of the list.

Kroy Tanning Company (fdba Wilton Tanning Company) has been issued a new federal wastewater discharge permit which effectively controls the discharge of lead to acceptable levels, and recent monitoring has shown they are in compliance. Therefore, Wilson Stream and Kroy Tanning Company should be removed from the list.

As previously mentioned, dioxin has now been found in fish from the West Branch of the Sebasticook River below Hartland. Dioxin should be added as a new 307(a) toxic to the description of the waterbody and municipal treatment plant discharge. Dioxin was previously listed for the other waterbodies for which fish consumption advisories were issued.

Other recent data from the Dioxin Monitoring Program showed levels of dioxin and furan in sludge from the Berwick Sewer District discharge at levels higher than those found in the Hartland sludge. However, as there have been no fish analyzed from the Salmon Falls River below Berwick, DEP does not propose to add Berwick to the 304(l) list at this time. DEP will collect fish from this river during 1990 to be analyzed for dioxin and furan.

Table 10. Pollution Related Fish Kills in Maine: 1988 and 1989.

Waterbody	Town	Date	Species	Number	Estimated Cause
Medomak River	Waldoboro	7/23/88	*Fundulus* sp.	100+	Unknown agent from electrical components industry
Mattanawcook Stream	Lincoln	7/25/88	Mixed	650+	Bypass of pulp/paper mill wastewater
Androscoggin River	Jay	8/12/88	Mixed	<100	High BOD discharge from pulp/paper mill
Mattanawcook Stream	Lincoln	8/14/88	Mixed	400	pH shock from sodium hydroxide spill at pulp/paper mill
Mattanawcook Stream	Lincoln	9/14/88	Mixed	100	pH shock from sodium aluminate spill at pulp/paper mill
Mantle Lake	Presque Isle	7/19/89	Brook Trout	75+	Unknown agent from storm drain
Mattanawcook Stream	Lincoln	7/28/89	Mixed	200+	Bypass of untreated pulp/paper waste and thermal discharge

Chapter 3 - Water Quality Assessment of Rivers, Streams and Brooks

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 18 major rivers. Ten of these 18 rivers are tributaries of still larger rivers. Four of these 18 rivers (the Allagash, Dead, East Branch of the Penobscot, and West Branch of the Penobscot) lie in remote areas and can be characterized as pristine.

Seven of the 18 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.

Seven of these 18 rivers (the Mattawamkeag, Moose, Piscataquis, Saco, Sandy, Sebasticook and Union) are less densely settled and industrialized than the preceding group but historically had segments with pollution problems. For one of these rivers, the Piscataquis, wastewater treatment facilities are still under construction.

As shown in Table 11, 931 of 1,230 miles of major river main stems in Maine attain the interim goals of the Clean Water Act. As previously stated, the most significant cause

Table 11 - Maine Attainment Status: Major Rivers.[1]

River Name	Drainage Area Total	Drainage Area In Maine	Maine Length (miles)	Fish[2] miles	Swim[3] miles	Fish/Swim miles
Androscoggin[4]	3,542	2,817	115	0	87	0 (0%)
Kennebec[4]	5,893	5,893	145	89	142	89 (61%)
Dead	874	874	23	23	23	23 (100%)
Moose	722	722	52	52	52	52 (100%)
Sandy	596	596	70	70	70	70 (100%)
Sebasticook	946	946	50	37	50	37 (74%)
Penobscot[4]	8,207	8,207	80	23	73	23 (29%)
East Branch	1,120	1,120	46	46	46	46 (100%)
Mattawamkeag	1,507	1,507	50	50	50	50 (100%)
Piscataquis	1,453	1,453	65	57	30	30 (48%)
West Branch	2,131	2,131	49	48	46	45 (92%)
Presumpscot[4]	641	641	23	16	16	16 (70%)
Saco	1,700	815	82	82	81	81 (99%)
Saint Croix	1,631	994	56	45	56	45 (80%)
Saint John[5]	8,275	4,266	161	161	161	161 (100%)
Allagash	1,235	1,235	54	54	54	54 (100%)
Aroostook	2,418	2,405	106	106	106	106 (100%)
Union	563	563	3	3	3	3 (100%)
TOTAL MILES			1230	962	1146	931
PERCENTAGE				(78%)	(93%)	(76%)

1 Major: Those with a drainage area greater than 500 square miles.
2 Those which attain the criteria for protection and propagation of fish and wildlife.
3 Those which attain the criteria for recreation in and on the water.
4 Segments of the Androscoggin River (115 miles), Kennebec River (56 miles), Penobscot River (57 miles), Presumpscot River (7 miles), St. Croix River (11 miles), and Sebasticook River (13 miles) do not fully attain their designated use of "fishing" due to the presence of dioxin in fish tissues. The State Toxicologist has issued an advisory on limiting consumption of fish caught in these rivers.
5 That portion of the basin upstream of the Hamlin, Maine - Grand Falls, New Brunswick boundary.

for not fully supporting the uses of the Maine 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 river segment in Maine which does not attain classification standards is identified in Appendix I along with a description of cause(s) of nonattainment.

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 CSOs. During spring as well as during summer rain storms, the carrying capacity of sewers can be exceeded.

As part of Maine's present initiative to correct aesthetic problems, the State is planning a rehabilitation program for CSOs which will identify and treat those most objectionable to the public. This will be funded by State and local sources. A priority system is presently in design.

Although Federal assistance for construction of wastewater treatment facilities is scheduled to end in 1992, it is hoped that all municipalities needing treatment facilities will have received funding by then. Since 1989, Maine has been implementing a revolving load fund to assist with future construction. Facility needs such as upgrading wastewater collection and treatment systems will require a continuing Federal financial commitment to the infrastructure upon which clean water is dependent.

Minor Rivers, Streams and Brooks

The percentage of watercourse miles suitable for fishing and swimming in Maine is highest for small watercourses and lowest for major rivers (Table 12). 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 12. Maine Attainment Status: Rivers, Streams and Brooks Evaluated in Terms of the Interim Goals of the Clean Water Act.

Waterbody Type	Miles in Maine	Miles "Fishable"	Miles "Swimmable"
Major Rivers	1,230	962 (78.2%)	1,146 (93.1%)
Minor Rivers, Streams, and Brooks	30,442	30,320 (99.6%)	30,360 (99.7%)
	31,672	31,282 (98.8%)	31,506 (99.5%)

While the type of facility projects underway ten years ago consisted mostly of building large-scale wastewater treatment facilities to accept wastewater from existing sewers, the types of projects needed in the future are quite different. Small and medium-scale wastewater treatment facility projects dominate plans for new construction. In many cases, sewage collection systems and wastewater treatment facilities need upgrading. Where water quality limited segments occur, extraordinary expenditures for wastewater treatment (advanced secondary, tertiary or even completely removing a discharge from waterbody) will be required. Additionally, ensuring the proper functioning of treatment is a formidable task and increasingly more of the funds allocated for water quality control will be applied to this activity.

Water Quality Trends

To determine water quality trends on a statewide or national level, available information must be evaluated in terms of appropriate criteria. Since water quality management in the United States is based on protection of uses, water quality trends should be evaluated in terms of attaining the interim goals of the Federal Water Quality Act - recreation in and on the water and protection and propagation of fish, shellfish and wildlife. If the water quality of a particular river segment is evaluated in terms of its attainment/nonattainment of the national interim goals, analysis is both simplified and made more meaningful. The trend projected to occur over the next two years is that there 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 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 saw 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. As detailed in the section on major rivers, it was those waterbodies which had the most severe water quality problems in 1975. The water quality problems were 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. During the years 1975-1977, secondary wastewater treatment began at all but one of the pulp and/or paper manufacturing facilities located in Maine. 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.

While qualitative improvements in the uses made of water represent an important trend, it still seems more important to describe historical water quality in terms of scientifically valid criteria necessary to support the uses which are the national interim goals. Evaluating historical suitability for habitat presents different problems than does evaluation of past suitability for swimming but both evaluations require some common data bases. Most important in this study is preparation of a chronology of pollutant loading and wastewater treatment in the State. In the absence of data of adequate quality or quantity describing the past chemical, biological and bacteriological quality of waters, much reliance will have to be made on mathematical models of the past effects of pollution sources.

Complicating factors in these evaluations are reconciling present practices of weekly sampling and use of 90% confidence limits for data evaluation with past sampling which sometimes consisted of one or a few samples collected from a site each year. Coupled with these factors are institutional considerations. For example, although Maine's coastal waters are much cleaner than they were twenty years ago, the number of acres open to shellfish harvesting is about the same as 20 years ago. The reason for this is that there were areas open to harvesting twenty years ago which probably should have been closed.

While wastewater treatment facilities and sewage collection systems are most commonly thought of as the infrastructure supporting water quality control; manure storage pits, fencing to keep cattle out of streams and soil conservation projects are also important components of the infrastructure necessary for the protection of water quality. Currently, the Federal financial assistance which is necessary to meet these infrastructure needs is in jeopardy. Congress reauthorized the CWA in 1987 but it is uncertain when the capital-intensive projects needed to complete Maine's water cleanup can commence. Although the 1987 CWA amendments authorized $70 million in fiscal year 1988 for state programs for control of nonpoint source pollution, it was not until 1989 that $40 million of these funds were appropriated. It may take twenty years or more to correct pollution problems due to nonpoint source pollution. Without continuation of the Federal financial role in water quality management, long-term water quality trends in Maine and the nation will be towards degradation rather than protection and improvement.

Chapter 4 - Lake Water Quality Assessment

Background/Trophic Status

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 (TSI) 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.

The water quality statistics presented in this section are based on the acreage of "significant" lakes rather than the acreage of all lakes. For the purposes of this assessment, "significant" lakes are those 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. Lakes in this category are those for which the DIFW or DEP have gathered data for fisheries management or baseline water quality information, as well as lakes for which there are special concerns. Many of the DIFW surveyed lakes have been included in the DEP lake monitoring program. The DEP has also conducted monitoring on some lakes (also considered significant) which were not surveyed by DIFW. Significant lakes comprise 47% (2705) of the total number (5785) of Maine lakes and 97% (960,583 acres) of total lakes surface area (986,776 acres).

The Maine statutory goal for the management of lakes and ponds is a stable or decreasing trophic state and freedom from culturally induced algal blooms which impair their use and enjoyment. While Maine statute defines this condition as acceptable water quality, it does not necessarily constitute natural or pristine conditions where lake watersheds already have extensive agricultural or residential development.

The Maine management goal for lakes recognizes the existing diversity of trophic state. Those who place a high value on water clarity or who prefer to fish only for trout and salmon can enjoy the resource of a lake with a low trophic state. Lakes with a naturally high trophic state provide opportunities for those anglers who want to catch bass and perch.

The trophic state of a lake is calculated based on measurements of transparency, chlorophyll, and phosphorus content. It may also be assigned subjectively to lakes which are not monitored. Application of the Trophic State Index (TSI) allows DEP to determine if a measurable change in trophic status is occurring. This metric is valuable in that it integrates a substantial amount of data to afford a relatively unbiased evaluation of overall water quality.

Since 1979, Maine has assigned a TSI to monitored lakes with sufficient data to allow a "valid" calculation of this statistic. The numerical index allows an objective method of ranking lakes and detecting trends which may be masked by reliance on transparency readings alone. TSI statistics are sometimes calculated for lakes on which trophic data exists for only one parameter (usually transparency) but these are less reliable as indicators of overall conditions.

Assignment of trophic status based on subjective evaluation or on limited data such as minimum secchi disk readings does not directly equate to the numerical TSI. It does, in combination with the TSI, allow some assessment of trophic state on the largest possible number of Maine lakes and is especially useful for planning purposes.

For the purposes of this report, trophic status has been assigned to lakes under criteria which reflect both professional judgment and numerical data. Lakes are divided into three categories based on the type and extent of the data set available for analysis.

1. Monitored Lakes with valid TSI. Lakes for which adequate data exist to assign a TSI are considered oligotrophic if the TSI is in the 0-25 range. Lakes with TSI values greater than 25 and which also have recorded transparencies less than 2 meters during two or more years are designated eutrophic provided the average water color is less than 25 standard platinum units (SPU). High color in lakes can result in depressed secchi disk readings which are not necessarily indicative of algal blooms. Highly colored lakes may be designated eutrophic if other data (e.g., chlorophyll a) indicate elevated productivity. The remaining lakes, those with valid TSI greater than 25 which have not supported repeated algal blooms, are considered mesotrophic.

2. Monitored lakes with insufficient data to calculate a valid TSI. Lakes in this category for which mean transparencies exceed 8 meters are considered oligotrophic. Eutrophic status is assigned if a lake with a color of less than 25 SPU experiences transparency minima less than 2 meters during two or more years. Eutrophic status may also be assigned for a lake with high color (>25 SPU) and reduced transparencies if such conditions have been accompanied by elevated chlorophyll a readings (> 7 ppb) or when professional judgment and observations indicate very high productivity. The remaining lakes, those with mean transparency less than 8 meters which have not supported repeated algal blooms, are considered mesotrophic.

3. Evaluated lakes with no quantitative trophic data. Many lakes have been assigned one of the three trophic ratings based on the professional judgment of DEP staff or DIFW staff. Trophic status ratings were made by the DIFW on almost all of the 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 has assigned a 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.

   A synopsis of the trophic status of significant Maine lakes is presented below. The database on total phosphorus is being computerized for analysis. Trophic status of significant lakes will be re-assessed as part of this ongoing project.

Table 13 displays the DEP assigned trophic rating for 663 monitored lakes. The remaining 1219 significant lakes as evaluated by DIFW are described in Table 14.

Table 13. Trophic Status of Significant Maine Lakes by River Basin (DEP Monitored lakes).

Basin	Oligotrophic acres	Mesotrophic acres	Eutrophic acres
Saint John	2,844	61,244	109,986
Penobscot	27,717	140,873	2,249
Kennebec	9,878	150,486	24,238
Androscoggin	4,680	70,693	2,348
Eastern Coastal	9,769	156,870	8,742
Western Coastal	32,164	34	527
All Basins	87,052	614,533	49,090
Number of Lakes	64	548	51
% of Significant Lakes (960,583 acres)	9.1%	64.0%	5.1%
% of Total Lakes (986,776 acres)	8.8%	62.3%	5.0%

Table 14. Trophic Status of 1219 Significant Maine Lakes (DIFW Evaluation).

Class	Number of Lakes	Acres
Oligotrophic	90	21,971
Mesotrophic	527	45,630
Eutrophic	602	108,949

As noted earlier, DEP and DIFW trophic assignments are not equivalent. For example, it is likely that a large number of the 602 lakes rated "eutrophic" by DIFW would be assigned a mesotrophic category 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,. so lakes with extensive natural macrophyte beds but with clear water were often evaluated by DIFW biologists as eutrophic.

Of the significant lakes, 3.6% of the surface area is unclassified for trophic status because data or evaluations do not exist despite having vulnerability modeling or morphometric surveys done. Similarly, an additional 2.5% of all lake acreage is not trophically classified since they are not designated "significant."

Impaired and Threatened Lakes

Impairment is based on attainment of CWA goals and support of designated uses.

Clean Water Act Goals

Attainment of CWA interim goals for significant lakes (Table 15) has been assessed on the basis of the following:

Fishable

Fully meeting: Lakes which exhibit no dissolved oxygen impairment which would reduce the viability of a cold water fishery.

Partially meeting: Lakes which exhibit dissolved oxygen impairment which would reduce the viability of a cold water fishery. Impairment of the fishery (or human ability to fish) by culturally enhanced macrophyte growth, sediment delivery, or other habitat modification has not been assessed, primarily due to lack of current information and the difficulty of data acquisition.

Swimmable

Fully meeting: Lakes which do not exhibit repeated (at least two seasons) of intense algal blooms.

Partially meeting: Lakes which exhibit repeated (at least two seasons) of intense algal blooms.

Table 15. Attainment Status of Significant Lakes Based on the Interim Goals of the Clean Water Act.

	Fishable			Swimmable		
CWA Goal Attainment	#	acres	%	#	acres	%
Attaining	2549	796,394	83%	2654	911,493	95%
Partially Attaining	156	164,189	17%	51	49,090	5%
Not Attaining	0			0		
Not Attainable	0			0		
Total	2705	960,583		2705	960,583	

Designated Use Support

Information on designated use support (Tables 16 and 17) has been based on the following standards:

Fully Supporting: Lakes with no known history of conditions reducing the viability of aquatic habitat (such as reduced dissolved oxygen or toxic effects), human use impairment, or violations of State water quality standards and which are considered to be fully supporting their designated uses.

Fully Supporting, But Threatened: Lakes (either monitored or evaluated) for which there are no recorded signs of impairment of use or classification, but which exhibit a predicted rate of phosphorus increase in excess of those detailed in the section on Vulnerability Assessment. Lakes are also considered threatened if they have experienced an algal bloom but are not yet considered impaired.

Partially Supporting: Lakes showing evidence of dissolved oxygen (DO) depletion which would reduce the viability of a cold water fishery. This is interpreted as altering the natural habitat and thus is considered to be partially supporting the designated uses. Not only does low DO reduce habitat viability for coldwater fish, it also alters habitat for a variety of organisms, including benthic invertebrates. In this report, lakes are considered to have altered habitat as a result of DO depletion if more than 50% of the metalimnion/hypoliminion (total depth >5 meters) evidences DO of less than 3 ppm during a monitored period. Approximately 155 monitored lakes fall into this category. Further work needs to be done to identify lakes which naturally develop anoxic profiles such as highly colored, kettle hole ponds. Regardless of whether these lakes experience natural or culturally induced organic loading, summertime anoxia brings with it the possibility of internal phosphorus recycling. This means they may be particularly sensitive to increased cultural nutrient loading.

This category also includes lakes where swimming or other human activities are impaired due to culturally-induced algal blooms. DEP uses the functional definition of secchi disk transparency less than 2 meters (background color <30 SPU) as attaining bloom conditions. Colored lakes (>30 SPU) are included as use impaired if other trophic data and/or professional judgment indicates elevated productivity which is likely due to cultural alterations.

Not Supporting: Lakes with conditions which result in complete loss of normal human use, loss of fishery, or substantial habitat alteration are considered as not supporting their designated uses. No lakes in Maine are currently assigned to this category, since recorded use impairments do not extend to complete loss of use. However, substantial decline of salmonid fisheries has been documented in some instances.

Table 16. Attainment Based on Maine Class GPA Designated Uses.

Degree of Use Support	Total Number / Acreage Evaluated	Monitored	Assessed
Fully Supporting	1760 /198,323	336 /515,705	2096 /714,028
Fully Supporting but Threatened	266 / 11,384	144 /46,440	410 / 57,824
Partially Supporting	0	185 /188,566	185 /188,566
Not Supporting	0	0	0
Total	2026 /209,707	665 /750711	2691 /960,418

Of all significant lakes, 14 (165 acres) have not been assessed for designated use support due to lack of data. Of the 156 lakes assessed as partially meeting use support for fisheries due to summertime anoxia, 43 (24,474 acres) are managed by DIFW for warm water fisheries only. At this time, DEP has not determined to what extent these lakes might support cold water fisheries if DO depletion were not a factor.

Of the 50 lakes (7,317 acres) which have experienced only one recorded season of algal bloom(s), 26 are rated as threatened by either the Vulnerability Index criteria (19 lakes) and/or are impaired by hypolimnetic anoxia (14 lakes). A total of 24 lakes (4,555 acres)

Table 17. Attainment Status for Significant Lakes by Basin.

Basin	Total Number / Acreage: Full Attainment of Class GPA Standards (*/*)[1]	Partial Attainment Repeated Algal Blooms[2]	Depressed Dissolved Oxygen
St. John	252 / 65,544 (2 / 85)	11 / 10,986	12 / 18,753
Penobscot	818 / 247,141 (10 / 1,485)	4 / 2,249	15 / 12,986
Kennebec	488 / 172,947 (9 / 2,894)	20 / 24,238	29 / 26,933
Androscoggin	215 / 64,535 (4 / 413)	4 / 2,348	19 / 18,600
East Coastal	488 / 166,535 (6 / 2,264)	7 / 8,742	24 / 41,217
West Coastal	251 / 55,119 (5 / 586)	5 / 527	35 / 20,987
All Basins	2,520 / 772,017 (36 / 7,727)	51 / 49,090	134 / 139,476

[1] Lakes which have experienced one algal bloom
[2] Lakes which have experienced two or more seasons with algal blooms

would not be selected by VI or DO evaluations, which indicates the value of volunteer monitoring system to detect lakes with marginal water quality.

Most of the lakes which have not been assessed are very likely to 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.

Eight lakes (78 acres) are not currently assigned to any major drainage basin. These are believed to fully attain GPA standards. 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 except for dissolved oxygen. Despite this apparently suitable water quality, 19% of the lake surface area does not fully attain Maine classification standards due to periodic algal blooms and/or low dissolved oxygen. Table 18 details current water quality trends for Maine Lakes. Lake-specific information concerning lakes in the partial attainment and threatened categories is summarized in Appendix I.

Table 18. Water Quality Trends and GPA Standards of Significant Lakes.

Category	Trend	# Assessed	Acreage	% of Total Acreage
A) Repeated Algal Blooms	Deteriorating	3	4,287	0.45%
	Stable	28	22,255	2.32%
	Improving	6	8,982	0.93%
	Unknown	14	13,566	1.41%
	Subtotal	51	49,090	5.11%
B) Hypolimnetic DO Depletion[1]		134	139,476	14.52%
Total not Meeting GPA		185	188,566	19.63%
Total Meeting GPA		2,506	771,852	80.37%
Total Assessed for GPA Attainment		2,691	960,418	100.00%

[1] DO depletions have not been evaluated for trends

Of the 5,774 lakes, 3,083 have not been assessed in this report. Despite the large number, the "unassessed" lakes make up only 3.4% of the 994,560 acres of Maine lakes. Trends noted in the above analysis are based on occurrence of repeated algal blooms and do not include DO evaluations. Assignment of trends is done by professional evaluation and inspections of the data set. Previous trend analyses of the data indicated that changes in transparency have not been statistically significant in part due to the large variability of seasonal/yearly data and, in some cases, due to small data sets.

There have been no recorded lakes with first-time blooms in 1988-1989. Several lakes reported as deteriorating in the 1988 305(b) report (e.g., China Lake) have conditions which appear stabilized, although long-term deterioration may continue if increased external loading develops. An increase in the number of lakes reported "Stable/No Trend" and "Unknown Trend" in attainment reflects concern for those lakes which have repeatedly bloomed in the 1970s and 1980s and which may be in a semi-stable condition. Some lakes, such as East Pond, which were listed as deteriorating in the 1988 report bloomed during only one season and thus have not shown a definite decline in water quality. One lake (Threemile Pond) has definitely improved, primarily due to reduced internal phosphorus recycling after the 1988 aluminum treatment.

Evaluation of attainment status is based on whether repeated algal blooms occur or if there is evidence of hypolimnetic DO depletion. The largest percentage of non-attainment acreage (14.52%) is attributed to anoxic conditions, presumed to be due to allocthonous organic loading or algal productivity. It is important to note 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 sufficiently altered by cultural activity.

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 51 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.

An analysis of the causes and sources of water quality impairment of these lakes is summarized earlier in this report and by waterbody in Appendix I. It should be noted that this is based on personal knowledge of staff and as such does not allow 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 with diagnostic studies or restoration projects, fairly detailed assessments are available which emphasize the diverse nature of nonpoint source impacts and their changing nature through time. It has become obvious that a number of non-attainment lakes may be substantially affected by internal nutrient recycling which may be the result of historic, but not necessarily current, land use effects.

Threatened Lakes

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 an absolute 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. Threatened Maine lakes in major drainage basins are summarized in Table 19.

Table 19. Threatened Lakes by Major Drainage Basin.

Basin	(Number / Acreage) Threatened Lake Acreage
Unknown	4 / 42
Saint John	3 / 164
Penobscot	57 / 13,116
Kennebec	85 / 20,418
Androscoggin	50 / 17,564
East Coastal	122 / 21,294
West Coastal	171 / 29,646
All Basins	492 / 102,244

Four threatened lakes (42 acres) are not currently assigned to any drainage basin.

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 arbitrarily defined "perceivable" increase in trophic state as a 1 ppb increase in mean lake phosphorus concentration. In this assessment that definition is expanded to consider current water quality and morphometry of each lake.

Maine lakes have been classified into one of six Water Quality Categories based on both current water quality and sensitivity to change (Table 20).

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 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	------

Lakes with inadequate data were assigned the default category of "Moderate/Sensitve".

Table 20. Water Quality Categories of Maine Lakes for Planning Purposes.

Category: Outstanding Quality

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 of < 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.

Category: Good Quality

Lakes in this category are clear average SDT of 6.1 to 9.1 meters (20 to 30 feet) with relatively low algal 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.

Category: Moderate/Stable Quality

These lakes are less clear average SDT of 3.1 to 6.1 meters (10 to 20 ft.) but do not have summer algae blooms (minimum SDT is greater than 6 feet). Algae levels are moderate (chlorophyll a 4 to 7 ppb) as are phosphorus concentrations (10 to 20 ppb). Despite their relatively high nutrient and algal levels, lakes in this category do not appear to have a high risk of developing algae 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.

Category: Moderate/Sensitive Quality

These lakes exhibit clarity, algae and nutrient levels similar to the moderate/stable lakes, but have a high potential for developing algae 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.

Category: Poor/Restorable Quality Lakes

This category supports obnoxious summer algae blooms, minimum SDT is 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.

Category: Poor/Non-restorable Quality

These lakes have a long history of obnoxious summer 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 that land use 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 nutrient loading change attributable to land use alterations other than development, as 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. Lacking 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 types as well as noncultural 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 reevaluation of post-1986 development, will result in continuing revision of the "threatened" category.

Of the 185 lakes listed as impaired, only 74 (40%) are also assessed as "Threatened" under the vulnerability criteria detailed above. This is an indication that, while rates of development and attendant nutrient loading impacts 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. Lag time in lake response makes vulnerability estimations most valuable as a general planning tool.

Control Methods

Existing State programs controlling pollution of lakes generally fall into three categories: regulation, technical assistance and guidelines, and remedial projects. The DEP has abated many of the major sources of pollution to several Maine lakes through statutes, regulations, permit review, and lake restoration projects. The major threat to maintaining the present high water quality of lakes is changing land use, the greatest change being the transition from predominantly forested, undeveloped land to low density residential development. A heightened public awareness of the vulnerability of lake water quality has resulted in recognition of nonpoint sources 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. Silvicultural management is coming under increasing scrutiny 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. 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 of 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 Water Quality Act Section 319 Nonpoint Source Control Program will enhance 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, will complement the new Maine new Phosphorus Control Program. Section 319 implementation projects are targeted for the Sebago Lake, China Lake, Webber Pond and Madawaska Lake among others.

Regulation

The Maine water classification statute (38 MRSA, Article 4-A) allows no new point source discharges of pollutants to lakes. Current 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. Despite tertiary treatment, the Sanford discharge contributes to the nonattainment of classification in Estes Lake. Serious consideration is being given to the elimination of the Rangeley (Haley Pond) and St. Agatha (Long Lake) discharges through alternative treatment methods.

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. If research funding is available, the DEP hopes to better define the potential for effects on lake water quality by subsurface migration of phosphorus from substandard leachfields.

In 1988, the Maine Legislature consolidated a number of resource protection statutes (and their attendant regulations) under the Natural Resources Protection Act (NRPA). Provisions of the act require 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 impact of proposed developments in conjunction with others in the watershed.

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 effect the entire watershed and usually reflect only minimum protection standards for lakes. The proposed mandatory inclusion of zoning on all second order or larger streams would help considerably in focusing attention on other areas of sensitive lake watersheds.

Municipal land use ordinances vary widely across the State in terms of their detail and application concerning lake protection. Adoption of comprehensive plans, as mandated by 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 now being encouraged to adopt the nutrient control methods referenced above in comprehensive development of review ordinances.

Silvicultural practices are generally not controlled by regulation, but Maine Department of Conservation (DOC) guidelines are applied in Maine's unorganized townships and are commonly used for guidance in the organized municipalities. These guidelines include standards for stream crossings, road and ditch construction and general erosion control. Since timber harvesting is the predominant land use in a large number of lake watersheds (especially in the unorganized territories), these standards are vital to reducing sediment and nutrient impacts, especially those short term, on lakes and streams. Maine does not currently license or require training of timber harvesters for resource protection. The 1989 Forest Practices Act will result in new regulations designed to enhance resource management, including water quality protection.

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, especially in sensitive lake watersheds.

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.

The DEP Lakes Management Program stresses comprehensive planning, education and resource protection in addition to the Department's traditional role in enforcing environmental laws. Cooperative projects with Maine Soil and Water Conservation Districts for education and landowner contacts in lake watersheds are increasingly important. Several research projects in cooperation with the University of Maine are aimed at developing nonpoint source controls. Recognizing that public outreach and education are the cornerstones of water quality protection, an educational campaign begun in 1989 emphasizes lake related issues. An ambitious brochure production program has already reached thousands of people. A wide variety of related topics will be covered in 1990-91 pending availability of funds. Water quality videos and curriculum materials are being distributed to schools across the State.

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.

Non-traditional methods to control the increased phosphorus export associated with development, such as installation of phosphorus control wet-ponds, infiltration systems and vegetated buffer strips, are gaining acceptance. The technology for this 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. A methods manual and technical training program recently developed by the DEP are now available on a state-wide basis through the Technical Assistance Unit and through staff of Regional Planning Agencies assigned to this program. 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. 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 mandated municipal comprehensive planning process.

The Maine Department of Transportation, Environmental Services Section, has recently begun to place increased emphasis on project planning for erosion control in sensitive lake watersheds. The recently instituted 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 Maine Department of Transportation on alternative seed mixes, application techniques and timing is an example of changes in customary procedures needed to safeguard water quality in sensitive watersheds.

Agricultural controls, especially manure management, are emphasized in heavily farmed lake watersheds. Implementation of advanced manure handling techniques, especially semi-solid collection and application systems, soil-crop analyses for critical nutrient balances, and pasture management have been added to other established methods on an increasing basis. Through the Conservation Reserve Program (CRP) a substantial acreage of highly erodible land has been removed from potato production, especially in northern Maine. Besides CRP land, crop rotation with oats and other grains and runoff management has produced significant improvements in the discharge of silt, nutrients, and pesticides from cooperating farms.

In 1989, LURC published its Action Program for Management of Lakes in Maine's Unorganized Territories. This document contained policy guidance which explicitly considers water quality preservation and stresses stormwater management and the potential for phosphorus and sediment loading to lakes from future development. This document also proposes formation of "Lake Concept Plans". These will be designed to provide a cooperative and integrated view of landowners' development plans. This will allow LURC to give guidance to landowners so that future permit reviews may be facilitated while ensuring an opportunity to manage the cumulative impacts of development, including water quality considerations. The first of these plans (encompassing lakes) is currently being developed.

Some projects bearing on lake water quality protection are also funded under Sections 205(j)(1) and 604(b) of the CWA under the competitive grants program of DEP. Projects proposed for 205(j)(1)/604(b) funding in 1990 include analysis and promotion of a watershed district for the Pushaw Lakes, the assessment of urban storm sewer loading to Annabessacook Lake, and a determination of the potential for ephemeral stratification/internal phosphorus recycling in North Pond (Norway).

Restoration Efforts

General Description of the Maine Lakes Management Plan

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.

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, the limited state staff available must be concentrated on high priority problems, especially with respect to 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, although 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 (if at all), DEP relies on the frequently imperfect application of municipal ordinances to be the first line of defense in these matters. DEP emphasizes providing guidance to towns and landowners for individual land use decisions. DEP experiences have illustrated the effectiveness of both 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 (and especially phosphorus control) over the long term, usually a ten to fifty year period.

Maine's current comprehensive planning mandate to municipalities has resulted in a three-tiered schedule, with towns showing the highest rates of growth being required to update their comprehensive plans (and thus the basis for local regulation of land use decisions) by 1991. These towns are the ones which the DEP Technical Assistance Unit is now contacting directly, providing planning manuals, watershed maps, and water quality data needed to pursue the planning process for their lakes. Staff stresses inter-community communications in this process, especially where towns share lake watersheds in common. DEP has found, however, that many of these 138 "tier-one" towns are so heavily engaged in the planning process that it is very difficult for them to adequately consider the full range of implications that lake water quality protection has for their plans. However, a number of Towns not currently experiencing high growth rates and which may not be currently revising their plans have or will soon adopt the technical methodology for 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.

Besides the above standards for development review, Maine is also developing a variety of BMPs under the Nonpoint Source Management Program which will be of substantial benefit to lakes water quality, especially in the areas of forestry activities, road construction and maintenance, and agricultural practices. Many of these BMPs will be initially developed as technical guidance but will eventually be incorporated into regulations and ordinances.

The future of Maine lake water quality will depend in great measure on how well DEP promotes evolving guidance for protection and on efforts in educating Maine citizens. Restoration of lake water quality, with its great expense and technical difficulty, will continue to be pursued, but emphasis will remain on planning for protection and the inevitable growth of development in lakes watersheds.

Restoration Projects

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 and focus on nonpoint source control and municipal policy development. Each of the current projects has had 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 nonpoint source control has been the focus of the SCS and Conservation Districts in several restorations. Increasingly, District staff expertise has been utilized for non-agricultural technical assistance, as in the case of two current projects (China Lake and Threemile Pond).

The 1988 305(b) report detailed nine Maine restoration projects. Table 21 lists completed restoration, current projects and those recently proposed.

Table 21. Maine Lake Restoration Projects.

Lakes with Completed Restoration Projects

Haley Pond (Dallas & Rangeley)

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 algae blooms in the lake. Blooms have only occurred twice since 1975, and both of these blooms were associated with breakdowns in the tertiary treatment system. However, substantial concern exists about development growth in the area and associated nonpoint sources and increased loading from the treatment plant. Funding - Federal and State Municipal Construction Grants.

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

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 receive an alum treatment 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 suggests that internal recycling may be rising. Though Annabessacook Lake still supports annual algal blooms, the duration and intensity of these blooms has been <u>much</u> 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. Funding - EPA Clean Lakes Program, Local contributions, Cobbossee Watershed Districts and DEP In-Kind Services.

Sebasticook Lake (Newport)

This restoration project addressed four points: (1) elimination of point sources at Dexter (completed 1988), (2) reduction of point sources at Corinna (ongoing), (3) reduction of nonpoint agricultural 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 1985 has resulted in a 50% reduction in lake phosphorus concentrations. These reductions in phosphorus loading have resulted in decreased incidence, duration and intensity of algal blooms. The effect of elimination of the Dexter sewage discharge in 1989 and of continued annual drawdowns should further improve water quality in the future. Funding - EPA Clean Lake Program, USDA Act, Local Funding, State and Federal Municipal Construction Grants and DEP In-Kind Services.

Estes Lake (Alfred & Sanford)

In 1982, tertiary treatment for phosphorus removal was installed at the Sanford wastewater treatment plant at a cost of approximately S9 million. Results were dramatic. Annual blooms were almost completely eliminated except following periods when the STP discharge approached or exceeded license limits. In 1988, the license limit for total phosphorus was reduced for the summer period to eliminate remaining problems. Funding - Federal and State Municipal Construction Grants and local match.

Table 21. Maine Lake Restoration Projects (continued).

Lakes with Completed Restoration Projects (continued)

Sabattus Pond (Greene, Sabattus & Wales)

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

Salmon Lake (Belgrade & Oakland)

Best Management Practices were implemented on two farms in the watershed. No in-lake treatment has been proposed so recovery depends on natural flushing. It is expected to be a long time before recovery is measurable and no statistically significant change has been noted. Residents however, claim that algal blooms are less frequent and less dense. Funding - EPA and ASCS with in-kind services from DEP and landowners.

Togus Pond (Augusta)

Shorefront homeowners have independently and voluntarily cooperated by correcting their own problems. For example, over 20 new septic systems were installed at homeowners' expense despite the fact that they were not required by law to do so. Future treatment to control internal recycling may be appropriate. Funding - Property owners and State in-kind services for technical assistance.

Lovejoy Pond (Albion)

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

Cochnewagon Lake (Monmouth)

Restoration involved a successful 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 is pending for this lake to assess Aluminum treatment effects and nonpoint source. Funding - EPA Clean Lakes Program, State Lake Restoration and Protection Fund, local contributions, Cobbossee Watershed District and DEP in-kind services.

Table 21. Maine Lake Restoration Projects (continued).

Current Projects

Webber Pond (Vassalboro)

Restoration project included control of nonpoint agricultural sources of phosphorus, reduction of shoreline erosion problems and control of internal recycling of phosphorus by enhanced seasonal drawdown, (requiring dam reconstruction). All of there are completed except for some of the shoreline erosion control work which will be completed in 1990. Since dam reconstruction in 1985, the lake has exhibited reduced duration, frequency and intensity of algal blooms. Continued drawdown, should result in further improvement of water quality. Funding - EPA Clean Lake Program, State Lake Restoration and Protection Fund, USDA Watershed Protection and Flood Prevention Act, Local contributions and DEP in-kind services.

Three Mile Pond (China, Vassalboro & Windsor)

This restoration project involves control of nonpoint agricultural and nonagricultural sources of phosphorus and an alum treatment of the lake sediments in 1988 to control internal recycling of phosphorus. The only remaining portion of the project is to work with the towns and the lake association to resolve remaining major non-agricultural sources of phosphorus in the watershed, particularly from road and camp road erosion problems. Though water quality in the summer of 1989, following the aluminum treatment was very good and evidence suggests that internal recycling was reduced by up to 75%, it is too early to assess the long term effectiveness of the treatment. Funding - EPA Clean Lakes Program, State Lake Restoration and Protection Program, USDA Watershed Protection and Flood Prevention Act, local contributions and DEP in-kind services.

China Lake (China & Vassalboro)

This project consists of two phases: reduction of major nonpoint sources of erosion (and resultant phosphorus loading) and the reduction of internal phosphorus loading through nutrient 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. This phase also 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. Nutrient inactivation for internal phosphorus control will be undertaken if significant progress is made toward the objectives of the first phase. Funding - EPA Clean Lakes Program, Maine Lake Restoration and Protection Fund, USDA/ASCS cost-sharing, Town and local contributions, Maine Soil and Water conservation Commission (Challenge Grant) and in-kind services by the DEP and the local Soil and Water Conservation District and volunteers.

Table 21. Maine Lake Restoration Projects (continued).

Current Projects (continued)

Long Lake and Cross Lake (St. Agatha, T.16, R.5, W.E.L.S., T.17, R.3, W.E.L.S., T.17, R.4, W.E.L.S, & T.17, R.5, W.E.L.S.)

Documented water quality problems in these two lakes has prompted substantial local concern. An extensive nonpoint source survey of two tributary watersheds has been completed. The Conservation District has also 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. An aggressive educational campaign by the area lakes association has been conducted over the last two years. The DEP has designated staff with nonpoint source pollution control expertise to work in these watersheds. Funding - USDA/ASCS Special Watershed Project, Maine Lake Restoration and Protection Fund, the University of Maine, the St. John Valley Soil and Water Conservation District, the Fish River Lakes Water Quality Association and the Aroostook County RC&D.

Pending Restoration Projects

Chickawaukie Lake (Rockland & Rockport)

This is a two-phase project including nonpoint source reduction and education coupled with long-term protection planning followed by nutrient inactivation. The project is slated for 1990-1993 pending EPA Clean Lakes Program grant approval. Funding - EPA Clean Lakes Program along with State and local funds (including in-kind services).

Madawaska Lake (Westmanland, & T.16, R.4, W.E.L.S.)

A diagnostic/feasibility study has been proposed which will include State funds recently appropriated, EPA Clean Lakes Program Phase I support (application pending), along with DEP and local in-kind services. This project will examine water and nutrient budgets, include an intensive nonpoint source survey and monitor tributaries to assess the effects of forestry practices in the watershed.

Acid Effects on Lakes

Estimates place the number of non-dystrophic Maine lakes which are currently acidic (Acid Neutralizing Capacity or ANC < 0) at less than 100. Although all Maine surface waters which have had their acid-base chemistry analyzed show increased non-marine SO_4 concentrations resultant from acidic deposition, only a portion of known acidic lakes can be considered as having been predominantly affected by atmospheric deposition.

Over the last decade, the effects of acidic deposition have been 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 about 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 HELM project, and 128 seepage lakes in or associated with mapped aquifers were assessed in the 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.

Approximately 1,003 lakes (an estimated 713,336 acres) have been assessed for high acidity, predominantly by using measures of pH and ANC. There are about 58 acidic lakes (ANC < 0) comprising a total surface area of 646 acres (1.0% of the lakes and 0.06% of the lake surface area in the state). Eighteen acidic lakes are at least ten acres or greater in size; 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 to be some (probably less than 50) additional acidic drainage and seepage lakes in the 1 to 10 acre size range.

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 (ANC < 0; DOC < 5 mg/L) lakes (drainage and seepage) 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.

The extent of aluminum mobilization due to increased acidity is dependent on the presence/absence of substances which bind aluminum such as ligands/DOC and flourine. 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. The distribution of total aluminum in the 58 acidic lakes is shown in Table 22.

Table 22. Aluminum Distribution in Acidic Lakes.

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

Total aluminum was determined on filtered (0.4 m), acidified samples according to EPA ELS/LTM protocols. 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 of these, however 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. Many of the fishless lakes are small, isolated, and/or high elevation, with poor breeding habitat.

Paleolimnologic investigations in New England have concluded that some lakes apparently have become acidified in the past 20 - 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 (LTM) 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.

No attempt has been made to mitigate the effects of acidic deposition or resultant toxic mobilization for the following reasons: only a small percentage of surface waters have been acidified by acidic deposition; lakes affected by acidic deposition are typically small in surface area; paleological evidence suggests that those lakes with depressed pH attributable to acidic deposition, were historically low in pH as a result inherent watershed characteristics; no alteration of fish populations can be attributed to acidic deposition at this time; 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

In Maine, only one lake (Annabesacook, 1,420 acres total area, 400 acres affected) is known to be affected by toxic wastes and the level of contamination is such that EPA has recommended pregnant women not swim in the contaminated area.

Chapter 5 - Estuarine and Marine Water Quality Assessment

Background

In 1988, the Maine Legislature established a State program to monitor and research toxic pollution within the 3,600 miles of near coastal waters. Prior to this, no one agency was responsible for conducting pollution research. Information was sporadic and often not comparable to other work. The Maine Marine Monitoring Program has developed a standardized approach which allows Maine data to be compared with and complement such data bases as the National Status and Trends Program of National Oceanographic and Atmospheric Administration. In the two years of its existence, the scope of responsibility has increased to include not only toxic pollution but nutrients. Eutrophication of coastal waters now appears to be a legitimate concern. Phytoplankton blooms in small embayments have been observed in several locations. With the expansion of municipal treatment facilities and growth of the aquaculture industry, a closer look at nutrient enrichment is warranted.

Information on the five coastal health topics, eutrophication, habitat modification, changes in living resources, toxics contamination and pathogen contamination is discussed below.

Eutrophication

Good information on enrichment processes in Maine coastal waters is lacking. However, anecdotal evidence exists which suggests Maine should be placing more emphasis in this area of research. A complete shellfish kill occurred in 1988 in Maquoit Bay in Brunswick which was coincidental 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. To fill this information void, Maine now is requiring nutrient monitoring of new discharges, and of existing discharges as their licenses are renewed. In addition, select waterbodies such as Maquoit Bay are being monitored by private individuals so that patterns and trends can be established which will enable Maine to avoid blooms in the future, through better waste load management.

Habitat Modification

At this point in the program, data on habitat alteration is limited. Maine law strictly regulates activities in all coastal wetlands as defined by those lands below spring high tide. Any activity below spring high tide must be permitted. Although permits are issued only after an environmental review by water quality specialists, marine biologists and geologists, follow up and compliance monitoring is needed to determine actual habitat loss.

Changes in Living Resources

Maine is about to complete development of its freshwater biological criteria after 10 years of effort. The knowledge of marine biological community responses to certain activities is only now beginning to evolve. DEP is looking at the biological effects of organic enrichment from salmon net pen aquaculture. Pollution associated with this activity has fewer confounding variables associated with it and therefore is more likely to yield interpretable results. Conclusions drawn from these efforts, however, are years away.

As part of the Casco Bay Protection and Management Plan, DEP is looking at benthic community shifts over the past decade within the Fore River area. Initial sample results suggest that biological responses have occurred in the vicinity of the South Portland POTW outfall and oil terminal facility areas. Causation, however, is not yet clear.

Toxics Contamination

Recent findings by researchers outside of State government strongly suggest more research needs to be done. Past assumptions that the Maine coast is largely free from contamination have been shown to be questionable. Penobscot Bay, Casco Bay, and Boothbay Harbor contain levels of contaminants comparable to estuaries thought to be the most polluted on the East coast. Polynuclear aromatic hydrocarbons in Casco Bay ranked fifth highest and PCBs ranked 11th highest in a national NOAA survey. Winter flounder livers in Casco Bay contained the highest level of lead, third highest level of silver, fifth highest level of zinc, and 10th highest level of copper. In Boothbay Harbor, which the National Marine Fisheries Service selected as a "control" site for an east coast metals survey, crabs ranked second highest in lead levels (see Case History at end of section).

The primary emphasis of the Maine Marine Monitoring Program is toxics through a three pronged approach. Sediment chemical quality, blue mussel tissue quality, and marine biological community structure are being monitored to provide a better picture of the extent and impacts associated with toxic contamination. To date, DEP has identified six areas of concern based on sediment and/or blue mussel tissue analyses (Table 23).

Table 23. Marine and Estuarine Areas of Concern with Regards to Toxic Contamination.[1]

	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 nonattainment or adverse impact. Monitoring will be required to be coupled with standards development before any conclusions can be drawn.

Pathogen Contamination

An estimated total of 158 square miles are closed to shellfish harvesting by DMR. These closings are based on water samples collected in shallow water along the shore since Maine's program is largely focused on regulation of shellfish harvesting in the intertidal zone.

There are about 71 square miles of intertidal mudflats in Maine which 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.

About 90% 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. There are 124 square miles of near shore waters which do not fully support these uses due to high bacteria levels. Because bacteria standards are more restrictive for shellfish harvesting than for swimming, all but 2.3 square miles of these nonattainment waters support the use of swimming but not shellfish harvesting. See Appendix I for more information on estuarine and marine waters with impaired uses.

Case History

Chosen as a clean control site by the NMFS because it was known to be free of traditional heavy industry, Boothbay Harbor became part of an east coast survey of heavy metals. It came as a great surprise, then to discover that the lead values of the control site actually ranked second highest of all the NMFS sites. In 1986, the DEP conducted an intensive study of the harbor to assess the extent and magnitude of pollution. No discharge of lead to Boothbay Harbor is known. The effluent quality of the town treatment plant does not explain the levels. Although DEP will probably never know for certain, data from Boothbay suggest that the source(s) of lead relates to human activity. Most of the town's urban runoff washes into Town and Mill Cove. With that is carried the lead from automobile exhausts and crankcase oil drippings. The town landfill lies upstream of one contaminated area of the cove and presumably is responsible for a portion of the metal load. In addition, several boat yards are thought to be a potential source of runoff containing paint chips and sandblasting waste. Investigation into these sources is needed to confirm any suggestion, but it appears thus far that nonpoint sources unrelated to treated industrial wastewater are the culprit.

National Estuary Program

In July 1989, Governor McKernan nominated Casco Bay to the EPA National Estuary Program. Although designation has not yet been announced, both DEP and EPA Region I are engaged in a Casco Bay Management Plan. The plan consists of five parts: monitoring and research, enforcement, licensing, regulation, and public education. With or without National Estuary Status, plan implementation is proceeding.

Chapter 6 - Wetland Information

Background

The Maine Wetlands Conservation Priority Plan, prepared by the DOC Bureau of Parks and Recreation and the Maine State Planning Office, estimates 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 fresh brackish marshes.

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

This report uses the United States Fish and Wildlife Service (USF&WS) definition of wetlands which requires wetlands to have one or more of the following three attributes: at least periodically, the land supports predominantly hydrophytes (plants adapted to water saturated soils); the substrate is predominantly undrained hydric soil; and/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 24 details the areas of wetlands by type presented in the Maine Wetlands Conservation Priority Plan. Five different sources of data were referenced to create that table: National Wetland Inventory (NWI) completed by the USF&WS; 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 DIFW; 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 and the Department of Environmental Protection (OER/DEP).

Five sources of data were needed to create Table 24 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 Maine Wetlands Inventory); 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).

Table 24. 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	2,000
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

Saline	**87,500**
Brackish	**70,000**
Palustrine	**5,041,683**
Total	**5,199,183**

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 25).

Table 25. Maine Wetlands Loss Since circa 1780s.[1]

Surface Area Water	Surface Area Total	Estimate of Original Wetlands circa 1780s	% of Surface Area	Wetlands Estimate of Existing Wetlands circa 1980s	% of Surface Area	Wetland in Terms of % Loss
1,460,480	21,257,600	6,460,000	30.4%	5,199,183	24.5%	- 20%

[1] From Draft Wetland Loss Report, National Wetlands Inventory, USF&WS.

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 on the Kennebec River developed on floodplains.

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

1. **Commercial, Residential and Urban Development** - Commercial, residential and urban development causes 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 of 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 activity, 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, or "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 resurvey 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 (>40 acres in size) used by wildlife. Inventory efforts focused on regions containing 90% of the wetlands of importance to waterfowl. The resurvey 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 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. Quoting from the results: "Although wetlands have not been substantially altered over the past three decades, riparian areas surrounding them are rapidly being developed". Quite often, the edge of coastal marshes or other wetlands were developed, cleared or filled, reducing the availability of these ares for wildlife and often result in secondary negative impacts to wetlands such as nonpoint source pollution. Where losses have occurred, they are generally small and incremental, but again most seriously affected edge habitats and usually not requiring a coastal wetland permits.

Permits reviewed by the Wetland Control Board, 1967 - 1973

The Wetlands Control Board, administered by the DMR, 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 receive permits range 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 fill to prevent erosion.

Most of the permitted activities were for bulkheads, seawalls and 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 requests 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"; that "very few substantial coastal wetland fills have been approved", with only six cases in the 20 years since the enactment of the law had filling greater than one acre occurred (according to DEP staff). 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:

1. The Natural Resources Protection Act

The Natural Resources Protection Act (NRPA) became effective August 4, 1988. The NRPA consolidates several laws pertaining to coastal wetlands and sand dunes; freshwater wetlands; great ponds; rivers, streams, and brooks; fragile mountain areas; and, significant wildlife areas.

The intent of the NRPA is to prevent the degradation or destruction and to encourage the enhancement of protected natural resource areas. It prohibits most alteration activities adjacent to a protected area without a permit from DEP.

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 any permanent structure (permanent structure is one placed or constructed in a fixed location for a period exceeding 7 months of the year) in a protected natural 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; on sand dunes, unreasonably interfere with sand supply or movement, or increase erosion; or, cross a river segment identified in the law as "outstanding," unless no other alternative having less adverse impact on the river exists.

Permits are usually needed for working in or disturbing soil within 100 feet of a protected natural resource area. However, these areas are not always easy to identify. In particular, determining wetland boundaries may require technical expertise because wetlands are identified based on vegetation and hydrology.

Maps identifying unforested wetlands greater than 10 acres in size are available from DEP, most municipal offices, or may be purchased from the Maine Geological Survey. The Maine Geological Survey plans to complete mapping of all wetlands large than 1 acre over the next several years. Maine does not require municipalities to complete wetland resource inventories, but would provide technical assistance to any municipality willing to complete one.

Wetlands are not included in the Maine water classification program, but a draft regulation to implement the Natural Resources Protection Act classifies wetlands 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. Consists of salt-tolerant or estuarine marsh vegetation; intertidal soft bottom (mud, sand or mixed sand and gravel); or vegetated hard bottom (ledge or boulder bottom supporting various marine algal species such as Fucus or Ascophyllum);*
>>
>> *b. Is located within 250 feet of any great pond;*

NOTE: More than one classification may apply to the same wetland, depending on the distance to a water body.

>> *c. Contains rare 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;*
>>
>> *d. Contains a palustrine natural community listed on the Maine Natural Community Classification and ranked S1 or S2 (20 or fewer documented occurrences in Maine).*
>>
>> *e. Contains significant wildlife habitat as defined under 38 MRSA, Section 480-B and as determined by the Maine Department of Inland Fisheries and Wildlife or the Maine Department of Marine Resources, whether or not the area has been mapped.*

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, river, stream or brook;

NOTE: More than one classification may apply to the same wetland, depending on the distance to a water body.

b. Contains at least 20,000 square feet of emergent marsh vegetation or open water during normal high water conditions;

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

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 water bodies."

The draft regulations require that mitigation of proposed alterations result in no net loss of wetland <u>function</u> and that there be minimal alteration where possible.

2. 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 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. Of the 450 organized municipalities with shoreland zoning ordinances, 107 have State-imposed ordinances. 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 nonconforming uses. All land use activities -- even those not requiring a permit -- must comply with all the applicable land use standards described in the ordinance. All land within 250 feet of the upland edge of coastal and freshwater wetlands and land within 75 feet of certain streams is included in the shoreland zone.

3. 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").

The purpose of the Act is to require the registration of dams by their owners, to provide for the awarding of abandoned dams to new owners, and to 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 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.

4. Site Location of Development Law

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

Maine has not been delegated authority to approve permits for the disposal of dredged fill material under Section 404 of the 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.

The long-term success of the Maine wetlands protection program will depend on the extent that wetlands protection efforts are incorporated into existing and new environmental programs. As previously stated, wetland protection authority exists at the State and local level. Other existing regulatory programs are adopting wetland protection components in their workplans. For example, the Maine nonpoint source pollution control program proposes to evaluate the impacts of NPS 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.

PART IV: GROUNDWATER

Chapter 1 - Overview

Public interest in groundwater 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 groundwater supplied from private wells, public wells, or springs. Groundwater is the source of approximately 98% of all the water used by households with individual supplies. In addition, approximately 60% of the water needs of Maine livestock are derived from groundwater. Industrial groundwater use is slightly less than the volume withdrawn for drinking water. Additional federal requirements for surface water treatment are increasing the shift to groundwater use for public water supplies.

Generally, the groundwater supply in Maine is adequate. In a 1984 study by SPO, it was estimated that Maine stores one hundred trillion gallons of fresh groundwater in the pore spaces of unconsolidated glacial deposits and in the fractures of underlying bedrock. Less than one percent of the annual groundwater recharge is withdrawn by all water users each year. The remaining annual groundwater recharge is lost through evapotranspiration or discharges to ponds, lakes, rivers, and streams.

Groundwater 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 groundwater quality increases, more widespread detection of contamination can be expected as efforts to monitor known and potential problems increase. Because of slow groundwater flow rates and low biological activity, groundwater contaminants are extremely persistent. Centuries may be required for natural processes to restore contaminated groundwater to potable standards.

In 1989, the State adopted the Maine Groundwater Management Strategy to articulate its groundwater 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 groundwater and surface water and proposes to implement pollution prevention programs during the next four years of the program.

Major impediments to effective groundwater protection in Maine are (1) absence of an accurate groundwater 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 groundwater research and groundwater protection programs and (4) general public unfamiliarity with key groundwater concepts and issues. Public misconceptions about groundwater are probably the major factor contributing to degradation of this resource.

Chapter 2 - Groundwater Quality

Groundwater in Maine is classified by its suitability for drinking water purposes. According to current Maine Statute, groundwater is classified as either potable (GW-A) or unpotable (GW-B). Water is unpotable when the concentrations of chemical compounds detected exceed the maximum exposure guideline as defined by DHS. Although there are many localities where groundwater is unpotable and highly contaminated, no groundwater is currently classified GW-B. Future legislation will be developed to amend the existing groundwater classification system to impose stricter wellhead protection measures in zones around public and high-density private groundwater supplies. In this system all groundwater will have a goal of being potable.

Detailed quantitative estimates of the statewide extent of groundwater contamination are not now, and probably never will be, available. In addition, current information about groundwater contamination in Maine does not necessarily portray the actual situation accurately. This information reflects which contaminants 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 pollution potential since some activities (e.g., agriculture) occur in sparsely populated areas with few available wells to monitor.

Major Sources of Contamination

Almost all groundwater contamination in Maine originates from nonpoint source pollution rather than point source pollution. Table 26 lists the major sources of groundwater contamination in Maine and Table 27 lists the substances contaminating groundwater.

Table 26. Major Sources of Groundwater Contamination in Maine.

Source	Contamination Present	Rank
Septic Tanks	X	5
Municipal Landfills	X	3
On-site Industrial Landfills (excluding pits, lagoons & surface impoundments)	X	
Other Landfills	X	
Surface Impoundments (excluding oil and gas brine pits)	X	
Oil and Gas Brine Pits		
Underground Storage Tanks	X	1
Injection Wells	X	
Abandoned Hazardous Waste Sites	X	
Regulated Hazardous Waste Sites		
Salt Water Intrusion	X	
Land Application Treatment	X	
Agricultural Activities	X	2
Road Salting (and storage)	X	4
Other - Radon from Geologic Sources	X	

Table 27. Substances Contaminating Maine Groundwater.

Organic Chemicals		Metals	X
Volatile	X	Radioactive Material	X
Synthetic	X		
		Pesticides	X
Inorganic Chemicals			
Nitrates	X	Other Agrichemicals	X
Fluorides			
Arsenic	X	Petroleum Products	X
Brine/Salinity	X		
Other			

The following discussion is limited to nine nonpoint contamination sources that appear to be responsible for most groundwater 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, things as diverse as golf courses, cemeteries, dry cleaners, burned buildings, and automobile service stations are potential threats to groundwater.

Petroleum Products and Leaking Underground Storage Tanks

The DEP, Bureau of Oil and Hazardous Materials Control, Division of Response Services responded to approximately 7,500 spill incidents and investigations between 1984 and 1989. Over 60% of these responses involved discharges of petroleum products to soil and groundwater. Between 1980 and 1988, petroleum-related discharges contaminated over 500 private wells. Sources of petroleum discharge range from overturned tanker trailers to tank overfills. Most of those discharges were from leaking underground storage tanks (LUST) and piping. Leaking underground storage tanks are viewed as the biggest threat to groundwater quality in Maine. 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 establishes procedures for abandonment of tanks and prohibits the operation, maintenance, or storage of petroleum in any storage facility or tank which 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 <u>and</u> 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 <u>and</u> is located in a sensitive geological area; and,

D. October 1, 1997, 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 34,000 tanks have been registered; an estimated 2,000 to 3,000 tanks remain unregistered. Since 1986, approximately 5,000 inactive or old tanks have been removed.

Agriculture

The total estimated cropland and pastureland in Maine is approximately 700,000 acres. Agricultural chemicals and manure are estimated to be the second biggest potential source of groundwater 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 chemicals are applied to 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 viewed as the main agricultural groundwater contaminants.

<u>Pesticides.</u> Although at high concentrations pesticides have known acute health effects, because they are generally present in low concentrations in groundwater 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 groundwater 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 groundwater 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 groundwater 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). Temik was not analyzed in this study. 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.

__Nitrates.__ The documented adverse health effects of nitrate (potential for causing methemoglobinemia in infants and complicity in producing carcinogenic nitrosamines) and its mobility in groundwater, may make it the most significant agricultural contaminant in Maine groundwater. 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 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). 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.

Documentation of nitrate contamination in groundwater from manure storage and spreading is limited mostly to DEP case files. At the DeCoster Farm in Turner, poultry manure disposal has caused extensive groundwater nitrate contamination in both the overburden and bedrock. One well showed nitrate concentrations above 600 mg/L. Leachate generated from uncovered manure piles has contaminated nearby residential bedrock wells in Charleston and Clinton with nitrate concentrations exceeding 100 mg/L.

The extent of nitrate groundwater contamination from manure is unknown but probably significant. Manure application at rates recommended in the 1972 Maine Manure and Manure Sludge Disposal on Land guidelines exceeds nitrate nutrient utilization rates for forage crops. The Maine Soil and Water Conservation Districts 1988 Manure Management Project found that the plow layer in approximately one-half of the 249 cornfields 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 be leached to groundwater, i.e., some will be bound by soil organic matter, the data shows a very high potential for groundwater quality degradation exists beneath these fields. The agricultural community in Maine acknowledges these 1972 guidelines are outdated and guidelines are being developed that reflect application according to agronomic utilization rates.

DAFRR statistics indicate that farmland available for manure spreading consists of approximately 222,000 acres of hay and 29,000 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.

Landfills

Another serious threat to groundwater is from leachate generated in landfills. Approximately two million tons of solid waste are deposited in Maine's landfills annually. 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 groundwater if the leachate is allowed to migrate beyond the landfill bottom. It seems likely that most landfills without leachate collection systems and low-permeability liners are polluting groundwater.

Currently, there are 185 active landfills and 269 known inactive sites. Of the active landfills:

1. forty-five sites are on sand and gravel aquifers and at many of these, groundwater contamination has been documented;

2. sixty other sites have contaminated surface water and/or groundwater and are considered to be substandard; thirty-seven of these sites have serious groundwater contamination;

3. thirty-four sites have no reported problems with surface water or groundwater; and,

4. forty-six sites are inactive dumps 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 to conduct and complete by January 1, 1993, environmental evaluations of "open" municipal solid waste landfills and provide a recommended closure plan for each landfill. Investigation of 37 sites (most of the sites with serious groundwater contamination) is in progress. Seven of these sites are threatening or contaminating private or public drinking water supplies; these include Biddeford, Gray, Kennebunk, Pittsfield, Paris, Westbrook, and Windham. Thirty-seven sites will be officially closed in 1990 according to DEP guidelines. Remediation and closure activities will be funded by an innovative State grant program.

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 groundwater degradation in Maine. DEP field investigations have documented over 130 drinking water wells in the State that have been made unpotable (chloride in excess of 250 mg/L) by contamination from sand-salt storage contamination. Sodium concentrations above the Maine 20 mg/L Primary Drinking Water Standard 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 groundwater downgradient. The impacts range from the Maine Department of Transportation (DOT) 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 which 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. Using this estimate, an average 250 tons of salt stored in a sand-salt pile would discharge 25 tons of salt if uncovered. Ignoring the cation exchange capacity of the soil, it has been calculated that this is enough salt to raise sodium levels from their background levels (5 mg/L) to the DHS health advisory limit (20 mg/L) in approximately 156 million gallons of water. Similar calculations show that an average salt pile can bring 15 million gallons of water per year from background chloride concentrations (5 mg/L) to the DHS limit of 250 mg/L. For perspective, the annual volume of groundwater recharge in till ranges from 120,000 to 300,000 gallons/acre; in sand and gravel deposits it ranges from 480,000 to 600,000 gallons/acre.

In 1985, the Maine Legislature directed the DEP to prioritize all known sand-salt storage areas according to the extent of their groundwater contamination problems. Documentation of groundwater contamination was based primarily on private well testing and terrain conductivity surveys. In 1986, the Legislature passed two laws to protect groundwater 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 requires that all sand-salt be stored under building cover by January 1, 1996. After this date most of the salt contamination associated with road-salt will be limited to a relatively narrow zone along Maine roadsides. Contamination caused by sand-salt spreading is associated with poorly drained road sides and is usually ephemeral, with groundwater salt concentrations dropping to near-background levels during the spring months. Nonetheless, DOT files indicate that since 1969 at least 45 wells have been made unpotable by sand-salt spreading on roadways.

Septic Systems

It is estimated there are in excess of 230,000 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 groundwater contamination, septic systems directly discharge the largest volume of wastewater into the subsurface environment. The major contaminants of concern found in septic systems are nitrate, bacteria, and viruses. As discussed above, 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 major public health concern.

Major factors affecting the potential of septic systems to contaminate drinking water are (1) the density of the systems per unit area and, (2) hydrogeological conditions. Areas with high septic system density may experience substantial groundwater 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 groundwater contains approximately 30-40 mg/L nitrate-nitrogen. Modeling studies presented to regulators during the past decade have relied on dilution from groundwater recharge and significant plume dispersion as the major mechanisms to reduce nitrate concentrations in septic system effluent. However, little groundwater quality monitoring downgradient of residential developments is being performed to verify predicted nitrate concentrations.

Research conducted on an unconfined sand and gravel aquifer in Canada suggests the dispersion and dilution assumptions commonly used in modeling nitrate attenuation may be inappropriate for sand and gravel deposits. The research found plume dispersion was low in the sand and gravel aquifer studied, and septic systems located there were capable of generating extremely long, thin plumes of impacted groundwater. Thus, impacted groundwater in sand and gravel aquifers may persist much further downgradient than conventional modeling studies predict.

In addition, models generally do not consider the effect of soil type on effluent nitrate concentrations. Researchers at the University of Maine measured mean nitrate-nitrogen concentrations in the soil water downgradient from septic systems that ranged between less than 1 to 410 mg/L, depending on soil type. Preliminary results from research being conducted in Canada suggest that denitrification of septic system nitrate may occur in some soils. This is significant since natural dehumidification in soils was not previously considered a significant mechanism for nitrate reduction in groundwater.

Examination of well water testing results from private homes in Maine may identify the threat of conventional septic systems to drinking water. Computerized water quality data from the DHS Public Health Laboratory for the period March-December 1989 show approximately 5.8% of the well samples tested for nitrate-nitrogen had concentrations exceeding 5 mg/L (2006 analyses total); approximately 1.5% of these samples exceeded the 10 mg/L Primary Drinking Water Standard. Public Health Laboratory data for the period September 1986-June 1987 indicates 1.5% of the well samples tested for nitrate-nitrogen had concentrations exceeding 5 mg/L.

Data for the period March-December 1989 show that 36% of the well samples tested for fecal coliform tested positive (535 analyses total). Interpretation of fecal coliform data is difficult since some bacteria of non-human origin are included in this group. Viruses in groundwater from septic systems have been enumerated in research projects but are not part of routine well water testing. Bacteria are not good indicators of viral threats.

During 1990, DEP, DHS and MGS will be conducting research to evaluate groundwater nitrate concentrations in 26 unsewered residential areas and to test commonly used nitrate models. These studies will also examine the influence of soil type and geology on nitrate concentrations. The effects of septic systems on groundwater quality in Maine are considered to be a major data gap in the Maine Nonpoint Source Pollution Assessment, which should be rectified by this federally funded (Section 319 of the Act) research.

Hazardous Waste Sites

There are 65 sites documented in Maine where hazardous wastes have contaminated groundwater. Common hazardous substances found in the groundwater at these sites include organic solvents, 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, but because of the extreme health hazard they present, they receive a disproportionately large amount of the funds available for groundwater protection, mostly for monitoring and remediation.

Forty-seven of these sites have been designated by the State as uncontrolled sites. Seven of these are Superfund Sites, including the Brunswick Naval Air Station, McKin Disposal Site, O'Connor Salvage, Pinette Landfill, Saco Tannery Pits, Union Chemical site, and Winthrop Landfill. Loring Air Force Base and the Saco Municipal Landfill are expected to be listed as Superfund Sites in 1990. Ninety-two drinking water wells have been contaminated at uncontrolled sites and numerous other wells are at risk.

The other 18 contaminated sites are operating manufacturing facilities licensed under the Resource Conservation and Recovery Act (RCRA). Three of theses RCRA sites are thought to be affecting drinking water wells. Eight wells may have been contaminated with solvents from lagoons at the GTE facility in Standish, and solvents from the Maine Electronics Plant in Lisbon may have contaminated the municipal water supply which serves over 2,000 customers. Several manufacturing facilities at the Sanford Industrial Park are suspected as the source of solvents contaminating the Town wellfield which serves over 6,500 customers.

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, lagoons, and floor drains. 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 chemicals.

Because of their high groundwater contamination potential, the DEP has focused most of the UIC Program efforts on inventorying and eliminating automobile service station floor drains. Responses mailed to over 3,000 service stations in 1988 and 1989 show 585 facilities had floor drains discharging directly to the soil or septic systems and 438 facilities had floor drains discharging directly to publicly owned treatment works. Many of these facilities have been required to seal their floor drains or install oil/water separators connected to holding tanks to store the separator effluent before disposal at a licensed facility. No groundwater quality monitoring has been performed at any of the facilities to assess groundwater degradation.

Other businesses handling hazardous materials will be targeted for future inspection. These include: manufacturing facilities, funeral homes, dry cleaners, autobody 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 groundwater.

Surface Impoundments

Storage, treatment, and disposal of liquid and semi-liquid materials in surface impoundments has long been suspected as a major source of groundwater 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 groundwater 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 groundwater contamination was detected in six of these; and,

7. most surface impoundments in Maine pose a high potential for groundwater 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 groundwater contamination at the various sites. Improperly operated and abandoned sites probably continue to degrade groundwater quality today. A systematic evaluation of all open and abandoned surface impoundments would facilitate a more comprehensive assessment of their groundwater impacts.

Salt-water Intrusion

In coastal areas, excessive groundwater 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 which 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, incidences of saltwater intrusion are expected to increase.

Chapter 3 - Public Health and Environmental Concerns

Contaminants found in groundwater 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 groundwater. 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 groundwater is difficult because there are no generally acceptable protocols for testing the effects of contaminant interactions.

Because groundwater generally provides baseflow 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 groundwater quality degradation and the water quality of streams and brooks during low-flow conditions.

Not all groundwater 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 groundwater that had previously been regarded as safe. 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 are associated with increased incidence of lung cancer. The question remaining is whether radon levels found in some Maine homes can have a similar health effect. Hopefully, additional research in Maine will increase understanding of the nature and extent of this water quality problem.

Chapter 4 - Water Quality Trends

Detailed quantitative estimates of the statewide extent and effects of groundwater 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 groundwater quality sampling difficult. The hilly topography and complex geology have created numerous localized groundwater flow basins, "groundwatershed", 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 groundwater quality upgradient, but they are not indicators of groundwater quality elsewhere, either inside or outside a particular "groundwatershed". Current information about the State groundwater contamination problems may not describe the actual situation as much as it reflects the reason for the investigation and the manner in which they are conducted -- the contaminants tested for, where the monitoring occurred, and how it was performed.

New occurrences of groundwater contamination are being documented in Maine each year. Although discovery of existing contamination is expected to continue, future incidences of contamination are expected to decline substantially as State groundwater 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 substantially reduce discharges from leaking underground storage tanks.

2. Continued development and implementation of a strategy to protect groundwater from agricultural chemicals will diminish the impact of pesticides and fertilizers on groundwater 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.

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 groundwater quality.

4. Investigation and closure of polluting landfills will eliminate one of the most prominent sources of contamination in the State. Creation of the Maine Waste Management Agency to deal with all 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 groundwater. However, elevated concentrations of sodium and chloride will persist in the groundwater adjacent to roadsides unless an economical substitute for sodium chloride can be found.

6. Research will be conducted to evaluate the overall effectiveness of conventional septic systems. Depending on the results of the study, revisions may be made to the Maine Rules for Subsurface Wastewater Disposal to ensure drinking water quality. Increased reliance on environmentally safer alternative wastewater disposal technologies will also safeguard drinking water quality.

7. The emphasis of the UIC Program emphasis on inventory and elimination or control of shallow injection wells will undoubtedly aid groundwater protection efforts. Although the extent of contamination from shallow well injection is unknown, the potential groundwater quality impacts resulting from routine and accidental discharges of toxic and hazardous substances is serious.

8. The Maine Nonpoint Source Pollution Program will have the most impact toward reducing groundwater 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 groundwater contamination from many of those sources, the deleterious groundwater quality impacts from many of the activities are well documented. Development of BMPs for those activities may proceed concurrently with groundwater 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

Construction of Wastewater Treatment Facilities

Although most of the large communities in Maine have publicly-owned sewage treatment facilities, there are still a number of areas where domestic sewage is either inadequately treated or not treated at all. Such areas include entire towns or villages as well as small groups of homes, businesses or seasonal dwellings.

Some communities have sewage treatment facilities that do not adequately treat sewage, either due to 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 infiltration or inflow, resulting in combined sewer overflows, ineffective treatment and/or excessive treatment and maintenance costs.

Many of the communities in Maine are characterized by low population densities and depend on individual septic systems to provide sewage treatment. 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). Areas with sewage treatment problems can usually be grouped into one or more of five general categories:

1. areas with a sewage collection system but lacking a sewage treatment facility;

2. areas with inadequately treated or untreated individual sewage discharges;

3. areas with sewage treatment facilities needing design improvement or upgrading;

4. areas with sewage treatment facilities needing process control or maintenance improvements; and,

5. areas with sewage collection systems that need improvements.

Maine uses multiple approaches to deal with point source discharges. The Federal Water Pollution Control Act Amendments of 1972 require that discharges from municipal sewage collection systems receive secondary treatment (providing approximately 85-90% removal of conventional pollutants). This requirement is reflected in Maine sewage treatment facility construction grant and discharge licensing programs. Similarly, industrial discharges are licensed and treated in accordance with the effluent limitation requirements of the Federal Water Quality Act or more stringent State requirements.

For septic systems, the Maine Subsurface Wastewater Disposal Rules require that homeowners with individual systems 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 DHS.

Municipal Facilities Program

Federal and State cost-sharing money for the construction of municipally-owned sewage treatment facilities is administered by DEP through its Municipal Construction Grants Program. In accordance with the requirements of the Federal Water Quality Act and Title 38 MRSA Sections 411 and 412, the State program is designed to distribute Federal and State funds on a worst-first priority basis to communities with sewage treatment problems.

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) shellfishery 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 Priority Point System is described in more detail in the "State of Maine Municipal Construction Grants Program," published annually by the DEP, Bureau of Water Quality Control, Division of Engineering and Technical Assistance. In addition to describing the administrative aspects of the Municipal Construction Grants Program, the above-mentioned document lists in descending order of priority for the entire State of Maine, those projects which are on the "active" list for the current fiscal year, as well as those projects which are expected to be active in subsequent years (the extended priority list).

During the calendar years 1988 and 1989, eleven new or upgraded municipal wastewater treatment facilities began operating in Maine. The planning and construction of these large municipal facilities as well as facilities for small communities is coordinated by DEP, Division of Engineering and Technical Assistance.

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.

State 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 provides up to $1 million each year for the construction of waste treatment systems. It authorizes the DEP to pay up to 90% of the cost of such systems. Grants are limited to $100,000 for each town. Projects are assigned to a priority list and then selected from that 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 refunded by a bond issue approved in November 1989.

This program fills a need which is largely unmet by the Federal Construction Grants Program. It allows DEP to go into a town which has a low volume of untreated wastewater entering public waters and to install individual or cluster treatment systems in a very cost-effective manner. During the eight year period the Small Community Facilities Program has been in existence, over 1,300 small systems in 89 towns have been constructed. As a result of these efforts, significant benefits have accrued including the reopening to harvest of over 300 acres of shellfishing areas.

Industrial Wastewater Treatment

A wide variety of industries in Maine involve processes which result in the generation of contaminated wastewaters. Industrial discharges are treated either at a municipal sewage treatment facility or at an industrial facility designed specifically to treat wastewaters from that source. 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 wastewater lowers the dissolved oxygen of the receiving waterbody. Others may change pH or add pollutants with a potential for toxicity.

The period between 1972 and 1977 witnessed an intensive effort by industries to provide best practical treatment for untreated discharges. By 1977, all major industries with individual discharges were providing secondary treatment or its equivalent. Since then, additional treatment of small industrial-source discharges has occurred as municipal treatment facilities have been constructed and as additional untreated industrial discharges have been discovered. Although Federal construction grants for municipal wastewater treatment facilities has provided financial assistance for treatment of some industrial wastewater, the construction of most facilities treating industrial wastewater has been funded by the affected industries.

Licensing of Wastewater Discharges

Limits for the discharge of wastewaters 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, 2) the level of treatment required to provide protection for the water quality standards of the receiving water. In Maine, discharge limits can also be generated according to the need of the facility. This "need" is defined by statistical analysis of the previous discharge records for specific pollutants. By using this statistical approach to licensing, final effluent limits can be significantly lower than both the technology-based and water quality-based limits. When developing limits, the most stringent limits generated from these three methods are used in the license.

The Federal Water Quality Act established national "standards of performance" for the control of discharges of pollutants, including those generated by industrial processes. Section 301 of the Act required that by 1977, industrial point source discharges of conventional pollutants be treated by the application of best practicable control technology (BPT) when they are treated at an industrial treatment facility. The Code of Federal Regulations lists conventional pollutants as follows: 1) biochemical oxygen demand, 2) total suspended solids, 3) pH, 4) fecal coliform and, 5) oil and grease. The Code of Federal Regulations, Title 40, Part 400 et seq. establishes technology-based effluent limitation standards for conventional pollutants and some non-conventional pollutants such as metals. The amount of pollutant reduction required by those regulations is related to the type of industry and amount of goods being manufactured daily.

Industrial discharges in Maine are regulated according to whether the industry discharges to a municipal sewage collection system or not. Industries other than those which discharge to a publicly owned sewage treatment facility are covered by a dual federal-state licensing system under the requirements outlined in the preceding paragraph. Such industries are issued an NPDES (National Pollutant Discharge Elimination System) permit by the EPA as well as a discharge license from the Maine Board of Environmental Protection. In all cases, the effluent reduction required by the

Maine license for a particular manufacturer is equal to or more stringent than the level of effluent reduction required of that manufacturer by the NPDES permit.

Industries which discharge wastewaters to a publicly-owned sewage treatment facility are required to pretreat wastes which would otherwise interfere with the operation of the treatment facility 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.

Municipal and industrial discharges of wastewater containing toxic or hazardous pollutants are required to apply "best available control technology" (BAT) in order to achieve effluent limitations established pursuant to Sections 301 and 307 of the Clean Water Act. As with discharges of conventional pollutants, effluent limitations for toxic and hazardous pollutants are included in the NPDES permits and the Maine discharge licenses for industries other than those which discharge to a publicly owned sewage treatment facility. The Administrator of the EPA publishes effluent limitations and standards of treatment efficiency for each of the various pollutants classified as toxic or hazardous.

Using the effluent limitations required by law, taking into account the water quality conditions in the receiving waterbody, and statistically analyzing the facility's discharge record, the DEP Bureau of Water Quality Control, Division of Licensing and Enforcement, prepares municipal, industrial, commercial and residential waste discharge licenses. While the term of these licenses is for up to five years, the BEP may impose additional pollutant reduction requirements on a particular discharger's license if justified by the need to protect public health.

Elimination of Overboard Discharges

With the goal of reclaiming closed shellfish areas, in 1987 the Maine legislature passed an act which prohibited new discharges from single family dwellings and required that relicensing of existing facilities only occur where it was shown that there was no other practical alternative. This law has great significance for the future management of Maine coastal waters where near shore property typically has no capacity for underground wastewater treatment systems (septic tanks with leach fields). The State has developed a funding mechanism to help defray the cost to the homeowner who, as a result of the law, will be required to replace an existing treatment system.

Compliance Evaluation

DEP uses a three part program to evaluate compliance of wastewater treatment facilities. The compliance evaluation program involves onsite 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 or exceedences of license limits. During inspections, the facility and facility records are checked to prevent problems which might result in license violations that would lower the quality of the receiving water.

Maine requires that wastewater treatment plant operators be certified and the DEP administers qualifying examinations for five levels of operator certification for biological plants and three levels of certification for physical/chemical plants.

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 bulking and odor control, programs are conducted which take a more systematic approach to improving wastewater treatment operations.

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.

Investigation of Citizen Complaints

During the past two years, the DEP Bureau of Water Quality Control 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 Water Bureau staff time is devoted to responding to citizen concerns.

Enforcement of Water Quality Laws

The Division of Licensing and Enforcement is responsible for all formal enforcement actions taken by the Bureau of Water Quality Control. However, much of Maine's enforcement action on nonpoint source pollution is conducted by the Division of Enforcement and Field Services in the DEP, Bureau of Land Quality Control, the Maine LURC, and other agencies. In addition to formal enforcement actions, the enforcement section assists and confers with other divisions on violations which do not require formal action. These violations include untreated point source discharges and serious nonpoint discharges to both surface and ground waters. By fostering voluntary compliance with Maine's water pollution control laws, unnecessary litigation is avoided and the overall effectiveness of the enforcement program is maximized.

The general philosophy of the DEP, Bureau of Water Quality Control is to gain compliance and resolve problems at the lowest level appropriate, and to maximize the spirit of cooperation between the DEP and the regulated community. An important part of this approach is monthly Non-Compliance Review (NCR) meetings. At these meetings, specific compliance problems at licensed treatment facilities are discussed and a course of action is decided. 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 and has facilitated the referral of violations to the enforcement section. A similar but less formal line of communication exists for complaints, unlicensed discharges and other types of non-recurring violations. DEP enforcement priorities have generally been based on the size of violations, potential for environmental harm, recurrence of violations and precedents involved. This is illustrated by the relatively large proportion of enforcement actions involving large industries.

Chapter 2 - Nonpoint Source Pollution Control Program

Background

Guidance issued by EPA in July of 1987 states that "nonpoint source pollution is caused by diffuse sources that are not regulated as point sources and normally is associated with agricultural, silvicultural and urban runoff, runoff from construction activities, etc." Additional sources of nonpoint pollution in Maine include leaking underground storage tanks, landfills, accidental chemical spills, snow dumps, sand/salt piles and septic systems.

Maine's role in controlling nonpoint source pollution should be examined in the context of Section 319 of the CWA (part of the 1987 amendments). The Federal "Nonpoint Source Management Program" requires:

1. an identification of Maine waters which do not meet the requirements of their classification (38 MRSA, Article 4-A) due to nonpoint source pollution;
2. a description of the types of nonpoint pollution sources affecting water quality in Maine;
3. a description of current State, regional and local programs for the control of nonpoint source pollution;
4. a description of Maine's process for identifying Best Management Practices (BMPs);
5. a description of what actions for the control of nonpoint source pollution constitute BMPs in the State of Maine;
6. a schedule containing annual milestones for initiation of new programs and implementation of BMPs;
7. a certification by the attorney general of the State that the laws of the State provide adequate authority to implement such management program or, if there is not adequate authority, a list of such additional authorities as will be necessary to implement such management program and a schedule and commitment by the State to seek such additional authorities as expeditiously as practicable;
8. itemization of Federal, State and other funding sources (other than assistance provided under Section 319) which will be available for supporting implementation of BMPs; and,
9. additional administrative items.

The wide variety of activities which produce nonpoint source pollution combined with a vast network of governmental study, regulation and enforcement of the problem requires a coordinated effort that is both interagency and intergovernmental in nature. The Maine NPS Coordinator is located in the DEP, Bureau of Water Quality Control. To date, the NPS Coordinator's major task has been to coordinate the preparation of the assessment and management plan in accordance with the requirements of Section 319 of the CWA.

To aid in the preparation of these reports, the Coordinator formed a broad-based working group. The NPS Advisory Committee has representatives of DAFRR, DOC, DEP, DHS, DOT, DMR, SPO, Maine Soil and Water Conservation Commission; Maine Association of Conservation Districts; Maine Association of Regional Councils; the U.S. Geological Survey, the USDA Soil Conservation Service and the University of Maine Extension Service, and representatives from industry and citizen environmental organizations. The combined effort of various government agencies and interest groups, each knowledgeable about its own programs, enables the State to begin implementing a comprehensive program for the control of nonpoint source pollution.

As Maine develops programs to deal specifically with nonpoint source controls, it is essential for interagency communication to occur. Many programs are being consolidated where duplication exists or are being expanded to address initiatives outlined in the Maine NPS Management Plan. Funding for personnel can often be shared by State, regional and local agencies, to provide both an interagency liaison and a source of financial relief. The intergovernmental personnel agreement currently utilized by the DEP and the SCS is one such example. The Maine NPS Assessment defines the parameters of each governmental agency and highlights their common ground as well.

Following preparation of the Maine NPS Assessment Report, nonpoint source (NPS) pollution is now acknowledged to be a major source of water use impairment to Maine surface water and groundwater resources. The recently completed assessment on NPS pollution indicates that nonpoint-related impacts occur in every drainage basin in Maine. However, the types and extent of water quality problems associated with these sources of pollution vary considerably among basins.

The NPS Assessment further indicates that overall, the major causes of use impairment to surface water from nonpoint sources are siltation and turbidity, nutrients, and flow alteration. The major causes of groundwater contamination are pollutants originating from landfills, petroleum product storage or transport, and human waste disposal systems.

To respond to various NPS pollution problems in an orderly and effective manner over the next four fiscal years and beyond, management program objectives and action plans that increase the efficiency of federal and state nonpoint source controls have been developed. Within the Maine NPS Management Plan, achieving visible water quality improvement or protecting high-quality waters from degradation will be accomplished using one or a combination of six management initiatives: information and education, financial assistance, technical assistance, monitoring and evaluation, enforcement, and continued planning. Although the Maine program will utilize all six elements, initial program initiatives will focus on the information and education and technical assistance components to control NPS pollution. Future efforts will increasingly focus on enforcement actions based upon the relative threats of pollutants and the vulnerability of the water resource. Financial assistance, monitoring and evaluation components will be conducted as funds become available.

Following, is a discussions of current NPS related projects which have been developed to address NPS pollution problems in the state. Additional information is available in the Maine NPS Assessment Report and Management Plan.

Current 205(j)(5) Projects

Tasks presented in the 1990 205(j)(5) Workplan focus on the development of technical guidelines, public education documents, technical training and additional assessment efforts. These materials will be used in technical assistance efforts by the Bureau of Water Quality Control and other resource agencies and organizations. A focal point for these technical assistance activities will be the Maine Comprehensive Planning and Land Use Regulation Act of 1987. The DEP intends to supplement the technical assistance initiatives undertaken by the Department of Economic and Community Development (DECD), and other state and local agencies, in implementing the requirements of the Act.

Major components include:

1. development and publication of BMPs for each NPS category;

2. publication of a soil erosion and sedimentation control manual;

3. evaluation of septic systems and subsurface wastewater impacts on groundwater;

4. conduct NPS training for foresters in priority watersheds;

5. conduct landuse inventories in priority watersheds; and,

6. perform loading analysis for NPS pollution in Casco Bay.

Current 319 Projects

During January, 1990, DEP received approval from EPA on seven NPS projects. The projects, which focus on pollution prevention efforts in both threatened and impaired priority waterbodies, are described briefly below.

Casco Bay Project. Casco Bay is a high priority waterbody in Maine and has been nominated for inclusion in the National Marine Estuary Program. The project will: 1) provide direct technical assistance to municipalities implementing land use ordinances requiring BMPs; 2) increase compliance monitoring and enforcement actions: and 3) educate the public on the benefits of BMP utilization. Additional technical and enforcement staff will assist municipalities and land owners implementing BMPs. Public education efforts include publishing educational brochures and conducting five water quality workshops. One major goal is institutionalizing the NPS program in this watershed.

Sebago Lake Pollution Prevention Project. This project will address existing and potential nonpoint source pollution by helping the Portland Water District (PWD) supply technical assistance to watershed communities implementing land use ordinances, including BMPs for the control of NPS pollution. Over 3,000 landowners live in the shoreland zone (250') and Sebago Lake is the water supply for Maine's largest population center. This project will involve extensive interagency cooperation among PWD, DEP, SWCDs, RPCs and municipalities.

Kennebec County Project. This project will accelerate implementation of the nonpoint source pollution control program in Kennebec County, which has numerous waterbodies threatened and impaired by several types of nonpoint source pollution. Components of the project include: 1) providing an expert to assist municipalities and landowners with solid waste management, erosion and sedimentation control, and water quality planning and implementation activities; 2) implementing BMPs at China Lake as a demonstration project; 3) increasing the monitoring of targeted waterbodies; 4) developing, reviewing and adopting municipal ordinances; 5) digitizing soil, land use, zoning and topographical information; and, 6) providing information and coordinating public participation. A major focus will be on institutionalizing the NPS program to ensure long term benefits.

Rules and Regulations Development Project. This project will develop and implement rules and regulations for major NPS categories. Emphasis is on completing regulatory research, drafting, and adopting rules and regulations for pollution prevention in the categories of transportation facilities/support and chemical use and storage.

Forestry BMP Implementation Project. This project will implement a pollution prevention, enforcement and incentive program for use of BMPs in priority watersheds. Emphasis will be given to control of NPS pollution at the source. The project involves extensive interagency cooperation and involvement between state regulatory and planning agencies. Increased enforcement activities are targeted to specific waterbodies through additional technical and enforcement personnel, and incorporation of forestry BMPs into agency rules and regulations and local ordinances. Targeted waterbodies as well as the statewide program will benefit from the incentive program and proposed changes to rules, regulations and ordinances.

Nitrate Pollution from Subsurface Disposal Project. Although there is widespread use of numerous predictive models to calculate nitrate concentrations at downgradient site boundaries, very little monitoring data exists to verify the accuracy of those models. The 1989 Maine Groundwater Management Strategy identified the need to measure actual groundwater nitrate levels. This project will measure nitrate concentrations in domestic wells located in 26 unsewered residential developments to assess the impact of subsurface wastewater disposal systems on groundwater quality in relation to nitrate and evaluate the effectiveness of current surface wastewater disposal rules and regulations to protect drinking water quality.

BMP Performance Evaluation Project. The project will evaluate the performance of BMPs implemented in priority watersheds. Major NPS categories addressed include: development, agriculture and forestry. Specific tasks will include a literature search of all available related information and before and after demonstration projects on priority watershed(s) to measure changes in NPS pollutants following BMP installation.

Chapter 3 - Groundwater Protection Program

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

1. State interagency coordination of groundwater programs;

2. continuing development of the state groundwater strategy;

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

4. implementation of state groundwater strategy programs.

State Interagency Coordination of Groundwater Programs

Unlike the management of surface waters which is centered in the DEP Bureau of Water Quality Control, the management of groundwater quality in Maine is distributed among eight state agencies and 495 municipalities. To effectively coordinate these diverse interests in groundwater management, an Executive Order was issued in 1985 which established a Groundwater Standing Committee under the State Land and Water Resources Council. The Standing Committee is composed of the Commissioners of the DEP, DHS, DAFRR; the Director of the SPO; and representatives of the Maine Association of Regional Councils and the University of Maine Land and Water Resources Center. The Commissioner of DEP, is Chairman of the Standing Committee.

The Committee's Policy Subcommittee prioritizes groundwater management program requirements each year and schedules key activities that provide for increased protection and better management. The Policy Subcommittee develops and prioritizes draft groundwater legislation for each legislative session. The Standing Committee meets as necessary (at least quarterly) to discuss mechanisms for better interagency coordination of groundwater management programs.

The Maine Groundwater Strategy

Recognizing the multi-agency effort required to fulfill the requirements of the EPA State Groundwater Strategy development program, the Maine Groundwater Standing Committee is well suited to overall coordination of strategy development. The Standing Committee represents all Maine agencies active in groundwater management and directs the activities of the State Groundwater Coordinator. The Standing Committee's Policy Subcommittee has broadened the representation on the Standing Committee by including the director of the Maine Field Office of the USGS Water Resource Division, and the directors of the DEP,.Bureaus of Water Quality Control, Land Quality Control, Oil and Hazardous Materials Control and Solid Waste Management. The Standing Committee has completed the initial development of a Maine groundwater management strategy which was approved by the Governor on August 2, 1989 and accepted by the EPA on

September 6, 1989. This strategy will be updated each biennium and a new two-year action plan will be created as required by EPA.

Maine has made significant progress but still has much to accomplish regarding EPA groundwater strategy guidance. The Maine aquifer mapping program, groundwater standards, and enforcement provisions are established but poorly funded. The proposed classification system, monitoring, data collection and analysis, groundwater use, source control, and groundwater/surface water/natural resource coordination programs all require further development. The Standing Committee's Policy Subcommittee will be meeting frequently to further develop the Maine groundwater strategy. The next edition of the Strategy is expected in October 1990.

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

The Maine Groundwater Management Strategy details groundwater protection problems. The Maine Groundwater Coordinator keeps the EPA Groundwater Program Administrator for Maine fully informed of the progress of groundwater strategy implementation and further development. The EPA Groundwater Program Administrator for Maine is invited to all State Groundwater Policy Subcommittee meetings on strategy development and receives written reports on each strategy development meeting. The EPA directs suggestions and comments on the State Groundwater strategy or related groundwater protection programs to the Standing Committee directly or through the State Groundwater Coordinator. The State Groundwater Coordinator schedules any meetings that the EPA feels are necessary for assessment purposes. The EPA Groundwater Program Administrator for Maine receives The Water Tap monthly, detailing State program progress and State groundwater problems as well as State Legislative updates during Legislative sessions.

Most major groundwater threatening activities, such as underground storage tanks, sand-salt piles, and solid waste, 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 by septic systems and specific underground injections is needed. Studies to assess the groundwater impacts of fertilizers and septic systems are scheduled to begin in 1990. Studies to determine the impacts of agricultural pesticides are on-going. These assessments will be conducted in conjunction with the State Pesticide Management Strategy, the Nonpoint Source Pollution Control Program, and the Underground Injection Control Program respectively within the next two to five years.

Implementation of State Groundwater Strategy Programs

The Governor has designated the Groundwater Standing Committee to oversee and ensure implementation of the Maine Groundwater Management Strategy. Current program thrusts and the biennial development of two-year action plans have been discussed above.

Over the next five years, Maine groundwater protection efforts will significantly change and grow. Maine groundwater protection policy is completing a phase dominated by retroactive cleanup of pollution and entering a phase that will be dominated by prevention planning. The Maine implementation of groundwater programs is geared to this reality.

The majority of the effort to safely site and operate potential threatening activities will be assumed by local governments through the Wellhead Protection Program at DHS and the Comprehensive Planning Program at the DECD. The Maine Pesticide Management Strategy under development at the DAFRR will provide for monitoring and control of agricultural chemical use. DEP and MGS will continue to provide the groundwater research which serves as the basis for some of the groundwater protection initiatives in the State. DEP, Bureau of Water Quality Control will continue to focus its research on groundwater 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 groundwater quality through a combination of education and regulation. Public education to protect groundwater will become increasingly important in the future. DEP regulatory responsibilities will increase as many of the nonpoint source pollution activities impacting groundwater come under regulatory scrutiny.

Other agencies (DOT, LURC, DAFRR, DOC) will be responsible for groundwater protection by ensuring adoption of BMPs for their related activities that pose a threat to groundwater 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.

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 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, Sec. 413 and 414.

Chapter 4 - Cost/Benefit Analysis

The costs and benefits of Maine water pollution control programs are difficult to assess. During 1987, the DEP, Bureau of Water Quality Control converted historical expenditures for municipal wastewater treatment facilities into 1987 dollars to better gauge the cost of that one component of water pollution control. Through use of Gross National Product Implicit Price Deflators it was found that actual expenditures of $455,540,418 made between 1960 and 1986 for wastewater treatment facility construction is the equivalent of $991,594,528 in 1987 dollars.

In early 1986, Maine took a novel approach to assessing the results of its water quality management programs. A questionnaire was administered to 163 citizen volunteers who are members of the Regional Water Quality Advisory Committees. This approach seems appropriate in that "a favorable cost/benefit ratio" is just another way of saying that "the public's perception is that it was worth the cost." The following eight questions and their responses provide one water quality management cost/benefit assessment:

1) *Maine's water cleanup effort of the last 15 years has provided enough benefits to justify its cost.*

   Yes (76.2%) *No (5.5%)* *Don't know (18.4%)*

2) *Maine's water cleanup of the last 15 years has*

   a. Increased employment in my region (21.6%)
   b. Had no effect on employment in my region (32.4%)
   c. Decreased employment in my region (10.8%)
   d. Don't know (35.1%)

Maine's water cleanup efforts have made my region (better, unchanged or worse) for:

	Better	Unchanged	Worse
3) Farming	18.1%	67.6%	14.3%
4) Industry	19.4%	51.5%	29.1%
5) Logging	6.5%	61.3%	32.3%
6) Residence	72.0%	24.3%	3.7%
7) Small Business	27.6%	63.8%	8.6%
8) Tourism	74.3%	24.8%	1.0%

The cost for staffing and operating the DEP water program in State fiscal year 1989 was $2.76 million. Nearly $200,000 of that amount was awarded to other agencies or municipalities to carry out the objectives of the Maine water program. About half the operating budget comes from state general funds and half from federal grants.

The DEP administered various infrastructure improvement programs, most notably for the construction of wastewater treatment plants, that had a total of $28.6 million allocated for the completion of those projects ($20.8 million was from federal grants sources and $7.8 million from State sources).

Chapter 5 - Water Monitoring Program

Background

The sampling programs of the DEP Bureau of Water Quality Control are conducted to administer two sections of environmental law; 1) the Water Classification Program (38 MRSA, Article 4-A) and 2) Wastewater Discharges (38 MRSA Sections 413 to 414-A). Although the Bureau of Water Quality Control works under the authority of numerous other statutes and regulations, they can be considered as secondary and supportive of the Water Classification Program and Wastewater Discharge statutes.

The following description of the entire sampling program of the Bureau of Water Quality Control 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
   4. Trophic state (for lakes)
   5. Other parameters (e.g. priority pollutants at selected sites)

B. **Assimilative Capacity/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 lakeshed parameters.

D. **Tissue Monitoring**. Assessment of contamination levels in fish flesh for bioaccumulable metals and organics.

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 discharges licenses by sampling effluents.

B. **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 Bureau 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 Bureau ambient water quality monitoring program results in the following products:

1. a biennial report - 305(b) - to Congress and the Maine Legislature on what State waters are not attaining their classification;

2. recommendations on how wastewater discharges should be licensed;

3. special reports on what attainment impacts 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 which describe the suitability of various State waters for swimming and fishing.

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

Selection of Waterbodies To Be Sampled

Water quality is the cumulative result of several 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 28 serves as a guide for selection of which waters are to be sampled (high priority) and which waters are not to be sampled (low priority). These listings are not definitive and much is left to professional judgment.

Table 28. Priorities for Water Quality Sampling.

FRESH	MARINE
************************** HIGH PRIORITY **************************	
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 ************************	
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 prosed discharges and/or activities
3. Lakes with moderately vulnerable characteristics.	
************************** LOW PRIORITY **************************	
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 which ensure the validity of information generated. For the parameters of bacteria, dissolved oxygen (DO) and temperature, DEP uses the following types of sampling programs for rivers, streams and brooks:

1. **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 DO, temperature, bacteria and river stage.

a. **Assessment of Attainment for Bacterial Water Quality Standards**. To produce a valid assessment of attainment for recreational water quality criteria, a minimum of 12 samples collected between May 15 and September 30 at regular intervals (usually weekly) are required. The samples are then analyzed for Escherichia coli. Sampling for fecal coliform bacteria in Maine waters has been discontinued because of this lack of validity for assessing environmental quality of that parameter.

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 DO 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, DO samplings are scheduled for "worst case" conditions as regards DO levels. Sampling is focused on flows which approximate 7Q10 when available.

2. **Annual Assessment of Attainment**. This program results in a five year plan which identifies stations which should be sampled every year and other stations which should be sampled one year out of every five years. The stations which are sampled each year are referred to as The Maine Primary Monitoring Network (synonymous with what EPA refers to as a Fixed Station Network). Stations which 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 (total number of stations is about 1000 including discontinued ones). Stations in the Maine Primary Monitoring Network are located in major receiving waters, especially those which have documented water quality problems or which are suspected problems. The Maine Secondary Sampling Network consists of other high and medium priority stations which fit into an efficient sampling route and provide information on annual assessments of attainment provide the public with information on suitability for swimming and other aspects of water quality. Hence the procedures outlined in item (2), Assessment of Attainment for Bacterial Water Quality Standards are incorporated into this program. Because this program also serves as a double-check on license compliance for wastewater treatment plants, the parameters of DO, temperature, turbidity, etc. are also determined during some weeks at select stations.

3. **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 began in the early 1970s and used Surber

sampling to characterize the organisms present on river bottoms. Since 1981, however, the program has used artificial 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 biologically monitored by use of artificial substrates. 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.

Use of 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 if water quality "provides for the protection and propagation of fish...and wildlife."

4. **Assimilative Capacity Studies.** The Toxics and Permits Section of DEP Division of Environmental Evaluation and Lake Studies determines what license conditions are necessary to avoid problems due to toxicity or low dissolved oxygen (DO) levels.

   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 a two-tiered one.

   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 lower 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 by a license applicant must be approved as to method by the Toxics and Permits Section prior to initiation if 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 is 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.

Assimilative capacity studies are used in the following situations:

A. For rivers where DO 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 DO.

B. For rivers where a new BOD-containing discharge is proposed, the river is modeled to ensure that the new discharge will not violate the DO requirements of classification.

C. 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 DO requirements of classification.

An assimilative capacity study for DO 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 DO 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, DO 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 DO data collected during the second field survey. The model most often used is QUAL-2E. The modeling sometimes shows a need for additional data. This results in a third and, occasionally, a fourth field survey being done 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 for denying a permit for proposed activities but are more commonly used to formulate management options. Since one goal of water quality management is to attain classification, these management options may include actions such as effluent reduction or flow augmentation.

5. **Lake Monitoring.** The Lake Studies Section of the DEP Division of Environmental Evaluation and Lake Studies coordinates the monitoring program. The Maine lake monitoring program includes the following components:

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

Volunteers are trained and provided with equipment to sample transparency, and in some cases chlorophyll a and phosphorus, bi-weekly for five months during the open water season. The DEP conducts a more intensive survey of approximately one-third of the lakes in the program each year. This intensive sampling, known as baselining, is done on a rotating basis. Thus, each lake in the VMP is baselined once every three years. Additional sampling or deviation from this schedule depends on unexpected water quality problems and/or complaints. The 1989 baseline lake sampling program was greatly expanded to include approximately 95 lakes for which little or no water quality data existed. This represents a 20 percent increase in the number of Maine lakes with a water quality database. The purpose of the Voluntary Monitoring Program is two-fold. It provides data on a large number of lakes which is used to identify trends of improving or declining water quality. It also provides a unique opportunity for communication and education, since monitors often end up functioning as a liaison between the Lake Studies Section and the local lake community, keeping the DEP informed on local concerns and visa-versa.

In recent years the program included 200 to 250 monitors, but the quality of data received has been highly variable. In 1989, 51 percent of the 245 monitors provided complete sets of data while 21 percent provided no data at all. Largely because of the date quality problem, the goals of the program are undergoing change. The main goal of the program is now education and communication. Expansion of the program will be targeted in order to influence people associated with extremely or highly vulnerable lakes.

In 1990, a new reporting format will be used for reporting 1989 data back to monitors. The new format will include the addition of graphic analyses, making the report easier to understand and, hopefully, maintain the interest of monitors in the program. The DEP has also computerized the VMP mailing list and plans on using more personalized letters instead of the standard form letters now in use.

In 1990, the VMP will target lakes selected by the DEP Technical Assistance Unit and the Nonpoint Source Control Program. Additional lakes may be added to the targeted list in response to public opinion. The VMP is pursuing a 319 grant from the Maine NPS program to help implement several of the above mentioned plans.

B. Federal Clean Lakes (Section 314) Project Lakes

There are a number of currently active 314 projects in the State. They include Webber Pond (initiated in 1985), Cochnewagon Lake (initiated in 1986) and Threemile Pond (initiated in 1987). Lakes where 314 projects have been completed but where monitoring continues include, Sabattus Pond, Salmon Lake and Sebasticook Lake. All of these lakes are monitored intensively on a regular basis for transparency, chlorophyll, nutrients, dissolved oxygen, temperature, pH, alkalinity, and phytoplankton composition. Additional parameters are included in specific projects. Improvements in water quality have occurred on all lake restoration projects. The DEP has also secured a 314 grant for a lake protection project in the Long Lake (Bridgton) Watershed. This project will produce a 50-year management plan for in the watershed.

Madawaska Lake will be submitted for Phase I funding for 1990-91, while Three mile Pond will be submitted for Phase III funding. Madawaska Lake experienced an intense algal bloom for the first time in 1987. The bloom apparently commenced in early July and endured until the first of October. In 1988 another bloom appeared from mid-July until mid-September; while no bloom occurred in 1989, water quality is still considered to not be meeting state water quality standards. Land use is believed to be a major factor affecting the lake, including heavy shoreline development and large-scale clearcuts in the lakeshed.

Threemile Pond has experienced relatively high total phosphorus (20-35 ppb) and correspondingly high productivity. This included excessive algal growth (Chlorophyll-a Levels > 40-60 ppb) and algal scums over several years in the late 1970s and 1980s. In 1988 the pond was treated by using nutrient immobilization and nonpoint source reduction. Recent concerns about the adequacy of only one year of post-restoration monitoring, highlights the need for a long-term data base to assess treatment efficacy.

C. Diagnostic Study Lakes

Trends of declining water quality have been evident on several lakes in Maine, including China Lake, Togus Pond, Three Cornered Pond and Chickawaukie Lake. Diagnostic studies are being conducted on these lakes to determine the nature of their problems, external sources of phosphorus loading, the extent of internal loading and the feasibility of potential solutions. The vulnerability index, in combination with the volunteer monitoring program, has identified additional lakes with potential need of diagnostic analysis.

D. **Special Study Lakes**

The department monitors a number of lakes to provide answers to specific questions. For example, the DMR has a program to reestablish 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 wet ponds in the removal of phosphorus from agricultural run-off is currently being performed in Aroostook County. Long and Cross Lakes have historically received large amounts of high phosphorus run-off from agricultural lands. The current study entails monitoring run-off entering and exiting the wet ponds and determining efficiencies of phosphorus, organic matter, and TSS removal.

6. **Estuarine/Marine Monitoring.** Much of Maine sampling of salt waters is conducted by DMR. The bulk of the DMR sampling program is concerned with bacteria levels in shellfish propagation areas. Marine bacteriology is conducted in accordance with the protocols of the National Shellfish Sanitation Program to protect the 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. Bacteria sampling at selected swimming beaches and other marine areas is conducted by the DEP during the summer months. These beaches are sampled at least twelve times each year with samples analyzed by the enterococci technique.

   Sampling for dissolved oxygen, conductivity and temperature has determined that dissolved oxygen levels are very near the saturation point in most of Maine's near shore waters. Where DO depression has been documented (usually in harbors with restricted water circulation) monitoring for dissolved oxygen, salinity and temperature is conducted by DEP during the summer months.

7. **Groundwater Monitoring**. As elsewhere, Maine monitoring of groundwater 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. Groundwater 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 Water Quality Control, Land Quality Control and Oil and Hazardous Material Control, the DOT, Well Claims Unit, the DHS, Division of Health Engineering, the DHS, Environmental Health Unit and DARFF, Board of Pesticide Control. The data is stored on paper or in computer files. Much of this data is 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 groundwater 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 groundwater quality or quantity. Such monitoring is generally carried out by the MGS and the U.S. Geological Survey (USGS) under one or another of several cooperative agreements. USGS maintains a statewide network of groundwater observation wells to track changes in water quality and quantity. The data thus derived is incorporated into the maps and reports generated by the program and have proven invaluable to town planning boards and other State efforts such as the registration of underground oil storage tanks and site reviews of various land use proposals.

Within the DEP, groundwater data is obtained by sampling done either by Department staff, permit-holders or as the result of enforcement agreements. The Bureau of Land Quality Control generally requires operators of landfills to sample groundwater and report their findings to the DEP on a periodic basis. Similarly the DEP Bureau of Oil and Hazardous Materials (BOHMC) requires periodic sampling and reporting various businesses or industries classified as hazardous waste storage facilities or under the terms of enforcement agreements. This data is generally conducted in commercial laboratories according to EPA standards. BOHMC field staff sample groundwater to determine groundwater quality impacts associated with uncontrolled hazardous waste sites, oil or fuel spills from stationary or mobile sources and approved hazardous waste or hazardous materials storage facilities. Some BOHMC groundwater monitoring is intended to help locate new water supplies to replace those polluted by gasoline.

Chapter 6 - Special State Concerns/Recommendations

Maine is faced with a variety of issues that affect water quality. The purpose of this section is to highlight these issues. Following are brief summaries of these issues and the present status of efforts to address these issues.

Growth Management

Maine is presently experiencing a dramatic increase in residential/recreational related development. Much of this development is focused towards its water resources - ocean, lake, and river frontage. A significant challenge to the State will be management of this growth such that the water resources of the State are protected. Growth management statutes have been recently enacted to deal with this problem. DEP has entered into several projects related to effects of growth in lake watersheds.

Dioxin

Sampling in 1984 as part of the National Dioxin Survey detected significant levels of dioxin in several Maine rivers. Subsequent sampling has identified numerous sources of dioxin, including the pulp and paper and leather tanning industries. Fish tissue sampling has established that a significant level of contamination exists and an advisory on consumption is in effect for the Androscoggin River, Presumpscot River, Kennebec River, Penobscot River and West Branch of the Sebasticook River. In 1989, the Legislature established a dioxin monitoring program requiring the DEP to collect quarterly sludge and annual fish tissue samples from selected waters.

Aesthetic Quality Problems

In 1987, the Department conducted public hearings as part of the water classification process. At these hearings, substantial testimony was received stating the State had achieved excellent improvements in water quality in recent years but that the public was still reluctant to use the Androscoggin River due to a variety of aesthetic problems. In particular, the public found the amount of color, foam, turbidity and odor in certain waters to be objectionable. The sources of these problems are pulp and paper manufacturing and combined sewer overflows. In January of 1988, the Governor directed the Board of Environmental Protection to investigate these issues and prepare recommendations to alleviate the problems so that uses are not impaired. That study was completed and draft legislation is now pending.

Mining

The recent discovery of relatively rich metal ore deposits, notably copper, zinc and silver, in Northern and Western Maine has led to efforts by the DEP to investigate the potential water quality impacts associated with metal mining operations. Many of these ore deposits are sited in Class A watersheds where State law requires businesses to comply with the ultimate goals of the CWA and discharge no pollutants to public waters. A challenge facing Maine in the near future, in mining and other development possibilities, is reconciling the State's needs for clean water and economic development.

Water Supply

Rapidly growing populations in Southern and Coastal Maine have placed increasing pressure on ground and surface supplies and accelerated the search for alternatives to existing sources as well as additional supplies. This pressure comes at a time when it is being discovered that there is less water available than previously believed, mostly due to groundwater contamination. Although some states have been gravely concerned with water quantity from their beginnings, Maine, with its abundant water resources, has only recently faced this issue. It is anticipated that growing concern over water quantity will serve to enhance concern over protecting water quality.

Recommendations

Decisive, positive action by the people of Maine is needed to effectively manage water resources for the future. Polluted waters must be cleansed and future water quality problems prevented. It is far less expensive to prevent pollution of the environment than to repair the consequences of neglect.

The task of managing water resources is formidable, and cannot be done by a few state agencies or special interest groups. It requires the input of an informed, committed public.

During the summer of 1989, DEP conducted ten public meetings and distributed 5,200 surveys to Maine people to get their input on how Maine waters should be managed and protected. This public process began the formulation of the Maine Clean Water Strategy.

Two common threads connected the issues raised as a result of the public participation process in the Clean Water Strategy. These two ideas were: 1) the importance of all water resources, and 2) the need for local involvement and consideration in the use of water resources.

Responses at the hearings and to the questionnaires indicated the people of Maine consider all water resources equally valuable. Workshop participants repeatedly stated one water body should not be prioritized at the expense of others, and that the problems of all water bodies should be addressed equally.

Five central issues and numerous program specific issues were emphasized at the public workshops and on many questionnaires. 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.

The following recommendations are proposed in response to those issues and needs:

1. Maine, and especially DEP should increase and improve activities to educate the public and directly involve everyone in managing water resources. Those activities should involve state, regional and local governments, and schools.

   This should be done by establishing a central clearing house for the dissemination of information on water quality issues, developing an environmental curriculum for Maine schools, and by better informing Maine people of water quality issues through more frequent meetings and periodic newsletters.

2. State government must provide technical assistance to municipalities in order to adequately protect surface and ground

water resources of Maine. This may be accomplished by developing the capability to provide local technical assistance through the creation of regional watershed districts and DEP devoting more staff to technical assistance activities.

3. State and local regulatory agencies should increase enforcement actions against violators of environmental laws. Monetary penalties collected for violations should be able to be used to better the environmental. Additionally, a greater public awareness of environmental issues will increase voluntary compliance.

4. More information is needed on the quality of water locally. People want greater involvement in collecting ambient water quality monitoring data.

   The increased knowledge of ambient water quality should allow local citizens to better target their government's efforts to improve water quality. A more informed citizenry will identify and eliminate many water quality problems at the local level, without involving federal or state officials.

   State agencies must provide more information to Maine people on the quality of their waters.

   DEP will submit water quality reports to municipal officials on a biennial basis and will annually consult with towns prior to developing and implementing ambient water quality monitoring programs to determine where and what sampling is needed.

5. Maine must devote more resources to improving coastal environment. Increased state water quality management plans, described in two reports: "Maine's Marine Environment, A Plan for Protection," and "Casco Bay, Agenda for Action," call for increased monitoring of coastal waters and enforcement of environmental laws.

   DEP should examine the extent and effect of chemical contaminants on marine and estuarine ecosystems.

   DEP should develop methods to determine compliance with the biological water quality standards of the classification system.

   DEP and other agencies should examine the effects of new coastal activities such as aquaculture.

   The Governor should seek to establish Casco Bay as a designated Nationally Significant Estuary under Section 320 of Federal Water Quality Act.

   The Department of Marine Resources should identify affected shellfish areas and other resources affected by contamination.

   Pump out facilities should be provided for recreational boats where possible.

DEP should provide education on marine pollution issues, sources of contamination, and how they can diminish the value of the marine environment.

6. DEP must educate the public on the damage caused by poor planning and development, and coordinate thorough review of developments within the jurisdiction of the Department.

   DEP should develop a public education program modeled after the lakes program to make the public, particularly local officials, aware of the value and vulnerability of small brooks, streams, and wetlands.

   DEP and other agencies and municipalities should develop appropriate regulations to protect habitat, and provide review services for proposed development.

   DEP should develop a pilot project for habitat restoration on one or two small watercourses to demonstrate feasibility of restoration practices.