This contains the entire document of the Comprehensive Conservation and Management Plan for Narragansett Bay, December 1992.

The report can be downloaded from:

http://www.epa.gov/owow/estuaries/ccmp/documents/*narragansettbay_ccmp.pdf*

File 1 of 1

December 1992

Jessica Cogan

ABSTRACT

TITLE:	Comprehensive Conservation and Management Plan for Narragansett Bay
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ABSTRACT: This document sets forth goals and implementation strategies to improve and sustain the health of Narragansett Bay. It is the culmination of six years of research and review of the issues by scientists, planners, interest groups, and legal experts, an endeavor funded by the U.S. Environmental Protection Agency and overseen by an Executive Committee of directors of Environmental Management, the Coastal Resources Management Council, the R.I. Division of Planning, and the Water Quality Branch of USEPA Region I.

The Plan has six distinct but interrelated parts: an Introduction, establishing the need for the Plan, the history of the Narragansett Bay Project, and the process of Plan development; Background, describing "the state of the Bay"; Goals; Issues, Objectives, and Strategies; information on Plan Implementation, including unfinished agenda; and Summary Matrices. These are followed by an extensive Bibliography and Appendices.

DEDICATION

"If we have seen further, it is by
standing upon the shoulders of giants."

Paraphrased fr. Sir Isaac Newton

The first edition of the Narragansett Bay *Comprehensive Conservation and Management Plan* (1992) is dedicated to Senator John Chafee, Mr. Robert L. Bendick, Jr., Ms. Gertrude "Trudy" Coxe and Mr. Michael Deland who were instrumental in founding the Narragansett Bay Project. These individuals should be credited for recognizing that the nation's inheritance in its coastal waters ultimately depends upon the nation's ability to comprehend the relationship between estuaries and the land, and the durability of the public - private partnership to steward the use of coastal resources for the next generation.

The staff of the Narragansett Bay Project also extends its deepest appreciation and thanks to Mr. Daniel W. Varin, Ms. Louise Durfee, Mr. Malcolm J. Grant and Mr. James W. Fester for their counsel and perseverance; the staffs of the Rhode Island Department of Environmental Management, the Rhode Island Coastal Resources Management Council, and the Rhode Island Division of Planning, who labored on the Narragansett Bay Plan knowing they were to be its custodians; the Project's Committees for keeping their eyes on the prize; friends and supporters of the planning process; and the generations of citizens that must now take the lead in protecting Narragansett Bay.

THE STATE OF RHODE ISLAND
AND
PROVIDENCE PLANTATIONS
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STATE PLANNING COUNCIL
Policy Statement on Implementation of the Comprehensive Conservation and Management Plan for Narragansett Bay

The state recognizes the need for all levels of government and the private sector to cooperate in implementing the recommendations of this plan. The benefits of a clean Bay are important to federal, state, and local governments alike. Each level has a role in striving toward the goals of the plan. It is important to recognize that many recommendations are already required by state or federal law, such as the Clean Water Act. In such cases, the state is limited in its ability to reassign responsibility for recommended actions.

Local role

what does this imply?

Local governments are properly assigned to carry out many recommendations of the plan. However, in plan implementation decisions, the state shall not assign responsibilities disproportionately to local governments, who are least able in terms of financial and other resources to support new efforts. The state shall provide cities and towns with financial and technical assistance, where possible, to implement recommendations of the plan and shall attempt to secure assistance from federal agencies also, where appropriate. No city or town shall be held solely responsible for accomplishing recommendations, in the absence of equitably proportioned federal or state assistance, if these actions are not otherwise required by federal or state law and would impose a severe and unreasonable burden as determined by state officials. In determining consistency of a local comprehensive plan with the State Guide Plan, the state shall recognize that goals represent ideals rather than immediately achievable objectives, and shall take into account the reasonableness of expecting local governments to implement State Guide Plan recommendations. The state shall recognize the different scale and responsibilities of local government; limitations on their authority, capacity, and ability to pay; and competing demands for resources. Local plans shall be found inconsistent with the State Guide Plan only where they:

shouldn't that have been considered in drafting CCMP

- directly conflict with goals, policies, or recommendations;
- use erroneous data or incompatible forecasts to justify different goals, policies, or recommendations; or
- fail to include or recognize state goals, policies, or recommendations when it is appropriate and feasible to do so.

Federal role

The federal government should also be committed to help implement the plan. The state shall notify the Rhode Island Congressional delegation of the financial enormity of some of the actions called for in the plan, and shall request funding to assist with plan implementation.

Role of Massachusetts

Rhode Island shall work with Massachusetts to assure that many of the actions proposed in the plan are pursued. Sixty percent of the Narragansett Bay watershed lies in Massachusetts. Efforts of the two states must be coordinated so that resources are used most efficiently.

Role of industry

In future implementation activities, the state shall emphasize communication with industries. Industrial users of the Bay must be given an idea of what is reasonably expected of them, in terms of taxes, fees, and regulations. Industries are already concerned about the business climate and competitive disadvantages; they need to be reassured about the plan's long-run economic benefits and recognition of economic development needs. Continued participation and support from industry are essential to the success of the plan. The state shall advocate that the federal government implement a low-interest loan program tailored to assist industries in upgrading to best-available wastewater treatment technology.

Role of the public

People whose activities affect the Bay can often prevent pollution problems, so that costly cleanup or regulatory programs are unnecessary. Public education programs are crucial; for example, in how to maintain septic systems, care for lawns and gardens, and dispose of boat wastes.

The CCMP is intended to be a working guide to future actions that will preserve and restore Narragansett Bay. It calls for agencies, industry, interest groups, and the public to continue the planning process: completing unfinished studies, developing new recommendations, monitoring progress, and revising old recommendations and priorities as conditions change. This should be a living, useful plan that builds on past collective efforts and maintains the momentum of achieving the goals for Narragansett Bay.

PREFACE

Narragansett Bay is arguably the best-studied estuary in the United States, but until now has lacked a single, Bay-wide blueprint for improving its health and sustaining it for generations to come. The purpose of this *Comprehensive Conservation and Management Plan* (CCMP) is to provide that blueprint, after examining and assessing problem areas and possible solutions.

Toward that end, the authors of the CCMP evaluated potential and existing mechanisms for implementing the Plan's recommendations, making suggestions for expanding regulatory responsibilities as well as planning horizons. Authors of the reports and briefing papers that contributed to the Plan are listed in Appendix C; Bay Project staff are shown in Appendix B.

It was left to the Bay Project Management Committee to resolve any conflicts through exhaustive consensus building and principled compromise, a process that was truly remarkable considering the scope of the Project, the volumes of scientific material to be considered, and the many competing and at times contentious uses of the Bay as natural resource, recreational site, fishing ground, and receiving water. The names of the individuals who served on the Management Committee and performed that unenviable task are also listed in Appendix B. Chaired by Malcolm J. Grant, Associate Director of the R.I. Department of Environmental Management, they deserve special recognition for bringing the Plan into being, and will continue to merit recognition as they help bring the Plan into full implementation.

Likewise is credit due members of the Bay Project staff who conducted an extensive program of public outreach and education. Many issues were brought to the Management Committee and addressed as a result of that outreach. This endeavor was spearheaded by Caroline A. Karp, Esq., Project Manager, and Judith E. Korch, Communications Coordinator. Ms. Karp spoke before many different audiences, answering questions and soliciting advice and support for the Project, while Ms. Korch edited an excellent newsletter explaining Bay management issues and how the Project intended to address them. Assistance from the staff of Planners Collaborative, Inc., must also be mentioned.

Because the CCMP was written as an element of the State Guide Plan, certain background information and recommendations in the "Briefing Papers" prepared for the Management Committee had to be digested and re-presented in language appropriate for the Guide Plan. Bruce F. Vild, Principal Planner, of the R.I. Division of Planning, was responsible for that task, working under the direction of Susan P. Morrison, Chief of Systems Planning, and John P. O'Brien,

Supervising Planner. Mr. Vild wrote, edited, and reworked several drafts of Parts 03, 04, and 05, along with the Bibliography and this modest Preface, under Task 209 of the Division's Work Program.

The final revisions to the Plan, representing the consensus of the Bay Project Management Committee, Bay Project Executive Committee, and the State Planning Council, were done by Richard C. Ribb, Environmental Policy Analyst, of the Bay Project staff. The CCMP as the reader sees it now is the product of his editorial work.

The process of developing the Plan is further described in Part 715-01, Introduction.

The Plan is organized in a straightforward way, continuing with Parts 715-02, background; 03, goals; 04, analysis of issues and strategies; 05, implementation; and 06, summary of recommendations and costs. A 24-page Executive Summary appears at the beginning of the Plan.

Funding and guidance for the Narragansett Bay Project were provided by the U.S. Environmental Protection Agency.

The State Planning Council adopted the CCMP as an element of the State Guide Plan on October 8, 1992, and made a few revisions on December 10, 1992.

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EXECUTIVE SUMMARY

INTRODUCTION

The Narragansett Bay *Comprehensive Conservation and Management Plan* (*CCMP*) represents the culmination of a unique experiment in environmental policy-making. Over a period of seven years (1985 to 1992), more than 100 people representing 45 federal, state, and local government agencies, universities, marine trade organizations, environmental advocacy groups, industry, and land development interests met under the aegis of the Narragansett Bay Project (NBP), a member of the U.S. Environmental Protection Agency's (EPA) National Estuary Program, to consider the future of Narragansett Bay and the Narragansett Bay basin.

The NBP's specific mandate under Section 320 of the federal Clean Water Act was to "...recommend priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected." In order to satisfy this broad charge, the Bay Project's governing committees directed the completion of over 100 peer-reviewed scientific and policy studies that focused on the following identified issues of concern:

- Impacts of toxic pollutants,
- Impacts of nutrients and eutrophication,
- Land-based impacts on water and habitat quality,
- Health and abundance of living resources,
- Fisheries management,
- Health risk to consumers of seafood, and
- Environmental impacts on commercial and recreational uses of Narragansett Bay.

These studies provided the NBP's governing committees with an objective basis to determine the relative significance of problems confronting the Bay basin in terms of environmental impacts and impairment of water quality-dependent uses of the Bay, *e.g.*, shellfish harvesting. These studies, in combination with NBP briefing papers also provided a starting point for recommending specific actions to protect and restore Narragansett Bay. [See Appendix C for a complete list of NBP publications.]

BACKGROUND: DESCRIPTION OF THE PROBLEM

In many respects, Narragansett Bay is the "Everyman" of American estuaries. Major urban and industrial centers developed along the major rivers tributary to the Bay to take advantage of water supply and easy access to foreign markets from protected deep water ports. As the cities flourished and the region's economic base and transportation options diversified, the population sprawled along the adjacent coastline—accompanied by commercial development and public infrastructure such as roads, public water supplies, and sewers. The Bay's resulting economic importance to the region is clear—in 1989 dollars, the Bay generated almost $2.5 billion in revenues for the State of Rhode Island based on direct exploitation of Bay fisheries, tourism, marine-related industry, marine research and education, and U.S. Navy-related activities. Narragansett Bay's water and habitat quality reflects its urban history and recent suburban pattern of development, as well as the multiple demands placed on it by its citizens.

This history of environmental degradation in the Bay basin can largely be explained by four "universal" attributes of the Narragansett Bay system which continue to affect the pollutants generated in the Bay basin, and the environmental fate of those pollutants in Narragansett Bay. The first attribute is the geography of the Narragansett Bay watershed. The second attribute is population density within the Bay basin; the third is population distribution within the basin;

and the fourth is the trend in population growth and distribution.

The Bay watershed—or the land area that ultimately drains water (and entrained pollutants) to Narragansett Bay—is over ten times larger than the surface area of the Bay itself, and extends well into the Commonwealth of Massachusetts. In fact, 60 percent of the Bay basin lies within the Commonwealth up to the headwaters of the Blackstone and Taunton Rivers, and 67 of the 100 cities and towns in the Bay basin are in Massachusetts. This geographic and political reality is significant because land use and environmental policies throughout the basin ultimately affect Narragansett Bay. For example, a governmental decision to divert water from a Bay tributary for ultimate discharge to another drainage basin reduces the flow in the Bay tributary, thereby affecting the quality of riverine habitat, and reducing the net flow to Narragansett Bay.

Population density within the Bay basin affects both the volumes of water use and ultimate wastewater discharge. Based on the 1980 census, the Narragansett Bay watershed is one of the most densely populated estuarine systems in the country with a population of 1.8 million people—887,863 in Rhode Island and 949,465 in Massachusetts—and an overall density of 1,109 people per square mile compared to a national average of 64 people per square mile. Most of the wastewater flow generated in the basin is treated by one of the 33 wastewater treatment facilities in the basin, although 12 Rhode Island communities are completely unsewered as are several in Massachusetts. Since the population continues to be concentrated in the metropolitan areas of Providence, Rhode Island, and Worcester and Fall River, Massachusetts, the largest volumes of wastewater enter Narragansett Bay at the mouths of the Blackstone, Pawtuxet, Providence-Seekonk, and Taunton Rivers.

Population distribution and land use within the basin also strongly affect the environmental quality of Narragansett Bay. The region's industrial and manufacturing core coincides with the major urban areas in the Blackstone-Providence and Taunton River basins. As a result, the largest volumes of industrial wastewater, and industrial-derived toxic pollutants, also enter Narragansett Bay at the mouths of the Blackstone, Pawtuxet, Providence and Taunton Rivers, and decrease along a down-Bay gradient toward Rhode Island Sound. However, domestic wastewater and point and nonpoint source pollutants generated by commercial, industrial, agricultural, construction and municipal activities in other communities in the basin also enter the Bay in proportion to local population density and land use patterns.

Although the Bay pollution gradient follows the Providence River-Rhode Island Sound axis and matches the history of the basin, projected changes in population growth and population density suggest that a different type and pattern of pollution problem may emerge in the future. The Rhode Island Division of Planning (RIDOP) has projected an average 20 percent growth rate for Rhode Island's suburban and rural communities between 1985 and 2010, compared to a 2.6 percent growth rate in the state's cities, and a statewide growth rate of 9.5 percent. Although 69 percent of the state's population already lives in a coastal city or town, coastal communities are expected to grow more rapidly than the state averages. In addition, based on the projected rate and distribution of growth, the RIDOP estimates that 88 percent of the developable lands in Rhode Island could be fully developed by 2010. (Note: Local zoning ordinances in effect in 1979 would authorize development of 95.5 percent of Rhode Island lands under local jurisdiction.) If this trend toward suburbanization and development of rural areas continues or accelerates, there will be profound consequences for the region's wastewater and waste disposal infrastructure related to increased population. There will also be detrimental consequences for the region's natural resources and remnant critical areas related to habitat loss and degradation.

(The major human impacts on Narragansett Bay are described below and summarized in Table I by geographic region.)

SEWAGE

Human sewage represents the most ubiquitous and overriding pollution problem in the Narragansett Bay basin. Based on 1990 census figures for Rhode Island and Massachusetts and per capita estimates of water use, over 125 million gallons of wastewater carrying a mixture of sanitary and household wastes are discharged each day to municipal wastewater treatment facilities (WWTF) and on-site sewage disposal systems (OSDS) in the basin. The majority of this wastestream receives some level of treatment and disinfection prior to discharge to the Bay and its tributaries. However, 37 percent of Rhode Island's population depends upon OSDSs to treat residential and commercial wastes. In addition, over 100 combined sewer overflows (CSO) in the Providence River region and the City of Fall River discharge a mixture of untreated sewage and stormwater to the Bay after rain events. As a result, multiple sources of untreated and partially treated sewage continue to discharge to the Bay—almost 100 years after the risks associated with human exposure to water-borne bacteria and viruses were first described.

All 33 WWTFs in the basin use chlorine disinfection which is relatively effective at killing bacteria but ineffective at killing viruses, including potential human pathogens responsible for causing illnesses such as polio, hepatitis, and gastroenteritis. On the one hand, cholera, typhoid, polio and infectious hepatitis appear to be water-borne diseases of the past in the northeast because of improvements in sanitary conditions, medical advances, improvements in wastewater treatment, and the development of bacteriological standards governing the certification of Bay waters for commercial and recreational use. However, sewage discharges to Narragansett Bay and its tributaries continue to pose a threat to public health and water quality-dependent uses of Bay waters such as swimming and shellfish harvesting.

At the present time, 40 percent of Narragansett Bay is permanently or conditionally closed to shellfish harvesting because of actual or suspected contamination from sewage-derived bacteria and viruses. The Providence River and Mount Hope Bay have been permanently closed to shellfish harvesting since the 1940s, and upper Narragansett Bay is routinely closed following rain storms because of CSO discharges of untreated sewage. Perhaps more disturbingly, however, all the closures of recent years have occurred in suburban areas such as the Narrow and Kickemuit Rivers, Point Judith Pond, and the coves surrounding Greenwich Bay—all as a result of actual or suspected evidence of sewage contamination from septic systems, storm drains and boats. Several bathing beaches in upper Narragansett Bay are also closed because of sewage contamination, and a number of coves and embayments—including the Pawtuxet, Providence, Seekonk, Kickemuit, Cole and Lees Rivers; Greenwich, Apponaug and Warwick Coves; and portions of Mount Hope Bay—suffer from seasonal dissolved oxygen depletion, algal blooms and occasional fish kills related to organic loadings from sanitary wastewater inputs.

In urban areas, point sources, including WWTFs, WWTF bypasses and CSOs represent the major sources of human fecal waste. The CSOs are also a major source of floatable human wastes, which foul the coastline and aesthetically limit use of the shore. In suburban and developing coastal areas, the major sources of human fecal wastes include failed and failing OSDSs, illegal sewer cross-connections to storm drains, and improper sewage discharges from vessels.

Although the population in the basin has grown and will continue to grow, sewage contamination represents a largely unnecessary public health and environmental risk given the treatment, disposal and disinfection technologies that are currently available. The region's failure to more carefully manage and abate the discharge of untreated human sanitary wastes will inevitably result in additional closures of shellfish harvesting areas, overall environmental degradation, and economic losses related to further limitations on water quality-dependent uses of the Bay. Therefore, public investment in more effec-

tive WWTF disinfection technologies and CSO abatement should be the highest priorities in urban areas of the Bay basin. The highest priority in suburbanizing areas and rural areas of the basin should be the implementation of more effective controls on the location, density and use of OSDSs in order to manage the incremental, cumulative impacts of population growth and land development on receiving water quality.

TOXIC POLLUTANTS

The Providence-Worcester corridor along the Blackstone River is acknowledged as the birthplace of the Industrial Revolution in the United States, and upper Narragansett Bay continues to reflect this heritage. Significant areas of the Providence River and its major tributaries, including the Blackstone, Pawtuxet, Woonasquatucket, Moshassuck and Ten Mile Rivers, continue to exceed federal and state water quality standards designed to protect aquatic life from exposure to toxic pollutants. Other less urban areas of the Bay, including parts of Portsmouth and Newport Harbor, Greenwich Bay and Mount Hope Bay, also show evidence of significant metals contamination although not in violation of federal and state standards.

Industry has historically been the largest source of toxic pollutant discharges to Narragansett Bay. However, federal, state, local and industry initiatives undertaken pursuant to the federal Clean Water Act have resulted in significant reductions in industrial pollutant loadings since the 1970s. As a result, non-industrial sources such as commercial and household toxic and hazardous wastes, motor vehicle emissions and leaks, and urban and highway runoff are increasingly significant sources of contamination throughout the Bay basin. In addition, suburbanization and diffusion of commercial growth away from existing industrial centers, combined with the emergence of new industries with "exotic" waste characteristics, have resulted in new sources and types of surface and groundwater contamination in developing areas of the Bay basin.

The levels of measured toxic pollutants in Bay waters do not pose an immediate public health risk, in part because the most severely contaminated areas are already closed to fish and shellfish harvesting due to sewage contamination. However, the presence and persistence of toxic pollutants in the environment contribute to habitat degradation, reduced fitness of aquatic organisms, and an unnecessary additive public health risk for some consumers of seafood harvested from the Providence River region. Elevated toxic pollutant levels in municipal sewage sludge and septage also limit the region's ability to consider alternative disposal methods such as agricultural or residential use of composted solid wastes. In addition, the presence of contaminated sediments in the Providence River basin and other commercially important ports and harbors complicates decision making about dredging to support navigation and boating activity. Unless a concerted effort is made to reduce domestic, commercial, industrial, urban and agricultural use and disposal of toxic pollutants, citizens of Rhode Island and Massachusetts should expect to see limited water quality improvements related to continuing source reduction efforts by industry.

LIVING RESOURCES

Many federal and state agencies with jurisdiction in Rhode Island and Massachusetts have programs to protect discrete elements of the Bay ecosystem. For example, the Rhode Island Department of Environmental Management (RIDEM) and the Coastal Resources Management Council (CRMC) have programs to protect drinking water supplies, tidal and non-tidal wetlands, barrier beaches, commercially harvested species, and state and federally-listed threatened and endangered species. However, these programs are not adequately coordinated to effectively protect water supply recharge areas, upland riparian corridors, intertidal and subtidal habitats, or key breeding, nursery and foraging habitats. Nor are they effectively coordinated to preserve unique, ecologically important, or remnant natural resources or populations.

Both Rhode Island and Massachusetts have experienced declines and collapses of important fisheries in recent years. Rhode Island, for example, recently imposed a moratorium on commercial and recreational harvesting of winter flounder in Narragansett Bay, Little Narragansett Bay, and the coastal salt ponds in order to allow the native winter flounder population to recover from overfishing. Other historically important fisheries such as the oyster, bay scallop, soft shell clam, Atlantic salmon, shad, menhaden, tautog, and windowpane flounder have experienced similar declines due to overfishing, physical obstruction of river flow and drainage, destruction of key subtidal habitats, and pollution. In addition, apart from the states' efforts to protect state and federally-listed threatened and endangered species, little governmental attention has been paid to protecting non-commercially important species or their associated habitats.

A concerted regional effort will be necessary to effectively manage (and sustain) commercial and recreational harvests of indigenous fisheries. In addition, land use controls and land acquisition efforts within Rhode Island and Massachusetts should be coordinated to focus on critical areas threatened by suburbanization and rural development in order to protect or restore remnant critical habitats for native plants and animals, as well as to protect human use and enjoyment of these resources. The region's failure to regulate the use of its natural resources will continue the present cycle of collapsed fisheries and economic hardship for the fishing community. The region's failure to regulate the development of its critical areas will ultimately result in the loss of biological diversity, sustainable ecosystem function, and human use and enjoyment of these resources.

PROGRESS TO DATE AND THE UNFINISHED AGENDA

A great deal of progress has been made in spite of this picture. Data compiled by the NBP suggest that programs initiated under the federal Clean Water Act, such as mandatory secondary sewage treatment, the industrial pretreatment program, and the phase-out of leaded gasoline, have measurably improved dissolved oxygen concentrations and reduced toxic pollutant loadings to Narragansett Bay. The most significant evidence of the environmental benefit of this investment can be seen in the Providence River. Recent state initiatives such as mandatory recycling and toxics' source reduction programs are expected to further reduce pollutant inputs. Rhode Island's open space acquisition program and its recent moratorium on winter flounder fishing also represent important initiatives with respect to protection of critical resources, and establishing modern principles of resource management.

However, a virtual revolution in land management philosophy and practice will be required to deal with the incremental degradation of water quality related to population growth in the Bay basin. Coastal towns in the Narragansett Bay basin have experienced dramatic population growth and development since the 1970s. The Town of Narragansett, for example, tripled its population between 1960 and 1990 and the Town of East Greenwich essentially doubled over the same period. As a result, many of the developing communities fronting Narragansett Bay lack the necessary infrastructure, *e.g.*, public water and sewers, to cope with the consequences of this rate of growth. Since demographic projections indicate that future growth will continue to concentrate in rural and suburban areas, many of which are unsewered, the population's dependency upon OSDSs will also increase. The environmental consequences of failing to effectively manage population growth are readily observable in terms of increasing restrictions on shellfish harvesting in the vicinity of intensively developing residential areas and crowded harbors, increased fouling of the shore by floatable human wastes, and the increased incidence and geographic extent of seasonal low oxygen problems, algal blooms and fish kills.

Without effective land use controls, the trend toward suburbanization and dispersion of the population to currently undeveloped areas of the Bay basin will also result in the physical

loss of remaining unprotected natural habitats. In addition, the unregulated development of open space within the watershed—including deforestation and encroachment on wetlands—can also disrupt the natural hydrological cycle, increase stormwater runoff, promote erosion, and result in new point and nonpoint sources of pollution. Evidence of these effects already exists. For example, the RIDOP reported a 15 percent decrease in the acreage of forested lands between 1982 and 1988 associated with the recent development boom, and the U.S. Department of Agriculture Soil Conservation Service (USDA SCS) estimates that over 100,000 tons of sediment are washed into the Bay and its tributaries each year as the result of unregulated runoff from construction sites, road surfaces, and agricultural lands. In addition, the RIDEM estimates that, as of 1991, 45 percent of its 674 river miles are threatened by nonpoint and point sources of pollution, while an additional 25 percent of the state's rivers are only partially supporting or are not supporting their designated uses. The consequences of failing to effectively manage land use include the physical loss and/or degradation of natural resources, loss of biological diversity, increasing limitations on water quality-dependent uses, and ultimately, a decrease in the Bay ecosystem's sustainable revenue generating potential.

SOLUTIONS: THE NARRAGANSETT BAY *CCMP*

The Narragansett Bay *CCMP* reflects the complexity of the Bay's environmental problems, the diversity of pollutant sources, the variety of demands that continue to be placed on the Bay's resources, and the difficulty in identifying simple solutions. The complexity of the *CCMP* also reflects the complexity of the planning process itself. However, the Project's governing committees ultimately agreed on the environmental, social, and economic necessity of protecting and restoring Narragansett Bay. As a result, the *CCMP* represents a community vision of the measures that must be taken by the State of Rhode Island and the Commonwealth of Massachusetts in conjunction with the municipalities and the federal government, to achieve the following goals for Narragansett Bay:

1. prevent further degradation of water quality;

2. protect diminishing high quality critical resource areas;

3. improve management of Bay-dependent living resources;

4. rehabilitate degraded waters throughout the Bay basin; and

5. coordinate and oversee implementation of the *CCMP*.

The organization of the *CCMP*, summary cost and financing information, and highest priority implementation actions are briefly described below.

ORGANIZATION AND USE OF THE *CCMP*

The *CCMP* is intended first and foremost to be a "blueprint" for immediate coordinated action by federal, state, and local implementing authorities. (The ten highest priority implementation actions are briefly described below, by goal, and summarized in Table II with information on projected costs and implementation status.) However, the *CCMP* acknowledges that many of the recommended actions will have to be staged over many years in order to achieve measurable progress and respond to changing demographic, environmental and economic conditions in the Bay basin. Therefore, the "Issues, Objectives, and Strategies" section of the *CCMP* (Part 715-04) is intended for use by implementing authorities and other users with a specialized interest in particular issues over a five to ten year planning horizon. Related high priority recommendations in each chapter are identified with bolded text and a checkmark. (Table 715-06(1) Summary of *CCMP* Recommendations summarizes all *CCMP* actions according to whether the primary focus of the recommended initiative is on additional policy development, planning, regulation, public education, research or capital improvement.)

Readers should also note that space has been reserved for *CCMP* chapters on Greenwich Bay, Management of Living Marine Resources, Management of Marine and Riverine Sediments, Bay Governance, and Role of Public Participation in *CCMP* Implementation. The Management of Living Marine Resources, and Management of Marine and Riverine Sediments chapters should be completed as soon as possible in order to address the continuing trend toward collapse of important fisheries and loss of critical habitats; and the need to resolve the region's dredging and sediment management concerns. The Role of Public Participation chapter should also be completed as a high priority because of the need for broad public understanding of its role in environmental protection and the environmental and economic consequences of failing to act. Sufficient information currently exists to address these subject areas. Completion of the Greenwich Bay chapter should be deferred until the RIDEM and CRMC complete the preliminary basin plan and recommend comprehensive pollution abatement and growth management initiatives to restore and protect Greenwich Bay.

Since the *CCMP* has been developed based on information collected between 1985 and 1991, the Plan should be revised as new information becomes available, new solutions emerge, and new priorities are established. In particular, the *CCMP* should not be used to stifle independent, creative solutions to the described problems, and should not be interpreted to dictate implementation schedules independent of the federal, state and local governments' competing social obligations and ability to pay. The "Implementation" section (715-05) provides an overview of the existing system of Bay governance, proposes an institutional structure for implementing the *CCMP*, and includes summary cost and financial information as the basis for future financial planning.

IMPLEMENTING THE *CCMP*

The *CCMP* explicitly recognizes that a sustained and coordinated interstate and interagency effort will be required over many years to achieve measurable progress in protecting and restoring Narragansett Bay. The Plan also recognizes that progress toward implementation will depend upon the availability of adequate and sustained funding, particularly for the state and local implementing authorities. The institutional and financial initiatives recommended in the *CCMP* are expected to provide the platform to support on-going implementation efforts. In addition, a variety of actions taken between 1985 and 1992 will also contribute to *CCMP* implementation. These institutional and financial efforts to assure implementation are briefly described below, and discussed in much greater detail in Part 715-05 of the Plan.

The *CCMP* recommends that the NBP committee structure be maintained in order to coordinate interstate and interagency efforts, and provide a permanent forum for the public to participate in future *CCMP* implementation and planning. The EPA Region I, RIDEM, RIDOP, and CRMC have agreed to continue their historic leadership role in the future by participating on the new Narragansett Bay Implementation Committee. Since many *CCMP* recommendations will depend upon municipal governments in Rhode Island and Massachusetts, it is essential that municipal representatives also serve on the Implementation Committee. Continued representation from academia, environmental advocacy groups, the business community, and marine trade organizations should be assured via establishment of a Narragansett Bay Policy Committee that assumes the responsibilities of the existing NBP Management Committee. In addition, *CCMP* implementation efforts should be coordinated with regional planning efforts such as the Bay State-Ocean State Compact, the Rhode Island Rivers Council, and RIDOP's *Greenspace 2000* initiative.

Although there is broad institutional support for the actions recommended in the *CCMP*, all the participants in the planning process acknowledge that progress toward effective implementation will be negligible without coordinated and predictable funding, partic-

ularly since the total estimated cost of implementing the *CCMP* over the next five years (1992 to 1997) is $392 million—$283 million for Rhode Island, and $109 million for Massachusetts. It is important, however, to consider several aspects of these cost projections, and the available revenue options.

1. The total estimated cost of *CCMP* implementation over the next five years is $20.2 million for Rhode Island and $10.3 million for Massachusetts—excluding projected capital costs associated with federally-mandated CSO abatement, proposed remediation of contaminated sediments on the Blackstone River, a state match for a $13 million FHWA grant, and proposed reauthorization of Rhode Island's Sewer and Water Supply Failure Fund. Over 90 percent of Rhode Island's and Massachusetts' total *CCMP* costs between 1992 and 1997 are associated with mandatory CSO abatement and proposed remediation of Blackstone River sediments.

2. If Rhode Island's total estimated non-capital costs ($20.2 million) were distributed evenly over the next five years, Rhode Island's first year expenditures would be $4.04 million, or 0.30 percent of Rhode Island's 1992 state budget. This estimated annual cost would amount to an annual, per capita cost of $4.03 to each of Rhode Island's 1,003,464 citizens for five years. Complete state financing, and a per capita distribution of *CCMP* costs are not realistic or desirable. However, the *CCMP* is clearly affordable over the long term if not the short term.

3. The procedure used to estimate the cost of *CCMP* implementation assumes that every action recommended in the Plan requires *new* funding (i.e., existing funds and staff time that could potentially be directed toward CCMP implementation are not included in the cost estimates). This overestimates the cost of implementation in two respects. First, many recommended actions have been initiated since the planning process began in June 1990—several as a direct result of the *CCMP* planning process. Second, *CCMP* planning estimates do not account for existing revenue sources such as the Aqua Fund bond fund and the State Revolving Funds, that may, in fact, be partially available to help finance *CCMP* implementation, recognizing that *CCMP* priorities will compete with other environmental priorities for existing revenues.

4. Although the *CCMP* cost estimates do not include expected federal costs of implementation, the *CCMP* explicitly states that federal financial assistance will be necessary to assist with implementation, particularly with respect to planned capital improvement projects. In fact, the *CCMP* has already acted as a "magnet" for external implementation funding, and may continue to do so in the future. (For example, Rhode Island received a $13 million demonstration grant under the federal Surface Transportation Act of 1991 to abate highway runoff from Interstate 95 and other coastal roadways that discharge runoff to Narragansett Bay.)

5. *CCMP* cost estimates do not include private sector costs associated with implementation. However, the NBP worked closely with affected business groups to identify economic incentives and financing options to facilitate private sector compliance with new regulatory requirements. These recommendations are incorporated into the *CCMP*. In addition, unit costs for implementing specific *CCMP* actions are reported where information is available. For example, the average cost of installing a marina pump-out facility, and the average cost per pump-out are reported, as are the average expected costs of establishing a wastewater management district (WWMD), and the annual homeowner cost of belonging to a WWMD.

6. Municipal costs are reported in the plan where available and where an accurate estimation is possible. However, the ultimate implementation costs for municipalities will vary depending on differing environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees. For detailed cost estimation information, refer to the NBP technical

report, *CCMP Cost Estimation and Funding Strategy* (Apogee Research Inc./NBP, 1992)

7. A public opinion survey completed for the NBP in 1991 indicated that 47 percent of the 430 Rhode Island and 102 Massachusetts respondents believe that reducing pollution in the Bay should be an immediate priority, while an additional 46 percent believe that some work should begin immediately, but that more action should wait until the economy becomes stronger. In addition, the majority of the respondents were personally willing to pay more to protect the future of the Bay and its watershed. Although attitudes differ as to the best way to pay for cleaning up the Bay, strong support exists for several funding options:

- 91 percent believe that polluters should pay for environmental remediation through fines, taxes, or other charges;

- 79 percent would support personal tax increases to fund remedial efforts, providing that increases are not excessive and funds are used for environmental purposes;

- 78 percent would support a bond issue to fund Bay improvements; and

- 63 percent would accept increased user fees, such as increased fees for fishing licenses and beach access, as long as the increases are reasonable and the funds are dedicated for Bay-related purposes.

[Note: the margin of error for the Rhode Island portion of the survey was +/- 4.7%.]

8. Finally, the projected cost of *CCMP* implementation should be viewed within a broader economic context in two respects. First, a healthy Bay is a revenue generator—over $2 billion in revenues were generated by Bay-related activities in 1989, mostly attributable to tourism. However, the region's failure to invest in pollution abatement, source reduction, and sustainable use of the Bay's natural resources will ultimately have negative economic consequences for the entire region in terms of reduced fisheries landings, declining tourism-related revenues, and diminishing quality of life for citizens of the Bay basin. Second, *CCMP* implementation can contribute directly to economic growth in the region in terms of creating jobs and stimulating the development of new industries and technologies. For example, based on recommendations presented in the *CCMP*, area businesses could successfully exploit emerging national and international markets for innovative pollution abatement, source reduction, and waste treatment technologies. The *CCMP* also challenges public and private entrepreneurs to establish new, sustainable marine-related businesses related to aquaculture, marine research and monitoring, and marine education.

In summary, the cost of implementing the *CCMP* may superficially seem high. However, significant progress toward implementation is financially achievable if the political and institutional will exists to examine existing revenue sources, and to tailor new revenue sources to agreed-upon *CCMP* priorities.

Implementation efforts undertaken during the *CCMP* planning process will also contribute to the success of future actions to protect and restore Narragansett Bay. The NBP's efforts to develop practical planning "tools", establish permanent technical assistance programs, and obtain additional funding to support recommended planning and pollution abatement initiatives are described in Section 715-01-04 (Process of Plan Development). In addition, many agencies and organizations have also begun to implement portions of the *CCMP*. These efforts are recorded in the summary matrices following each *CCMP* chapter.

However, the "Letters of Support" (Appendix G), and the "Preliminary Agreements to Implement the Approved *CCMP*" (Section 715-05-06) possibly represent the most significant evidence of a basin-wide commitment to implement the *CCMP*. The "Letters" and "Preliminary Agreements" speak for themselves with respect to institutional willingness to participate in *CCMP* imple-

mentation. The authors of these documents clearly recognize that the *CCMP* is not perfect, that it is, however, a *plan* and, therefore, can be revised as new information becomes available and new solutions emerge. The agency agreements also explicitly state that real funding constraints exist and that successful implementation will depend upon coordinated action by federal, state and local implementing authorities, and the private sector. Most importantly, however, the "Letters of Support", and the "Preliminary Agreements" implicitly recognize that moving forward with implementation of the *CCMP* is the most responsible course of action to protect the region's long-term investment in and enjoyment of Narragansett Bay.

HIGHEST PRIORITY ACTIONS FOR IMPLEMENTATION

GOAL: ***The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to prevent further degradation and incrementally improve water quality in developing coastal areas with deteriorating water quality.***

The following actions should be undertaken as soon as possible in order to prevent further degradation of water quality in rural and suburbanizing areas of the Narragansett Bay basin:

ACTION: The State of Rhode Island and the Commonwealth of Massachusetts should adopt legislation requiring municipalities to establish wastewater management districts (WWMD) in order to assure the proper inspection and maintenance of on-site sewage disposal systems (OSDS). In addition, the State and the Commonwealth should amend existing regulations governing siting, design, construction, and maintenance of on-site sewage disposal systems.

Rhode Island passed legislation in 1987 enabling municipalities to establish WWMDs to oversee the maintenance of OSDSs, and manage septage disposal within their jurisdictions. Although several municipalities are presently considering adopting WWMD ordinances, no districts have been established to date in the Narragansett Bay basin. Since the statewide OSDS failure rate is estimated to be three percent, and reportedly may be as high as 15 percent in some communities, WWMDs must be established to provide routine inspection, maintenance, and enforcement of residential and commercial OSDSs.

Both states also need to modernize the rules and regulations governing new, repaired, and replaced OSDSs. The revised regulations should address siting criteria, density limits in critical resource areas, buffer and set-back requirements, prohibitions on the use of chemical additives and garbage disposals, and enforcement. In addition, design and performance standards should be established for a range of on-site wastewater treatment technologies that can be approved for use in areas where conventional systems do not adequately protect receiving waters and/or habitat.

ACTION: The State of Rhode Island and the Commonwealth of Massachusetts should prepare a marina pump-out facility siting plan for Narragansett Bay that includes a consistent written policy for (1) regulating the construction of marinas, docks, and mooring fields; and (2) enforcing prohibitions against boater discharges in Narragansett Bay.

As of 1989, over 160 marinas, boat yards, and boat ramps were providing services to an estimated 58,000 registered and unregistered boaters in Rhode Island and Massachusetts portions of Narragansett Bay. However, only five marine pump-out stations were in operation in 1991—although three additional stations in Narragansett Bay and four stations on Block Island are expected to be in operation by Summer 1992. Although federal and state law prohibits the discharge of improperly treated vessel wastes within the three-mile territorial limit, the lack of available services, as well as observed violations of bacteriological standards in the vicinity of marine facilities, suggest that illegal discharges occur. A potentially serious public health risk exists to the extent that discharges of untreated or partially treated sewage occur near bathing beaches or shellfish harvesting areas.

Efforts to implement this recommendation are partially complete. However, RIDEM, CRMC, and Massachusetts authorities will need to reconcile inconsistent water quality and water use standards governing the use of

tidal waters in order to regulate the future construction or expansion of marine facilities. These agencies should also continue to work with harbormasters, marine trade organizations and boaters through the RIDEM Boating Safety courses and CRMC's Harbor Management Planning process to establish marine pump-out facilities, and investigate the use of boat inspection stations. Low interest loans for construction of publicly maintained pump-out facilities may be available from the Rhode Island Aqua Fund, the State Revolving Fund, or the states' Wallop-Breaux funds. Operating costs of the facilities should be recoverable from user fees. Ultimately, RIDEM and CRMC should work with coastal communities to petition the EPA to designate all or part of Narragansett Bay as a "no discharge area" in order to help protect water quality-dependent uses of Narragansett Bay.

The intent of CCMP recommendations concerning the reconciliation of CRMC and RIDEM water quality and water use standards is to:

1. Identify geographical and programmatic areas where CRMC water use and RIDEM water quality standards result in inconsistent regulation of permitted activities;

2. Reconcile, to the greatest extent possible, identified differences in water use and water quality classifications on a programmatic basis;

3. Establish appropriate memoranda of agreement between RIDEM and CRMC to ensure permitting activities by both agencies support the maintenance of water-dependent uses provided for in established water quality standards.

ACTION: The Federal government, the State of Rhode Island, and the Commonwealth of Massachusetts should develop useful guidance for municipal officials regarding (1) "best management practices" (BMPs) to control nonpoint source pollution, (2) innovative, environmentally protective land management and growth management practices, and (3) development of local and regional stormwater management plans to reduce or treat storm runoff.

Rhode Island municipalities exercise control over land use via zoning ordinances, special use ordinances, and direct state grants of authority. Municipal control over land use has recently been clarified and strengthened as the result of the Comprehensive Planning and Land Use Regulation Act of 1988 and the Zoning Enabling Act of 1991 which require communities to develop local comprehensive land use plans following state guidelines, and to adopt zoning ordinances and maps in conformance with the plans. These statutes also broaden the authority of Rhode Island municipalities to adopt and enforce environmentally protective policies. However, many communities still rely on volunteer planning and zoning boards—some without paid professional planning staffs, and few with environmentally trained professionals—to make complicated land use decisions.

In order to help assure predictable and environmentally appropriate land use decisions, local officials need standardized, practical guidance that describes pollution sources, pollution abatement options, and innovative land use and growth management controls. For example, the states should develop detailed guidance regarding regional stormwater management options, management of stormwater utilities, and design and performance standards for recommended "best management practices". Just as importantly, the municipalities need guidance on how to apply and defend the use of innovative growth and land use management techniques such as overlay protection districts, cluster zoning, development scheduling, and pollutant loading ordinances. Local officials also need straightforward descriptions of state regulatory requirements, and increased access to training and technical assistance in implementing new programs.

A great deal of useful information regarding structural and non-structural "best management practices" has already been compiled. For example, EPA has sponsored

the states' Nonpoint Source Management Programs pursuant to Section 319 of the Clean Water Act, and has prepared draft guidance for implementation of the states' Coastal Nonpoint Pollution Control Programs, as required by Section 6217 of the 1990 Amendments to the Coastal Zone Management Act. The guidance produced by the RIDOP and the Rhode Island Land Management Project to assist communities with the development of their local comprehensive plans provides the basis for future educational efforts. State efforts to prepare this information and provide technical assistance should continue. However, these efforts must be coordinated through a statewide nonpoint source advisory committee that is jointly chaired by the state environmental protection and coastal zone management agencies in order to assure consistency and avoid unnecessary duplication of effort.

GOAL: The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to protect diminishing high quality critical resource areas throughout the Bay basin.

The following actions should be taken in order to effectively protect diminishing high quality critical resources in the Narragansett Bay basin:

ACTION: The State of Rhode Island and the Commonwealth of Massachusetts should develop statewide *Critical Resource Protection Policies* that include: (1) objective criteria for designating critical resources and critical resource protection areas, (2) a Geo-graphic Information System-based mapped inventory of identified resources, and (3) regulatory and non-regulatory controls for protecting identified critical resources.

Sustained use of coastal aquatic and living resources may require some areas to be retained in their natural states. For example, protection of drinking water supplies will require some limitations on development within water supply recharge areas. Similarly, critical nursery, breeding and foraging habitat for Bay fisheries, waterfowl and threatened and endangered species will have to be managed in order to protect the long-term viability of these populations. Effective protection of these coastal resources, however, will depend upon coordinated efforts to manage adjacent and upstream land areas.

The RIDOP's *Greenspace 2000* planning effort will assist Rhode Island in identifying resources that should be protected for aesthetic, recreational, and environmental reasons. The habitat inventory prepared by the NBP will also help with respect to identification of critical coastal and subtidal habitats and resources. In addition, Massachusetts' recent amendments to its Threatened and Endangered Species Act, which authorize public and private entities to nominate areas for designation as *Areas of Environmental Concern*, the Scituate Reservoir Watershed Plan, and CRMC's more recent Special Area Management (SAM) Plans provide models for managing future growth in designated critical areas.

New funds will be required to support this effort, although some funding may be available through federal grants to RIDEM for *CCMP* implementation. These funds will not be sufficient, however, to support the mapping effort or the necessary participation of state and local agencies.

ACTION: The Rhode Island Coastal Resources Management Council (CRMC), the Rhode Island Department of Environmental Management (RIDEM), and other state and local planning and implementing authorities should undertake the preparation of a *Special Area Management (SAM) Plan* for Greenwich Bay.

The strengths of the CRMC's *SAM Plan* process are that it recognizes the role of local government in governing land use, and that it can be used as a vehicle to focus the efforts

of state regulatory agencies. The Greenwich Bay *SAM Plan* should explicitly address point and nonpoint pollution sources, the need for additional sewering in the Greenwich Bay basin based on existing and projected population growth, long-term management of the Greenwich Bay Shellfish Management Area, and protection of remaining critical marine resources. Data collected by the NBP and others, including an engineering review of wastewater treatment infrastructure in the basin, should be used to develop the SAM Plan in combination with local land use and facilities plans.

Partial funding for development of a preliminary Greenwich Bay basin plan may be available via a Rhode Island Aqua Fund grant to the NBP, and an interagency agreement to prepare the plan has been in existence since November 1990. Additional funds may be necessary to develop a more detailed *SAM Plan*, and will be necessary to fund eventual implementation of point and nonpoint source controls.

GOAL: The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the federal government, should act to more effectively manage commercially, recreationally, and ecologically important estuarine-dependent living resources.

The following actions should be taken in order to assure that a balanced and biologically diverse indigenous population of estuarine-dependent flora and fauna is maintained in Narragansett Bay:

ACTION: The State of Rhode Island and the Commonwealth of Massachusetts should develop species-specific management plans for managing: (1) commercially, recreationally, and ecologically important fish and shellfish, (2) all threatened and endangered estuarine-dependent plants and animals, and (3) the re-introduction of native anadromous and catadromous fisheries to Bay tributaries, wherever possible.

Rhode Island's wildlife management efforts primarily focus on commercially harvestable living resources because of limited state appropriations, staffing shortages, and the requirements of federal granting agencies. Apart from the RIDEM Natural Heritage program's efforts to monitor the distribution and abundance of threatened and endangered species, there is no systematic effort to manage ecologically important estuarine-dependent plants and animals, or their habitats. In addition, the RIDEM Division of Fish and Wildlife's efforts to manage commercially important fisheries and re-establish native anadromous fisheries rarely include efforts to protect critical breeding or nursery habitats or related elements of the ecosystem.

Therefore, the proposed management plans should identify the causes of observed declines in Narragansett Bay fish, invertebrate, and plant species, and propose specific management strategies for their protection, restoration, and management. The plans should also address protection and management of key breeding, spawning, and foraging habitats of estuarine-dependent plants and animals. A Narragansett Bay *Quahog Management Plan* should be considered the highest priority because of the economic and historic importance of the quahog fishery in Rhode Island, and the effect of sewage contamination of coastal waters on the future of the industry. This plan should be completed prior to any decision to re-open Mount Hope Bay or upper Narragansett Bay to shellfish harvesting as a result of CSO abatement in these areas. Native anadromous fisheries also deserve special attention because of their reliance on unimpaired riverine water quality and unrestricted river flow. Restoration of native fisheries such as shad and Atlantic salmon should be viewed as indicators of

riverine health as the Bay's tributaries are restored.

The RIDEM Division of Fish and Wildlife has recently completed a winter flounder management plan, as well as species' profiles for several commercially and recreationally important fishes. The profiles represent an important source of information to support the development of subsequent management plans. Additional state funding will be required to support this effort. However, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service should be strongly encouraged to expand or revise their grant eligibility criteria to support the states' efforts to develop these management plans, particularly for ecologically important species and their associated habitats.

GOAL: The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to rehabilitate degraded waters in the Bay basin and restore water quality-dependent uses of Narragansett Bay.

The following actions should be initiated as soon as possible in order to reduce the discharge of toxic pollutants, untreated fecal wastes, and sewage-derived floatables to Narragansett Bay and its tributary waters:

ACTION: The U.S. Environmental Protection Agency (EPA), the State of Rhode Island, and the Commonwealth of Massachusetts should: (1) revise existing municipal and industrial discharge permits to include enforceable, numeric, and chemical-specific limits for all toxic chemicals listed on the Narragansett Bay "List of Toxics of Concern," (2) enforce compliance with these revised discharge limits, and (3) include other significant non-industrial sources of toxic chemicals within these regulatory programs in order to meet state water quality goals for state waters.

There is persuasive scientific evidence that the regulatory programs initiated pursuant to the Federal Clean Water Act, in combination with voluntary source reduction efforts by industry, improvements in wastewater treatment technology, and outright product bans, have been moderately successful in reducing toxic pollutant discharges to Narragansett Bay. However, the existing federal and state regulatory programs control only some of the pollutant sources and pollutants that are potentially of public health or environmental concern. In addition, due to competing program requirements, existing chemical limits intended to protect human health and aquatic life are rarely enforced by EPA, the states, or the municipalities. Although EPA and the states should focus on regulating discharges of toxic pollutants, they should also support efforts to reduce the use of these pollutants. Innovative efforts by organizations such as Rhode Island's Hazardous Waste Reduction Program, Massachusetts' Blackstone Project and the Rhode Island Pollution Prevention Council to promote source reduction (*e.g.*, conservation, raw material substitution, recycling, use of recycled and reclaimed materials) should, therefore, continue to be supported.
Additional funds will be required to support expansion of existing regulatory programs at both the state and municipal level. Potential funding sources include discharge fees assessed on the basis of the volume of water used and/or pollutant characteristics of the waste, penalties for violations of discharge limits, set-asides from the *Hard to Dispose of Materials* tax, and general appropriations. The states' source reduction efforts should also be funded from these revenue sources.

ACTION: The U.S. Environmental Protection Agency (EPA), the State of Rhode Island, the Commonwealth of Massachusetts, and the relevant municipalities and publicly owned wastewater treatment facilities (WWTFs) should proceed with current efforts to abate the combined sewer overflows (CSOs) in Mount Hope Bay and the

Providence and Blackstone Rivers in accordance with a statewide CSO abatement priority ranking system.

CSO abatement is required by EPA, RIDEM, and the Massachusetts Department of Environmental Protection completely independently of the *CCMP*. CSOs in the City of Fall River are directly and overwhelmingly responsible for the closure of Mount Hope Bay to shellfishing. The City of Fall River is presently under an EPA compliance order to abate these CSOs, and has reportedly eliminated illegal dry weather discharges to the Quequechan River. Rhode Island and Massachusetts should synchronize negotiation of interstate agreements about Mount Hope Bay water quality standards, and future plans for regulating shellfish harvesting with Massachusetts' plans for abatement of the Fall River CSOs.

CSOs and WWTF bypasses in the Providence-Blackstone-Seekonk Rivers were responsible for closing the conditional shellfishing areas in upper Narragansett Bay for 281 days in 1990. Until recently, jurisdiction over the 89 CSOs in the Providence-Seekonk River basins was divided between the Narragansett Bay Water Quality District Commission (NBC) and the Blackstone Valley District Commission (BVDC). The merger of the BVDC and the NBC in early 1992 should, therefore, facilitate the development of a comprehensive, basinwide plan for abating these CSOs in a cost-effective and environmentally beneficial manner.

Estimated costs for abatement of the Fall River CSOs are approximately $122 million. Abatement of the Providence-Blackstone-Seekonk River CSOs is projected to exceed $325 million. A significant portion of the costs for construction of CSO abatement facilities is expected to be recovered from sewer use fees although some funding may be available through the State Revolving Funds, subject to other state priorities for wastewater treatment projects.

GOAL: ***The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the federal government and the municipalities, should establish necessary interstate and interagency agreements to coordinate and oversee implementation of the Narragansett Bay Comprehensive Conservation and Management Plan.***

The following actions should be undertaken in order to assure coordinated implementation of the *CCMP* and to achieve measurable progress toward restoring and protecting Narragansett Bay:

ACTION: The U.S. Environmental Protection Agency (EPA), the State of Rhode Island, and the Commonwealth of Massachusetts should cooperate to establish a Narragansett Bay Implementation Committee, a Narragansett Bay Policy Committee, and a Narragansett Bay planning section to: (1) coordinate and oversee *CCMP* implementation, including negotiation of interagency agreements where necessary, (2) participate in *CCMP* implementation by drafting necessary legislation, regulations, and policies, and by participating as commenters in federal consistency reviews, (3) supervise and review the results of the long-term monitoring program, and (4) revise the *CCMP*, as necessary, based on new scientific, policy, and/or economic information.

Completion of the *CCMP* signals the beginning of the implementation process. The ability of the federal, state, and local authorities in the Narragansett Bay basin to implement the *CCMP* obviously depends upon available funding. However, implementation of the *CCMP* also depends upon coordinated interstate and interagency action, public support, and the ability to continuously upgrade and refine *CCMP* recommendations, priorities, and implementation schedules. Therefore, the imple-

menting authorities should continue to work together to coordinate their actions, solicit public comment, evaluate progress, and revise the *CCMP* based upon new scientific, policy, and economic information.

The Narragansett Bay Implementation Committee, modeled after the Narragansett Bay Project Executive Committee, should be responsible for coordinating agency action. The Narragansett Bay Policy Committee, modeled after the Narragansett Bay Project Management Committee, should provide a permanent forum for the public to comment on policy matters related to the health and governance of Narragansett Bay. A Narragansett Bay planning section should be established within RIDEM to provide staff support to *CCMP* implementing authorities; oversee the long-term monitoring program; and assist with *CCMP* implementation.

The recommended oversight committees are expected to be volunteer boards that meet routinely to review progress to date. Some external funding may be available from the EPA to oversee *CCMP* implementation. These funds, in conjunction with appropriate state funds, should be sufficient to support basic staff activities on behalf of the Narragansett Bay *CCMP*.

ACTION: The U.S. Environmental Protection Agency (EPA), the State of Rhode Island, the Commonwealth of Massachusetts, and other federal, state, and local authorities should cooperate in the execution of a long-term monitoring program for Narragansett Bay in order to measure the effectiveness of actions taken pursuant to the *CCMP* and to evaluate trends in the status and health of Narragansett Bay.

Section 320 of the federal Clean Water Act requires participants in the National Estuary Program to evaluate the effectiveness of actions taken pursuant to the *CCMP* and to report biennially to Congress on the status and health of the estuary. The long-term monitoring plan for Narragansett Bay builds on baseline physical, chemical, biological, and physiographic information collected by the NBP and others since 1985. The monitoring plan will enable regulators, planners, and scientists to evaluate the success of pollution control and source reduction measures, CSO abatement, and living resource management efforts, as well as to evaluate changes in the health of Narragansett Bay and its living resources.

Since over 40 separate monitoring programs administered by different federal, state, and local agencies are presently collecting information relevant to the management of Narragansett Bay, the State of Rhode Island should also make a concerted effort to establish and maintain a centralized natural resources database to archive this information. A centralized repository of natural resources data, linked to the existing Narragansett Bay Data System (NBDS) and the Rhode Island Geographic Information System (RIGIS), will enable resource managers to more effectively identify natural resource problems and trends.

The success of the long-term monitoring program in future years will depend upon coordinating the activities of all agencies that support monitoring programs, and also upon additional federal and state funding. The nucleus of a statewide natural resources database presently exists in the form of the NBDS and the RIGIS. However, an additional and continuing source of funds will be required to maintain the databases for the use of all state and local resource management agencies. Discussions are presently under way with regard to affiliating the NBDS with the University of Rhode Island's Coastal Institute.

SUMMARY

The high priority implementation actions, which are described more completely in the body of the *CCMP*, represent only a subset of all the pollution abatement and resource protection initiatives recommended in the Plan. (See Table II and Table 715-06(1) .) Although the Narragansett Bay *CCMP* borrows and descends from a long line of basin planning efforts in the State of Rhode Island, this Plan proposes many sweeping changes in the way government and the public address environmental protection. Most of the recommended actions anticipate and promote changes in the way citizens of Rhode Island and Massachusetts use raw materials and dispose of waste—the *CCMP* consistently stresses reduction in the use of polluting substances as the most cost-effective means to protect the integrity of the Bay ecosystem. Most of the recommended actions acknowledge that Narragansett Bay and the Bay basin will experience surges in growth over the next few decades—the *CCMP* consistently stresses the need to manage the impacts of the rate and distribution of growth as the only hope for protecting Narragansett Bay and avoiding costly remedial efforts in the future. Most importantly, all of the recommended actions consider Narragansett Bay within the context of its watershed and within the context of its changing demographics and use—the *CCMP* stresses that protection of Narragansett Bay cannot be separated from protection of its watershed. Finally, the *CCMP* also attempts to nurture the sense of stewardship that many Rhode Islanders already feel for the Bay. Therefore, the *Comprehensive Conservation and Management Plan* represents a view shared by many citizens of the Narragansett Bay basin: The protection and restoration of Narragansett Bay are realistically within the grasp of the Bay's managers, its trustees, *and most importantly*, its beneficiaries.

The Narragansett Bay Project Management Committee met on July 27, 1992, and recommended that the *CCMP* be transmitted to the Narragansett Bay Project Executive Committee for final approval. The Executive Committee met on August 4, 1992, and voted (three in favor and one abstention) to send the *CCMP* to the Governor of Rhode Island and the Administrator of the U.S. EPA for their signatures.

Providence, Rhode Island

15 August 1992

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NBP Executive Committee

The Narragansett Bay Project Executive Committee:

Ms. Louise Durfee, Director
R.I. Department of Environmental Management

Mr. Ronald Manfredonia, Chief
Water Quality Branch
U.S. Environmental Protection Agency
Region I

Mr. George L. Sisson, Jr., Acting Chair
R.I. Coastal Resources Management Council

Mr. Daniel W. Varin, Assoc. Director
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Division of Planning

NARRAGANSETT BAY PROJECT MANAGEMENT COMMITTEE (1991/1992)

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Mr. Daniel Beardsley
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Brown University

TABLE I. SUMMARY OF BAY PROBLEMS, RANKED, BY REGION

BAY-WIDE			
PROBLEM(S)	**CAUSE(S)**	**SOURCE(S)**	**RISKS**
1. Loss of major fisheries	1. Overfishing	1. Efficiency of harvesting techniques, and level of effort 2. Lack of adequate information, and resource management structure	Failure to intervene will perpetuate the cycle of collapsing commercial fisheries, and resulting economic hardship.
	2. Habitat loss	1. Lack of adequate land use controls to protect critical habitats from effects of population growth and development 2. Habitat degradation due to point and nonpoint pollutant inputs	Failure to intervene will result in incremental loss of critical habitats, habitat degradation, eventual loss of biological diversity, and increased limitations on human use and enjoyment of natural resources.
2. Limitations on water quality-dependent uses	1. Fecal contamination	1. Human sewage from WWTFs 2. Human sewage from CSOs 3. Human sewage from OSDSs, storm drains, boater discharges	Failure to more effectively disinfect WWTF discharges and abate CSO discharges will permanently limit shellfish harvesting in urban areas. Failure to abate nonpoint pollution sources will result in increased closures of harvesting areas in suburbanizing regions.
	2. Toxics contamination	1. Industrial discharges and emissions 2. Residential, commercial discharges, motor vehicle emissions and runoff 3. Accidental chemical spills	Failure to reduce use and disposal of toxic pollutants will result in long-term public health risk to seafood consumers, incremental environmental degradation, and damage to aquatic organisms.

TABLE I. SUMMARY OF BAY PROBLEMS, RANKED, BY REGION

SUBURBANIZING AND UNDEVELOPED AREAS *e.g.*, **PARTS OF THE SAKONNET RIVER**			
PROBLEM(S)	**CAUSE(S)**	**SOURCE(S)**	**RISKS**
1. Trend toward habitat degradation and loss	Lack of adequate land use and development density controls to protect critical habitats and water quality	Rate and pattern of population growth and development	Failure to more effectively regulate land use and the density of development will result in incremental loss of critical habitats for aquatic plants and animals, and incremental degradation of water quality.

SUBURBAN AND URBANIZING AREAS *e.g.*, **GREENWICH BAY, NEWPORT HARBOR**			
PROBLEM(S)	**CAUSE(S)**	**SOURCE(S)**	**RISKS**
1. Trend toward limitation on water quality-dependent uses	Fecal contamination	Human sewage from WWTFs, OSDSs, storm drains, boater discharges	Failure to abate or more effectively treat existing sources of fecal contamination, and failure to limit density of future development dependent on septic systems will result in increased closures of shellfish harvesting areas, and other limitations on water quality-dependent uses.

TABLE I. SUMMARY OF BAY PROBLEMS, RANKED, BY REGION

2. Pockets of contaminated sediments	Toxics contamination and excess organic loadings	Historic and current discharges of toxic pollutants and domestic wastes from local industrial, commercial and residential sources	Failure to reduce use and disposal of toxic pollutants will result in further environmental degradation, may increase the long-term health risk to seafood consumers, and will limit future dredging and dredged material disposal options.
3. Habitat degradation and loss	Lack of adequate land use and development density controls to protect critical habitats	Rate and pattern of population growth and development	Failure to protect remnant critical habitats will result in incremental loss of critical habitats for aquatic plants and animals, incremental degradation of water quality, and eventual loss of biological diversity.

MOUNT HOPE BAY

PROBLEM(S)	CAUSE(S)	SOURCE(S)	RISKS
1. Limitations on water quality-dependent uses	1. Fecal contamination	1. Combined sewer overflows - Fall River	Failure to abate Fall River CSOs will result in permanent closure of 6,820 acres in Mount Hope Bay and parts of the Kickemuit River to commercial quahog, oyster, mussel fisheries.

TABLE I. SUMMARY OF BAY PROBLEMS, RANKED, BY REGION

PROVIDENCE-SEEKONK RIVER

PROBLEM(S)	CAUSE(S)	SOURCE(S)	RISKS
1. Limitations on water quality-dependent uses. (Also applies to segments of the Blackstone, Pawtuxet, Woonasquatucket, Moshassuck and Ten Mile Rivers.)	1. Fecal contamination	1. Human sewage from WWTFs 2. Human sewage from CSOs	Failure to more effectively disinfect WWTF discharges will result in continued closure of 5,430 acres to shellfish harvesting and swimming. Failure to abate CSOs will result in continued (intermittent) closure of 9,853 acres to shellfish harvesting.
2. Exceedance of Federal and state water quality standards intended to protect aquatic life and public health. (Also applies to segments of the Blackstone, Pawtuxet, Woonasquatucket, Moshassuck and Ten Mile Rivers.)	1. Toxics contamination, and excess nutrient inputs	1. Industrial, residential, commercial discharges through WWTFs and runoff (toxics) 2. Human sewage from WWTFs (nutrients)	Failure to reduce use and disposal of toxic pollutants will result in long-term health risk to seafood consumers, and further environmental degradation. Failure to reduce excess nutrient inputs could result in algal blooms, prolonged episodes of low oxygen, and/or fish kills.
3. Contaminated sediments. (Also applies to segments of the Blackstone, Pawtuxet, Woonasquatucket, Moshassuck and Ten Mile Rivers.)	1. Toxics contamination	1. Historic and current discharges of toxic pollutants and domestic wastes from sources in the Providence River basin, including the Blackstone and Pawtuxet Rivers	Failure to reduce use and disposal of toxic pollutants will result in further environmental degradation and long-term public health risk to seafood consumers, and will limit future dredging and dredged material disposal options.

TABLE II. HIGHEST PRIORITY ACTIONS FOR IMMEDIATE IMPLEMENTATION

Recommended Action	Implementing Authorities	Goal no.					Cost by Year		Implementation Status
		1	2	3	4	5	92-93	93-94	
Adopt legislation requiring municipalities to establish wastewater management districts and amend existing regulations governing siting, design, construction, and maintenance of on-site sewage disposal systems.	RIDEM, MADEP, CRMC, RIDOP, municipalities or utilities, *e.g.*, WWTFs	X					95,000	0	Estimated cost is for dev'pt of OSDS regulations. Estimated first year cost to establish WWMD is $150,000, recoverable from user fees. [See RIDEM's "Preliminary Agreement".]
Implement a marina pump-out facility siting plan for Narragansett Bay that includes a consistent written policy for (1) regulating the construction of marinas, docks, and mooring fields; and (2) enforcing prohibitions against boater discharges in Narragansett Bay.	RIDEM, CRMC, municipal and private boating facilities	X					45,000	0	Cost estimate includes RIDEM-CRMC coordination efforts. Estimated cost of installing pump-outs ($11,500) is not included. [See EPA and RIDEM "Preliminary Agreements".]
Develop guidance for municipal officials regarding (1) "best management practices" to control nonpoint source pollution, (2) innovative, environmentally protective land management and growth management practices, and (3) development of local and regional stormwater management plans to reduce or treat storm runoff.	RIDEM, MADEP, CRMC, MACZM, RIDOP, EPA, USDA, NOAA, RI and MA Cooperative Extensions	X					111,000	111,000	Some funding may be available from EPA, NOAA, and USDA through CWA Section 319, CZMA Section 6217, and USDA SCS nonpoint source control initiatives. [See EPA, USDA SCS, RIDEM and RIDOP "Preliminary Agreements."]
Develop statewide *Critical Resource Protection Policies* that include (1) objective criteria for designating critical resources and critical resource protection areas, (2) a Geographic Information System-based mapped inventory of identified resources, and (3) regulatory and non-regulatory controls for protecting identified critical resources.	RIDEM, MADEP, CRMC, MACZM, RIDOP, municipalities		X				180,000	105,000	Some external federal funding may be available in 92-93 to initiate policy development. [See RIDEM and RIDOP "Preliminary Agreements".]

See 715-05-06 "Preliminary Agreements to Implement the Approved Narragansett Bay *CCMP*.

Priority Actions are listed

TABLE II. HIGHEST PRIORITY ACTIONS FOR IMMEDIATE IMPLEMENTATION

Recommended Action	Implementing Authorities	Goal no.					Cost by Year		Implementation Status
		1	2	3	4	5	92-93	93-94	
Prepare a Special Area Management (SAM) Plan for Greenwich Bay.	CRMC, RIDEM, RIDOP, munic.		X				150,000	100,000	$150,000 may be available for preliminary Greenwich Bay Plan. [See RIDEM-CRMC-NBP Interagency MOA (1991).]
Develop species-specific management plans for managing (1) commercially, recreationally, and ecologically important fish and shellfish; (2) all threatened and endangered estuarine-dependent plants and animals; and (3) the re-introduction of native anadromous and catadromous fisheries to Bay tributaries, wherever possible.	NOAA, USFWS, RIDEM, MADFW			X			N/A	N/A	No cost estimate prepared. Quahog Management Plan is highest priority. [See RIDEM "Preliminary Agreement", pending availability of funding.]
(1) Revise existing municipal and industrial discharge permits to include enforceable, numeric, and chemical-specific limits for all toxic chemicals listed on the Narragansett Bay "List of Toxics of Concern," (2) enforce compliance with these revised discharge limits, and (3) include other significant non-industrial sources of toxic chemicals in these regulatory programs in order to meet state water quality goals for state waters.	EPA, RIDEM, MADEP, WWTFs				X		50,000	62,500	Costs estimated <u>only</u> for state permitting and enforcement efforts. WWTF costs are recoverable from user fees, and are not presented. [See EPA and RIDEM "Preliminary Agreements".]
Continue efforts to abate the combined sewer overflows (CSOs) in Mount Hope Bay and the Providence and Blackstone Rivers in accordance with a statewide CSO abatement priority ranking system.	EPA, RIDEM, MADEP, NBC, City of Fall River				X		15,192,500	19,732,000	Primarily planning and design costs. Major capital construction costs begin in 94-95. [See EPA and RIDEM "Preliminary Agreements".]

See 715-05-06 "Preliminary Agreements to Implement the Approved Narragansett Bay *CCMP*.

TABLE III. SUMMARY OF ESTIMATED CCMP COSTS

COST ESTIMATES BY SUBJECT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
Source Reduction: Toxics	1,532,500	755,000	720,000	755,000	918,500	1,801,000	853,500	1,116,000	853,500	1,116,000	4,878,000	5,543,000
Source Reduction: Nutrients	2,500	150,000	29,375	0	30,625	400,000	54,375	0	29,375	0	146,250	550,000
Source Control: Water Management and Wastewater Treatment	20,000	0	20,000	0	46,250	0	45,000	0	20,000	0	151,250	0
Source Control: Combined Sewer Overflows	102,500	15,090,000	60,000	19,672,000	82,500	103,481,000	65,000	116,462,000	70,000	86,222,250	380,000	340,927,250
Source Control: On-Site Sewage Disposal Systems	138,750	5,000,000	5,000	0	130,000	0	85,000	0	92,500	0	451,250	5,000,000
Source Control: Boater Discharges	210,000	107,250	10,000	6,000	57,500	6,180	20,000	6,000	20,000	6,000	317,500	131,430
Source Reduction: Nonpoint Sources	828,750	12,000	400,000	12,000	880,750	97,000	3,172,000	97,000	3,072,000	97,000	8,353,500	315,000
Land Use	257,500	12,000	167,500	12,000	437,500	12,000	330,000	12,000	305,000	12,000	1,497,500	60,000
Protection of Critical Areas	315,000	334,000	165,000	417,000	211,250	250,000	145,000	167,000	145,000	167,000	981,250	1,335,000
Public Health	384,000	354,550	281,500	340,000	521,500	355,000	456,500	340,000	471,500	340,000	2,115,000	1,729,550
Mount Hope Bay	182,500	50,000	15,000	50,000	37,500	250,000	15,000	0	15,000	0	265,000	350,000
Blackstone River	360,625	134,750	110,625	20,750	355,000	12,140,000	125,000	12,000	125,000	12,000	1,076,250	12,319,500
CCMP Implementation and Governance	448,750	265,000	390,000	265,000	400,000	265,000	400,000	265,000	400,000	265,000	2,038,750	1,325,000
TOTALS	4,783,375	22,264,550	2,374,000	21,549,750	4,108,875	119,057,180	5,766,375	118,477,000	5,618,875	88,237,250	22,651,500	369,585,730
TOTAL BY YEAR		27,047,925		23,923,750		123,166,055		124,243,375		93,856,125		392,237,230

TABLE II. HIGHEST PRIORITY ACTIONS FOR IMMEDIATE IMPLEMENTATION

Recommended Action	Implementing Authorities	Goal no.					Cost by Year		Implementation Status
		1	2	3	4	5	92-93	93-94	
Establish a Narragansett Bay Implementation Committee, a Narragansett Bay Policy Committee, and a Narragansett Bay planning section to oversee *CCMP* implementation.	NBP Executive Committee, NBP Management Committee					X	270,000	270,000	Some external federal funding available in 92-93 and 93-94 to begin implementation. [See EPA, RIDEM, RIDOP "Preliminary Agreements".]
Implement a long-term monitoring program for Narragansett Bay	RIDEM, MADEP, EPA, NOAA, RIDOH, MADPH					X	250,000	250,000	Coordination of on-going programs will offset projected cost. [See EPA ERLN's "Preliminary Agreement".]
Total cost							**16,343,500**	**20,630,500**	

See 715-05-06 "Preliminary Agreements to Implement the Approved Narragansett Bay *CCMP*.

715-01 INTRODUCTION

In establishing the National Estuary Program, the United States Congress recognized the special need to protect an important but endangered resource: our nation's estuaries. Four regional estuary projects were created in 1985, modeled on the Chesapeake Bay Program's multi-state effort to manage watershed-based impacts on the Bay. The 1987 amendments to the Clean Water Act formally established the National Estuary Program (NEP), and identified six "estuaries of national significance," including Narragansett Bay, that appeared to be threatened by pollution, overdevelopment or overuse. The goal of the NEP, which is administered by the United States Environmental Protection Agency (EPA), is to protect and improve estuarine water quality and habitat in order to support balanced and diverse marine resources, and to restore water quality-dependent uses of the estuary. Specifically, Section 320 of the federal Clean Water Act of 1987 directs participants in the NEP to convene Management Conferences to develop "Comprehensive Conservation and Management Plans" in order to "...recommend priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected."

The Narragansett Bay Project (NBP) was established in 1985 under the joint sponsorship of the EPA and the Rhode Island Department of Environmental Management (RIDEM). A Narragansett Bay Management Conference was formally convened for the purpose of preparing a Narragansett Bay *Comprehensive Conservation and Management Plan* (*CCMP*) when Narragansett Bay was officially designated an "estuary of national significance" on March 11, 1988. The NBP's mandate is to develop a comprehensive management plan for restoring, protecting and managing Narragansett Bay's natural resources based on a thorough evaluation of the Bay's water quality, natural resource and use-related problems. The NBP has received over $10 million since 1985 from federal appropriations provided under the federal Clean Water Act and matching funds provided by the State of Rhode Island.

01-01 The Need for a Comprehensive Conservation and Management Plan

In 1985, citing its concern for the "health and ecological integrity" of the nation's estuaries and estuarine resources, the United States Congress identified Narragansett Bay as one of four urban estuaries, nationwide, that required prompt, coordinated government action to reverse a trend toward deteriorating water quality, gradual loss of natural resources and increasing impairment of water quality-dependent uses of the estuary, such as shellfish harvesting. The NBP was subsequently established to administer a five year study of the Bay and its resources.

Public opinion surveys and goal-setting workshops conducted by the NBP in 1986 and early 1987 confirmed that many Rhode Islanders shared Congress' perception that Narragansett Bay was in poor health and needed coordinated public action to restore and protect it for future generations. As a result, the NBP's mandate was explicitly broadened to require the development of a *CCMP* to restore and protect Narragansett Bay under the 1987 amendments to the federal Clean Water Act. The need for a comprehensive management plan that addresses the entire Narragansett Bay watershed is more completely documented in Section 715-02 ('State of the Bay') and Section 715-04 ('Issues and Strategies'). [A list of commonly used abbreviations and acronyms is given in Appendix A.]

01-02 History of the Project

The NBP program office was established in 1985 under the joint sponsorship of the EPA and the RIDEM to develop a comprehensive strategy to address water quality and living

resource problems throughout the watershed, based on a directed study of the Bay and its resources. Through the process described in Section 01-04, the NBP identified seven issues that required additional study and possible corrective action:

1. Impacts of toxic pollutants;

2. Impacts of nutrients and eutrophication;

3. Land-based impacts on water quality;

4. Health and abundance of living resources and habitat;

5. Fisheries management;

6. Health risk to consumers of seafood; and

7. Recreational uses of Narragansett Bay. (Korch *et al.*, 1989:1)

Based on these seven issues of concern, the NBP, with the advice and approval of the NBP's governing committees (See Section 01-03), then began a comprehensive and integrated course of scientific study to describe the geographic distribution, magnitude and source(s) of environmental, public health and use-related problems facing Narragansett Bay. Over 110 scientific and policy-related studies were funded by the NBP between 1985 and 1991, several of them in cooperation with other federal and state agencies with jurisdiction in the Narragansett Bay watershed. These studies provided the basis for further policy development and specific recommendations for corrective action.

Under the 1987 amendments to the Clean Water Act, the NBP was nominated for inclusion in EPA's National Estuary Program. On March 11, 1988, Mr. Lee Thomas, Administrator of the EPA, and Rhode Island Governor Edward D. DiPrete signed a 'designation agreement' that officially recognized Narragansett Bay as "an estuary of national significance," included the NBP as a member of the National Estuary Program, and committed the EPA and the State of Rhode Island to developing an implementable *Comprehensive Conservation and Management Plan* (*CCMP*) for Narragansett Bay.

The NBP continued to conduct scientific and policy-related surveys of the Bay and Bay basin following the 'designation agreement'. However, the Project also began to emphasize implementation of corrective actions. For example, the NBP:

1) established demonstration projects in the areas of nonpoint source pollution control ('Land Management Project'), toxic pollutant use reduction ('Hazardous Waste Reduction Project') and coordination of citizens' monitoring programs ('Citizens' Monitoring Project');

2) developed a Narragansett Bay Data System for the archival and analysis of long-term monitoring data;

3) developed planning tools for state and local resource managers such as a watershed-based pollutant loading model, technical guidance for delineation of buffer strips, and a mapped inventory of key coastal and subtidal habitats and species;

4) successfully competed for additional funds to develop a preliminary basin plan for Greenwich Bay, collect information to support basin planning efforts in Mount Hope Bay and the Blackstone River, and design and construct storm runoff controls on Interstate Highway 95;

5) participated on various state commissions involved with drafting legislation and/or developing statewide policy in the areas of water conservation, septage management, regionalization of municipal wastewater treatment facilities, protection of critical areas, and distribution of Aqua Fund bond funds for remediation of identified problems in Narragansett Bay; and

6) focused its public outreach program on implementation strategies for correcting identified environmental problems.

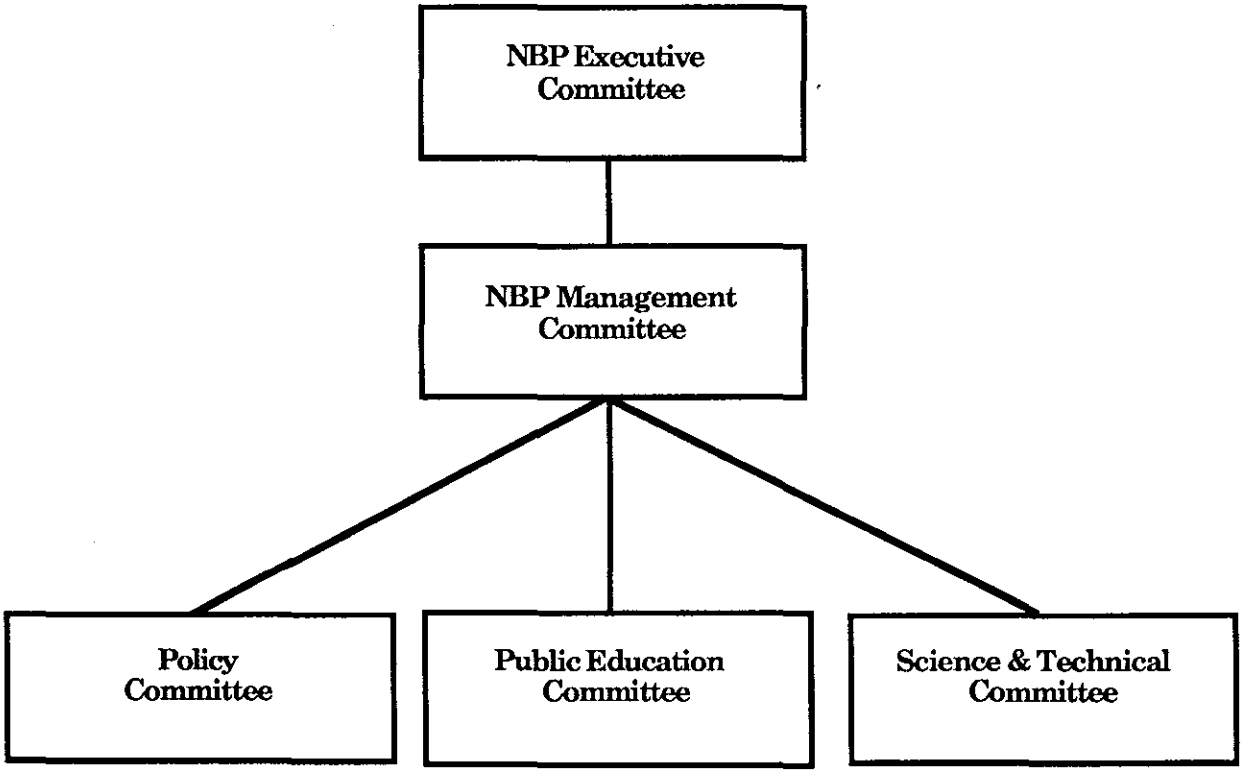
01-03 Project Governance

All activities of the NBP were governed by a hierarchy of advisory committees [Figure 715-01(1)]. The NBP Executive Committee, comprised of the Regional Administrator of the EPA Region I and the Director of the RIDEM, exercised ultimate decision-making authority regarding NBP policy direction between 1985 and 1990. In early 1990, the Executive Committee was expanded to include the Associate Director of the Rhode Island Division of Planning (RIDOP) and the Chair of the Rhode Island Coastal Resources Management Council (CRMC) as the NBP began to develop interagency agreements about implementation of the *CCMP*.

The NBP Management Committee was established in 1985 as the Project's primary decision-making body. The Committee provided broad representation to a diverse group of managers and users of Narragansett Bay in the interest of achieving the broadest possible consensus about the Narragansett Bay *CCMP*. Federal, state, and local officials from Rhode Island and Massachusetts as well as representatives from marine, land development and metals industry trade organizations; environmental and commercial fishing organizations; and academia were represented at the invitation of the Executive Committee. Since 60% of the Bay watershed lies in Massachusetts, Massachusetts representation on the Management Committee was crucial to the development of CCMP recommendations and the orchestration of subsequent implementation activities. [A complete list of NBP Management Committee members is given in Appendix B.] The more than 100 professionals who served on the Management Committee between 1985 an 1992 donated their time, energy, and ideas to help oversee all phases of the development of the *CCMP* from design

Figure 715-01 (1).

Structure of Narragansett Bay Project Advisory Committees



of the research program through completion of the final *CCMP*. The Management Committee, which reported to the Executive Committee, also established subcommittees to advise Project staff and the Management Committee on specialized issues in different areas of expertise. Standing NBP subcommittees included the Policy, Public Education, and Science and Technical Advisory Committees. A technical staff housed within the RIDEM administered the daily activities of the Project and reported to the Management Committee. [A complete list of NBP subcommittee members is provided in Appendix B. A complete list of NBP staff is presented in Appendix B.]

01-04 Process of Plan Development

At the heart of the Narragansett Bay Project was an extensive research effort to objectively identify environmental problems and trends in the Bay and Bay watershed. This was coupled with a deliberate effort to reach common agreement about goals for Narragansett Bay and an open planning process. Public opportunities to participate in the planning process included conferences and "roundtable" discussions, a review of *CCMP* research and recommendations by the broadly representative NBP Management Committee and relevant Bay constituencies, a series of public information meetings on the draft *CCMP*, in association with a 101-day public comment period, and a formal public hearing conducted by the Rhode Island State Planning Council (Korch *et al.*, 1989:1).

The *CCMP* planning process involved four major steps which are described in more detail below:

1) Research and (early) implementation projects;

2) Public participation;

3) Planning and preliminary review; and

4) *CCMP* review and approval.

(A schematic illustrating the entire *CCMP* development process from research through the adoption of the *CCMP* is shown in Figure 715-01(2).)

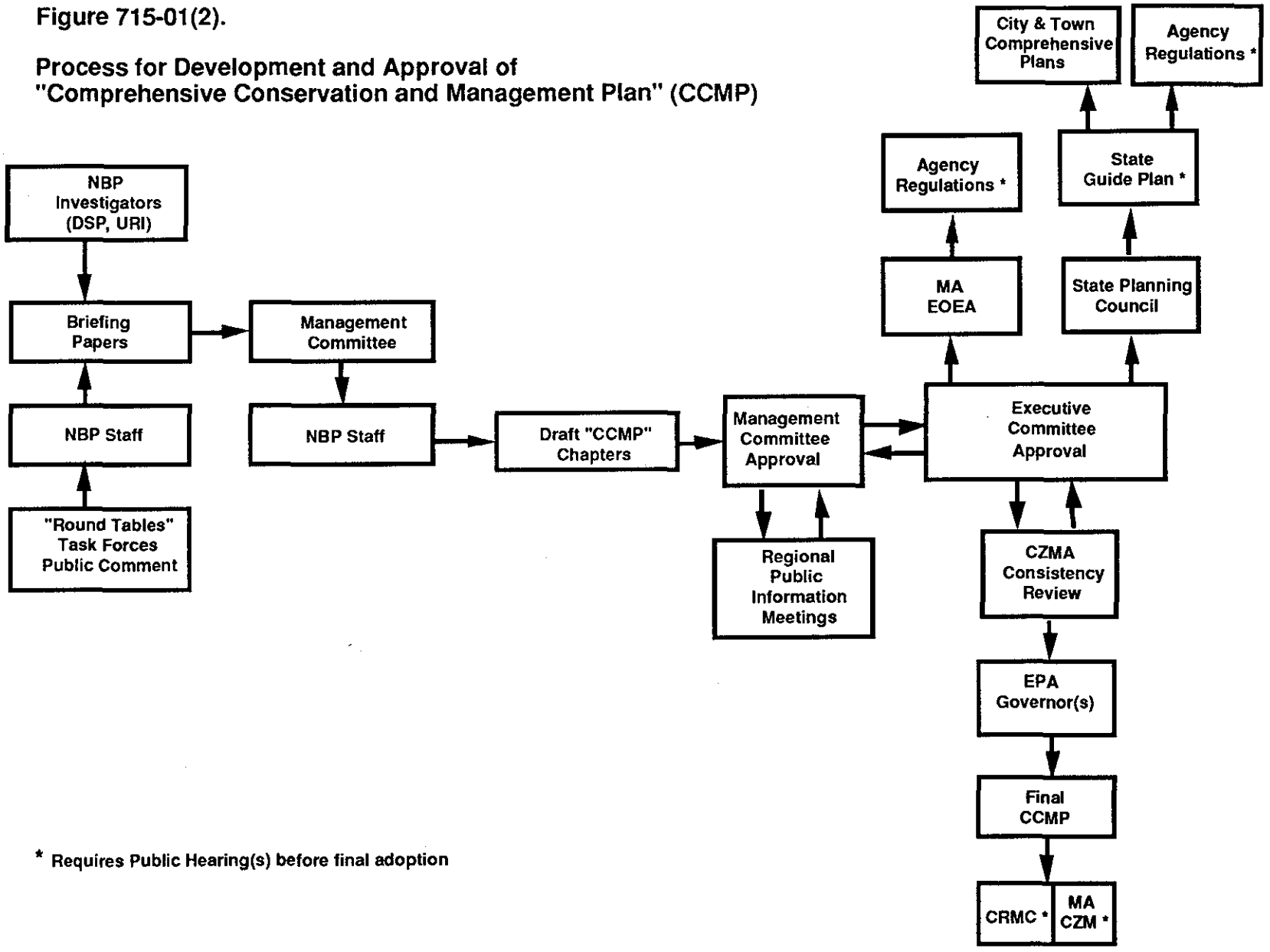
01-04-01 Research and (Early) Implementation Projects

The Narragansett Bay Project funded over 110 scientific and policy-related research projects from 1985 to 1991 in order to systematically examine the major issues of concern identified by the Management Committee and the general public. [See Section 01-04-02 regarding the NBP's process for identifying issues of concern and preliminary goals for restoring and protecting Narragansett Bay.] Research was conducted in the following areas: water and sediment quality, water quality modeling, land-use impacts on environmental quality, health and abundance of living resources and critical habitats, environmental policy and institutional analysis, and economics and public finance. [A bibliography of approved NBP research reports is given in Appendix C.] Approximately 75 percent of the NBP's entire budget went to supporting this research effort between 1985 and 1990. The remainder of the NBP budget went to program administration, public education, data management and supporting demonstration projects or "action plans". Beginning in 1990, the majority of NBP funds were used for development of the *CCMP*.

The NBP's research activities were planned by the NBP Science and Technical Advisory Subcommittee and the NBP staff, subject to Management Committee approval. Early studies focused on Bay-wide water quality trends and point source pollutant inputs. Later studies gradually narrowed to focus on specific geographic regions, pollution sources originating elsewhere in the watershed, and specific environmental problems and solutions. Every study was subject to extensive peer review and revision by the authors prior to publication. In addition, investigators were required to submit all original data for permanent archival in the Narragansett Bay Data System and/or the Rhode Island Geographic Information System (RIGIS). Copies of published technical reports were distributed to selected Rhode

Figure 715-01(2).

Process for Development and Approval of "Comprehensive Conservation and Management Plan" (CCMP)



* Requires Public Hearing(s) before final adoption

Island state depository libraries and major Rhode Island academic institutions. In 1988, the NBP received additional federal grant funds from the EPA to establish demonstration projects or "action plans". These demonstration projects were developed as pioneering efforts to begin implementation of eventual *CCMP* recommendations. The Hazardous Waste Reduction Project (HWRP) and the Land Management Project (LMP) were established in 1988; the Citizens' Monitoring Project (CMP) was started in 1990. The NBP also collaborated with various federal, state and local agencies during the *CCMP*-development process to secure funds to start implementation of some elements of the *CCMP*, and draft necessary legislation. These efforts are briefly described below.

The HWRP was designed to assist Rhode Island industries in reducing the use and disposal of toxic chemicals. The HWRP has since been incorporated into the RIDEM's Office of Environmental Coordination and has won several national and international awards for its pioneering efforts in working with area industries, universities and agencies to demonstrate the economic and environmental benefits of source reduction.

The LMP was developed to assist Rhode Island cities and towns in managing growth and development to control nonpoint sources of pollution. LMP staff also worked with state agencies to provide technical assistance to Rhode Island cities and towns during the development of local comprehensive land use plans. The LMP worked with municipalities and the development community to document 'best management practices' (BMPs) and test educational materials such as model growth management ordinances.

The CMP was established in 1990 to act as a liaison between citizens' monitoring groups and state water quality regulators. The CMP focused its early efforts on persuading state officials to use citizen-generated data in the *State of the State's Waters (305(b))* water quality planning report, and to identify water quality problems requiring possible regulatory action. The CMP was also instrumental in expanding the existing network of citizens' monitoring programs to include coastal waters.

The NBP also worked closely with various federal, state and local agencies during the *CCMP* planning process to begin early implementation of *CCMP* initiatives, where possible. In some cases, the NBP worked with other agencies to develop additional scientific information needed in order to begin implementation of the *CCMP*. For example, the NBP cooperated with the Massachusetts Coastal Zone Management Agency (MACZM) and the Rhode Island Coastal Resources Management Council (CRMC) to secure funds for water quality surveys in the tidal portion of the Taunton River to support future basin-planning efforts. The NBP worked with the EPA, the RIDEM and the Massachusetts Department of Environmental Protection (MADEP) in 1991 to perform river-wide water quality surveys of the Blackstone River to support future wasteload allocations for metals and nutrients.

The NBP also initiated or assisted with actual implementation of *CCMP* recommendations. For example, in 1990, the NBP was awarded a grant from the Rhode Island Aqua Fund Council to develop a preliminary basin plan for Greenwich Bay, and subsequently negotiated an interagency agreement between the RIDEM and the CRMC for completion of the basin plan. The NBP also worked with *Green Rhode Island* to develop draft legislation on mandatory water conservation; with the Governor's Blackstone Valley District Commission/Narragansett Bay Commission Study Committee on Regionalization to develop recommendations regarding the merger of two Rhode Island wastewater treatment authorities; and with the RIDEM to develop legislation on regulation of vessel discharges and designation of "no discharge areas". All three bills were passed by the Rhode Island General Assembly in 1991. NBP staff also drafted legislation for submittal in the 1992 or 1993 legislative session to require Rhode Island municipalities to establish wastewater management districts' to manage septage wastes generated by on-site sewage disposal systems. NBP staff are also working with the Rhode Island Association of Realtors to draft a

"seller disclosure" law to require property owners to report the status of on-site sewage disposal systems to prospective buyers.

01-04-02 Public Participation

From the Project's inception, the Management Committee and NBP staff conducted an open and accessible planning process to help draft a comprehensive plan that was principled, but also realistic and achievable. The Bay Project routinely sought advice from Bay user groups, including fishermen, quahoggers, boaters and industry trade organizations, as well as from environmentalists, scientists, developers, planners and government regulators. Representatives from these and other groups also participated in NBP-sponsored environmental review panels and public outreach programs, and on the Management Committee itself (Korch *et al.*, 1989:3).

There were three overall goals of the NBP's public outreach/education program in conformance with the mandate of the National Estuary Program. The NBP's first major public outreach initiative was to develop common agreements about issues of concern and goals for restoring and protecting Narragansett Bay. The NBP commissioned a public opinion survey in 1986 and a series of goal-setting workshops in 1987 in order to determine whether common agreements existed regarding goals for restoring and protecting Narragansett Bay. The results of these efforts were used by the NBP Management Committee to prioritize Project goals and define the scope of the Project's research and planning activities. The Project's goals were periodically reviewed by the Committee based on information from the studies and the NBP's on-going public outreach activities. The NBP conducted a follow-up public opinion survey in the fall of 1991 in order to determine whether the public's perception about Bay water quality, priorities for corrective action, or willingness to pay had changed since 1986.

The second major goal of the NBP's public participation program was to educate and inform the general public about the need for a comprehensive plan for Narragansett Bay. With advice from the NBP Public Education Subcommittee, the NBP made a concerted effort to inform the public about the NBP planning effort and the Project's major research findings. For example, the NBP maintained a 5,000 person mailing list, an information hot-line, and an extensive publications file. The Project produced and distributed news releases, fact sheets (*Current Facts*), a series of newspaper articles (*Baywatch* and *Bay Action Plans*), a newsletter (*Currents*), annual progress reports, and videotaped and arranged the broadcast of panel discussions on major issues. The NBP staff also gave presentations at national, regional and local meetings and participated in public events such as Earth Day, the Rhode Island Boat Show, and the Providence Waterfront festival. These public education/public information efforts were conducted continuously from 1985 through adoption of the *CCMP*. [A list of the NBP's public outreach activities is presented in Appendix D.]

The third goal of the NBP's public participation program was to establish general agreement on realistic and achievable strategies and schedules for implementing the *CCMP* in order to assure that the implementing authorities performed their obligations as described in the Plan (Planners Collaborative, Inc. *et al.*, 1990). Roundtable discussions were conducted with government officials and representatives from the shellfish, metals and recreational boating industries; Blackstone River constituencies; and the land development community beginning in 1990. The roundtables were used to present scientific findings and preliminary recommendations to concerned constituencies, and to develop early agreements about *CCMP* implementation strategies. The NBP also worked with the staffs from other agencies, including the NBP's demonstration projects, to disseminate information about workable techniques for controlling pollution sources. For example, in 1990 the NBP, in cooperation with the Land Management Project, the RIDEM Nonpoint Source Pollution Management Program, and other organizations, co-sponsored *Designs for a Better Bay*, an awards program to recognize achievements in environmentally sensitive land use

design and development. This effort generated broad interest that resulted in similar design competitions in other estuary programs. In addition, the NBP, in cooperation with RIDEM's Ocean State Cleanup and Recycling Program, produced a wallet-sized *Clean Water Shopping Guide* to help people choose environmentally safe household products. Over 65,000 wallet guides were distributed with the assistance of New England Electric, the Narragansett Bay Commission, and other sewer and water authorities. The NBP also worked with Save The Bay and area communities to stencil storm drains tributary to the Bay with a "no dumping" warning. Finally, the NBP coordinated public review and comment on the draft *CCMP* following its release on January 10, 1992 (See Section 01-04-04). [See Appendix D, Part 1 for a list of NBP public outreach activities related to the draft *CCMP*.]

01-04-03 Planning and Preliminary Review

In mid-1990, following the substantial completion of the NBP's scientific investigations, the NBP Management Committee began to develop recommendations for abating identified problems in Narragansett Bay. Because of the scope and complexity of the available scientific information, the NBP staff prepared seventeen 'briefing papers' that summarized the relevant scientific information and proposed alternative strategies for addressing identified environmental, public health and/or use-related problems. The briefing papers were subject to technical review prior to distribution to the Committee for discussion. The Committee generally limited its review to discussion of controversial recommendations that one or more Committee members disagreed with and were unable to resolve with the staff. After review and approval, each briefing paper was published with minutes of the Management Committee meetings, summaries of decisions, and lists of Committee participants. [See Appendix C for a list of NBP publications, including briefing papers.] Recommendations approved by the Management Committee were forwarded to the Rhode Island Division of Planning (RIDOP) for incorporation into the *CCMP*.

The Management Committee began the process of prioritizing *CCMP* goals and strategies in 1991 after approximately half the briefing papers had been reviewed and preliminary cost and public finance information became available. In a series of facilitated discussions in June and November 1991, the Management Committee prioritized goals and objectives, agreed on which strategies would be expected to produce the greatest and most cost-effective environmental benefit over a five to ten year planning horizon, and identified 16 specific actions as the highest priority for implementation in the first two years after *CCMP* approval. Related recommendations were subsequently combined into the ten priority actions presented in the Executive Summary. Related high priority recommendations are also identified in each chapter (715-04, 715-05) with a checkmark and bolded text. The Committee's deliberations resulted in the draft *CCMP* which was subsequently distributed for public review and comment in January 1992.

01-04-04: *CCMP* Review and Approval

The NBP Management Committee conducted public review and comment on the draft *CCMP* in four phases. As the *CCMP* was being developed, the Project organized briefing sessions with targeted interest groups, government officials, and citizens throughout the Narragansett Bay area. In addition, between October 1991 and February 1992, Project staff presented the entire draft *CCMP* to the Technical Committee of the Rhode Island State Planning Council. These sessions were used to develop preliminary agreements about recommendations in the Plan. The NBP also conducted a major outreach effort to acquaint the general public with the Project's findings and solicit comment on proposed solutions.

The second phase of public review and comment commenced with the official release of the draft Narragansett Bay *CCMP* at a Rhode Island State House ceremony presided over by Governor Bruce Sundlun on January 10, 1992. A public notice announcing the release of the draft *CCMP*, the duration of the comment period, and the time and location of public information meetings, was published in

the Providence-Journal Bulletin newspaper on the same date. The original comment period extended from January 10, 1992 to March 2, 1992. In response to agency requests, the comment period was reopened for 30 days beginning on March 20, 1992. The extension of the comment period was also published in the Providence Journal-Bulletin, effectively resulting in a 101-day public comment period. [See Appendix D, Part 1 for a complete list of NBP public outreach activities related to the release of the draft *CCMP* for public comment.]

In association with the release of the draft *CCMP*, over 100 copies of the draft plan were distributed to NBP Committee members, the Rhode Island State Planning Council, municipal representatives and others. The draft *CCMP* was also distributed to thirteen public libraries in Rhode Island and Massachusetts. In addition, over 12,000 brochures and 2,200 *CCMP* "pocket summaries" were distributed to the Project's mailing list and interested members of the public at the beginning of the public comment period in order to promote interest in the public information meetings. The NBP also promoted the availability of the draft *CCMP* and the public information meetings through radio and television interviews and public service announcements, and a series of press releases and newspaper articles. Between February 11th and April 9th, the NBP conducted six formal public information meetings in Rhode Island and the Massachusetts portion of the Bay watershed. The purpose of the public information meetings was to present an overview of the draft *CCMP* and invite public comment. Over 150 people attended these meetings. In addition, Project staff made presentations on the draft *CCMP* to various special interest groups, state agencies and public officials. [See Appendix D, Part 1 for a complete list of NBP public outreach activities related to the release of the draft *CCMP* for public comment; and Appendix G for a transcript of public comments and proceedings of public information meetings.]

The third phase of the *CCMP* approval process involved compiling and responding to comments received on the draft *CCMP*. Written comments were submitted by 38 individuals and organizations between January and May 1992. After Management Committee review and discussion of the staff's response to comments, the draft *CCMP* was revised and returned to the NBP Management and Executive Committees for approval. [See Appendix E for a summary list of commenting individuals and organizations; Appendix F for a summary of NBP response to comments; and Appendix G, Parts 1 through 4 for the full text of comments.] The revised final *CCMP* was then submitted to the EPA Administrator and the Governor of Rhode Island for approval.

The draft Plan was simultaneously presented to the Rhode Island State Planning Council for review as an element of the *Rhode Island State Guide Plan*, The public hearing scheduled by the Rhode Island Division of Planning as part of the State Planning Council's deliberations represented the fourth and final phase of the public review process. The notice of public hearing was published in the Providence Journal-Bulletin on May 28, 1992. The hearing, held on June 17, 1992, solicited public comment on the draft *CCMP*, including the NBP's *Response to Comments Received as of April 24, 1992* and the draft Narragansett Bay *CCMP Funding Strategy*. These comments were considered by the State Planning Council in making final revisions to the *CCMP* as an element of the *Rhode Island State Guide Plan*.

715-02 BACKGROUND: STATE OF THE BAY

Narragansett Bay is often referred to as "Rhode Island's most important resource." This statement acknowledges that the Bay and its associated watershed continue to supply the region with an abundance of seafood, secure transportation routes and sheltered harbors, and lovely places to live and play. However, Narragansett Bay and its tributaries are also "working" bodies of water because they are also relied upon to supply the region with energy, drinking water and a receptacle for receiving and diluting much of the region's industrial, commercial, and municipal wastes.

Like other urban and urbanizing estuaries, the health of Narragansett Bay has been compromised by some of these uses. However, in recent years, some of these threats have been abated or eliminated. For example, the U.S. Environmental Protection Agency (EPA) and the states of Rhode Island and Massachusetts have invested heavily in converting most of the region's wastewater treatment facilities to secondary treatment, resulting in improved water quality. In addition, many industries in the region have modified their manufacturing and disposal practices and have significantly reduced the discharge of toxic pollutants into the Bay and its tributaries. Many communities in the Bay watershed are also beginning to grapple with the environmental consequences of growth and development.

But other pressures continue to stress Narragansett Bay. Population growth and development throughout the region have increased pollutant loadings to suburban and rural as well as urban portions of the Bay. Fisheries stocks have declined, and sediments in some areas are severely contaminated. Environmental and public health problems related strictly to population growth are not likely to disappear, since population is expected to increase within the Narragansett Bay watershed, particularly in rural and coastal areas (RIDOA, 1989a).

Although there is evidence that water quality has improved in some areas of the Bay in recent decades (see, for example, Karp *et al.*, 1990; Nixon, 1990, 1991; Metcalf & Eddy, Inc., 1991b; Penniman *et al.*, 1991a, 1991b), the pressures posed by projected population growth and development in the Bay basin must be addressed. Federal, state and local government must prepare for the projected growth in the region by protecting critical habitats. Although many point sources of pollution have been controlled, government must begin to regulate important nonpoint sources of pollution and the environmental consequences of growth and development. In addition to addressing current problems, the region also must attempt to prevent future problems from emerging. All levels of government and the public will have to act systematically and in concert to protect and restore this "estuary of national significance."

The purpose of "State of the Bay" is to summarize existing background knowledge about the environmental problems facing Narragansett Bay in order to establish the framework for the corrective actions recommended in Parts 715-04 (Issues, Objectives, and Strategies) and 715-05 (Implementation) of the *CCMP*. Based on information collected by the Narragansett Bay Project (NBP) and others between 1985 and 1991, this section describes the (1) physiographic setting of Narragansett Bay; (2) the history and current uses of the Bay; (3) pollutant sources, status, and trends; (4) living resources and critical habitats; (5) public health concerns; (6) governance by federal, state, and local authorities; and (7) priorities for action.

02-01 Physiographic Setting

Estuaries are semi-enclosed bodies of water, open to the sea. Within estuaries, seawater is diluted by the fresh waters carried by rivers and draining from coastal lands. Estuaries are productive biological regions, habitats, and breeding grounds for fish, shellfish, and many other organisms.

Narragansett Bay covers 147 square miles of water surface (Figure 715-02(1)). Its water-

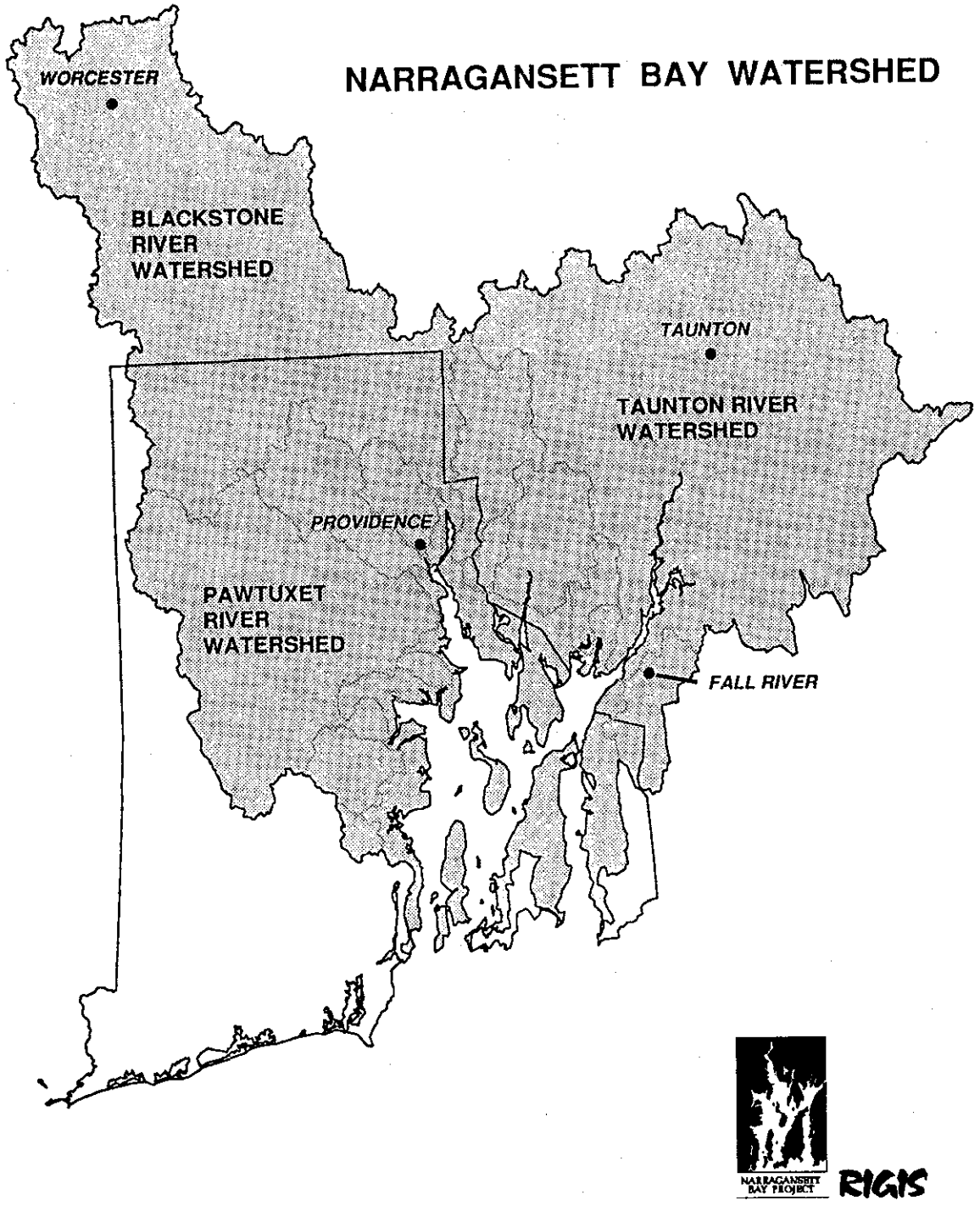


Figure 715-02 (1). **Narragansett Bay watershed in Rhode Island and Massachusetts. (Map provided by NBP, RIGIS.)**

shed comprises 1,657 square miles, 61 percent of which is in Massachusetts and 39 percent in Rhode Island. Major cities within the watershed include Worcester, Fall River, Taunton, and Brockton, Massachusetts; and Providence, Woonsocket, Cranston, Warwick, and Newport, Rhode Island.

When the last glaciers retreated northward from New England about 10,000 years ago, what is now Narragansett Bay was a series of streams and upland areas. The glaciers had reached as far south as the current Long Island, Block Island, and Martha's Vineyard. Those islands are all parts of terminal moraines, great mounds formed when the glaciers dropped the rocks, cobbles, gravel, and sand they had scraped off the New England landscape. Smaller moraines were formed farther inland, at points where the glaciers paused in their retreat. These moraines formed the low hills along the southern shore of Rhode Island.

As the glacial ice melted, sea level rose, flooding three river valleys and forming Narragansett Bay. Sea level continues to rise in the region, at a rate of about one foot each century. Some scientists believe that global warming could increase the rate of sea level rise to as much as eleven feet each century.

Narragansett Bay connects with Rhode Island Sound through the three ancient, drowned river valleys, the East and West Passages and the Sakonnet River (Figure 715-02(2)). East Passage is the deepest valley, averaging 50 feet (15.3 meters). In contrast, the average depth of the Bay is 27 feet (8.3 meters), and West Passage averages 25 feet (7.6 meters). East Passage provides deep water access for large vessels as far as Prudence Island, and dredged channels allow further passage to ports on the Providence and Taunton Rivers.

02-01-01 Freshwater Inputs

Total freshwater input to the Bay has been estimated to be approximately 2,400 million gallons per day (MGD) (Pilson, 1985; Ries, 1990). Most of the freshwater entering the Bay, about 80 percent of the total flow, comes from Bay tributaries which are recharged by approximately 46 inches of annual precipitation (Ries, 1990; Pilson 1991). Other freshwater sources include direct precipitation on the Bay (310 MGD), wastewater treatment facilities (WWTFs) (248 MGD or 98 billion gallons per year), and combined sewer overflows (CSOs) (4 billion gallons per year). Groundwater and suburban stormdrains also contribute an unknown volume of freshwater. The Blackstone, Taunton, and Pawtuxet Rivers account for 63 percent of the total measured input of freshwater. Smaller rivers and streams, including the Woonasquatucket, Moshassuck, Ten Mile, Palmer, and Hunt Rivers account for the rest of the riverine flow, but do not contribute substantially to the total flow of water (Figure 715-02(3)) (Ries, 1990).

Water flowing from the rivers in the system is modified by dams and diversion of water from stream basins. Important flood control and water supply reservoirs within the watershed include the West Hill Dam Reservoir on the West River, near Uxbridge, Massachusetts, and the Scituate Reservoir on the North Branch of the Pawtuxet River. Water from the Taunton River is diverted to supply the City of New Bedford with drinking water. Water from the Nashua River watershed is used to supply the City of Worcester with drinking water, which is subsequently discharged to the Blackstone River as effluent from the Upper Blackstone Water Pollution Abatement District (UBWPAD) WWTF (Ries, 1990).

Direct precipitation onto the Bay surface accounts for approximately 13 percent of the freshwater input (the equivalent of 310 MGD) to the Bay. An additional 10 percent, about 248 MGD, comes from the 33 WWTFs, that discharge directly into the Bay or Bay tributaries (Karp *et al.*, 1990; Ries, 1990). Of this amount, approximately 52 percent is from Rhode Island facilities, and the remainder is from Massachusetts. The Narragansett Bay Commission's (NBC) Field's Point and Bucklin Point facilities, and the UBWPAD contribute the greatest volumes of wastewater. Total annual inputs of freshwater

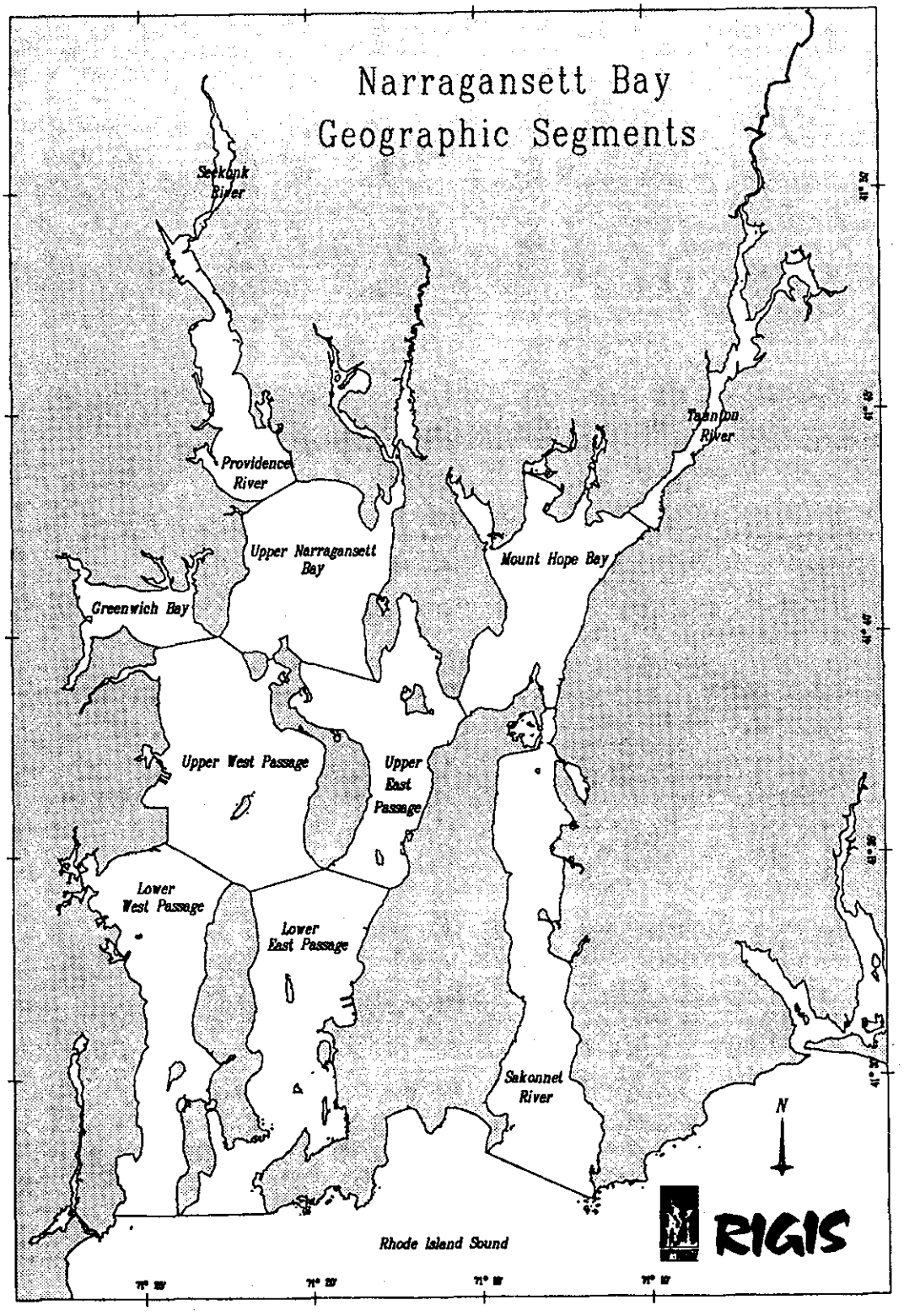


Figure 715-02 (2). Geographic segments of Narragansett Bay. (Map provided by NBP, RIGIS.)

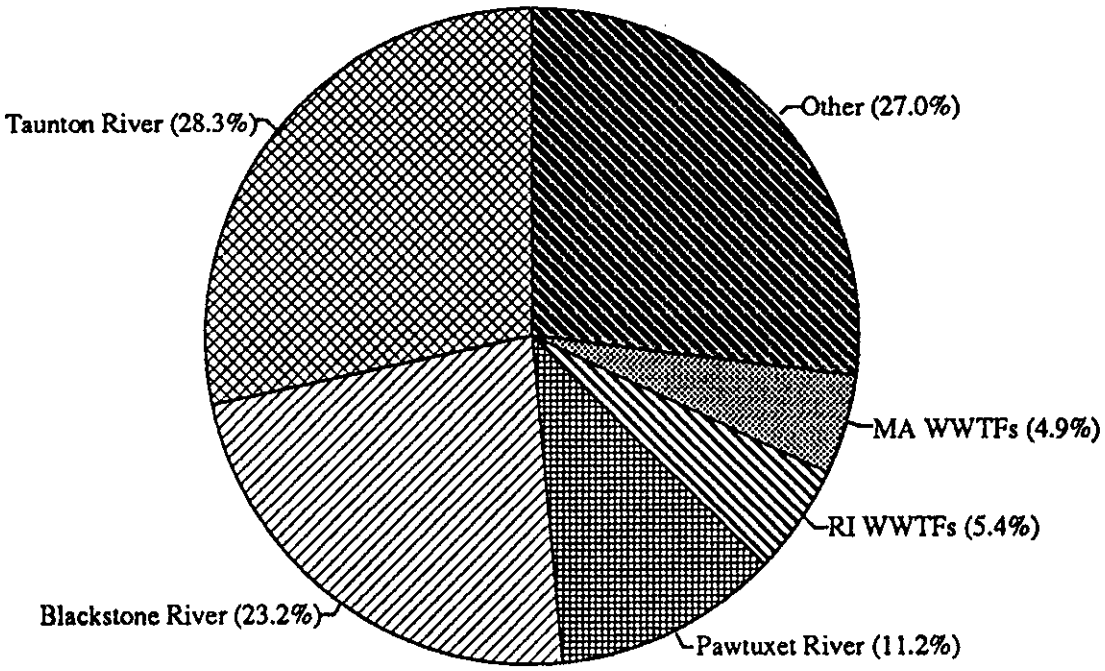


Figure 715-02 (3). Sources of freshwater to Narragansett Bay displayed as percentage of total annual freshwater input. (Data from Ries 1990 and Penniman *et al.*, 1991a.)

from CSOs (approximately 4 billion gallons per year) are small compared to inputs from the WWTFs (approximately 98 billion gallons per year), but during storms, they may contribute significant amounts of water (Metcalf & Eddy, Inc., 1991b). Flow of groundwater directly into the Bay has not been measured.

02-01-02 Circulation

Circulation of water within the Bay is complex, but important to understand because these circulation patterns affect the distribution of sediments, nutrients, pollutants, and microscopic floating plants and animals in the Bay. Because most freshwater sources are at the head of the Bay, there is a salinity gradient, with fresher waters in the Upper Bay and saltier water in the Lower Bay.

Freshwater is less dense than saltwater. Therefore, freshwater from the rivers tends to float on top of the saltwater, gradually mixing as it moves seaward. The currents, produced by this seaward flow, called nontidal currents, move at speeds of less than one half knot. They are, in part, responsible for moving water out of the Bay and into Rhode Island Sound, a process that takes between ten and 40 days. The average residence time of a molecule of water in the Bay is 26 days (Pilson, 1985).

Although the net movement of water in Narragansett Bay is downstream from the rivers to Rhode Island Sound, tidal currents also mix Bay waters. Tidal currents are the most important force mixing Bay waters and also help to move water in and out of the Bay. Tides are caused by the gravitational pull of the moon and the sun and the earth's rotation, and they cause the waters of the Bay to rise

and fall three to four feet every 12-and-a-half hours. Tides travel up the Bay like a wave, so high tide in Providence is about 20 minutes later than high tide in Newport. Tidal currents average one-and-a-half knots, and are even faster in certain areas.

Winds also play an important, although sporadic, role in circulation. During the summer, southwesterly winds dominate in the Bay. In the winter, most winds are northwesterly. Average wind speeds are highest in December and January, and result in accelerated movement of water out of the estuary and into Rhode Island Sound.

02-01-03 Sediments and Coastal Features

The glacial deposits of Narragansett Bay are overlain by a layer of material that has washed down into the Bay from its rivers. Rivers and the erosion of coastal bluffs provide most sedimentary material to the Bay. In general, there are finer-grained materials in the Upper Bay than there are at the mouth (Figure 715-02(4)) (McMaster, 1960; French *et al.*, 1992). The Providence River and protected harbors and coves of the Bay also contain finer-grained sediments. Areas with fine-grained sediments are likely sinks for particle-associated toxic pollutants in the Bay.

The cobble shores along most of Narragansett Bay are a reminder of the glacial deposits that helped form the area. The most common type of shoreline found around the Bay is a narrow beach of gravel and cobble that backs up to a scarp or bluff composed of glacial till. Sandy beaches are found along the ocean shores at the mouth of the Bay and in a few areas such as Conimicut Point in the Bay's interior. Rocky shorelines are found at Beavertail, Common Fence, and Brenton points. In protected areas where sediments accumulate, salt marshes fringe the shoreline (McMaster, 1960; French *et al.*, 1992).

Another important shoreline feature are the manmade structures that line approximately 25 percent of the shore. These structures include bulkheads or seawalls that were designed to prevent erosion. However, most coastal erosion in the Bay results from major storms, such as hurricanes. Sometimes these structures actually hasten erosion by concentrating the wave energy in the area of the barrier.

02-02 History and Uses of the Bay

The oldest signs of human habitation in the Narragansett Bay area are about 3,300 years old. These remains were discovered on Conanicut Island. Europeans may have come to the area as early as Viking times, and Narragansett Bay may have been visited by the Englishman John Cabot in 1498. However, the first confirmed exploration of the Bay was by Giovanni da Verrazano in the ship *Dauphine* in 1524.

In 1635, Roger Williams, banished from the Massachusetts Bay Colony for his zealous desire to reform its church, landed by canoe on a peninsula called "Mooshassuc," a point where the City of Providence now stands. He was welcomed by the local Indians, who according to legend invited him to dine upon succotash and boiled bass. In 1644 Roger Williams obtained an official charter, incorporating the "Providence Plantations In Narragansett Bay."

The history of Narragansett Bay is one of rapid and intense population growth, accompanied by changes in land use, industrialization, and increased use of the Bay. The many and varied commercial uses of Narragansett Bay (Table 715-02(1)) contribute to the economic value of the Bay to the State of Rhode Island and the region. However, these uses sometimes conflict resulting in the degradation of Bay resources, and consequently impairment of water quality dependent uses of the Bay.

02-02-01 Population Growth

At the beginning of the 1800s, the rate of population growth was greater in Rhode Island than in any other New England state. Today, partially as a result of the industries that have prospered in the region, 1.8 million people live within the Narragansett Bay watershed, about half in Massachusetts and half in Rhode Island (Figure 715-02(5)). The area is densely populated, with 1,109

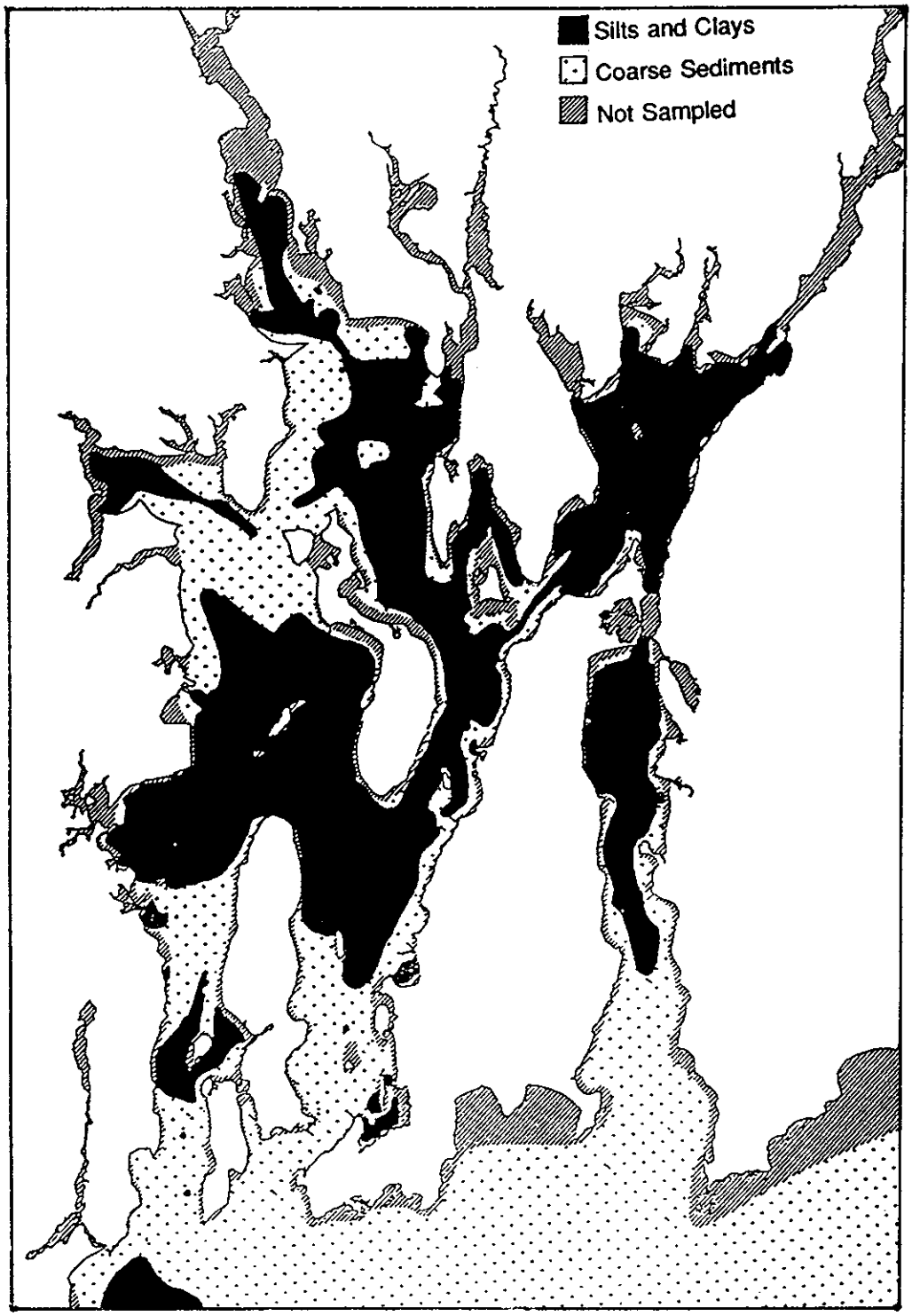


Figure 715-02 (4). Distribution of sediments in Narragansett Bay. (Data from McMaster, 1960.)

Table 715-02 (1). Estimated annual revenues associated with Narragansett Bay. (Data are from Rorholm and Farrell, 1992, and are in thousands of 1982-1984 dollars.)

SOURCE	1967	1979	1989
Navy, except education	646,132	103,004	383,123
Marine Education, R & D	106,919	251,891	220,759
Marine Transportation	144,234	199,927	140,968
Bridges	3,257	6,335	8,631
Commercial Fishing	6,611	34,444	42,308
Marine Industry	179,659	518,821	637,365
Marine Recreation	78,766	121,975	146,761
Waste Disposal	21,557	21,664	31,111
TOTAL	1,187,135	1,258,061	1,611,026

people per square mile. In comparison, the nearby Buzzards Bay watershed in Massachusetts has only 613 people per square mile (NOAA, 1990).

Although Providence, Fall River, Worcester, and Brockton remain the most populated areas in the Narragansett Bay watershed, population growth is now greater in the suburban and rural areas. From 1960-90, population in Rhode Island's cities actually decreased by an average of four percent, while it almost doubled in the average town (RIDOA, 1989a). Although population growth has slowed in recent years, it is expected to continue well into the twenty-first century, with statewide growth of 9.5 percent projected over the years 1985-2010. Population growth is expected to continue to be greatest in the coastal and rural towns of the watershed (RIDOA, 1989a).

02-02-02 Changes in Land Use

As the population of Rhode Island has grown, the look of its landscape has also changed. Native Americans cultivated some of the land before the arrival of European settlers. During colonial times, about 75 percent of the state was cleared for agriculture. By 1935, however, about a third of this cleared land was no longer cultivated, and forests grew back from fields (RIDOA, 1989a). Since then, much of the area has become urbanized, and now about 36 percent of the total land area of Rhode Island is developed, seven percent is agricultural, and with the remainder forest, wetlands, and "open space" (Dixon *et al.*, 1991; RIGIS, 1991).

The number of housing units in the Narragansett Bay watershed has grown even faster than its population (Figure 715-02(6)). In Rhode Island's cities, the average number

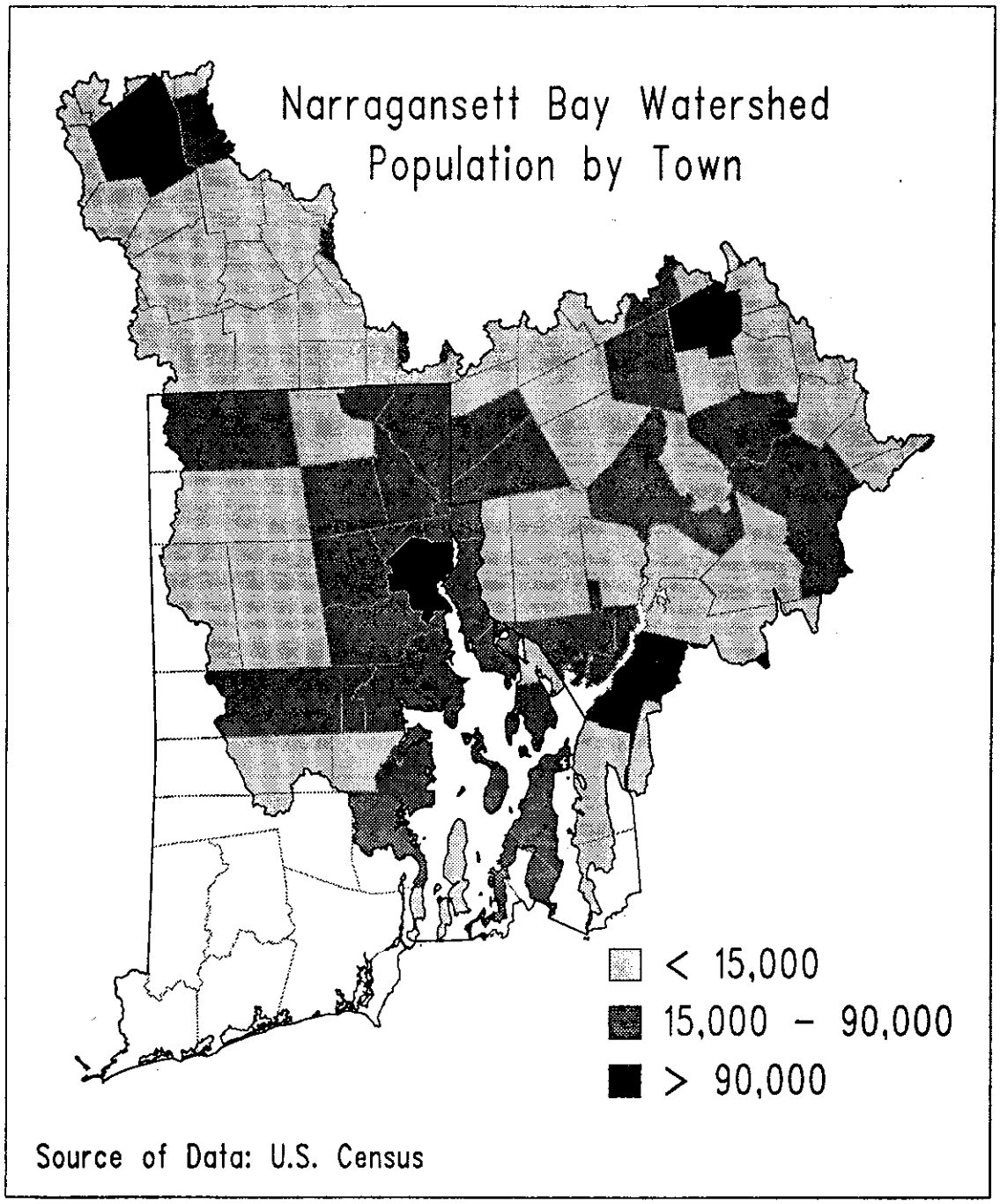


Figure 715-02 (5). **Narragansett Bay watershed population by municipality according to the 1980 census. (Map from NBP, RIGIS.)**

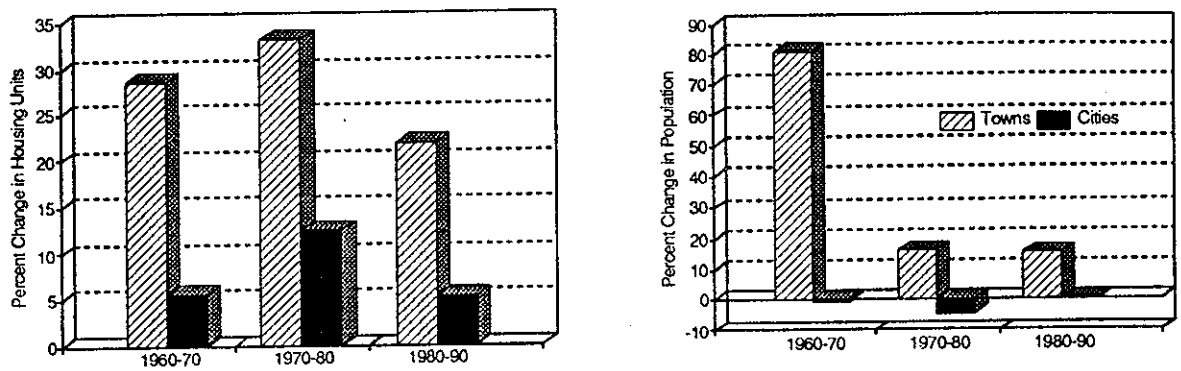


Figure 715-02 (6). Changes in population and number of housing units in Narragansett Bay cities and towns over 1960 to 1990. (Data from NBP.)

of housing units increased by an average of 27 percent during 1960-1990. In the towns, the average number of houses more than doubled during the same period. Similar to other areas of the country, the average size of a household has declined substantially since 1970. During the same period, average sizes of house lots have grown, spreading development farther into once-rural areas of the watershed. Growth is expected to be slower in the 1990s than it was in the 1980s, but increased pressures are expected to continue in rural and coastal communities (RIDOA, 1989a).

02-02-03 Ships, Shipping, and the Navy

Even before Rhode Island became a colony, Dutch settlers had established trading posts along Narragansett Bay. Shipyards were active by 1646, and the shipping trades of Newport and Providence prospered. During colonial days, shipping dominated the Rhode Island economy, largely due to the lucrative rum/slave trade.

During the 1830s, the economic influence in Rhode Island shifted from shipping to textile manufacturing. Although, shipping remained an important means for importing raw materials to the region and exporting textiles, shipbuilding declined substantially. Today, most shipping in the Narragansett Bay region consists of petroleum, automobile, and lumber imports. Oil imports reached a peak in 1973, just before the Arab oil embargo plunged New England into a period of oil and gas shortages.

Beginning in 1979, investments were made to bring container ships to Rhode Island, opening the state to nonpetroleum imports. Relatively few goods are now exported from Rhode Island by ship or barge. However, in Rhode Island in 1987 more than $64 million were spent on buying boats and boat-related equipment. Marine transportation revenues have been estimated as $171 million in 1989. Toll receipts at the bridges spanning the Bay totaled $8 million in 1989. Marine industry, including ship and boat building, marine equipment, and production of fresh and frozen fish products accounted for $679 million (Rorholm and Farrell, 1992).

A military presence has been important in Narragansett Bay since the Revolutionary War. Throughout most of the history of the United States, coastal forts were an important part of the defense of the nation. After World War I, such defenses became outmoded. However, the Navy maintained a strong

presence in Narragansett Bay which peaked in 1941 to 1946 during World War II. In 1973, the Navy substantially reduced its facilities in Narragansett Bay. However, Naval activities remain a significant part of the regional economy. The Navy is closing additional bases, some of which are potential EPA Superfund sites, because they are contaminated with toxic pollutants.

Wages and salaries for naval personnel, contracts and other procurements, and minor aid to local schools totaled $383 million in 1989. Approximately 29 percent of that amount was spent on direct personnel payments, the remaining 71 percent on contracts. This value represents an increase over the preceding decade, although the total spent by the Navy is less than it once was.

The Navy, along with federal and state governments, also funds marine education and research and development. Approximately $221 million in salaries, wages, supplies, and equipment was spent in naval education, federal laboratories in Narragansett, the University of Rhode Island's marine programs, and other state laboratories.

02-02-04 Industry

During the 1790s, Rhode Island became the center of the American Industrial Revolution. Samuel Slater's introduction of a primitive factory system to Moses Brown's textile mill in Pawtucket, Rhode Island, is often cited as the Industrial Revolution's beginning in the United States. The mill harnessed the energy of the Blackstone River to spin cotton into thread.

At first, the Industrial Revolution spread slowly, but with government needs for the War of 1812 and the inventions of the power loom and machinery to clean cotton, the Rhode Island cotton industry expanded dramatically. By 1860, both the woolen and the cotton industries were dominated by the factories that lined the shores of the Blackstone River.

With the growth of the textile industry came comparable growth in the production of machinery and machine tools. David Wilkinson, who made the castings for Slater's first carding machines and later developed the power loom, also invented the American industrial lathe and was an early experimenter with steam power. In 1793, he cast and assembled a steam engine that powered a paddleboat on the Providence River. He installed a steam engine in his own mill in 1810.

The expansion and diversification of the Industrial Revolution were apparent throughout the Narragansett Bay watershed, but were concentrated in the upper portions of the Bay and along the major rivers. Metal industries were interspersed with the textile industry along the Blackstone and Pawtuxet rivers and in Providence. Farther up the Blackstone River, the City of Worcester, Massachusetts, became a center for manufacturing textile machinery.

With the outbreak of the Civil War, Rhode Island began to manufacture munitions for the Union Army and boilers for the Navy, in addition to textiles. The return of peace brought an even greater prosperity, when firms that had become established during the war diversified into the manufacture of locomotives, tools, and sewing machines.

Providence jewelers also prospered after the Civil War, overtaking cotton manufacturing as the city's leading industry in 1880. The precious metals industry had its beginnings in the late 1700s, when Seril Dodge began to manufacture silver buckles, and his brother Nehemial Dodge opened a jewelry, clockmaking, and goldsmith shop. By 1880, Providence could call itself the "jewelry capital of the world."

In the more than a century that has followed 1880, industry has become more diversified, and manufacturing has declined to a smaller share of the economy of the region. In 1990, 332,000 Rhode Islanders were employed in the service industries, while only 118,000 were employed in manufacturing.

02-02-05 Fishing

Fishing was undoubtedly important to the Native Americans who lived along Narragansett Bay's shores before the arrival of European colonists. Archaeological excavations on Conanicut and Block Islands show the importance of seafood in the region. Tales from colonial times paint pictures of a Narragansett Bay teeming with sea life, of lobsters that could be caught by hand at low tide, of vast schools of bluefish and cod, and of dense beds of oysters and clams.

Early colonists caught fish on hook and line or with small seines. During the second half of the 1800s, floating and staked traps blocked large parts of the Bay. Concern that these traps could decimate fish stocks led to strict restrictions on their use. During the 1930s, trawlers began to drag the bottom of the Bay for fish.

Oysters were once abundant in Narragansett Bay. In the early days, they were among the staples of the colonial diet. As in most East Coast states, production of cultivated oysters in leased beds peaked around 1910. By the 1930s, decreased oyster production could no longer meet the continued, stable local demand. Explanations for this decline have been many and varied. Overfishing was noted in East Greenwich, Rhode Island, as early as 1766, and legislation controlling harvests was very strict by the 1860s (Desbonnet and Lee, 1991). Predators and pollution have also been implicated in oyster declines. The 1954 hurricane dealt the final blow to the already weakened industry, killing an estimated 90 percent of the oysters. The last oyster dealer in Rhode Island went out of business in 1957 (Desbonnet and Lee, 1991). Since then, the cultivated oyster business has not recovered, possibly because of additional environmental degradation and coastal development, and competition from other oyster-growing areas. However, there is recent anecdotal evidence of recovery of oyster beds near East Providence, Prudence Island, and areas of Mount Hope Bay.

Native shad, alewife and Atlantic salmon fisheries were also historically important. All three species depended on Bay tributaries for spawning. Dams, effluent from the textile and metal product industries, and sewage pollution almost eliminated shad from Narragansett Bay in the 1880s. Although shad populations remained small, catches peaked again in Rhode Island in the 1940s, a result of high fishing pressures during World War II. Subsequent catches fell rapidly, due to decreased demand and decreased availability, possibly due to overfishing. This brief period of high catches during the war was not a symptom of recovery of the fish but rather an artificial peak, produced by extreme demand and exploitation of the resource (Olsen and Stevenson, 1975). The alewife fishery was essentially gone by 1925. The salmon fishery had already collapsed by 1869, probably because there were no suitable upstream spawning grounds due to flow restrictions and/or water quality (USFWS, 1989).

Menhaden, which spawn within upper Narragansett Bay and Mount Hope Bay rather than upstream in freshwater have fared somewhat better than the shad, salmon, and alewives. Overfishing by fish traps caused the fishery to fail in the late 1800s. Since then, harvests have diminished (Oviatt, 1977). However, by weight, menhaden remains the largest commercial fishery in the Bay.

Today, the quahog, or hard clam, represents Narragansett Bay's primary commercial fishery. Other commercial fisheries include lobster, long-finned squid, scup, silver hake, squirrel hake, summer flounder, sand flounder, ocean pout, butterfish, and cod (Jeffries et al., 1989). There are also significant recreational fisheries for bluefish and tautog. Until recently, winter flounder supported economically important commercial and recreational fisheries. However, in 1991, because of concerns over drastic declines in abundance, largely due to overfishing, Rhode Island banned commercial and recreational fishing for winter flounder in Narragansett Bay, Little Narragansett Bay, and the coastal salt ponds.

Overfishing, habitat destruction and contamination by toxic pollutants represent ongoing threats to these resources. Total

landings of finfish declined from 72.5 million pounds in 1985 to 26.5 million pounds in 1989, with winter flounder accounting for 19 million pounds of the decrease (NOAA/NMFS, 1991). Total value of the finfish landings decreased from $33.2 million to $2.9 million during that period (NOAA/NMFS, 1991). Like the oyster and the shad, these fisheries also could be destroyed.

02-02-06 Recreation

Narragansett Bay's many small harbors and protected, sandy beaches contributed to its reputation as a recreation area. During the 1880s, Newport was perhaps the most affluent and extravagant resort area in the country. The extreme affluence ended with the 1929 stock market crash, and the 1938 hurricane destroyed many resorts along the Bay's southern shores. Beginning in the 1960s, however, family vacationing in the Narragansett Bay area began to boom, and this boom has continued.

Rhode Island residents and tourists today take part in sailing, world-renowned yachting regattas, music festivals, swimming, fishing, surfing, and picnicking. An estimated 32,000 people visit Rhode Island each day in the summer. Between 5 and 10 million tourists visit Rhode Island each year, primarily in the summer and primarily around the Bay. In 1989 more than $1400 million was spent by tourists in Rhode Island, much of it on Bay-related activities.

Tourism is now the State of Rhode Island's third largest employer. The state operates 25 state parks, and there are many shoreline campgrounds and picnic areas. One hundred and seventy marinas dot the coastline; tourist services and outlet stores line the major and minor highways; and an increasing number of conventions brings tourists to the state throughout the year.

02-02-07 Use of the Bay for Waste Disposal

Despite the importance of tourism to the region's economy, some areas of the Upper Bay are closed to swimming, other water-contact sports, and shellfish harvesting. These closures result entirely from pollution associated with population growth and urban-industrial development in near coastal areas. Municipal and industrial wastes and dredged materials have been disposed of in the Bay.

Human wastes have probably been discharged into the Bay as long as the area has been inhabited. In 1854, Providence was the seventh largest city in the United States. Most people used cesspools and privies, the contents of which were used as fertilizer or disposed of in landfills. The Moshassuck River, a branch of the Providence River, was used as an open sewer, and regular outbreaks of cholera claimed the lives of the people who dwelled along its shores. Population growth was enormous, and increasing quantities of sewage entered the river, along with wastes from slaughter houses and woolen mills.

A sewer system became a necessity for the City of Providence in 1871, when the city provided its residents with running water. Indoor toilets were connected to existing cesspools, and the increased volumes of water used in flushing overflowed the systems. Construction of a sewer system began immediately. That system discharged wastes directly into the rivers and the Bay.

In 1884, City Engineer Samuel M. Gray was dispatched to Europe to learn about the latest methods of treating sewage, and in 1901, the Providence Sewage Treatment System began operation at Field's Point. The system used chemicals to facilitate precipitation of sludge from the raw sewage. The sludge was then used as fertilizer, while the remaining effluent was discharged into the Bay (Nixon, 1990).

Within a decade of its opening, Providence had outgrown its sewage treatment system. The City began to barge the sludge and dump it into the Bay east of Prudence Island and about 14 miles south of the city. In addition, the chemical-precipitation method brought by Samuel Gray from Europe was proving an unsatisfactory sewage-treatment process.

In 1925, the Providence City Council visited eight cities throughout the United States to

learn about new sewage treatment methods. Conversion of the Field's Point facility to use an activated-sludge process was completed in 1934. Other improvements to the system were made in subsequent years.

By the 1970s, this system was again inadequate. The facility had become antiquated, an inadequately sized staff maintained it, and charges of political mismanagement were leveled at its directors. Raw sewage was regularly released into the Bay, and sewage solids were found on beaches. In 1980, a regional approach to managing the problems of sewage waste treatment was adopted with the creation of the Narragansett Bay Commission (NBC). With financial assistance from the EPA and the State of Rhode Island, the NBC has been able to reconstruct and upgrade the Field's Point facility.

The Bay also receives numerous discharges from the industries that flourish in the region. Today, 33 major industries in Massachusetts and Rhode Island continue to discharge directly into the watershed under federal National Pollutant Discharge Elimination System (NPDES) major permits or Rhode Island Pollutant Discharge Elimination System (RIPDES) permits. There are also numerous industrial and commercial discharges to sewer systems. These indirect discharges ultimately reach Narragansett Bay.

Sewage effluent and sludge are not the only materials that have been disposed of in Narragansett Bay. Because many parts of Narragansett Bay are shallow, regular dredging of channels and harbors has been conducted to maintain access for the small boats or large ships that use them. Materials dredged from the bottom were disposed of on salt marshes and other coastal lands until the 1960s. Many of Narragansett Bay's fringing salt marshes were filled to support coastal development.

Dredged material was also disposed in Narragansett Bay's deeper waters. Between 1949 and 1966, material was dumped off the southern end of Prudence Island, as well as at the Brenton Reef Disposal Area, near the mouth of Narragansett Bay in Rhode Island Sound. Dredged material is no longer disposed within Narragansett Bay waters because no site has been designated in the Bay. Upland disposal still occurs, subject to receipt of permits from the Rhode Island Coastal Resources Management Council (CRMC), the Rhode Island Department of Environmental Management (RIDEM), and the U.S. Army Corps of Engineers (USACOE).

02-03 Pollutant Sources, Status, and Trends

02-03-01 Pollutant Sources and Water Quality

Three major classes of anthropogenic pollutants are discharged to Narragansett Bay and the Bay basin: fecal wastes, potentially including pathogenic bacteria and viruses; excess nutrients and oxygen-demanding organic matter; and toxic pollutants, including trace metals and organic compounds. Although these pollutants are generated by industrial, commercial and domestic activities throughout the Bay basin, they enter the Bay from myriad point and nonpoint sources.

Point sources, such as the discharge pipes for WWTFs and industrial facilities, are a major route for delivery of pollutants to the Bay. Each year approximately 98 billion gallons of treated wastewater enter the Bay from 33 WWTFs serving over one million people in Rhode Island and Massachusetts. In addition, each year over 100 CSOs in the basin discharge approximately four billion gallons of untreated sewage and stormwater to the Bay waters (Figure 715-02(7)). Direct industrial discharges also contribute to the pollutant load.

Nonpoint sources are more diffuse and difficult to quantify. Nonpoint sources of contaminants to the Bay include runoff from highways, parking lots, farmlands and lawns. Seepage from on-site sewage disposal systems; discharges by ships and boats; accidental chemical spills; and resuspension of contaminated sediments also represent locally important sources of contaminated deposition.

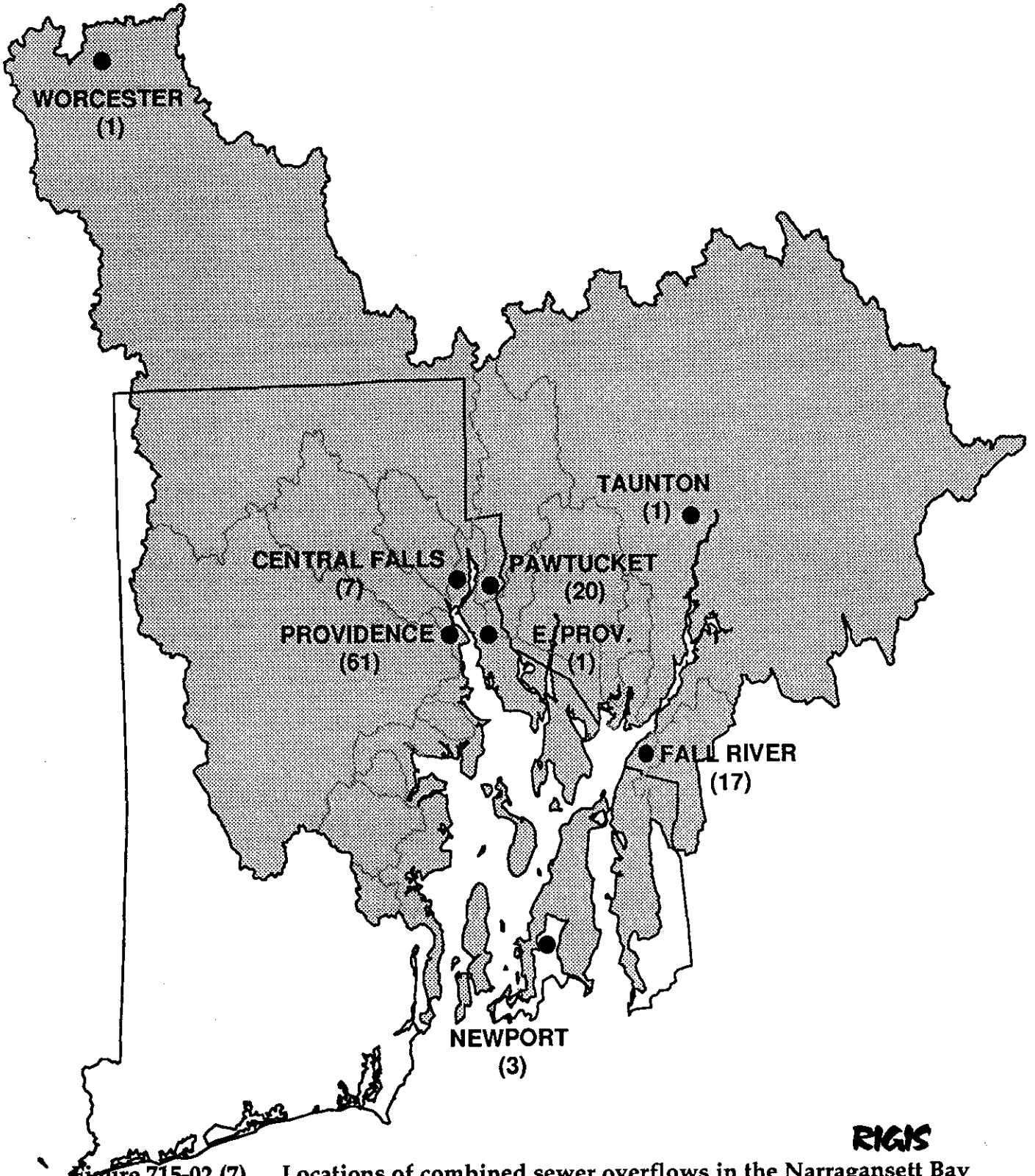


Figure 715-02 (7). Locations of combined sewer overflows in the Narragansett Bay watershed. (Map provided by NBP, RIGIS.)

The states of Rhode Island and Massachusetts classify the state's waters according to the condition and goals for the waters' uses. Seawaters are classified as follows:

Class SA	Suitable for bathing and contact recreation, shellfish harvesting for direct human consumption, and fish and wildlife habitat.
Class SB	Suitable for bathing and contact recreation, for shellfish harvesting for human consumption after depuration, and fish and wildlife habitat.
Class SC	Suitable for boating and secondary contact recreation, fish and wildlife habitat, industrial cooling, and aesthetic value.

Discharges into the waters must meet limitations necessary to ensure compliance with specific state water quality standards, which limit concentrations of specific pollutants in order to protect aquatic life and human health. The CRMC has established different water use classifications for Rhode Island's coastal waters in order to govern authorized uses of coastal waters. The CRMC's six water use categories are:

Type 1	Conservation area
Type 2	Low-intensity use
Type 3	High-intensity boating
Type 4	Multipurpose waters
Type 5	Commercial and recreational harbors
Type 6	Industrial waterfronts and commercial navigation channels.

02-03-02 Suspended Solids and Biochemical Oxygen Demand (BOD)

Rivers constitute the major erosional source of suspended solids. However, suspended solids and oxygen-demanding substances also enter the Bay from point and nonpoint source discharges to the rivers. Coastal wastewater treatment facilities are another major source of solids and BOD. CSOs and industrial discharges also contribute to BOD loadings.

Historically, BOD loadings have increased as a result of population growth. However, these loadings decreased throughout the basin with the implementation of secondary treatment of municipal wastes as required under the federal Clean Water Act. Secondary treatment employs biological methods to reduce the amount of organic material in wastewater. The trend toward improved oxygen concentrations in the Providence River can be correlated with improved BOD and suspended solids removal by the Blackstone Valley District Commission (BVDC) [Note that the BVDC WWTF is now the NBC Bucklin Point WWTF.] and the NBC Field's Point.

02-03-03 Pathogens

Pathogens are disease-causing organisms such as bacteria, viruses, and protozoa. Human pathogens, including the bacteria responsible for cholera and typhoid, and viruses responsible for infectious hepatitis and gastroenteritis can be present in human fecal wastes and may enter the Bay from WWTFs, CSOs, septic systems, and, in some areas, discharges from boats. Water-borne pathogens can be hazardous to swimmers and to people who eat raw or incompletely cooked seafood harvested from sewage-contaminated waters.

Rhode Island and Massachusetts open and close beaches and shellfish-growing areas based upon concentrations of one type of bacteria, fecal coliforms. These bacteria are considered "indicators," that is, while they are not pathogenic, they indicate the presence of fecal waste and the possible presence of

pathogenic bacteria. Another type of bacteria, enterococcus, has been proposed by EPA as a better indicator for marine swimming beaches, and the NBP has funded research on the potential use of alternative indicators of human fecal waste, such as the use of a male-specific bacteriophage and the spores of the bacterium *Clostridium perfringens*. Because the bacteriophage and *Clostridium perfringens* spores are more resistant to chlorination from wastewater treatment than other indicators, they may be more accurate environmental indicators of the presence of human fecal waste.

Fecal wastes and potential pathogens enter the Bay from WWTFs, bypasses to those facilities, CSOs, stormdrains, septic systems, stormwater runoff, and, in some areas, boater discharges. Although the dry weather loadings of fecal coliform bacteria are so large that more than 28 percent of Narragansett Bay is permanently closed to shellfishing, CSOs represents the greatest inputs of coliform bacteria to the Providence River and Mount Hope Bay during rainstorms. In rainy weather, WWTF bypasses and the CSOs in Providence, Pawtucket, and Central Falls are the major sources of untreated or partially treated sewage to the Providence-Seekonk River and the Upper Bay. Similarly CSOs in Fall River, MA, are the major source of untreated fecal waste to Mount Hope Bay. During rainstorms, sampling has shown that 95 percent of the fecal coliform bacteria entering Mount Hope Bay and 80 percent entering the Providence River come from CSOs. Annual loadings of coliform bacteria from CSOs are about 10,000 times higher than the loadings from wastewater treatment facilities and about 200 times higher than loadings from separated stormdrains.

Nonurban, developing coastal areas are also affected by discharges and releases of fecal wastes to coastal waters. Areas presumptively affected by boater wastes because of dense assemblages of marinas and mooring fields are seasonally closed to shellfishing. Improperly sited, poorly designed, inadequately maintained, and failing septic systems, and illegal sanitary cross connections to stormdrains also contribute fecal wastes to coastal waters and have resulted in local restrictions on shellfish harvesting.

02-03-04 Nutrients

Nutrients are essential to the functioning of the Narragansett Bay ecosystem. However, excessive inputs of nutrients, especially nitrogen and phosphorus can cause ecological problems and impairments to uses of portions of the Bay. Nutrients can stimulate blooms of microscopic plants, called phytoplankton. When these phytoplankton die, they decay. The bacteria causing the decay consume oxygen in the water, potentially leaving insufficient oxygen for shellfish, fish, and other animals. Blooms of larger macroalgae (seaweeds) can carpet coves and other enclosed areas. In extreme conditions, oxygen depletion related to nutrient loadings can kill fish and invertebrates and produce anoxic sediment conditions.

Nutrients enter the Bay from WWTFs, CSOs, individual septic systems, runoff from agricultural land and lawns, groundwater and the atmosphere (Figure 715-02(8)). The EPA and the National Oceanic and Atmospheric Administration (NOAA) have classified Narragansett Bay as receiving average amounts of nutrients compared to other estuaries in the northeast. However, the effects of excess nutrients are more important in coves and poorly flushed areas than in the open areas of the Bay. Unfortunately, few data are available for the small coves.

The lowest concentrations of dissolved oxygen in the Bay are found in the Providence, Seekonk, Pawtuxet, and Blackstone Rivers during the late summer (Pilson and Hunt, 1989; Penniman *et al.*, 1991b). Nitrates and phosphates are most concentrated in these areas and in the Taunton River because of major urban wastewater inputs of sewage (Figure 715-02(9)). However, pictures taken with a sediment-profiling camera have indicated that the aquatic communities living in portions of Greenwich Bay and Potowomut Cove are also stressed, perhaps as a result of excessive nutrient loads from point and nonpoint sources (Valente *et al.*, 1992).

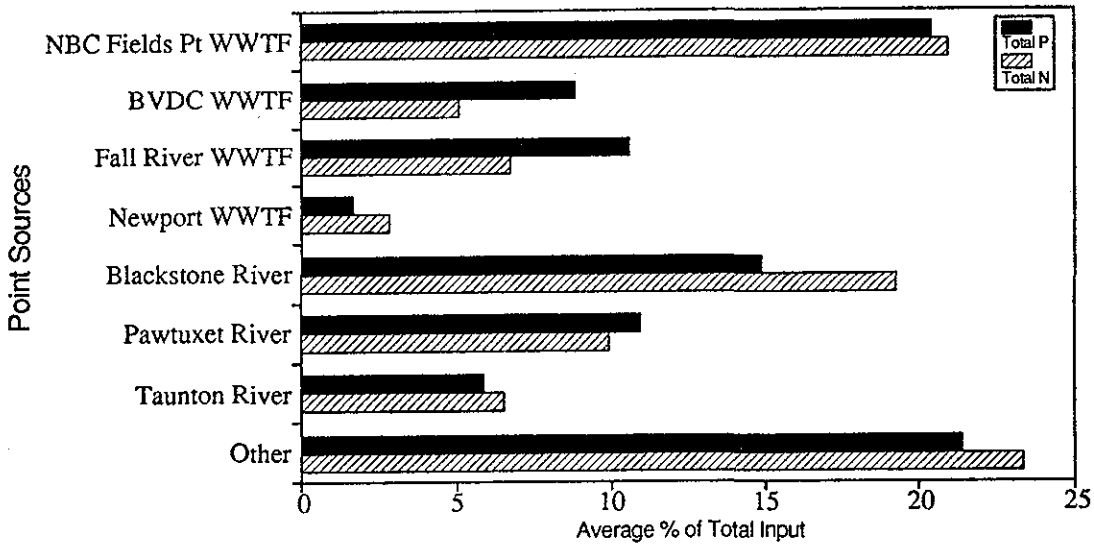


Figure 715-02 (8). **Point sources of nutrients to Narragansett Bay. (Data are from Pilson and Hunt, 1989. "Other" refers to other drainage areas.) [Note that the BVDC WWTF is now the NBC Bucklin Point WWTF.]**

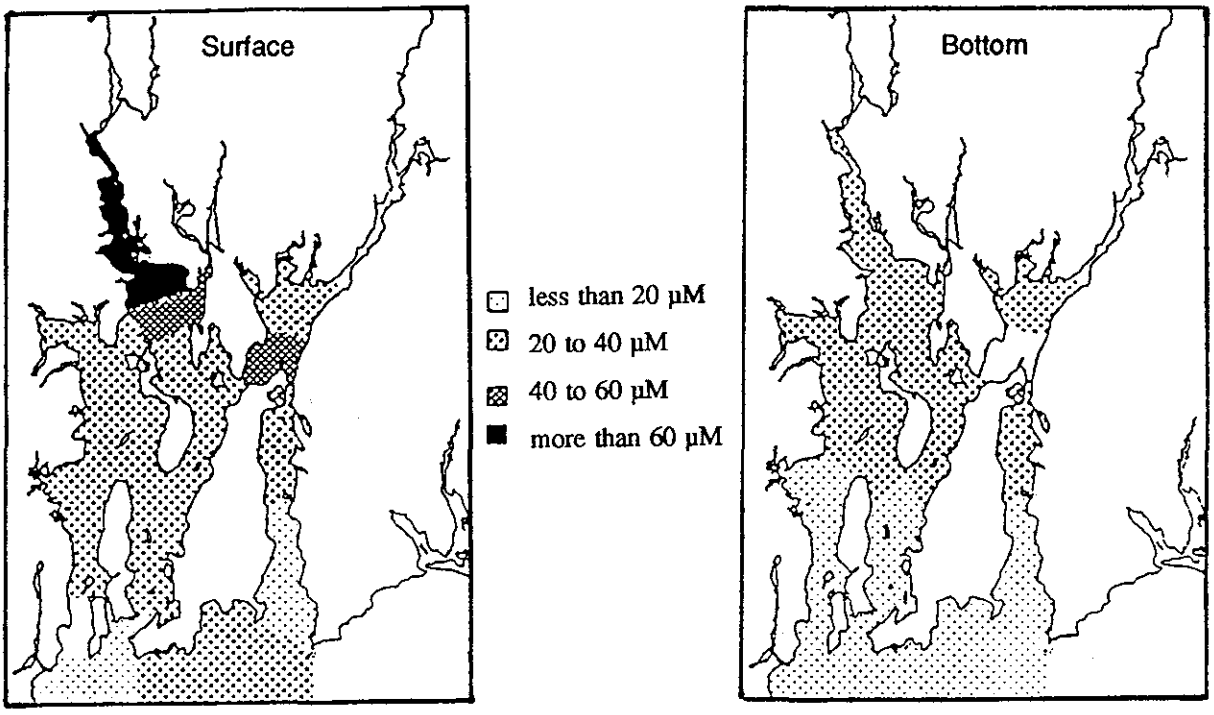


Figure 715-02 (9). **Nitrogen concentrations for surface and bottom waters in October 1985. (Data are from Pilson and Hunt, 1989.)**

02-03-05 Toxic Pollutants

Narragansett Bay has a long history of inputs of toxic metals and toxic organic compounds (Figure 715-02(10)). Many toxic metals and some toxic organic compounds exist naturally in low concentrations. Some toxic metals are often called trace metals, because they occur naturally in low concentrations and are essential nutrients for plants and animals. At higher concentrations, however, toxic metals and organic compounds can cause reproductive or metabolic disorders and death, and additionally may accumulate in the tissues of plants and animals. These metals and organic compounds are most toxic to sea life when they are dissolved in water. Metals that are adsorbed to sediment particles and buried in oxygen-poor sediments are relatively nontoxic unless the sediments are resuspended, re-aerated, and solubilized or consumed by organisms. However, many petroleum-based and synthetic organic compounds remain toxic when they are adsorbed to particles.

Toxic metals of particular concern in the environment include copper, cadmium, lead, zinc, chromium, silver, nickel, and mercury (Figure 715-02(11)). The largest anthropogenic sources of these metals originate in the most industrialized portion of the Bay watershed, where they are used in the manufacture of jewelry and other metal products, and the electroplating, cement, and textile industries. Copper also comes from copper water pipes used throughout the region in residential as well as commercial and industrial areas. The lead from solder used, until recently, to connect copper pipes can also leach into the water. In parts of the watershed where drinking water comes from reservoirs rather than groundwater, acid rain has caused the water to corrode the copper pipes and lead solder at a greater rate than normal. A major source of lead to the environment was from gasoline combustion until 1974, when unleaded fuel was required for all new automobiles. Burning of wood, coal, and oil has also contributed to increased environmental concentrations of metals.

During dry weather, most trace metals enter the Bay from the NBC Field's Point WWTF and upstream sources on the Blackstone River including the UBWPAD WWTF. During rainy weather, the major point sources are the NBC's Field's Point and NBC's Bucklin Point (formerly BVDC) WWTFs although the Blackstone and Pawtuxet rivers represent the largest metals loadings (Wright *et al.*, 1992a).

Concentrations of toxic metals are greatest in waters at the head of the Bay and decrease down-Bay toward Rhode Island Sound (Figure 715-02(12)). The highest concentrations of metals in the Upper Bay are found in the Seekonk River, where the Blackstone River enters the Bay (Bender *et al.*, 1989; Metcalf & Eddy, Inc., 1991a). Concentrations of dissolved nickel are 20 times higher in the Upper Bay than in Rhode Island Sound. Concentrations of cadmium are ten times higher, and concentrations of chromium are four times higher. Concentrations of copper and nickel are highest near the Field's Point WWTF and in the Blackstone River.

Toxic organic compounds include petroleum-derived contaminants known as petroleum hydrocarbons (PHCs) and polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), and pesticides such as DDT. Petroleum compounds have many uses, such as for fuel or lubrication. PAHs are produced when wood, coal, or oil are burned. PCBs were widely used in electrical transformers until the domestic manufacture of PCBs was banned in 1977. DDT and some other persistent pesticides have also been banned from sale or use in the U.S. Today's pesticides generally degrade much faster than those used in the past. However, PCBs and DDT remain measurable in the Narragansett Bay ecosystem.

Petroleum compounds enter the Bay from large, catastrophic oil spills such as the *World Prodigy* spill which released 294,000 gallons of oil near the mouth of the Bay in June 1989. Although the amount of unrecovered oil from the *World Prodigy* was approximately equal to the amount of oil that enters

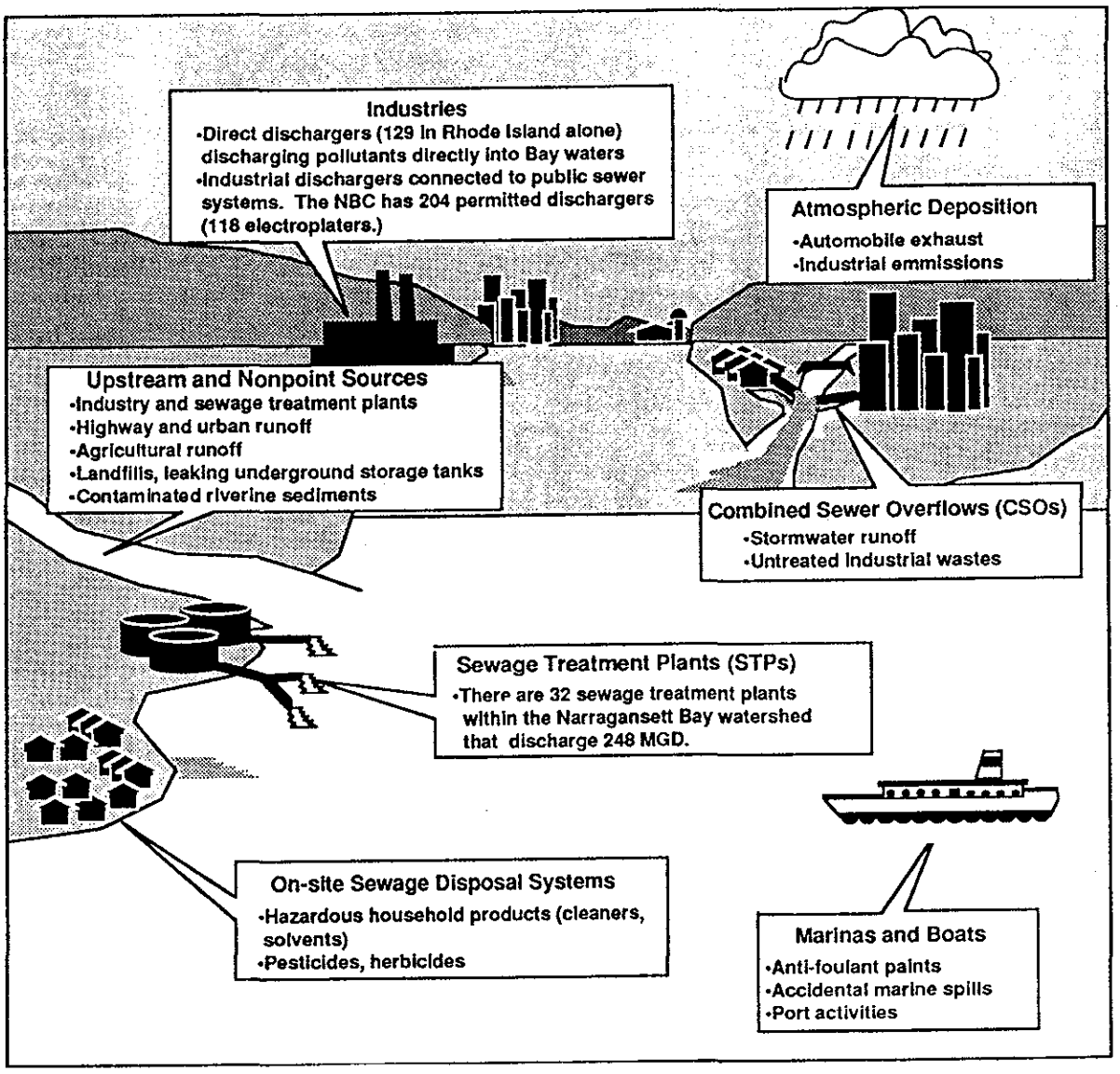


Figure 715-02 (10). Point and nonpoint sources of toxic contaminants to Narragansett Bay. (From NBP.)

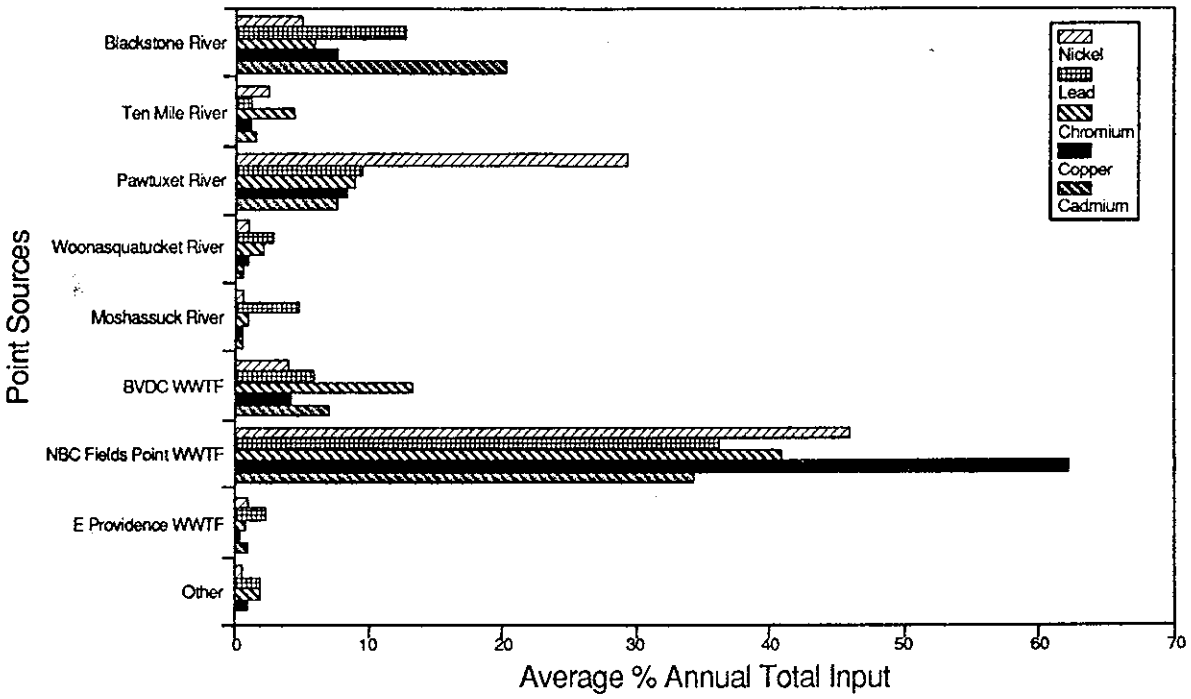


Figure 715-02 (11). Point sources of metals to Narragansett Bay. (Data from Metcalf & Eddy, Inc., 1991; "Other" includes BVDC CSO, BVDC Bypass, NBC CSO Area A.) [Note that BVDC is now part of NBC, and that the BVDC WWTF is now the NBC Bucklin Point WWTF.]

the Bay from all sources every two years, large, accidental spills represent only two percent of the annual average amount of oil entering Narragansett Bay. Therefore, persistent, chronic sources of petroleum to the Bay are of even greater importance. WWTFs and urban runoff are the largest contributors of these toxic organic compounds to the Bay. More than 60 percent of PHCs enter the Bay annually from WWTFs, primarily Field's Point. River inputs, mostly from the Taunton and Blackstone Rivers, account for more than 90 percent of PAHs (Metcalf & Eddy, Inc., 1991a).

Rivers also continue to contribute PCBs to the Bay, presumably from historic sources of contamination (Figure 715-02(13)). Water quality criteria for toxic pollutants, established to protect aquatic life, are exceeded in several locations within the Bay watershed primarily in the Blackstone, Pawtuxet, and Providence-Seekonk River basins (Table 715-02(2)) (Metcalf & Eddy, Inc., 1991a; Penniman *et al.*, 1991a).

02-03-06 Historical Trends and Current Status of Pollution in the Bay

The pollution history of urban estuaries such as Narragansett Bay can be told from undisturbed sediments (Corbin, 1989). Unless sediments have been disturbed by dredging, burrowing animals, or storms, the history of an area is shown in the layers of materials that are deposited on the sediment surface. The approximate age of sediments and sedimentation rates can be obtained using measurements of certain radioactive compounds.

Studies of Narragansett Bay's sediments have detected toxic metal pollution from the beginning of industrialization of the Providence area in 1750. Typical of most Narragansett Bay sediments, the sediments of the Seekonk River indicate sharp increases in

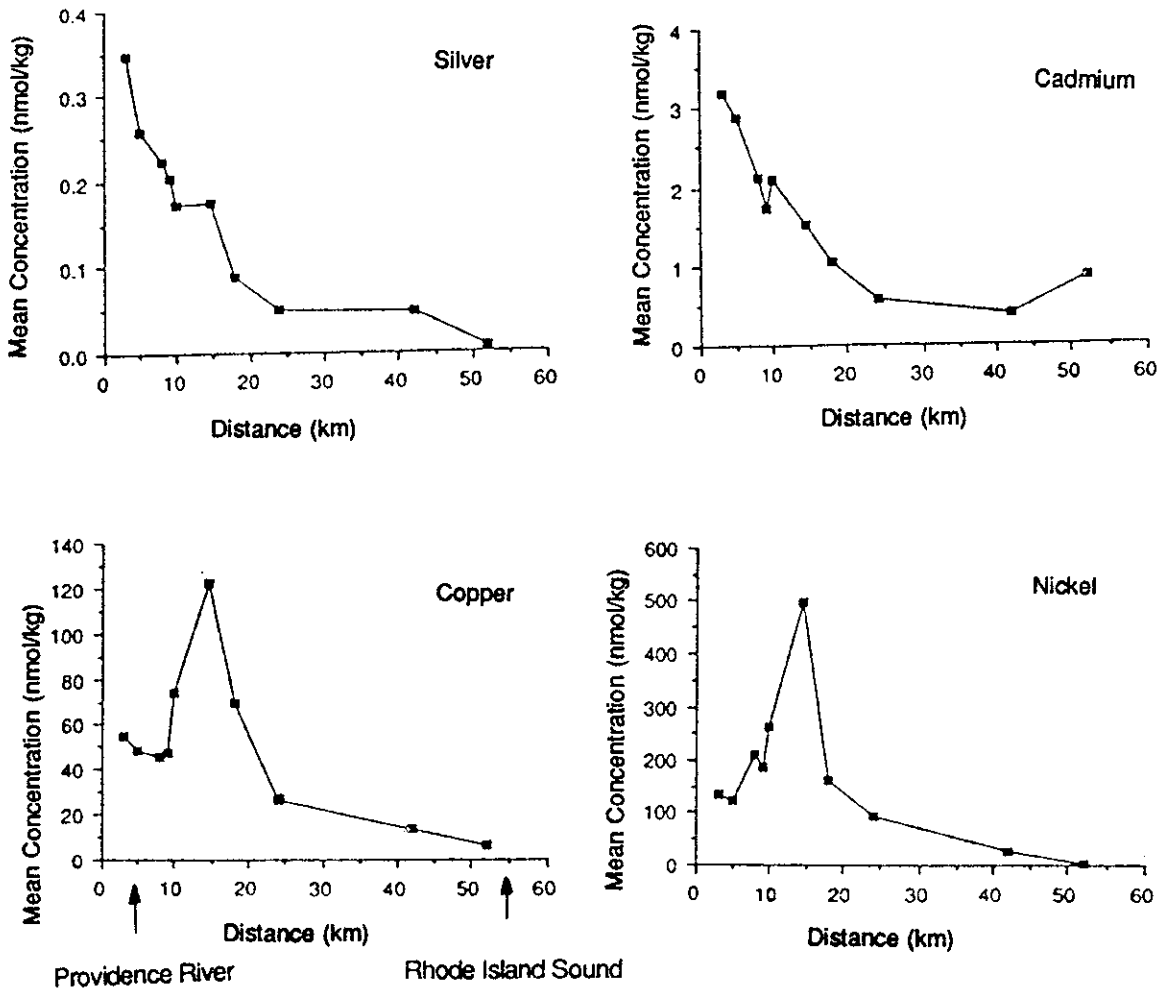


Figure 715-02 (12). Average concentrations (nanomoles/kg) of metals in Narragansett Bay as a function of distance (kilometers) from the Seekonk River. (Data are from Bender *et al.*, 1989, and are corrected for salinity effects.)

copper, lead, and silver loadings beginning in the 1860s, when metals use and processing increased dramatically, and ending abruptly in the late 1890s to 1900, around the time that the sewer system began discharging at Field's Point. The sediment cores indicate that metals inputs increased during the 1920s and 1930s (Figure 715-02(14)) (Corbin, 1989).

Concentrations of metals in the surface sediments show similar geographic trends to those in the water, with highest concentrations at the head of the Bay. However, there are also localized "hot spots," areas with especially high concentrations of contaminants not near centers of human activity. Such areas include Apponaug Cove, Brushneck Cove, Bullock's Cove, Greenwich Cove, Newport Harbor, Pawtuxet Cove, Warwick Cove, and Wickford Cove. Some of these sites reflect contamination from historic shipbuilding or industrial activity. A major "hot spot" is near Quonset Point where the Naval Air Rework Facility refurbished airplanes. Impoundments along the Blackstone River are the sites of some of the highest concentrations of metals ever measured in riverine sediments. Other sites, such as Bristol Harbor and Greenwich Cove, also receive toxic pollutants from residential, commercial, industrial, and agricultural activities.

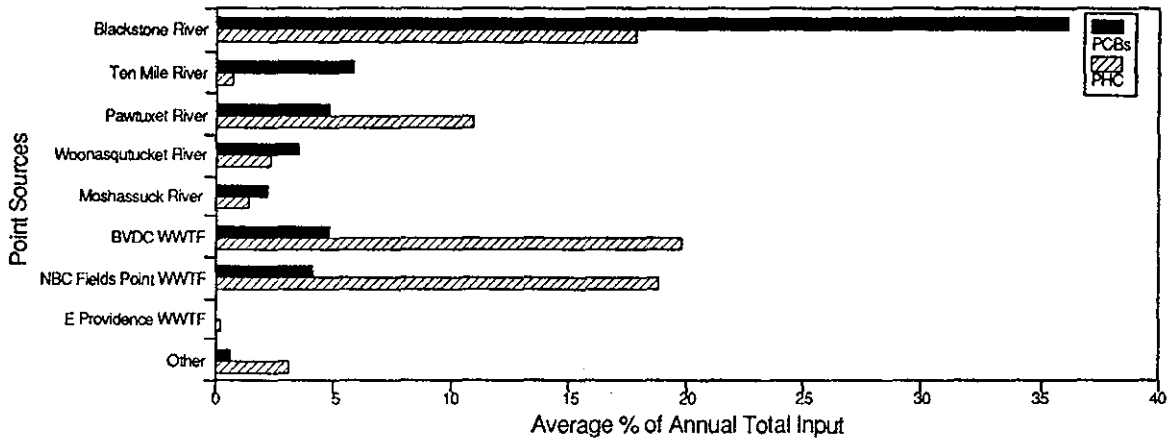


Figure 715-02 (13). Point sources of toxic organic contaminants to Narragansett Bay. (Data from Metcalf & Eddy, Inc., 1991a; "Other" includes BVDC CSO, BVDC Bypass, NBC CSO Area A.) [Note that BVDC is now part of NBC, and that the BVDC WWTF is now the NBC Bucklin Point WWTF.]

The deposition of organic pollutants has a different history from that of toxic metals. Concentrations of PHCs and PAHs both increase at points that coincide with increases in the use of fossil fuels in the late 1800s. At that time, coal and oil were burned in factories, and coal-fired passenger steamers cruised into the Bay. One sediment core from the East Passage has its highest concentrations of PHCs below the surface, possibly due to the disposal of dredged material that took place east of Prudence Island until 1965 (Corbin, 1989).

Some data show that inputs of some pollutants, notably PCBs and toxic metals, have decreased (Metcalf & Eddy, Inc., 1991a). For example, annual records from the Field's Point WWTF indicate that toxic metal inputs to the Bay decreased by 83 percent, from almost 1 million pounds to less than 200,000 pounds between 1981 and 1990 (Figure 715-02(15)). While recent trends show a decrease in concentrations of toxic metals, other evidence points to the need for continued monitoring and improvement. Data from the Providence River indicate that water quality standards for copper and nickel are exceeded. Concentrations of cadmium, copper, chromium, lead, and PCBs also exceed federal water quality criteria on many stretches of the Blackstone, Pawtuxet, Woonsocket, Moshassuck, and Ten Mile rivers (Table 715-02(2)).

Comparisons of studies conducted during 1977-1980 and 1985-1986 also show decreases in the concentrations of toxic metals found in sediments. There has been a fourfold decrease in copper concentrations in the surface sediments of the Providence River, and sediment nickel concentrations have decreased by 50 percent. In samples taken from Providence River sediments, there is no indication that inputs of cadmium or silver and, for some sites, lead have decreased (Corbin, 1989). However, sediment samples from the Seekonk River indicate a 71 percent decrease in lead since the 1950s (Corbin, 1989).

Recent declines in toxic metals loadings may be due in part to the industrial pretreatment programs implemented by 13 of Rhode Island's 19 WWTFs since 1982. Other reasons for the decline could be attrition of industries or changes in industrial processes in the watershed.

Table 715-02 (2). Areas exceeding aquatic life water quality criteria in Narragansett Bay. (Data are from Wright *et al.*, 1992a; Kipp and Zingarelli, 1991; and Metcalf & Eddy, Inc., 1991a.)

Substances	Areas Exceeding Water Quality Criteria for the Protection of Aquatic Life
PCBs	Blackstone River (MA) downstream of Upper Blackstone WWTF Blackstone River (RI) downstream of Woonsocket WWTF to tidal portion of the river Mouths of Pawtuxet, Moshassuck, and Ten Mile rivers
Cadmium	Pawtuxet River near Warwick and Cranston WWTFs Mouths of Blackstone, Pawtuxet, Ten Mile, and Woonasquatucket rivers Blackstone River (MA/RI) between Upper Blackstone and Woonsocket WWTFs
Copper	Blackstone River (MA) downstream of Upper Blackstone WWTF Blackstone River (RI) near Woonsocket WWTF Pawtuxet River below Cranston WWTF Mouths of Blackstone, Moshassuck, Pawtuxet, Ten Mile, and Woonasquatucket rivers Seekonk and Providence rivers
Chromium	Mouths of Blackstone, Moshassuck, and Ten Mile rivers
Nickel	Seekonk and Providence rivers
Lead	Blackstone River (MA) downstream of Upper Blackstone WWTF Blackstone River (RI) downstream of Woonsocket WWTF Pawtuxet River near Warwick and Cranston WWTFs Mouths of Blackstone, Moshassuck, Pawtuxet, Ten Mile, and Woonasquatucket rivers

A study of the effectiveness of three industrial pretreatment programs uncovered significant areas that need improvement (Sutinen and Lee, 1990). The study showed that permit requirements for pretreatment are not always met and that the UBWPAD WWTF in Worcester, Massachusetts, has increased its metals loadings to the Bay. Another study has indicated that metals loadings from the Fall River, Massachusetts, WWTF have also increased (Metcalf & Eddy, Inc., 1991a).

02-03-07 Pollutant Concentrations in Natural Resources

The presence of toxic pollutants in Narragansett Bay waters and sediments can impair the growth, reproduction, and general health of marine animals and plants. High concentrations of contaminants in marine fish and shellfish that are consumed by the public can cause human health effects. Shellfish such as mussels and quahogs concentrate pollutants above the levels found in their surroundings. Concentrations of contaminants in shellfish vary depending upon location of the animals within the Bay and their ability to metabolize individual pollutants.

In general, concentrations of toxic metal and toxic organic contaminants in shellfish are higher in the Providence River than in the middle or lower parts of the Bay (Metcalf & Eddy, Inc., 1991a). However, there are pock-

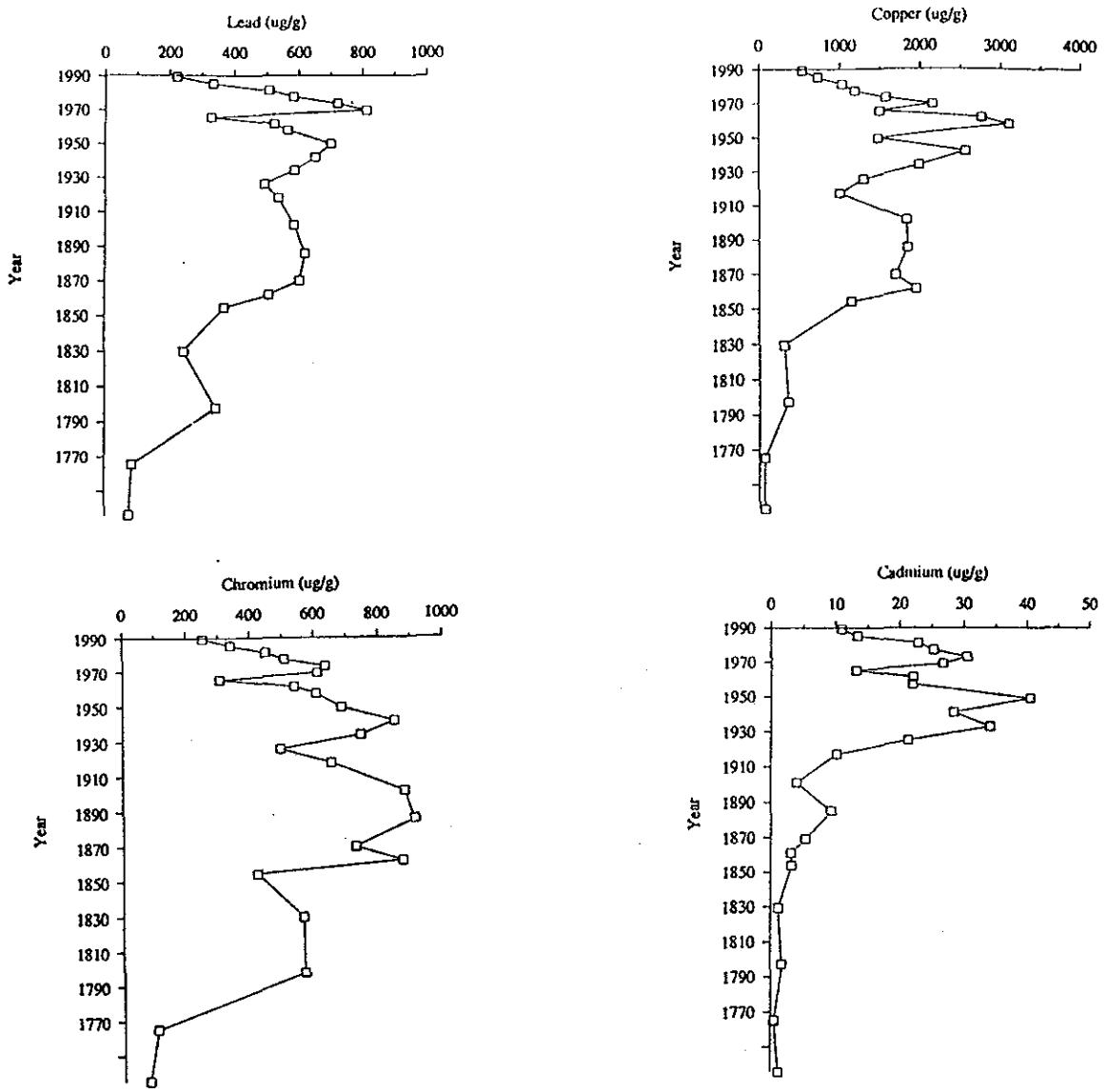


Figure 715-02 (14). Concentrations (micrograms metals/gram of sediment) of metals in sediment cores from the Seekonk River. (Data are from Corbin, 1989.)

ets of increased levels of toxic metals in areas thought to receive only local inputs of pollutants. For example, there are elevated concentrations of metals in shellfish from the area near the Naval Air Rework Facility at Quonset Point, an area that also has high concentrations of toxic metals and organic compounds in the sediments.

Concentrations of toxic organic compounds in shellfish trend from higher in the Upper Bay to low in the Lower Bay, although localized high concentrations of PHCs and PAHs have been found in shellfish from Allen Harbor, which is just north of Davisville and Quonset Point and near the site of an abandoned Navy landfill.

No historical trends in concentrations of contaminants in shellfish have been found. Concentrations of metals in quahogs have varied by a factor of less than two since 1971. This lack of a trend suggests that either exposure concentrations have remained relatively constant or that quahogs can metabolically control internal metal concentrations.

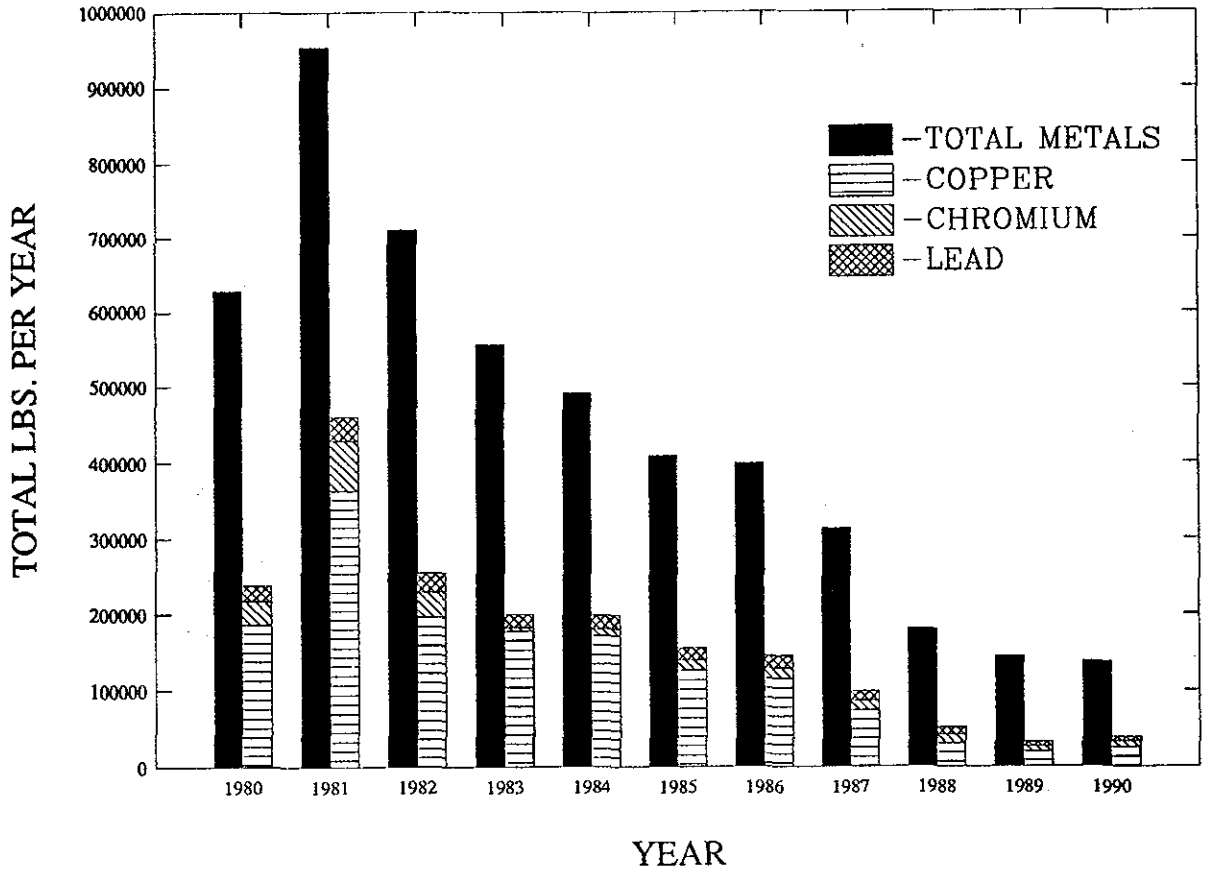


Figure 715-02 (15). Annual inputs of metals from the Field's Point WWTF. (Data are from the Narragansett Bay Commission, 1990.)

02-03-08 Comparisons to Other Estuaries

The National Status and Trends Program, conducted by NOAA, surveys more than 200 sites on the East, West, and Gulf coasts of the United States and Hawaii for concentrations of metals and organic contaminants in sediments and animals (Table 715-02(3)) (NOAA, 1989a, 1989b). Status and Trends Program data from 1984 to 1987 show that Narragansett Bay sediments are similar to other northeast, urban estuaries. For mercury, selenium, silver, and PAHs, sediments from Narragansett Bay rank among the 20-most-contaminated embayments measured by NOAA (NOAA, 1989a, 1989b).

Mussels collected in Narragansett Bay have ranked among the 20-most-contaminated of the National Status and Trends Program sites for copper and lead. In 1986, Narragansett Bay mussels were sixth-most-contaminated out of 72 for copper, eighth of 145 for lead, and twenty-fifth of 145 for nickel. Concentrations of contaminants in flounder livers ranked fourteenth of 42 for PCBs and sixth of 42 for lead (NOAA, 1989a, 1989b).

Table 715-02 (3). **Average concentrations of organic contaminants (nanograms of metals/gram) and toxic metals (micrograms of metals/gram) in selected estuaries. (Data are from NOAA National Status and Trends Program, NOAA, 1989a, 1989b. Tissues are blue mussel for all sites except Delaware Bay, where oysters were sampled.)**

	PAH	PCB	Copper	Chromium	Cadmium	Lead
Sediments*						
Narragansett Bay	3,890	151	87.1	148	0.565	88.2
Boston Harbor	19,300	673	172	308	2.02	178
Salem Harbor, MA	15,600	591	126	3,370	9.79	260
Delaware Bay	980	122	26.6	111	0.810	44.0
Elliot Bay, WA	11,000	902	243	214	2.47	70.3
Bellingham Bay, WA	1,640	10.0	58.9	207	0.440	13.5
Hudson-Raritan	5,830	539	179	216	2.12	230
Tissues**						
Narragansett Bay	160	270	9.00	1.70	1.30	4.45
Boston Harbor	1,520	820	12.2	2.00	1.32	9.70
Salem Harbor, MA	580	500	11.0	4.10	0.780	22.0
Delaware Bay	234	350	298	0.682	7.70	0.718
Elliot Bay, WA	4,200	700	10.0	1.60	2.60	3.10
Bellingham Bay, WA	330	100	11.0	3.40	3.10	1.20
Hudson-Raritan	1,600	1,990	15.3	5.16	5.90	10.9

*Average of 4-year mean concentrations from 3-4 sites
**Average of 3-year mean concentrations from 2-3 sites

02-04 Living Resources and Critical Habitats

02-04-01 Phytoplankton

Tiny, single-celled plants, phytoplankton, provide most of the energy for animals that live within Narragansett Bay (Kremer and Nixon, 1978; Kremer, 1990). Because Narragansett Bay is a relatively deep estuary, seaweeds, seagrasses and salt-marsh grasses are less important as food sources, although, to the extent these habitats have survived shoreline modification, they provide critical spawning and nursery habitat (French *et al.*, 1992). Phytoplankton, including diatoms and flagellates, are food for zooplankton, small animals that live in the water column, and for some fishes. Living and decaying phytoplankton also feed many of the animals living on the bottom of Narragansett Bay, including filter-feeding shellfish.

Typically, populations of phytoplankton bloom in late winter to early spring and again in the late summer, although this pattern may vary (Figure 715-02(16)) (Hinga *et al.*, 1989). Denser populations of plankton are found in the upper portions of the Bay than at the mouth, possibly because the nutrients in sewage act as fertilizer.

Few major changes in the numbers or kinds of phytoplankton over the past 35 years have been documented (Hinga *et al.*, 1989). One major event did occur in 1985 when a very small and previously unidentified alga, *Aureococcus anophagefferens*, bloomed (Smayda, 1988, 1989). The algae were so abundant that the event became known as a "brown tide." Because the brown tide algae were a poor food source, shellfish consumed them in great quantities but were unable to grow or thrive. Many shellfish died, particularly mussels and bay scallops. The cause of this bloom remains unknown, and it is not possible to attribute its appearance directly to pollution of the Bay. Another brown tide event occurred in 1986, although this bloom was limited to some coves and embayments, including Greenwich Cove.

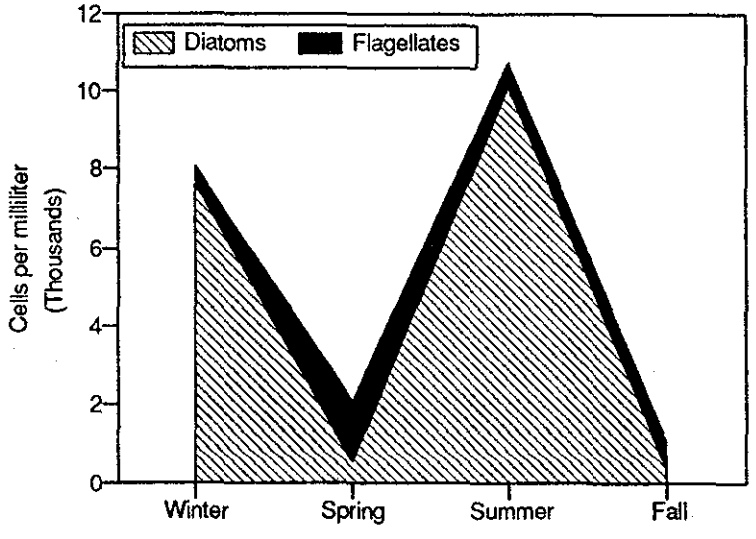


Figure 715-02 (16). Annual cycle of phytoplankton populations in Narragansett Bay. (Data are from Hinga *et al.*, 1989.)

02-04-02 Zooplankton

The zooplankton community of Narragansett Bay is similar to other open-water coastal areas in the Northeast (Durbin and Durbin, 1989, 1990). The community is dominated by two species of copepods, *Acartia hudsonica* and *Acartia tonsa*. Copepods are very small crustaceans, related to lobsters and crabs. No dramatic differences between the populations of zooplankton of the upper and lower parts of the Bay have been noted, nor do there seem to be any major historical changes in the community (Durbin and Durbin, 1989, 1990).

02-04-03 Bottom Animals

The bottom animals or benthos of Narragansett Bay have been studied since before the turn of the century (Frithsen, 1990). Because most attached or infaunal benthic animals live most of their lives in the same area, scientists think of them as good integrators of conditions at one location over long periods of time. However, changes in benthic populations along a gradient from the Upper Bay to the Lower Bay have been difficult to interpret (Frithsen, 1990). Pollutant concentrations decrease along that gradient, but salinity and loadings of organic matter also vary along the same pattern.

Among the animals living on the bottom of Narragansett Bay are several commercially important shellfish, including the hard clam (*Mercenaria mercenaria*), American lobster (*Homarus americanus*), surf clam (*Spisula solidissima*), blue mussel (*Mytilus edulis*), rock crab (*Cancer irroratus*), and Jonah crab (*Cancer borealis*) (French *et al.*, 1992). In the past, the soft-shell clam (*Mya arenaria*), bay scallop (*Argopecten irradians*), and American oyster (*Crassostrea virginica*) were also abundant in Narragansett Bay.

Of these shellfish, the hard clam or quahog fishery is the most important commercial fishery remaining in the Bay (Pratt *et al.*, 1992). Only the lobster fishery brings in more money to Rhode Island fishermen, although many lobsters are caught offshore (Figure 715-02(17)).

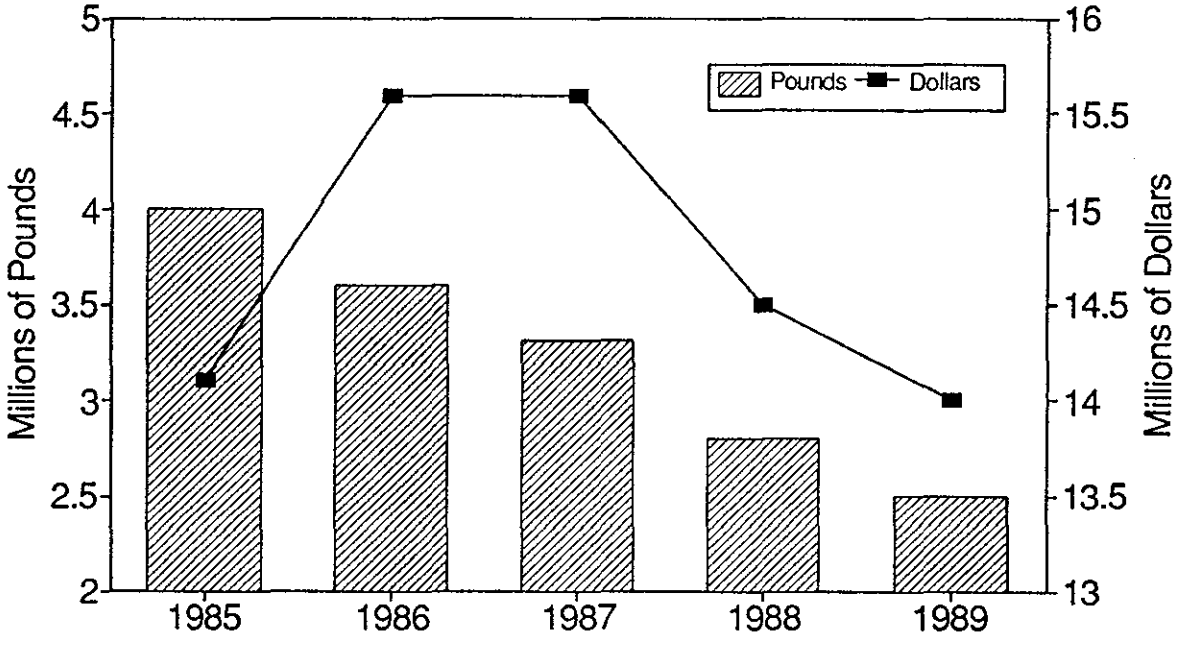


Figure 715-02(17). Commercial landings of Narragansett Bay quahogs. (Data are from NOAA/NMFS.)

The quahog is the most abundant animal of its size living within the bottom sediments of Narragansett Bay (Frithsen, 1990; Pratt *et al.*, 1992). The highest densities of quahogs are found in the mid and upper portions of the Bay, including the Providence River, an area that is currently closed to harvesting. Quahogs in the Providence River have the highest measured tissue levels of toxic contaminants in the Bay basin, although there is no histopathological evidence of disease related to pollutant exposure (Kern, 1990).

02-04-04 Fishes

Both bottom-dwelling and open-water fish inhabit or visit Narragansett Bay (Jeffries and Johnson, 1974; Powell 1989). Among the bottom fish, the most common commercial species used to be the winter flounder, *Pseudopleuronectes americanus* (Figure 715-02(18)) (Jeffries *et al.*, 1989). Winter flounder live year-round within the Bay and may migrate outside the Bay to Rhode Island Sound (Gray, 1991). Periodically, abundances of winter flounder have declined drastically. For example, from 1968-1976, the population declined to only 15 percent of its 1968 levels (Jeffries *et al.*, 1989). By 1979, the population had recovered, but it subsequently declined again. Although these cycles are not completely understood, they appear to be closely related to higher-than-average water temperatures during the development and growth stages of young fish (Jeffries and Johnson, 1974). Such population fluctuations may be quite normal. However, chronic overfishing and alteration of spawning habitat are now thought to be the primary cause for the declining winter flounder population (Figure 715-02(19)). Although pollution has not been directly implicated as a cause for winter flounder declines, the Narragansett Bay Project has found that abnormalities in flounder livers are more prevalent in the Upper Bay at Warwick Neck, than in the Lower Bay at Whale Rock (Lee *et al.*, 1991).

Other fishes, such as scup, menhaden, striped bass and bluefish, make seasonal migrations into Bay waters. Recreational fisheries exist for striped bass and bluefish. The commercial menhaden fishery is the largest in the Bay by weight.

02-04-05 Birds

Resident and migratory birds are common within the Narragansett Bay region (French *et al.*, 1992). Gulls and terns nest on islands and other isolated areas. The Bay is an important wintering area for many sea ducks and other waterbirds. Small shorebirds pass through the Narragansett Bay area as they migrate north in the spring and south in the fall. Raptors, such as osprey, historically nested along the coast in large numbers. Their populations were diminished by DDT and other pesticides and by habitat loss, but are currently rebounding. Sites on Sakonnet Point, Fort Wetherill, Prudence Island, Rose Island, Big Gould Island, Dyer Island, Hope Island, Little Gould Island, Hog Island and Spar Island are some of the important locations of colonial waterbird rookeries in the Bay (French *et al.*, 1992).

02-04-06 Habitats

Ecologically fragile habitats in the Narragansett Bay system include saltwater and freshwater wetlands, fish breeding and nursery grounds, inland surface waters, and shallow embayments that can be easily affected by excess nutrients, toxic compounds, solids (erosion), and outright destruction or modification.

Salt marshes provide a nursery ground for fish and shellfish, protection from coastal storms, and habitat for wildlife. Salt marshes cover about 2800 acres of land around Narragansett Bay. An additional 4400 acres are tidal flats. Within Narragansett Bay, there are approximately 80 km of narrow, fringing salt marsh, marshes that line the edges of rocky shores or developed areas (French *et al.*, 1992).

Freshwater wetlands provide habitats for plants and animals, filters for pollutants entering the groundwater, and protection from stormwater damage. Freshwater wetlands make up about 63,000 acres, six percent of the watershed.

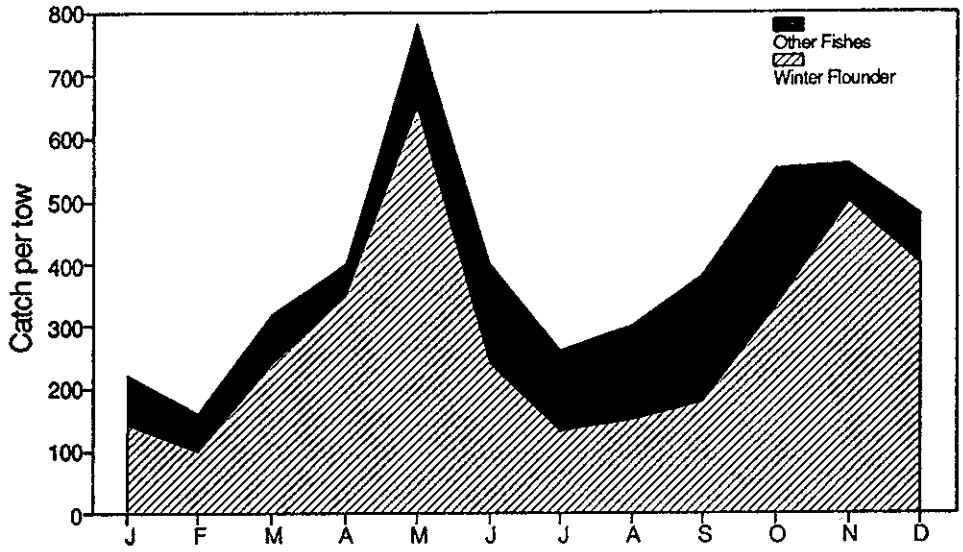


Figure 715-02 (18). **Annual fluctuations in fish populations in Narragansett Bay. (Data are from Jeffries *et al.*, 1989, and represent surveys rather than commercial harvests.)**

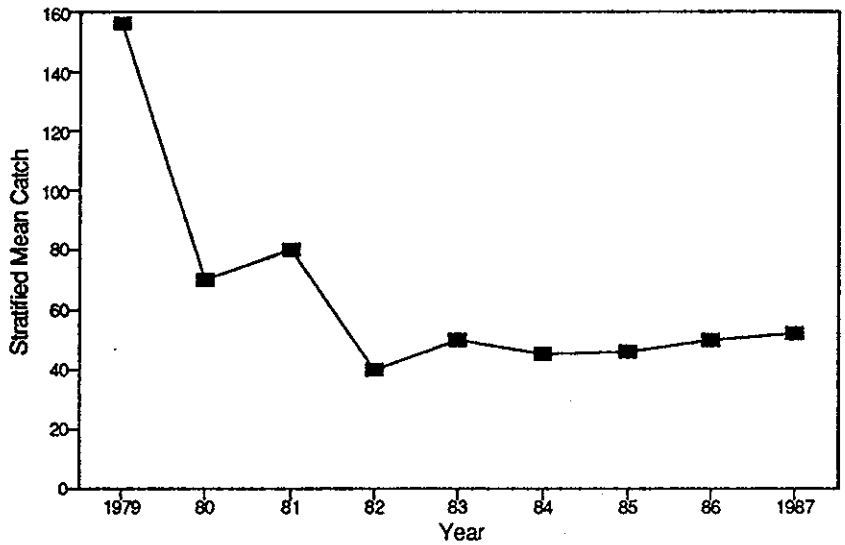


Figure 715-02 (19). **Winter flounder catches between 1979 and 1987. (Data are from NOAA/NMFS and reflect surveys rather than commercial harvests.)**

Fish habitats in Narragansett Bay include areas for anadromous fish runs; spawning and nursery areas for winter flounder, juvenile lobsters, and other fish and shellfish; and current and historic shellfish beds. Most winter flounder larvae are found in the Upper Bay (French *et al.*, 1992). One part of the National Estuarine Research Reserve, just offshore from Nag Creek Marsh, is thought to be a spawning site for flounder.

Nutrient-sensitive areas include embayments, salt ponds, freshwater ponds, bogs, and fens. These poorly flushed areas are particularly sensitive to development and commercial and recreational activities. These areas are not well-studied but are the areas that may be most affected by excess loadings of nutrients (Penniman *et al.*, 1991b).

02-05 Public Health Concerns

The major public health concern for Narragansett Bay, as for other coastal areas in the United States, is the safety of eating raw or incompletely cooked shellfish (quahogs, oysters) harvested from sewage-contaminated waters (Kipp, 1990). However, another public health concern exists with respect to the additive lifetime risk of contracting cancer for people who consume large amounts of seafood harvested from chemically contaminated areas of the Bay. A more minor public health concern for the region is the risk of infection from swimming in sewage-contaminated waters.

In the past, consumption of sewage-contaminated seafood led to outbreaks of bacterial and viral diseases, such as typhoid fever cholera, and hepatitis. Fortunately, such outbreaks have not occurred in the Narragansett Bay area for decades. Wastewater is now disinfected with chlorine to kill bacteria, and bacterial indicators of fecal contamination are routinely monitored in shellfish harvesting waters. Today, there is greater concern about sewage-derived viruses, such as those that cause infectious hepatitis and gastroenteritis since chlorine is a relatively ineffective viricide compared to alternative disinfection techniques.

Shellfish beds in Narragansett Bay are closed if the levels of fecal coliform bacteria indicate that sewage has contaminated the clams. Approximately 40 percent of the Bay is restricted to shellfishing. Twenty-eight percent of the Bay, including Mount Hope Bay, the Providence River, and several smaller areas are permanently closed, because the levels of fecal coliform bacteria are consistently higher than the state standard. Upper Narragansett Bay is a "conditional" area that is closed for at least seven days following a half inch of rain over a one-day period. These closures are made because of the great influx of untreated sewage from CSOs during rain. An additional 769 acres near marinas are closed during the summer months, because they can receive sewage discharges from boats. In 1991 an additional 40 acres in the Palmer River were closed, due to high levels of fecal coliform bacteria that have been attributed to septic systems and stormdrains as sources (Figure 715-02(20)) (Karp *et al.*, 1990).

The long-term cancer risk from eating fish and shellfish from Narragansett Bay is probably not currently a problem for most consumers, although concern for eating seafood harvested from urban estuaries remains a public health issue for all urban coastal areas (Kipp, 1990).

Narragansett Bay quahogs do not exceed U.S. Food and Drug Administration (FDA) alert limits for mercury, PCBs, chlordane, DDT, or DDT's breakdown products, DDE or DDD, the only contaminants for which such limits have been set. Using estimates of average and maximum consumption, the Narragansett Bay Project found that heavy consumers (15 g/day) of quahogs from the Providence River could be at a slightly greater risk of contracting cancer compared to average consumers (1.2 g/day) (Kipp, 1990). In comparison to other estuaries, consuming quahogs from Narragansett Bay is safer than eating fish from New York Harbor or Lake Michigan or clams, lobster or flounder from Quincy Bay in Massachusetts.

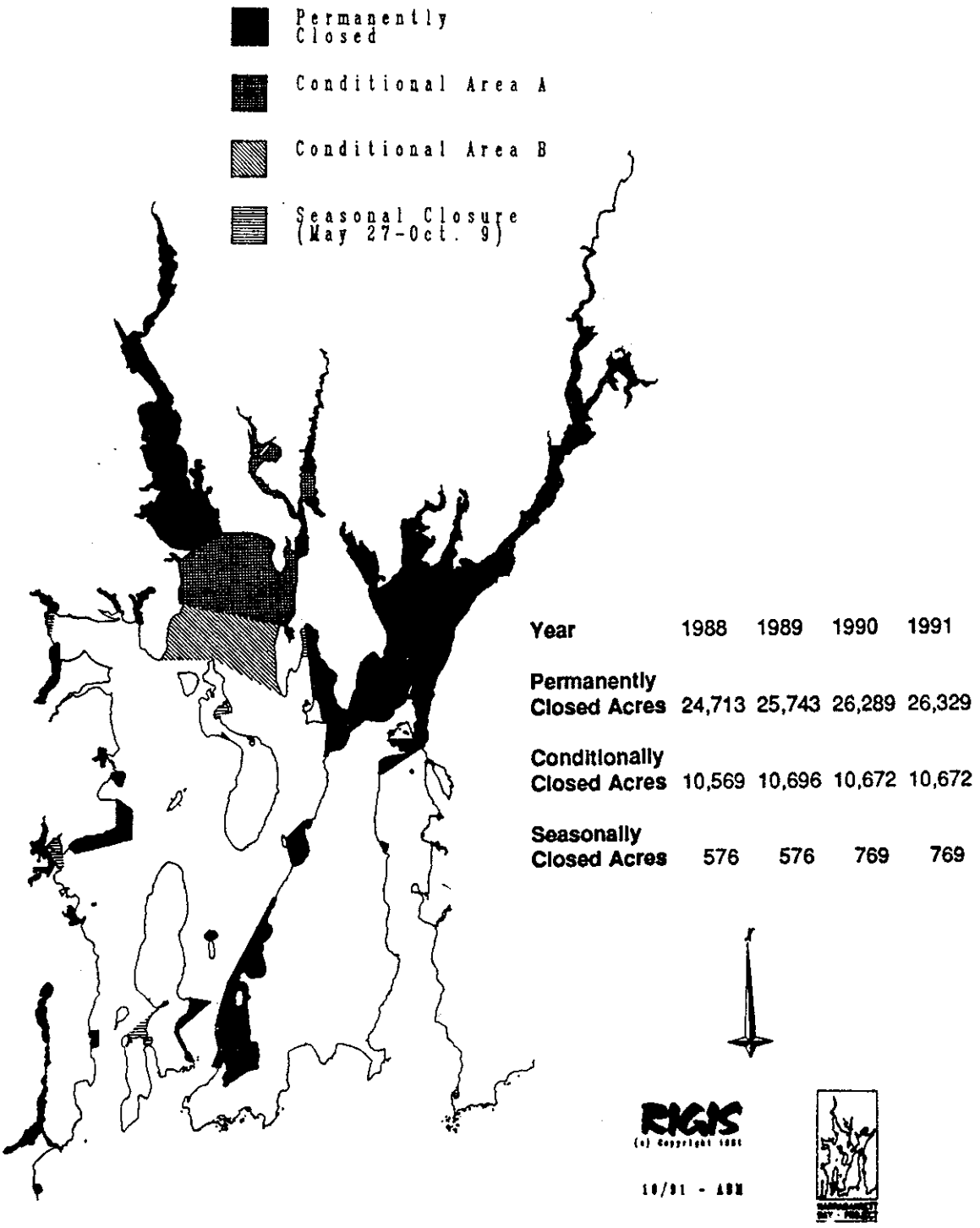


Figure 715-02(20). Shellfish closure areas in Narragansett Bay. (Data from NBP, RIGIS.)

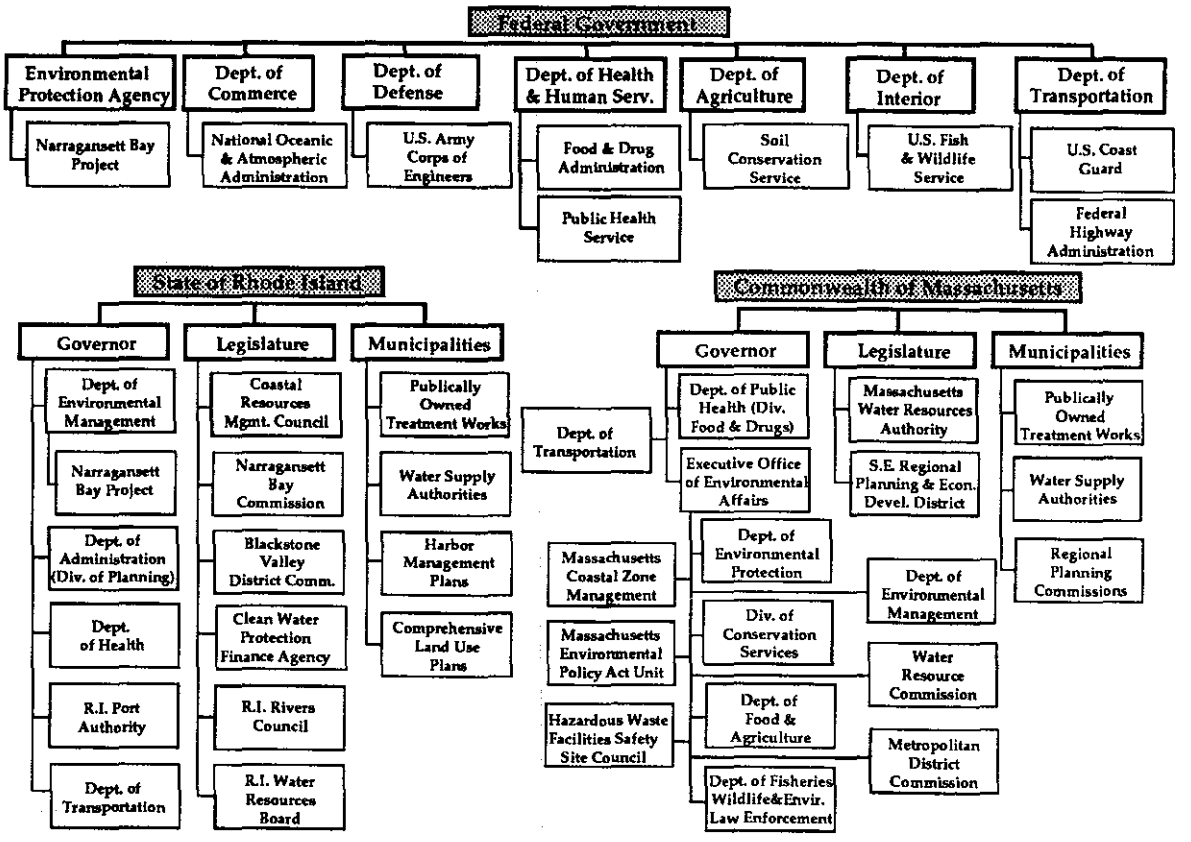


Figure 715-02 (21). Federal, state, and local agencies involved in Narragansett Bay planning and regulation.

For winter flounder, the pattern is similar to that for quahogs. Consumers of average amounts for flounder (1 g/day) are at no increased risk, while persons who consume large amounts of flounder (165 g/day) would be at slightly above what EPA believes is an acceptable risk (Kipp, 1990). Few data are available to calculate health risks of consuming other fish or shellfish from Narragansett Bay. However, the Rhode Island Department of Health (RIDOH) has issued a health advisory regarding consumption of bluefish and striped bass because of PCB levels. Since these species migrate along the entire East coast, their contamination is an issue for the entire region.

02-06 Bay and Watershed Governance

Resource management and pollution control in Narragansett Bay are governed by a complex network of federal, state and local authorities (Figure 715-02(21)). The State of Rhode Island takes the primary state-level role in governance of the Bay's open water. However, since 61 percent of the Narragansett Bay watershed is within Massachusetts, its environmental laws and policies also affect the Bay.

Congress's passage of the Clean Water Act (CWA) of 1972 firmly established the federal commitment to controlling pollution in coastal waters, and this legislation has controlled subsequent efforts by federal, state, and local agencies. EPA has the primary responsibility for the National Estuary Program, established by Congress in the amendments to the CWA in 1987.

Congress also enacted the Coastal Zone Management Act (CZMA) in 1972 to preserve,

protect, develop and enhance coastal resources. Activities conducted under this act are administered by NOAA and state Coastal Zone Management (CZM) programs. The CZMA was amended in 1990 to include much broader state responsibility for controlling nonpoint source pollution in the coastal zone.

Other federal laws that affect Narragansett Bay include the following:

- National Environmental Policy Act of 1965, which requires that any project involving federal legislation, funds, or activities that could significantly alter the quality of the human environment must be the subject of an environmental impact statement.

- Coastal Barrier Resource Act of 1982, which protects barrier beaches, wetlands, and nearshore waters and provides funds for maintenance, research, and public safety.

- Estuarine Areas Act of 1968, which provides for the preservation, protection, and restoration of valuable estuaries.

- Shoreline Protection Act of 1988, which protects coastal waters from litter and pollution by providing for permits to transport municipal and commercial wastes in coastal waters and regulates waste handling.

- Marine Protection, Research and Sanctuaries Act of 1972, which regulates ocean dumping of industrial and municipal wastes and dredged material.

- Submerged Lands Act of 1953, which allows states to manage, administer, lease, develop, and use submerged land and natural resources beneath navigable waters.

- Land and Water Conservation Fund Act of 1965, which provides funds for and authorizes federal assistance to states in planning, acquisition, and development of needed land and other areas and facilities.

- River and Harbors and Flood Control Act of 1970, which requires that all civil projects undertaken by the Army Corps of Engineers consider environmental, social, and economic effects.

- National Flood Insurance Act of 1968, which encourages state and local governments to make appropriate land-use adjustments to constrict the development of land that is exposed to flooding.

- Endangered Species Act of 1973, which identifies, lists, and protects endangered and threatened species and requires that all federal actions avoid destroying or modifying critical habitats.

- Fish and Wildlife Coordination Act of 1958, which requires that fish and wildlife conservation receive equal consideration and be coordinated with other features of water resources programs through planning, development, maintenance, and coordination of fish and wildlife conservation and rehabilitation.

- Fish and Wildlife Conservation Act of 1980, which provides funds and technical assistance to states for the development, revision, implementation, and monitoring of conservation plans and programs for nongame fish and wildlife.

- Migratory Bird Conservation Act of 1962, which provides funds and authorization for the acquisition of areas for the protection and management of migratory birds.

- Wild and Scenic Rivers Act of 1968, which provides for preservation of selected rivers.

- Magnuson Fishery Conservation and Management Act of 1976, which promotes domestic commercial and recreational fishing through sound conservation and management principles.

- Anadromous Fish Conservation Act of 1965, which provides for the conservation, development, and enhancement of fishes

that spawn in freshwater and live as adults in saltwater.

- Department of Transportation Act of 1966, which establishes a policy that special efforts should be made to preserve the natural beauty of the countryside and public park and recreation lands, wildlife and waterfowl refuges, and historic sites.

- Water Bank Act of 1970, which implements a continuous program to prevent the serious loss of wetlands and preserves, restores, and improves wetlands.

- Safe Drinking Water Act, as amended in 1986, which authorizes the adoption of national standards and treatment technologies for public drinking water.

- Resource Conservation and Recovery Act, the 1976 amendment to the Solid Waste Disposal Act, which provides standards for treatment, storage, and disposal facilities for hazardous wastes, aimed at preventing contamination of surface and groundwater.

- Comprehensive Environmental Response, Compensation, and Liability Act of 1980, which established the Superfund program to clean up existing or closed hazardous waste sites.

Federal agencies that influence pollution control and resource management issues include not only EPA and NOAA, but also FDA, which sets allowable levels of contaminants in fish and shellfish consumed by humans; USACOE, which regulates dredging activities and runs the permit program which governs the discharge of dredged and fill material into navigable waters; the U.S. Coast Guard, which is responsible for enforcing vessel discharge prohibitions and responding to spills in navigable waters; the U.S. Navy which possesses numerous properties in coastal areas; the Federal Energy Regulatory Commission (FERC), which licenses hydroelectric facilities; and the U.S. Fish and Wildlife Service (USFWS) which is charged with managing and protecting indigenous fish and wildlife.

The State of Rhode Island enacted legislation as early as 1920 to "prohibit and regulate the pollution of waters of the state." RIDEM, formed in 1977, now has jurisdiction over water quality policy and management. RIDEM has also produced the *Non-Point Source Management Plan* and the *State Clean Water Strategy*. The *Non-Point Source Management Plan* specifies management approaches to decrease nonpoint sources of contaminants to the Bay. The *State Clean Water Strategy* will integrate assessment and management plans for point and nonpoint sources of contaminants.

Another Rhode Island state agency, CRMC, was established in 1971 as an independent planning and management authority. CRMC is charged with protecting and managing Rhode Island's coastal zone, and has the authority to develop and enforce plans related to the use of land and water in coastal areas. The CRMC, in collaboration with RIDEM and other nonpoint source planning programs, is expected to develop the State's Coastal Nonpoint Pollution Control Program (CNPCP) mandated under Section 6217 of the 1990 Amendments to the federal CZMA.

Other programs administered by the state include the following:

- ISDS permit process, which ensures that the siting, design, and operation of septic systems is protective of public health and environmental quality.

- Freshwater wetlands permit process, which protects water quality, groundwater recharge abilities, wildlife habitat, recreational values, and unique wetland characteristics.

- Water quality classification process, which classifies Rhode Island waters and sets forth policies for their use.

- Natural Heritage Program, which identifies habitats for rare or threatened species.

- Endangered Species of Plants and Animals Act, a state law that prohibits the sale of federal endangered or threatened species.

- Erosion and Sediment Control Act, which enables communities to require developers to submit erosion and sediment control plans.

- Groundwater Protection Act, which establishes state policies for groundwater protection.

- Wellhead Protection Program, which delineates wellhead areas in need of protection, identifies contaminant sources, develops management strategies and ordinances, guides siting of new wells, and provides contingency plans for events of well contamination.

- Underground Storage Tank Regulation, which implements a registration system and establishes design requirements, testing schedules and procedures, and measures for siting underground tanks.

- Hazardous Waste Regulation, which governs the storage, transport, treatment, and disposal of hazardous wastes.

- Hazardous Waste Management Facilities, which establishes a process for siting hazardous waste management facilities.

- Solid Waste Regulation, which authorizes prohibition of disposal of solid waste in groundwater aquifer areas.

- Underground Injection Control Program, which is intended to preserve the quality of the groundwaters of the state by assuring the proper location, design, construction, maintenance, and operation of injection wells and other subsurface disposal systems.

- Pesticide Control, which authorizes regulation of registration, sale, storage, transport, use, application, and disposal of pesticides.

- Public Drinking Water Protection Act, which allows public water supply authorities to impose a charge on water use.

One recent Rhode Island law affects land-use issues in the watershed and consequently will affect the water quality of the Bay. The Comprehensive Planning and Land Use Regulation Act, passed in 1988, requires all cities and towns to produce a comprehensive plan to guide development. The Zoning Enabling Act, enacted in 1991, expands local authority to enforce the plans developed under the Comprehensive Planning and Land Use Regulation Act.

The Commonwealth of Massachusetts has agencies and programs that mirror many of the activities carried out in Rhode Island. However, proposed projects affecting Narragansett Bay may meet different financial or political priorities in Rhode Island and Massachusetts. Many local zoning ordinances also address environmental protection and resource management.

Because environmental regulation often produces conflicts between public and private rights and expectations, the federal and state courts also play an important role in governance of the Bay. Also, although they have no official regulatory capacity, environmental groups, trade organizations, other special interest groups and the local universities also influence resource management and pollution control policies.

Each of these groups—federal, state and local governments, environmental groups, marine trade organizations, other special interest groups and the universities—have the best intentions for proper management and preservation of the Bay's resources. However, the number of organizations and laws that affect the Bay is complex. It is difficult to coordinate all interested parties and applicable laws and programs.

02-07 Priorities

Narragansett Bay is a complex natural system that supports varied and sometimes conflicting human uses. However, the Bay

ecosystem faces multiple environmental threats as a direct result of the intensity of human activity in the basin. These threats include, loss of overexploited fisheries, loss and degradation of critical natural habitats, and contamination of water, sediments, and living resources. In addition, unmanaged development and population growth, in combination with current waste disposal practices, have resulted in significant limitations on water quality-dependent uses of the Bay. Part 715-04 (Issues, Objectives, and Strategies) describes these problems in detail and recommends detailed policies and corrective actions to address them over the next five to ten years.

Three relatively distinct regions of the Bay and Bay watershed can be identified with respect to anthropogenic impacts and the need for restoration and protection. The first region, comprises the Providence River basin, Upper Narragansett Bay, and much of Mount Hope Bay. As described earlier, this area has the longest history and greatest magnitude of environmental insult of the entire Narragansett Bay basin which is related entirely to the history of urban and industrial development. For example, the Providence, Seekonk, Pawtuxet Rivers, and portions of the lower Taunton River have all experienced significant periods of low dissolved oxygen indicative of excessive BOD or nutrient loadings. This area also has elevated levels of various toxic pollutants in the water column, in some cases, which exceed federal and state aquatic life criteria. The long history of anthropogenic loadings of toxic compounds is apparent in the amounts of toxic materials remaining in the bottom sediments in this area. The Blackstone and Seekonk river sediments are particularly contaminated. For the Providence-Seekonk River and part of Mount Hope Bay, in particular, the volume of untreated wastewater released during rain events from CSOs carries with it huge amounts of fecal coliform bacteria and, potentially, human pathogens.

Point sources, *i.e.*, WWTFs, WWTF bypasses, CSOs, and storm drains are the major sources of pollution to this part of the Bay. In part because of this fact, control of several of these pollutants has progressed substantially. For example, BOD loadings from WWTFs have been dramatically reduced because of the mandatory secondary treatment requirements imposed pursuant to the CWA. Toxic pollutants entering the Bay have also declined dramatically, partially as a result of the CWA Industrial Pretreatment Program, part, as a result of changes in demographics, and part as a result of voluntary source reduction efforts by industry. However, as described above, water quality problems still remain. Thus, the environmental priorities are to:

- Continue to reduce the amounts of toxic pollutants entering this part of the Bay by enhancing and expanding the Industrial Pretreatment Programs, and, reducing the contributions from commercial and domestic sources.

- Determine if excessive nutrients, primarily from WWTFs, are the cause of eutrophic conditions in the Providence-Seekonk River and, if so, reduce loads of these pollutants.

- Abate the release from CSOs and WWTF bypasses of untreated wastewater that results in substantial contributions of fecal coliforms, suspended solids, and floatable wastes to this region.

The second region of the basin comprises areas that are experiencing rapid development or are already heavily developed but lack municipal sewers. For example, several sections of Narragansett Bay, such as Greenwich Bay, the Narrow River, and Wickford Harbor are increasingly being degraded by fecal wastes, nutrients, and toxic pollutants resulting in increasing limitations on water-quality dependent uses. Runoff and leachate from old, poorly designed and/or poorly maintained septic systems are believed to represent a significant pollution problem. In addition, the conversion of undeveloped land to impervious surfaces associated with development results in loss and degradation of natural habitats and greater volumes of stormwater runoff and stormwater runoff-borne pollutants. In some of the coves in this region, large numbers of boats may cause seasonal and local water

quality degradation related to boater discharges of fecal wastes, fueling operations, and other boatyard-related activities. In contrast to the Upper Bay, most of the pollutants in this region derive from nonpoint sources. Therefore, solutions to these problems are somewhat more complex and, to a great extent, involve planning efforts to better accommodate growth in this region in a more sustainable manner. These solutions include:

- Regulatory and technological mechanisms to reduce loadings of on-site sewage disposal system or OSDS-derived pollutants, to surface and ground waters. These measures include better regulation of septic systems, better maintenance schemes for septic systems (*i.e.*, through the establishment of wastewater management districts), and measures to address the cumulative effects of septic systems by considering and regulating OSDS density at a subwatershed level.

- Installing marina pump-outs to reduce boater discharges of fecal waste.

- Providing municipal officials with practical technical guidance on BMPs to control nonpoint source pollution, and innovative land use and growth management practices.

The third region of the basin is represented by those areas that are currently the most pristine or the least impacted by anthropogenic activities. These areas include parts of the Sakonnet River, many of the islands in Bay, and much of the lower Bay. Many of the problems described for the mid-Bay region are only just beginning to emerge in this third region. Thus, early and aggressive application of many of the initiatives outlined above will protect these more pristine areas from significant degradation or loss of natural resources. Efforts in this region should focus on land use and growth management initiatives to prevent the irreversible loss or degradation of critical natural resources and habitats.

Finally, a Bay-wide problem is the loss, and occasionally catastrophic declines, of living resources and habitats. The solutions to these problems are the development and implementation of scientifically-based management plans, not only for commercially or recreationally important species, but also for the ecologically important species and the significant habitats on which all these organisms depend. In addition, these solutions may require the modification of the concept of "free and common fisheries" in order to control the overexploitation of many living marine resources.

In summary, managers must not be deceived into thinking that Narragansett Bay's environmental, public health, and use-related problems can be solved by focusing on a single pollutant source, class of pollutants or remedial action. Although, in many cases, control of a single source will help to reduce inputs of several contaminant types, in others, multiple sources will have to be controlled to achieve significant reductions in a single class of pollutants. The major challenges for Narragansett Bay's managers will be to evaluate the relative environmental and social importance of these problems and balance these concerns against the technological, institutional, and economic feasibility of implementing solutions.

715-03 GOALS

The five goal statements listed below have been adopted by the Narragansett Bay Project (NBP) in order to guide future efforts to protect and restore Narragansett Bay.

Statement of the Goals for Restoring and Protecting Narragansett Bay

1. **The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to prevent further degradation and incrementally improve water quality in developing coastal areas with deteriorating water quality.**

2. **The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to protect diminishing high quality critical resource areas throughout the Bay basin.**

3. **The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government, should act to more effectively manage commercially, recreationally, and ecologically important estuarine-dependent living resources.**

4. **The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should act to rehabilitate degraded waters throughout the Bay basin and restore water quality-dependent uses of Narragansett Bay.**

5. **The State of Rhode Island and the Commonwealth of Massachusetts, in conjunction with the Federal government and the municipalities, should establish necessary interstate and interagency agreements and mechanisms to coordinate and oversee implementation of the Narragansett Bay Comprehensive Conservation and Management Plan.**

The Narragansett Bay goal statements mirror the overall goal of the EPA's National Estuary Program, which is to: "...restore and maintain the chemical, physical and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected."

More specifically, however, the goals for protecting and restoring Narragansett Bay evolved from the NBP Management Committee's original list of "issues of concern", which are as follows:

- Impacts of toxic pollutants,
- Impacts of nutrients and eutrophication,
- Land-based impacts on water and habitat quality,
- Health and abundance of living resources,
- Fisheries management,
- Health risk to consumers of seafood, and
- Environmental impacts on commercial and recreational uses of Narragansett Bay.

Since the NBP's entire research and planning effort focussed on these identified "issues of concern", the goals for the protection and restoration of Narragansett Bay also reflect the NBP's

increasingly sophisticated understanding of the relationship between human activities throughout the Bay basin and the ultimate public health, environmental and ecological consequences for Narragansett Bay. As a result, the goal statements listed above integrate the NBP planning community's understanding of the problems facing Narragansett Bay with its collective judgment about technological, institutional, political, and economic factors affecting eventual *CCMP* implementation. However, it is extremely important to read these goal statements within the context of the entire *CCMP*. The agencies responsible for *CCMP* implementation, and the public, should continuously measure their progress in implementing the recommendations contained in Parts 715-04 and 715-05 of the *CCMP* against these goals for protecting and restoring Narragansett Bay.

715-04 ISSUES, OBJECTIVES, AND STRATEGIES

In conformance with Section 320 of the federal Clean Water Act, the overall goal of the Narragansett Bay *Comprehensive Conservation and Management Plan (CCMP)* is to:

> "...recommend priority corrective actions and compliance schedules addressing point and nonpoint sources of pollution to restore and maintain the chemical, physical and biological integrity of the estuary, including restoration and maintenance of water quality, a balanced indigenous population of shellfish, fish and wildlife, and recreational activities in the estuary, and assure that the designated uses of the estuary are protected."

Part 715-04, therefore, represents the core of the Narragansett Bay *CCMP*. Each chapter establishes a resource-related objective, and recommends detailed strategies for resolving a specific aspect of an identified environmental "issue of concern" for Narragansett Bay. The overall "issues of concern" for Narragansett Bay, as identified by the Narragansett Bay Project's governing committees in 1985-86, are as follows:

- Impacts of toxic pollutants,
- Impacts of nutrients and eutrophication,
- Land-based impacts on water and habitat quality,
- Health and abundance of living resources,
- Fisheries management,
- Health risk to consumers of seafood, and
- Environmental impacts on commercial and recreational uses of Narragansett Bay.

These general "issues of concern" dictated the scope of the NBP's entire $10 million research and planning effort since 1985. As a result, this part of the *CCMP* is based on the most contemporary scientific, social, legal and economic information available to the Narragansett Bay planning community as of 1991, including over 100 technical reports and 15 briefing papers commissioned and published by the NBP between 1985 and 1992. [See Bibliography and Appendix C.] All of these chapters were refereed by the NBP Management Committee and outside reviewers. In addition, many of these chapters were developed in consultation with representatives of affected Bay constituencies. [See 715-01-04 Process of Plan Development.] Part 715-04 of the Narragansett Bay *CCMP*, therefore, represents the planning community's best collective judgment about strategies for addressing the sources, and environmental and use-related consequences of identified Bay problems.

Since many interrelated anthropogenic activities contribute to observed Bay problems, Part 715-04 is divided into three sections: Source Control - Source Reduction (715-04-01); Resource Protection (715-04-02); and Areas of Special Concern (715-04-03). Section 715-04-01 (Source Control - Source Reduction) addresses major classes of pollutants (*e.g.*, toxics and nutrients); and major pollutant sources and pollutant pathways (*e.g.*, wastewater treatment facilities, combined sewer overflows, on-site sewage disposal systems, boater discharges, nonpoint pollution sources). Section 715-04-02 (Resource Management) focuses on human uses of the land and natural resources that affect the integrity, function and human use of the Bay ecosystem. Section 715-04-03 (Areas of Special Concern) addresses specific geographic regions of the Bay basin which require an integrated approach to address pollution, resource management and use-related concerns.

These chapters attempt to be objective and comprehensive with respect to existing environmental and use impairments, predicted environmental trends, and recommended strategies. However, the research community's understanding of basic estuarine processes and human interactions with the environment is not complete. [See Section 715-05-05 Unfinished Agenda.] In addition, the planning and regulatory community's ability to manipulate the environment and predict the outcome is also limited—partially by the lack of appropriate technology and/or

legal authority, partially by limited resources, and partially by fragmented geographic and/or subject matter jurisdiction. [See Section 715-05-02 *CCMP* Implementation and Governance.] As a result, the recommendations presented in Part 715-04 reflect existing scientific uncertainty about the Bay ecosystem, available technological and regulatory solutions, and the complexity of the existing structure of Bay governance. Therefore, implementing authorities and interested readers should use these chapters recognizing that the scientific community's understanding of Bay problems is continually improving, and that technological and regulatory solutions are continually evolving.

04-01 Source Control-Source Reduction

The Narragansett Bay basin has been continuously inhabited by humans for over 10,000 years. However, the earliest evidence of serious water quality and natural resource problems date from the colonial period, and are associated with population growth, modification of the landscape, and industrialization. Water quality in some limited regions of the Bay basin has improved in recent decades, primarily because of the large public investment in water pollution control technology, and most conspicuously in the Providence River. However, other near-coastal areas and tributaries show signs of deteriorating water quality and increasing impairment of water quality-dependent uses related to the trend toward suburbanization and development of rural areas of the Bay watershed.

Section 715-04-01 focuses on reducing current inputs of human fecal waste, toxic pollutants, and nutrients in order to restore threatened and degraded waters, and to restore water quality-dependent uses of the Bay. In addition, a combination of regulatory controls and non-regulatory, economic incentives are recommended in order to reduce future inputs of polluting substances associated with projected increases in population growth and development in the Bay basin. The Section also addresses significant pollutant sources and pollutant pathways (*i.e.*, combined sewer overflows, on-site sewage disposal systems, boater discharges, and nonpoint sources) responsible for discharging multiple classes of pollutants.

04-01-01 Source Reduction: Toxics

Objective for the Reduction of Toxics Inputs

The State of Rhode Island and the Commonwealth of Massachusetts should eliminate the discharge or release of toxic pollutants to the environment, from all sources, in order to protect public health and safety; the integrity of air, land and water resources; the health of aquatic and terrestrial plants and animals, and other economically viable uses of natural resources.

Introduction

The term "toxics", for the purposes of this discussion, refers to heavy metals and organic chemicals that may produce adverse human health or ecological effects when introduced into the environment at toxic levels. Human (or 'anthropogenic') sources of toxic pollutants to the Narragansett Bay basin include industrial, commercial and household wastes; agricultural and lawn chemicals; motor vehicle emissions and leaks; accidental releases and deliberate disposal.

The pathways by which toxic pollutants enter Narragansett Bay include rivers, publicly owned wastewater treatment facilities (WWTF), combined sewer overflows (CSO), direct industrial discharges, urban, highway and lawn runoff, groundwater discharge to surface waters, atmospheric deposition, and remobilization of contaminated sediments (Penniman *et al.*, 1991a).

Statement of the Problem

Although the metals and some of the organics occur naturally in low concentrations, they can accumulate in the tissues of plants and animals, causing physiological damage or death at elevated concentrations. On the other hand, synthetic organic chemicals, such as polychlorinated biphenyls (PCB) and chlorinated pesticides, often persist in the environment and can cause biological harm at low concentrations (Penniman *et al.*, 1991a:1).

Ambient concentrations of metals may be derived from the weathering of mineral de-

posits, or anthropogenically (and at toxic levels) from metal finishing and electroplating industry discharges and emissions, improper disposal of factory and domestic wastes, corrosion of copper and lead pipes, boat antifouling paints, *etc.* Toxic organic chemicals enter the Bay from the burning of fossil fuels, industrial and domestic discharges of organic solvents, chronic small chemical releases and from catastrophic spills, such as the *World Prodigy* spill of #2 heating oil in 1989. Many forms of toxic pollutants adsorb to particles that eventually settle to the bottom of the Bay, resulting in their accumulation in the sediments or tissues of marine organisms (Penniman *et al.*, 1991a:2). Others remain in solution, depending on temperature, salinity, pH, and chemical reactivity.

Biological Effects

Marine organisms, including fish and shellfish, can accumulate toxics in their tissues from the sediments and water to which they are exposed, and by consuming food that contains toxic pollutants. The effects of this accumulation can be both acute and chronic for organisms exposed to elevated contaminant levels. Acute toxicity, including death and population disruption, can occur in cases of extreme or persistent exposure to toxics. For example, lobster, mussel, benthic invertebrate and plankton kills in the intertidal and shallow subtidal areas heavily fouled by the *World Prodigy* oil spill represent an acute biological response to an extreme exposure to toxic petroleum derivatives (Pilson, 1990).

Sublethal exposures to toxic pollutants can cause carcinogenic, mutagenic and behavioral effects, organic tissue damage, general reduction in organism fitness and ability to reproduce, and change in community stability (Jeon and Oviatt, 1991; Penniman, 1991a). Elevated toxics levels in edible tissues of harvested seafood can also pose human health risks. For example, neurological disorders and an increased risk of cancer may be caused by chronic exposures to seafood contaminated with toxics (Kipp, 1990; Penniman *et al.*, 1991a:2-3). [See 04-02-04 Resource Protection: Public Health for further discussion.]

Temporal and Spatial Distribution

Chemical profiles from sediment cores show marked increases in metals' concentrations that coincide with the beginning of industrialization in the Narragansett Bay basin (Corbin, 1989; King, 1991; Penniman *et al.*, 1991a). The magnitude and environmental effect of industrial inputs have varied over time, however, due to changes in manufacturing, dam construction on tributaries, interception of industrial discharges to municipal sewers, improvements in wastewater treatment and industrial pretreatment technologies, as well as changes in disposal strategies for municipal sewage sludge (Penniman *et al.*, 1991a:1). For example, there is convincing evidence that significant reductions in inputs of some metals to the Providence River have occurred since the 1970s (King, 1991; Bender *et al.* 1989; Penniman *et al.*, 1991a:4). These reductions correspond to reductions in metals loadings to municipal WWTFs, changes in the metal finishing industry and reduction in use of leaded gasoline (Penniman *et al.*, 1991a:4).

Toxic metal and organic pollutant concentrations in Bay waters and sediments generally decrease along a down-bay gradient from the Providence and Seekonk Rivers to Rhode Island Sound (Doering *et al.*, 1989; Vandal and Fitzgerald, 1988; Bender *et al.*, 1989; Pilson and Hunt, 1989; Nixon, 1991; Metcalf & Eddy, Inc., 1991a). This gradient reflects distance from industrial and urban centers as well as Bay circulation patterns, depositional gradients and contaminant reactivity with seawater and suspended solids. Although total metals loadings to upper Narragansett Bay have decreased significantly in recent years (Penniman *et al.*, 1991a:5), marine aquatic life criteria for copper, nickel, and occasionally lead are still exceeded in the Providence and Seekonk Rivers. In addition, freshwater aquatic life criteria for copper, nickel, lead, chromium, cadmium, and polychlorinated biphenyls are persistently exceeded in segments of the Blackstone, Pawtuxet, Woonasquatucket, and Moshassuck Rivers and localized tox-

ics' "hot spots" still exist in other areas of the Bay basin related to local municipal, industrial, commercial, agricultural, and defense activities (Penniman *et al.*, 1991a:5).

Existing Policies

Discharges and releases of toxic metals and organic chemicals to the environment are regulated under a variety of federal laws, including the Clean Water Act (CWA), the Resource Conservation and Recovery Act (RCRA), the Clean Air Act (CAA), the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and the Toxic Substances Control Act (TSCA). Discharges to freshwater and marine receiving waters are regulated under the CWA via the National Pollutant Discharge Elimination System (NPDES) and, indirectly via the National Pretreatment Program (NPP). Permitting authority may be delegated to the states for administration of both programs as is the case for Rhode Island (Penniman *et al.*, 1991a:10).

In addition, both Rhode Island and Massachusetts have established non-regulatory programs for reducing industrial discharges of toxics to the environment. These programs are described below. The State and the Commonwealth also participate, along with other New England states, and the States of New York and New Jersey, in the Northeast Waste Management Officials' Association (NEWMOA), which focuses on exchanging information regarding pollution prevention strategies (Penniman *et al.*, 1991a:15).

Water Quality Criteria

The Clean Water Act requires states to adopt water quality standards to protect public health, aquatic resources, and designated uses of state waters. These standards define the level of ambient water quality that must be achieved to support desired uses of the waterbody. Discharges into receiving waters are regulated, therefore, to ensure compliance with state water quality standards and protect designated uses of the state's waters.

In setting water quality standards, two sets of criteria are considered: aquatic life criteria and human health criteria. Aquatic life criteria are based on toxicity of specific chemicals to test animals. The U.S. Environmental Protection Agency (EPA) has developed aquatic life criteria for 30 toxic pollutants. Human health criteria, on the other hand, are based on toxic chemical concentrations in the tissues of edible organisms that could result in unacceptable, adverse health effects to human consumers, based on risk assessment analyses (Kipp, 1990). The EPA has developed human health criteria for 108 toxic pollutants.

Massachusetts has recently adopted, by reference, both aquatic life and human health criteria. Rhode Island has adopted criteria for the protection of aquatic life and is currently promulgating criteria for the protection of human health. However, some differences exist between Rhode Island and Massachusetts with respect to the designated uses and water quality standards of shared waterbodies such as Mount Hope Bay and the Blackstone River (Penniman *et al.*, 1991a:11).

Regulation of Discharges to Receiving Waters

In Rhode Island, the EPA has delegated primary authority for administering the NPDES permit program to the state, which issues "RIPDES" permits. The Rhode Island Pollutant Discharge Elimination System or RIPDES permits (and NPDES permits in Massachusetts, a "non-delegated" state) set effluent discharge limits for direct municipal and industrial wastewater dischargers to protect receiving water quality. Permit requirements typically include effluent monitoring, chemical toxicity testing, and periodic priority pollutant scans. Monthly monitoring and quarterly noncompliance reports are submitted to the state and EPA Region I. Failure to comply with permit limits or monitoring and reporting requirements is considered a violation of the Clean Water Act (and state water quality protection laws) and subject to enforcement action. The Rhode Island Department of Environmental Management (RIDEM) is primarily respon-

sible for permitting and enforcement in Rhode Island. In Massachusetts, NPDES permits are issued and enforced jointly by EPA and the Massachusetts Department of Environmental Protection (MADEP) (Penniman *et al.*, 1991a:10).

RIDEM regulates 129 direct dischargers to Narragansett Bay via RIPDES permits, 25 of which are "major" permittees based on flow, effluent, and receiving water characteristics. There are 116 permittees in the Massachusetts portion of Narragansett Bay watershed; 34 in the Blackstone River basin, 56 in the Taunton River basin and 15 along the Ten Mile River. Thirty-six of the Massachusetts dischargers are classified as "major" (Penniman *et al.*, 1991a:13).

Pursuant to the National Pretreatment Program (NPP), industrial discharges to WWTFs are regulated by local WWTFs under state and/or EPA supervision. WWTFs, or "local control authorities", issue enforceable discharge permits to industrial users that specify industry-specific effluent limits, general prohibitions on discharging materials that may adversely affect worker health or WWTF operation, and local limits that reflect the WWTF's own RIPDES (NPDES) permit limits, operating requirements, and/or receiving water quality standards. (Penniman et al., 1991a:14)

In Rhode Island, the EPA has delegated supervisory responsibility for industrial pretreatment programs to the state, and administrative responsibilities to the WWTFs. Thirteen of Rhode Island's 19 WWTFs have established industrial pretreatment programs as of 1991. In Massachusetts, these responsibilities are delegated directly to the WWTFs (as opposed to the Commonwealth), subject to EPA oversight. Seven of the 17 Massachusetts WWTFs in the Narragansett Bay basin have industrial pretreatment programs as of 1991 (Penniman *et al.*, 1991a:14).

Source Reduction

Rhode Island has established several programs that focus on reducing the use and release of toxic pollutants to the environment ("pollution prevention") rather than end-of-pipe regulation. Two Rhode Island laws specifically address reducing the discharge or disposal of toxic wastes. The Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act of 1986 (R.I.G.L. 23-19.10-1 *et seq.*) provides grants and low interest loans to industry for the development and demonstration of waste reduction and recycling technologies. The Hard-to-Dispose Material—Control and Recycling Act of 1989 (R.I.G.L. 37-15.1-1 *et seq.*) levies a surcharge on "hard-to-dispose" materials, such as organic solvents, oil, antifreeze, batteries, *etc.*, in order to encourage recycling and decrease use of hazardous materials (Penniman *et al.*, 1991a:15). These programs are administered by the RIDEM Office of Environmental Coordination's Hazardous Waste Reduction Program (HWRP). The HWRP also performs waste reduction assessments for Rhode Island industries, recommends more effective waste minimization practices, and tracks cost savings achieved by industries that implement pollution prevention practices (Penniman *et al.*, 1991a:16).

Other waste reduction programs in Rhode Island include the statewide *Capacity Assurance Plan* which will update waste reduction targets for hazardous wastes, including metals, and develop disposal strategies to account for the total volume of hazardous waste generated in Rhode Island; and EPA's Industrial Toxics Project, under which the state has agreed to work with industry to reduce total environmental releases of 17 pollutants by as much as 50 percent by 1995 (Penniman *et al.*, 1991a:16). The RIDEM also participates in a newly-created coalition of government, environmental groups, and industry representatives called the Rhode Island Pollution Prevention Council (RIPPC). The RIPCC is developing economic and regulatory incentives to increase source reduction, identifying markets for recycled materials, recommending priorities for research and development, and coordinating educational and technical assistance efforts (Penniman *et al.*, 1991a:16-17).

The Commonwealth of Massachusetts has initiated comparable source reduction pro-

grams. The Massachusetts Toxics Use Reduction Act, enacted in 1990, calls for a 50 percent reduction in toxic waste produced statewide by 1997 and emphasizes source reduction as opposed to end-of-pipe permitting to achieve this goal (Penniman *et al.*, 1991a:17). In addition, Massachusetts established the experimental Blackstone Project in 1989 to provide technical assistance to industries along the Commonwealth's portion of the Blackstone River. The Blackstone Project also works with state regulatory agencies to test the feasibility of regulating a facility's entire manufacturing process under a single consolidated discharge permit with respect to discharges, releases, and off-site transfers of toxics to all media (Penniman *et al.*, 1991a:17).

Analysis

At present, the most serious water quality degradation related to toxic pollutants occurs in the Providence River and its major tributaries—the Blackstone, Pawtuxet, Woonasquatucket, Moshassuck, and Ten Mile Rivers. However, elevated concentrations of some toxic substances also occur in other less urban areas of the Bay. For example, elevated mercury concentrations have been measured in Mount Hope Bay sediments, and sediment cores recently collected from the center of Greenwich Bay and Apponaug Cove show recent copper concentrations at five to 20 times above pre-Colonial levels. In addition, copper levels in Greenwich Bay have decreased by only five to ten percent compared to 67 percent in the Seekonk River over the same time period (King, 1991; Penniman *et al.* 1991a:4). Importantly, mussel tissue samples collected from relatively clean sites in Narragansett Bay (near Spar Island in Mount Hope Bay) were found to be the sixth most contaminated of 72 sites in the United States for copper and the eighth most contaminated of 145 estuaries sampled for lead (NOAA, 1987). Based on these findings, the use and discharge of toxics substances should be reduced throughout the Bay watershed.

Federal and state regulations governing the use, discharge, emission, and off-site waste transfer of toxic materials focus on industrial sources and are administered according to the environmental medium (air, land, water) that receives the waste. This regulatory approach may inadvertently 1) create incentives for shifting toxic wastes to other media in response to changing regulatory requirements; 2) create inconsistent or redundant regulatory requirements; 3) discourage development and testing of new treatment technologies; and 4) confound the agencies' ability to measure progress in achieving net reductions in toxics loadings to the environment. Existing regulatory policies may also inadvertently create incentives for industrial users to relocate away from highly regulated urban areas to areas with inadequate infrastructure (water, sewer) and/or less stringent regulatory requirements.

As noted above, toxic substances enter the Narragansett Bay watershed via a variety of pathways and derive from numerous natural and anthropogenic sources. WWTFs, followed by rivers, are the major pathways for the discharge of toxics to Narragansett Bay, although both receive wastes from direct (*e.g.*, industry, households) and indirect or nonpoint (*e.g.*, contaminated groundwater, runoff) pollutant sources. Since Rhode Island's Industrial Pretreatment Program, in combination with industry efforts, has resulted in significant reductions in industrial toxics loadings to WWTFs, up to 40 percent of the total metals discharged to the Narragansett Bay Commission (NBC) Field's Point facility at the present time could derive from non-industrial sources, including residential and commercial dischargers , corrosion of water supply conveyance systems, contaminated groundwater and runoff (Metcalf & Eddy, 1990a). Therefore, as industry continues to reduce its use and disposal of toxics, non-industrial sources such as commercial, agricultural, municipal and domestic users of toxic chemicals (including fossil fuels), urban and highway runoff, and groundwater discharge to surface waters may represent an increasingly significant contribution of toxics throughout the Bay basin.

Finally, human health and aquatic life criteria presently exist for a small subset of the

chemical compounds that are potentially of concern in marine systems. An even smaller subset of these anthropogenically—produced pollutants are presently controlled through the regulatory permit process—many WWTFs in the Narragansett Bay basin do not have effluent metals limits and even fewer have organic chemical limits (Penniman *et al.*, 1991a:17). However, there are numerous industrial, commercial, agricultural, and domestic sources of these non-regulated chemicals in the Narragansett Bay basin, and the regulatory problem may become increasingly serious in the future as new industries with "exotic" wastestreams, *e.g.*, bioengineering and pharmaceutical companies, become established. Consequently, source reduction and regulatory strategies should be developed that apply to a broader spectrum of potentially toxic chemicals rather than addressing only those toxic substances for which local data are available.

In summary, the existing trend toward industrial source reduction offers great potential for overall, permanent reductions in toxics loadings to upper Narragansett Bay. However, toxics-related problems in the Narragansett Bay basin are not limited to a single geographic region, a single category of users or a small group of toxic compounds. As a result, both regulatory and non-regulatory approaches should be evaluated in order to achieve basin-wide reductions in toxics use and discharge to the Bay.

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: TOXICS

CODE	POLICY	AGENCIES	STATUS
I.	The State of Rhode Island and the Commonwealth of Massachusetts should reduce total toxics loadings to Narragansett Bay basin from all sources by maximizing conservation of natural resources and minimizing the use, generation, and discharge of toxics to the environment.		
I.A.	Comprehensive Regulation of Toxics		
I.A.1.a.	The U.S. Environmental Protection Agency (EPA), the State of Rhode Island, and the Commonwealth of Massachusetts should assure that inconsistent, unclear or inappropriate regulatory policies and requirements do not create unnecessary impediments to achieving source reduction or reductions in toxics loadings to the environment. In order to implement this recommendation, the EPA, the Rhode Island Department of Environmental Management (RIDEM) and Massachusetts counterparts should prepare a report within one year following approval of the Narragansett Bay *Comprehensive Conservation and Management Plan* (*CCMP*) that evaluates potential conflicts among regulations pertaining to toxic pollutants, and formulates strategies to resolve identified conflicts. On an ongoing basis, these agencies should publish summary explanations of policies and/or regulations identified by interagency advisory groups as possibly interfering with progress toward source reduction. EPA Region I should appoint a single individual to receive notification and coordinate responses to federal policies or regulations that have been so identified. Examples of regulatory and program requirements that should be reviewed include: i. The Resource Conservation and Recovery Act (RCRA) permitting and reporting requirements regarding "hazardous waste treatment" that have been construed to apply to industries that install *zero discharge* recycling systems. ii. Federal and state discharge requirements that have been construed to apply to pilot scale research and development projects. iii. Federal program requirements that have been construed to prohibit the issuance of facility-based permits and consolidation of reporting requirements.	EPA, RIDEM, MADEP, NEWMOAA, RIPPC, Local control authorities	RIPPC, NEWMOAA, and R.I. local control authorities have identified several possible conflicts.

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I.A.1.b.	The EPA, the State of Rhode Island and the Commonwealth of Massachusetts should continue to participate in interagency pollution prevention advisory groups that review regulations and regulatory programs, recommend pollution prevention strategies and goals, review scientific and technological advances, exchange information on new technologies, and act as a liaison to industry.	EPA, RIDEM, MADEP, MADEM	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.A.1.c.	The Commonwealth of Massachusetts should hire a Massachusetts Pretreatment Coordinator to act as a liaison with other states, local control authorities, and interagency pollution prevention advisory groups as soon as possible.	MADEP and/or MADEM	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.A.2.	To assure that waste minimization practices and best available technologies (BATs) are used wherever practicable to minimize cross-media transfer of toxic chemical wastes, the EPA, RIDEM, and Massachusetts counterparts should encourage better training of program staff in all aspects of toxic materials regulation. These agencies should: a. Provide regulatory staff with continuing education in the municipal, industrial and manufacturing processes they regulate. b. Train regulatory staff to conduct coordinated, facility-wide inspections for all discharges, releases, and off-site transfers of regulated wastes.	EPA, RIDEM, MADEP, MADEM	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.A.3.	a. The State of Rhode Island should be included on EPA Region I, Massachusetts Department of Environmental Protection (MADEP), and Massachusetts Coastal Zone Management (MACZM) lists of automatic reviewers of Massachusetts' discharge permits within the Narragansett Bay basin. b. The State of Rhode Island should be included on EPA Region I, Massachusetts Department of Environmental Protection (MADEP), and Massachusetts Coastal Zone Management (MACZM) lists of automatic reviewers of Massachusetts' water withdrawal permits within the Narragansett Bay basin. c. RIDEM, the Rhode Island Coastal Resources Management Program (CRMC) and the Rhode Island Division of Planning (RIDOP) should identify appropriate agency contacts to receive notice and provide reviews consistent with their jurisdiction and mandates under Coastal Zone Management Act Section 307, Executive Order 12372 and other sources of federal consistency review authority.	EPA, MADEP, MACZM, RIDEM, CRMC, RIDOP	

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I.A.4. ✓	To the fullest extent of their authority, the EPA, RIDEM, and MADEP should require all regulated municipal and industrial dischargers to minimize the use, generation, and disposal of toxic substances to the maximum extent practicable. In order to implement this recommendation: a. The EPA should develop a waste minimization report form that consolidates the requirements of the *Capacity Assurance Plan* (RIDEM, 1989a) and the *Rhode Island Hazardous Waste Reduction and Reporting Manual* (Center for Environmental Studies, 1989). b. By December 1995, the EPA and RIDEM should, to the fullest extent of their authority, require the completion of a waste minimization report by all significant industrial users subject to industrial pretreatment program requirements and should incorporate relevant portions of waste minimization plans into discharge permits, including schedules for implementing pollution prevention and toxics use reduction practices. The RIDEM should provide affected dischargers with assistance in completing the waste minimization report form to be developed by the EPA in order to educate and train industry personnel and improve compliance with regulatory requirements. c. The EPA, RIDEM, MADEP, and local control authorities, to the maximum extent possible, should revise existing industrial pretreatment regulations to require all significant industrial users found to be in significant noncompliance with industrial pretreatment discharge standards to undergo a formal on-site waste reduction assessment, and to submit a waste minimization report. The waste minimization report should establish short-term (three to five years) and long-term (greater than five years) goals for source reduction and treatment options and should quantitatively report actual reductions in use and disposal of toxics in all media, biennially, for the next five years. ["Significant noncompliance" is defined in 40 CFR § 403.8 (f) (2) (vii) (A) (B) for the purposes of this recommendation.] d. The federal government, the State of Rhode Island, and the Commonwealth of Massachusetts should establish economic incentives to encourage private investment in research, development, and implementation of pollution reduction technologies. (See Rec. IE)	EPA, RIDEM, MADEP	[See RIDEM "Preliminary Agreement," Section 715-05-06. re: possible revision to Industrial Pretreatment regulations, the R.I. Clean Air Act, and the R.I. Hazardous Waste Mgt. Act re: waste reduction assessments and waste minimization reports.]

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CODE	POLICY	AGENCIES	STATUS
I.B.	WWTFs and Direct Industrial Dischargers		
I.B.1.	The EPA, RIDEM, and MADEP should effectively regulate direct toxic pollutant discharges to Narragansett Bay and its tributaries. In order to implement this recommendation:		
I.B.1.a. ✓	The EPA, RIDEM, and Massachusetts counterparts should establish a basin-wide *Narragansett Bay List of Toxics of Concern*. The list should be based on documented exceedances of human health and aquatic life criteria anywhere in the Bay basin, all compounds regulated in existing permits, and best professional judgment of agency personnel. Based on existing information, the following chemicals should be included on the *List:* cadmium, chromium, copper, lead, mercury, nickel, zinc, cyanide, total petroleum hydrocarbons (PHC), polyaromatic hydrocarbons (PAH), and polychlorinated biphenyls (PCB).	EPA, RIDEM, MADEP, RIDOH, MADPH	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.B.1.b. ✓	The EPA, RIDEM, and MADEP should issue National Pollutant Discharge Elimination System/Rhode Island Pollutant Discharge Elimination System (NPDES/RIPDES) permits to wastewater treatment facilities (WWTF) and direct industrial dischargers that are presently operating under expired permits, and, to the extent allowed by current regulations, revise existing permits to include effluent limits for all toxic metal and organic pollutants of concern in the Narragansett Bay basin sufficient to achieve water quality standards. i. The following NPDES/RIPDES discharge permits have expired and should be reissued as soon as possible: Douglas (Mass.), Upper Blackstone Water Pollution Abatement District (Mass.), Narragansett Bay Commission Field's Point (R.I.), Narragansett Bay Commission Bucklin Point (R.I.), and Woonsocket (R.I.), Smithfield (R.I.) and Warren (R.I.). ii. To the extent allowed by current regulations, the following NPDES discharge permits should be revised as soon as possible to include enforceable numeric, chemical-specific effluent limits for all metal and organic chemicals of concern: Grafton (Mass.), Hopedale (Mass.), Millbury (Mass.), and Uxbridge (Mass.).	EPA, RIDEM, MADEP	Smithfield RIPDES permit issued 1992; Draft NBC Bucklin Point RIPDES permit issued Dec. 31, 1990; Draft NBC Field's Point RIPDES permit issued June 1992.

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I.B.1.c.	By December 1993, the EPA, RIDEM (or RIDOE), and MADEP should cooperatively perform a metals wasteload allocation for the Blackstone-Seekonk-Providence River basin and Upper Narragansett Bay in order to identify waters and sediments impaired by metals, and develop individual control strategies for identified point source dischargers. NPDES/RIPDES permits with enforceable, numeric, chemical-specific effluent limits, revised to the extent allowed by current regulations, shall be issued to all dischargers in the affected basin within two years following completion of the waste load allocation.	EPA, RIDEM, MADEP	Dryweather survey completed Summer 1991. [See EPA Region I and RIDEM "Preliminary Agreements," Section 715-05-06. re: commitment to wet weather survey, WLA.]
I.B.2.	The EPA, RIDEM, and MADEP should effectively measure direct toxic pollutant discharges to Narragansett Bay and its tributaries in order to allow systematic comparisons of temporal and spatial trends in pollutant loadings and receiving water quality. To the fullest extent of their authority, the EPA, RIDEM, and MADEP should: a. Require all dischargers subject to NPDES/RIPDES permits in the Narragansett Bay basin to routinely report monthly influent and effluent concentrations and loadings of all permitted toxic pollutants on the *Narragansett Bay List of Toxics of Concern* ; and b. Implement a receiving water monitoring program that is adequate to determine compliance with federal and state water quality standards, and evaluate regional trends in water quality. [See 05-02-04 CCMP Implementation and Governance: Long-Term Monitoring for related recommendation.]	EPA, RIDEM, MADEP	

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I.B.3 ✓	**The EPA, RIDEM and MADEP should effectively enforce limitations on direct toxic pollutant discharges to Narragansett Bay and its tributaries. These agencies should take the following actions to increase compliance with existing discharge requirements:** **a. Increase the frequency of unannounced on-site inspections and compliance monitoring at all WWTFs and direct industrial dischargers.** **b. Take timely and appropriate enforcement action for persistent noncompliance (more than three consecutive months) with chemical-specific effluent and toxicity limits, including monetary penalties that remove all benefits of noncompliance.** **c. Require WWTFs and businesses found to be in significant noncompliance with NPDES or RIPDES permits to publish notices in newspapers of general circulation identifying the violation, the penalty, and measures taken to prevent future violations.** **["Significant noncompliance" is defined in EPA Quality Noncompliance Report Workshop, December 1985 for the purposes of this recommendation.]**	**EPA, RIDEM, MADEP**	**[See EPA Region I and RIDEM "Preliminary Agreements," Section 715-05-06 re: inspection and enforcement.]**
I.B.4.	In order to increase compliance with existing discharge and other permit requirements, Rhode Island and Massachusetts state agencies should seek legislative expansion of federal and state "citizen suit" jurisdiction under the Clean Water Act (CWA), RCRA, Clean Air Act (CAA), Toxic Substances Control Act (TSCA), and state equivalents, as necessary to provide legal standing to citizen "watchdog" organizations to enforce, where applicable, all permit requirements regarding toxics discharges, releases, and off-site waste transfers to all media. In addition, state agencies should seek to establish federal and state "citizen suit" jurisdiction under the CZMA, Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), and state implementing programs.	RIDEM, CRMC, Mass. counterparts	

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I.C.	Industrial Users		
I.C.1.	The EPA, RIDEM, and local control authorities, including their Massachusetts counterparts, should verify, on an ongoing basis, that all industrial users subject to industrial pretreatment requirements are operating pursuant to discharge permits. In order to ensure that Massachusetts, Rhode Island, and local regulators are covering all industrial sources: a. Facilities files maintained by local control authorities and regulatory divisions of RIDEM and Massachusetts counterparts should be compared. b. Water use records should be examined for evidence of above-average water consumption in residential areas to detect unregulated manufacturing operations. c. Records of the Rhode Island Department of Economic Development and its Massachusetts counterpart, tax records, and all other appropriate public records listing manufacturing firms registered in Rhode Island and Massachusetts [SIC codes 20 to 39] should be examined. d. The State of Rhode Island and Commonwealth of Massachusetts should *not* offer a one-time amnesty for presently unregulated businesses to comply voluntarily with federal and state permitting requirements for wastewater, solid or hazardous waste disposal, and air emissions.	EPA, RIDEM, MADEP, local control authorities	RIDEM reviews WWTF Industrial Pretreatment program operations annually.

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I.C.2. ✓	In order to reduce the rate of noncompliance with industrial pretreatment program requirements, the EPA, RIDEM, local control authorities, and their Massachusetts counterparts should rigorously enforce industry compliance with existing industrial pretreatment program requirements, including all chemical-specific and toxicity-based discharge limits, and monitoring and reporting requirements. ["Significant noncompliance" is defined in 40 CFR § 403.8 (f) (2) (vii) (A) (B) for the purposes of this recommendation.] In order to implement this recommendation: a. RIDEM and MADEP should require training and/or certification for municipal industrial pretreatment program staff, including inspectors and industry personnel charged with overseeing industrial wastewater pretreatment operations. b. These agencies should take timely and appropriate administrative, civil, and criminal enforcement action against all regulated industrial dischargers found to be in significant noncompliance with chemical-specific effluent and toxicity limits, as defined in 40 CFR § 403.8 (f) (2) (vii) (A) (B), including monetary penalties that remove all benefits of noncompliance, and jail sentences for principals of firms found to be in violation of criminal provisions of the industrial pretreatment program requirements. c. All regulated industrial dischargers found to be in significant noncompliance with federal, state, and local discharge limitations, as defined in 40 CFR § 403.8 (f) (2) (vii) (A) (B), should be required to publish notices in newspapers of general circulation identifying the violation(s), the penalty, and measures taken to prevent future violations. d. Within the limits of their jurisdiction, a "whistle-blower" statute should be drafted, or existing statutory authority amended, to reward individuals who provide information regarding industries that are presently operating without required regulatory oversight. This statute should be patterned after federal "whistle-blower" measures and should include job-protection provisions. e. These agencies should formally review the administration and enforcement of any industrial pretreatment program where more than or equal to 15 percent of the regulated industries are in significant noncompliance with program requirements.	EPA, RIDEM, MADEP, local control authorities	[See RIDEM and EPA Region I "Preliminary Agreements," Section 715-05-06 re: enforcement and audits of Industrial Pretreatment programs.]

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I.C.3. ✓	The EPA, RIDEM, local control authorities, and their Massachusetts counterparts should systematically encourage regulated industrial dischargers to use and implement source reduction practices. In order to implement this recommendation, these agencies should: a. To the fullest extent of their authority, require completion of a waste minimization report by all significant industrial users subject to Industrial Pretreatment Program requirements; and revise existing industrial pretreatment regulations to require all dischargers found to be in significant noncompliance with industrial pretreatment standards, as defined in 40 CFR § 403.8 (f) (2) (vii) (A) (B), to receive a complete, on-site waste reduction assessment. [See Recommendation I.A.4.] b. Require certified design drawings of source reduction, reclaim, and recycle plans to be submitted as a requirement of the permitting process. Design drawings should be certified by a registered Professional Engineer or any individual formally approved by either the State Board of Registration for Professional Engineers or RIDEM to certify industrial process design drawings. c. Require industry-wide implementation of proven, affordable technologies or processes that reduce the use or generation of toxic pollutants without shifting waste to another medium, (*e.g.*, the use of substitutions for chlorinated and/or fluorinated degreasers), unless an industry can demonstrate that an equally effective alternative exists. d. Pending clarification of RIDEM's authority, the RIDEM should implement the requirements of the Chemical Purchasing Act of 1990 (R.I.G.L. 42-110), as amended, to assure that companies that purchase restricted chemicals are licensed by RIDEM based, in part, on the company's spill contingency plans and permit compliance record.	EPA, RIDEM, MADEP, local control authorities	[See EPA Region I and RIDEM "Preliminary Agreements," Section 715-05-06 re: emphasis on source reduction.]

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I.C.4.	Within two years following approval of the *CCMP*, the EPA should authorize, establish, and oversee pilot facility-based permitting projects in both Rhode Island and Massachusetts to test procedures for streamlining the permitting process and achieving overall reductions in pollutant loadings to all environmental media, *i.e.*, each participating industrial user should receive a single permit covering discharges, releases, and off-site waste transfers to all media rather than separate permits for dischargers to air, land, and water. Within one year following completion of the demonstration project the EPA should: a. Prepare a written evaluation of the administrative and regulatory success of the pilot projects, including the Blackstone Project, compared to conventional regulation of industrial dischargers. b. Determine whether the pilot project should be expanded, modified, or discontinued. c. Identify sections of relevant federal and state statutes and regulations that would have to be amended to allow complete implementation of facility-based permitting.	EPA	[See EPA Region I "Preliminary Agreement," Section 715-05-06 re: technical assistance to states on whole facility permitting.]

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I.D.	Other Generators of Toxic Pollutants		
I.D.1.	In order to measure adequately and to begin regulating non- industrial sources of toxic pollutants:		
I.D.1.a.	The RIDEM, local control authorities, and their Massachusetts counterparts, with technical assistance provided by EPA, should expand the categories of commercial enterprises subject to industrial pretreatment program requirements to include any discharger that discharges more than 500 gallons per day of mixed sanitary and process wastewater or generates more than ten kilograms per month or one 55-gallon drum per year of hazardous waste. [Activities to be considered include, but are not limited to, auto body shops, hospital, dental, medical, and photo laboratories, and dry cleaners.] All other commercial enterprises that discharge directly to sewers or generate septage that is ultimately discharged to a WWTF should be evaluated for inclusion in pretreatment programs by December 1995. These policies should be consistently implemented on a watershed-wide basis. The following policies should also be implemented as soon as possible:	RIDEM, MADEP, EPA, local control authorities	[See EPA Region I "Preliminary Agreement," Section 715-05-06 re: technical assistance to local control authorities for expansion of Industrial Pretreatment Program.]
I.D.1.a.i.	The establishment of enforceable pretreatment standards for toxic metals and organic chemicals in septage, and enforcement of existing state prohibitions on the discharge of non-domestic waste to on-site sewage disposal systems (OSDS). RIDEM and its Massachusetts counterparts should consider requiring an annual report from non-residential property owners served by OSDSs regarding manufacturing and service activities on-site that result in any discharge to the OSDS.	RIDEM, Mass. counterpart	
I.D.1.a.ii.	The expansion of existing household toxic waste collection, recycling, and disposal centers to allow collection of wastes generated by *tiny-quantity waste handlers* on a cost-recovery basis. The EPA, RIDEM, and Massachusetts counterparts should review their regulations to assure that unnecessary regulatory impediments to proper waste collection, recycling and disposal are modified or removed. [For the purpose of this recommendation, *tiny quantity waste handlers* are defined as "individuals or small businesses that produce less than ten kg per month, or less than one 55 gallon drum per year, of hazardous waste" (Roque, 1991), and are not subject to State hazardous waste or industrial pretreatment program requirements.]	EPA, RIDEM, Mass. counterpart	

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I.D.1.a. iii.	The reinstitution of the RIDEM household toxic waste collection, recycling, and disposal program as soon as possible. The RIDEM should evaluate alternative financing options to institute this program permanently.	RIDEM	RIDEM re-instituted program in 1992 and is seeking permanent funding
I.D.1.b.	The State of Rhode Island and Commonwealth of Massachusetts should require more rigorous annual motor vehicle inspections for air emissions and fluid leaks, including oil leaks, and should link annual motor vehicle registration fees and/or State excise taxes to EPA-rated gasoline mileage in order to promote the use of gasoline efficient vehicles. The State of Rhode Island and Commonwealth of Massachusetts should develop public education materials regarding the environmental effects of chronic oil leaks and highway runoff.	R.I. and Mass.	R.I. House Bill #8589 (1992) will require RIDEM to promulgate vehicle emission regulations, if passed.
I.D.1.c.	On an ongoing basis and within the limits of their jurisdiction, the EPA, the State of Rhode Island, the Commonwealth of Massachusetts, and consumer groups should make every reasonable effort to reduce household use of toxics by: i. Identifying environmentally safe substitutes for commonly used household chemicals. ii. Assessing "hard to dispose" taxes on household products containing toxic metals or organic chemicals. Revenues generated by the "hard to dispose tax" should be deposited in a RIDEM restricted receipt account and dedicated to future source reduction efforts in the State of Rhode Island. iii. Providing options for safe collection, recycling, and disposal, where possible, for household products containing toxic metals or organic chemicals, including oil. iv. Reducing the use of products containing chemicals in amounts that could be toxic to humans or aquatic life, or will interfere with WWTF processes or sludge disposal.	EPA, RIDEM, MADEP, MADEM, consumer groups, environ-mental advocacy groups	

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I.E.	Economic Incentives and Disincentives		
I.E.1.	The federal government, including the EPA, the State of Rhode Island, and the Commonwealth of Massachusetts should develop and apply market incentives for toxics that make wasteful or environmentally unsound use and disposal practices expensive. For example: a. Rhode Island and Massachusetts should adjust existing water rate structures to remove subsidies and encourage conservation, *i.e.*, by establishing use fees that increase with the volume of water consumed. [Note, legislation encouraging water conservation and recommending inclining block rates for water use was passed by the Rhode Island General Assembly in 1991, amending R.I.G.L. 46-15.4.] b. Local control authorities in Rhode Island and Massachusetts should assess discharge fees on industrial wastewater discharges based on volume, pollutant loading, toxicity and/or receiving water quality, *e.g.*, 50 percent of the fee charged based on the volume of discharge and 50 percent charged based on loadings of conventional and toxic pollutants in the wastestream. c. Rhode Island and Massachusetts should tax raw materials and/or products that are either individually toxic or are toxic in combination with other materials in order to promote conservation and recycling, *e.g.*, Rhode Island's "Hard to Dispose Materials" Act of 1989, Massachusetts "Toxic Use Reduction Act". d. Massachusetts should establish a deposit-refund system on items such as batteries, automobile tires, *etc.*, modeled after Rhode Island's "Battery Deposit and Control Act," in order to discourage improper disposal. e. Rhode Island and Massachusetts should actively inform the public about health and environmental risks associated with pollutant discharges and the industrial, commercial, and agricultural use of chemicals by advertising the existence of federal and state *Community Right to Know* resources.	EPA, R.I., Mass., local control authorities	[See RIDEP, RIDOH "Preliminary Agreements," Section 715-05-06 re: enforcement of water conservation measures in Water Supply Management Act (1991).]

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I.E.2.	The federal government, including the EPA, and the State of Rhode Island, and Commonwealth of Massachusetts should encourage and reward private investment in pollution-reduction technologies. In addition, new regulatory initiatives regarding the mandatory use of BATs should be coupled with financial assistance programs to the extent possible in order to facilitate industry conversion to pollution reduction technologies. For example: a. Rhode Island and Massachusetts should consider offering tax credits to industries that are in compliance with their discharge permits and can document reductions of greater than or equal to 25 percent in discharges, releases, and off-site transfers of toxics relative to 1989 levels. The tax credit should reward source reduction initiatives and should not compensate for reduced production. The amount of the tax credit should be proportional to actual reductions in use and disposal achieved. b. Public interest groups and government agencies, within the limit of their authority, should promote environmentally safe products and/or develop a "Seal of Approval" for products of environmentally-sound manufacturing processes. Relevant federal and state authorities should develop regulations to govern the marketing of products as "environmentally safe." [See Rhode Island's "Waste Recycling" Act that provides for the adoption of a "distinctive logo to identify materials that are composed of recycled materials, recyclable materials or which are packaged in a source-reduced manner" (R.I.G.L. 23-18.8-3)]. c. Rhode Island and Massachusetts should establish and maintain a state-funded, low-interest revolving loan fund to stimulate research and development into new technologies and waste reducing processes, and to enable qualified small-to-medium-size businesses to invest in pollution control technology. Grants should be available to support research and development. Loans should be available to enable qualified companies to invest in proven technologies. [Note: Rhode Island enacted the "Hazardous Waste Reduction, Recycling, and Treatment Research and Demonstration Act of 1986" with a $2 million appropriation for these purposes.]	EPA, R.I., Mass.	R.I. Hazardous Waste Demonstration Act bond fund (1986) has $1.5 million remaining as of 3/92; R.I. Aqua Fund bond fund (1989) has $3.8 million remaining as of 3/92 as grants and low interest loans for industry.

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I.E.3.	The federal government, including the EPA, the State of Rhode Island, and the Commonwealth of Massachusetts should protect the states' economic welfare and environmental integrity by promoting the development of *green* business. For example: a. Rhode Island and Massachusetts should establish *small business incubators,* in conjunction with universities and the private sector, to provide capital, research, and marketing support to promote the development of commercially viable *green* technologies and products. [The incubators would provide i) Low-interest loans to small manufacturing concerns in reclaimed and recycled materials, products manufactured from reclaimed or recycled materials, or innovative production or waste treatment technologies; ii) research facility assistance for developing innovative processes and/or products; iii) governmental assistance in processing necessary permits; iv) private assistance in marketing or private investment.] b. Rhode Island and Massachusetts should foster markets for reclaimed and recycled materials as well as for products manufactured from reclaimed and recycled materials. Rhode Island and Massachusetts should consider adopting legislation requiring the state government to purchase products manufactured from reclaimed and recycled materials, if available, and to the extent that agency budgets are adjusted accordingly. c. To the extent permitted by federal and state law, trade organizations in Rhode Island and Massachusetts should be encouraged to consider pooling resources to purchase raw materials, shared equipment, and contractual services, to reduce the amount of hazardous materials in inventory, and to achieve economies of scale that would improve the region's competitive advantage. The EPA, RIDEM, and MADEP should work with trade organizations to identify appropriate areas for pooling resources. d. Rhode Island and Massachusetts should require imported manufactured goods to meet the same federal and state production standards as locally-produced goods, or label country or state of origin.	EPA, R.I., Mass., industry trade organizations, industry	

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I.F.	Information Exchange and Technology Transfer		
I.F.1.	The EPA and the State of Rhode Island should continue to provide financial support to the Rhode Island Hazardous Waste Reduction Program (HWRP). Similar technical assistance and clearinghouse programs should continue to be supported in Massachusetts. The technical assistance programs should: b. Establish procedures within industry to promote environmentally protective, cost-effective technologies and conservation measures, *e.g.*, see the HWRP's "quality circle" approach. c. Encourage industry and professional trade organizations to share the experiences of *home-grown* source reduction techniques. d. Organize demonstrations by consultants and vendors of new pretreatment and source reduction technologies. In addition, the Rhode Island Pollution Prevention Council (RIPPC) and/or the HWRP should establish a *Technology Review Board* to review emerging pollution reduction technologies. e. Provide waste reduction assessment services for large, medium, and small businesses that are significant industrial users subject to industrial pretreatment standards in order to identify cost-effective managerial, manufacturing, pretreatment and disposal options that will, if implemented, result in a net reduction in use of natural resources and toxics discharge. f. Work with government, industry, and academia to test full scale *demonstration models* of experimental production or pretreatment processes in working Rhode Island plants. g. Assist and work with regulators to develop standardized monitoring, reporting, permitting, and inspection procedures.	EPA, R.I., Mass., HWRP, RIPPC, Mass. counterparts	RIDEM HWRP receives ongoing state support for these activities. [See RIDEM "Preliminary Agreement," Section 715-05-06 re: cooperative agreement with URI to test experimental source reduction techniques in R.I. businesses.]

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I.G.	Treatment		
I.G.1.	To achieve net reductions and to prevent cross-media transfers of pollutants, all source reduction options should be considered *before* considering treatment for removal of toxics from a municipal, industrial, or commercial wastestream. The EPA, RIDEM, and Massachusetts counterparts should, however, follow developments in chemical, biological, and/or physical technologies for the degradation of toxic compounds into environmentally safe forms.	EPA, RIDEM, MADEP	
I.G.2.	The State of Rhode Island and the Commonwealth of Massachusetts should establish and maintain a state-funded low interest revolving loan fund to enable qualified small to medium size businesses to invest in proven source reduction technologies. Grants should be available to stimulate and support research and development.	R.I., Mass.	R.I. Hazardous Waste Demonstration Act and Aqua Fund bond funds have over $5 million remaining but temporarily frozen (1992).
II.	The State of Rhode Island and the Commonwealth of Massachusetts should make every reasonable effort to reduce industrial emissions, discharges and off-site waste transfers of the following chemicals to 50 percent of 1989 levels by 1995: cadmium, chromium, copper, lead, mercury, nickel, silver, zinc, cyanide and their compounds.		
II.A.	The EPA, RIDEM, and Massachusetts counterparts should establish numeric, water quality-based effluent limits for cadmium, chromium, copper, nickel, lead, mercury, silver, and zinc for all WWTFs operating in the Bay watershed that 1) have identified sources of these metals in their service areas, and/or 2) contribute to violations of public health or aquatic life criteria for these metals.	EPA, RIDEM, MADEP	

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II.B.	As part of their triennial review of water quality regulations, RIDEM and MADEP should evaluate whether existing water quality criteria for cadmium, chromium, copper, nickel, lead, mercury, silver, and zinc are appropriate based on evidence of toxicity, bioaccumulation, water quality or habitat degradation, or existing or desired uses of the waterbody, and determine whether site-specific human health or aquatic life criteria should be developed for these compounds. 1. In no case shall an existing aquatic life criterion be relaxed for any waterbody or segment of the waterbody unless the RIDEM or MADEP, with EPA approval, demonstrates that the pollutant in question does not contribute to observed toxicity, bioaccumulation, water quality or habitat degradation, or limitations on existing or desired uses of the waterbody. 2. In no case shall site-specific criteria developed for a limited segment of a waterbody be extrapolated to another waterbody without an explicit comparison of their hydrologic, ecological, and physiographic conditions. 3. In no case shall public funds be used to assist a non-governmental entity to develop site-specific criteria.	RIDEM, MADEP, EPA	The UBWPAD is evaluating use of site-specific criteria for Upper Blackstone (1992).
II.C.	The RIDEM, local control authorities, and Massachusetts counterparts should require regulated industries throughout the Narragansett Bay basin to use the best available technology (BAT) to reduce the use, generation, release and disposal of cadmium, chromium, copper, nickel, lead, mercury, silver, zinc, and cyanide. (For the purpose of this recommendation, BAT shall be defined as a practicably available, proven technology or process that can achieve the most stringent limits currently in use within the watershed.) The requirement to use BAT should be implemented independently of "local limits" established by a state or local control authority in order to: a) develop uniform incentives for source reduction, b) remove competitive advantages resulting entirely from differing regulatory requirements, and c) remove economic and regulatory incentives for industries to locate or relocate in the basins of relatively uncontaminated receiving waters in order to take advantage of less stringent "local limits".	RIDEM, MADEP, local control authorities, EPA	

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II.D.	To the fullest extent of their authority, the EPA, RIDEM, local control authorities, and Massachusetts counterparts should require all industrial dischargers subject to industrial pretreatment program requirements to file a waste minimization report by 1995 that sets short-term (three- to five-year) goals for reducing discharges, releases and off-site transfers of cadmium, chromium, copper, nickel, lead, mercury, silver, zinc, cyanide and related compounds. Industrial dischargers that can document reductions in loadings before 1989 should receive credit for reductions already achieved.	EPA, RIDEM, MADEP, local control authorities	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
II.E. ✓	**The EPA, RIDEM, HWRP, and Massachusetts counterparts should emphasize raw material substitution techniques, modifications of standard manufacturing processes, and best-available technological processes for reducing industrial use and/or discharge to the wastestream of cadmium, chromium, copper, nickel, lead, mercury, silver, zinc, and cyanide.**	**EPA, RIDEM, HWRP, Mass. counterparts**	
II.F.	Where copper or lead concentrations in the water supply are identified as important background sources of total copper or lead, the RIDEM, the Rhode Island Department of Health (RIDOH), and their Massachusetts counterparts shall require the water supply authorities to reduce copper or lead concentrations by reducing or eliminating corrosion of the conveyance system, eliminating the use of copper-based algaecides, and/or eliminating any anthropogenic inputs of copper or lead into the water supply, as appropriate.	EPA, RIDEM, RIDOH, Mass. counterparts	[See RIDOH "Preliminary Agreement," Section 715-05-06 re: enforcement of Safe Drinking Water Act requirements for copper, lead.]
II.G.	The State of Rhode Island and Commonwealth of Massachusetts should condition the use of copper-based herbicides to treat human-induced eutrophication of surface waters tributary to Narragansett Bay on the submittal of a management plan that addresses the feasibility of alternative control measures, including septic system repair or replacement, vegetative buffers, stormwater controls, density controls, and other land management options. In addition: 1. The EPA should make every effort to reconcile requirements of the Safe Drinking Water Act and the Clean Water Act with regard to human health and aquatic life criteria for copper. 2. The State of Rhode Island and Commonwealth of Massachusetts should discourage the use of copper-based herbicides on surface waters tributary to Narragansett Bay.	EPA, USDA, RIDEM, CRMC, Mass. counterparts	

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III.	The State of Rhode Island and the Commonwealth of Massachusetts should make every reasonable effort to reduce industrial emissions, discharges and off-site waste transfer of the following chemicals to 50 percent of 1989 levels by 1995: benzene, carbon tetrachloride, chloroform, dichloromethane, dioxin, methyl ethyl ketone, methyl isobutyl ketone, tetrachloroethylene, toluene, trichloroethylene, xylenes, 1,1,1,-trichloroethane.		
III.A.	Industry trade organizations should endorse the RIDEM's effort to encourage voluntary industry participation in meeting the toxics reductions targeted in the EPA's *Industrial Toxics* ("33/50") *Project.* To evaluate the state's success in meeting the targeted reductions, toxics loadings should be quantitatively measured and reported. Massachusetts should be encouraged to participate voluntarily in the *Industrial Toxics* ("33/50") *Project.*	RIDEM, Mass. counterparts, industry	
IV.	The State of Rhode Island and the Commonwealth of Massachusetts should make every reasonable effort to reduce industrial discharges, releases, including accidental releases, and off-site waste transfers of the following chemicals to 50 percent of 1989 levels by 1995: petroleum hydrocarbons (PHC) and polycyclic aromatic hydrocarbons (PAH).		
IV.A.	By December 1993, the EPA and/or the U.S. Food and Drug Administration (FDA) should develop national aquatic life criteria and human health criteria, including action levels for human consumption of seafood, for PHCs and PAHs.	EPA, FDA	

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IV.B.	The EPA, the Federal Highway Administration (FHWA), the State of Rhode Island, and the Commonwealth of Massachusetts should undertake the following actions to reduce motor vehicle-related discharges, releases and emissions of PHCs and PAHs to the Narragansett Bay basin: 1. The State of Rhode Island and the Commonwealth of Massachusetts should emphasize pollution prevention as the preferred long-term strategy for reducing petroleum inputs to Narragansett Bay. Pollution prevention measures could include more rigorous regulation of air emissions and motor vehicle fluid leaks, and incentives to encourage the use of fuel efficient motor vehicles, mass transit, and alternatives to fossil fuels. 2. The FHWA, the State of Rhode Island and the Commonwealth of Massachusetts should require the use of best management practices (BMP) as an absolute condition of new road construction or major upgrades where any road drainage would otherwise be discharged to Narragansett Bay or its tributaries. The state Departments of Transportation should use BMPs identified by EPA and the states' Section 319 and 6217 Nonpoint Source Management Programs until the FHWA promulgates new guidelines consistent with the 1991 Internal Surface Transportation Efficiency Act. 3. The FHWA, EPA, and state Departments of Transportation should support additional research into the design of BMPs to capture and treat road runoff consistent with the mandate of the 1991 Internal Surface Transportation Efficiency Act.	EPA, FHWA, RIDEM, RIDOT, CRMC, Mass. counterparts	[See "Preliminary Agreements," Section 715-05-06; RIDEM re: promulgation of vehicle emission regulations; USDA SCS re: provision of site inspection services to RIDOT; Mass Conservation Districts.] R.I. received $13 million "demonstration" grant from FHWA for runoff abatement projects on I-95 and other coastal highways draining to Narragansett Bay. Non-federal match of $3.6 million required.

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IV.C.	The federal government, the State of Rhode Island and the Commonwealth of Massachusetts should make every reasonable effort to reduce the risk of accidental marine spills of petroleum products and other chemicals in Narragansett Bay and its tributaries. Implementation efforts should include: 1. Development of appropriate federal and state legislation governing tanker hull design, use of satellite navigation in Rhode Island waters, and the professional qualifications and use of pilots in Rhode Island waters. 2. Establishing State causes of action and remedies for spill-related harm to the public's interest in natural resources, including the cost of restoring natural habitats and living resources. 3. Development of appropriate federal and state regulations to: a. govern fuel hose fittings on vessels and marine facilities with fueling stations; b. require all marine facilities with fueling stations to have formal plans to deal with accidental oil or gasoline spills; and c. require all marine facilities with fueling stations to maintain spill containment equipment on site, and provide trained personnel to implement spill containment measures. 4. Preparing, as soon as possible, updated *Oil Spill Contingency Plans* for emergency spill response and environmental damage assessment, with provisions for responding to oil and chemical spills related to the bulk storage of chemicals in the floodplain of Narragansett Bay, near Bay tributaries, and within the Narragansett Bay watershed. 5. Design, engineering, and deployment of tailored oil booms for critical areas such as tidal creeks and rivers, salt marshes, coves, and developed harbors.	U.S. Congress, EPA, R.I., Mass.	[See RIDEM "Preliminary Agreement," Section 715-05-06 re: update of *Oil Spill Contingency Plan*.]
IV.D.	The State of Rhode Island and Commonwealth of Massachusetts, in conjunction with local governments, should provide continuing support for local facilities to collect waste oil from homeowners' automobiles and boats.		

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V.	Within two years following approval of the *CCMP*, the EPA, U.S. Department of Agriculture (USDA), RIDEM, and their Massachusetts counterparts shall review existing guidelines governing the use of pesticides and herbicides in the Narragansett Bay basin and recommend revised regulations or requirements, as necessary.		
V.A.	Within one year following approval of the *CCMP*, the EPA, USDA, RIDEM, and their Massachusetts counterparts should prepare a preliminary survey of the areal extent, magnitude, and ecological and public health risk associated with pesticide and herbicide use (including both commercial and over-the-counter sources) in the Narragansett Bay basin. Existing data should be used to the maximum extent possible.	USDA, EPA, RIDEM, Mass. counterparts	[See USDA SCS "Preliminary Agreement," Section 715-05-06 re: pesticide use survey.]
V.B.	Within one year following approval of the *CCMP*, the State of Rhode Island and Commonwealth of Massachusetts should prepare a comprehensive survey of pesticide and herbicide use in the Narragansett Bay basin, including name, active ingredient(s), method of application, and target species for each chemical; type and number of users; amount of each chemical used per unit area based on land use type; and total amount of each chemical used per year.	RIDEM, Mass. counterparts	[See USDA SCS "Preliminary Agreement," Section 715-05-06 re: pesticide use survey.]
V.C.	The USDA Soil Conservation Service and affiliated Cooperative Extension Programs should increase assistance to farmers in planning for pest management and develop homeowner programs to reduce the use of pesticides.	USDA, Coop. Extension	[See USDA SCS "Preliminary Agreement," Section 715-05-06 re: pest management, pesticide labeling.]

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Estimated Cost of Implementation—Source Reduction: Toxics

Table 715 -04(1) summarizes the estimated costs associated with the implementation of this chapter's recommendations. The major initial costs incurred by implementation of Element I (Comprehensive Regulation of Toxics) include hiring a Massachusetts Pretreatment Coordinator, development and distribution of a consolidated waste minimization report form, and providing technical assistance to dischargers in the completion of the waste minimization report. Coordination and training costs are to be spread over the five-year period. Element IB (WWTFs; Direct Dischargers) focuses on regulations of municipal and industrial dischargers. Major actions include a metals wasteload allocation for the Blackstone, Seekonk, and Providence River basin at approximately $700,000 ($100,000 of this cost exclusive of monitoring conducted by the Narragansett Bay Project, has been provided by the EPA). Other major costs for this element include inspection and enforcement. One possible major cost associated with meeting more stringent limits on toxics is the upgrading of the Upper Blackstone Water Pollution Abatement District (UBWPAD) facilities; UBWPAD estimates that, based on a Camp, Dresser, and McKee analysis (which is not an engineering study), the cost of WWTF upgrade necessary to meet such limits (possibly utilizing reverse osmosis technology) could be as high as $150 million. Element IC (Industrial Users) includes a recommendation requiring that waste reduction, reclamation, and recycling plans submitted by industrial users be certified by a Professional Engineer; this could result in additional costs to the private sector. Other private costs could result from the recommended requirement that industries implement alternative waste reduction technologies.

Element ID (Other Generators) includes provisions for the expansion of the Industrial Pretreatment program, an action that would require WWTFs to obtain additional personnel for permitting and enforcement (increased fees could cover additional costs). Additionally, this element recommends that the RIDEM Household Hazardous Waste Collection Program be expanded to include "tiny quantity" commercial and industrial waste generators. This recommendation was not costed since it is expected to operate on a cost-recovery basis. Another recommendation from this section that could operate on a cost-recovery basis is the establishment (in both Rhode Island and Massachusetts) of a stringent auto inspection program for air emissions and fluid leaks. It should be noted that the success of cost-recovery programs can be limited by political opposition, the ability of those affected to pay, and the concerns that the institution of fees could put certain industries at a competitive disadvantage. Major costs in Element IE (Economic Incentives) include annual costs associated with promoting source reduction and providing technical assistance to industries in the Bay basin. The fiscal impacts of providing economic incentives cannot be determined until such measures are specifically designed. Additionally, this chapter recommends that imported manufactured goods be required to meet the same federal and state production standards as locally-produced goods; it is possible that this action could raise the cost of some goods to consumers. Element IF (Information Exchange) contains a recommendation that the HWRP establish a Technology Review Board; it is intended that members will serve on a voluntary basis.

Elements II and III (Metals and Toxic Organics) include recommendations that standardized effluent limits for certain metals and organics, based on the most stringent limits currently in use, be applied to specific industry categories. It is possible that this requirement could result in additional costs to some industrial dischargers. Also, a recommended requirement that water suppliers reduce copper and lead concentrations within their conveyance systems could place significant financial burdens on these suppliers.

Element IV (PAHs and PHCs) contains a recommendation that state departments of transportation support research into the design of BMPs to treat road runoff; a possible existing source of funding for this is the funding available from the 1991 Internal

Surface Transportation Efficiency Act. Funding resulting from this act is providing $13 million to Rhode Island for nonpoint source pollution abatement projects on the Pawtuxet River; a non-federal match of $3.6 million is required.

The remaining elements contain actions geared toward the setting of effluent limits, the development of water quality criteria, efforts to prevent or reduce petroleum inputs to the Bay, and a survey of pesticide use in the watershed.

WWTFs, RIDEM, and MADEP are the primary implementing authorities. These agencies would need to coordinate many of the *CCMP* implementation activities with the EPA.

For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report* (Apogee Research Inc./NBP, 1992).

Table 715-04(1)

ESTIMATED COST OF IMPLEMENTATION
SOURCE REDUCTION: TOXICS

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
IA-Comprehensive Regulation	162,500	5,000	90,000	5,000	90,000	5,000	90,000	5,000	90,000	5,000	522,500	25,000
IB-WWTFs; Direct Dischargers	65,000	0	212,500	0	323,500	1,046,000	323,500	346,000	323,500	346,000	1,248,000	1,738,000
IC-Industrial Users	82,500	0	45,000	0	45,000	0	45,000	0	45,000	0	262,500	0
ID-Other Generators	298,750	6,000	265,000	6,000	292,500	6,000	277,500	21,000	277,500	21,000	1,411,250	60,000
IE-Economic Incentives	423,750	24,000	70,000	24,000	80,000	24,000	80,000	24,000	80,000	24,000	733,750	120,000
IF-Information Exchange	0	0	0	0	0	0	0	0	0	0	0	0
IG-Treatment	25,000	0	0	0	0	0	0	0	0	0	25,000	0
II-Metals and Cyanide	175,000	0	15,000	0	65,000	0	15,000	0	15,000	0	285,000	0
III-Toxic Organics	0	0	0	0	0	0	0	0	0	0	0	0
IV-PAHs and PHCs	62,500	720,000	10,000	720,000	10,000	720,000	10,000	720,000	10,000	720,000	102,500	3,600,000
V-Pesticides and Herbicides	237,500	0	12,500	0	12,500	0	12,500	0	12,500	0	287,500	0
		0		0				0				
TOTALS	1,532,500	755,000	720,000	755,000	918,500	1,801,000	853,500	1,116,000	853,500	1,116,000	4,878,000	5,543,000
TOTAL BY YEAR		2,287,500		1,475,000		2,719,500		1,969,500		1,969,500		10,421,000

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	736,250	23,000	305,000	23,000	265,000	513,000	235,000	23,000	235,000	23,000	1,776,250	605,000
RIDOH	0	0	0	0	12,500	0	0	0	0	0	12,500	0
URI	12,500	0	12,500	0	12,500	0	12,500	0	12,500	0	62,500	0
RI Legislature	3,750	0	0	0	0	0	0	0	0	0	3,750	0
RIDOT	0	720,000	0	720,000		720,000	0	720,000	0	720,000	0	3,600,000
MADEP	306,250	12,000	142,500	12,000	140,000	222,000	122,500	12,000	122,500	12,000	833,750	270,000
MADPH	0	0	0	0	12,500	0	0	0	0	0	12,500	0
MA Legislature	3,750	0	0	0	0	0	0	0	0	0	3,750	0
WWTFs	470,000	0	260,000	0	476,000	346,000	483,500	361,000	483,500	361,000	2,173,000	1,068,000
TOTALS	1,532,500	755,000	720,000	755,000	918,500	1,801,000	853,500	1,116,000	853,500	1,116,000	4,878,000	5,543,000
TOTAL BY YEAR		2,287,500		1,475,000		2,719,500		1,969,500		1,969,500		10,421,000

04-01-02 Source Reduction: Nutrients

Objective for the Reduction of Nutrient Inputs

The State of Rhode Island and the Commonwealth of Massachusetts should manage point and nonpoint sources of nutrients to the Narragansett Bay watershed in order to prevent eutrophication and to minimize undesirable nutrient-related effects to Narragansett Bay and its tributaries, and reduce loadings where nutrient-related water quality impacts have been demonstrated.

Introduction

Nutrients are essential for plant and animal growth. The availability of two such nutrients, nitrogen and phosphorus, may limit plant growth in aquatic systems. In freshwater, phosphorus is generally thought to be the limiting nutrient; in most marine and estuarine waters, the limiting nutrient is nitrogen (Penniman *et al.*, 1991b:1). When introduced into aquatic systems in excessive amounts, however, these nutrients may cause a variety of detrimental effects. One such effect is the rapid growth of microscopic algae (*i.e.*, phytoplankton), seaweeds, or other aquatic plants. Decomposition of this organic matter by bacteria may consume enough oxygen in the water to cause fish kills or other detrimental effects on the biota. There may also be more subtle impacts, such as changes in the numbers and types of species living on and in the bottom sediments or in the water column (Penniman *et al.*, 1991b:1-2, 6).

Anthropogenic loadings of excessive nutrients arise from both point (*e.g.*, principally wastewater treatment facilities) and nonpoint sources (*e.g.*, septic systems, fertilizers, animal wastes, and atmospheric deposition). Because phosphorus is the limiting nutrient in freshwater environments and nitrogen in marine and estuarine systems, control strategies will depend upon whether the receiving waters are fresh or saline (Penniman *et al.*, 1991b:6).

Statement of the Problem

The impacts of excessive nutrient loadings to aquatic systems in the Narragansett Bay watershed are determined, in great part, by the sources of the nutrient loads, the hydrographic characteristics of the receiving waters, and whether the receiving waters are fresh or saline. Thus, the Providence-Seekonk River and parts of the Blackstone and Pawtuxet rivers have displayed periodic low dissolved oxygen concentrations measured during a number of surveys over a period of many years (Penniman *et al.*, 1991b:13-23). The low dissolved oxygen concentrations in the Providence-Seekonk region have contributed to detrimental changes to the community of organisms living on the bottom of the river (Germano *et al.*,1992) and have periodically resulted in fish kills, at least historically. Most recently (August 1991) lowered dissolved oxygen concentrations were observed throughout the Providence-Seekonk River in the Upper Bay as far south as Rocky Point-Rumstick Point (McKenna, 1991:1-2). Other regions of the Bay that periodically and, increasingly, have experienced low dissolved oxygen concentrations include Greenwich Bay, Mount Hope Bay, Apponaug Cove, and several other poorly flushed embayments around the Bay (Penniman *et al.*, 1991b:13-23; Dettmann *et al.*, 1992).

Riverine and wastewater treatment facility (WWTF) inputs are the major sources of nitrogen to the Providence-Seekonk River and Upper Narragansett Bay (Oviatt, 1980; Metcalf & Eddy, Inc., 1991b; Penniman *et al.*, 1991b:2, 24). In other areas, like many of the small coves along the shores of Narragansett Bay where there are no direct WWTF discharges, nonpoint sources are the primary contributors. These nonpoint sources include fertilizers that are washed overland by stormwater or leached to the groundwater, nutrients from functional and failed septic systems that are carried either by stormwater or groundwater flow, and nitrogenous compounds in the atmosphere—the combustion products of gasoline and other fossil fuels—that are deposited by precipitation (Penniman *et al.*, 1991b:2).

In homes served by on-site sewage disposal systems (OSDS), high-phosphate laundry detergents may be responsible for half of the phosphorus loadings to the septic systems, while garbage disposals may contribute significantly to biochemical oxygen demand (BOD) and suspended solids (EPA, 1980; EPA, 1991a; Penniman *et al.*, 1991b:55). It should be noted that low phosphate detergents are readily available, and that Indiana, Maryland, Michigan, Minnesota, New York, and Wisconsin currently have restrictions on the phosphate content of laundry and/or dishwasher detergents. The extent of phosphorus (*i.e.*, phosphate) movement in groundwater is limited under most conditions by natural soil processes. The contact time for the effluent in unsaturated soil (determined largely by percolation characteristics and OSDS hydraulic loading rates) and the age of the system influences the effectiveness of phosphate removal. Excessive, long-term loadings can saturate the soils' adsorptive capacity. Additionally, with phosphorus-sensitive waterbodies (*i.e.*, primarily freshwater), even limited additional loadings may cause eutrophication.

Unlike phosphate, nitrogen, in the form of nitrate from OSDS effluent, moves freely through the coarse-textured soils common to much of Rhode Island once it is below the depth where plant roots occur, and is only attenuated by dilution with surrounding groundwater. Since nitrate can travel significant distances in groundwater (*e.g.*, at least 330 feet, Penniman *et al.*, 1991b: 34), in general only limited biological, physical, or chemical processes will act to attenuate groundwater nitrate. Thus, controls over the numbers of OSDSs in a watershed and OSDS setback requirements reduce total nitrogen loading rates and, to a more limited extent, increase dilution with available groundwater.

Measurements of dissolved inorganic nitrogen and phosphorus and chlorophyll *a* (as an indication of phytoplankton biomass) show elevated concentrations in the Providence River decreasing down-Bay to Rhode Island Sound (Doering *et al.*, 1988a; Doering *et al.*, 1988b; Penniman *et al.*, 1991b:20-21). As described above, the Blackstone and Providence-Seekonk Rivers experience periodic *hypoxic* (low oxygen) and in some cases *anoxic* (no oxygen) conditions due to nutrient and BOD loadings from WWTFs. Greenwich Bay and Mount Hope Bay have had similar incidents of low dissolved oxygen. Potential pollution sources to Greenwich Bay and adjoining coves include the East Greenwich WWTF, stormwater runoff, OSDSs, and boats (Penniman *et al.*, 1991b:3, 18).

Wherever water circulation is restricted and vertical stratification of the water column occurs, nutrient loadings may be particularly critical in causing low dissolved oxygen concentrations. Following an algal bloom, the replenishment of the oxygen taken out of the water by bacterial decomposition may be limited to the upper layer of water, where photosynthesis and re-aeration from the atmosphere occur. Lower layers may tend toward anoxic conditions. The problem is particularly acute in the summer, because warm water holds less oxygen than cold water (Penniman *et al.*, 1991b:3-4). Poorly flushed embayments subject to this phenomenon include Apponaug Cove; vertically stratified waters occur in the Providence-Seekonk River (Penniman *et al.*, 1991b:8).

Greenwich Bay and adjacent coves have been demonstrated to have degraded benthic habitats and communities, possibly attributable to high organic and nutrient loadings from anthropogenic sources. Several coves around Greenwich Bay suffer from seasonally-persistent low dissolved oxygen concentrations, algal blooms, and fish kills (Germano and Rhodes, 1989; RIDEM, 1990a; Nowicki and McKenna, 1990). In addition, Greenwich Bay was the locus of the brown tidal algal blooms that occurred in 1985 and 1986 (Smayda, 1988, 1989; Nowicki and McKenna, 1990; Penniman *et al.*, 1991b:49).

A study jointly funded by the Narragansett Bay Project (NBP) and the U.S. Environmental Protection Agency (EPA) in 1986 found that the East Greenwich WWTF was a major source of BOD and suspended solids to Greenwich Cove, and because of circulation patterns, could also affect Greenwich Bay (Frithsen *et al.*, 1987;

Dettmann *et al.*, 1989; Nowicki and McKenna, 1990). This study was performed prior to an upgrade of the East Greenwich WWTF. However, population growth in East Greenwich has already exceeded projections for the year 2010, suggesting that the Town's wastewater facility will continue to be a significant source of nitrogen, phosphorus, and BOD to Greenwich Cove and Greenwich Bay (Penniman *et al.*, 1991b:49). Metcalf & Eddy, Inc., in a study commissioned by the NBP in 1990, assessed several options for upgrading the East Greenwich treatment facility, but concluded that further study was necessary to assess the impacts of any changes (Metcalf & Eddy, Inc., 1991c).

It also needs to be determined whether additional sewering is necessary to mitigate water quality problems associated with failed or failing OSDSs in the Greenwich Bay basin. A preliminary basin plan will be developed by the Rhode Island Department of Environmental Management (RIDEM), the Rhode Island Coastal Resources Management Council (CRMC), the NBP, and local governments pursuant to an interagency agreement executed in November 1990 to assess the situation and recommend the appropriate technological and land use controls (Penniman *et al.*, 1991b:49-50). The preliminary Greenwich Bay basin plan and the subsequent Greenwich Bay Special Area Management (SAM) Plan should use existing local comprehensive land use and facilities plans to help identify areas where sewering may be required in order to alleviate impacts from existing, sub-standard septic systems.

Existing Policies

WWTFs

In general, wastewater treatment facilities (WWTFs) do not have specific permit limits for nutrients. Primary and secondary WWTF effluents are regulated for BOD, suspended solids, and other conventional and toxic pollutants. In other words, conventional wastewater treatment is primarily concerned with reducing BOD and suspended solids in the final effluent, and not eutrophication of receiving waters due to excessive loadings of nutrients (Penniman *et al.*, 1991b:13, 27).

Septic Systems

Current OSDS regulations in Rhode Island affect septic system location, design, installation or alteration, and maintenance. Determination of site suitability includes such factors as location relative to wetlands, surface water bodies and drinking water supplies, slope, type of soil, percolation tests, maximum groundwater elevation, and occurrence of impervious formations. There are special regulations for sensitive areas, such as lateral setbacks of 150 feet within coastal erosion-prone areas and the Narrow River and coastal pond watersheds, and 200 feet in the Scituate Reservoir watershed (RIDOA, 1990a). However, there is no requirement within current regulations that percolation tests performed in determining subdivision delineations correspond with final location of OSDSs on individual lots (Penniman *et al.*, 1991b:52).

The CRMC has encouraged the use of alternative septic system designs in certain unsewered areas where nitrogen loadings from domestic waste would be a problem. The CRMC has required the installation of denitrifying RUCK systems in the salt pond region of southern Rhode Island, for example. The homeowner might also be required to install a standard OSDS as a back-up in the event of failure of the alternative system (Penniman *et al.*, 1991b:35).

To ensure routine inspection and maintenance of both conventional and alternative septic systems, as well as adequate septage disposal capacity, the State of Rhode Island passed enabling legislation in 1987 allowing municipalities to establish wastewater management districts (WWMDs) (RIDOA, 1987; Penniman *et al.*, 1991b:36). Although no WWMDs have been formed to date (1991), three towns—Hopkinton, Narragansett, and Jamestown—have begun developing WWMD ordinances (Penniman *et al.*, 1991b:54).

Analysis

Effective long-term management of nutrient loadings to surface waters is best approached from a watershed-level perspective. CRMC's SAM Plan process represents one effective vehicle for managing nutrient inputs via land use and density controls. There are, however, a number of approaches for controlling nutrient loadings on a watershed (or subwatershed) basis. (Penniman *et al.*, 1991b: 33-40) For example, the Buzzards Bay Project (1990) has established a subwatershed approach to control nitrogen loadings to nutrient-sensitive waterbodies by setting limits on OSDS density based upon modelled loadings that would achieve a "critical nutrient loading limit" designed to protect the receiving waters from eutrophication (Buzzards Bay Project, 1990; Monahan *et al.* 1991). OSDS density controls are also proposed as one of the "management practices" in the *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1991a:4-40 to 4-41). Therefore, the state's Coastal Nonpoint Pollution Control Program (CNPCP), that will be developed jointly between CRMC and RIDEM as required by Section 6217 of the 1990 Amendments to the Coastal Zone Management Act or CZMA (EPA, 1991a; NOAA/EPA, 1991), may include enforceable watershed-based mechanisms to limit the cumulative impact of nitrogen loading to coastal waters from OSDS. [Note: A more detailed discussion of the CNPCP, required by Section 6217 of the 1990 Amendments to the CZMA, is presented in 04-01-07: Source Reduction: Nonpoint Sources.]

Another mechanism to control nutrient loads is through the establishment of total maximum daily loads (TMDL) and associated waste load allocations (WLA) (EPA, 1991a). For example, in cases where excessive nutrient loads cause eutrophication and/or loss of fish or wildlife habitat in spite of discharger compliance with technology-based requirements, water-quality based controls may be required in order to achieve desired uses (*e.g.*, Providence-Seekonk River). In such cases, the state must determine the amount of nutrients or BOD that the waterbody can assimilate and meet water quality standards (*e.g.*, dissolved oxygen). The amount of pollutant that the waterbody can assimilate is called the TMDL. Based upon the TMDL, permissible loads from both point and nonpoint sources are calculated. The TMDL is then allocated among point and nonpoint sources based upon WLA (for point sources) and load allocations or LA (for nonpoint sources).

The State of North Carolina has established a statutory definition of "nutrient-sensitive waters" (NSW) as "waters that are experiencing or are subject to excessive growth of microscopic or macroscopic vegetation .... [which will] ... substantially impair the use of the water for its best usage..." Designation as NSW requires the development and implementation of a nutrient management strategy. The North Carolina Environmental Management Commission designated the 5,400 square mile Tar-Pamlico River basin as nutrient-sensitive waters in September 1989. The implementation of the nutrient reduction/control strategy includes a "nutrient-trading" strategy between point source (*e.g.*, WWTFs) and nonpoint source (*e.g.*, farmers) dischargers of nitrogen and phosphorus. Interim nutrient reduction goals have been established prior to the development of a TMDL and water quality model for the Tar-Pamlico River estuary.

On the other hand, while taking a watershed-wide approach, care should be taken not to trivialize localized impacts, especially near major point sources and in subembayments where tidal flushing is limited. Assessments of loadings and their effects and the development of mitigation strategies must focus on areas of demonstrated impacts, or where future conditions such as population growth or land use changes are likely to degrade water quality (Penniman *et al.*, 1991b:7-8).

<u>Water Quality Criteria vs. Waste Load Allocation Models</u>

Water quality standards are based on the water quality criteria necessary to maintain a waterbody's designated uses (*e.g.*, fishing, swimming, or fish and wildlife habitat). However, as mentioned above, no nutrients

water quality criteria have been promulgated nationally that specifically protect aquatic organisms from the effects of eutrophication and other impacts of excessive nutrients (Penniman *et al.*, 1991b:13). In addition, at present, EPA can only establish nutrients loadings limits for dischargers if the need for nutrient removal has been demonstrated empirically by evidence of hypoxia, anoxia or other indicators of eutrophic conditions in the receiving water, *and* the basis for nutrient loadings reductions has been apportioned via a WLA.

A WLA is a mathematical model that relates pollutant loadings, *e.g.*, nutrient and BOD loadings, to the maintenance of minimum in-stream water quality criteria, *e.g.*, dissolved oxygen levels. The model is used to establish WWTF discharge limits for BOD and, if necessary, nutrients, in order to achieve the desired dissolved oxygen concentrations in the receiving water. The RIDEM has conducted a WLA for the Pawtuxet River, for example, and assigned more stringent effluent limits for BOD to the Cranston, Warwick, and West Warwick WWTFs (Penniman *et al.*, 1991b:4). However, the WLA approach does not account for ecological impacts of excess nutrient additions other than those related directly to dissolved oxygen concentrations. In addition, the WLA approach is reactive rather than proactive since it is only applied after evidence of a negative environmental impact already exists.

Protective aquatic life criteria should be developed for nutrients in order to enable federal, state and local regulatory agencies to govern future sources of nutrients to receiving waters before evidence of eutrophication occurs. These criteria should go beyond simply establishing threshold concentrations of nutrients in the water column since these concentrations may have little relationship to the existence of, or potential for, eutrophic conditions. For example, phytoplankton and seaweeds rapidly take up and recycle available nitrogen, leaving low nutrient concentrations in the water column itself but potentially resulting in nuisance algal blooms. Therefore, to accurately assess and limit the potential for eutrophication, it may be more appropriate to set nutrient loading limits rather than water column concentrations as standards (Buzzards Bay Project, 1990; Penniman *et al.*, 1991b:13).

Any chemical-specific criteria that would apply could be complemented by biological criteria. The EPA has issued guidance for states to develop biological criteria to incorporate into state water quality standards (EPA, 1990). These criteria may be numerical values (*e.g.*, indices of community structure), narrative descriptions of aquatic communities, or characteristics of unimpaired waters to be compared with other waterbodies (Penniman *et al.*, 1991b:44). By utilizing a biological or community descriptor, biological criteria can provide better detection of impairment resulting from unknown types or sources of pollutants or the synergistic effects of individual pollutants, in a similar fashion to whole effluent toxicity testing. Biological criteria should be particularly useful in detecting eutrophication and other nutrient-related impacts—that is, in addition to lowered dissolved oxygen—from point or nonpoint sources (Penniman *et al.*, 1991b:44).

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NUTRIENTS

CODE	POLICY	AGENCIES	STATUS
I.	Point source loadings of nutrients to Narragansett Bay should be reduced where receiving water impacts from nutrients have been demonstrated. Increases in point source loadings of nutrients to Narragansett Bay should be minimized to prevent eutrophication and undesirable nutrient-related effects to Narragansett Bay and its tributaries.		
I.A.	The U.S. Environmental Protection Agency (EPA) should establish protective aquatic life water quality criteria and/or annual loading criteria for eutrophication and related impacts from nitrogen and phosphorus to fresh, estuarine, and marine receiving waters by January 1994. Any nutrient-related criteria should be more inclusive of ecosystem function than merely simple water column concentration of either phosphorus or nitrogen. 1. The EPA should provide guidance for the states to adopt biological criteria for the detection and regulation of nutrient (*i.e.*, nitrogen and phosphorus) loadings impacts upon fresh, marine, and estuarine receiving waters. The proposed biological criteria should be more sensitive to nutrient specific effects than, for example, simple benthic community composition. 2. Once established these criteria should be considered for incorporation by the State of Rhode Island and the Commonwealth of Massachusetts into their Coastal Nonpoint Source Programs developed pursuant to Section 6217(g) of the Coastal Zone Management Act Reauthorization Amendments of 1990 in order to assist in delineating "critical coastal areas", as defined in *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance* (EPA, 1991a:1-20).	EPA, NOAA, RIDEM, CRMC, MADEP, MACZM	[See EPA/ ERL, Narragansett. "Preliminary Agreement," Section 715-05-06 re: development of nutrient criteria for marine waters.]
I.B.	The EPA should establish enforceable nutrient effluent limits for wastewater treatment facilities (WWTFs) based upon removal efficiencies achievable by best achievable technology (BAT) for secondary and tertiary wastewater; and should require WWTF influent and effluent monitoring of nitrogen and phosphorus.	EPA	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NUTRIENTS

CODE	POLICY	AGENCIES	STATUS
I.C.	Based upon the results of the Narragansett Bay Project-sponsored *Dissolved Oxygen Model of the Providence-Seekonk River* (Dettmann *et al.*, 1992), the Rhode Island Department of Environmental Management (RIDEM) and EPA should prepare a waste load allocation (WLA) of nutrients for point source dischargers to the Providence-Seekonk River and require loadings reductions, if necessary, to achieve dissolved oxygen water quality standards.	RIDEM, EPA	NBP-sponsored Eutrophication Screening Model completed, June 1992. [See EPA/ERL, Narragansett, RIDEM "Preliminary Agreements," Section 715-05-06 re: Providence River WLA.]
I.D.	The EPA, the Massachusetts Department of Environmental Protection (MADEP), and RIDEM should conduct synoptic dry weather and wet weather water quality surveys of the Blackstone River in order to: 1. Help identify the relative importance of nutrient loadings from point source discharges, runoff, and sediment resuspension utilizing water quality modelling methodology. 2. Use that modelling to prepare a WLA of nutrients and biochemical oxygen demand (BOD) for point and nonpoint source dischargers to the Blackstone River system based upon any demonstrated violations of dissolved oxygen water quality criteria in the Blackstone or impacts to the Providence-Seekonk River.	EPA, RIDEM, MADEP	[See EPA Region I "Preliminary Agreement," Section 715-05-06 re: DO-BOD-nutrients modeling on the Blackstone River.]
I.E.	As part of the implementation of advanced waste treatment for Warwick, West Warwick, and Cranston WWTFs, RIDEM and the WWTFs shall conduct a monitoring program to verify that compliance with the final Rhode Island Pollutant Discharge Elimination System (RIPDES) effluent limits is sufficient to meet water quality standards for the Pawtuxet River. If these BOD limits are insufficient to meet water quality standards for dissolved oxygen, RIDEM should consider establishing nutrient effluent limits for these WWTFs.	RIDEM, Warwick WWTF, W.Warwick WWTF, Cranston WWTF	[See RIDEM "Preliminary Agreement," Section 715-05-06 re: Pawtuxet River monitoring.]

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
I.F.	Greenwich Bay		
I.F.1.	In order to alleviate low dissolved oxygen concentrations in Greenwich Bay, the EPA, RIDEM, and the East Greenwich WWTF should conduct a WLA for point and nonpoint sources to Greenwich Bay when the RIPDES permit for the East Greenwich WWTF is renewed in 1993.	EPA, RIDEM, E. Greenwich WWTF	[See EPA Region I "Preliminary Agreement," Section 715-05-06.]
I.F.2. ✓	**The Rhode Island Coastal Resources Management Council (CRMC), the RIDEM, and other state and local planning and implementation authorities should develop a Special Area Management (SAM) Plan for the Greenwich Bay region. Data collected by the NBP and others, including an engineering review of wastewater management infrastructure in the basin and local comprehensive and facility siting plans should be used to the maximum extent possible in preparing the SAM Plan. The SAM Plan should address:** **a. Both major point and nonpoint sources of pollution to Greenwich Bay;** **b. The long-term need for sewering in the basin to alleviate nonpoint source pollution relating to septic systems;** **c. The needs for sewering related to existing and projected population growth;** **d. Long-term management of the Greenwich Bay shellfish resource; and** **e. Capital costs associated with implementation of the SAM Plan and sources of federal and state funding available for implementation.**	**CRMC, RIDEM**	**$150,000 may be available for preliminary basin plan pursuant to RIDEM-CRMC-NBP Interagency MOA. [See RIDEM "Preliminary Agreement," Section 715-05-06.]**

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RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NUTRIENTS

CODE	POLICY	AGENCIES	STATUS
II.	Land use activities along the shores of Narragansett Bay and all nutrient-sensitive tributary waters and wetlands within the Narragansett Bay basin should be required to provide for management of nutrient loadings to receiving waters.		
II.A.	The State of Rhode Island, the Commonwealth of Massachusetts, and local municipalities should adopt consistent policies in the Narragansett Bay watershed to control on-site sewage disposal system (OSDS) densities at the subwatershed level in order to minimize nitrogen loadings (*i.e.*, dissolved inorganic nitrogen) to marine and estuarine waters. The recommendation should be implemented in sequence as described below.		
II.A.1.	The RIDEM, CRMC, MADEP, and Massachusetts Coastal Zone Management (MACZM) should delineate all nutrient-sensitive waters (and associated subwatersheds) in the Narragansett Bay basin. Possible criteria to be used in delineating nutrient-sensitive waters include: 1) poorly flushed coastal embayments, 2) waterbodies subject to summer vertical stratification, 3) waterbodies with large watershed areas relative to the receiving waterbody area, 4) waterbodies experiencing water column or sediment hypoxia or anoxia, and/or 5) waterbodies experiencing excessive growth of microscopic or macroscopic vegetation, and/or fish kills.	RIDEM, CRMC, MADEP, MACZM	
II.A.2.	The RIDEM and MADEP, in conjunction with the Rhode Island Division of Planning (RIDOP), CRMC, MACZM, and local governments (as appropriate), should require minimum two acre zoning to control OSDS density in currently unplatted areas. Cluster development should be strongly encouraged to attain the nitrogen-loading equivalent of a two acre OSDS density for the number of units considered. In addition, RIDEM and MADEP, in conjunction with CRMC and MACZM, should develop design and performance standards for alternative OSDS technologies to be required for use in all subwatersheds of nutrient-sensitive waters in order to minimize the cumulative impact of nutrient inputs to the receiving waters. [*Note*: The prescriptive OSDS density controls and setback requirements are interim measures to be used until the site-specific density controls recommended in II.A.3 (below) are developed.]	RIDEM, MADEP, RIDOP, CRMC, MACZM, municipalities	See 04-01-05 Source Control: On-site Sewage Disposal Systems.

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
II.A.3.	The EPA, RIDEM, MADEP, CRMC, and MACZM should evaluate the effectiveness of existing approaches to control OSDS density based upon nitrogen loading and provide funding to develop and test a model ordinance for the Narragansett Bay watershed. The model should use site-specific criteria (*e.g.*, soils, watershed and receiving water characteristics) to the greatest extent possible. [The model developed by the Buzzards Bay Project should be evaluated for application in the Narragansett Bay watershed.]	EPA, RIDEM, MADEP, CRMC, MACZM	[See EPA Region I "Preliminary Agreement," Section 715-05-06 re: workshops on nitrogen management.]
II.B.	The OSDS setback distance should be increased to a standard minimum distance in unplatted areas adjacent to critical resources, including identified nutrient-sensitive waterbodies. The OSDS setback distance on existing lots of record in nutrient-sensitive watersheds should be increased to a minimum of 75 feet up to the maximum possible distance. The Rhode Island OSDS (as ISDS) Regulations (RIDEM 1989f) should be revised to: 1. Ensure that water level verification and percolation tests be performed on a lot-by-lot basis coincident with the location of the individual OSDS systems after individual lots are delineated; and 2. Provide a procedure for an applicant to seek a variance from the setback requirements if evidence of no significant impact from additional nutrient loading to adjacent waterbodies can be demonstrated based on site-specific data.	EPA, RIDEM, MADEP, CRMC, MACZM	See 04-01-05 Source Control: On-site Sewage Disposal Systems
II.C.	Best management practices for nutrient control		
II.C.1.	The State of Rhode Island should adopt the *Rhode Island Soil Erosion and Sediment Control Handbook*(RIDEM, 1989e) and *Rhode Island Stormwater Design and Installation Standards Manual* when completed (Boyd, 1991) as required best management practices (BMP) within the Narragansett Bay watershed to the extent that these practices are at least as protective as the "management measures" presented in the final *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1991a).	RIDEM, CRMC, Mass. counterparts	[See USDA SCS "Preliminary Agreement,", Section 715-05-06 re: efforts to establish soil erosion and sediment control regulations in Mass.]

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CODE	POLICY	AGENCIES	STATUS
II.C.2.	In developing BMPs to control pollutants carried by surface water runoff, the "vegetated buffer strip delineation work group" [described in 04-02-02 Resource Protection: Protection of Critical Areas], should consider buffer strips or vegetated filter strips as BMPs based upon all the functions that buffer strips can perform. The "vegetated buffer delineation work group" should emphasize the maintenance of natural, undisturbed riparian areas, as defined in *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1991a: 7-2 to 7-3), and should consider all available research results on buffer strip delineation.	RIDEM, CRMC	[See CRMC "Preliminary Agreement," Section 715-05-06.]
II.C.3.	The "vegetated buffer strip delineation work group" [described in 04-02-02 Resource Protection: Protection of Critical Areas] should consider establishing a prescriptive buffer area adjacent to nutrient-sensitive waters where the use of nitrogen and phosphorus-containing fertilizers would be prohibited. In addition, RIDEM, MADEP, MACZM, CRMC, U.S. Department of Agriculture Soil Conservation Service, and State Cooperative Extension Services should produce outreach information to inform the public of the impacts of excessive fertilizer use on aquatic systems, and to discourage fertilizer use near waterbodies and wetlands.	RIDEM, MADEP, MACZM, CRMC, USDA SCS, Cooperative Extensions	[See USDA SCS "Preliminary Agreement," Section 715-05-06 re: development of a state nutrient management program.]
II.D.	The State of Rhode Island and the Commonwealth of Massachusetts should legislatively require the establishment of wastewater management districts (WWMDs) by all municipalities having unsewered areas within the Narragansett Bay watershed by December 1995. Priority should be given to those municipalities bordering nutrient-sensitive estuarine receiving waters.	R.I., Mass.	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
II.E.	The State of Rhode Island and the Commonwealth of Massachusetts should require certification of OSDS tank structural integrity (visually determined by certified septage pumper/hauler and included as part of pumpout receipt), frequency of historical pumping, date of most recent pumping, and history of leach field failure as part of required seller disclosure information.	R.I., Mass.	R.I. Assoc. of Realtors submitted draft "seller disclosure" legislation (HR 8891) in 1992 legislative session.

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II.F.	The State of Rhode Island should ban the retail sale and advertisement of acid and organic chemical solvents for use in septic systems. The Commonwealth of Massachusetts should ban the use, sale, and advertisement of such chemicals. The State of Rhode Island and the Commonwealth of Massachusetts should institute informational campaigns to inform the public of the risk of environmental damage from these products.	R.I., Mass.	
II.G.	The State of Rhode Island and the Commonwealth of Massachusetts should prohibit the sale of laundry detergents containing greater than 0.5 percent elemental phosphorus by weight and dishwashing detergents containing greater than 8.7 percent elemental phosphorus by weight. The RIDEM and MADEP should establish phosphate limits for other commercial detergents, including those used by car washes.	R.I., Mass.	
II.H.	The State of Rhode Island and the Commonwealth of Massachusetts should prohibit the installation of garbage disposal systems in residences and businesses served by OSDSs. RIDEM and MADEP should establish outreach information to inform the public of the relative impacts and waste contributions from residential garbage disposal systems in order to help reduce the use of existing garbage disposals.	R.I., Mass., RIDEM, MADEP	
II.I.	The Rhode Island Solid Waste Management Corporation, the Rhode Island Association of Sustainable Agriculture (RISA), RIDEM and Rhode Island municipalities should encourage efforts by WWTFs to compost sludge, septage, boater septage wastes and yard wastes.	R.I. SWMC, RISA, RIDEM, municipalities	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NUTRIENTS

CODE	POLICY	AGENCIES	STATUS
III	The State of Rhode Island and the Commonwealth of Massachusetts should support programs to establish a greater understanding of the effects of and processes controlling nutrients in the Narragansett Bay watershed in order to support management of loadings and effects.		
III.A.	The EPA, the Commonwealth of Massachusetts, and the States of Rhode Island, New York, and Connecticut should establish joint monitoring stations in the Rhode Island Sound-Long Island Sound region to provide for baseline information on the oceanic input of nutrients to Buzzards Bay, Narragansett Bay, and Long Island Sound.	EPA, Mass., R.I., N.Y., Conn.	[See EPA Region I "Preliminary Agreement," Section 715-05-06.]
III.B.	The EPA, the National Oceanic and Atmospheric Administration (NOAA), the State of Rhode Island, and the Commonwealth of Massachusetts should support a permanent, comprehensive monitoring program to assess the impact of direct wet and dry atmospheric deposition of nutrients and toxics to the Narragansett Bay watershed.	EPA, NOAA, R.I., Mass.	[See EPA Region I "Preliminary Agreement," Section 715-05-06.]
III.C.	The State of Rhode Island and the Commonwealth of Massachusetts should increase monitoring and assessment of summer low dissolved oxygen concentrations in Mount Hope Bay and the Taunton River and, if necessary, establish and implement nutrient reduction strategies for the Mount Hope Bay watershed. The assessment of nutrient loads to Mount Hope Bay should include possible nitrogen and BOD contributions from the Brayton Point Power Plant cooling water effluent.	MADEP, RIDEM	[See RIDEM. "Preliminary Agreement," Section 715-05-06.]
III.D.	The State of Rhode Island should support a permanent Volunteer Monitoring Program Coordinator within RIDEM with the responsibility, in part, to provide technical support to citizen monitoring programs in Narragansett Bay embayments and tidal rivers in order to achieve more complete monitoring coverage of these areas.	RIDEM	[See RIDEM. "Preliminary Agreement," Section 715-05-06.; and Chapter 05-02-04 Long-term Monitoring.]

✓ - **High Priority Action**

Estimated Cost of Implementation—Source Reduction: Nutrients

Table 715-04(2) summarizes the estimated costs associated with the implementation of this chapter's recommendations. The major costs associated with Element I (Point Sources) are to complete a waste load allocation for nutrients in the Providence-Seekonk River ($150,000) and a water quality model of point and nonpoint sources to Greenwich Bay ($400,000). Major recommended actions that are costed elsewhere include synoptic wet/dry weather water quality surveys (04-03-02 Areas of Special Concern: Blackstone River), a SAM Plan for Greenwich Bay (04-02-02 Resource Protection: Protection of Critical Areas), and monitoring of the Pawtuxet River to verify compliance with NPDES/RIPDES effluent limits (04-01-01 Source Reduction: Toxics). Other costs relate to coordination with other agencies.

The major actions recommended under Element II (Land Use Strategies) are a requirement for the establishment of Wastewater Management Districts (costed under 04-01-03 Source Control: Water Management) and the development of a vegetated buffer guidance (costed under 04-02-02 Resource Protection: Protection of Critical Areas). Other minor costs include the adoption of standards and the creation of legislation prohibiting high phosphate detergents. A recommended requirement for two acre zoning to control OSDS density in the subwatersheds of nutrient-sensitive waters could potentially cause a loss of tax revenue to a municipality as well as having an impact on the profitability of land to landowners. The legislative cost associated with revision of zoning ordinances to Bay watershed municipalities is estimated at $117,500. Monitoring recommendations in Element III (Scientific Understanding) are costed under the Mount Hope Bay (04-03-01) and *CCMP* Governance (715-05-02) chapters.

RIDEM will be responsible for the cost of the major actions recommended in this chapter with some smaller personnel costs to CRMC, MADEP, and MACZM. There will also be coordination activities between these state agencies and federal agencies.

For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report*(Apogee Research Inc./NBP, 1992).

Table 715-04(2)

ESTIMATED COST OF IMPLEMENTATION
SOURCE REDUCTION: NUTRIENTS

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
I-Reduce Point Source Loads	0	150,000	0	0	0	400,000	25,000	0	0	0	25,000	550,000
II-Manage Land Use Activities	2,500	0	29,375	0	30,625	0	29,375	0	29,375	0	121,250	0
III-Effects and Processes	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	2,500	150,000	29,375	0	30,625	400,000	54,375	0	29,375	0	146,250	550,000
TOTAL BY YEAR		152,500		29,375		430,625		54,375		29,375		696,250

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	1,250	150,000	0	0	1,250	400,000	0	0	0	0	2,500	550,000
RI CRMC	0	0	0	0	0	0	12,500	0	0	0	12,500	0
MADEP	1,250	0	0	0	0	0	0	0	0	0	1,250	0
MACZM	0	0	0	0	0	0	12,500	0	0	0	12,500	0
Municipalities*	0	0	29,375	0	29,375	0	29,375	0	29,375	0	117,500	0
TOTALS	2,500	150,000	29,375	0	30,625	400,000	54,375	0	29,375	0	146,250	550,000
TOTAL BY YEAR		152,500		29,375		430,625		54,375		29,375		696,250

* Ultimate implementation costs will vary for each municipality depending on its particular environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees.

04-01-03 Source Control: Water Management and Wastewater Treatment

Objective for Water Management and Wastewater Treatment

The State of Rhode Island should improve the water quality of Narragansett Bay and its tributaries through institutional changes in the organizations responsible for water supply and use, and wastewater treatment and discharge within the Narragansett Bay watershed. The institutional changes should be intended to produce direct water quality benefits or to result in economic or administrative efficiencies which can then be translated into water quality improvements.

Introduction

Water supply, water use, wastewater treatment, and wastewater discharge are fundamentally linked. In most cases, water supply to domestic, commercial, or industrial users is ultimately discharged through a municipal treatment system and discharged to receiving waters. However, the use of water, from supply to ultimate disposal, is typically managed according to the particular location, destination and/or use of the water in question. As a result, the institutional framework used to manage water is extremely complex.

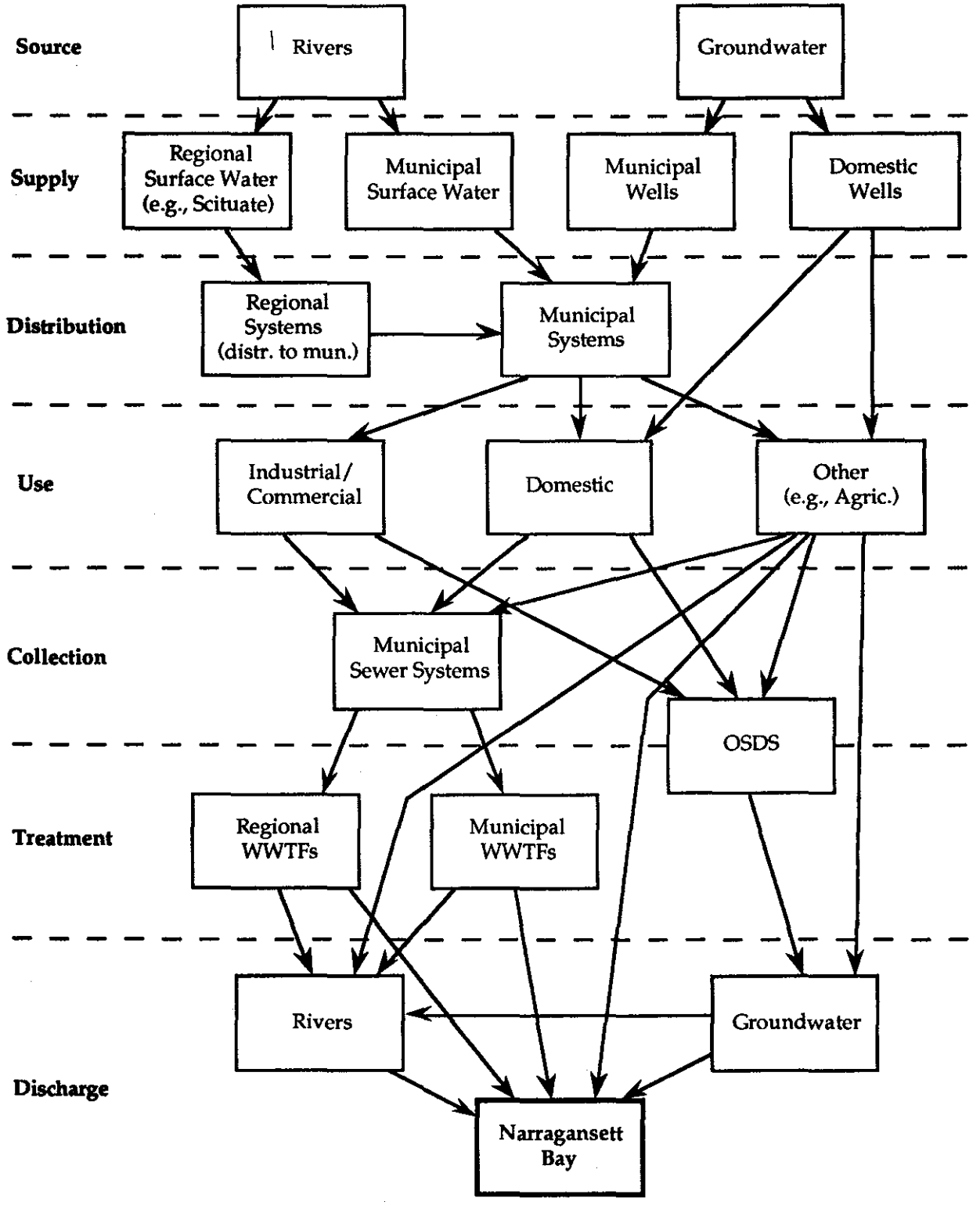
In populated areas, domestic, industrial, commercial, and agricultural water supplies are typically provided through publicly owned or commercial water suppliers, or by on-site wells. This water is then distributed to residential, commercial, and industrial users through municipal distribution systems. "Used" water is subsequently discharged through municipal sewer systems to publicly owned wastewater treatment facilities (WWTFs), or to on-site sewage disposal systems (OSDSs), for treatment and ultimate discharge to a receiving water — such as Narragansett Bay or one of its tributaries. Other water uses such as irrigation, power generation, and cooling may rely on direct withdrawals from surface waters or groundwater, and result in direct or indirect (runoff) discharge to a receiving surface water or groundwater, often without treatment. Figure 715-04(1) shows the many paths that water may take from its source to its ultimate discharge as wastewater (Zingarelli and Karp, 1991:1-2).

In Rhode Island alone, 30 major water suppliers provide the water supply of 90 percent of the state's residents. Many of the major suppliers are regulated by the Public Utilities Commission (PUC), although some of the major suppliers and most of the minor suppliers are not. Municipal sewage collection and conveyance systems are administered by each sewered community in the watershed for the primary purpose of protecting public health and safety and maintaining water quality. However, the municipalities also use sewer plans as a means to manage local growth and development (Zingarelli and Karp, 1991:1).

There are presently 33 WWTFs in the Narragansett Bay watershed, administered by 32 separate regional or municipal sewage treatment authorities in Rhode Island and Massachusetts. (As a result of the recent merger of the Narragansett Bay Commission and the Blackstone Valley District Commission, the Narragansett Bay Commission administers both the Field's Point and Bucklin Point WWTFs.) These sewer authorities have no control over the water supply systems or the OSDSs within their service area, nor do the water suppliers have any control over the treatment authorities.

In addition, local decisions about water supply and wastewater treatment have historically been regulated by different federal, state, and regional agencies, often with overlapping authority. In some cases, regulatory authority over water use, water quality, and wastewater quality is exercised by separate departments or divisions within those agencies (Zingarelli and Karp, 1991:1). Therefore, as described in the following sections, restructuring the institutional framework for managing water could be an important step in improving the water quality of Narragansett Bay and its tributaries (Zingarelli and Karp, 1991:3).

Figure 715-04(1). Path of Water from Source to Discharge



Statement of the Problem

The large number of water suppliers in Rhode Island has historically made statewide water supply planning a difficult task. In addition, the large number of federal, regional, state, and local authorities with responsibility for water supply and wastewater treatment in the Narragansett Bay basin has complicated the state's ability to manage water use and protect water quality. The effects of the existing, decentralized system of regulating water supply and wastewater treatment on water conservation and water quality are discussed below.

Billing Practices *vs.* Conservation

Water use rates used in the Narragansett Bay basin range from an annual flat charge to regular and timely usage-based billing. The price charged for water is often low relative to the true cost of providing the water and, in many cases, billing is infrequent and reflects declining block rates (*i.e.*, the price per gallon decreases as consumption increases). In addition, water meters are often nonexistent, nonfunctioning, or read only sporadically (Zingarelli and Karp, 1991:5). As a result, existing billing practices often create disincentives for individual consumers to conserve water or to invest in water conservation technology.

Similarly, there is little incentive for water supply or wastewater treatment authorities to invest in water conservation since their mandate has traditionally been limited to assuring adequate supplies or treatment. In addition, the ability of these authorities to reform the water rate structure is often limited by the absence of accurate metering at the point of water withdrawal and/or at the point of consumption, and, occasionally, by lack of jurisdiction over the metering system itself. In other cases, narrow interpretations of existing legal requirements have effectively blocked efforts to impose water rates that increase with increased water use (inclining rates) (Zingarelli and Karp, 1991:5).

Inconsistent Regulation of WWTFs

Individual wastewater treatment facilities within each state operate under unique physical and regulatory conditions. The physical operation of each facility depends upon when it was built, particularly the technologies available at the time it was built, and when major upgrades were undertaken. In addition, the local industrial and residential base determines the chemical characteristics of the wastewater influent to a WWTF, leading to differences in regulation (such as the establishment of a pretreatment program). Differences in local environmental conditions, such as the characteristics of the receiving water (marine or freshwater, dilution field, *etc.*), also lead to different treatment and effluent limits for each facility.

Since a WWTF permit is effective for five years, each WWTF is regulated according to which regulations apply at the time the facility's operating permit is issued. Therefore, different regulatory requirements can be imposed on neighboring WWTFs discharging to the same receiving water, at least temporarily, as new requirements are phased into effect (Zingarelli and Karp, 1991:7). Although there may in some cases be reasons for treating WWTFs individually, it is important to evaluate by a basinwide approach whether the regulatory requirements are achieving their intended result. However, as a result of the number of regulated WWTFs in the Bay basin, the federal and state regulatory agencies rarely make geographically comprehensive decisions about the cumulative impacts of WWTF discharges to regulated waterbodies. Regionalization of WWTFs could, therefore, be one approach to promote basinwide planning and basinwide regulation of pollutant sources to protect shared waters.

Existing Policies

In Massachusetts, water supply functions have been administered both by the Department of Environmental Management (MADEM) and by the Department of Environmental Protection (MADEP), and wastewater treatment functions primarily by the MADEP. In Rhode Island, a Water

Supply Management Division was established within the Rhode Island Department of Environmental Management (RIDEM) in 1991 by Executive Order. Wastewater treatment facilities are also regulated by the RIDEM. Municipal sewage collection systems are administered by each sewered community in the Narragansett Bay watershed, as mentioned above (Zingarelli and Karp, 1991:1).

Rhode Island's institutional structure for governing the supply and pricing of water is highly complex. Agencies with significant water use responsibilities in the State of Rhode Island include the State Water Resources Board, the Rhode Island Division of Planning (RIDOP), the Department of Health (RIDOH) Division of Water Supply, RIDEM's Divisions of Water Resources, Freshwater Wetlands, and Water Supply Management, and the Public Utilities Commission (PUC) (Zingarelli and Karp, 1991:4). Since water supply and wastewater treatment are managed as unrelated functions by both states, policies affecting water conservation and wastewater treatment are addressed separately, see below.

Water Conservation

Almost 90 percent of Rhode Island's residents rely on water supplied by 30 major water departments. The rates and operating practices of the largest of these 30 water providers are regulated by the PUC. The large number of water suppliers complicates regional planning and cooperation, as stated above, and is an impediment in itself to water conservation (Arthur D. Little, Inc., *et al.*, 1990). The need for water conservation and regional water supply planning have been identified in many recent activities, including the *Water Supply Analysis for the State of Rhode Island* prepared for the Rhode Island Water Resources Coordinating Council in 1990, the establishment of a Water Supply Management Division within RIDEM in 1991, and the draft *Water Supply Plan* completed by the RIDOP in 1992.

Legislation passed by the Rhode Island General Assembly in 1991, however, offers a significant opportunity to improve water conservation. The legislation, based on extensive work by the Narragansett Bay Project, other participants in the "Green Rhode Island" initiative, and the RIDOP, requires water suppliers to complete water supply management plans that consider both *demand management* and *system management* measures to promote water conservation. These might include fee and billing structures, retrofitting water-saving plumbing equipment, effective metering, leak repair and prevention, and public education programs. The law also establishes guidelines for setting fees, rates, and charges that are intended to improve water supply management (R.I.G.L. 46-15.4, as amended; Zingarelli and Karp, 1991:5-6).

WWTF Management

In the early years of the Clean Water Act, state and federal subsidies for WWTFs were provided through the Construction Grants program. This program and its successor, the State Revolving Fund (SRF), include specific federal eligibility requirements for participation in the program. The State of Rhode Island, in funding its SRF, contributed additional state money into the program and established the Clean Water Protection Finance Agency in order to be able to fund projects that might not be eligible under federal requirements. The investment of state funds indicates some public recognition of the *statewide* benefits of wastewater treatment. In addition, the eligibility requirements for SRF loans indicate an appreciation of those projects with the greatest statewide rather than local benefit (Zingarelli and Karp, 1991:8).

Before the Clean Water Act, however, there was a precedent in Rhode Island for regionalizing WWTFs. The Blackstone Valley District Commission (BVDC) was created by the General Assembly in 1947, when lawmakers concluded:

> Economy and efficiency dictate the desirability for an overall plan for dealing with the sewage and industrial wastes which originate in several municipalities and industries located in the Blackstone and

> Moshassuck Valleys... [T]he problem can best be solved by the creation of a state agency for the planning, construction, operation, and maintenance of appropriate facilities (R.I.G.L. 46-21-2).

The act creating the Narragansett Bay Commission (NBC) in 1980 echoed these sentiments, and added:

> [B]ecause of the scope and complexity of the work necessary to correct and minimize these pollution discharges and the scope of financing required, local municipalities in the Providence metropolitan area have been unable alone to cope properly and immediately with the magnitude of the pollution discharges (R.I.G.L. 46-25-2(c)).

In 1991, legislation was passed authorizing the merger of BVDC and NBC in early 1992. The merger statute noted that "economy, efficiency, and technological advances dictate the desirability of having one entity to formulate, coordinate, and regulate an overall plan to reduce the discharge of sewerage and industrial wastes..." (R.I.G.L. 46-25-2(g); Zingarelli and Karp, 1991:8) .

Even so, WWTFs in the Narragansett Bay watershed are, with few exceptions, still owned and operated by the communities in which they are located. The watershed contains 33 regionally or municipally owned WWTFs, operated by 32 separate entities, 15 in Rhode Island and 17 in Massachusetts. Facilities in both Rhode Island and Massachusetts are subject to National Pollutant Discharge Elimination System (NPDES) permit requirements. In Massachusetts, NPDES permits are issued and enforced by the U.S. Environmental Protection Agency (EPA). Concurrently, State discharge permits are issued by the Commonwealth of Massachusetts through MADEP. In Rhode Island, WWTFs must obtain Rhode Island Pollutant Discharge Elimination System (RIPDES) permits, based on the NPDES program but delegated by the EPA to RIDEM. In spite of similar permitting programs and EPA oversight in both Massachusetts and Rhode Island, WWTFs are typically *not* regulated in a consistent manner, either basinwide or statewide (Zingarelli and Karp, 1991:7). For example, the inconsistencies in discharge permit limits for toxic pollutants between WWTFs in Rhode Island and Massachusetts are described in 04-01-01 Source Reduction: Toxics.

Analysis

Water Conservation

The volume of water used for domestic, commercial, and industrial purposes has a direct effect on the water quality of the Bay and its tributary ground and surface waters. Water conservation measures may be necessary in some instances simply to assure adequate water supplies (Arthur D. Little, Inc. *et al.*, 1990). Water conservation efforts should also be pursued to help reduce wastewater load, particularly to OSDSs. The failure rate of OSDSs can be reduced in some cases by reducing the hydraulic load on the leach field, particularly in areas with saturated or poorly drained soils. In addition, reducing wastewater loads can extend the lifetime and lower the capital needs of publicly owned wastewater treatment facilities (WWTFs), if the system is nearing its treatment capacity. Water conservation may result in a less dilute influent load to the WWTF, which in some cases may make effective treatment more difficult to achieve (Zingarelli and Karp, 1991:4).

Rhode Island's recent enactment of water conservation legislation (R.I.G.L. 46-15.4, as amended) provides sufficient authority to the PUC and state management agencies to effectively implement water conservation measures. In support of that legislation, all water suppliers should be required to utilize all feasible and effective water conservation measures prior to developing new sources of water supply or abandoning existing sources. Active water conservation programs could be developed through fee and billing structures; retrofitting of water-saving plumbing equipment, including performance of water audits and installation of devices at cost or no direct cost to users; meter

installation, replacement, and reading; leak detection, repair, and prevention; and public education programs, including programs for municipal and state building officials (Zingarelli and Karp, 1991:6).

WWTF Consolidation

Consolidation of publicly owned wastewater treatment facilities may better protect the states' economic and environmental interests for several reasons. First, to the extent that WWTF improvements are financed and partially subsidized through the state-administered revolving loan funds, the public's investment could be better protected by preferentially financing projects based, in part, on their expected statewide benefit. Regional treatment authorities, with their focus on *regional* water quality and facility planning, would have a greater interest in providing benefits to the general public rather than to residents of a narrow geographic region. Basinwide pollution abatement and growth management alternatives would, therefore, be evaluated more objectively, and more consistently implemented (Zingarelli and Karp, 1991:8-9).

In evaluating possible consolidation or regionalization of WWTFs, environmental (*e.g.*, water quality improvements) and economic (*e.g.*, cost savings resulting from operational efficiencies) issues are most important. However, other issues, such as equity considerations in establishing a consistent user fee schedule, must also be considered (Metcalf & Eddy, Inc., 1991c).

- Environmental and Economic Benefits

The environmental and economic benefits to be achieved from consolidation of WWTFs are fundamentally linked. Establishment of a uniform system for managing geographically complex programs (*e.g.*, combined sewer overflow (CSO) abatement) can result in the development of solutions that provide the greatest environmental benefit at the least cost. Similarly, any economic efficiencies achieved from merging programs could result in direct cost savings that could be re-invested into further capital or program improvements. For example, efficiencies could be achieved through consolidation of the labor pool, establishment of a single billing and accounting system, centralization of laboratory, library, and training facilities, and standardization of maintenance programs, including bulk purchases of materials and chemicals (Zingarelli and Karp, 1991:11).

Administrative consolidation of wastewater treatment authorities into a regional or statewide utility could also facilitate the examination of structural solutions to local wastewater treatment and disposal problems. For example, three communities on the Pawtuxet River (West Warwick, Warwick, and Cranston) are each conducting a facility plan to evaluate alternatives for providing advanced wastewater treatment (AWT), under a consent agreement with RIDEM. Although each community is investigating regional AWT alternatives as part of its facility plan, and regional AWT could be implemented without consolidating the three treatment authorities, the facility planning process and any ultimately recommended regional solution would doubtlessly be facilitated through consolidation of the three WWTFs into a Pawtuxet River Treatment Authority. In addition, basinwide pollution abatement and growth management alternatives could most objectively be evaluated and consistently implemented by a regional Pawtuxet River Treatment Authority, rather than by individual communities, which may have a self-interest in recommending community-specific solutions (Zingarelli and Karp, 1991:9).[See "Other Issues" below.]

There are many additional examples of potential environmental advantages from consolidating WWTFs. Consolidated WWTFs may be better able to equalize the utilization of treatment capacity, rather than allowing some plants to operate periodically at or above their design capacity. This approach may also reduce or eliminate some of the WWTF bypasses and CSO discharges that currently occur, if base wastewater loads or storm flows can be transferred to plants with available capacity. Opportunities may also be present for regional solutions to the problem of sludge disposal, through methods such as compost-

ing, incineration, or pelletization (Zingarelli and Karp, 1991:10).

Administrative consolidation of treatment authorities may also directly lead to environmental benefits. An authority's management structure and other institutional constraints, such as a mismatch between its treatment requirements and financial capabilities, may result in its failure to comply with permit conditions (University of Rhode Island Intergovernmental Policy Analysis Program, 1990). Consolidation of authorities with severe financial constraints or ineffective management structures into those with financial capability and effective management could result in direct water quality improvements, or cost savings that could be reinvested into such improvements (Zingarelli and Karp, 1991:11).

Consolidation should also promote the standardization of several programs. In these cases, while direct environmental benefits may be difficult to document, more effective regulatory programs would result, thus producing indirect environmental benefits. Examples of programs that could be improved with standardization include the industrial pretreatment program and septage disposal programs (Zingarelli and Karp, 1991:12).

It is also likely that consolidation would result in a significantly reduced workload for facility staff. A reduction in the number of RIPDES/NPDES discharge permits — with an associated reduction in mailings, public hearings, discharge monitoring reports, *etc.*, — would be one instance where the workload of state and federal regulators would be reduced as well (Zingarelli and Karp, 1991:12).

- Equity Issues

User fees vary widely between existing authorities. This may be due to the different costs for providing treatment, in some cases at different treatment levels, from one authority to the next. On the other hand, some sewer authorities recover debt service and other costs through the general property tax rate rather than through user fees. As part of any consolidation, a consistent schedule to recover all operating and capital costs from user fees, varying strictly with the cost of treatment or other characteristics of the service subarea, would have to be established system wide. However, residents of those communities that currently have relatively low user fees because the cost of treatment is subsidized by property taxes might consider such a system inequitable, particularly if not accompanied by a corresponding decrease in property taxes (Zingarelli and Karp, 1991:12-13).

A related equity issue to be considered would be the issue of debt retirement. Communities have varying levels of outstanding debt service, related to the time when major construction was last undertaken (Metcalf & Eddy, Inc., 1991c). An equitable arrangement of retiring debt would have to be established so that those communities with low remaining outstanding debt would not be penalized (Zingarelli and Karp, 1991:13).

In Rhode Island, regulation of consolidated treatment authorities through the PUC may be an appropriate channel for resolution of such financial and equity issues. The PUC is charged with providing "fair regulation of public utilities and carriers in the interest of the public." (R.I.G.L. 39-1-1(b)) Although existing authority of the PUC over wastewater treatment authorities is currently limited to the NBC, expansion of PUC authority to other regional wastewater treatment authorities would likely prove the most effective means of resolving interjurisdictional issues regarding rate and debt equity (Zingarelli and Karp, 1991:13).

- Other Issues

One political impediment to consolidation may be a desire by communities to retain control of their WWTFs. Those communities with an effective management structure may be reluctant to relinquish control to a regional authority, as well as having to assume costs for improvement of the more poorly-run plants (Metcalf & Eddy, Inc., 1991c). Similarly, regional planning and siting for "undesirable" facilities (*e.g.*, sludge incinerators) may result in certain

member communities considering themselves to be unfairly treated.

Additionally, individual communities may consider control over lateral sewers an important tool in planning and management of growth. The issue of whether control of lateral sewers should be transferred to a regional authority should also be investigated as part of an analysis of the feasibility and desirability of WWTF consolidation (Zingarelli and Karp, 1991:12).

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: WATER MANAGEMENT AND WASTEWATER TREATMENT

CODE	POLICY	AGENCIES	STATUS
I.	The State of Rhode Island should maximize conservation of its water supplies in order to minimize the volume of wastewater generated and ultimately discharged to Narragansett Bay and its tributaries.		
I.A.	The Rhode Island Department of Environmental Management (RIDEM) Division of Water Supply Management, the Rhode Island Department of Health (RIDOH) Division of Drinking Water Quality, the Rhode Island Department of Administration Division of Planning (RIDOP), the Division of Public Utilities, and the Public Utilities Commission (PUC) should actively enforce the requirements of the Water Supply Management Act of 1991 (R.I.G.L. 46-15.4, as amended by P.L. 1991, ch. 311).	RIDEM, RIDOH, RIDOP, PUC	[See RIDOP and RIDOH "Preliminary Agreements," Section 715-05-06.]
I.B.	These agencies should ensure that all water suppliers develop active water conservation programs through: 1. Fee and billing structures; 2. Retrofitting of water-saving plumbing equipment, including performance of water audits and installation of devices at cost or no direct cost to users; 3. Meter installation, testing, replacement, and reading for domestic, commercial, and industrial users; 4. Leak detection, repair, and prevention; 5. Public education programs, including programs for municipal and state building officials; and 6. Other feasible water conservation measures.	RIDEM, RIDOH, RIDOP, PUC	
I.C.	These agencies should evaluate whether consolidation of water supply authorities may be an appropriate measure to enhance water conservation efforts or to effect other water quality improvements, either directly or indirectly.	USGS, RIDEM, RIDOH, RIDOP, PUC	[See USGS and RIDEM "Preliminary Agreements," Section 715-05-06 re: development of a water use database to evaluate demand on water supplies, and effect on wastewater treatment.]
I.D.	All water suppliers should be required to utilize all feasible and effective water conservation measures, including those listed above, prior to developing new sources of water supply or abandoning existing sources. Water suppliers should utilize sources within their watershed prior to utilizing out-of-basin transfers for water supply.	RIDEM, RIDOH, RIDOP, PUC, Water Suppliers	

✓ – High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: WATER MANAGEMENT AND WASTEWATER TREATMENT

CODE	POLICY	AGENCIES	STATUS
II.	The State of Rhode Island should maximize the economic and administrative efficiency of the State's wastewater treatment facilities (WWTFs) in order to more effectively protect Narragansett Bay and its tributaries from the effects of wastewater treatment and disposal.		
II.A.	The State of Rhode Island should establish a commission to evaluate the feasibility of consolidating its WWTFs. The commission should determine whether such consolidation, if feasible, should consist of: 1. Individual consolidation measures (*e.g.*, incorporation of the Smithfield and East Providence sewer districts into the Narragansett Bay Commission (NBC); merger of the West Warwick, Warwick, and Cranston sewer districts); or 2. Establishment of a few regional wastewater treatment authorities based on political subdivision boundaries (*e.g.*, by county), or based on watershed boundaries (*e.g.*, Upper Bay, West Bay, East Bay, coastal); or 3. Establishment of a statewide wastewater treatment authority by phasing individual consolidations to regional authorities and, eventually, to a single state authority.	State of R.I.	NBC-BVDC officially merged in January 1992. RIDEM is requiring Cranston, Warwick and W. Warwick to consider regional options for achieving advanced treatment requirements in the Pawtuxet River.
II.B.	The commission should also examine: 1. The feasibility of forming a combined authority (or authorities, if regional consolidation is recommended) to manage both wastewater treatment and water supply; and 2. The desirability of bringing regional treatment authorities under the regulation of the PUC.	State of R.I.	[See USGS "Preliminary Agreement," Section 715-05-06 re: development of a water use database to evaluate demand on water supplies, and effect on wastewater treatment.]

✓ – High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: WATER MANAGEMENT AND WASTEWATER TREATMENT

CODE	POLICY	AGENCIES	STATUS
II.C.	The commission should consider the following issues in evaluating the aforementioned consolidation alternatives: 1. Environmental effects of WWTF consolidation, including: a. Feasibility of regional CSO abatement measures; b. Feasibility of regional treatment alternatives (*e.g.*, advanced wastewater treatment); c. Feasibility of regional pretreatment, sludge disposal, and effluent reuse programs; d. Probability of achieving improved wastewater treatment through effective management and financial capabilities; and e. Availability of additional funding for environmental improvements as a result of economic savings (see below). 2. Economic effects of WWTF consolidation, including: a. Personnel consolidation; b. Centralized billing and accounting system; c. Centralized laboratory, library, and training center; d. Pooling or bulk purchase of equipment and materials; and e. Uniformity of maintenance programs. 3. Other effects of WWTF consolidation, including: a. Standardization of programs; b. Community control of WWTFs and lateral sewers; c. User fee schedules and debt retirement; and d. Desirability of placing WWTFs under PUC authority.	State of R.I.	
II.D.	In addition, the commission: 1. Should recommend whether the following structural regionalization alternatives should be technically evaluated through the facility planning process: a. Consolidation of East Greenwich and Quonset Point WWTF discharges to a new deepwater outfall at Quonset Point; b. Consolidation of Narragansett Bay Commission Bucklin Point (formerly BVDC) and East Providence WWTF discharges to a single discharge at East Providence. 2. Should <u>not</u> consider a facility plan for a consolidated marine outfall off Point Judith unless new scientific information is developed on the potential water quality impacts of such a project on Narragansett Bay and Rhode Island Sound.	State of R.I.	

✓ – High Priority Action

Estimated Cost of Implementation - Source Control: Water Management and Wastewater Treatment

Table 715-04(3) summarizes the estimated costs associated with implementing the recommendations in this chapter. Element I (Water Conservation) requires State agencies to actively enforce the use of water conservation measures by the State's water suppliers prior to the development of new drinking water supply sources or the abandonment of existing sources. The costs involved ($100,000) are spread out evenly over the five-year planning period. Element II (WWTF Consolidation) recommends the creation of a commission to evaluate the feasibility of establishing a regional or statewide wastewater treatment authority. This would occur in 1994-95 and would conclude in the following year. Both Elements require coordination activities between the major State agencies (RIDEM, RIDOH, and RIDOP) and municipalities.

Although the NBP actively supported the action, the costs associated with consolidating the NBC and BVDC WWTFs have not been included because the merger became official prior to completion of the *CCMP*. Similarly, the costs associated with the upgrade of the Cranston, Warwick, and West Warwick WWTFs on the Pawtuxet River have not been included since the action was mandated by RIDEM independently of the *CCMP*. However, RIDEM's most recent estimate (June 1992) of the capital costs associated with the upgrade of the individual WWTFs is: Cranston, $30 million; Warwick, $25 million; and West Warwick, $20 million. Consistent with the recommendations in this chapter, a regional solution may be more cost-effective to the extent that these communities seek partial state financing from the Rhode Island Clean Water Protection Finance Agency (RICWPFA) or another state revenue source in order to complete the advanced treatment projects.

For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report* (Apogee Research Inc./NBP, 1992).

Table 715-04(3)

ESTIMATED COST OF IMPLEMENTATION
SOURCE CONTROL: WATER MANAGEMENT AND WASTEWATER TREATMENT

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
I-Water Conservation	20,000	0	20,000	0	20,000	0	20,000	0	20,000	0	100,000	0
II-WWTF Consolidation	0	0	0	0	26,250	0	25,000	0	0	0	51,250	0
TOTALS	20,000	0	20,000	0	46,250	0	45,000	0	20,000	0	151,250	0
TOTAL BY YEAR		20,000		20,000		46,250		45,000		20,000		151,250

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	5,000	0	5,000	0	11,250	0	10,000	0	5,000	0	36,250	0
RIDOH	5,000	0	5,000	0	5,000	0	5,000	0	5,000	0	25,000	0
RIDOP	5,000	0	5,000	0	10,000	0	10,000	0	5,000	0	35,000	0
RI PUC	5,000	0	5,000	0	5,000	0	5,000	0	5,000	0	25,000	0
RI Governor's Office	0	0	0	0	5,000	0	5,000	0	0	0	10,000	0
RI Municipalities*	0	0	0	0	5,000	0	5,000	0	0	0	10,000	0
WWTFs	0	0	0	0	5,000	0	5,000	0	0	0	10,000	0
TOTALS	20,000	0	20,000	0	46,250	0	45,000	0	20,000	0	151,250	0
TOTAL BY YEAR		20,000		20,000		46,250		45,000		20,000		151,250

* Ultimate implementation costs will vary for each municipality depending on its particular environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees.

04-01-04 Source Control: Combined Sewer Overflows

Objective for the Abatement of Combined Sewer Overflows

Combined sewer overflows within the State of Rhode Island and the Commonwealth of Massachusetts shall be eliminated or brought into compliance by the year 2000 with technology-based requirements and applicable state water quality standards, in order to preserve and restore existing and historical uses wherever possible.

Introduction

In many older communities, wastewater and storm runoff is collected, conveyed, and discharged by a single system, the combined sewer. During periods of precipitation or snow melt, the combined flows of wastewater and runoff may exceed the carrying and treatment capacities of the conveyance system and the associated wastewater treatment facility (WWTF). At these times, hydraulic overload of the facility or flooding is prevented by combined sewer overflows (CSOs), which divert excess flows from the combined sewer directly to a receiving water (Zingarelli and Karp, 1990:i). A combined sewer system is described schematically in Figure 715-04(2).

Statement of the Problem

Combined sewer overflows and WWTF bypasses are the greatest source of fecal contamination to the receiving waters of Narragansett Bay (Zingarelli and Karp, 1990:9). Discharges from CSOs also release untreated, or partially treated, industrial process wastewater. In general, the flow of untreated sewage, industrial wastewater, and urban runoff from CSOs can contribute to violations in water quality criteria for turbidity, dissolved oxygen, bacteria, metals, and toxic organic pollutants. These discharges also may contribute to low oxygen conditions in some areas due to high levels of nutrients and solids loadings. While some CSO impacts, particularly those relating to turbidity or dissolved oxygen, tend to be localized around the outfall, others, such as fecal contamination, may be significantly more widespread (Zingarelli and Karp, 1990).

Discharges from CSOs and WWTF bypasses into Narragansett Bay's receiving waters have contributed to the permanent closure of 26,000 acres of shellfish harvesting areas in Mount Hope Bay and the Providence River, and, following precipitation events, result in the closure of an additional 10,672 acres in the upper bay (Zingarelli and Karp, 1990:8-9). Closures in conditional harvesting areas run for a minimum of seven days after the storm. These periods, added together over the course of a year, can represent a significant amount of time. In 1990, for example, CSO-related harvesting prohibitions in the conditional area spanned 281 days.

Leaks and hardware failure in combined sewers can cause discharges to receiving waters even in dry weather. Additionally, wherever the structural integrity of the drainage system is compromised, significant volumes of groundwater may be able to infiltrate. This can cause dry weather overflows and increased overflows during storms. Physical blockages of the regulating structures can also result in overflows in both dry and wet weather (Zingarelli and Karp, 1990:1).

More than a hundred CSOs and WWTF bypasses discharge directly into Narragansett Bay or its tributaries. Their locations are indicated in Figure 715-04(3). The annual discharge to the Bay from these facilities is estimated to be four billion gallons—compared to 73 billion gallons per year from the WWTFs themselves (Zingarelli and Karp, 1990:2).

Existing Policies

Combined sewer overflows are "point sources" (of water pollution) regulated through the National Pollutant Discharge Elimination System (NPDES). In Rhode Island, CSOs are subject to Rhode Island Pollutant Discharge Elimination System (RIPDES) permits. [See 04-01-01 Source Reduction: Toxics.] In Massachusetts, the U.S. Environmental Protection Agency

Figure 715-04(2): Schematic of CSO System.

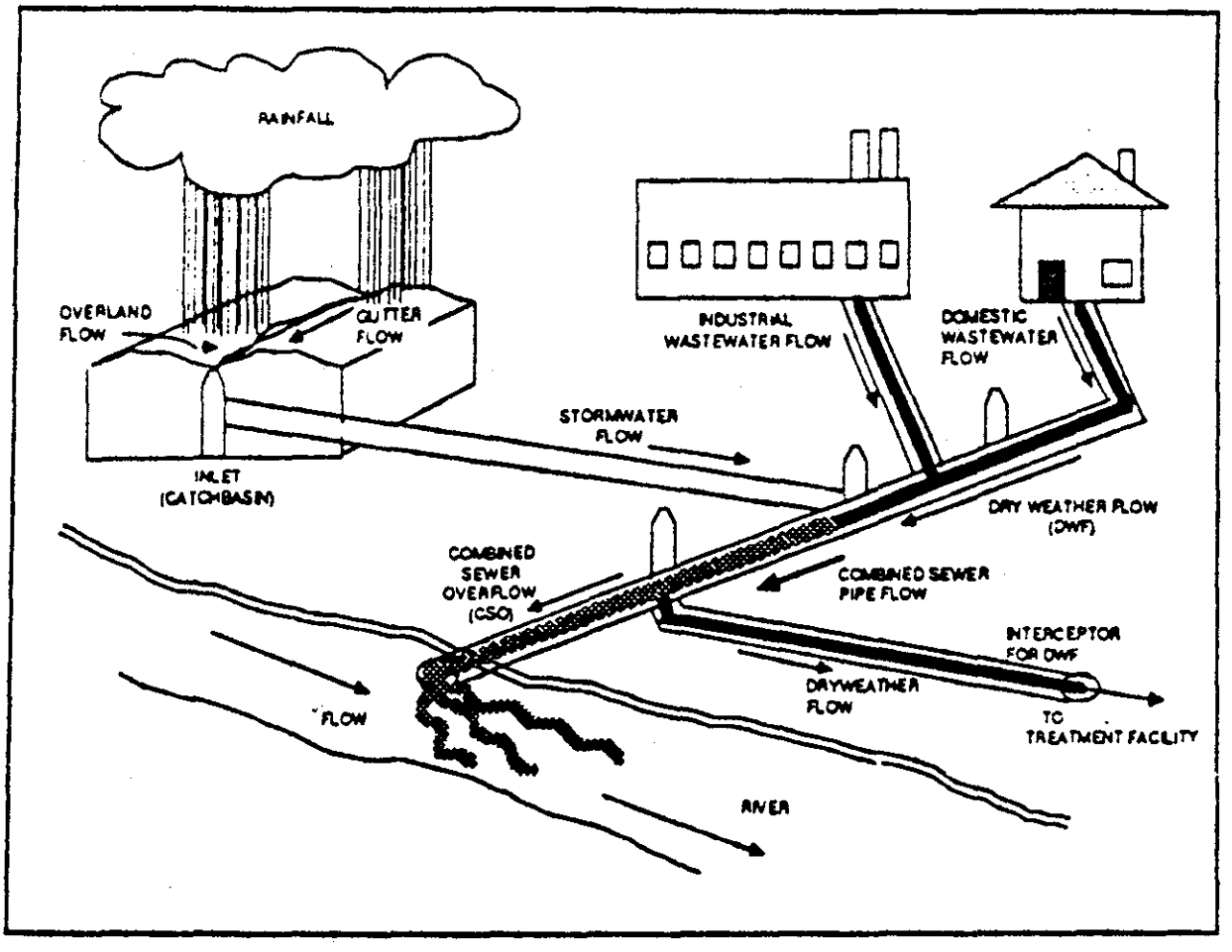
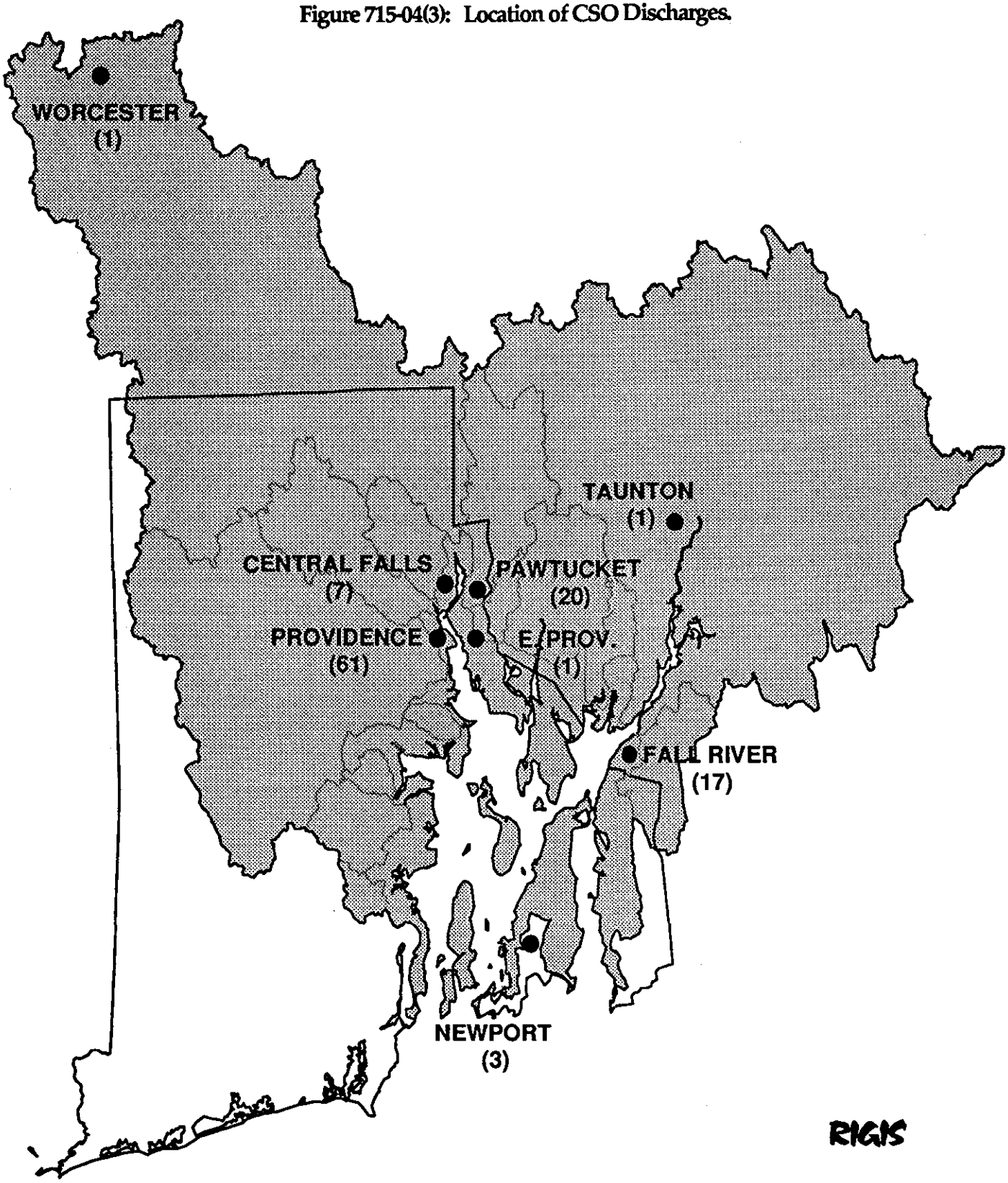


Figure 715-04(3): Location of CSO Discharges.



(EPA) Region I has retained this authority under National Pollutant Discharge Elimination System (NPDES).

The EPA formulated a *National Combined Sewer Overflow Control Strategy* in 1989. The *Strategy* is "designed to complement the control programs for sanitary sewers and separate storm sewers. [It] establishes a uniform, nationally-consistent approach to developing and issuing NPDES permits for CSOs...State-wide permitting strategies will be developed by the States or Regions to ensure implementation with this CSO strategy." (EPA, 1989a:1,3) As a minimum, the *Strategy* proposes that states and municipalities employ technology-based measures to meet the goals of the Clean Water Act. Included among these methods are regular maintenance, effective pretreatment programs, maximization of flow to WWTFs, a prohibition of dry weather overflows, and control of fecal, solid, and floatable materials in wet weather overflows. In addition, "the CWA under Section 301(b)(1)(C) also requires any additional permit limits that may be necessary to protect State water quality standards" (EPA, 1989a:6).

In response to EPA's *National Strategy*, the Rhode Island Department of Environmental Management (RIDEM) prepared a *Combined Sewer Overflow Policy* that was approved by the EPA in April 1990. This policy requires that each CSO discharge receive *equivalent primary treatment*—"the use of or combined uses of storage, screening, settling, or other technologies such that the treated effluent results in removal rates of 50% of the Total Suspended Solids (TSS) and 35% of the Biochemical Oxygen Demand (BOD) loadings[,] or 100% of all settleable solids, whichever is demonstrated to have the greatest water quality impact" (RIDEM/Division of Water Resources (DWR), 1990b:n.p.). All flows created by the hypothetical one-year, six-hour design storm, and storms occurring more frequently, are subject to the requirement of equivalent primary treatment (Zingarelli and Karp, 1990:4). If equivalent primary treatment cannot sufficiently abate water quality impacts from a particular CSO, RIDEM reserves the right to require more extensive treatment (RIDEM/DWR, 1990b).

As opposed to establishing specific removal rates for components of CSO discharges, Massachusetts' *Implementation Policy for the Abatement of Pollution from Combined Sewer Overflows* requires the outright elimination of impacts on receiving waters. Impact elimination is determined by the nondegradation of the receiving water's designated use. This use classification, assigned according to the Commonwealth's Water Quality Standards, must be maintained for storms up to the hypothetical three-month storm, a design storm of such intensity that it is expected to occur or to be exceeded once every three months. If overflows cannot be eliminated, relocated, or otherwise sufficiently mitigated, the receiving water may be assigned a "partial-use" subcategory to denote occasional short-term impairment of use (Commonwealth of Massachusetts, 1990a:n.p.; Zingarelli and Karp, 1990:5).

Analysis

State Policies

The policy approaches taken by state government in Rhode Island and Massachusetts with regard to the CSO problem are dissimilar, though both are sanctioned by the EPA. In Rhode Island, there is a specific technology-based requirement for abatement: effective primary treatment for storm events up to the one-year, six-hour design storm. In Massachusetts, the standard is maintenance of use categories in affected waterbodies, for events up to the three-month design storm. Massachusetts has no technology-based requirement *per se*.

Both CSO policies are very new, and to date there have not been any abatement projects constructed since their implementation that test either one. The EPA has left it up to the individual states to establish their own policies and procedures for maintaining water quality standards, and no major inequities have yet been reported due to the difference in approaches. However, it is possible that the fundamental difference in policies (*e.g.*, the different design storms) will result in fundamentally different abatement projects and water quality benefits in Rhode Island and Massachusetts. It is also quite possible that

the different policies eventually will cause problems in shared waters such as Mount Hope Bay. For example, planned abatement facilities for Fall River, which will be designed under Massachusetts' CSO policy, could be insufficient to meet Rhode Island's goals for its portion of Mount Hope Bay (Zingarelli and Karp, 1990:14).

Rhode Island's CSO policy allows a CSO authority to petition the RIDEM for relief from the requirement of effective primary treatment should "significant beneficial water quality improvements" be demonstrated using a cost-benefit analysis from incorporating a lesser level of treatment. No provisions are included in the policy, however, outlining the specific actions that the authority must undertake to petition for relief.

Abatement Strategies

There are three basic types of structural abatement measures. The first is separation of combined sewer flows into independent sanitary and storm flows, followed by full (usually secondary) treatment of sanitary flows. The second is storage of overflows in detention systems at centralized locations or at individual overflow points, and subsequent discharge to WWTFs when treatment capacity is available. The third is treatment of the overflows, also at either centralized or localized sites, by such measures as screening and sedimentation, coagulation-flocculation, or swirl concentration-vortex separation, plus disinfection (typically chlorination or chlorination/ dechlorination) (Zingarelli and Karp, 1990:10-11).

Non-structural measures, or "best management practices" (BMPs), may also be used, either as stand-alone strategies or in conjunction with structural measures to reduce the scale of structural improvements. Some basic BMPs are street sweeping, controlling erosion at construction sites, eliminating infiltration and inflow, flushing sewers to remove trapped solids, and increasing network storage (Zingarelli and Karp, 1990:10-11).

Progress on the Local Level

Local authorities in the Narragansett Bay watershed have completed several CSO abatement projects:

- The City of Worcester constructed a CSO facility that stores, screens, and (in summer months only) disinfects discharges, with engineered capabilities up to the five-year storm. The facility officially went on line on December 8, 1990, the effective date of its NPDES permit.

- Newport completed its CSO treatment and disinfection facility on Washington Street in March 1991, and renovated and modified a microstrainer facility on Wellington Street that had experienced operational problems.

- After implementing the first phase of its local abatement plan, Fall River is reported as having virtually eliminated illegal dry-weather discharges to the Quequechan River from the city's CSOs.

- The Narragansett Bay Commission (NBC) has constructed several improvements to its system to provide in-line storage and divert combined sewage flows to the Field's Point WWTF (Zingarelli and Karp, 1990:12).

Several more projects have been proposed and tentatively scheduled for completion within the next ten years:

- Fall River's storage and treatment follow-up is expected to be completed by the year 2000, at a cost of $122.4 million (Maguire Group, 1990).

- The NBC will conduct a program of repairs and renovations, storage and treatment facilities, and sewer separation, for its Field's

Point service area. The total cost is estimated at almost $200 million (Narragansett Bay Commission, 1991).

- The Blackstone Valley District Commission (BVDC) on behalf of the cities of Pawtucket and Central Falls began a CSO abatement study for the Blackstone and Seekonk Rivers in November 1990. The study, being completed by the NBC as a result of its merger with BVDC, has issued a draft report recommending CSO abatement facilities estimated to cost approximately $117 million (Beta Engineering and CH2M Hill, 1992).

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
I.	CSO Abatement Policies		
I.A.	The EPA should carefully review and monitor the implementation of state CSO policies to ensure that states are consistently and equitably moving toward compliance with water quality standards.	EPA	[See EPA. Region I "Preliminary Agreement," Section 715-05-06.]
I.A.1.	The EPA should review relevant federal and state CSO policies every three years, concurrent with the review of state water quality standards, with subsequent review as needed, to ensure that the policies, as applied, are adequate to ensure compliance with state water quality standards. The Narragansett Bay Project should convene a forum of representatives from the EPA, State of Rhode Island, and Commonwealth of Massachusetts to develop a written statement of agreement on the goals, interpretation, and implementation of these policies.	EPA, NBP, RIDEM, MADEP	
I.A.2.	Efforts should be taken to reconcile the water quality classifications of interstate waters, such as Mount Hope Bay and the Blackstone River.	EPA, RIDEM, MADEP	[See RIDEM "Preliminary Agreement," Section 715-05-06; 04-03-01 Areas of Special Concern: Mount Hope Bay; and 04-03-02 Blackstone River.]
I.A.3.	The EPA and the states should ensure that receiving water monitoring is conducted within a defined area of all CSO discharge zones, in order to assess the ultimate success of CSO abatement projects in achieving water quality standards.	EPA, RIDEM, MADEP	[See EPA Region I "Preliminary Agreement," Section 715-05-06.]

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
I.A.4.	The EPA should carefully review NPDES/RIPDES permits issued to CSO dischargers, to ensure that: a. The permits are in compliance with all applicable CSO policies (federal, regional, and state). b. The permits are sufficiently stringent to attain designated uses of receiving waters. c. Appropriate state or local authorities monitor receiving waters to evaluate the success of CSO abatement in meeting water quality standards. Permits that affect interstate waters should be reviewed by both states to ensure consistency with water quality standards in both states. d. Particular attention should be paid to the water quality impacts of the Narragansett Bay Commission (NBC) Bucklin Point North Diversion Structure. EPA and RIDEM should review the NBC CSO abatement study to ensure that the projects recommended are consistent with the state CSO policy and, based on the data in that study, make CSO abatement at the North Diversion Structure a high priority (see Recommendation III.A.). An effluent (Recommendation I.E.) and receiving water quality (Recommendation I.A.3.) monitoring program should be established to determine if the level of CSO abatement provided by the project is sufficient to meet water quality standards. EPA, RIDEM, and NBC should subsequently review the results of the monitoring program to determine whether greater than primary treatment should be required for all flows from the North Diversion Structure to achieve the State's goals for CSO abatement.	EPA, RIDEM, NBC	See Recomm. I.A.3., I.E., III.A. EPA currently issues or reviews all NPDES and RIPDES permits issued to CSO dischargers.
I.B.	The RIDEM CSO policy should be revised, as quickly as possible, to incorporate a stronger water quality-based approach, in addition to the current technology-based approach, to CSO abatement, noting that: 1. Revisions to the RIDEM CSO policy should not be interpreted to delay CSO abatement projects undertaken by publicly owned wastewater treatment facilities (WWTFs) under current policy [See Recommendation I.C.]. 2. Water quality-based permits are predicated on water quality-based criteria that may now vary in neighboring states with shared waterbodies.	RIDEM	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.C.	CSO abatement plans developed before the approval of revised state CSO policies should be subject to all requirements of those policies. Those WWTFs currently implementing CSO abatement plans based on current policies in "good faith" should continue to implement those plans.	EPA, RIDEM, MADEP, CSO authorities	[See EPA Region I "Preliminary Agreement," Section 715-05-06.]

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
I.D.	A documented waiver process, open to public review, should be established for requesting a waiver from the RIDEM's technology-based CSO requirement of effective primary treatment for storms up to the one-year, six-hour design storm, noting that the specific requirements for a waiver can only be determined on a case-by-case basis.	RIDEM	
I.E.	A program of CSO discharge monitoring should be established, through NPDES/RIPDES discharge permits, that includes monitoring of selected outfalls. The respective states should cooperate with the implementing authority in developing the program. 1. A calibrated and verified model (*e.g.*, SWMM) of the combined sewer system in a given community should be utilized to determine the storm characteristics that would be likely to result in CSO discharge. Forecasted and observed weather data would be used to determine when such storms are likely to occur or are occurring. a. The above model would be used to identify "critical" CSO outfalls. b. The "critical" outfalls would be monitored for three to five storms of variable intensity per year to test the predictions of the model and performance of the CSO or CSO abatement facility. 2. A system would be established to monitor, on a rotating basis, "non-critical" outfalls. 3. Routine monitoring of all outfalls would be conducted to ensure the elimination of dry-weather discharges (which are illegal). 4. The results of this monitoring would be used to recalibrate the model, if necessary.	EPA, RIDEM, MADEP	[See EPA Region I and RIDEM "Preliminary Agreements," Section 715-05-06.]
I.F.	Authorities responsible for CSOs should be required to maximize CSO discharge flows under their jurisdiction to WWTFs, so as to take maximum advantage of the primary and secondary treatment capacity of the WWTF.	CSO authorities	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
I.G.	WWTFs should make maximum possible use of existing primary and secondary treatment capacity available for treatment of CSO flows. CSO flows, once brought into a WWTF for treatment, should be subject to requirements of the Clean Water Act (CWA). 1. In cases where secondary treatment capacity is limited, however, consideration should be made to allow flexibility in implementing CWA secondary treatment requirements for the combined flow, in order to allow for maximum use of existing capacity without harming the integrity of the WWTF structure or treatment processes. 2. Secondary capacity of WWTFs should not be increased exclusively for the purpose of treating all wet weather flows at the WWTF.	WWTFs	
II.	CSO Abatement Technologies		
II.A.	Proposed CSO abatement measures should be evaluated based on their ability to achieve the goal of meeting water quality standards and preserving and restoring historic uses, in addition to their compliance with existing state and federal requirements. Secondary benefits of alternative measures, such as providing the greatest possible treatment of the stormwater portion of combined flows, should also be considered.	EPA, RIDEM, MADEP, CSO authorities	
II.B.	The need for disinfection of CSO flows should be evaluated based upon the expected ability to meet the desired goal of preserving and restoring historic uses such as shellfish harvesting balanced against potential treatment or chlorine toxicity problems.	EPA, RIDEM, MADEP, CSO authorities	See 04-02-04 Resource Protection: Public Health

✓ - High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
III.	Financing and Implementation		
III.A. ✓	**The State of Rhode Island and Commonwealth of Massachusetts should develop statewide priority rankings to help determine how state funds should be spent on CSO abatement projects.** **1. The Rhode Island prioritization schedule should be jointly prepared by NBP and RIDEM staff.** **2. Massachusetts should develop a prioritization schedule which recognizes the importance of and places a high priority on CSO abatement measures for the portion of the Commonwealth within the Narragansett Bay watershed (*i.e.*, Fall River).** **3. These rankings should be used in conjunction with internal priorities established by individual communities and WWTFs.** **4. The rankings are not to prevent any currently planned and funded projects from proceeding.** **5. Factors to be considered in developing the prioritization schedule include pre- and post-abatement values of:** **a. Volume of CSO discharge.** **b. Pollutant loading of CSO discharge.** **c. Water quality impacts of CSO discharge, including probable impacts on existing and desired uses of receiving waters.** **d. Frequency of CSO discharge.** **e. Readiness to proceed with CSO abatement.** **f. Cost of and benefits from CSO abatement.**	**RIDEM, Narragansett Bay Planning Section, NBC, MADEP**	**CSO abatement is required under federal and state laws regulations, and/or policies. [See RIDEM "Preliminary Agreement," Section 715-05-06 re: development of a priority ranking system.]**
III.B.	All sources of funding should be considered for the financing of CSO abatement projects, including reauthorization of the Clean Water Act, federal and state grants, the State Revolving Fund, and local sources.	EPA, State of R.I., Comm. of Mass., municipalities	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

CODE	POLICY	AGENCIES	STATUS
IV.	Sewer Connection Issues		
IV.A.	Sewer authorities with combined sewers should implement a policy that: 1. Allows "no net increase" of stormwater flows to combined sewers as a result of new construction. Potential stormwater increases should be mitigated by on-site measures (*e.g.*, detention basins). 2. Requires new sanitary connections to tie in to separate sanitary sewers whenever technically and economically feasible. 3. Encourages cross-jurisdictional sanitary connections to separate sanitary sewers whenever feasible and necessary to avoid connection to combined sewers. 4. Requires a two-for-one reduction in infiltration/inflow (I/I) for any new sanitary connections to the system. An I/I analysis should be performed prior to requiring the reductions to determine if I/I is a significant contributor to influent flows. The sewer authority would have the responsibility for ensuring the reduction, and the option of whether to pass the responsibility on to the developer. 5. A moratorium on new sanitary connections to combined sewers should <u>not</u> be considered, since such a policy would tend to direct development away from areas having existing infrastructure to areas requiring the construction of new infrastructure.	R.I. and Mass. sewer authorities	
IV.B.	Storm drains that discharge sanitary waste due to illegal connections, effectively operating as combined sewers, should <u>not</u> be regulated in the same manner as CSOs. Sanitary connections to storm drains are illegal and must be eliminated.	EPA, RIDEM, MADEP, municipalities	

✓ - **High Priority Action**

Estimated Cost of Implementation—
Source Control: Combined Sewer Overflows

Table 715-04(4) summarizes the estimated costs associated with implementing the recommendations in this chapter. Element I (Abatement Policies) contains recommendations that require agencies to review CSO policies, coordinate activities, and to monitor the implementation of such policies. The cost of monitoring CSO discharges is included under Long-Term Monitoring (05-02-04) and Source Reduction: Toxics (04-01-01). The substantial costs associated with large-scale CSO abatement projects are reflected in Element III (Finance and Implementation). The majority of these capital costs (approximately 73 percent) are for NBC projects; the remainder go toward CSO abatement projects planned for WWTFs in the Cities of Taunton and Fall River, Massachusetts. Element IV (Sewer Connection) displays the oversight costs that NBC will encounter in implementing policies regarding new connections to combined sewers. This section also recommends that municipalities eliminate illegal sanitary connections to stormdrain systems; this activity has potential for significant costs, however, these cannot be estimated due to the varying type, size, and location of these systems in the many Bay watershed municipalities.

CSO abatement costs will extend beyond the five-year planning period (post-1997 capital cost of $92.8 million) as will the repayment of bonds issued for CSO abatement purposes. NBC will have additional staffing needs over the project life to perform planning and oversight. There will also be minor coordination and review costs for RIDEM and MADEP.

For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report* (Apogee Research Inc./NBP, 1992).

Table 715-04(4)

ESTIMATED COST OF IMPLEMENTATION
SOURCE CONTROL: COMBINED SEWER OVERFLOWS

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
I-Abatement Policies	12,500	0	0	0	22,500	0	5,000	0	10,000	0	50,000	0
II-Abatement Technologies	5,000	0	0	0	0	0	0	0	0	0	5,000	0
III-Finance and Implement	35,000	15,090,000	10,000	19,672,000	10,000	103,481,000	10,000	116,462,000	10,000	86,222,250	75,000	340,927,250
IV-Sewer Connection Issues	50,000	0	50,000	0	50,000	0	50,000	0	50,000	0	250,000	0
TOTALS	102,500	15,090,000	60,000	19,672,000	82,500	103,481,000	65,000	116,462,000	70,000	86,222,250	380,000	340,927,250
TOTAL BY YEAR		15,192,500		19,732,000		103,563,500		116,527,000		86,292,250		341,307,250

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	22,500	0	5,000	0	22,500	0	10,000	0	15,000	0	75,000	0
MADEP	15,000	0	5,000	0	10,000	0	5,000	0	5,000	0	40,000	0
NBC	55,000	13,104,000	50,000	17,686,000	50,000	70,313,000	50,000	83,294,000	50,000	63,753,250	255,000	248,150,250
Fall River WWTF	5,000	1,956,000	0	1,956,000	0	31,835,000	0	31,835,000	0	21,135,000	5,000	88,717,000
Taunton WWTF	5,000	30,000	0	30,000	0	1,333,000	0	1,333,000	0	1,334,000	5,000	4,060,000
Municipalities*	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	102,500	15,090,000	60,000	19,672,000	82,500	103,481,000	65,000	116,462,000	70,000	86,222,250	380,000	340,927,250
TOTAL BY YEAR		15,192,500		19,732,000		103,563,500		116,527,000		86,292,250		341,307,250

* Ultimate implementation costs will vary for each municipality depending on its particular environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees.

04-01-05 Source Control: On-Site Sewage Disposal Systems

Objective for Management of On-Site Sewage Disposal Systems

The State of Rhode Island, the Commonwealth of Massachusetts, and their municipal governments should undertake initiatives to mitigate and prevent contamination of Narragansett Bay and tributary waters from on-site sewage disposal system wastes in order to minimize public health risks, environmental degradation and impairment of water quality-dependent uses.

Introduction

On-site sewage disposal systems, or OSDS, are an important source of surface and groundwater contamination in the Narragansett Bay basin. Septic systems that are located in poorly drained soils, or which are poorly designed, constructed, or maintained can fail because the assimilative or "treatment" capacity of the soil is exceeded (Zingarelli and Karp, 1991:16; RIDOA, 1987). Similarly, OSDSs fail to provide effective treatment where the cumulative density of development causes hydraulic overload of OSDS leach fields, and where property owners have constructed (illegal) sub-surface drains from the leach field. However, properly designed and completely functional septic systems can also represent a source of viruses, nutrients, and toxic chemicals to receiving waters (Karp *et al.*, 1990:32-34 ; Penniman *et al.* 1991b:33-39; Zingarelli and Karp, 1991:16).

Statement of the Problem

Thirty-seven percent of Rhode Islanders depend upon OSDSs for treatment of domestic, household wastes, and 12 of Rhode Island's 39 cities and towns are completely unsewered, as are several communities in the Massachusetts portion of the Narragansett Bay watershed (RIDOA, 1989a). In addition, over 70 percent of the Narragansett Bay coastline is unsewered and served by OSDSs (Roman, 1990; Karp *et al.*, 1990:32). The potential for contamination of the Bay from OSDS runoff and leachate is exacerbated by increasing residential and commercial development in unsewered suburban and rural areas of the basin, and the conversion of seasonal homes with OSDSs—many installed prior to modern regulations—to year-round residences (Karp *et al.*, 1990:32-33). Closures of shellfish harvesting grounds in several Narragansett Bay embayments have been at least partially attributed to septic system failures (USDA SCS, 1990:9; RIDEM, 1990a; Karp *et al.*, 1990:33; Zingarelli and Karp, 1991:17).

Septic system location, design, age, maintenance, and use are critical considerations for individual septic systems. In general, OSDSs installed prior to Rhode Island's adoption of septic system regulations in 1969 tend to be the systems that fail. Routine maintenance such as pumping out the septic tank, checking the integrity of the tank and the leach field, conserving water, and avoiding disposal of household and commercial toxic and hazardous wastes would help to improve septic system performance, and extend the life of the leach field. However, individual property owners are often unaware of the need for routine maintenance until the system fails (USDA SCS, 1990).

The OSDS issue is further complicated by problems that stem from properly functioning septic systems. Depending upon soil type, water saturation, and other factors, viruses and dissolved chemical pollutants can migrate long distances down-gradient from properly functioning OSDSs and ultimately leach into surface or groundwaters (Karp *et al.*, 1990:33; Penniman *et al.*, 1991b:38). Therefore, residential and commercial OSDSs sited in aquifer recharge areas represent a potential threat to drinking water supplies, as well as to other surface and groundwater supplies. In addition, the cumulative environmental impact associated with the density of residential and commercial septic systems is not usually considered when new septic systems are approved. As a result, the current regulatory system, which focuses on failed septic systems, only addresses part of the problem.

Existing Policies

In Rhode Island, state agencies oversee the siting, design, construction, and regulation of OSDSs, although local governments have the authority to manage OSDS density and maintenance in their communities. Municipal boards of health exercise these responsibilities in Massachusetts. The federal government does not exercise regulatory jurisdiction over any aspect of OSDS design, siting or density. However, the U.S. Environmental Protection Agency (EPA) has issued draft technical guidance regarding OSDS design and performance standards, and siting criteria in support of the Clean Water Act Section 319 Nonpoint Source Pollution Control Program, and the Section 6217 Coastal Nonpoint Management Program (EPA, 1987a; EPA, 1991a; EPA-NOAA, 1991).

The Rhode Island Department of Environmental Management's (RIDEM) OSDS regulations require new and replaced OSDSs to be installed at least three feet above the seasonal high water table, or five feet above impervious formations, and require a minimum setback of 50 feet from surface waters. However, RIDEM requires a 150-foot setback and a four-foot separation distance from groundwater in the Salt Pond region, and a 200-foot setback in the Scituate Reservoir watershed in order to protect these identified critical areas (RIDEM, 1989b). The Rhode Island Coastal Resources Management Council (CRMC) can require up to 180-foot setbacks between septic systems and surface waters in erosion-prone areas (Karp *et al.*, 1990:33).

Rhode Island has also recognized that existing OSDSs need to be managed to assure proper treatment and disposal of septic system wastes. Pursuant to legislation passed in 1987, Rhode Island cities and towns have broad authority to establish "wastewater management districts" (WWMD) to assure that residential and commercial septic systems are routinely inspected and properly maintained. In addition, RIDEM presently requires publicly-owned wastewater treatment facilities (WWTF) to accept septage generated within their service areas for treatment (Zingarelli and Karp, 1991:18).

Two financial assistance programs have been available in Rhode Island to help property owners repair or replace failed septic systems: the $5-million Sewer and Water Supply Failure Fund and the Rhode Island Aqua Fund. However, the Sewer and Water Supply Failure funds were completely expended in 1990, and Aqua Fund bond funds are not available to assist individual property owners.

In summary, state agencies oversee the siting, design, construction, and regulation of septic systems in Rhode Island, although local governments have the authority to manage septic system density and septage disposal issues in their communities. Municipal boards of health exercise these responsibilities in Massachusetts.

Analysis

As of 1991, over 1,200 acres of Rhode Island's salt ponds, tidal rivers and coastal embayments were permanently or seasonally closed to shellfish harvesting due, in part, to runoff and leachate from septic systems, illegal sewer connections to storm drains, and illegal boater discharges (RIDEM, 1990a; Zingarelli and Karp, 1991:17). Some of these areas also show signs of nutrient enrichment, including increased frequency of algal blooms and low dissolved oxygen concentrations. In addition, shoreline surveys of coastal embayments indicate that some property owners have installed (illegal) subsurface drains in the OSDS leach fields resulting in the direct discharge of septic wastes to receiving waters (Zingarelli and Karp, 1991:17).

An OSDS Task Force convened by RIDEM in 1985 recommended increasing the minimum separation distance from the bottom of the OSDS to the seasonal high water table to four feet, at least in critical resource areas and areas with excessively permeable soils. The Task Force also suggested greater horizontal buffer distances between septic systems and critical surface water and groundwater resources to allow for some additional

incidental treatment in the event of a septic system failure.

However, the recommendations of the Task Force were not completely adopted by the RIDEM and may not be sufficient in any case to protect the public from exposure to bacterial or viral pathogens, or to protect living marine resources from other dissolved pollutants in domestic waste (Penniman *et al.*, 1991b:22-24). For example, based on an EPA septic system siting model that evaluated pollutant transport (EPA, 1987a), Roman (1990) concluded that even if the groundwater separation distance were increased to ten feet or 30 feet, fecal contamination would still be considered "probable" because of the poorly drained soils typical of Rhode Island's coastal zone.

Violations, Remediation, and Enforcement

The Rhode Island Division of Planning (RIDOP) estimates that the overall septic system failure rate is between three and five percent, based upon the number of violations reported to the Rhode Island Department of Health (RIDOH) that are subsequently acted upon by RIDEM because the property owner failed to correct the problem. The scope of the problem may be substantially underestimated, however, since property owners are likely to have failed or failing systems pumped out for aesthetic and sanitary reasons before state regulators intervene. In addition, the results of a property owner survey in the Town of Narragansett suggested that the septic system failure rate could be as high as ten to 15 percent in some communities (Zingarelli and Karp, 1991:17). [Note: In 1989, for example, RIDEM issued 2,462 Letters of Warning and 103 Notices of Violation, and the Rhode Island Aqua Fund Council received applications for grant funding from seven communities representing over 2,000 households with failed or failing septic systems (Karp *et al.*, 1990:33).]

In Massachusetts, where responsibility for OSDS installation resides with each municipality, the adequacy of inspection and enforcement is reported to be uneven from community to community (USDA SCS, 1990:3). Regulation of existing septic systems is also erratic in Rhode Island where OSDS inspection and enforcement depends entirely on RIDEM's ability to investigate reported septic system failures. Although Rhode Island cities and towns have had broad authority to establish WWMDs to manage septic systems since 1987, no districts have been established as of 1992. Reasons cited by municipal officials include lack of guaranteed septage disposal options, lack of start-up capital, and political unwillingness to assess user fees to support the districts (Zingarelli and Karp, 1991:19). Efforts to establish a WWMD in the Town of Narragansett in 1991 were tabled because of public opposition to user fees and concerns about granting access to septic system inspectors.

Sewering Unsewered Areas

Sewering represents a necessary solution in some densely developed areas where chronically failing OSDS contribute to surface or groundwater contamination, or limitations on water quality-dependent uses. However, sewering, without appropriate land use controls, can result in more intensive development, increase impervious surfaces (roads, driveways, roofs, sidewalks, *etc.*,) and compound runoff problems. Many planners and regulators, therefore, view sewering as a last resort, acceptable only in extreme cases where the carrying capacity of the soil has been exceeded due to overdevelopment, and where no reasonable alternative or group of alternatives would work.

Routine OSDS inspection and maintenance, water conservation, replacement of failed and failing septic systems, and the use of denitrifying or other advanced treatment technologies, including artificial wetlands and solar aquatic greenhouses represent some alternatives to sewering. In addition, new technologies are emerging with respect to septage treatment. For example, the Massachusetts Department of Environmental Protection (MADEP) issued regulatory approvals to a solar aquatics-type septage treatment facility in Harwich, MA in 1992. [See 04-01-03 Source Control: Water Management and Wastewater Treatment for a brief description of the experimental solar

aquatics wastewater treatment facility at Narragansett Bay Commission Field's Point in Providence.]

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.	The State of Rhode Island and the Commonwealth of Massachusetts should adopt consistent policies and regulations in the Narragansett Bay watershed to regulate the location, design, construction, and use of on-site sewage disposal systems (OSDS) in order to minimize OSDS-derived pollutant loadings to Narragansett Bay and its tributary waters.		
I.A. ✓	**The Rhode Island Department of Environmental Management (RIDEM), subject to interagency review, shall review the adequacy of existing minimum standards in the *Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction, and Maintenance of Individual Sewage Disposal Systems* (1989b) with respect to setbacks from drinking water supplies and identified critical resources, minimum separation distances from groundwater, and OSDS design and performance standards, *and:***	**RIDEM, CRMC, MADEP, MACZM**	**[See RIDEM and CRMC "Preliminary Agreements," Section 715-05-06 re: revision of ISDS regulations.] Mass. expects to release draft Title V regulations for public review in fall 1992.**
I.A.1.	The OSDS setback from identified critical resources, including nutrient-sensitive waterbodies, should be increased to a prescribed minimum distance in order to reduce groundwater transport of OSDS-derived fecal contaminants, dissolved nutrients, and toxic pollutants. [*Note*: Prescriptive OSDS setback distances are recommended as an *interim* measure until criteria and standards for site-specific OSDS density controls are established. See 04-01-02 Source Reduction: Nutrients for a description of approaches used to establish site-specific OSDS density controls; and 04-02-02 Resource Protection: Protection of Critical Areas for discussion of critical resource areas.] In order to implement this recommendation:	RIDEM, MADEP, MACZM	

✓ - High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.A.1.a.	The OSDS setback distance should be increased to at least 200 feet in unplatted areas adjacent to critical resources, including nutrient-sensitive waterbodies, unless evidence of no significant water quality or use impairment from additional OSDS loadings to adjacent surface or groundwaters can be demonstrated. [Note: In establishing a prescriptive minimum setback distance, RIDEM should review the effectiveness of the 150 foot setback and four foot groundwater separation distance in the coastal pond area. RIDEM should also review existing information regarding groundwater transport of *bacteria* (Roman, 1990; Weiskel and Heufelder, 1989; EPA, 1987a); *viruses* (Roman, 1990; Reneau *et al.* 1989; EPA, 1987a); *nitrogen* (Valiella and Costa, 1988; Groffman *et al.*, 1991); and *toxic pollutants* (Groffman *et al.*, 1991) in evaluating the need for more protective OSDS setback requirements.]	RIDEM, MADEP, MACZM	
I.A.1.b.	The OSDS setback distance should be increased to a minimum of seventy-five feet, up to the maximum possible distance, for existing lots of record.	RIDEM, MADEP, MACZM	
I.A.1.c.	Cluster development should be strongly encouraged in order to obtain appropriately protective OSDS setbacks from critical resources. Unit density limits should include the area of the setback to the extent possible.	RIDEM, MADEP, MACZM	
I.A.2.	The OSDS requirements of minimum depths to ground water should consider factors to account for flooding and sea level rise over the life of the septic system on lots located in Flood Hazard Areas. [See 04-02-02 Resource Protection: Protection of Critical Areas for further recommendations concerning planning for sea level rise.]	RIDEM, MADEP, MACZM	
I.A.3.	The OSDS regulations should be revised to ensure that water level verification and percolation tests are performed on a lot-by-lot basis, coincident with the location of the individual septic systems after the lots are delineated.	RIDEM, MADEP, MACZM	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.A.4.	The OSDS regulations should be revised to include applicability criteria, design and performance standards, and effluent limits for a range of alternative OSDS technologies that may be allowed for use in areas: a. Where dimensions or characteristics of the site preclude the use of conventional on-site sewage disposal systems. b. Identified as "critical resource protection areas," including drinking water supply watersheds, watersheds of nutrient-sensitive waters, and waters where water quality problems already exist (*e.g.*, bacteriological and nutrient-related problems such as shellfishing restrictions, persistent hypoxia, algal blooms, *etc.*). The OSDS regulations, as revised, should explicitly recognize that some "critical resource protection areas" are undevelopable with presently available technologies, and that sewering may be the appropriate technology of last resort in some completely developed areas with water quality problems and/or limitations on water quality-dependent uses attributable to OSDSs. c. Presently platted or developed in ≤ 1/2 acre lot sizes. d. Zoned for ≤ 1/2 acre lots close to "critical resource protection areas," where site characteristics indicate that water quality, ecological, or use impairments of the "critical resource protection area" could occur. e. Where there is evidence of existing water quality, habitat, or use impairments related to septic systems.	RIDEM, MADEP, MACZM	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.A.4.f.	Where characteristics of the site indicate that water quality, ecological, or use impairments of ground or surface waters related to septic system use could occur. [RIDEM should refer to the EPA *Design Manual for Onsite Sewage Disposal Systems* (in prep., 1992); guidance developed for the Coastal Zone Management Section 6217 Coastal Nonpoint Pollution Control Program (CNPCP), including *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1991a) and the Rhode Island Land Management Project's *Management Measures for Onsite Sewage Disposal Systems in Coastal Areas* (draft, Myers, 1991); OSDS regulations from other jurisdictions, including Massachusetts' Title 5 requirements (310 CMR 15), as amended; and recommendations in other chapters of the Narragansett Bay *CCMP* in order to develop specific pollutant loading targets and effluent limits, applicability criteria, and design and performance standards for alternative OSDS technologies.]	RIDEM, MADEP, MACZM	
I.A.5.	The RIDEM and Massachusetts counterparts should consider establishing a special approval for experimental OSDSs in order to encourage the development of more effective OSDS technologies, and develop baseline data on the performance of new technologies. The experimental OSDS permit should be linked to groundwater monitoring requirements, and posting of a performance bond. [In developing the requirements for experimental permits RIDEM and the Massachusetts Department of Environmental Protection (MADEP) should review the Virginia Department of Health's (draft) *Alternative Discharging Sewage Treatment System Regulations for Individual Single Family Dwellings* (1992).]	RIDEM, MADEP, MACZM	
I.A.6.	The OSDS regulations should be revised, as necessary, to identify innovative septage treatment and disposal options such as incineration, "solar aquatics" treatment, composting, and land application, and the revised regulations should be cross-referenced to the RIDEM's *Rules and Regulations Pertaining to the Treatment, Disposal, Utilization and Transportation of Wastewater Treatment Facility Sludge* (1991).	RIDEM, MADEP, MACZM	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.B.	The RIDEM and MADEP, in conjunction with the Rhode Island Division of Planning (RIDOP), the Rhode Island Coastal Resources Management Council (CRMC), Massachusetts Coastal Zone Management (MACZM), and local governments (as appropriate), should require minimum two-acre zoning and cluster development in currently unplatted areas adjacent to critical resources, including nutrient-sensitive waters, in order to control OSDS density and reduce OSDS-generated pollutant loads. Alternatively, these agencies should require the use of approved OSDS treatment technology adequate to provide wastewater treatment equivalent to two acre OSDS density, unless evidence of no significant water quality or use impairment from additional OSDS loadings can be demonstrated. [*Note*: The prescriptive OSDS density controls are recommended as an interim measure until criteria and standards for site-specific OSDS density controls are established. See 04-01-02 Source Reduction: Nutrients for a description of approaches used to establish site-specific OSDS density controls.]	RIDEM, RIDOP, CRMC, Mass. counterparts, municipalities	
I.C.	The RIDOP should revise the *Handbook on the Local Comprehensive Plan* (1989b) as necessary, to require revised local comprehensive plans to include: 1. An evaluation of the distribution and performance of OSDSs in the community with respect to existing and projected cumulative impacts on water quality; and 2. Recommendations regarding appropriate land use policies to regulate OSDS densities, sewering, and wastewater treatment facility (WWTF) upgrades to protect surface and groundwater quality.	RIDOP	
I.D.	The State of Rhode Island and the Commonwealth of Massachusetts should require owners of residences and other facilities with OSDSs to keep the following records of system maintenance, to be made available to prospective buyers, realtors, and banks before ownership of the land can be transferred. The required seller disclosure information should include the following information: 1. Installation date and type of OSDS. 2. Certification of OSDS tank structural integrity (visually determined by certified septage pumper/hauler and included as part of pump-out receipt). 3. Frequency of historical pumping, date of most recent pumping, and history of leach field failure.	R.I., Mass.	R.I. Association of Realtors submitted draft legislation in 1992 session requiring use of "seller disclosure" statement, including status of septic systems.

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
I.E.	The State of Rhode Island should ban the retail sale and advertisement of acid and organic chemical solvents for use in septic systems. The Commonwealth of Massachusetts should ban the use, sale, and advertisement of such chemicals. The State and Commonwealth should also initiate informational campaigns to inform the public of the risk of environmental damage from these products.	R.I., Mass.	
I.F.	The State of Rhode Island and Commonwealth of Massachusetts should prohibit the installation of garbage disposal systems in residences and businesses served by OSDSs in order to reduce nutrient loadings to the septic system. In addition, the State and the Commonwealth should consider requiring the use of grease traps on commercial and residential properties served by OSDSs in order to improve OSDS performance, and increase the lifetime of the leach field.	R.I., Mass., Building Code Commissions	
I.G.	The RIDEM and the Rhode Island Department of Health (RIDOH) should negotiate an interagency Memorandum of Agreement transferring responsibility for OSDS inspections to RIDEM.	RIDEM, RIDOH	Completed September 1990. RIDOH retains jurisdiction to inspect food establishments.
I.H. ✓	**The State of Rhode Island and the Commonwealth of Massachusetts should develop educational programs for municipal officials and the general public that describe the environmental and financial risks of failing to address OSDS density and maintenance.**	**RIDEM, RIDOP, CRMC, Mass. counterparts**	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.	By 1995, all properties served by OSDSs in unsewered areas of Rhode Island and the Narragansett Bay basin should be included within a wastewater management district (WWMD) that provides for routine inspection and maintenance of septic systems and adequate treatment and disposal of septic system wastes.		
II.A.✓	**In order to assure that all properties in the Narragansett Bay basin served by OSDSs are routinely inspected and maintained, the RIDEM and RIDOP should prepare draft legislation for submittal in 1993 that amends R.I.G.L. 45-24.5-1 *et seq.* to require each Rhode Island municipality to establish, or to associate with, an established WWMD by no later than January 1995.** **1. WWMDs established pursuant to Chapter 24.5, as amended, should be administered by regional and municipal WWTFs, other utilities, or municipal governments.** **2. Each WWMD should provide for routine inspection and maintenance of all OSDSs within the WWMD, and adequate treatment of all septic system waste generated within the WWMD.** **3. Comparable legislation should be adopted by the Commonwealth of Massachusetts for application, at least, in the Massachusetts portion of the Narragansett Bay basin.**	**RIDEM, RIDOP, CRMC, WWMDs, Mass. counterparts, municipalities**	**No WWMDs have been established in R.I. as of June 1992. Legislation drafted by NBP in 1991 was not submitted. [See RIDEM "Preliminary Agreement," Section 715-05-06 re: agreement to actively promote establishment of WWMDs.**
II.B.	In order to assure that WWMDs effectively and consistently carry out the responsibilities of the District with respect to septage management, the State of Rhode Island and Commonwealth of Massachusetts should establish appropriate enabling authority and administrative and regulatory controls. To implement this recommendation:		

✓ - High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.B.1.	The WWMDs established pursuant to Chapter 24.5, as amended, should be empowered to exercise the following additional "powers and duties" pursuant to Section 4 of R.I.G.L. 45-24.5 [Subsections (a) through (j) of R.I.G.L. 45-24.5-4 as presently written, should continue to be exercised by WWMDs administered by local governments, WWTFs or other utilities.]: a. Require more effective wastewater treatment using septic system technologies approved in RIDEM's *Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction, and Maintenance of Individual Sewage Disposal Systems* (1989b), as amended, in areas delineated by the municipality as "critical resource protection areas." b. Establish mandatory water conservation requirements for all property owners served by on-site septic systems within the WWMD. c. Establish and enforce prohibitions on the discharge of regulated toxic chemicals to septic systems covered by the WWMD. d. Establish and enforce standards governing the quality of septage eligible for treatment and disposal at the WWTF. e. Establish and enforce mandatory disclosure and reporting requirements regarding septic system maintenance and performance for all property owners served by the WWMD. f. Certify to RIDEM that WWTF treatment and disposal capacity exists to handle septic system wastes generated by any new or expanded septic system approved by RIDEM within the WWMD's service area. g. Advise RIDEM and appropriate municipal officials whether remedial or enforcement action is necessary based on documented septic system failure, the presence of illegal subsurface drains, or evidence of surface or groundwater contamination related to direct or indirect discharges from septic systems within the WWMD. h. Evaluate the cumulative public health and environmental impacts associated with existing and proposed septic systems within the WWMD's service area. i. Assure that property owners perform required repair or replacement of failed or failing OSDSs by enforcement of a lien on the property in question. j. Establish user fees adequate to assure complete cost recovery for all expenses related to operation of the WWMD, including administration of the WWMD, inspection and maintenance of OSDSs, septage treatment and disposal, compliance and environmental monitoring related to OSDS performance, enforcement, and maintenance of a revolving loan fund for repair/replacement of failed septic systems.	RIDEM, RIDOP, Mass. counter-parts	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.B.2.	The WWMDs established pursuant to Chapter 24.5, as amended, should be required to exercise the following additional "duties" pursuant to a new section of R.I.G.L. 45-24.5 that explicitly requires all WWMDs to: a. Maintain records of septic system inspection, maintenance, pumping frequency, installation, repair, and replacement in a standardized format that is available for periodic review by RIDEM. b. Notify RIDEM regarding the location of failed or failing on-site sewage disposal system(s) within the WWMD's jurisdiction. c. Notify RIDEM regarding the location of ground or surface waters contaminated directly or indirectly by on-site septage disposal systems within the WWMD. d. Notify RIDEM regarding "critical resource protection areas" delineated by the municipality within the WWMD's jurisdiction that require more effective wastewater treatment, using septic system technologies approved in RIDEM's *Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction, and Maintenance of Individual Sewage Disposal Systems* (1989b), as amended.	RIDEM, RIDOP, WWMDs, Mass. counterparts, municipalities	
II.B.3.	The RIDOP shall: a. Review and approve all WWMD ordinances and plans developed pursuant to R.I.G.L. 45-24.5-1 *et seq.* based upon technical guidance developed by RIDOP, RIDEM, and CRMC. [The model ordinance developed by the RIDOP ("*Scituate Reservoir Management Plan: Waste Water Management Districts...A Starting Point*". Report #62, 1987) should be referenced in Section 4 of R.I.G.L. 45-24.5, as amended.] b. Recommend the creation of regional WWMDs using the boundaries proposed in Rhode Island's '208' Areawide Water Quality Plan if the RIDEM determines that completely unsewered municipalities in Rhode Island have not been included within a WWMD by 1995.	RIDOP	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.C.	In order to provide for adequate treatment and disposal of all septic system wastes generated within the Narragansett Bay basin, the following measures should be taken:		
II.C.1.	A new section should be added to R.I.G.L. 45-24.5 that explicitly requires every municipal WWTF in the State of Rhode Island to provide for adequate treatment and disposal of all septic system wastes generated within the municipality by January 1995. [This recommendation should apply to every WWTF in the State of Rhode Island that is subject to Rhode Island Discharge Elimination System (RIPDES) permitting requirements and eligible to receive federal or state funds.]	RIDEM, RIDOP, Mass counterparts	RIDEM currently requires WWTFs to accept septage generated within their service areas.
II.C.2.	A new section should be added to R.I.G.L. 45-24.5 that explicitly requires regional WWTFs such as the Narragansett Bay Commission (NBC) and the Port Authority facility at Quonset Point to reserve septage treatment and disposal capacity after 1995 for municipalities within the regional WWTF's existing service area; completely unsewered municipalities that are not served by a regional or municipal WWTF; and municipalities that can demonstrate that municipally-generated septage cannot be treated at other WWTFs because of limitations on treatment capacity. a. This requirement shall not be interpreted to relieve other WWTFs or municipalities from the obligation to establish WWMDs as required under R.I.G.L. 45-24.5, as amended. b. In addition, regional and state-operated WWTFs subject to this section, as amended, shall not be required to modify or waive existing criteria governing the acceptance of septage for treatment and disposal, or the rate structure applied to other users of the WWTF in order to satisfy the requirements of the Section, as amended. [The requirement to reserve septage treatment capacity may be waived by the Director of RIDEM if the Department finds that the reserved capacity is unnecessary.]	RIDEM, RIDOP, WWTFs	Port Authority septage receiving facility (17,000 gpd) should go on line in 1992. NBC Field's Pt. facility stopped accepting septage in 1992 because of odor complaints. NBC plans to design septage receiving facility at Field's Pt. within two years. NBC Bucklin Pt. currently accepts septage generated within its service area.

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.C.3.	The RIDEM and the MADEP shall determine what daily volume of septage each WWTF can accept for treatment and disposal without violating its National Pollutant Discharge Elimination System (NPDES)/RIPDES effluent limits; and require every WWTF to adopt numerical septage discharge limits governing the acceptance of septage for treatment and disposal. In addition, the U.S. Environmental Protection Agency (EPA), RIDEM, MADEP and local industrial pretreatment programs shall: a. Evaluate all commercial enterprises that generate septage within the Narragansett Bay watershed for inclusion in industrial pretreatment programs by December 1995. [See 04-01-01 Source Reduction: Toxics for further discussion of the proposed expansion of the pretreatment program.] b. Establish enforceable pretreatment standards for toxic metals and organic chemicals in septage and enforce existing state prohibitions on the discharge of non-domestic waste to OSDSs. c. Develop technical guidance to govern the promulgation of standards and, to the maximum extent practicable, ensure that consistent standards regarding septage quality are adopted and enforced statewide. [These agencies should review chemical criteria developed by the NBC to determine whether septage is acceptable for disposal.] d. Cooperate in developing regional septage disposal options.	EPA, RIDEM, WWTFs, Industrial Pretreatment Programs, municipalities, Mass. counterparts	
II.D.	In order to assure that failed on-site sewage disposal systems are repaired or replaced and that WWMDs are established and financially able to effectively carry out the responsibilities of the District with respect to septage management:	EPA, RIDEM, RICWPFA (SRF), R.I. Aqua Fund, WWTFs, Mass. counterparts	
II.D.1.	The State of Rhode Island should re-authorize the "Sewer and Water Supply Failure Fund" as a revolving loan fund to allow continued repair and replacement of failed individual OSDSs. Loans should be conditioned on the existence of local WWMDs.	State of R.I.	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
II.D.2.	The EPA, Rhode Island Clean Water Protection Finance Agency (RICWPFA), Rhode Island Aqua Fund Council and Massachusetts State Revolving Fund Authority (SRF) should provide economic incentives for municipalities to establish WWMDs prior to the 1995 deadline and for municipalities and regional WWTFs to establish regional WWMDs. Such incentives might take the form of reduced interest rates on SRF loans to municipalities or regional WWTFs that: a. have established WWMDs prior to the 1995 deadline; b. have expanded the jurisdiction of the WWMD to include other municipalities; and/or c. are accepting septage from municipalities outside the WWMD.	RIDEM, RICWPFA (SRF), R.I. Aqua Fund, Mass. counterparts	
II.D.3.	Municipal WWMDs should establish user fees sufficient to cover all costs associated with administering and operating the WWMD. a. The municipality may consider establishing an "avoidable surcharge" system whereby a portion of the user fee is waived upon the property owner providing proof of OSDS inspection on an annual basis, and proof that the OSDS has been pumped according to a pre-established schedule. b. The user fee or surcharge should be sufficient to cover the Town's costs in providing substituted inspection and pumping services, encourage voluntary compliance with OSDS maintenance requirements, and all administrative and operating costs of the WWMD.	Municipalities, WWMDs	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

CODE	POLICY	AGENCIES	STATUS
III.	The State of Rhode Island and the Commonwealth of Massachusetts should encourage the use of water conservation and alternative wastewater treatment technologies before extending public sewers in order to avoid increased development in critical or sensitive areas that cannot accommodate additional growth. In order to implement this recommendation, A. The State of Rhode Island and the Commonwealth of Massachusetts should recommend sewering in sensitive areas of the Narragansett Bay watershed *if and only if* the area is "built-out" in terms of pollutant loading or existing zoning, *and* after all reasonable alternatives are explored, including, but not limited to mandatory water conservation and the use of alternative on-site wastewater treatment technologies, such as composting toilets, engineered wetlands or solar aquatic facilities. B. The RIDEM, CRMC, RIDOP, their Massachusetts counterparts, and all local permitting authorities should increase their efforts to educate the public about the need and procedures for maintaining OSDSs. C. The EPA, RIDEM, CRMC, and their Massachusetts counterparts should explore the permitted use of alternative wastewater and septage treatment technologies, such as passive solar aquatic "greenhouses." These agencies should carefully consider whether the proposed alternative technologies have been proven effective and whether the use of these technologies will promote increased development in critical or sensitive areas where the pollutant carrying capacity of the land is exceeded.	EPA, RIDEM, RIDOP, CRMC, Mass. counterparts	[See RIDOP and RIDOH "Preliminary Agreements," Section 715-05-06 re: enforcement of water conservation provisions of R.I.G.L. 46-15.4. MADEP issued regulatory approvals to solar aquatics septage treatment facility in Harwich, Mass. in June 1992.

✓ - High Priority Action

Estimated Cost of Implementation—Source Control:On-Site Sewage Disposal Systems

Table 715-04(5) summarizes the estimated costs associated with implementing the recommendations in this chapter. The major cost in Element I (Policies and Regulations) is the recommended evaluation of the effectiveness of existing OSDS density controls based upon nitrogen loading ($127,500). Activities included in this are the development of nutrient and runoff loading models and providing training to state and local officials. The delineation of nutrient-sensitive waters is costed under 04-02-02 Resource Protection: Protection of Critical Areas. There are lesser costs associated with the revision of regulations, interagency coordination, and legislative costs.

Element II (Wastewater Management Districts) contains the largest cost in this table, a $5,000,000 reauthorization of the Rhode Island Sewer and Water Supply Failure Fund. There are also costs pertaining to review of WWMD ordinances, agency guidance, and legislative actions. The major costs associated with Element II are for municipalities to establish WWMDs, although all administrative and operating costs are expected to be recovered from user fees. The establishment of WWMDs would create an additional annual cost for OSDS owners which would be offset by the fact that WWMD fees include the cost of septic system pumping (average pumping cost is $100). An indication of the cost of implementing a WWMD appears in an application to the Rhode Island Aqua Fund by the Town of Narragansett (June 1991). The Town requested funding in the amount of $143,140 for staff costs, public education, mapping and inventory of OSDSs, seed money for a revolving loan fund ($75,000), consultant services, and office supplies and equipment. An additional $14,160 would be derived from a first year user charge of approximately $2.80 per OSDS owner (based on 5,075 systems townwide). Total first year costs are estimated to be $157,300. In the second year, an average annual fee of $50.58 would be initiated and charged to each OSDS owner. The $256,000 derived from this annual charge would fully fund the operation of the WWMD. Also included in this section is a recommendation that the state provide economic incentives to WWTFs to establish WWMDs; the cost of providing these incentives cannot be estimated until specific incentives are selected.

The personnel costs for the recommendations in this chapter are distributed mainly between RIDEM and MADEP, with lesser legislative costs going to the Rhode Island and Massachusetts Legislatures and local governments. For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report* (Apogee Research Inc./NBP, 1992).

Table 715-04(5)

ESTIMATED COST OF IMPLEMENTATION
SOURCE CONTROL: ON-SITE SEWAGE DISPOSAL SYSTEMS

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
I-Policies and Regulations	67,500	0	0	0	50,000	0	50,000	0	57,500	0	225,000	0
II-Wastewater Mgt. Districts	66,250	5,000,000	0	0	75,000	0	30,000	0	30,000	0	201,250	5,000,000
III-Alternative Technologies	5,000	0	5,000	0	5,000	0	5,000	0	5,000	0	25,000	0
TOTALS	138,750	5,000,000	5,000	0	130,000	0	85,000	0	92,500	0	451,250	5,000,000
TOTAL BY YEAR		5,138,750		5,000		130,000		85,000		92,500		5,451,250

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	66,250	5,000,000	0	0	30,000	0	25,000	0	25,000	0	146,250	5,000,000
RI CRMC	0	0	0	0	30,000	0	25,000	0	25,000	0	80,000	0
RIDOP	1,250	0	0	0	30,000	0	5,000	0	5,000	0	41,250	0
RI Legisature	12,500	0	0	0	12,500	0	0	0	0	0	25,000	0
MADEP	43,750	0	5,000	0	10,000	0	5,000	0	5,000	0	68,750	0
MACZM	0	0	0	0	5,000	0	25,000	0	25,000	0	55,000	0
MA Legislature	15,000	0	0	0	12,500	0	0	0	0	0	27,500	0
Municipalities*	0	0	0	0	0	0	0	0	7,500	0	7,500	0
TOTALS	138,750	5,000,000	5,000	0	130,000	0	85,000	0	92,500	0	451,250	5,000,000
TOTAL BY YEAR		5,138,750		5,000		130,000		85,000		92,500		5,451,250

* Ultimate implementation costs will vary for each municipality depending on its particular environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees.

04-01-06 Source Control: Boater Discharges

Objective for the Management of Boater Discharges

The State of Rhode Island and the Commonwealth of Massachusetts should reduce or eliminate the discharge of untreated and partially treated sewage from vessels operating in Narragansett Bay in order to assist in meeting the states' water quality goals, and to restore and protect water quality-dependent uses of the Bay.

Introduction

Boating is a desirable water-dependent use of the Bay for commercial, recreational and economic reasons. However, boaters operating within Narragansett Bay potentially represent a seasonally and locally significant public health risk related to the improper treatment and disposal of boater-generated sewage. The magnitude of the problem is related to the location of boat anchorages with respect to bathing and shellfish harvesting areas, boat density, and the lack of publicly available toilet and pump-out facilities (Karp and Penniman, 1991:1). In addition, it should be noted that boater discharges of floatables (trash, sewage solids), solvents (marine paints, antifreeze, cleaning agents), and petroleum derivatives (gasoline, oil, grease) also contribute to water quality and habitat degradation. Recognizing the importance of boating and related marine activities, the goal of abating boater discharges is to protect public health, prevent water quality and habitat degradation, and restore and protect water quality-dependent uses of the Bay.

Statement of the Problem

There were over 160 private marinas, yacht clubs, boat yards, town docks, and launching ramps operating in Narragansett Bay, including Mount Hope Bay, in summer of 1988 according to *Boating Almanac* estimates. These facilities provided in excess of 15,000 berths, slips, and moorings for recreational and commercial vessels, not including storage on land. The actual level of boating activity in Narragansett Bay is, however, much higher than reported slip capacity. Over 32,500 boats were registered with the Rhode Island Department of Environmental Management (RIDEM) Division of Boating Safety in 1991 compared to 29,900 in 1990; 28,500 in 1989; and 29,000 in 1988. In excess of 28,000 additional boats—including vessels documented by the U.S. Coast Guard (18,000), visitors (6,000), boats registered in Massachusetts and operating in Bay waters (number unknown), and vessels not required to register (4,000)—are also estimated to have used Rhode Island waters in 1988 (Roman, 1990; Karp and Penniman, 1991:i).

Land-based toilet and pump-out facilities for boaters are scarce in Narragansett Bay relative to the current level of boating activity. Based on the U.S. Environmental Protection Agency's (EPA) recommended formula of one pump-out station per 300 boats with marine sanitation devices (MSD) in "transient" harbors, and one pump-out station per 600 boats with MSDs in "parking lot" harbors for the use of both resident and transient boaters, approximately 30 pump-out facilities should be in service in Narragansett Bay based on 1988-1992 boat registration statistics. However, only five marine pump-out facilities were available in Narragansett Bay waters in 1990 and 1991 although eight stations are expected to be in operation in Narragansett Bay by June 1992. In addition, several coastal communities, including Warwick and Cranston, are planning to install municipal pump-out facilities as part of their *Harbor Management Plans*. Furthermore, as of summer, 1988, only 27 percent of the marinas, yacht clubs, and boat launching facilities throughout the Bay were reported to have shoreside toilet facilities. As a result, vessel discharges to the Bay can be inferred from the scarcity of suitable disposal options.

Boater wastes can be a significant public health problem if untreated or partially treated sewage discharges occur in poorly flushed or shallow waters in the vicinity of shellfish harvesting areas and bathing beaches (Karp and Penniman, 1991:3). For example, the RIDEM has closed approximately 115 acres in the coves surrounding Greenwich Bay, in part because of the ob-

served exceedance of fecal coliform concentrations in waters adjacent to marinas (Karp and Penniman, 1991:1). Boater discharges of sanitary wastes, however, represent only one source of fecal contamination to coastal waters. Other sources of contamination in suburban areas of the Bay include runoff and leachate from on-site sewage disposal systems (OSDS), illegal subsurface drains from OSDS leach fields, and illegal sewer connections to stormdrains. In urban areas such as the Providence River basin, vessel discharges are relatively insignificant compared to municipal wastewater treatment facility (WWTF) and combined sewer discharges.

Existing Policies

Section 312 of the federal Clean Water Act governs vessel discharges to all navigable waters of the United States, including Narragansett Bay. Under Section 312, untreated wastes from vessels with installed toilets must either be discharged beyond the three-mile limit or transferred to land for proper treatment and disposal. Direct discharge to state waters is permitted if and only if the waste is properly treated (macerated and disinfected) on-board with a Type 1 or Type 2 MSD. Section 312, as amended in 1987, authorizes the U.S. Coast Guard—and the states to enforce discharge prohibitions with respect to all vessels with installed heads. Both Rhode Island and Massachusetts re-negotiated their existing "statements of understanding" with the U.S. Coast Guard in March 1991 to begin implementing their authority to enforce federal MSD standards for vessels operating in State and Commonwealth waters.

The RIDEM is separately authorized to enforce prohibitions on the unpermitted disposal of pollutants, including untreated or partially treated sewage, to Rhode Island's surface waters (R.I.G.L. 46-12-5). In addition, RIDEM is required to investigate the sanitary quality of shellfishing waters (R.I.G.L. 20-8.1-3), and to determine whether the waters are "polluted" based on direct fecal coliform measurements or "evidence that significant volumes of fresh raw sewage or inadequately purified sewage may reach the area intermittently" (R.I.G.L. 20-8.1-4) (Karp and Penniman, 1991:1). Acting on existing legislative authority and the states' expanded authority to enforce Section 312, the Rhode Island General Assembly enacted R.I.G.L. 46-12-39, "Discharge of Sewage from Boats," in 1991 to enable the RIDEM to enforce federal MSD standards in Rhode Island waters, including Narragansett Bay, and enforce vessel sewage discharge prohibitions in "no-discharge areas" designated by EPA.

Several mechanisms also exist to enable the states to regulate the shore-based operations of marine facilities. The Rhode Island Coastal Resources Management Council (CRMC) encourages coastal communities to include provisions for marina pump-out facilities in their local *Harbor Management Plans*. In addition, the CRMC specifically prohibits the construction or expansion of marinas in Type 1 waters, the construction of new marinas in Type 2 waters, and the placement of new moorings areas in Type 1 waters. The CRMC does allow new mooring areas and expansions of existing mooring areas in Type 2 waters and allows for the continued operation of marinas in Type 2 waters (CRMC, 1983:23-24). Similarly, the RIDEM prohibits expansion of marinas and mooring fields in Class SA waters because these waters are deemed suitable for bathing and contact recreation, shellfish harvesting for direct human consumption, and fish and wildlife habitat (RIDEM/DWR, 1984:10). The Massachusetts Department of Environmental Protection (MADEP) Division of Wetlands and Waterways Regulation can require marine sewage pump-out stations to be installed as a licensing condition at new boating facilities, and at existing facilities that propose to expand by ten or more berths above existing capacity.

The Clean Water Act Section 401 water quality certification process represents another means for state agencies to comment on a marine facility's plans to control boater-generated sewage, as well as runoff and leachate from boatyard, parking, fueling and dredging operations. CRMC, for example, requires applicants to obtain a Section 401 water quality certification from RIDEM as a

prerequisite to licensing new or expanded marine facilities, and permitting dredging operations. Finally, the 1990 amendments to the federal Coastal Zone Management Act (CZMA) require states' coastal management and nonpoint source management programs to prepare Coastal Nonpoint Pollution Control Plans in coordination with existing Clean Water Act nonpoint source programs and policies established under Sections 208, 303, 319 and 320 [See 04-01-07 Source Reduction: Nonpoint Sources for further discussion of Section 6217 Coastal Nonpoint Pollution Control Plans]. The Section 6217 Coastal Nonpoint Pollution Control Plans are expected to provide the states with a powerful regulatory tool for reviewing all aspects of marine facility operations in order to better protect marine receiving waters. The EPA issued draft guidance on management measures to be used under CZMA Section 6217 in May 1991; the states' coastal management and nonpoint source management programs are expected to begin preparing Coastal Nonpoint Pollution Control Plans in 1992.

Analysis

The effectiveness of the initiatives described above may be compromised by existing boat density and use, the limited availability of marina pump-out facilities, and the increasing demand for recreational boating on Narragansett Bay (Karp and Penniman, 1991:3). The rate of compliance with federal MSD requirements for treatment of sanitary waste has been estimated by EPA to be as low as ten percent (Karp and Penniman, 1991:15). However, the federal and state governments' ability to enforce compliance with equipment requirements or prohibitions on boater disposal of untreated sewage is severely limited by the logistics of inspecting individual boats.

The relative significance of boater discharges into the Bay is also difficult to determine, except in coves and embayments where no other anthropogenic sources of fecal contamination exist (*e.g.*, Potters Cove, Prudence Island). In developed harbors and marinas, for example, boaters represent only one of several possible sources of fecal contamination. Other potential sources include runoff and leachate from failed and failing septic systems, illegal subsurface drains from OSDS leach fields, and storm drains conveying human and animal waste. In major urban areas such as the Providence River, WWTFs, and combined sewer overflows (CSO) represent the major source of fecal contaminants.

Boater discharges are not easily quantified because boats are mobile, boat use and occupancy rates are variable, and discharges are likely to be surreptitious and sporadic. However, an indirect estimation procedure comparing inputs of fecal waste from boats to the entire Bay with other sources indicated that boater discharges would be closely comparable to the estimated daily inputs of fecal coliform bacteria from the Blackstone and Taunton Rivers (Karp and Penniman, 1991:3). Furthermore, measured levels of fecal coliforms from the Great Salt Pond on Block Island show summer increases exceeding 200 coliforms/100 ml water during periods when large numbers of boats are present (Committee for the Great Salt Pond, 1992:1). [Note that concentrations exceeding 15 coliforms/100 ml are considered unsafe for shellfishing, and that concentrations exceeding 50 coliforms/100 ml are considered unsafe for swimming.] The present level of boating activity and the scarcity of waste disposal options in Narragansett Bay suggests that boater discharges can be a locally significant source of fecal contaminants and pathogens in poorly flushed or shallow waters, and are of particular concern near shellfishing and swimming areas (Karp and Penniman, 1991:3).

In 1990-1991 two groups of government and trade organization representatives, meeting respectively under the auspices of the Rhode Island Marine Advisory Service's Boat Sewage Management Task Force and the Narragansett Bay Project's (NBP) Boater Waste Round Tables, recommended that sewage pump-out facilities be strategically located around Narragansett Bay to provide recreational and commercial boaters easy access. Factors that have been identified as significant in determining the appropriate ratio of boats per pump-out facility include EPA's recommended formula for determin-

ing pump-out density, the number and length of vessels requiring pump-out services, geographic location of the facility, public notice of pump-out locations, accessibility to boaters, ease of use, and cost per pump-out (Karp and Penniman, 1991:7).

Sanitary wastes collected at marinas still require treatment prior to disposal whether the wastes are handled as septage or discharged directly to a WWTF. Marinas must treat the waste on-site in an OSDS, hold the waste on-site and have it periodically pumped by a septage hauler for transport to a WWTF, or directly tie-in to a nearby WWTF (Karp and Penniman, 1991:10).

On-site treatment of boater waste presents problems related to soil type (permeability), depth to water table, seawater intrusion and exchange, and chemical and physical characteristics of the waste that interfere with microbial decomposition [See 04-01-05, Source Control: On-site Sewage Disposal Systems] . On-site holding tanks in the coastal zone are subject to primary problems associated with corrosion and maintenance, and secondary problems related to ultimate disposal at WWTFs. Historically, municipal wastewater treatment facilities were reluctant to accept boat septage out of concern that the concentration of chemical additives used in boat waste (*e.g.*, formalin, chlorine, and hyperchlorous acid) may be toxic to the biological treatment process, or that metals contained in dyes may increase metals loadings to the plant. Several industrial pretreatment program administrators have noted, however, that the additives commonly used to preserve and deodorize boat wastes are quickly broken down when mixed and diluted with normal sanitary wastestreams, and that "benign" disinfection and deodorizing agents are commercially available (Karp and Penniman, 1991:10). In addition, RIDEM officials indicate that Rhode Island WWTFs are currently accepting boat-generated sewage (J. Migliore, RIDEM, personal communication).

Direct marina tie-ins to local WWTFs would, however, eliminate several of the problems described above since treatment would not occur on-site, and the size of the on-site holding tank could, therefore, be reduced or eliminated. In addition, boater wastes would be continuously discharged to the WWTF at low volumes which would alleviate concerns about possible toxicity associated with chemically-treated boater wastes and septage. WWTF treatment capacity is not an issue since the volume of sanitary waste expected to be generated by boaters per day, according to Rhode Island Division of Planning (RIDOP) estimates, represents less than 0.1 percent of the design capacity of Rhode Island WWTFs (Raytheon, 1978).

In summary, boating represents a desirable water-dependent use of the Bay for commercial, recreational and economic reasons. However, boaters and related shore-based activities also represent a potential seasonal, and locally significant, source of fecal contaminants and other nonpoint source pollutants to the Bay. Most importantly, vessel-related sewage discharges are relatively easy and inexpensive to eliminate if appropriate and convenient disposal options are made available to boaters. Therefore, recognizing the importance of boating and related marine activities to the region, the goal of abating boater discharges is to protect public health, prevent water quality and habitat degradation, and restore and protect water quality-dependent uses of the Bay.

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.	The State of Rhode Island and the Commonwealth of Massachusetts should reduce or eliminate boat sewage discharges in order to assist in meeting the states' water quality goals, and to restore and protect water quality-dependent uses of the Bay.		
I.A.1.	The State of Rhode Island should undertake the following administrative actions to identify areas of Narragansett Bay that should be protected from vessel discharges: The Rhode Island Department of Environmental Management (RIDEM) and Rhode Island Coastal Resources Management Council (CRMC) should continue or resume discussions on reconciling RIDEM water quality classifications, CRMC water use classifications, and state regulations regarding uses of tidal waters.	RIDEM, CRMC	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.A.2. ✓	**The RIDEM Divisions of Water Resources, Fish and Wildlife, and Planning and Development (Natural Heritage Program), and the CRMC should prepare and update maps of critical marine resource areas on a biennial basis.** **a. These maps should indicate the location of high quality (Class SA; Type 1, Type 2) waters; critical or significant tidal and subtidal habitats; shellfish harvesting areas that are of significant or outstanding commercial or recreational value; threatened or endangered marine flora and fauna; bathing beaches; marine waters where state water quality criteria are currently exceeded; areas targeted for restoration projects; and areas where restrictions on marine expansion, placement of mooring fields and/or boater discharges should apply.** **b. The maps should be based on existing information, including information compiled by the NBP-funded *Habitat Inventory* (French *et al.*, 1992). The maps should be used with the Coastal Resources Management Plan, Special Area Management (SAM) Plans, local *Harbor Management Plans*, and relevant RIDEM regulations to assess an area's potential to be designated a "special or protected" area or a "no discharge area."**	**RIDEM, CRMC, Mass. counterparts**	**See 715-04-02, Protection of Critical Areas Rec. I.B.**

✓ - High Priority Action

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.B.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake the following actions to establish additional marina pump-out facilities around Narragansett Bay:		
I.B.1. ✓	**Develop and implement a Bay-wide pump-out facility plan in order to assure convenient boater access to pump-out facilities.** **a. Consistent with U.S. Environmental Protection Agency (EPA) guidelines for designating "no discharge areas", the RIDEM and CRMC should work toward establishing one pump-out station per 300 boats with marine sanitation devices (MSDs) in "transient" harbors, and one pump-out station per 600 boats with MSDs in "parking lot" harbors for the use of both resident <u>and</u> transient boaters. This approach should be adopted for all of Narragansett Bay, including portions of Mount Hope Bay and the Taunton River located within Massachusetts, and should be coordinated to the greatest extent possible with marine pump-out facility plans in approved local Harbor Management Plans.** **b. Regional land-based waste disposal facilities, or mobile pump-out vessels in association with fixed land-based facilities, should be encouraged. These facilities should be directly connected to municipal sewers wherever possible.** **c. Pump-out facilities should be located at or near central service areas such as fuel docks wherever possible in order to provide convenient boater access and increase the probability of use by boaters.** **d. Waste disposal facilities funded with public monies should be available to all users and should have controlled fees for a designated period of time.** **e. Dump stations for "porta-potties" should be provided for boaters.**	**RIDEM, CRMC, Mass. counterparts**	**Five pump-out stations were operating in Narragansett Bay in 1991. Three more are expected in 1992. [See RIDEM and CRMC "Preliminary Agreements," Section 715-05-06 re: siting marina pump-outs.]**
I.B.2.	Establish and maintain publicly available shore-based toilet and/or pump-out facilities at heavily used state parks with boat facilities.	RIDEM, Mass. counterpart	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.B.3.	Coastal communities with municipal marine facilities should establish and maintain publicly available shore-based toilet and/or pump-out facilities.	Municipalities	Jamestown and Warren, R.I. will have municipal pump-outs operating by 1992. The Warwick, Cranston, and Block Island Harbor Mgt. Plans propose municipal facilities.
I.B.4.	All private facilities that service or accommodate boats with MSDs or port-a-potties should provide convenient and affordable shore-based toilet facilities and waste disposal facilities. However, the states should phase in requirements for sewage pump-out stations at private marine facilities, including mooring fields, over a three to five year period in order to: a. Evaluate the performance of existing pump-out facilities, including boater acceptance and compliance. b. Establish procedures for the treatment and disposal of boater wastes. c. Enable the operators of public and private facilities to secure low-cost financing from funding sources such as the Rhode Island Aqua Fund and the State Revolving Funds.	RIDEM, CRMC, Private marine facilities	
I.C.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake the following actions to assure proper collection, treatment and disposal of boater wastes:		
I.C.1.	The RIDEM and the CRMC should continue or resume discussions on developing a written policy for regulating construction of marinas, docks, mooring fields and boater discharges. The agencies will formulate a mutually agreeable method to address the cumulative impacts of marinas, docks, and mooring fields, using an areal or other basis.	RIDEM, CRMC	[See CRMC "Preliminary Agreement," Section 715-05-06 re: implementation and enforcement of state dock and marina policy.]

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.C.2.	The RIDEM and CRMC should continue to restrict marina expansion and the development of mooring fields in all marine waters that are: a. Classified as SA or Type 1 or, as appropriate, Type 2 in order to assure that boating activity does not cause water quality degradation. [*Note*: RIDEM and CRMC permit mooring fields established in Class SA and Type 1 waters before 1988 to remain, although they are not allowed to expand.] b. Where existing access to shellfish harvesting areas, finfishing areas, and bathing beaches may be jeopardized by potential increases in boat sewage discharges. c. Where water quality standards are already exceeded *unless* the applicant can demonstrate that the proposed activity will not result in further water quality degradation. d. Included within the boundaries of marine sanctuaries such as the Narragansett Bay National Estuarine Research Reserve (NB-NERR). e. Identified as important breeding, spawning, nursery or foraging habitats for commercially, recreationally or ecologically important plants and animals. f. Identified as shellfish harvesting areas that are of significant or outstanding commercial or recreational value. [However, RIDEM should *not* issue Rhode Island Pollutant Discharge Elimination System (RIPDES) discharge permits to marinas at this time because of the difficulty in defining the land and water area that would be subject to permit limitations at each facility.]	RIDEM, CRMC, Mass. counterparts	[See CRMC "Preliminary Agreement," Section 715-05-06 re: restriction of marina expansion in vicinity of critical marine habitats.]

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.C.3.	The U.S. Army Corps of Engineers (USACOE), RIDEM, CRMC, and their Massachusetts counterparts should require developers of marina facilities to submit complete plans for the collection, treatment and disposal of boater wastes as part of the application for a permit to expand or develop new facilities. a. The size of on-site holding tanks for boater wastes should be based on the projected volume of boater waste that could be generated within a two week period assuming all boaters served by the facility use the pump-out and waste disposal services provided by the facility. In order to allow "down-sizing" of holding tanks where physical site restrictions exist, the RIDEM should require more frequent pump-outs and establish a mandatory holding tank maintenance schedule as a condition of permitting. b. In lieu of facility-specific information regarding the number of vessels, occupancy rate and frequency of use, dimensional requirements for holding tanks should be based on calculations of waste generated per boat per three day period presented in the *Marina Task Study* (Raytheon, 1978).	ACOE, RIDEM, CRMC, Mass. counterparts	
I.C.4.	Marinas and other marine facilities that are presently served by on-site septic systems should be required to tie-in to municipal wastewater treatment facilities (WWTF) when existing or planned sewer lines are located nearby. In addition, a. State-approved municipal *Harbor Management Plans* should contain a policy encouraging vessels that are continuously occupied for more than two days (*i.e.*, "live-aboards") to dock at marinas with direct tie-ins to municipal sewers, shore-based toilet facilities or sewage pump-out facilities. b. The CRMC in cooperation with the RIDEM, the RIMTA, the International Marina Institute (IMI), and other trade organizations, should assess the number and location of "live-aboards" and houseboats using Narragansett Bay facilities in order to evaluate the magnitude of the problem.	Municipalities, private marine facilities, CRMC, RIDEM, RIMTA, IMI	See "New England Coastal Marine Pumpout Survey" (IMI, 1992) re: marina waste disposal.

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.C.5.	To the fullest extent allowed by law, RIDEM and MADEP shall require WWTFs to accept septage generated within the WWTF's municipal service area as a condition of the WWTF's RIPDES/NPDES permit. In addition, to the fullest extent allowed by law, state grants and subsidized loans awarded to WWTFs shall be conditioned upon the WWTF's acceptance of septage generated within the WWTF's municipal service area, unless RIDEM or MADEP, as appropriate, has waived the septage disposal requirement. [See 04-01-05 Source Control: On-site Sewage Disposal Systems.] a. The RIDEM should require municipal WWTFs that are *not* presently accepting boater waste from boating facilities within their jurisdiction or service area to include provisions for direct marina tie-ins and treatment of boat septage as a mandatory part of the facility planning process. b. The RIDEM, with input from the CRMC and the Rhode Island Septage Management Task Force, should continue to work with WWTFs that do accept vessel wastes to encourage them to accept boater wastes from sources outside their jurisdiction or service area. c. Within the limits of their regulatory jurisdiction, the EPA, the RIDEM, the Massachusetts Department of Environmental Protection (MADEP), and local WWTF industrial pretreatment coordinators should develop criteria for chemical treatment and WWTF handling of boat wastes. d. To the extent permitted by law, the EPA, the RIDEM and Massachusetts counterparts should work with the Rhode Island Sea Grant Marine Advisory Service to generate a list of chemicals currently used to treat (disinfect, deodorize) boater wastes that should be phased out of use by 1994.	EPA, RIDEM, CRMC, R.I. Septage Mgt. Task Force, Mass. counterparts, WWTFs, URI Sea Grant	[See RIDEM "Preliminary Agreement," Section 715-05-06.]
I.C.6.	The RIDEM, CRMC and the Rhode Island Septage Management Task Force should include boater septage in their considerations of a statewide policy for septage treatment and disposal, including the establishment of regional wastewater management districts (WWMDs). Municipal *Harbor Management Plans* should include marinas in WWMDs as districts are developed. Requirements for marinas to be incorporated into WWMDs, as appropriate, should be included in the technical guidance for the establishment of WWMDs.	RIDEM, CRMC, R.I. Septage Task Force, municipalities	

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RECOMMENDED POLICIES AND ACTIONS
SOURCE CONTROL: BOATER DISCHARGES

CODE	POLICY	AGENCIES	STATUS
I.D.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake the following actions to educate boaters about the proper treatment and disposal of boater wastes:		
I.D.1. ✓	**The RIDEM Division of Enforcement, Office of Boating Safety should institute a boater education program regarding proper boater waste disposal. This program should:** **a. Provide information on how to install, operate and maintain a MSD.** **b. Promote the use of MSDs and pump-out stations.** **c. Describe applicable federal and state laws regarding disposal of boat waste, including federal and state penalties for illegal disposal.** **d. Identify designated "no discharge areas" and areas where waste disposal is prohibited in order to protect shellfishing waters or bathing beaches.** **e. Identify the locations of operational pump-out stations, including harbors served by mobile pump-out vessels. The RIDEM Division of Enforcement's Office of Boating Safety or Parks and Recreation should produce a map of Narragansett Bay and adjacent waters that clearly indicates the location of available pump-out stations. The map should:** **i. Include or reference the general schedule of operating hours of pump-out facilities, and the fee schedule for pump-out services.** **ii. Describe the draft requirements of vessels that may be excluded because of insufficient water depth adjacent to pump-out facilities.** **iii. Include fees, if any.**	**RIDEM, Mass. counterpart**	**[See RIDEM "Preliminary Agreement," Section 715-05-06.]**
I.D.2.	General public educational programs should be performed in conjunction with the University of Rhode Island's Narragansett Bay Classroom, public schools, Rhode Island Marine Trade Association (RIMTA), trade shows, and harbormasters to the maximum extent possible.	RIDEM, RIMTA, URI	
I.D.3	Boater education materials, including EPA's *Environmental Guide for Mariners*, should be distributed with boat registration forms; through Boater Safety courses offered by U.S. Coast Guard through the U.S. Coast Guard Auxiliary and the RIDEM Division of Enforcement, Office of Boating Safety (and its Massachusetts counterpart), and by relevant marine trades organizations.	USGS, RIDEM, Mass. counterpart	RIDEM distributed EPA's "Guide" at various boat shows in 1992.

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
I.D.4.	EPA Region I, RIDEM and appropriate Massachusetts authorities should work together to develop and display a sign that clearly indicates the availability of pump-out facilities. The sign should be immediately recognizable and visible from the water.	EPA, RIDEM, Mass. counterpart	EPA Region I has developed a sign for use in Narragansett Bay in 1992.
I.D.5.	Within the limit of their jurisdiction, the federal and state agencies, RIMTA and other trade organizations should promote and/or require the use of environmentally-safe holding tank additives that will not interfere with OSDS or WWTF performance.	EPA, RIDEM, MADEP, RIMTA, IMI, URI	
I.E.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake the following regulatory actions to regulate boaters with respect to treatment and disposal of boater wastes:		
I.E.1.	The State of Rhode Island and the Commonwealth of Massachusetts should encourage the U.S. Congress to amend the Clean Water Act to require the installation of Type III MSDs with holding tanks, or portable toilets, on all commercial and recreational vessels that are designed with overnight accommodations or are greater than 25 feet in total length and are registered to operate in state waters.	RIDEM, Mass. counterpart, RIMTA, IMI	
I.E.2.	Rhode Island and Massachusetts should promulgate regulations pursuant to existing state authority over pollutant discharges to surface waters that would: a. License some full service maintenance or repair boating facilities as official vessel inspection stations. b. Require all vessels required to have MSDs to be inspected at the time of registration for the presence of properly installed and functioning MSD equipment. [In Rhode Island, this program should be administered by the RIDEM Division of Enforcement, Office of Boating Safety.]	RIDEM, Mass. counterpart	

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
I.F.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake or continue the following actions to enforce requirements regarding the treatment and disposal of boater wastes:		
I.F.1. ✓	**The RIDEM and the CRMC should continue to work with and encourage marinas to require boaters to obey all rules and regulations relating to boater discharge and to report and, if necessary, expel all violators of these rules. [For example, the RIDEM should consider requiring marine facilities operators to certify that facility users have agreed in writing to comply with all federal, state and local rules and regulations pertaining to the discharge of sewage from boats and that failure to comply may result in termination of any contract or agreement to use the facilities.]**	**RIDEM, CRMC, Mass. counterpart**	
I.F.2. ✓	**The RIDEM, CRMC, U.S. Coast Guard and EPA Region I should continue to implement the *Interagency Memorandum of Agreement* and modify the *Agreement* as necessary to provide for: a. Increased and consistent U.S. Coast Guard enforcement of MSD equipment requirements during routine inspections of all commercial and recreational vessels operating in state waters. b. Delegation of authority to state and local governments for enforcement of MSD and boater waste disposal requirements. RIDEM and local harbormasters should actively enforce boater discharge regulations enacted as R.I.G.L. 46-12-39 *et seq.*.**	**EPA, USCG, RIDEM, CRMC, Mass. counterparts, harbor masters**	**CWA, as amended, and Interagency MOA provide for delegating of enforcement authority. R.I.G.L. 46-12-39 passed in 1991.**
I.F.3.	The U.S. Coast Guard, in consultation with the EPA, should review and enforce federal MSD manufacturing, installation and maintenance requirements. [For example, the U.S. Coast Guard should require operators of vessels with Type I and II MSDs to comply with federal and applicable state laws regarding operation, maintenance and required retrofits of MSD equipment. In addition, the Coast Guard Auxiliary should be requested to include inspection for the presence of an approved and operational MSD on-board as a condition of issuing courtesy inspection stickers.]	USCG, EPA	

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
I.F.4.	Based on agreements reached with the U.S. Coast Guard and to the extent allowed under Section 312 of the Clean Water Act, necessary state and local enabling legislation and regulations should be drafted that describe requirements for MSD installation and use, discharge limitations, disposal, treatment and enforcement. [NOTE: The Rhode Island General Assembly passed a bill titled "An Act Relating to Marine Discharge of Sewage" during the 1991 legislative session. The statute a) prohibits boat discharges of sewage in the waters of the state unless treated with a Type I or Type II MSD in "proper working condition"; b) prohibits boat discharges of sewage in any area declared to be a no-discharge area; c) authorizes RIDEM, harbormasters, assistant harbormasters, and police officers to enforce the provisions of the Act; and d) establishes penalties for violations of the provisions of the Act (R.I.G.L. 46-12-39).]	RIDEM, Mass. counterpart, municipalities	
I.F.5.	The RIDEM and its Massachusetts counterpart should establish penalties for violation of sewage discharge regulations. For example, penalties could include fines, payable by mail; and/or loss of state boat registration privileges; or loss of permission to operate in state waters for out-of-state boaters.	RIDEM, Mass. counterpart	
I.F.6.	Municipal *Harbor Management Plans* should include plans for increasing and enforcing the use of available marina pump-outs. For example, a. Municipalities should establish fines for boaters who discharge untreated sewage (or solid waste) in local waters. b. Docking privileges should be conditional on use of available pump-out facilities. c. Municipalities should be encouraged to appoint full-time harbormasters and harbormasters should be delegated full inspection and enforcement powers in conjunction with RIDEM and the U.S. Coast Guard as part of the *Interagency Memorandum of Agreement* and R.I.G.L. 46-12-39.	RIDEM, CRMC, Municipalities	Seven of twenty-one draft Harbor Management Plans submitted for CRMC, RIDEM review; seven approved by CRMC, two approved by RIDEM as of June 1992.

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
I.F.7.	Owners and operators of public and private marinas, yacht clubs, *etc.*, should enforce the use of pump-out facilities by their customers by: a. Providing mobile pump-out vessels in combination with shore-based facilities to increase convenience of the service, ensure a higher rate of boater compliance, and increase boater awareness of equipment and discharge requirements. b. Contractually linking docking privileges with proper disposal of boat wastes. For example, harbormasters and marina operators should consider requiring valve seals on vessels with overboard discharge fittings and/or using dye tablets to monitor for improper overboard discharges. c. Including the cost of pump-outs in the docking fee and/or offering coupons, rebates or other incentives to promote the use of pump-out facilities.	Municipalities, private marine facilities	
I.G.	The State of Rhode Island and the Commonwealth of Massachusetts should undertake the following actions to assist in financing the treatment and disposal of boater wastes: 1. Rhode Island and Massachusetts should investigate the possibility of increasing the pass-through of federal and state funds available from boat registration fees to coastal communities in order to support local enforcement of equipment and discharge requirements. 2. Rhode Island should investigate the possible use of the State Revolving Fund to provide low-interest loans to public and private operators of marine facilities for the construction of marine pump-out facilities.	RIDEM, RICWPFA, Mass. counterparts	

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RECOMMENDED POLICIES AND ACTIONS
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CODE	POLICY	AGENCIES	STATUS
II.	The State of Rhode Island and the Commonwealth of Massachusetts should petition the EPA to designate all or part of Narragansett Bay as a "no discharge area" for vessel discharges.		
II.A.	By 1995, the State of Rhode Island and the Commonwealth of Massachusetts should petition the EPA pursuant to 40 CFR §140.4 to designate all or part of Narragansett Bay as a "no discharge area" in order to abate vessel-related sources of fecal contaminants and to better protect water quality, critical marine habitats, important living resources, and existing and future water quality-dependent uses of Narragansett Bay. Pursuant to 40 CFR §140, the petition must include: 1) a certification that the protection and enhancement of the waters described in the petition requires greater environmental protection than that provided by the applicable federal standard; 2) a map showing the location of commercial and recreational pump-out facilities; 3) a description of the location of pump-out facilities within waters designated for no-discharge; 4) the general schedule of operating hours of the pump-out facilities; 5) the draft requirements on vessels that may be excluded because of insufficient water depth adjacent to the facility; 6) information indicating that treatment of wastes from such pump-out facilities is in conformance with federal law; and 7) information on vessel population and vessel usage of the subject waters. [In addition, EPA Region I, which reviews "no discharge area" petitions in the New England region, encourages petitioners to include: 1) information on the percentage of boats with Type 3 MSDs, if possible; and 2) identification of aquatic recreational areas, aquatic sanctuaries, identifiable fish spawning or nursery areas and areas of intensive boating activity.]	RIDEM, CRMC, Mass. counterparts, municipalities, EPA	[See EPA Region I and RIDEM "Preliminary Agreements," Section 715-05-06.] RIDEM will petition EPA for "no discharge area" status for Jamestown and Block Island as high priorities in 1992 or 1993

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CODE	POLICY	AGENCIES	STATUS
II.B. ✓	**In its petition, the State of Rhode Island and the Commonwealth of Massachusetts should specifically identify certain regions of Narragansett Bay such as the Narragansett Bay National Estuarine Research Reserve (NB-NERR) (seaward to the 18 meter isobath), Greenwich Bay, Dutch Island Harbor, Wickford Harbor, Newport Harbor, Great Salt Pond, and the coastal ponds as appropriate for "no discharge" status.**	**RIDEM, CRMC, municipalities, EPA**	**[See RIDEM "Preliminary Agreement," Section 715-05-06 re: Great Salt Pond.]**
II.C.	In its certification to EPA that the protection and enhancement of the waters described in the petition require greater environmental protection than the applicable federal standard, the State of Rhode Island and the Commonwealth of Massachusetts should emphasize their value as marine sanctuaries; shellfish management areas; historic and scenic waterfronts; and should supply evidence that boat sewage discharges may be contributing to water quality degradation and/or limitations on historic or existing water quality-dependent uses.	RIDEM, CRMC, Mass. counterparts, municipalities, EPA	

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Estimated Cost of Implementation—Source Control: Boater Discharges

Table 715-04(6) summarizes the estimated costs associated with implementing the recommendations in this chapter. Most of the recommended actions are to be implemented in 1992-93. Initial activities include reconciling state water quality and water use policies, instituting and enforcing boater discharge regulations, and developing criteria for the treatment and disposal of boater wastes. (The issue of industrial pretreatment standards for boater wastes is partially costed under 04-01-01 Source Reduction: Toxics). RIDEM and CRMC will require funding for additional staff, legislative costs, and minor capital investment. MADEP and MACZM will incur costs for agency coordination and public education.

Element IB (Establish Pump-outs) includes a major capital cost for the construction of marina pump-out stations. Based on a survey of Rhode Island and Massachusetts marinas (public and private), the average cost of installing a pump-out facility was $11,500; this varies with proximity to sewer lines, desired capacity, and staffing needs. Boaters could be charged a pump-out fee to partially subsidize the operation of pump-out facilities. Two hundred ninety-five marinas in New England responded to a boating use survey conducted in 1991; according to this survey, the average regional cost per pump-out was $4.00, although the range was between $50.00 and $0.00 per pump-out (IMI, 1992:37). Lower fees will, however, provide an incentive for boaters to use the service.

State costs represent construction of marine pump-outs in State parks with major boating facilities, and could be partially subsidized with pump-out fees. The cost of installing marine pump-out facilities in municipal harbors could be partially subsidized by State Revolving Fund (SRF) loans to municipalities. The Rhode Island SRF (Clean Water Protection Finance Agency) could also potentially provide loans to private marina operations if the loans were funneled through the municipal government. Municipal and private pump-out facilities could be operated on a cost-recovery basis via pump-out fees. Private operators could also include the cost as part of the seasonal docking fee, with or without a redeemable coupon for each pump-out.

Element IC (Collection and Treatment) contains a recommendation that marinas presently served by OSDSs be required to hook up to municipal WWTFs, if possible. Marina owners would be responsible for the cost of installing a sewer line, and for annual sewer use charges. Sewer expenses could be recovered through increased docking fees. Element ID (Public Education) includes annual costs to RIDEM for developing and distributing educational materials to the boating public. Element IE (Regulatory Actions) recommends that all recreational and commercial vessels greater than 25 feet, designed with overnight accommodations, be required to install Type III marine sanitation devices (MSDs). Enforcement of this requirement will represent a cost to boaters that are not already in compliance. This section also recommends that some boat yards become state vessel inspection stations; additional staff time and equipment could be covered by inspection fees.

For further details regarding the *CCMP* cost estimation process and funding strategies, refer to the *Narragansett Bay CCMP Cost Estimation and Funding Report* (Apogee Research Inc./NBP, 1992).

Table 715-04(6)

ESTIMATED COST OF IMPLEMENTATION
SOURCE CONTROL: BOATER DISCHARGES

COST ESTIMATES BY ELEMENT	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
IA-Administrative Actions	10,000	0	0	0	0	0	0	0	0	0	10,000	0
IB-Establish Pump-Outs	20,000	101,250	0	0	0	0	0	0	0	0	20,000	101,250
IC-Collection and Treatment	87,500	0	0	0	25,000	0	0	0	0	0	112,500	0
ID-Public Education	17,500	6,000	10,000	6,000	10,000	6,180	10,000	6,000	10,000	6,000	57,500	30,180
IE-Regulatory Actions	25,000	0	0	0	10,000	0	10,000	0	10,000	0	55,000	0
IF-Enforcement Actions	27,500	0	0	0	12,500	0	0	0	0	0	40,000	0
IG-Financing Treatment	22,500	0	0	0	0	0	0	0	0	0	22,500	0
II-"No Discharge" Zone	0	0	0	0	0	0	0	0	0	0	0	0
TOTALS	210,000	107,250	10,000	6,000	57,500	6,180	20,000	6,000	20,000	6,000	317,500	131,430
TOTAL BY YEAR		317,250		16,000		63,680		26,000		26,000		448,930

COST ESTIMATES BY AGENCY	92-93		93-94		94-95		95-96		96-97		Total 92-97	
	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other	Personnel	Other
RIDEM	108,750	39,750	5,000	6,000	22,500	6,090	10,000	6,000	10,000	6,000	156,250	63,840
RI CRMC	27,500	0	0	0	25,000	0	0	0	0	0	52,500	0
RI CWPFA	5,000	0	0	0	0	0	0	0	0	0	5,000	0
URI	5,000	0	0	0	0	0	0	0	0	0	5,000	0
MADEP	48,750	0	5,000	0	10,000	90	10,000	0	10,000	0	83,750	90
MACZM	5,000	0	0	0	0	0	0	0	0	0	5,000	0
Municipalities*	0	67,500	0	0	0	0	0	0	0	0	0	67,500
WWTFs	10,000	0	0	0	0	0	0	0	0	0	10,000	0
TOTALS	210,000	107,250	10,000	6,000	57,500	6,180	20,000	6,000	20,000	6,000	317,500	131,430
TOTAL BY YEAR		317,250		16,000		63,680		26,000		26,000		448,930

* Ultimate implementation costs will vary for each municipality depending on its particular environmental and institutional conditions. In addition, the estimated municipal implementation costs do not include ultimate program and capital costs that may result from completion of underlying planning activities, or costs that are expected to be completely recoverable from user fees.

04-01-07 Source Reduction: Nonpoint Sources

Objective for the Reduction of Nonpoint Source Inputs

The State of Rhode Island and the Commonwealth of Massachusetts should reduce loadings of nonpoint source pollutants to Narragansett Bay.

Introduction

Nonpoint source pollution results from rain, snowmelt and groundwater transporting pollutants from many diffuse sources on the land surface. Some of the resulting pollutant load is entrained, decomposed or biologically assimilated. However, some of these pollutants are transported via surface runoff or percolation into the groundwater, and are subsequently deposited into streams, rivers, ponds, lakes, drinking water supply reservoirs, wetlands, and coastal waters (Boyd, 1991; EPA, 1991a). Although nonpoint source pollutants are continuously generated, they are differentiated from fixed, point sources by their sporadic and spatially variable nature.

Urban, residential, agricultural, commercial, and industrial activities contribute to nonpoint source pollution. As a result, nonpoint source pollutants discharged or released anywhere within the Narragansett Bay watershed have the potential of finding their way into the Bay via stormwater runoff or groundwater seepage. The potential for nonpoint source pollution increases as a function of the type, distribution and intensity of land use. The gradual increase of impervious or paved surfaces and the alteration of natural drainage patterns also results in increased volumes, peak discharges, and velocities of runoff (Stuart, 1991:1).

The quantity and quality of stormwater runoff reaching a waterbody is influenced by the size of the land area draining to the waterbody (*i.e.*, the basin or watershed), the use and management of that area, the slope of the land, and the physical characteristics of the path runoff follows as it flows through the drainage area. In general, as a drainage area becomes urbanized, the rate of flow (peak discharge) and volume of runoff increases significantly. Increased human activity results in more pollutant sources, and increased runoff volume and velocity (due to smoother surfaces) (Stuart, 1991:7). It should be noted, however, that wetlands provide an important function in the landscape by improving water quality, reducing sedimentation and storing stormwater runoff. Many water quality impairments are exacerbated by activities that interrupt the natural hydrological, physical, and biological processes of wetlands.

Statement of the Problem

The U.S. Department of Agriculture Soil Conservation Service (USDA SCS) has identified urban and residential runoff, runoff and leachate from failing septic systems, and sediment erosion from construction and agricultural sites as significant nonpoint sources of pollution within the watershed of Narragansett Bay (USDA SCS, 1990:2). Runoff from impervious surfaces (such as highways, roads, parking lots, and driveways) can carry sediment, metals, organic chemicals, and nutrients. Runoff from agricultural lands, livestock operations, sewage sludge landfills, lawns, and failed or failing septic systems can also carry fecal contaminants in addition to nutrients, sediments, and toxic substances, *e.g.*, pesticides (Stuart, 1992:3; Karp *et al.*, 1990:41). While forests are a major land type within the Bay watershed, less than one per cent, or 3,000 acres, of timber is commercially harvested each year. As a result, timber harvesting or *silviculture* appears to be an insignificant contributor of nonpoint source pollution to the Bay, noting that clear-cutting for urban development does result in nutrient releases and soil erosion (USDA SCS, 1990:2).

Figure 715-04(4) shows the potential pollutants associated with several land covers commonly found in the Narragansett Bay watershed. The land covers are listed in order of the volume of runoff likely to be generated given the same amount of rain on the same soil type, with the lowest runoff volume first.

Figure 715-04(4): Land Cover *vs.* Associated Potential Pollutants.

Low Runoff

"Natural" areas (wood, brush, unmanaged areas)	**Nutrients**
Managed grass (lawns, golf courses, hay, pasture, orchards)	**Nutrients, pesticides**
Cultivated land	**Nutrients, pesticides, sediment**
Construction sites	**Sediment, nutrients**
Roads, parking lots	**Petroleum products, salts, metals, sediment**

High Runoff

[*Note:* Addition of animal or human waste to any of these land covers adds pathogens and nutrients to the list of potential pollutants.]

One hundred and sixty four (164) surface water segments within the Narragansett Bay watershed were assessed by Rhode Island and Massachusetts as part of the 1988 *Nonpoint Source Assessments* in conjunction with development of the state Section 319 *Nonpoint Source Management Plans*. Surface runoff was identified as a major nonpoint source pollution transport mechanism in 70 percent of the waterbodies in Rhode Island with nonpoint source pollution problems. Failed on-site sewage disposal system (OSDS) and groundwater contamination were implicated in 49 percent of Rhode Island waterbodies with nonpoint source pollution problems. In Massachusetts, the reported figures were 43 percent for surface runoff and 20 percent for septic systems (USDA SCS, 1990:9).

Nutrients and/or eutrophication were identified as a nonpoint source pollution problem in 74 of the 164 assessed surface water segments in the Bay watershed. Agricultural runoff was a contributing source in 15 of the 74 segments; urban and residential runoff was identified as a contributing nonpoint source in 59. Solids and silt were identified as a problem in 61 of the 164 segments, noting that USDA SCS estimates that between 100,000 and 150,000 tons of sediment enters water bodies in the Bay watershed each year from urban development, construction sites, road runoff and cultivated fields. Nonpoint sources of metals were identified in 29 of the 164 segments; oils and greases in eight; and pesticides in two (Stuart, 1992: 7-11; RIDEM, 1988a; MADEQE, 1989).

In addition, nonpoint sources of fecal contamination have been implicated in the closure of approximately 17,000 acres of potential shellfish-harvesting waters in the Bay (RIDEM, 1990a). Nonpoint sources of fecal waste include runoff or leachate from failed septic systems, livestock operations, other animal waste, and illegal connections of sanitary drains to storm sewers. [*Note*: Storm drains, like combined sewers, are considered to be point sources under the federal CWA and the CZMA. However, storm drains are addressed in this chapter because the type of pollutants, frequency of discharge and appropriate source reduction measures are comparable to problems and solutions for stormwater runoff.]

Effective management of nonpoint source pollution is both technically and institutionally complicated. Potential pollutant sources—such as direct discharges of storm drains, poorly designed, installed or main-

tained septic systems, exposed soil in areas susceptible to erosion, and areas where fertilizers and pesticides are applied—are temporally variable, geographically scattered, and dependent on local physiographic site conditions. As a result, it is often difficult to quantitatively measure the pollutant loads related to a particular source, or to evaluate the relative importance of multiple sources. In addition, land use activities that alter the structure or natural hydrologic regime of wetland and riparian areas can create or exacerbate nonpoint source pollution problems. Similarly, the intensity of land use, *e.g.*, density of septic systems or area of impervious surface, often dictates the magnitude of nonpoint source pollution problems.

The pervasiveness of the nonpoint source problem also complicates management options. Federal, state, and local governments may lead the way by defining control methods, promoting educational efforts, conducting investigations, and providing enforcement activity where necessary. However, success in abating existing pollution sources and preventing new sources will require efforts by the development community, businesses, and individuals, as well as the government. Moreover, because human activities throughout the drainage area affect Bay water quality and habitat, the drainage area needs to be managed *as a whole* in order to effectively reduce incremental, cumulative impacts (Stuart, 1991:7).

Existing Policies

Federal Initiatives for Nonpoint Source Management

The U.S. Environmental Protection Agency (EPA) and the U.S. USDA have historically had primary responsibility for addressing nonpoint source pollution issues pursuant to the federal CWA, the Farm Bill and the Federal Insecticide, Fungicide, and Rodenticide Act. However, recent initiatives under the CZMA of 1990 and the Intermodal Surface Transportation Efficiency Act of 1991 have vested major nonpoint source management responsibilities in the National Oceanic and Atmospheric Administration's (NOAA) Coastal Zone Management Program and the Federal Highway Administration (FHWA). The major federal programs are briefly described below.

EPA-Administered Programs

The EPA administers nonpoint source planning and regulatory programs under the federal CWA. Section 319 of the federal Water Quality Act of 1987 established the Nonpoint Source Pollution Management Program and required each state to prepare an *Assessment of Sources* and a *Nonpoint Source Management Plan*. Both the Rhode Island and Massachusetts *Assessments* found stormwater runoff to be a significant source of pollutants within the Narragansett Bay watershed. The states' *Nonpoint Source Assessments* were updated in 1990, and the *Nonpoint Source Management Plans* are currently undergoing revision (Stuart, 1991:5). The EPA also administers Section 208 (Areawide Waste Treatment Management) and Section 320 (National Estuary Program) of the federal CWA which require participating states to address nonpoint pollution sources in state basin plans and *Comprehensive Conservation and Management Plans*.

The Water Quality Act (1987) also required the EPA to regulate certain stormwater discharges under the National Pollutant Discharge Elimination System (NPDES). Under the regulations finalized in November 1990, and later amended, industrial stormwater dischargers are required to apply for NPDES permits by October 1, 1992. Municipalities with separate storm sewer systems serving populations of 100,000 or more must also apply, and must develop a program for monitoring and reducing pollutants in the stormwater system by 1993. Worcester, Massachusetts, is the only city in the Narragansett Bay watershed affected by this requirement at the present time. The City of Providence has been exempted from this NPDES requirement because most of the city is served by combined sewers that are regulated under the combined sewer overflow abatement program (Stuart, 1991:18). However, Providence will use a grant from

the Rhode Island Aqua Fund to prepare an inventory of municipally-owned storm sewers, and will follow EPA guidance for detecting illegal upstream inputs.

USDA-Administered Programs

Technical assistance is available through three agencies of the U.S. Department of Agriculture (USDA): the Soil Conservation Service (SCS), the Cooperative Extension Service (CES) and the U.S. Forest Service. Each program relies on the states for delivery of their services to at least some extent. The SCS works with farmers on soil erosion, water quality and water conservation problems by helping them to plan management systems, and designing and inspecting best management practices. SCS is federally-funded, but works under the direction of local Conservation Districts, as established by state law.

The CES, administered through the states' land grant universities, relies on federal, state and local funding. Through research and technology transfer, CES provides land-users with practical technical assistance regarding the selection and care of animals, crop production, pest management (including pesticide applicator training), soil testing for fertilizer needs, and marketing. CES has expanded its programs to provide homeowners with gardening, lawn care and household management assistance as well. Assistance is provided through a local Extension Board.

The Forest Service depends completely on state forestry programs which are partially funded by the U.S. Forest Service. The Massachusetts Department of Environmental Protection (MADEP) Division of Forest and Parks and the Rhode Island Department of Environmental Management (RIDEM) Division of Forest Environment Services provide forest managers with evaluation of timber quality and productivity, preparation of forest management plans, marketing advice, evaluation and control of forest insect and disease problems, a harvesting and sawmill improvement program, certification of nursery stock (insect and disease free) and the sale of tree seedlings at cost.

Federal financial assistance is available to farmers and forest managers for the installation of soil and water conservation practices and woodland management practices, the purchase and operation of farms, crop insurance, and for controlling the price of some agricultural products. USDA's Farmers Home Administration (FmHA) provides low-interest loans for farm ownership, farm operating expenses and soil and water conservation practices. The USDA Agricultural Stabilization and Conservation Service (ASCS) administers most price-support programs, and shares the cost of installing certain soil and water conservation practices and woodland management practices.

The ASCS in Rhode Island has designated the Narragansett Bay watershed as a Special Project Area under the USDA Water Quality Initiative, which reserves funds for conservation practices within the watershed. SCS can also provide cost-sharing for conservation practices under its Watershed Protection Program. Under the USDA Water Quality Initiative, CES and SCS are combining efforts within specified geographic areas to work more closely with farmers in protecting water quality. The Pawcatuck River (R.I.) and Buzzard's Bay (MA) "Hydrologic Units" are two nearby areas that were selected for this special emphasis. Selection of areas and plan preparation are coordinated with the states' 319 Nonpoint Source Management and National Estuary Programs.

NOAA- Administered Programs

Section 6217 of the CZMA Reauthorization Amendments of 1990 represents another important federal nonpoint source initiative (Stuart, 1991:6). Section 6217 requires states to establish Coastal Nonpoint Pollution Control Programs (CNPCP) to "develop and implement management measures for nonpoint source pollution to restore and protect coastal waters..." (EPA, 1991a). As of May 1991, EPA and NOAA have jointly issued two draft documents that provide guidance for

states to develop CNPCPs: *Proposed Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters* (EPA, 1991a) and *Coastal Nonpoint Pollution Control Program: Program Development and Approval Guidance* (NOAA/EPA, 1991).

State CNPCPs must "provide for the implementation, at a minimum, of management measures in conformity with the guidance published under subsection (g) to protect coastal waters generally" (EPA, 1991a:1-5). In addition CNPCPs must:

> "(1) Identify land uses which, individually or cumulatively, may cause or contribute significantly to a degradation of (a) coastal waters where there is a failure to attain or maintain applicable water quality standards or protect designated uses, or (b) coastal waters that are threatened by reasonably foreseeable increases in pollution loadings from new or expanding sources;
>
> "(2) Identify critical coastal areas adjacent to coastal waters identified under the preceding paragraph;
>
> "(3) Implement additional management measures applicable to land uses and areas identified under paragraphs (1) and (2) above that are necessary to achieve and maintain applicable water quality standards and protect designated uses;
>
> "(4) Provide technical assistance to local governments and the public to implement management measures;
>
> "(5) Provide opportunities for public participation in all aspects of the program;
>
> "(6) Establish mechanisms to improve coordination among State and local agencies and officials responsible for land use programs and permitting, water quality permitting and enforcement, habitat protection, and public health and safety; and
>
> "(7) Propose to modify State coastal boundaries as necessary to implement NOAA recommendations under Section 6217(e), which are based on findings that inland boundaries must be modified to more effectively manage land and water uses to protect coastal waters" (EPA, 1991a:1-5 to 1-6).

Specific management measures are also proposed for several major sources of nonpoint pollution, including: (1) agricultural runoff; (2) urban runoff (including developed and developing areas); (3) silvicultural (forestry) runoff; (4) marinas and recreational boating; and (5) hydromodification, dams and levees, and shoreline erosion (EPA, 1991a: 1-9). The CNPCP will not include management measures for point source of pollutants regulated under the CWA (*e.g.*, combined sewer overflows, wastewater treatment facilities, storm drains, and boats).

CNPCPs are intended to "serve as an update and expansion of existing nonpoint source management programs and are to be coordinated closely with the existing coastal zone management programs", and "the state coastal zone and water quality agencies are to have co-equal roles" in developing the CNPCP (EPA, 1991a:1-5). Section 6217 also requires the CNPCP "to be coordinated with existing CWA programs under sections 208, 303, 319, and 320", as well as to establish coordination mechanisms with other agencies and officials responsible for various aspects of nonpoint source pollution control (NOAA/EPA, 1991:vii). The requirements for the state CNPCP described in draft NOAA and EPA guidance (EPA, 1991a; NOAA/EPA, 1991) mandate that the plan be well coordinated with CWA section 320 programs (*i.e.*, Comprehensive Conservation and Management Plans produced by National Estuary Projects). Thus, the development of the Rhode Island CNPCP under Section 6217 of the 1990 Reauthorization of the CZMA should use the Narragansett Bay *Comprehensive Conservation and Management Plan* (*CCMP*) and other relevant nonpoint source policies, plans and regulations to the greatest

extent possible. Conversely, implementation of relevant sections of the Narragansett Bay *CCMP* should be structured so as to be compatible with final guidance for CNPCPs.

Most significantly, state CNPCPs must contain "enforceable policies and mechanisms to implement the applicable requirements of the coastal nonpoint programs" as defined under Section 316 of the CZMA. Each state's CNPCP must be approved by both NOAA and EPA and will be implemented through changes to the state's nonpoint source pollution program (Section 319 of the CWA) and coastal zone management program (Section 306 of the CZMA) (NOAA/EPA, 1991: v). Failure to implement a CNPCP may result in loss of portions of federal funds allocated by NOAA and EPA to state CZMA Section 306 and CWA Section 319 programs.

State Initiatives for Nonpoint Pollution Management

Rhode Island and Massachusetts have both established state nonpoint source management programs pursuant to Section 319 of the federal Clean Water Act. Rhode Island's Nonpoint Source Management Program, which is administered through RIDEM's Office of Environmental Coordination, devoted the early years of the program to preparing the *Nonpoint Source Assessment* and the *Nonpoint Source Management Plan*. Subsequent state efforts included the preparation of technical guidance and model ordinances, and coordinating nonpoint source planning efforts with regulatory programs. Both states established external advisory committees to assist in the preparation of the nonpoint source management plans. Rhode Island established a 19-member Water Quality Advisory Committee in 1988 to assist in the development of the State Clean Water Strategy, including the *Nonpoint Source Management Plan*. The Committee included representatives from RIDEM's regulatory divisions, the Rhode Island Division of Planning (RIDOP), the Rhode Island Coastal Resources Management Council (CRMC), USDA SCS, the University of Rhode Island (URI), environmental advocacy groups, local government, and the Narragansett Bay Project (NBP). This Committee has not met, however, since the publication of the *Nonpoint Source Management Plan* (Stuart, 1991:5). The Commonwealth of Massachusetts established a 50-member advisory committee under the direction of the MADEP, and a nine-member Steering Committee chaired by Massachusetts Coastal Zone Management (MACZM) to advise MADEP on the development of the state's *Nonpoint Source Management Plan* (Stuart, 1991:5).

The Rhode Island *Nonpoint Source Management Plan* established a system for ranking the state's waters based on their condition, use and need for remedial action. The *Nonpoint Source Assessment* (RIDEM, 1990c) evaluated the state's waters to determine whether they were impaired (*i.e.*, not attaining their designated use according to the *Water Quality Regulations for Water Pollution Control*, RIDEM 1988b) or threatened (*i.e.*, in full support of designated uses, but subject to impairment by pollutants occurring in the watershed). The *Nonpoint Source Management Plan* then established established criteria for prioritizing assessed waterbodies for protection or restoration efforts based on their drinking water supply, bathing and recreation, habitat, and fish and wildlife value, recognizing that human use and habitat function are equally valuable protected uses (Stuart, 1991:4). The ranked list is used to prioritize state efforts to restore impaired waterbodies and protect threatened waters. The Massachusetts *Nonpoint Source Management Plan*, on the other hand, does not currently have a documented priority-setting process (Stuart, 1991:4).

Rhode Island's Nonpoint Source Management Program also developed some of the technical guidance and regulatory framework needed to begin to address nonpoint source issues, and worked with the NBP-sponsored Land Management Project to provide technical assistance to cities and towns in preparing their local comprehensive land use plans. The *Rhode Island Soil Erosion and Sediment Control Handbook* (RIDEM, 1989e) was revised to serve as a design manual for best management practices (BMPs), and Rhode Island erosion and sediment control enabling legislation was

revised to reflect the needs of local officials. RIDEM's efforts in 1991 focussed on developing performance standards for stormwater control BMPs as the basis for regulatory permits (*e.g.*, the RIDEM freshwater wetlands program). Regulations, applicability criteria, and performance standards are presently in draft form (Stuart, 1991: 6,17). In addition, the CRMC has agreed to base its stormwater regulations on the standards developed by RIDEM, thus making the Council's regulations consistent with RIDEM's. Stormwater management is required, for example, in certain Special Area Management (SAM) Plans, and new development proposals requiring CRMC permits must maintain the present quantity and quality of stormwater leaving the site (Stuart, 1991:6, 17).

Apart from the nonpoint source planning initiative established under Section 319, the states regulate other aspects of the nonpoint source pollution problem through their agricultural, pesticide, groundwater, wetlands and on-site sewage disposal regulatory programs. Both states also work with USDA Conservation Districts and Cooperative Extension Service to provide technical assistance, including site plan review, to municipalities and individual property owners. In addition, the Narragansett Bay Project-sponsored Land Management Project (LMP), which operated in conjunction with Rhode Island's Nonpoint Source Management Program between 1988 and 1992, played a key coordinating function among the agencies and organizations responsible for nonpoint source management. The LMP developed outreach materials and guidance documents, compiled model ordinances from other jurisdictions, and actively assisted cities and towns throughout the watershed in evaluating regulatory controls and structural BMPs for nonpoint source pollution control.

Analysis

Coordination of Nonpoint Source Management Programs

Perhaps the greatest impediment to implementation of an effective nonpoint source management strategy is the difficulty of coordinating the activities of the numerous agencies and organizations involved. Both Rhode Island and Massachusetts should maintain permanent state nonpoint source advisory committees with participation by federal, state and local resource management agencies, environmental advocacy groups, academia, and other interest groups. RIDEM and CRMC should consider developing an umbrella organization that builds on the advisory committees organized by Save the Bay and USDA SCS. The Environmental Data Centers at URI and MACZM, which supply statewide computer mapping and data analysis through their respective Geographic Information Systems (GIS), should also become important mechanisms for sharing information to assess potential nonpoint source pollutant contributions from changes in land use (Stuart, 1991:4). In addition, the statewide CNPCP that will be developed jointly between CRMC and RIDEM, as required by Section 6217 of the 1990 Amendments to the CZMA, will require enhanced coordination between relevant federal, state, and local agencies if it is to receive approval from the EPA and NOAA. Without such federal approval, both RIDEM's Section 319 Program and CRMC's Section 306 funding will be penalized.

Nonpoint Source Pollution Assessments and Planning

Section 319 of the CWA encourages states to update their *Nonpoint Source Assessments* as part of the state *Clean Water Strategy* and the *State of the State's Waters* reports required under Section 305(b) of the Act. In general, *Nonpoint Source Assessments* provide a great deal of information, and should be regarded as a major reference for implementing agencies and organizations. However, of the 200 waterbody segments making up the Narragansett Bay watershed, 39 along the Blackstone and Taunton Rivers in Massachusetts have not been evaluated. Since implementing agencies are expected to focus their efforts on priority waterbodies based on criteria and data reported in the *Nonpoint Source Assessments*, it is imperative to evaluate all waterbody segments, including wetlands.

Both Rhode Island and Massachusetts should use information gathered by citizen monitoring programs to supplement the state *Nonpoint Source Assessments*, particularly where the states do not have other recent sources of data (Stuart, 1991:15-16). A number of citizen-based water quality monitoring programs are already underway in the Narragansett Bay watershed. In addition, the Narragansett Bay Project established a Citizens Monitoring Coordinator position in 1990 to help coordinate the various Rhode Island programs, provide a liaison between the volunteer groups and RIDEM, and establish standardized sampling, analytical and reporting procedures (Stuart, 1991:16). The position, which is administered by RIDEM's Division of Water Resources, should be made permanent and Massachusetts should establish a similar position.

As noted above, the Massachusetts *Nonpoint Source Management Plan* does not have a documented priority-setting process to target waterbodies for protection and restoration. Although a substantial effort may be required to develop a joint nonpoint source priority ranking system, it would represent an invaluable step for directing basinwide efforts toward "protecting the best and fixing the worst" interstate waterbodies. The state Nonpoint Source Advisory Committees could be used to establish common goals and criteria for prioritizing implementation efforts in the Narragansett Bay basin. In addition, federal and state nonpoint source control implementation efforts in both states should be directed toward protecting and restoring the highest priority waterbodies in order to focus available funding and reduce unnecessary duplication of effort. Recognizing that nonpoint source controls should be the highest priority for some waterbodies, Rhode Island and Massachusetts should also develop a method for reconciling the nonpoint source priority list with the 305(b) point source and 303(d) waterbody priority lists in order to assure that available water pollution control funds are used effectively.

Regulation of Nonpoint Pollution Sources

Although RIDEM is scheduled to release draft stormwater control regulations by October 1992, the logistics and staff requirements involved with issuing and enforcing NPDES permits for each municipal and industrial stormwater discharge are significant and probably impossible to meet at the present time (Stuart, 1991:18). The EPA has issued draft guidance to assist state and local officials in detecting illegal sewer connections to storm drains. Technical guidance for communities seeking to abate and eliminate stormwater discharges is available through the state's *Nonpoint Source Management Plan* and the *Recommendations of the Stormwater Management and Erosion Control Committee Regarding the Development and Implementation of Technical Guidelines for Stormwater Management* (RIDEM, 1988a). The management measures identified as part of the proposed CNPCP to control nonpoint source pollution from urban sources (EPA, 1991a:4-1 to 4-47) will also help to reduce loadings to urban storm drains. The state and local governments should also consider using shoreline survey data collected by citizens' monitoring programs to identify illegal dry weather storm drain discharges. However, additional guidance is needed from EPA regarding appropriate stormwater discharge survey, prioritization and abatement strategies. [See 04-01-02 Source Reduction: Nutrients, and 04-01-05 Source Control: On-Site Sewage Disposal Systems for a discussion of groundwater contamination issues related to septic systems and fertilizer use.]

On the local level, several Rhode Island municipalities have adopted stormwater and nonpoint source-related management ordinances, and some communities have incorporated water quality or flooding considerations in their subdivision regulations. For example, Middletown requires no increase in peak discharge from the two and 25-year storms, and Smithfield includes a nutrient loading determination in the required environmental studies for a subdivision proposal. In addition, as of early 1992, 14 of 39 Rhode Island municipalities had adopted Soil Erosion and Sediment Control ordinances. However, none of the municipal or state programs presently address cumulative water quality impacts, nor are there compre-

hensive programs for mitigating them. Moreover, most cities and towns are not technically or financially equipped to deal with these issues in an aggressive manner (Myers, 1988; Stuart, 1991:7-8). Local comprehensive plans approved by the RIDOP pursuant to Rhode Island's Comprehensive Planning and Land Use Regulation Act (R.I.G.L.45-22.2-1 *et seq.*) will, however, provide the basis for new zoning ordinances and other growth management controls that reflect projected patterns of development and potential sources.

The federal and state agencies also clearly need to provide more effective guidance regarding applicability criteria, and design and performance standards for nonpoint source control best management practices (BMPs). The need for design and performance standards is especially critical when addressing residential or "urban" nonpoint source issues, because concern for nonpoint source pollution in that area is relatively new. The stormwater management standards and applicability criteria developed by RIDEM for its Section 319 *Nonpoint Source Management Plan* should be adopted by all the state nonpoint source control authorities, including the MADEP, Massachusetts Department of Food and Agriculture (MAFA), RIDEM's Divisions of Agriculture and Water Resources, the state coastal zone management agencies (*i.e.*, MACZM and CRMC) and Departments of Transportation, Cooperative Extension Service, Conservation Districts, and USDA SCS (Stuart, 1991:6). To the greatest extent practicable, these agencies should consider BMPs and performance standards recommended in the final Section 6217 CNPCP guidance under development by EPA and NOAA.

Finally, as noted previously, the states maintain a variety of technical assistance programs that address various nonpoint source pollution control issues. The USDA and its affiliated state programs should review the components of an Integrated Pest Management System to reduce the use of pesticides. Selection of pesticides based on water quality impacts, and more effective regulation of pesticide applicators should also be considered (Stuart, 1991:25). In addition, since roads and other paved surfaces can have a significant impact on stormwater quantity and quality, it is of special importance to ensure that control measures are adequately installed and maintained. Most state and local road construction inspectors are not specialists in nonpoint source management, and may not be able to give these measures the attention they deserve. This may be an area where use could be made of the Conservation Districts' site plan review and inspection programs (Stuart, 1991:21). Rhode Island Conservation Districts could also assist the CRMC in the review and inspection of stormwater management systems in sites within SAM Plan jurisdiction, and could assist RIDEM's Division of Freshwater Wetlands when stormwater management regulations are adopted. Similarly, the Environmental Review Teams available through the Rhode Island Resource Conservation and Development (RC&D) Council should be expanded to have a watershed-based perspective in order to assist municipalities in assessing the cumulative impact of development proposals. Massachusetts' Conservation Districts and RC&D Councils could play a similar role for Massachusetts municipalities in the Bay watershed (Stuart, 1991:23).

Recommended Policies and Actions and *Estimated Cost of Implementation* are presented in the following pages.

RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NONPOINT SOURCES

CODE	POLICY	AGENCIES	STATUS
I.	The State of Rhode Island and the Commonwealth of Massachusetts should develop and implement consistent nonpoint source guidance, standards, and practices for application throughout the Narragansett Bay Watershed, in order to control nonpoint source pollution problems in a consistent manner and reduce duplication of efforts. Guidance developed for the states' Coastal Nonpoint Pollution Control Programs (CNPCP) under Section 6217 of the 1990 Reauthorization of the Coastal Zone Management Act (CZMA) should be considered in revising existing guidance and standards.		
I.A.	Rhode Island and Massachusetts, with assistance from the U.S. Environmental Protection Agency (EPA), should adopt a consistent set of criteria for selecting priority waterbodies, including wetlands, in the Narragansett Bay watershed on which to focus efforts. The criteria used in Rhode Island Department of Environmental Management's (RIDEM) *Nonpoint Source Management Plan* to rank waterbodies for protection or restoration based on the status, use and ecological values of the waterbody are recommended. [Note: Wetlands are included as "waters of the State of Rhode Island" pursuant to R.I.G.L. 46-12-5. Therefore, unless specifically noted, all references to "waters" or "waterbodies" of the State include wetlands.] 1. The environmental management and coastal zone management agencies of Rhode Island and Massachusetts should focus future nonpoint source planning and implementation on those waterbodies identified as high priority for protection and restoration. The states' CNPCPs should use information and ranking criteria developed by state *Nonpoint Source Assessments* and other related information (*e.g.*, Narragansett Bay *Comprehensive Conservation and Management Plan)* to the greatest extent possible. 2. The states' nonpoint source priority waterbody list should be reconciled with the states' 305(b) point source, and 303(d) waterbody priority lists to the maximum extent possible in order to assure that available implementation funds are used effectively. 3. If further delineation of priority watersheds is needed for agency-specific programs, the agency should consult with the Rhode Island Environmental Data Center (EDC) in determining appropriate delineation criteria and any methods available to match waterbodies with their program requirements.	EPA, USDA SCS, RIDEM, CRMC, Mass. counterparts	

✓ - **High Priority Action**

RECOMMENDED POLICIES AND ACTIONS
SOURCE REDUCTION: NONPOINT SOURCES

CODE	POLICY	AGENCIES	STATUS
I.B. ✓	The Rhode Island and Massachusetts (Section 319 and Coastal) Nonpoint Source Coordinators should jointly maintain/reinstate a state Nonpoint Source Management Committee, to guide the nonpoint source control planning process, and to assist in developing new initiatives and the technical guidance needed for implementation. Coordination between the Rhode Island and Massachusetts Committees should be ensured. 1. Development of the new Section 6217 CNPCP, and update of the Section 319 *Nonpoint Source Management Plan* shall be coordinated within each state. EPA and the National Oceanographic and Atmospheric Administration (NOAA) shall make every effort to develop consistent policies and guidance regarding the control of nonpoint source pollution. The guidance developed for the CNPCP (EPA, 1991a) should be used to update the state's Section 319 *Nonpoint Source Management Plans* to the greatest extent practicable. 2. Design standards, applicability criteria, and performance standards for nonpoint source management systems and best management practices (BMPs) should be consistent throughout the Narragansett Bay Watershed to the greatest extent possible. The Rhode Island and Massachusetts Nonpoint Source Management Committees should agree on appropriate standards and should use existing CNPCP guidance (EPA, 1991a) to the greatest extent practicable. The State of Rhode Island should endorse the Rhode Island *Nonpoint Source Management Plan* and the *Recommendations of the Stormwater Management and Erosion Control Committee Regarding the Development and Implementation of Technical Guidelines for Stormwater Management* (1988a) for reducing stormwater pollutants.	RIDEM, CRMC, MADEP, MACZM, RIDOT, MA EOTC	[See RIDEM "Preliminary Agreement," Section 715-05-06 re: agreement to establish and jointly chair the Nonpoint Source Management Committee with CRMC. See USDA SCS and RIDOP "Preliminary Agreements," Section 715-05-06 re: agreement to participation on Nonpoint Source Management Committee.]

✓ - High Priority Action