STATE OF RHODE ISLAND AND PROVIDENCE PLANATIONS

2006 Section 305(b) Report

STATE OF THE STATE'S WATERS

RHODE ISLAND DEPARTMENT OF ENVIRONMENTAL MANAGEMENT

OFFICE OF WATER RESOURCES

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2006 SECTION 305(b)
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REPORT

DEPARTMENT OF ENVIRONMENTAL MANAGEMENT
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I. Executive Summary/ Overview

A. The 305(b) Process

Section 305(b) of the Federal Clean Water Act (CWA) requires each state to assess the health of their surface waters and submit biennial (every even year) reports describing the water quality conditions to the USEPA. This 305(b) assessment process is the principal means by which states, EPA, and the public evaluate water quality, the progress made in maintaining and restoring water quality, and the extent to which problems remain.

B. Water Quality Assessments

Section 305(b) of the CWA requires that states assess their water quality for attainment of the fishable and swimmable goals of the CWA. The state is to measure attainment of the CWA goals by determining how well the waters support their designated uses. For the purpose of this report, assessments are made on the following five individual designated uses: aquatic life, swimming, drinking water, fish consumption and shellfishing. DEM solicits and compiles data from all available sources prior to conducting the assessments. The data used to generate the information for this 2006 report are generally from 1999 through 2003, however, some data collected during 2004 and 2005 were available for incorporation as well.

Waterbodies, or segment of waterbodies, are evaluated to determine the level of use support attainment by comparing water quality data with the appropriate criteria for each designated use. If valid data are available to make such a judgment, then the waterbody is assessed and a determination is made as to whether the waterbody fully supports its uses or is in some manner impaired. One of the following four levels of use support attainment is assigned to the waterbody or water segment: fully supporting, fully supporting but threatened, partially supporting, or not supporting. Due to a potential terminology conflict associated with the application of the fully supporting but threatened category, this category was only applied to the assessment for one waterbody, a drinking water reservoir, at the request of the Department of Health. Partially supporting and not supporting assessment determinations are considered impairments.

Assessments to determine use support can be either "monitored assessments" based on recent monitoring data or "evaluated assessments" based on qualitative information or monitoring information which is more than 5 years old. In situations where the water quality information is lacking or is more than 10 years old, the waterbody is generally considered not assessed. Given data availability, it is possible and fairly common, for a waterbody to be assessed for one designated use (e.g. recreation) and not another (e.g. aquatic life). Currently, a waterbody is counted as assessed if any one of the designated uses is considered assessed.

In the assessments, the pollutants and other stressors (causes) that contribute to the actual or threatened impairment of designated uses in a waterbody or waterbody segment are listed if information allows. In addition, the sources, or activities, facilities, or conditions that contribute, or may contribute pollutants or stressors resulting in impairment of designated uses in a waterbody, are also listed if information is available. In general, the actual sources of impairment are not determined until a TMDL (Total Maximum Daily Load) is conducted on the waterbody. As such, most of the sources noted in this report are just potential sources. Common causes of non-support include metals, pathogens and nutrients. Potential major sources include municipal and industrial discharges, CSOs, and nonpoint sources such as stormwater runoff and failed septic systems.

Please note that refinements in the state's total waters and individual waterbody size estimates continued with this report. More accurate RIGIS estimates at a scale of 1:24,000 have been incorporated into the 2006 assessment database and report. In addition, more waterbodies (lakes and rivers) have been added to the assessment database. These refinements which changed the individual waterbody sizes, may significantly alter the various percentiles calculated in this report relative to previous reports. In other words, differences in percentiles between reports may simply be a factor of updated waterbody size estimates and not necessarily due to changes in monitoring effort, water pollution or other similar water quality reasons. Estimating trends is therefore, difficult to conduct at this time.

C. River Assessments

Approximately 42% (626 miles) of the 1,498 river miles (total river miles at 1:24,000 scale) in Rhode Island have been assessed for this report. The majority of unassessed river miles in general include the many small headwater streams and rivers of the state. Of the river miles assessed (626 miles), approximately 84% (523 miles) are considered monitored while approximately 16% (103 miles) are considered evaluated.

Approximately 61% (384 miles) of the state's rivers and streams assessed, fully support all of their designated uses. Approximately 39 % (242 miles) of the river miles assessed are considered impaired for one or more uses.

Data was available to assess 512 river miles for swimming use support. The data showed that 65% (334 miles) fully support the swimming use, and approximately 35% (178 miles) are considered impaired for swimming use. Data was available to assess 595 river miles for aquatic life use support. The data showed that 74% (441 miles) of the river miles assessed fully support aquatic life needs. Approximately 26% (154 miles) are considered impaired for aquatic life uses.

Data was available to assess 50 river miles for fish consumption use support. The data showed that 45% (22.44 miles) fully support the fish consumption use and approximately 55% (28 miles) are considered impaired for fish consumption use.

The most significant causes of non-support for rivers and streams are biodiversity impacts, pathogens, heavy metals, low DO and nutrients. In the majority of cases there is not enough data to link the causes of non-support to actual sources of the pollutant. Potential sources of non-support are, however, noted to include point sources (CSOs, municipal and industrial discharges), nonpoint sources (urban runoff/storm sewers, septic systems), hydromodification, and natural sources (wildlife and waterfowl).

Fifty-three (53) rivers and/or river segments reviewed for this report are located within Drinking Water Supply systems. These 53 rivers represent 114 river miles. Almost all of these rivers are considered unassessed for drinking water use. This is because the Department of Health only requires water quality data, to evaluate the source water, to be collected from the terminal reservoir of the system. The terminal reservoir is the location of the intake pumps. In general, sampling conducted elsewhere in the source waters of the system has been determined by the DOH to be too limited in scope to use in conducting a drinking water use assessment. The 4.04 river miles assessed, fully support the drinking water use.

D. Lake Assessments

Eighty-one percent (17,017 acres) of the 20,917 acres of lakes in Rhode Island have been assessed for this report. Of the lake acres assessed, approximately 73% (12,353 acres) are considered monitored and approximately 27% (4,664 acres) are considered evaluated.

Approximately 68% (11,650 acres) of lake acres assessed fully support all designated uses and less than 0.03% (<5 acres) assessed fully support all designated uses but are considered threatened. Approximately 32% (5,363 acres) of lake acres assessed do not support their uses and are considered impaired for one or more uses.

Data was available to assess 15,271 lake acres for swimming use support. The data indicated that most lake acres fully support their swimming use (96%, 14,720 lake acres). Approximately 4% (551 acres) of lake acres assessed are considered impaired for the swimming use.

Data was available to assess 15,868 lake acres for aquatic life use support. Approximately 80% (12,636 acres) of the lake acres assessed, fully support aquatic life needs. Approximately 20% (3,232acres) of lake acres assessed are impaired for aquatic life uses.

Data was available to assess 3,124 lake acres (28 lakes) for fish consumption. Information for this assessment comes from the Department of Health (HEALTH), Office of Environmental Risk Assessment. Approximately 23% (732 acres) of the lake acres assessed fully support fish consumption use. HEALTH has issued a fish consumption advisory for 77% (2392 acres), which represents 20 lakes.

Information for drinking water use assessments comes from HEALTH's Office of Drinking Water Quality. Forty-two (42) lakes assessed are used as drinking water supply sources. This represents 7,813 acres associated with the drinking water supply systems. Of these 7,813 acres, 5,484 acres (70%) are considered assessed for drinking water use for this report. The remaining 2,330 lake acres, or 30% were considered not assessed for drinking water use support. In general these 2,330 acres represent portions of the drinking water supply system that are upstream of the terminal reservoir. The terminal reservoir is the location within the drinking water supply system where HEALTH requires the water samples to be collected. Some of these upstream waters are not monitored or have only limited monitoring and are, therefore, considered unassessed for drinking water use in this report. Ninety-nine percent (5,424 acres) of the drinking water supply lake acres assessed were found to be fully supporting, and less than 1% (<5 acres) of the lake acres assessed fully support drinking water uses but are threatened.

Approximately 1% (55 acres) of drinking water supply lake acres assessed are considered impaired for the drinking water use.

For lakes and ponds, the major causes of non-support are high bacteria and nutrient levels and low dissolved oxygen. Another major cause of non-support in terms of total acreage effected, is from metals. Major sources of non-support in lakes and ponds are mainly from nonpoint source impacts such as urban and stormwater runoff. Agriculture, septic systems and flow modification are suspected sources of non-support in lakes.

Trophic classifications are provided for 179 lakes, covering a surface area of 18,061 acres. Of these, 94 are publicly-owned lakes/ponds which cover a surface area of 8,914 acres and 85 private lakes which cover a surface area of 9,147 acres. Five publicly-owned lakes are classified as hypereutrophic, twelve lakes are classified as eutrophic, 36 are considered to be within the mesotrophic range and 16 are considered to be oligotrophic. Trophic status is unknown for 19 public lakes and the rest of the public lakes (6) fall between several trophic classifications. These classifications are based on recent (2000-2004) Watershed Watch volunteer monitoring data.

E. Estuarine and Coastal Shoreline Assessments

All of the 156.4 square miles of estuarine waters were reviewed for this report. Over 99% (156.3 square miles) of the estuarine waters have enough data to be considered assessed for this report. Of those assessed areas, 99% (154.5 square miles) are considered monitored and approximately 1% (1.8 square miles) are considered evaluated. It is important to note that the large percent of estuarine waters considered assessed (99%, 154.5 square miles) are, to a large degree, only monitored for pathogens by the RIDEM Shellfish Monitoring Program. Therefore, the majority of Rhode Island’s estuarine waters have current monitoring data for pathogens to assess for swimming and shellfishing use support status. Dissolved oxygen data from seasonal surveys and fixed station buoys provide extensive data for the upper portion of the Bay. This data has been used to assess for aquatic life use support status.

Just over 69% (108.6 square miles) of the estuarine waters assessed fully support *all* uses. Approximately 30.5% (47.7 square miles) of the estuarine waters assessed are considered impaired for one or more uses.

Data was available to assess 156 square miles of estuarine waters for swimming use. Most estuarine waters assessed support their swimming uses (90%, 140.3 square miles). Approximately 10% (15.5 square miles) of the estuarine waters assessed are considered impaired for the swimming use due to violations of fecal coliform criteria.

Data was available to assess 116.5 square miles of estuarine waters for aquatic life use. The majority of estuarine waters assessed fully support aquatic life needs (64%, 74.6 square miles). Approximately 36% (42 square miles) are impaired for aquatic life uses.

The estuarine waters classified as SA and SA{b} are designated for shellfishing use. Excluding Rhode Island Sound and Block Island Sound, this represents approximately 133 square miles. Data was available to assess 131.4 square miles of SA and SA{b} waters for their shellfishing use support status. The majority of class SA and SA{b} waters assessed (79%, 104.3 square miles) fully support the shellfishing use. Partial support of the shellfishing use occurs in approximately 16% (21 square miles) of the estuarine waters. In general, this 21 square miles encompasses areas associated with seasonal or conditional shellfish closures. Approximately 5% (6 square miles) of the Class SA and SA{b} estuarine waters are permanently closed to shellfishing and are considered not supporting the shellfishing use. Overall, approximately 20% of all the waters designated for shellfishing are impaired for shellfishing use.

The major impacts on designated uses for the estuarine waters of Rhode Island are due to bacterial contamination, low dissolved oxygen and nutrient enrichment. The major sources of bacterial contamination are due to combined sewer overflows (CSOs). Wastewater treatment facilities, CSOs, and stormwater discharges are sources of the nutrient enrichment and low dissolved oxygen problem in the Bay. This water quality problem, while not fully characterized, indicates that nutrients are linked to adverse impacts of reduced dissolved oxygen levels, loss of eelgrass and increased production of nuisance macroalgae.

Rhode Island has 78.62 coastal shoreline miles. The coastal shoreline is defined as a line along the coast from Westerly to Point Judith, up to the mouth of the Narrow (Pettaquamscutt) River, across to Beavertail on Jamestown, across to Brenton Point in Newport and along the Newport coast to Sachuest Point, across to Sakonnet Point in Little Compton and along the coast in Little Compton to the Rhode Island/Massachusetts border. Bacteria data was available to assess the entire coastal shoreline for swimming and shellfishing use support status. All 78.62 miles were assessed as fully supporting both swimming and shellfishing uses.

F. Wetlands

Freshwater and coastal wetlands encompass approximately 18.4% of Rhode Island's landscape (127,721 acres). There are approximately 111,893 acres of freshwater and 15,828 acres of estuarine and marine wetland and deepwater habitats in the State, excluding the waters of the Narragansett Bay and the Pawcatuck River estuary (RIGIS 1988). Rhode Island's wetlands have been regulated and protected by state and federal statutes for over 30 years. The U.S. Army Corps of Engineers, with the assistance of the other federal resource protection agencies, namely, the U.S. Environmental Protection

Agency, the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, implement Section 404 of the Clean Water Act (33 U.S.C. 1341 and 1344) and Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. 403). Since 1971, the Department of Environmental Management (DEM) has implemented the Rhode Island Freshwater Wetlands Act (R.I.G.L. 2-1-18 et seq.). The Coastal Resources Management Council has been the designated agency for implementation of the federal Coastal Zone Management Act and regulates wetlands alteration in disputed coastal areas. DEM also implements Section 401 of the federal Clean Water Act. These statutes and accompanying regulations consistently require that applicants avoid and minimize alteration of freshwater and coastal wetlands. Efforts to improve the permitting process remains a DEM priority with implementation of the Governor's Wetland Task Force recommendations a primary focus of activity.

Rhode Island does not have statewide data on historic freshwater or coastal wetland loss. Historic losses can be attributed predominantly to urbanization, transportation projects and residential development. Data generated by DEM since 1998 indicates that the extent of permitted freshwater wetland loss is kept to a minimum through DEM's wetland regulatory programs. Unauthorized losses are higher and a compliance program is considered essential to deterring and reversing such losses through restorations.

Programs to advance wetland restoration have been expanded. The R.I. Coastal and Estuary Habitat Restoration Program was established in 2002 and has distributed grants to facilitate the design and construction of selected projects. Work to promote freshwater wetland and riparian buffer protection has also been undertaken. The State of Rhode Island and federal and local partners are collaborating on other proactive wetland protection initiatives: south shore coastal habitat inventory, wetland acquisitions, vernal pool identification and protection, among others. In 2005, DEM undertook a project to develop and implement a bioassessment program for wetlands in R.I. The program employs a rapid assessment protocol that helps identify stressors to the ecological health of wetlands.

G. Plan for Achieving Comprehensive Assessments

Monitoring and assessment are essential components of a comprehensive water quality program. EPA has established a goal of comprehensively characterizing the waters of each state using a variety of sampling designs targeted to the condition of, and goals for, the waters. This report documents that data is lacking for 58 percent of Rhode Island's river and stream miles and 19 percent of lake acreage. Additionally, little data is available on the presence of fish tissue contaminants in Rhode Island waters. The important role of monitoring was acknowledged by the RI legislature in 2004 with the passage of statutes that created the Rhode Island Environmental Monitoring Collaborative (RIEMC) and a mandate for development and implementation of a comprehensive monitoring strategy. In September 2005, working with partners, DEM completed a statewide strategy for monitoring surface waters which, when implemented, will build capacity to support statewide assessment of water quality conditions in Rhode Island's rivers, streams, lakes, ponds and coastal waters. When fully implemented as proposed, it will provide data essential to state management programs in several agencies. The strategy established a goal of comprehensively assessing water quality conditions with respect to supporting aquatic life and recreational uses of surface waters statewide over a five year period (by 2011). Working with limited resources, Rhode Island has made partial progress toward this goal by an expansion of monitoring programs. Since

2004, DEM has implemented or assisted in the following monitoring program enhancements to address these gaps. In Narragansett Bay, collaboration among agencies maintaining stations in the fixed-site monitoring network, which includes DEM, University of Rhode Island Graduate School of Oceanography, Narragansett Bay Commission, Narragansett Bay National Estuarine Research Reserve and Roger Williams University, was improved through expanded monitoring sites and joint data processing. In 2005, spatial surveys of hypoxia, coordinated by the Narragansett Bay Estuary Program and Brown University, with some support from DEM among others, were reinstituted and expanded using improved instrumentation. With respect to rivers and streams, in 2004, DEM, with its contractors, instituted the rotating basin monitoring strategy via a demonstration project in the Wood River Watershed. The approach is aimed at supporting comprehensive assessment of water quality conditions that is based on an the integration of biological, chemical and physical data The approach was subsequently applied in a majority of the Pawcatuck River (2005-2006) and several other watersheds in 2006.

H. Water Pollution Control Program

Over the past decade, the management of water resources, including water pollution control efforts, has increasingly reflected a watershed-based approach. Efforts to promote watershed-based management of the state’s water resources were strengthened in 2004 via legislative action. Following the large fish kill in Greenwich Bay and increased beach closures in 2003, the State created the Rhode Island Bays, Rivers and Watersheds Coordination Team and associated advisory committees to enhance efforts to protect, restore and manage Narragansett Bay and its watersheds and promote sustainable economic use of its natural resources. The Coordination Team which draws together seven state and quasi-state agencies, is engaged in developing a systems-level plan intended to further achieve ecosystem-based management for Narragansett Bay, its watershed and other watersheds.

Accompanying this effort was the establishment of the R.I. Environmental Monitoring Collaborative (RIEMC) that has provided a forum for improving coordination of existing monitoring efforts and identifying the critical gaps in current programs. In its January 2005 report to the Coordination Team, the RIEMC identified monitoring which was needed to help fulfill the goal of a comprehensive monitoring program to support adaptive management of the Bay as well as the state's watersheds. As resources have allowed, actions have been taken to implement a portion of the needed monitoring. Refer to Chapter III.A. Surface Water Monitoring Programs.

The Office of Water Resources (OWR) implements water pollution control programs through its two sections: Surface Water Protection and Groundwater and Wetlands Protection. Fundamental to surface water protection is the state's Water Quality Standards Program. This program ensures compliance with various provisions of the Federal Clean Water Act (CWA). Its purpose is to restore, preserve, and enhance the water quality of Rhode Island waters, to maintain existing uses and to protect the waters from pollutants so that the waters shall, where possible, be fishable and swimmable, and be available for all designated uses and thus assure protection for the public health welfare, and the environment. These objectives are implemented through the water quality standards which are a fundamental element of the state's Water Quality Regulations. The water quality standards are developed to define water quality goals for the state's waters by deciding what their uses will be (designated uses) and by setting criteria necessary to protect those uses. In addition to establishing water quality goals for state waters, surface water quality standards also serve as the regulatory basis for the establishment of water-quality-based treatment controls and strategies beyond technology-based controls.

Where waters are designated impaired, DEM has scheduled development of Total Maximum Daily Loads (TMDLs) for the parameters of concern. The current schedule extends until 2016. The TMDLs serve as water quality restoration plans that identify the sources of pollution, both point and nonpoint, and the actions needed to abate or mitigate pollutant loadings in order to restore designated uses of the affected waterbodies. Typically, the plans are developed based upon targeted water quality assessment studies. During the TMDL development process, which involves the public throughout, pollution sources are more fully characterized providing the technical basis for further investment in pollution controls. As of February 2006, TMDLs developed by DEM for 38 waterbodies had been approved by EPA

The OWR is delegated to administer the National Pollutant Discharge Elimination System (NPDES) program which is implemented by the OWR as the Rhode Island Pollutant Discharge Elimination System, known as the RIPDES Program. This is the backbone of the state's water pollution control strategy, which includes developing and enforcing permit limitations for municipal and industrial wastewaters, stormwater, and combined sewer overflows discharged directly to the waters of the state (RIPDES Program) as well as industrial wastewaters discharged to municipally-owned treatment facilities (the Pretreatment Program). The RIPDES program currently oversees permit development and compliance for 19 major municipal and 6 major industrial discharges in addition to over 100 minor discharges. The Pretreatment Program is necessary to prevent industrial discharges from interfering with the operation of municipal wastewater treatment facilities and/or causing the facility to violate its discharge limits. OWR provides oversight of 15 approved local pretreatment programs administered by publicly owned wastewater treatment facilities.

The Wastewater Treatment Facilities Program within the OWR consists of operation and maintenance (O&M) and design sections. The operation and maintenance section conducts inspections and compliance evaluations at all major and minor municipal facilities to ensure conformance with permit requirements and issues Orders of Approval for operation and maintenance manuals and review operation failures that result in permit violations. Review and approvals of wastewater facility plans, engineering reports and engineering plans and specifications for WWTF improvements, sanitary sewer systems and marine sewage pumpout facilities are conducted by this Section. The Wastewater Treatment Facilities Section is also responsible for issuing approvals for the disposal, utilization, and transportation of wastewater sludge and performing inspections to ensure that the sludge is being managed in the manner approved.

The Financial Assistance Program within the OWR consists of administering and/or assisting in the oversight of financial assistance programs aimed at assisting communities and other entities in achieving water quality protection goals. This program encompasses a number of financial assistance programs for the construction upgrade of wastewater collection systems and treatment facilities, including the State Revolving Loan Program, Non-Governmental Bond Fund Program, the Interceptor Bond Program and the Pawtuxet River Authority Bond Fund Program. It will play a key role in administering the bond fund programs approved by voters in the fall of 2004. It also coordinates with the R.I. Clean Water Finance Agency on its loan programs for water pollution control and drinking water infrastructure.

The OWR Freshwater Wetlands and Groundwater Section administers the Water Quality Certification Program, required by Section 401 of the Clean Water Act. This program ensures that certain types of projects; e.g. construction projects, do not adversely impact the quality of the state's water resources. It provides a key mechanism for enforcing antidegradation policies embodied in the state water quality regulations.

I. Nonpoint Source Pollution Management Program

Nonpoint pollution continues to present a widespread problem in Rhode Island waters. The RIDEM's Nonpoint Source Pollution Management Program, supported with federal Clean Water Act funding (Section 319), is focused on developing and implementing strategies to mitigate existing and prevent new sources of nonpoint source pollution. The non-regulatory program, administered by the DEM-OWR,

The Program is involved in a number of activities. Priority areas of focus include: (1) Onsite wastewater disposal system Septic System Management; (2) Stormwater Water Management and Integration with RIPDES Phase II; (3) implementation of BMPs consistent with support of TMDL recommendations; and (4) solicitation of community projects through a competitive granting process. promoting environmentally sound land use planning. Additionally, the state recognizes the need for watershed-based plans to provide an appropriate technical basis for implementing protection and restoration strategies.

Since 1999, the NPS Program has administered competitive solicitation for grant proposals using incremental 319(h) funding (i.e., Clean Water Action Plan funding).

Slightly over $4 million has been awarded, with most of the resulting projects involving structural best management practices aimed at abating nonpoint pollution sources. Projects have included: upgrading salt storage facilities, design and construction of stormwater treatment structures, use of innovative and alternative septic systems technologies, and selected habitat restoration projects expected to restore an impaired use of a surface water. As of 1/1/07, 36 projects have been completed, while 27 remain active. In recent years the 319 RFP has given priority to BMP implementation related to TMDLs in an effort to achieve water quality restoration goals. A state bond proposal, approved by voters in 2004, allowed the DEM to establish the $8.5 million Bay and Watersheds Restoration Fund. To date, DEM has awarded $3.2 million in state grants for water quality restoration projects, enhanced stormwater management and riparian buffer protection.

The Nonpoint Source Pollution Program has also focused on improving the capacity of Rhode Island local governments to address the major causes of nonpoint pollution in the state; septic systems and stormwater. Using state funds, DEM distributed planning grants to municipalities to develop both local wastewater management plans and stormwater management plans (consistent with Phase II requirements). These efforts have laid the groundwork for implementation of further nonpoint abatement actions. With respect to septic systems, 23 of 27 communities targeted by the state as needing local wastewater programs have developed or are in the process of developing such programs. As of March 2007, this has allowed the state Clean Water Finance Agency to make over $4 million in loans to 9 communities to facilitate repairs of failing septic systems under a program known as Community Septic System Loan Program (CSSLP). With respect to stormwater, distribution of $835,000 in planning grants helped spur development of local stormwater management plans. Thirty–six communities have developed local stormwater management plans (draft or final)providing a framework for promoting further abatement actions in the future; e.g. linking local plans to TMDL requirements.

J. Cost/Benefit Assessment

Rhode Island's water resources are valued for swimming, fishing and boating, as well as for commercial fishing and other water-related businesses. The importance and benefits of clean water on social and economic impacts is evident. However, a true assessment of the environmental impact, economic and social costs, and social benefits of effective water programs is, at best, difficult to determine. This is due to the complexities involved in quantifying the economic value of incremental improvements in water quality. Nonetheless, some estimates of the costs and benefits of improvements in water quality and water resources can be inferred from the projects funded by the Construction Grants, SRF and Non Point Source Programs and the associated environmental and economic benefits realized by the state.

K. Water Quality Monitoring Programs

The Rhode Island Water Monitoring Strategy (http://www.ci.uri.edu/Projects/RI-Monitoring/Docs/DEM_WQ_Oct_14_05.pdf), developed by DEM in collaboration with the RI Environmental Monitoring Collaborative, provides the framework for coordinating ambient water monitoring programs conducted by state government and its partners. The DEM-Office of Water Resources (DEM-OWR) has a primary role in implementing the strategy by both conducting monitoring and supporting monitoring done by other entities.

Collectively, the monitoring programs are aimed at gathering the ambient water data needed to assess water quality conditions and support management decision-making in water resource programs. The data are used to establish standards, measure progress toward state and federal water quality goals, support development of discharge permits among other uses. A mix of strategies is employed to obtain data from estuaries, rivers, streams, lakes and ponds.

In estuarine waters, the monitoring programs focus on concerns with hypoxia and pathogens. Expanded in recent years, the fixed-site network of 13 stations located on docks or buoys throughout the mid to upper Bay provides continuous data on dissolved oxygen, chlorophyll a, temperature and salinity. This spatially limited dataset is supplemented by dissolved oxygen surveys that involve collection of data from 75 stations periodically through the summer. Researchers, through both short and long-term projects, are also contributing data that assists in characterizing water chemistry in the Bay and coastal ponds. Additionally, periodic surveys of submerged aquatic vegetation (eelgrass) and macroalgae are generating data that overtime may prove useful as indicators of estuarine eutrophication. Pathogens are monitored extensively throughout estuarine waters via the DEM Shellfish Monitoring Program and also at beaches via the RI Department of Health. Volunteer programs generate data in Greenwich Bay, the coastal ponds and certain saltwater beaches.

The monitoring approach to freshwater rivers and streams was modified in 2004 from a solely fixed-site network to a rotating basin approach. Under this new approach, a portion of the state's rivers and streams are monitored each year with a goal of comprehensively covering the state every five years. While current resources limitations will prevent Rhode Island from achieving its five-year goal, as of the end of 2006, the approach has been applied in three cycles to about 20% percent of the state's watershed areas. This strategy integrates biological (macroinvertebrate), chemical and physical monitoring to produce characterizations of water quality conditions on a watershed basis. In addition, on the state's largest rivers, a long-term fixed site network has been re-instituted. Suspended in 2002, monitoring was targeted to resume in early 2007 with support from the Rhode Island Bays, Rivers and Watersheds Coordination Team. DEM partners with USGS for monthly monitoring of five stations on the Blackstone and Pawtuxet Rivers. Volunteers also monitor and generate data for a number of rivers and streams in RI.

Monitoring in lakes and ponds is largely a volunteer effort coordinated by URI-Watershed Watch. Lakes are monitored seasonally for water chemistry, clarity and pathogens. In addition, bathing beaches on lakes or ponds are monitored for pathogens pursuant per requirements of the Department of Health.

Where waters are impaired, DEM conducts or oversees the execution of more intensive water quality studies that are aimed at identifying the contributing sources of pollutants and developing a total maximum daily load (TMDL). Generally, short-term (1-3 years), these studies support development of water quality restoration plans that outline the recommended actions to abate and mitigate water quality impairments.

L. Public Health/Aquatic Life Concerns

Rhode Island state government has never sponsored a program to systematically assess fish tissue contamination. The current health advisories regarding fish consumption, issued by HEALTH Office of Environmental Risk Assessment, are based largely on data derived from other entities, primarily research conducted by the EPA

Aquatic Ecology Division at its Narragansett Lab. Only a small number of waterbodies and fish, however, have been tested for contaminants. Furthermore, the current data indicates that the degree of contamination is variable and difficult to extrapolate results from one river/lake to another. To fill this data gap, DEM's recently released Water Monitoring Strategy recommends that fish tissue be assessed systematically within the proposed rotating basin approach.

In August 2003, a massive fish kill brought attention to the problems associated with hypoxia in Narragansett Bay. DEM's assessment of the fish kill noted while the depletion of oxygen caused the death of marine life, a complex interaction of a range of factors combined to produce the prolonged low oxygen condition. These factors include rain, wind, temperature, geology and hydrodynamics along with anthropogenic sources of pollution. This event, combined with a notable increased in beach closure days, prompted the formation of the Governor's Narragansett Bay and Watershed Planning Commission which conducted an extensive review of water quality management concerns associated with the bay. The legislature also reviewed the issue via committee hearings in the Senate and the Bay Trust Study Commission established by the House. These initiatives led to the passage of legislation in June 2004 intended to strengthen the management of Narragansett Bay and its watershed by formation of the Rhode Island Bays, Rivers and Watersheds Coordination Team.

In 2005, three approved and/or conditionally approved stations that were previously in compliance with the shellfish program requirements, were closed due to exceedances of the bacterial standard. These closures included the upper portion of the Kickemuit River (44.3 acres), Trims Pond, located in the southern portion of Block

Island’s Great Salt Pond (14.9 acres), and an extension south of the closure line of Upper Point Judith Pond (51.6 acres).

No bathing beaches were closed in Rhode Island during 2004 and 2005 due to toxic impacts. The 2005 bathing season saw a decrease in beach closures and closure days from the 2004 season. Whereas 122 beach closure days were recorded for 2004, only 65 beach closure days were recorded for 2005. It should be noted that the total rainfall decreased 43% from 10.99 inches in 2004 to 6.24 inches in 2005. In addition, significant rainfall events (>0.50 inches in a 24-hour period from June 1- August 1 at T.F. Green) fell from 9 instances in 2004 to 4 instances in 2005.

There were no restrictions of surface drinking waters during 2004 and 2005 due to water quality problems in the surface water supply.

M. Groundwater

Groundwater is a locally abundant and widely used resource in Rhode Island. Approximately 26% of the state's population is supplied with drinking water from public and private wells (Solley et al 1998). Groundwater resources are expected to meet a substantial part of the state's future water supply needs. Groundwater quality in most parts of the state is suitable for human consumption and other uses without treatment. Furthermore, protection of groundwater quality is important to protect surface water quality, since during dry periods, water in streams is derived almost entirely from groundwater.

Rhode Island's groundwater resources are extremely vulnerable to contamination because of the generally shallow depth to groundwater, aquifer permeability, and the absence of any subsurface confining layers. Preventing groundwater pollution must be a priority if the long-term quality of the State's groundwater resources is to be protected.

Over 100 different contaminants have been detected in Rhode Island groundwater, with the most common being petroleum products, organic solvents, nitrate and historically the pesticide aldicarb (Temik). Contaminant sources include leaking underground fuel storage tanks, hazardous and industrial waste disposal sites, illegal or improper waste disposal, chemical and oil spills, landfills, septic systems, road salt storage and application practices, and fertilizer and pesticide applications. Most groundwater contamination problems occur on a localized basis originating from a specific source.

The Department of Environmental Management (DEM) is continuing to implement and refine a comprehensive groundwater protection program in response to legislative mandates and in response to the need to prevent further degradation of the state's valuable groundwater resources.

Below are the key findings from the 2006 review of groundwater quality in Rhode Island:

* Groundwater in Rhode Island is generally free of pollutants. Over 90% of the state is classified as suitable for drinking water use and other uses without treatment.

* Nitrate concentrations in public wells remained consistent with previous assessments with the annual percentage of public wells that exceeded 5 mg/l averaging 3% over this assessment period. Nitrate has been documented at concentrations in monitoring wells and private wells above the drinking water standard in the immediate vicinity of turf farms in southern RI.

* Data on sodium concentrations in public wells revealed that the annual

percentage of wells that exceeded 20 mg/l during this assessment period averaged 31% (ranging from (30% to 37%) compared to the previous assessment period from July 1995 to June 1999 where the average was 21% (ranging from 17% to 24%).

* Public well data indicates that groundwater resources are vulnerable to contamination by volatile organic compounds (VOCs). The most frequently detected VOC continues to be methyl tertiary butyl ether (MTBE), a gasoline additive. Typically, 15% to 25% of the public wells tested for VOCs during this reporting period had positive detections, which is consistent with previous reporting periods**.**

* Well closures -- of all the community and non-transient non-community wells in service at one point during the period from July 1999 to December 2005, one stratified drift municipal well was closed due to a leaking underground storage tank and 3 bedrock wells at an apartment complex were closed to due high arsenic concentrations.

* The leading cause of <u>new</u> groundwater contamination incidents reported to DEM continues to be the release of petroleum products stored in underground storage tanks.

N. Special State Concerns

In 2003, the Greenwich Bay fish kill and an unprecedented number of beach closings dramatically focused public attention on the water quality conditions in Narragansett Bay and the state's coastal waters. It highlighted the need for continued deliberate effort to abate the pollution sources that contribute to water quality degradation. Restoring and protecting the Bay and its watershed remains a challenge given both its dynamic ecosystem and the complex interaction of factors that influence water quality conditions. Improvements have been made in monitoring programs to reduce gaps in the collection of essential to discerning trends in water quality over time and evaluating program effectiveness. Sustaining the collaborative monitoring effort is This is essential to support an adaptive management approach to the Bay watershed that identifies emerging environmental or management problems and in response modifies programs to address such problems.

Rhode Island is continuing to make significant investments in pollution control infrastructure to abate water pollution. Water quality-based permits have required advanced treatment of many major dischargers (WWTFs), in order to reduce nutrient pollutant loadings. The permits reflect a nutrient reduction strategy that is aimed at achieving a 50% reduction in nitrogen loadings to the Upper Bay. Construction to achieve nutrient reductions is planned, underway or completed at 11 WWTFs in RI and also needed at several WWTF in Massachusetts. Implementation of the combined sewer overflow (CSO) abatement strategy remains a priority. Within the service area of the Narragansett Bay Commission (NBC), construction of Phase I of the abatement plan which has created underground storage capacity and eliminated untreated CSO discharges is nearing completion.

In addition to controlling point sources of pollution, it is now widely recognized that maintaining or restoring state waters to their desired condition (fishable, swimmable or drinkable, as appropriate) requires that dispersed sources of pollution, known as “non-point”, be abated.   With a majority of the state’s major WWTFs discharging into coastal waters, it is evident that the water quality problems identified in many watersheds are attributable largely to non-point pollution sources. Data available to date indicate that the most serious non-point pollution concerns with respect to surface water appear to be stormwater discharges, septic systems, and erosion and hydromodifications. These sources have adversely all types of surface waters including affected both the coastal ponds region, other coastal embayments, and inland freshwater lakes and ponds, including drinking water reservoirs, and rivers and streams. The most common pollutants of concern are bacteria, nutrients and sediments, respectively. Among nonpoint sources, addressing stormwater and septic system sources continue to be high priorities.

With respect to septic systems, DEM estimates that 50,000 of the 157,000 on-site wastewater systems in RI are substandard; e.g. cesspools. DEM is promoting the proper maintenance and where necessary upgrade of on-site systems through regulatory initiatives and the development of local wastewater management programs. Twenty-three of 27 targeted communities are in the process of developing or implementing local wastewater management programs, and will have a continuing need for state technical assistance. The state also expects to work on implementing strategies to accelerate the phase out of certain use of the estimated 50,000-60,000 cesspools still in use across consistent with pending legislation. (Note: Legislation regarding the phase out of cesspools was passed in 2007). Finally, DEM is in the process of developing rule changes for later in 2007 that will compel advanced treatment; e.g. removal of nitrogen, of on-site wastewater discharges in certain environmentally sensitive areas.

Stormwater management is another area in which the state and local governments must work together to implement effective pollution control strategies. DEM previously was able to provided grants to 36 municipalities to support development of local stormwater management plans. These plans outline actions that will be undertaken at the local level to comply with new stormwater permit requirements associated with implementing Phase II in Rhode Island. Support for implementing the plans will be crucial to controlling and mitigating the pollutant loadings stemming from stormwater discharges.

DEM, working with CRMC, is also updating the state's guidance manual on the design of stormwater management best management practices. In overhauling this manual, DEM expects to (1) adopt low impact development as a primary strategy for reducing and managing stormwater; 2) strengthen requirements to treat stormwater to accomplish water quality goals, and (3) require greater use of infiltration.

Legislation in 2004 created a RI Environmental Monitoring Collaborative (RIEMC) and mandated the development of a comprehensive monitoring strategy. DEM has developed a monitoring strategy focused on surface waters, which will be refined by the RIEMC. The significant gaps in available data will be addressed by employing a mix of strategies that includes fixed-site networks, a rotating basin approach, targeted surveys and the expanded use of biological indicators. Additional investment will be required to fully implement the strategy.

To promote restoration of water quality, DEM is continuing to focus on the development and implementation of restoration plans, known as Total Maximum Daily Loads (TMDLs) which characterize water pollution problems and recommend abatement action in targeted watersheds. As of February 2006, TMDLs have been approved by EPA for 38 waterbodies. DEM is giving priority in the distribution of 319 grants to TMDL implementation projects.

On an agency-wide basis, DEM is also promoting watershed-based approaches to resource protection and management. The goal of working on a watershed basis is to foster greater collaboration and coordination among all stakeholders to enhance protection or restoration efforts. Five watershed action plans have been completed. Seven local watershed council have been formally designated by the RI Rivers Council.

The watershed approach is also reflected in legislation creating a new Coordination Team, comprised of state agencies, for the management of Narragansett Bay and its watershed.

Since the inception of the federal CWA, Rhode Island has invested over $872 million in federal and state funds in the construction of wastewater treatment systems and other water pollution initiatives. Despite this commitment, Rhode Island continues to face a large future financing need with respect to pollution control infrastructure. A recent estimate by the Finance Panel of the Governor's Narragansett Bay and Watershed Planning Commission identified over a $1 billion in potential future expenses.

II. BACKGROUND

A. ATLAS

State Population: 2000 - 1,048,319
2004 estimate – 1,080,632

State Surface Area: Land Only - 1,058 $Mi.^2$
Total Area* - 1,214 $Mi.^2$
(*Including Inland Waters; Excluding Estuarine Areas)

Number of Major Watersheds: 10
Number of 8 digit HUCs: 5

Total Stream/River/ Miles: 1,498 Miles
(1:24,000 RIGIS)

Lakes/Ponds Total Acreage : 20,917 Acres
(1:24,000 RIGIS)

WETLAND TYPE	**AREA** (acres)
Riverine Nontidal Open Water	1832
Lacustrine Open Water	17,518
Palustrine Open Water	4481
Palustrine Emergent Wetland: Marsh/Wet Meadow	4341
Palustrine Emergent Wetland: Emergent Fen or Bog	229
Palustrine Scrub-Shrub Wetland: Shrub Swamp	9606
Palustrine Scrub-Shrub Wetland: Shrub Fen or Bog	2060
Palustrine Forested Wetland: Deciduous	60,694
Palustrine Forested Wetland: Coniferous	10,900
Palustrine Forested Wetland: Dead	225
Riverine Tidal Open Water	7.4
Estuarine Open Water	8175
Estuarine Emergent Wetland	4014
Estuarine Scrub-Shrub Wetland	93
Marine/Estuarine Rocky Shore	671
Marine/Estuarine Unconsolidated Shore	2874
TOTAL AREA	127,721 acres

Area of Estuarine Waters: 156.4 square miles

Coastal Shoreline Miles: 78.62 miles

B. WATER POLLUTION CONTROL PROGRAM

1. Watershed Approach

The watershed approach is a better way of managing our natural resources. The approach brings together government agencies, interest groups, businesses, and citizens to work on environmental issues ranging from water quality protection to open space acquisition within a watershed. The partnership aims to coordinate what have traditionally been separate government programs to use existing resources more effectively. Watershed partners share ideas, pool resources and work together to meet common goals to protect the environment on a regional basis.

With respect to Narragansett Bay and its watershed, legislation in 2004 created a Coordination Team for the management of Narragansett Bay. This formalizes and institutionalizes coordination among key state agencies with respect to the Bay and its watershed. The Coordination Team is engaged in development of a systems-level plan that establishes goals and priorities for water quality protection and restoration and the sustainable economic development of water-related businesses. By working with advisory committees that involve additional stakeholders, the Coordination Team will operate in a manner that reflects the principles of watershed-based resource management.

The legislature also strengthened DEM's authority for watershed-based management in separate legislation. The watershed approach continues to be reflected in environmental initiatives undertaken by DEM including its TMDL program which is further described in Chapter III.A.8. Other examples include planning for growth management, greenspace and riparian buffer protection and wetland restoration.

The RI Rivers Council has designated 10 watershed councils and is continuing develop programs to build capacity within these local organizations. Pursuant to legislation passed in 2004, the RI Rivers Council has been transferred to the RI Water Resources Board and is charged with planning and coordinating efforts to protect and restore Rhode Island's rivers.

2. Water Quality Standards Program

The Standards Section of the Office of Water Resources (OWR) implements the state's Water Quality Standards Program. The Water Quality Standards Program is responsible for ensuring compliance with the Federal Clean Water Act (CWA). The purpose of this program is to restore, preserve, and enhance the water quality of Rhode Island waters, to maintain existing uses and to protect the waters from pollutants so that the waters shall, where attainable, be fishable and swimmable, and be available for all designated uses and thus assure protection for the public health welfare, and the environment. These objectives are implemented through the water quality standards which are a fundamental element of the state's Water Quality Regulations. The water quality standards are developed to define water quality goals for the state's waters by deciding what their uses will be (designated uses), setting criteria necessary to protect those uses and developing policies to prevent degradation of water quality. In addition to establishing water quality goals for state waters, surface water quality standards also serve as the regulatory basis for the establishment of water-quality-based treatment controls and strategies beyond technology-based controls.

The present water quality condition of each waterbody may, or may not, fully support the designated goal. However, all activities which require an environmental approval must conform to the water quality criteria necessary to attain the designated use for that waterbody. Waters whose quality exceeds the minimum water quality criteria or water quality standard assigned to them are protected to maintain their high quality under the Antidegradation provisions of the Water Quality Regulations.

As described in the Water Quality Regulations, all surface waters of the state are assigned to one of four freshwater (Class AA, A, B, B1), or one of three saltwater (Class SA, SB, SB1), classifications. Each class is defined by the designated uses (see Section 2.1) which are the most sensitive and, therefore, governing water use(s) which it is intended to protect. Surface waters may be suitable for other beneficial uses, but are regulated to protect and enhance the designated uses. Another classification, Class C or SC, is available should it be proven through a Use Attainability Analysis (UAA) that this classification is appropriate. This C or SC classification is not, however, currently designated to any waterbodies because it does not meet the "swimmable" goals of the CWA.

In addition, the state has incorporated partial use classifications into the Water Quality Regulations. Partial use denotes specific restrictions of use assigned to a waterbody or waterbody segment that may affect the application of criteria. Partial use designations have been adopted in the Water Quality Regulations for waters which will likely be impacted by activities such as combined sewer overflows (CSOs) and concentrations of vessels (marinas and/or mooring fields). Partial use designation for waters impacted by CSOs are denoted by "{a}" following the classification. Partial use designation for waters with concentration of vessels are denoted by "{b}" following the classification. The Rhode Island Water Quality Classifications are as follows:

<u>Freshwater</u>:

(a). Class AA[@] - These waters are designated as a source of public drinking water supply (PDWS) or as tributary waters within a public drinking water supply watershed (the terminal reservoir of the PDWS are identified in Appendix A), for primary and secondary contact recreational activities and for fish and wildlife habitat. These waters shall have excellent aesthetic value.

(b). Class A - These waters are designated for primary and secondary contact recreational activities and for fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have excellent aesthetic value.

(b). Class B[*] - These waters are designated for fish and wildlife habitat and primary and secondary contact recreational activities. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value.

(c). Class B1[*] - These waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges. However all Class B criteria must be met.

(d). Class C - These waters are designated for secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for compatible industrial processes and cooling, hydropower, aquacultural uses, navigation, and irrigation and other agricultural uses. These water shall have good aesthetic value.

@ Class A waters used for public drinking water supply may be subject to restricted recreational use by State and local authorities.

* Certain Class B and B1 waterbody segments may have partial use designations assigned to them.

<u>Seawater</u>:

(a). Class SA* - These waters are designated for shellfish harvesting for direct human consumption, primary and secondary contact recreational activities, and fish and wildlife habitat. They shall be suitable for aquacultural uses, navigation and industrial cooling. These waters shall have good aesthetic value.

(b). Class SB* - These waters are designated for primary and secondary contact recreational activities; shellfish harvesting for controlled relay and depuration; and fish and wildlife habitat. They shall be suitable for aquacultural uses, navigation, and industrial cooling. These waters shall have good aesthetic value.

(c). Class SB1 * - These waters are designated for primary and secondary contact recreational activities and fish and wildlife habitat. They shall be suitable for aquacultural uses, navigation, and industrial cooling. These waters shall have good aesthetic value. Primary contact recreational activities may be impacted due to pathogens from approved wastewater discharges. However all Class SB criteria must be met.

(d). Class SC - These waters are designated for secondary contact recreational activities, and fish and wildlife habitat. They shall be suitable for aquacultural uses, navigation, and industrial cooling. These waters shall have good aesthetic value.

* Certain Class SA, SB and SB1 waterbody segments may have partial use designations assigned to them .

In addition, the state has incorporated partial use classifications into the Water Quality Regulations. Partial use denotes specific restrictions of use assigned to a waterbody or waterbody segment that may affect the application of criteria. For example, a partial use designation may be appropriate where waters are impacted by activities such as combined sewer overflows and concentrations of vessels.

<u>Partial Uses:</u>

(a). <u>CSO</u> - These waters will likely be impacted by combined sewer overflows in accordance with approved CSO Facilities Plans and in compliance with rule 19.E.1 of the Water Quality Regulations and the Rhode Island CSO Policy. Therefore, primary contact recreational activities; shellfishing uses; and fish and wildlife habitat will likely be restricted.

(b). Concentration of Vessels - These waters are in the vicinity of marinas and/or mooring fields and therefore seasonal shellfishing closures will likely be required as listed in the most recent (revised annually) RIDEM document entitled Shellfish Closure Areas. For Class SA waters, all Class SA criteria must be attained at all times.

The surface waters of the state are classified according to the list of water segments in Appendix A of the Water Quality Regulations. For waters not listed in Appendix A, the following apply:

(1). All streams tributary to Class A waters shall be Class A.

(2). All freshwaters hydrologically connected by surface waters and upstream of Class B, B1, SB, SB1, C or SC waters shall be Class B unless otherwise identified in Appendix A of these regulations.

(3). All other fresh waters, including, but not limited to, ponds, kettleholes and wetlands not listed in Appendix A shall be considered to be Class A.

(4). All seawaters not listed in Appendix A shall be considered to be Class SA. All saltwater and brackish wetlands contiguous to seawaters not listed in Appendix A shall be considered to be Class SA.

(5). All saltwater and brackish wetlands contiguous to seawaters listed in Appendix A shall be considered the same class as their associated seawaters.

3. TMDL Development – Water Quality Assessment Projects

The state's 303(d) list identifies the state's impaired waterbodies and provides a scheduled time frame for development of water quality restoration plans, also known as Total Maximum Daily Loads (TMDLs). The goal of the state's TMDL program is to develop and implement water quality restoration plans aimed at restoring impaired waterbodies to an acceptable condition that meets water quality standards and supports the waterbodies' designated uses (e.g. fishable and swimmable condition). Through the TMDL development process, water quality conditions are more thoroughly characterized and pollution sources, both point and non-point, identified providing the technical basis for the pollution abatement actions specified in the water quality restoration plans. Development of TMDLs can take over two years - typically including at minimum one year of data collection and the remainder of the time in data analysis, report writing, and review by EPA and the public. The 303(d) list's Group 1 identifies those waterbodies where TMDL development is currently underway (or expected to be initiated within two years of the 303(d) list publication).

As of February 2006, TMDLs for 38 waterbodies have been approved by US EPA. RIDEM is mandated by the federal Clean Water Act to prepare TMDLs for the state's impaired waterbodies, however much of the responsibility of implementing the TMDLs falls upon municipalities – with the most costly pollution control actions being upgrades to municipal wastewater treatment facilities and stormwater treatment systems. Private property owners also have a role to play in restoring the state's waters and certain TMDLs have specifically identified the need for corrective actions on private property. In addition, watershed councils and other non-profit organizations play a vital role in gaining popular support by educating the public as to the need for the various corrective actions and in implementing these water quality initiatives. Once the necessary corrective actions have been identified and a TMDL is completed, RIDEM works with other state and federal agencies, municipalities, watershed organizations, and private property owners to implement the TMDLs recommendations. A listing of approved TMDLs is shown in Table 2-1. More information, including access to reports, is available at http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm.

Table 2-1 Approved TMDLs as of February 2006

Waterbody	Parameter	Date approved by US EPA
Stafford Pond	Nutrients/ Excess Algal Growth/Low DO	March 1999
Hunt River	Pathogens	January 2001
Scrabbletown Brook	Pathogens	January 2001
Fry Brook	Pathogens	January 2001
Palmer River	Pathogens	May 2002
Runnins River	Pathogens	September 2002
Barrington River	Pathogens	September 2003
Narrow River including Mumford Brook	Pathogens	April 2002
Gilbert Stuart Stream	Pathogens	April 2002
Crooked Brook	Pathogens	February 2003
Saugatucket River	Pathogens	August 2003
Mitchell Brook	Pathogens	August 2003
Indian Run Brook	Pathogens	August 2003
Rocky Brook	Pathogens	August 2003
Yawgoo Pond	Phosphorus/ Excess Algal Growth/Low DO	June 2004
Barber Pond	Low DO	June 2004
Chickasheen Brook	Noxious Aquatic Plants/Phosphorus	June 2004
Sakonnet River	Pathogens	April 2005
The Cove	Pathogens	April 2005
Green Hill Pond	Pathogens	February 2006
Ninigret Pond	Pathogens	February 2006
Factory Pond Brook	Pathogens	February 2006
Teal Brook	Pathogens	February 2006
Greenwich Bay	Pathogens	February 2006
Greenwich Cove	Pathogens	February 2006
Apponaug Cove	Pathogens	February 2006
Brushneck Cove	Pathogens	February 2006
Buttonwoods Cove	Pathogens	February 2006
Warwick Cove	Pathogens	February 2006
Hardig Brook,	Pathogens	February 2006
Tuscatucket Brook,	Pathogens	February 2006
Maskerchugg River	Pathogens	February 2006
Baker Creek	Pathogens	February 2006
Dark Entry Brook	Pathogens	February 2006
Fosters Brook	Pathogens	February 2006
Greenwood Creek	Pathogens	February 2006
Southern Creek	Pathogens	February 2006

4. Point Source Control Program

The OWR regulates the design, construction, and operation and maintenance of wastewater treatment facilities. Wastewater discharge permitting and the implementation of the pretreatment program as well as stormwater permitting, is carried out by OWR through the federally delegated Rhode Island Pollution Discharge Elimination System (RIPDES) Program. The OWR staff also conduct operation and maintenance inspections and compliance evaluations at all major and minor municipal facilities. Review and approvals of wastewater facility plans, engineering reports and engineering plans and specifications for WWTF improvements, sanitary sewer systems and marine sewage pumpout facilities are conducted by the OWR staff.

a. Permitting

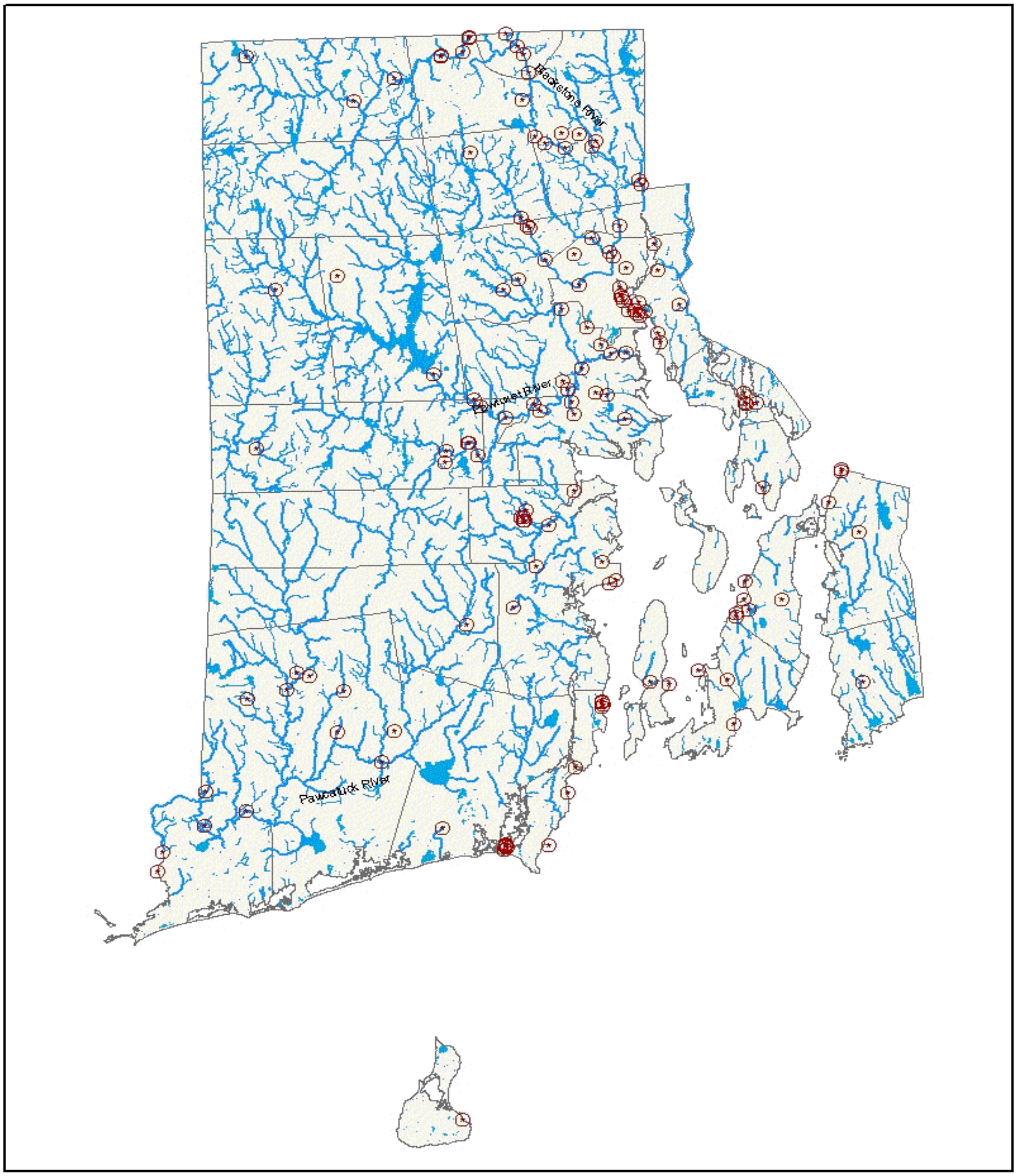
i. RIPDES

The Office of Water Resources (OWR) was delegated the authority to implement the National Pollution Discharge Elimination System (NPDES) Program, referred to as the RIPDES Program in Rhode Island, on September 17, 1984. The focus of the RIPDES Program has shifted from a treatment technology based permitting approach used in the past, to now stress the development of water quality based permit limitations that ensure that the receiving water will comply with applicable water quality criteria. Currently, the RIPDES Program has 19 active major municipal permittees with a total average daily permitted flow of 196.5 MGD and 6 active major industrial permittees with a total average daily permitted flow of 353.2 MGD (includes 345 MGD of cooling water). In addition to major facilities, the RIPDES Program is also responsible for permitting minor facilities. Figure 2-1 shows the location of the RIPDES permittees.

All of the major industrial and municipal RIPDES permits either contain water quality based limits or an analysis has been conducted which shows that water quality based limits are not necessary. The resulting permits typically contain limitations which permittees are unable to immediately comply with and, therefore, compliance schedules must be developed. It is a priority of the RIPDES Program to ensure that permittees complete the steps contained in these compliance schedules such that compliance with water quality based permit limits is achieved.

WWTFs are a significant source of nitrogen to the Seekonk River, Providence River and Upper Narragansett Bay. Excessive nutrient levels result in large algal blooms and violations of the minimum dissolved oxygen standards established to protect aquatic life. RIDEM has developed a phased plan for implementation of WWTF improvements based on consideration of implementation costs, analysis of the performance of available technology, and estimates of water quality improvements from experimental data. This implementation plan was presented and is consistent with the 50% reduction from the 1995-1996 WWTF loadings recommended by the Governor’s Narragansett Bay and Watershed Planning Commission that was also recently signed into law.

Figure 2-1 : **Locations of RIPDES Discharges**



As a result, by 2006, improvements at 8 WWTFs resulted in a 35% reduction in nitrogen loadings from the 11 RI facilities contributing to the upper Bay based on current WWTF flows. Two of these eight facilities (NBC Bucklin Point and Woonsocket) require additional modifications to achieve their permit limits of 5 mg/l. Status of the three remaining facilities is as follows: NBC Fields Point is in the processing of designing upgrades to achieve 5 mg/l (seasonal), East Providence has submitted a facilities plan to DEM and limits for the Warren WWTF are anticipated. To further control loadings to the Seekonk River, DEM has advocated strongly for comparable reductions from several Massachusetts WWTFs located upstream on the Blackstone and Ten Mile Rivers, the largest of which is the Upper Blackstone Water Pollutant Abatement District WWTF that serves the Worcester area. The RIPDES permits for 10 WWTFs contain the appropriate limits and 1 permit must be modified.

The RIPDES Program is also involved in the Narragansett Bay Commission (NBC) and Newport Combined Sewer Overflow (CSO) abatement planning projects. Currently there are four CSO treatment structures in Rhode Island. The NBC's Wet Weather Facility located at the Fields Point Wastewater Treatment Facility (WWTF) provides primary treatment for up to 123 MGD of wet weather flow. NBC's Wet Weather Facility located at Bucklin Point WWTF provides primary treatment for up to 70 MGD of wet weather flow. Newport's Washington Street CSO Facility provides storage for flow resulting from up to a three month storm and provides treatment for flows up to the one year storm. The third CSO treatment facility is Newport's Wellington Avenue Micro-strainer facility.

The NBC completed and received DEM approval of all final designs for the Phase I CSO facilities, which include the Main Spine Tunnel, Near Surface Facilities, the Bucklin Point wet weather treatment facility and Drop and Vent Shafts. NBC has initiated 14 of the 15 construction contracts for Phase I. The revised target date to complete all Phase I construction is October 2008. Phases II and III include the Pawtucket Tunnel, CSO interceptors, various sewer separation projects, and a wetland/lagoon treatment system which will proceed at a later date.

Other RIPDES Program responsibilities include the following: issuance of RIPDES permits to discharges necessary for the remediation of contaminated groundwater at Superfund and RCRA sites (including Davis Liquid, Rose Hill and Stamina Mills); issuance of general permits for discharges associated with the treatment of gasoline and/or #2 fuel oil contaminated groundwater; inspections of permitted facilities; and finalization of a general permit for discharges of non-contact cooling water.

ii. Pretreatment

OWR evaluates the status of the Publicly Owned Treatment Works (POTWs) Industrial Pretreatment Programs through Pretreatment Audits, Pretreatment Compliance Inspections (PCIs), review of updated program documentation as required (e.g., sewer use ordinances, technically-based local limits evaluations, enforcement response plans, sampling/inspection procedures, etc.), and review of annual reports required by POTW RIPDES permits. Moreover, the OWR continues to provide the POTWs with technical assistance and guidance in categorizing Industrial Users, interpretation and implementation of pretreatment regulations, administration of their pretreatment programs and enforcement issues.

The OWR provides ongoing oversight of fifteen approved local pretreatment programs. These programs regulate approximately 300 Significant Industrial Users (SIUs), over half of which are subject to Federal Categorical Pretreatment Standards.

The OWR's Pretreatment Section is also responsible for evaluating and assisting approved local pretreatment programs by regularly reviewing requests for modifications to existing local pretreatment programs in accordance with Federal and State Pretreatment Regulations.

Pretreatment Enforcement Tracking (PETs) data is entered directly into the EPA central computer database.

iii. Stormwater

The OWR initiated a Stormwater Permitting Program using funds from EPA's Section 104(b)(3), in 1992. Stormwater regulations and general permits for discharges of stormwater associated with industrial activity and construction activity disturbing greater than 5 acres became effective March 1993. The OWR continues to permit both construction activities and industrial facilities under these permits.

In February 2003, the RIPDES regulations were amended to include EPA's Phase II stormwater regulations that cover operators of small separate storm water systems (MS4s) in "urbanized areas" (UAs) as defined by the Bureau of the Census as well as construction activities disturbing equal to or greater than 1 acre and less than 5 acres.

The OWR issued the Small MS4 General Permit which became effective on December 2003. The General Permit required the MS4 operators to develop a Storm Water Management Program Plan (SWMPP) and to submit Annual Reports to document implementation of the plans. To date the OWR has reviewed and commented on 33 SWMPPs submitted by Cities and Towns and the RIDOT, and has reviewed the Annual Reports for the first year of program implementation.

The OWR issued a revised Construction General Permit which became effective September 2003. The General Permit included requirements for Phase II construction activities (>1 and <5 acres). The revised permit streamlines the permitting process by recognizing coordination between State and Local permitting programs. The Phase II small MS4 Regulations required all regulated small MS4 operators to develop a Qualified Local Program.

The OWR is also working on the issuance of a multi-sector stormwater permit. This permit will establish industrial "sectors" for various groups of industrial categories. The multi-sector stormwater permit will have permit requirements that are specific to each industrial category such as benchmark monitoring of storm water discharges used to evaluate the effectiveness of the facilities' Storm Water Pollution Prevention Plan (SWPPP).

iv. Sludge Management

The DEM/OWR has "Rules and Regulations Pertaining to the Disposal, Utilization and Transportation of Wastewater Treatment Facility Sludge." The regulations contain requirements dealing with land application, land disposal, composting (and other treatment methods), incineration, and distribution/utilization of sludge generated by municipal wastewater treatment facilities. The state will continue to issue Orders of Approval to wastewater treatment plants for the treatment, disposal, distribution, and utilization of sewage sludge, in accordance with the regulations. All sludge sites are inspected at least once per quarter to assure compliance with the regulations.

v. Water Quality Certification

The OWR administers the Water Quality Certification (WQC) Program aimed at insuring that certain types of projects or activities do not adversely impact the quality of the state's surface water resources. Water Quality certification is required by Section 401 of the Clean Water Act.

The WQC review consists of an evaluation of compliance with water quality standards, especially designated uses. Included in the certification review process are activities such as dredging projects, fill projects, site disturbances, marina construction or expansion, flow alterations and harbor management plans. The recent Water Quality Regulation triennial review adopted new processing procedures for WQC approvals.

vi. Enforcement/Permit Compliance

DEM recognizes that protection of water quality requires effective compliance oversight and enforcement of regulations concerning water pollution control. Under DEM's current structure, certain enforcement capabilities are consolidated within the Office of Compliance and Inspection (OC&I). Generally, this Office will be issuing formal Notices of Violation (NOVs) and investigate the majority of water-related complaints. Contested matters are generally appealed to the DEM Office of Administrative Adjudication.

OWR intends to encourage and/or maintain high level of voluntary compliance in programs such as RIPDES via administrative actions. Compliance matters requiring formal enforcement will be referred from OWR to OC&I as warranted. Resolution of any formal NOV is achieved by close coordination between the two offices, particularly in matters that involve obtaining a permit.

When needed, OWR supports formal enforcement actions by providing additional technical staff expertise and assistance in contested cases or as needed.

Within the RIPDES Program, OWR oversees compliance with permit requirements including computerization of data and issuing SNC letters. The RIPDES and Pretreatment Programs utilize EPA's Permit Compliance System (PCS) to track compliance with program requirements including, but not limited to the generation of the Quarterly Non-Compliance Reports (QNCRs).

vii. Wastewater Treatment Facilities Program

This program is responsible for the review and approval of wastewater facilities plans (a 20 year master plan for a community's wastewater needs), engineering reports and engineering design plans and specifications. Plans and specifications reviewed and approved include wastewater treatment facilities (WWTF) improvements, wastewater collection system expansion/improvements (projects with more than 30,000 gpd flow on an average daily basis) and marine sewage pumpout facilities. In addition, this program routinely performs field inspections of wastewater-related construction projects which are funded by the OWR's Funding Assistance Program, or are required as part of an enforcement action.

This program also has an active role in reviewing privatization agreements between municipalities and private companies hired to operate and maintain wastewater treatment and/or collection facilities, as well as providing system-wide capital improvements.

b. Point Source Control Monitoring Programs

i. Whole Effluent Toxicity Testing

Nineteen major wastewater treatment facilities, six minor sanitary wastewater treatment facilities, and 5 major industrial facilities are required to perform bioassays to evaluate whole effluent toxicity associated with their discharges. The results of these bioassays are used to determine whether further biomonitoring and/or toxicity reduction is needed in addition to permit limitations. Oversight and implementation of the WET testing program and evaluation of a whole effluent toxicity enforcement strategy is conducted by the OWR.

ii. User Fee Program

Chapter 46-12.4 of the Rhode Island General Laws authorized the Director of the Department of Environmental Management (DEM) to establish a system whereby fees were to be assessed for point source discharges into State waters. For the purposes of this act, a program has been implemented since 1983 in which effluent samples are collected at a minimum, annually, at all municipal dischargers and selected major and minor industrial dischargers. This constitutes sampling at a total of approximately 25 sites per year (cycle), with the major facilities being sampled 2 times per year. Sampling frequency depends upon the amount and type of pollutants present in the sample, with more frequent sampling performed at those discharges which are of greater environmental concern. These effluent samples are analyzed for EPA "Priority Pollutants." This data is utilized in permit revision evaluations and water quality impact analyses.

iii. Wastewater Facility Operation and Maintenance/Compliance Evaluations

The Operation and Maintenance (O & M) Section within the Wastewater Treatment Facilities Program of OWR protects the quality of the state's waters by regulating the proper operation and maintenance of wastewater systems. The O&M staff conducts regular inspections as needed as well as annual inspections of major permittees (municipal and industrial) utilizing revised EPA Compliance Evaluation Inspection Forms. Effluent sampling is no longer a part of these annual inspections. These inspections include a full plant walk-through and discussions with responsible plant personnel; however as-needed inspections on issue-specific items (such as odor control) may only involve a portion of the plant. At each inspection, O&M inspectors comment on general plant operations, maintenance, or housekeeping improvements. Less frequently, staff also inspects the various off-site wastewater pump stations for preventative purposes (approximately every 3 years or as needed).

The O&M staff also investigates and, as appropriate, refers for possible enforcement action any failures, emergencies or bypasses at these facilities or their pump stations/collection systems. There are roughly 30 - 60 such occurrences each year.

O&M staff also assists in the administration of EPA QA/QC programs for wastewater laboratories. Most recently the O&M Section has coordinated with the RIDOH to increase laboratory oversite during regular plant inspections.

On-going projects also include redrafting the O&M regulations and developing a program for the re-use of treated wastewater.

iv. Wastewater Facility Operation and Maintenance/Operator Certification

The O&M program provides administrative support and engineering assistance to the Rhode Island Board of Certification of Operators of Wastewater Treatment Facilities. The O&M Section's Principal Engineer is the Board's chair.

v. Wastewater Facility Operation and Maintenance/Operator Training

The O&M section also administers the Municipal Assistance/Operator Training Program, which is designed to provide on-site and classroom training on general or plant-specific technical (and non-technical) issues. The goal of the assistance is to bring plants into compliance or maintain compliance. Over the past year the program has focused on optimizing current facilities for ammonia and total nitrogen removal. A new initiative will be the development of online training programs.

5. Nonpoint Source Control Program

The RIDEM's Nonpoint Source Pollution Management Program, supported with federal Clean Water Act funding (Section 319), is focused on developing and implementing strategies to mitigate existing and prevent new sources of nonpoint source pollution. The non-regulatory program, administered by the DEM-OWR, is involved in a number of activities and coordinates with a number of other federal, state and other entities to achieve its goals of mitigation and prevention. Priority areas of focus include: (1) Onsite wastewater disposal system management; (2) Stormwater management; (3) implementation of BMPs consistent with TMDL recommendations; (4) promoting environmentally sound land use planning and (5) promoting clean marinas including no unacceptable discharges from boats. Additionally, the state recognizes the need for watershed-based plans to provide an appropriate technical basis for implementing protection and restoration strategies.

a. On-Site Wastewater Management

The Nonpoint Source Management Program has continued to work toward improved management of on-site wastewater systems, more commonly known as septic systems. Prior accomplishments include the implementation of soil based siting, licensing of designers and development of a program to review and approve innovative and alternative technologies. With the program improvements DEM has documented a significant increase in the installation of innovative and alternative technologies, including advanced treatment technologies that reduce the pollutant load over that of a conventional system. DEM-OWR estimates that over 6,200 systems have been installed using I& A technologies or components. Of this number, about 1,800 involved technologies for advanced treatment to reduce nutrient loadings. DEM expects this number to continue to rise given changes being proposed to statewide regulations that will mandate advanced treatment in certain environmentally sensitive areas such as the watersheds of the coastal ponds.

DEM estimates that Rhode Island has 57,000 substandard septic systems, many of them cesspools, among the 150,000 on-site systems in operation. DEM is continuing to encourage such systems to be replaced. Note: New state legislation in 2007 has mandated that certain systems must be taken out of service. DEM will be developing rule changes and working with municipalities to implement this new requirement.

DEM has also continued to work with municipalities to develop local capacity to promote effective on-site wastewater management. Toward this end, DEM provided funding assistance to develop and implement local wastewater management plans. As a result, 23 of 27 are developing or implementing local wastewater management plans. To support local inspection programs, DEM previously developed and published the *Septic System Checkup*, which provides guidance on how to inspect and maintain septic systems.

DEM continues to work with the Rhode Island Clean Water Finance Agency on the implementation of the Community Septic System Loan Program (CSSLP), which was instituted in 1999. CSSLP provides low-interest loan funds for the purpose of septic system repair and replacement. Establishing a local wastewater program is a prerequisite to qualify for a loan. As of March 2007, nine communities have been made available $4,150,000 in loans to support repair work in their communities.

b. Stormwater Management

Stormwater discharges are an important cause of impairments in many of the state's impaired surface waters. Given the densely developed landscape of RI, much of the problem is associated with existing untreated stormwater discharges. As a result of experiences in the TMDL program and the advent of the Phase II stormwater program under the RIPDES Program in 2003, DEM has increased its attention on stormwater management issues. Efforts are underway to strengthen requirements for BMPs applicable to new development and redevelopment projects. Policies and technical guidance has been developed to promote upland attenuation and retrofitting within existing stormwater systems to reduce untreated stormwater discharges. However, it is clear that successfully abating the problems associated with widespread untreated stormwater discharges will require that expanded efforts by the state, municipalities and private landowners be sustained over a period of years to achieve measurable progress in restoring water quality.

To help *prevent* the adverse effects of stormwater discharges, the DEM accomplished the following:

- Via the NPS Program, awarded $825,000 in state funded planning grants to 33 municipalities to support development of local stormwater management plans. DEM had previously provided funding to Warwick, West Warwick and Cranston as part of a pilot program. As a result 36 of 39 municipalities have for the first time some form of local stormwater plans (draft or final).

- With stakeholders, coordinated drafting an update to the manual of recommended stormwater best management practices. DEM is currently working on incorporating additional guidance regarding low impact development into the manual. Finalization of the manual, expected to be used in DEM and the Coastal Resources Management Council (CRMC) regulatory programs, is expected in 2008.

- Via collaboration of the Phase II Program and NPS programs, developed guidance materials on stormwater BMPs , financing of stormwater programs and provided access to this toolbox of information via the DEM web-site. DEM is also working with RI Department of Transportation, URI Cooperative Extension and other partners to develop training and public outreach about stormwater management.

- Within the DEM-OWR programs, developed policies to encourage greater upland attenuation and infiltration of stormwater to reduce volumes directly discharged into surface waters.

- Promoted Low Impact Development (LID) as a planning tool that can minimize runoff volumes from new developments.

c. Nonpoint Source Pollution Request for Competitive Grant Proposals

In 1999, the NPS program initiated a competitive solicitation for grant proposals related to implementation of nonpoint source pollution abatement using incremental 319(h) funding (i.e., Clean Water Action Plan funding). The RFP has been repeated as resources have allowed. As of 2006, a total of 63 projects have been awarded over $4 million in federal 319 funds. Projects have included building covered salt storage facilities, stormwater treatment BMPs, habitat restoration among others. In recent years, the RFP has focused on supporting water quality restoration actions consistent with recommendations of completed TMDLs. As of January 2007, 36 projects have been completed, and 27 remain active. Table 2-2 lists projects that have been undertaken through the competitive granting process. (Note: Projects are listed with the RFP year from which the initial grant award was made. For fiscal and grant management reasons, actual reimbursements to grantees may be paid from a different year subject to EPA approval.)

Table 2-2

Water Quality Restoration Actions[1]
In 1999

Sponsor & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Glocester Chepachet River	Onsite Construction of Demonstration Wastewater Systems and Stormwater Management Planning	A recent study, commissioned by the Town of Glocester, indicates some pathogens and nutrients from wastewater and stormwater inputs to the Chepachet River and Chepachet River Aquifer.	Design and build innovative septic systems as a demonstration project and develop a stormwater abatement plan.	$72,212
Providence Woonasquatucket River	Woonasquatucket/Lincoln, Lace and Braid Sluiceway Removal and Wetland Restoration	Biodiversity, pathogens, PCBs, dioxin and metals--this project will address VOCs, low Do, bacteria and habitat/wetland restoration.	Remove the sluice and restore freshwater wetlands values in the area.	$71,400
NRICD & Cranston Providence River (Still House Cove)	Still House Cove Stormwater BMP Feasibility	Stormwater has caused sedimentation and degradation of a salt marsh complex, which is inundated with Phragmites. Project compliments the Providence River TMDL.	Design a stormwater abatement BMP.	$14,614
Warwick Greenwich Bay	Greenwich Bay Watershed Stormwater Treatment Feasibility and Implementation Project	Pathogens, nutrients and hypoxia--Stormwater outfalls were previously identified in an Aqua Fund project or by URI in a TMDL study.	Design and install stormwater abatement BMPs at eight outfalls.	$240,000
SRICD Greenwich Bay	Brush Neck Cove Stormwater Abatement and Restoration Interim Measures	Pathogens, nutrients and hypoxia--Stormwater outfalls were previously identified in an Aqua Fund project and by URI in a TMDL study.	Investigate retrofit potentials for 10 stormwater systems, identify a priority listing of stormwater systems for future work and conduct public outreach.	$99,244
E. Greenwich Greenwich Cove	Greenwich Cove Stormwater Feasibility	Hypoxia and nutrients--E. Greenwich has identified three stormwater outfalls, which are considered major contributors.	Develop conceptual engineering designs for stormwater BMPs at 8 locations.	$15,000
Portsmouth Sakonnet River (Portsmouth Pk.)	Facilities Plan Update and Feasibility Study for Portsmouth and Island Parks	Pathogens--In a recent DEM study failed septic systems and stormwater were identified as sources of impairment.	Develop engineering designs for stormwater and wastewater abatement throughout Portsmouth and Island Park.	$60,000
North Kingstown & STB Wickford Harbor	Wickford Harbor Stormwater BMP Feasibility and Smart Growth Implementation	Wickford Harbor is conditionally closed to shellfishing, primarily due to its proximity to marinas.	Develop engineering designs and smartgrowth BMPs for stormwater abatement.	$59,384
TOTAL				$631,854

[1] Water quality restoration projects: (a) support restoration of waters impaired by nonpoint source pollution (NPS) or hydromodification; and/or (b) improve aquatic habitats degraded by NPS; and/or (c) demonstrate the utility of innovative approaches to solving water quality problems. Funding for these projects is provided under section 319 of the Clean Water Act.

Table 2-2 continued

Water Quality Restoration Actions
In 2000

Sponsor & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Smithfield Stillwater Reservoir	Smithfield Salt Storage Shed	Leachate from the uncovered municipal salt pile erodes into the watershed and possibly underlying aquifer.	Build a salt storage facility.	$ 66,000
Providence York Pond/ Seekonk River	York Pond Restoration	Stormwater is contributing sediment and other pollutant loading to York Pond, which flows into the Seekonk.	Implement stormwater mitigation habitat improvements to York Pond.	$161,762
Warren Warren (i.e., Kickemuit) Reservoir	Warren Reservoir Fish Way	Loss of an anadromous fish run (including an Alewife run) due to an impoundment for a drinking water supply.	Design and build a fish way.	$ 82,000
Warren Kickemuit River	Patterson Avenue Drainage Project	Stormwater runoff from the Patterson Avenue area containing TSS, metals, TPH, oil and grease is impacting the Kickemuit.	Installation of a Vortech unit and oil separator.	$ 72,000
Tiverton Unnamed wetland	Tiverton Salt Storage Facility	Salt leachate from an uncovered salt pile erodes into a nearby wetland.	Build a salt storage facility.	$ 63,600
Cranston Providence River	Cranston BMP Implementation	Hydrocarbons, metals, sand, floating debris in 3 stormwater outfalls at the ends of Armington, Norwood and Shaw avenues impact the Providence River.	Installation of 3 Vortech units and the purchase of a vacuum truck for maintenance of the Vortech units.	$118,380
TOTAL				$563,742

Table 2-2 continued

Water Quality Restoration Actions In 2001

Sponsor & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Smithfield Stillwater Reservoir	Public Works Facility Restoration Project	Soil erosion from an unprotected site has resulted in sedimentation of a nearby wetland adjacent to Stillwater Reservoir.	Project involves design, permitting and construction a stormwater detention pond and restoration of wetlands near Stillwater Reservoir in the Woonasquatucket Watershed.	$72,000
Cranston Providence River (Still House Cove)	Still House Cove Restoration	Stormwater has caused sedimentation and degradation of a salt marsh complex, which is inundated with Phragmites. Project compliments the Providence River TMDL.	Installation of a Vortech unit and restoration of estuarine wetlands.	$140,292
Warren Kickemuit River	Libby Lane Storm Drain Tide Gate to Eliminate Raccoons	Raccoons contribute fecal bacteria that degrades water quality of the Kickemuit River.	Project will prevent raccoons from entering the Libby Lane storm drain system.	$6,400
Warren Kickemuit River	Libby Lane Storm Drain Evaluation and Correction	Stormwater pollutants enter the Libby Lane storm drain system from a number of unconfirmed sources along the Kickemuit.	This project will confirm the sources and execute corrective actions.	$11,200
South Providence Development Corp.	17 Gordon Avenue Green Building	Stormwater from 17 Gordon Avenue enters a nearby storm drain that discharges to the Providence River.	This demonstration project is for retrofit construction of a greenroof and stormwater infiltration BMPs.	$93,000
East Greenwich Greenwich Cove	Greenwich Cove Upland Attenuation	Hypoxia and nutrients--E. Greenwich has identified three stormwater outfalls, which are considered major contributors.	Project is for design of a Vortech unit at Greenwich Cove, which was identified as high priority during a preceding NPS project and in the Greenwich Bay TMDL. The project also includes an innovative assessment of stormwater attenuation opportunities in the upland.	$26,000
Warren Kickemuit (i.e., Warren) Reservoir	Kickemuit Reservoir Stormwater Abatement Feasibility	Stormwater from multiple drainage pipes discharges into and degrades the Kickemuit Reservoir.	Project involves assessment of stormwater abatement opportunities and will implement recommendations of a completed TMDL.	$7,900
Warren Kickemuit River	Bay Road Stormwater Abatement	Polluted stormwater discharges to the Kickemuit River from the Bay Road Storm Drain System.	Project is for installation of a Vortech unit along the Kickemuit River and restoration of a coastal wetlands complex.	$45,800
TOTAL				**$402,592**

Table 2-2 continued

Water Quality Restoration Projects In 2003

Sponsors & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Barrington Allin's Cove	Allin's Cove Water Quality Restoration	Stormwater runoff impacts Allin's Cove. Allin's Cove connects with the Providence River, which is impaired by nutrients, DO, metals and pathogens.	Initiate design of management practices to abate stormwater impacts to Allin's Cove. Compliments restoration work being undertaken by the Army Corps of Engineers.	$13,500
Burrillville Clear River	Burrillville Salt Storage Facility	Currently, Burrillville's salt pile is uncovered and abuts the Clear River, which is scheduled for a TMDL.	Design and build a replacement salt storage facility.	$60,000
Coventry Tiogue Lake	East Shore Drive Stormwater Improvements	Pictures provided by the town show significant sedimentation that has resulted from stormwater runoff.	Design and construction of a stormwater management system.	$39,000
Coventry Pawtuxet River (unnamed wetland)	Coventry Salt Storage Facility	Coventry's existing salt pile is impacting a wetland complex adjacent to the Pawtuxet River, which is scheduled for a TMDL.	Design and build a replacement salt storage facility.	$60,000
Coventry Pawtuxet River (unnamed wetland)	Coventry Sandy Bottom Road Wetland Restoration	Runoff from Sandy Bottom Road impacts an adjacent wetland complex. The wetland is contiguous with the Pawtuxet River, which is impaired by lead and cadmium.	Conduct restoration of 26-acre wetland parcel at one end of Sandy Bottom Road.	$60,000
Cumberland West Sneech Brook (Blackstone River)	Cumberland Salt Storage Facility	Existing salt pile is impacting West Sneech Brook, which flows directly into the Blackstone River.	Design and build a replacement salt storage facility.	$40,000
DEM Parks and Recreation Ninigret Pond (Charlestown Breachway)	Charlestown Breachway Composting Toilets	Over 300,000 people use this public beach and camping area each year. State-owned facility lacks adequate wastewater treatment system.	Provide wastewater facilities (composting toilets) for the renovation of Charlestown Breachway.	$72,000
DEM Sustainable (town is a cooperator) Watersheds Narrow River	Narrow River TMDL Implementation	Stormwater is identified as a primary contributor of pathogens to the Narrow River. Project is a first step in abating stormwater pollutants identified in the Narrow River TMDL.	Initiate design of stormwater management practices along the Narrow River.	$76,962
East Providence Runnins River	East Providence Salt Storage Facility	Existing salt pile is impacting a wetlands complex of the Runnins River. This project compliments a TMDL.	Design and build a replacement salt storage facility.	$40,000

Table 2-2 continued

2003 continued

Sponsors & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Hopkinton Unnamed Wetland	Hopkinton Landfill Abatement	Leachate from a closed landfill is degrading groundwater and a nearby wetlands complex. The leachate contains contaminants such as aluminum and iron.	Design a liner and treatment system to abate leachate impacts.	$25,000
Kickemuit River Association Kickemuit River	Blue Tab Project for the Identification of Homes not tied into Sewers	Kickemuit River, which is impaired by pathogens, is scheduled for a TMDL. Although the area is sewered some homes are believed not to be tied in.	Identify homes that are not tied into local sewers and are likely to contribute pollutants to nearby storm drain systems.	$2,000
Middletown Maidford Brook and Aquifer	Middletown Salt Storage Facility	Existing salt pile is impacting the Maidford Brook and local groundwater.	Design and build a replacement salt storage facility.	$60,000
Newport Coaster's Harbor	Newport Salt Storage Facility	Existing salt pile is impacting Coaster's Harbor.	Design and build a replacement salt storage facility.	$40,000
Pawtuxet River Authority Lower Pawtuxet and Pocasset Rivers	Riparian Buffer Restoration Strategy for the Lower Pawtuxet and Pocasset Rivers	The habitats of the Pawtuxet and Pocasset rivers are heavily impacted by urbanization. This project compliments recommendations in the TMDL and local stormwater management plans.	Identify sites for restoration and conceptually design management practices.	$46,000
Portsmouth The Cove	Identification of Illicit Discharges to Storm Drain System	Stormwater pollutants enter the Portsmouth-Island Park storm drain system from a number of unconfirmed sources. The Cove is impaired by pathogens. This project implements TMDL and stormwater planning recommendations.	This project will confirm the sources and execute corrective actions.	$24,913
Save The Bay Providence River	Demonstrating Innovative Stormwater Management at the Bay Education Center	This site is adjacent to the Providence River, which is undergoing a TMDL and is impacted by stormwater runoff.	Demonstrate use of greenroof and other innovative stormwater management practices.	$150,000
Smithfield Woonasquatucket Reservoir	Woonasquatucket Reservoir Pollution Abatement	Untreated stormwater from nearby roadways and development is creating sedimentation in the Woonasquatucket Reservoir. The reservoir is connected to the Woonasquatucket River, which is impaired by metals, dioxin, PCBs, and pathogens.	Design, permitting and construction of a stormwater management system adjacent to Woonasquatucket Reservoir.	$109,918
Southern RI Conservation District Fry Brook	Discouraging Waterfowl in Fry Brook	Waterfowl are identified as a significant source of pathogens in the Fry Brook TMDL.	Initiate waterfowl management in Fry Brook.	$10,000

Table 2-2 continued

2003 continued

Sponsors & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
URI Graduate School of Oceanography Green Hill and Ninigret ponds	Restoration of Water Quality and Eelgrass Habitat in the RI Coastal Salt Ponds	Nitrates in groundwater have been identified as significant contributors to the eutrophication of Green Hill and Ninigret ponds.	This project demonstrates technology to reduce groundwater borne nitrates to the salt ponds. Project compliments recommendations of the TMDL and local stormwater management plans.	$40,000
URI Pollution Prevention Center Woonasquatucket River	Pollution Prevention Assessments in the Woonasquatucket	The Woonasquatucket River TMDL identifies stormwater from commercial operations (e.g., autobody shops) pollution as a significant contributor to impairments in the river.	Assess and reduce sources of stormwater pollution to the Woonasquatucket River from small commercial sites using pollution prevention strategies.	$40,000
Warren Warren River	Fecal Coliform Abatement at Warren Town Beach	EPA recently designated this beach as a "flagship" beach. Stormwater has been identified as contributing pathogens to the Warren River.	Initiate design of management practices to abate pathogen contamination of town beach.	$25,000
Warren Warren and Palmer Rivers	Restoration of Belcher Cove	Stormwater abatement is recommended in the Palmer River TMDL and Warren's stormwater management plan.	Design and implement stormwater management practices.	$25,000
Warwick Brushneck Cove (Greenwich Bay)	Brushneck Cove Infiltration	Nutrients and pathogens are identified in the Greenwich Bay TMDL as sources of impairment to Brushneck Cove and the bay.	Construction of a stormwater management system adjacent to Brushneck Cove.	$300,000
TOTAL				**$1,359,293**

Water Quality Restoration Projects
2004 RFP

Table 2-2 continued

Sponsor & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Barrington Prince's Pond	Barrington Salt Storage Facility	Stormwater runoff of sodium and chlorides	Construct a covered salt storage facility	$60,000
Middletown Bailey Brook	Slate Hill Farm Stormwater Retrofit	Sediments, nutrients and other pollutants associated with stormwater runoff	Stormwater BMP design and construction	$60,000
Middletown Maidford River	Maidford River Bank Stabilization Project	Sedimentation from severe erosion	Design and construct bank stabilization project to prevent erosion and restore habitat quality in the river	$34,197
Providence Roosevelt Lake	Roger Williams Park Lake Stormwater Management	Pathogens, nutrients associated with stormwater discharges and activities in vicinity of the ponds	Feasibility and design of BMPs	$42,000
Warren Warren Town Beach	Fecal Bacteria Abatement	Pathogens associated with stormwater runoff	Design and implementation of stormwater BMPs	$30,000
Warren Kickemuit River	Kickemuit River Stormwater Abatement	Pathogens and other pollutants associated with stormwater runoff	Final design and implemention of stormwater BMPs	$30,000
Warwick Tuscatucket Brook	Tuscatucket Stormwater Abatement	Pathogens and other pollutants associated with stormwater runoff	Assessment of the feasibility of retrofitting stormwater BMPs in this sub-basin	$58,000
Wood-Pawcatuck Watershed Association Yawgoo Pond	NPS Watershed Management Plan for Yawgoo and Barber Ponds	Excessive nutrients and other pollutants	Develop a plan for implementing TMDL recommendations and managing NPS sources	$38,400
West Warwick Pawtuxet River	Town Landfill Side Slope Closure	Sediment and other pollutants associated with erosion and leachate from the side slope of the former town landfill adjacent to the Pawtuxet River	Design proper side slope closure with adequate erosion controls	$40,000
				$392,597

Water Quality Restoration Projects
2005 RFP

Table 2-2 continued

Sponsor & Waterbody	Project Name	Impairment of Concern and Suspected Source	Project Plan	Award
Charlestown Green Hill Pond	Green Hill Pong TMDL Implementation Feasibility & Design	Stormwater discharges –pathogens and other pollutants	Design infiltrating catch basins and additional stormwater BMPs	$22,000*
East Greenwich Hunt River	Sun Valley Infiltration Project	Stormwater runoff	Design and construction of infiltration stormwater structures	$105,000*
East Greenwich Greenwich Cove	Hill and Harbor Stormwater Infiltration Project	Stormwater discharges – pathogens and other pollutants	Feasibility study to determine best locations for infiltration	$29,000*
Narragansett Narrow River	Narrow River Stormwater Abatement Implementation	Stormwater discharges – pathogens and other pollutants	Design and construction of stormwater BMPs	$200,000*
Narragansett Crooked Brook	Crooked Brook Pathogen Reduction Feasibility Study	Stormwater runoff – pathogens	Feasibility of stormwater BMPs on three municipal properties	$32,530*
Barrington Allin's Cove	Allin's Cove Water Quality Restoration	Stormwater discharges	Design and construction of stormwater BMPs in association with ACOE salt marsh restoration project.	$116,709*
DEM Town Pond - Portsmouth	Town Pond Environmental Restoration Project	Habitat degradation	20 acre salt marsh restoration	$200,000
Middletown	Gaudet Middle School Stormwater Retrofit	Stormwater runoff	Design and construction of an infiltration stormwater BMP	$41,811
Lincoln	Lincoln Municipal Rain Garden	Stormwater runoff	Install rain gardens on municipal properties	$13,340
				$760,390

* These projects also awarded state Bay and Watershed Restoration Fund grants.

d. Conservation Development

New development has often been criticized for causing environmental degradation and the loss of community character. DEM has been working with municipalities to encourage adoption of conservation development as a preferred approach to directing future growth at the local level. Conservation development is a more flexible site design process that allows communities to work collaboratively with developers to guide growth to the areas that are most suitable to support development. As one part of the process, sensitive or important environmental resources on a parcel are identified and growth is planned to eliminate or minimize impacts to such areas. A key objective is to identify and permanently protect a minimum of 50% of the parcel as open space. Guiding growth away from this open space not only avoids negative impacts to the environment and community character, but increases profit margins for homebuilders.

There are numerous environmental advantages to Conservation Development. Specifically, Conservation Development helps to meet the requirements for the post-construction runoff minimum control measure under the Phase II Stormwater Rule. These particular stormwater management requirements, which are inherent in Conservation Development, include directing growth to the most appropriate areas of a site, protecting wetlands and riparian areas, increasing open space preservation, maintaining buffers to surface waters, minimizing impervious surfaces, and reducing disturbance to soils and vegetation.

In addition to the environmental advantages of Conservation Development, there are also many social and cultural, as well as economic, advantages. Conservation Development protects historical and cultural sites, preserves aesthetic features and scenic views, provides both passive and active recreation areas, promotes a neighborhood/community atmosphere, and provides gathering spaces for neighborhood functions. In an economic sense, not only does Conservation Development preserve land without buying it, but it reduces town services costs for road maintenance and school transportation, speeds up the review process by avoiding sensitive areas early on, and increases the value and marketability of a site.

Using federal funds, DEM has provided planning assistance to ten rural and suburban communities interested in pursuing conservation development. Of the 21 communities targeted, 16 have moved forward to draft or adopt ordinance changes that incorporate this approach into local land use decision-making.

e. No Discharge Zone and Clean Marina Program

To address the non-point contribution of pollutants from boating activities, on August 10, 1998 the State of Rhode Island took a step toward ensuring better water quality in marine waters by designated their coastal waters as a No Discharge Area (NDA). The Rhode Island waters include territorial seas within three miles of shore, including all of Narragansett Bay. A No Discharge Area is a designated body of water in which the discharge of *treated* and *untreated* boat sewage is prohibited (this does not include greywater or sink water).

Sewage wastes discharged from boats may degrade water quality by introducing microorganisms, nutrients, and chemical products into the marine environment.

- Microorganisms, which include pathogens, and bacteria, may introduce diseases like hepatitis, typhoid fever and gastroenteritis to people in contact with the water, and can contaminate shellfish beds.
- Nutrients are necessary for the growth of microscopic plants and larger plants (seaweeds and eelgrass). However, when nutrients become too abundant they stimulate algae blooms which leads to depletion of oxygen in the water. Depletion of oxygen in water (called Hypoxia) can stress and even kill fish and other aquatic animals.
- Chemical products can be toxic to marine and estuarine life and could pose a problem in areas where boats congregate and where there is little tidal flushing.

Complying with vessel sewage discharge laws and regulations, and using pump-out facilities, are a necessary step to protect public health, water quality, and the marine environment. Recreational boats are not required to be equipped with a toilet, but if they are, the Marine Sanitation Device (MSD) must be Coast Guard approved, designed either to hold sewage for shore-based disposal or to treat the sewage prior to discharge. DEM has provided grants to encourage the establishment of pump-out facilities or pump-out boats to service boaters in Rhode Island waters. Over 40 pump-out facilities operate in RI coastal waters.

The Nonpoint Pollution Source Program has been working for many years on promoting BMPs at marinas that often handle a variety of hazardous and non-hazardous materials through guidance, workshops etc. Another aspect of this overall pollution prevention effort is the recently developed certification program known as the Clean Marina Program. The program is intended to recognize and reward marinas that go beyond regulatory requirements by applying innovative pollution prevention best management practices (BMPs) to their day-to-day operations. The program was developed collaboratively by the CRMC, DEM, RI Marine Trades Association and Save The Bay and launched in 2006.

6. Narragansett Bay Estuary Program CCMP

The Narragansett Bay Estuary Program (NBEP) is a federally funded program authorized in the Federal Clean Water Act, Section 320, National Estuary Program. It's purpose it to protect and preserve Narragansett Bay and its watershed through partnerships that restore natural resources, enhance water quality, and promote community involvement. With stakeholder involvement, the NBEP developed the 1993ansett Bay Comprehensive Conservation and

Management Plan (CCMP) which constitutes a comprehensive watershed ecosystem plan for conservation and management of natural resources in Narragansett Bay. The CCMP was adopted as an element of the State Guide Plan, which requires that state agency and municipal plans are consistent with the CCMP. The plan specifically recognizes that it should be a living and dynamic plan and should be periodically reviewed and revised to address current needs and issues. The NBEP has initiated work to produce a status and trends report for the Narragansett Bay watershed that will provide a basis for updating the CCMP.

The CCMP is based on the following overall goals:

- To prevent further degradation and incrementally improve water quality in developing coastal areas with deteriorating water quality;
- To protect diminishing high quality resource areas throughout the Bay watershed;
- To more effectively manage commercially, recreationally, and ecologically important estuarine-dependent living resources;
- To rehabilitate degraded waters in the Bay watershed and restore water quality-dependent uses of Narragansett Bay;
- To establish necessary interstate and interagency agreements and mechanisms to coordinate and oversee implementation of the Narragansett Bay Comprehensive Conservation and Management Plan.

In keeping with Congress' mandate, since 1993 the Narragansett Bay Estuary Program has been implementing the CCMP by coordinating planning, policy, technical assistance, science and outreach pertaining to the Bay and watershed ecosystem.

The NBEP has pursued implementation of the CCMP on a number of fronts including the restoration of anadromous fish to Bay rivers and streams and coastal marsh restoration, enhancing bi-state connections with stakeholders in the Massachusetts part of the watershed through grant programs and technical assistance, tackling data needs by actions such as instituting the first dissolved oxygen surveys of the Bay and creating the first baseline data sets on the status of the state's coastal habitats, increasing accountability and ability to measure environmental progress through development and use of Bay and watershed indicators, and creating a mechanism to broadcast information specific to Bay issues to the greatest possible number of watershed residents and stakeholders through the publication and distribution of the Narragansett Bay Journal. The NBEP is affiliated with the Coastal Institute at the University of Rhode Island's Graduate School of Oceanography and RIDEM.

7. Financial Assistance

In order to achieve the water pollution abatement/water quality goals of the State of Rhode Island, the Office of Water Resources (OWR) manages several funding assistance programs intended to aid governmental entities, businesses, and individuals in the planning, design and construction of their projects. These financial assistance programs consist of funds provided by both the State and federal government.

The State Revolving Fund (SRF) is Rhode Island's largest financial assistance program. The SRF program is co-managed by OWR and the RI Clean Water Finance Agency. Since the program's inception in 1990, the SRF program has awarded over \$564,000,000 in below market rate interest loans for 230 projects in 27 communities. While sewer extensions are the type of project most often funded, the SRF program has also provided assistance for wastewater treatment facility improvements, combined sewer overflow abatement projects, pumping station repairs, landfill closures and one open space acquisition. Finally, the SRF program has recently lowered the interest rate of its homeowner septic system repair loans as part of the state's initiative to phase out cesspools.

In November of 2004 the Rhode Island voters approved \$19,000,000 in state bond funds for water pollution abatement and habitat restoration projects. \$8.5M will be award as grants to local governmental units, non-governmental entities and individuals. The SRF program will use the remaining \$10.5M for water pollution abatement with an emphasis on nutrient removal projects.

The Interceptor Bond Fund (IBF) is the only bond fund program with a significant amount of authority (\$3.8 million as of January 1, 2004) remaining. The Fund's narrow focus – the installation of sewers equal to or greater than 10" in diameter – has limited the potential field of applicants. The IBF has awarded two grants for the maximum amount (\$500,000) within the past two years.

Table 2-3 below briefly details the funding provided by the OWR financial assistance programs:

Table 2-3 Funding Sources and Assistance Awards

Fund	Since 1972 CWA	Last 2 Years (2004 – 2005)
CWSRF	$564,047,855	$131,277,400
SRF – Community Septic System Loan Program	$2,400,000	800,000
SRF state fund	$58,095,000	$0
Construction Grants (terminated)	$284,200,000	$0
Construction Grants State Match (terminated)	$64,600,000	$0
Non-Governmental Fund*	$1,500,000	$75,000
Governmental Entities Fund**	883,542	58,542
Interceptor Bond Fund***	$2,061,832	$1,000,000
Sewage and Water Supply Failure Fund (terminated)	$5,000,000	$0
RI Pawtuxet River Water Quality Bond Fund (terminated)	$9,965,000	$0
Pawtuxet River Authority Bond Fund	8,968,000	2,500,829
Aqua Fund (terminated)	$9,632,626	$0
TOTAL	$1,011,353,855	135,661,771

* This fund provides grants to businesses, industries, and other non-governmental entities.

** This fund provides grants to communities for septic system management plans and stormwater management plans and implementation.

*** Includes $54,572 in low interest ISDS repair loans to individuals.

8. Coordination with other Agencies

Reflecting its broad responsibilities, the DEM Office of Water Resources regularly coordinates its activities with various other federal, state and local agencies and organizations. Staff from the DEM-OWR currently serve on the RI Rivers Council, the RI Environmental Monitoring Collaborative, CRMC Policy and Planning Subcommittee, NRCS State Team Committee and NBEP Management Committee among others. This coordination takes a number of different forms. In addition to EPA, examples of such coordination are as follows:

a. Coastal Resources Management Council - OWR coordinates with CRMC on permitting, policy development, aquaculture & dredging projects, SAM Plan development, revision and implementation revisions Clean Marina Program and invasive species management. DEM-OWR currently serves on the Policy and Planning Subcommittee.

b. Department of Health - DOH provides laboratory analytical services under contract multiple OWR programs. Program areas of coordination include investigation of beach closures and remedial actions, shellfish growing area monitoring program, private well contamination and monitoring of private wells, public water supply programs including source water assessment and the Drinking Water SRF and public health advisories for fish consumption.

c. Water Resources Board – DEM is a member of the Water Resources Board (WRB) and participates on the Watershed Resource Protection and Use Subcommittee. DEM and WRB both collaborated on the state’s streamflow gage network with USGS.

d. Natural Resource Conservation Service (NRCS)- Per the Memorandum of Understanding between DEM and NRCS, the Office will continue to coordinate with NRCS on Agricultural Wetlands issues. DEM-OWR also participates in the NRCS State Team meetings.

e. NOAA – DEM-OWR collaborates with NOAA-National Marine Fisheries Service (NMFS) and other partners as part of the Bay Window Program which supports monitoring activities in Narragansett Bay.

f. Army Corps of Engineers (ACOE) –OWR coordinates with ACOE on programmatic general permit (PGP) process and habitat restoration projects.

g. USGS – DEM-OWR contracts for services with USGS for monitoring of streamflows and water quality in large rivers in Rhode Island.

h. URI - Through a variety of mechanisms, seeking professional advice and contracting professional services, the OWR interacts with the University. Examples of programs the OWR cooperates with include Sea Grant, the Graduate School of Oceanography, Natural Resource Sciences, the Department of Civil and Environmental Engineering, and the Cooperative Extension to name several.

C. COST/BENEFIT ASSESSMENT OF CLEAN WATER

1. Overview

Section 305(b)(1)(D)(ii) and (iii) of the CWA requires an estimate of the economic and social impact to achieve the objectives of Section 305(b) and the economic and social benefits of such achievement.

Rhode Island's water resources are valued for swimming, fishing and boating, as well as for commercial fishing and other water-related businesses. The importance and benefits of clean water on social and economic impacts is evident. However, a true assessment of the environmental impact, economic and social costs, and social benefits of effective water programs is, at best, difficult to determine. This is due to the complexities involved in quantifying the economic value of incremental improvements in water quality. Nonetheless, some estimates of the costs and benefits of improvements in water quality and water resources can be inferred.

2. Social And Economic Value Of Rhode Island's Water Resources

Rhode Island's marine resources have always been central to its economic development. The state has developed one of the world's most significant marine related economic clusters. This cluster of is a concentration of firms, institutions and end users all relying directly or indirectly on the marine resources of Rhode Island, in particular Narragansett Bay. The marine cluster can be divided in to eight sectors: 1) tourism, recreation and events, 2) Boat building, 3) Boating related businesses, 4) Marine Transportation, 5) Fisheries and Aquaculture, 6) Military, 7) Shipbuilding and 8) Research, Technology Development and Education (RI Senate, 2002). Plans are underway via the RI Economic Monitoring Collaborative in association with the RI Bays, Rivers and Watersheds Coordination Team, to collect additional data to refine the State's understanding of this important component of the state's economy.

In 2000, the Narragansett Bay Estuary Program (NBEP) along with various state, federal and non-profit agencies co-sponsored a Narragansett Bay Summit to explore the relationship between Narragansett Bay and the regional economy. (The entire proceedings of the Summit can be found at www.nbep.org.) The Summit provided some characterization of the marine cluster in RI. Findings from the proceedings noted that the recreation value provided by all Rhode Island ecosystems is about $6.7 billion per year. Approximately $4 billion of this is derived from the state's water resources. Narragansett Bay, which occupies one-quarter of the state's total area, and has over 440 miles of coastline, along with the state's freshwater resources, is a major draw for approximately 16 million visitors a year, generating over $3.25 billion per year. Recreational boating was found as a significant and highly-valued use of the Bay. More than 44,000 recreational boats are registered statewide. The net economic value of sailing alone is estimated at $165 million annually.

The commercial fisheries industry is a major contributor to the state's economy. More than 3,000 boats, from quahog skiffs to draggers, are engaged in commercial fishing in Rhode Island. In 2003, 103 million pounds of fish were landed in Rhode Island, with a dockside value of more than $64 million. Nearly 800 workers are employed in 69 fish wholesale businesses and fish processing plants in the state.

The summer of 2004 brought more than six million visitors to RI's state parks and beach system, including close to three million visitors to Rhode Island state beaches. More than 230,000 visits to state campgrounds were also recorded. Over $3.3 million in revenue was generated by beach and campground attendance in 2004.

3. Water Pollution Control Expenditures

To protect Rhode Island's valuable water resources, an expenditure of significant funds and implementation of various water pollution control programs and projects as noted in section II.B. and summarized below, have been conducted.

Rhode Island has received $284,200,000 in Federal Construction Grants Program funds from the Environmental Protection Agency (EPA) since the inception of the Federal Clean Water Act (P.L. 92-500) in 1972. These federal grant funds along with the $64,600,000 in state matching grant funds made it possible for a number of wastewater treatment facility and sewer projects to be constructed (see 2002 RI 305(b) Report for details). The environmental and economic benefits produced by these projects are significant. These projects not only improved the water quality in the shellfish growing areas, but also allowed additional shellfish growing areas to be reopened. The Construction Grants program was closed out in 1998 and replaced by the SRF Program.

The State Revolving Fund (SRF) Program, is Rhode Island's largest financial assistance program. The SRF program is co-managed by OWR and the RI Clean Water Finance Agency. Since the program's inception in 1990, the SRF program has awarded over $564,000,000 in below market rate interest loans for 230 projects in 27 communities. While sewer extensions are the type of project most often funded, the SRF program has also provided assistance for wastewater treatment facility improvements, combined sewer overflow abatement projects, pumping station repairs and landfill closures.

Between 2003 – 2006, DEM awarded about $2.5 million in federal non-point source pollution abatement grants for 41 projects that will improve water quality throughout Rhode Island. The grants were given to 17 RI communities, four environmental non-profit agencies, a conservation district, the University of Rhode Island, and DEM for water quality restoration and onsite wastewater management projects.

In November 2004, Rhode Island voters approved a $70 million Open Space, Recreation, Bay and Watershed Bond. The referenda included $27 million in loans and grants for bay, watershed, and drinking water protection. The $10.5 million investment in wastewater improvement loans will finance a revolving loan fund that will leverage nearly $30 million for improvements to wastewater treatment plants. The nutrient removal and other water quality projects at wastewater treatment facilities will allow for progress toward reducing nitrogen discharges and other pollutants. The $8.5 million investment in clean water grants will leverage $17 million and will allow more progress toward the goal of making the state's polluted water bodies fishable and swimmable. It will help RI communities control storm water pollution; help farmers, marina operators, and other businesses reduce pollution that runs into the Bay and its tributaries after rainfalls; and help restore habitats along the waters' edge to keep pollutants from reaching streams, lakes and coastal waters. The $8 million investment in drinking water protection will allow the Rhode Island Water Resources Board to permanently protect groundwater and public drinking water supplies, including future well sites, to accommodate residential demand and economic development.

While water quality is much improved after 30 years of regulation of large discharges, reducing combined sewer overflows, nutrients from wastewater treatment facilities and the many thousands of remaining small and widely spread sources of pollution and restoring water quality remains a challenge. In a March 2004 Report, The Finance Panel of the Governor's Narragansett Bay and Watershed Planning Commission has initially identified over $1.4 billion in long-term funding necessary for the completion of infrastructure improvements that are needed to maintain and improve water quality within Narragansett Bay and the watersheds which constitutes the majority of the state. The panel report notes that this amount does not include all foreseeable infrastructure investments necessary to meet all water quality goals.

D. SPECIAL STATE CONCERNS AND RECOMMENDATIONS

1. State Concerns

a. Management of Narragansett Bay and its Watershed

State laws were revised in 2004 to formalize a process for coordinating and planning for the protection and restoration of Narragansett Bay and the promotion of sustainable water-based businesses. This followed an examination of Bay issues conducted by the executive and legislative branches in response to the fish kill in Greenwich Bay and beach closures that occurred during 2003. Work is underway to form a Coordination Team and advisory committees to support the development of a systems-level plan and budget for Bay and watershed management.

b. Narragansett Bay – Nutrients and Dissolved Oxygen

Previous monitoring projects have identified impacts of nutrient loadings to the Bay. Studies in the Providence River suggest that long-standing dissolved oxygen problems are linked to the level of nitrogen inputs to the upper estuary. Hypoxic conditions can adversely affect a variety of fish and shellfish species; with the extent of adverse impact influenced by the timing, frequency and duration of the hypoxic conditions. WWTFs are the most significant source of nutrients to upper Bay areas. During the summers of 1999-2003, DEM, in collaboration with partners, conducted dissolved oxygen surveys, which indicated concerns in the upper bay, Greenwich Bay and upper West Passage. Monitoring conducted since then has continued to document problems with hypoxia. The data has been used in combination with other information to develop a phased plan for implementation of WWTF improvements to reduce nitrogen loadings based on consideration of implementation costs, analysis of the performance of available technology, and estimates of water quality improvements from experimental data. This implementation plan reflects a goal of achieving a 50% reduction from the 1995-1996 WWTF loadings as recommended by the Governor's Narragansett Bay and Watershed Planning Commission (2003) and as required by law (RIGL 46-12).

Eight of 11 RI WWTFs targeted in the nutrient reduction strategy within the Upper Narragansett Bay watershed are achieving reductions as of 2007. These include Warwick, Cranston and West Warwick which discharge to the Pawtuxet River; Burrillville and Smithfield which discharge to the Clear River and Woonasquatucket River, respectively, as well as East Greenwich, NBC's Bucklin Point facility, and Warren which discharge to estuarine or tidal waters. NBC is moving forward with planning and design work to support nutrient reductions at its Field's Point WWTF – the state's largest.

In addition, the Town of Westerly completed construction of nutrient upgrades in October 2003, to reduce their nitrogen loading to Little Narragansett Bay.

c. Combined Sewer Overflows (CSOs) – Upper Narragansett Bay

The major impairment of use in Narragansett Bay results from bacterial contamination. Clearly, the most significant sources are the combined sewer overflows that discharge in the Providence metropolitan region into the upper bay or its tributaries. Significant portions of the estuary area temporarily closed to shellfishing following rainfall events of one-half inch or more. A previous inventory identified eighty-six CSO outfalls which discharge to the Providence River or its tributaries. The Narragansett Bay Commission (NBC) has eliminated sixteen CSOs by plugging the discharge pipes. As a result, the number of active CSOs in the NBC system is 70. The NBC's Wet Weather Facility located at the Fields Point WWTF provides primary treatment for up to 123 MGD of wet weather flow.

NBC has finished a system-wide CSO facilities plan. The recommended initial plan featured three tunnel branches and seven near surface storage facilities at total estimated project cost of $476 million. NBC established a CSO Stakeholder Group to involve interested parties in evaluating the current CSO program and alternative plans. After months of meetings, the stakeholder process developed a consensus around an alternative plan divided into phases. The group supported implementation of Phase I, which included a main tunnel, two stub tunnels and an upgrade to the Bucklin Point facility. Prior to initiating Phase II and III, the group determined additional evaluations, including water quality monitoring studies, were desirable. The Stakeholder Group will continue to monitor progress on the CSO abatement strategy

The NBC completed and received DEM approval of all final designs for the Phase I CSO facilities, which include the Main Spine Tunnel, Near Surface Facilities, the Bucklin Point wet weather treatment facility and Drop and Vent Shafts. Phases II and III include the Pawtucket Tunnel, CSO interceptors, various sewer separation projects, and a wetland/lagoon treatment system which will proceed at a later date.

d. Monitoring Needs

Through the 305(b) assessment process, DEM identified gaps in available water quality data as a significant concern. While steps have been taken to expand monitoring, as this report indicates, the data gaps remain significant: 20% of lake acres and 62% of river miles are unassessed. Additionally, data currently used to support the assessment of surface waters may become outdated in the near future creating additional gaps on selected parameters such as toxics/metals. OWR has completed a surface water monitoring strategy that was reviewed and endorsed by the RI Environmental Monitoring Collaborative (RIEMC) and Narragansett Bays, Rivers and Watersheds Coordination Team. The strategy consists of a mix of sampling designs organized to cost-effectively reduce data gaps while meeting the data needs of state water management programs. It includes fixed-site networks, adoption of a rotating basin approach to rivers to streams, targeted surveys and an expansion of the use of biological indicators. The framework reflects the partnerships and collaborations that occur among state, local and federal agencies, universities and colleges, other organizations and volunteers regarding monitoring activities. Consistent with the strategy, between 2004 and 2006, DEM-OWR was able to expand the fixed-site network in Narragansett Bay, initiate the rotating basin approach to sampling rivers and streams, expand the streamflow gage network and renew regular monitoring of the Blackstone and Pawtuxet Rivers by USGS. Additional resources will be required to fully implement a comprehensive monitoring program. The strategy will be periodically updated to support an adaptive management approach to water resource protection and restoration.

e. Watershed Restoration – Developing TMDLs

While restoring the quality of rivers, lakes and coastal waters to support their designated is an acknowledged state priority, accomplishing actual restoration remains a significant challenge. The 2006 303(d) list for Rhode Island includes 162 waterbody listings for a range of impairments. The most common impairments involve nutrients, pathogens and metals. Working within available resources, DEM and its contractors are conducting assessments of impaired waters pursuant to an aggressive schedule that now extends to 2016. The assessments and corresponding restoration plans, known as Total Daily Maximum Load (TMDLs), provide the technical basis for investing in pollution abatement. The development of TMDLs is done with stakeholder input at all stages. Given the nature of RI's water pollution problems and the significant contributions of nonpoint sources, the restoration plans in most watersheds will be multi-faceted. To support local implementation, DEM is giving priority to TMDL-related projects in the distribution of nonpoint abatement grants. However, it is clear that additional resources are needed in order to meet the demands of the TMDL mandate. The needs include funding for assessment, local capacity building, local implementation projects and program coordination.

f. Nonpoint Source Pollution – Septic Systems

Nonpoint pollution sources are suspected of being the major contributor in a majority of the impaired water bodies included on Rhode Island's 303(d)list. Septic systems - either failed or substandard - are recognized as one of the leading NPS problems in the state – contributing nutrients, bacteria and potentially viruses to both coastal and inland waters. Of the estimated 157,000 septic systems in the state, over 50,000 are suspected of being inadequate. Consistent with the Nonpoint Source Pollution Management Plan, a multi-faceted strategy has been pursued to prevent and abate pollution from septic systems. Key components of the strategy include: (1) licensing of ISDS designers and related regulatory reforms, (2) institution of soil-based siting approach, (3) expanded use of innovative and alternative (I & A) technologies; (4) establishment of local wastewater management programs, (5) providing financial assistance for upgrades of septic systems via the Clean Water Finance Agency (CWFA) and (6) expansion of public education and outreach; e.g. promote proper system maintenance. As a result of grants provided by DEM, twenty-three (23) of the 27 communities which rely significantly on septic systems are now developing or implementing local wastewater management programs. Continued implementation of program initiatives to encourage the upgrade and replacement of inadequate septic systems will remain a priority. The phase-out of cesspools was the subject to legislative action in 2007. DEM is also planning on revising its regulations to require advanced treatment for on-site wastewater systems located in environmentally sensitive areas; e.g. control of nitrogen discharges.

g. Nonpoint Source Pollution – Stormwater

Untreated stormwater discharges constitute a second major NPS pollution concern in RI. Runoff from a wide range of land uses, e.g. industrial, suburban, agricultural can contribute to water quality degradation. Given the density and pattern of development in the state, strategies to address stormwater management must involve both prevention and abatement; e.g. retrofit programs. With the implementation of Phase II stormwater requirements, DEM expects an increased demand for both technical and financial assistance from local entities. DEM was able to distribute planning grants to 36 municipalities to develop local stormwater plans. With passage of the 2004 bond issue, DEM has been able to distribute state grants to enhance local capacity to implement stormwater management through equipment purchases and support for illicit detection work. Additional local needs include, among others, improved guidance on BMPs, training and technical assistance related to Phase II, and continued financial assistance to build and implement local stormwater programs. The DEM-OWR has begun exploring the potential for utility districts to provide a stable source of funds to support stormwater management. Additionally, from the prevention perspective, there is a need to develop the local planning capacity to allow application of innovative land use controls, including low impact development techniques, which may have the benefit of reducing runoff. To be most effective, stormwater management strategies should be considered in the context of watersheds. DEM expects the development of TMDLs to continue to provide an important means to identify and prioritize stormwater abatement projects that are needed to accomplish watershed restoration goals.

h. Low Flow Impacts - Hydromodification/Withdrawals

Low flow characteristics of streams are important elements in the planning and developing of water resources, especially with respect to water supply and wastewater discharge. Planners and managers in Rhode Island are concerned that excessive withdrawals of water from certain streams or adjacent aquifers could severely impact the quantity and quality of stream water available during low flow periods. Two critical flow levels are the aquatic base flow and the 7Q10 flow. The aquatic base flow is a typically median flow which is known to provide adequate water in the stream to sustain a healthy aquatic habitat. The 7Q10 flow is the flow that is used to evaluate pollutant concentrations in relation to developing wastewater discharge permit limits. Information on flow levels of streams is readily available at locations where streamflow data have been systematically collected for a number of years by the U.S.G.S. However, there are only 22 continuous gaging stations currently operating in Rhode Island. As recent review of the status of gages indicated the network should be expanded in phases to potentially a total of 54 stations.

Rhode Island does not have a water withdrawal permitting system to regulate water withdrawals. Conditions may be placed on new projects involving withdrawals as a result of applying state wetlands or water quality regulations. Impacts to the aquatic habitat occur due to loss of riverbed area covered by water, receding wetlands, loss of vernal pools and inadequate instream water depth for a healthy, reproducing natural fish population. Additionally, lower flows increase pollutant concentrations downstream of dischargers and where discharge limits had been based on previous 7Q10 flows, the limits may no longer prove protective.

The concern about low flows has been identified as a priority in the Pawcatuck River basin due to a peak daily demand of water suppliers coinciding with heavy demand for irrigation withdrawals for both agriculture and golf courses. A subcommittee of the Wood-Pawcatuck Watershed Initiative formed to develop a voluntary approach to address water withdrawal concerns. As a result, a multi-year study was undertaken to assess the impacts on aquatic habitat due to water withdrawals in the Usquepaug watershed. This study has provided a stronger technical basis from which the voluntary management plan can be developed.

The RI Water Resources Board oversaw a stakeholder-based process to develop policies on water allocation. A Water Availability Program Advisory Committee (WAPAC) met for 18 months to develop recommendations. As part of this overall effort, DEM is continuing to work toward finalizing a streamflow standard. The RI WRB, working with USGS, is conducting water use and availability studies that will eventually cover nine basins. Further policy development is expected as an output of this effort.

i. Constraints on Funding Municipal Pollution Abatement Needs

The special concerns identified above coupled with the expanding eligibility's of the State Revolving Fund (SRF) program will place a greater need for an increase in the amount of SRF monies allotted to the State. The Annual Project Priority Lists regularly show water pollution abatement needs totaling over $600 million. In addition, the 2000 Needs Survey reported a documented total of $1.38 billion in wastewater needs for Rhode Island over the next 20 years. As we implement Phase II of the Storm Water Program, the needs for stormwater and nonpoint source will significantly increase over the $32 million presently indicated on the Needs Survey. Presently, SRF capitalization grants to Rhode Island are averaging only around $10 million per year.

In addition to the SRF, grants have served as important financial incentives for both water quality and habitat restoration projects. The state also needs to provide assistance to address municipal needs with respect to the implementation of programs at the local level. Key areas of need include stormwater management, on-site wastewater management, land use planning and habitat restoration. The state needs to continue to support a range of financial incentives in order to be successful.

j. Sediments – Toxics and Dredging

Toxics have been a significant concern historically in Rhode Island waters, particularly in the Upper Bay and urban rivers. However, with the effective implementation of industrial pretreatment at WWTFs, total metal loadings to surface waters from WWTFs have fallen dramatically. For example, the NBC documented a 93% decline in effluent metal loadings between 1981 and 1995. While surface waters have benefited from such improvements, the historical, long-term industrial use of Rhode Island's urban rivers have left a challenge with respect to toxic contamination of sediments. Sampling of sediments in the Woonasquatucket River watershed confirmed the presence of dioxin at elevated levels. Subsequently, the EPA expanded its assessment and eventually designated selected areas along the river on the National Priorities List (NPL). Unfortunately, the extent of sediment contamination in all RI urban rivers is not yet fully characterized and it remains a concern warranting future attention.

The presence of toxics in sediments makes the process of locating dredge disposal sites even more challenging. The ACOE has initiated the dredging of the Providence River shipping channel. Designated dredge disposal areas have been identified for this project and there are plans to allow other smaller dredging projects to utilize some of the sites prior to their final capping. CRMC has been tasked by the legislature to prepare a statewide dredging plan, which would address the long-term routine dredge disposal needs of marinas, etc. OWR will be involved in all dredging projects to insure that water quality impacts will be minimized.

k. Habitat Restoration – Coastal and Inland

Habitat restoration has become increasingly important on the national and local level, especially as studies across the country reveal how much of these resources we have lost or degraded. Here in R.I., we have lost 37% of all coastal wetlands that existed in colonial times (from 102,000 acres to 65,000 acres). Areas of the Bay that were once covered with eelgrass beds, such as Greenwich Bay, now have none. Recent studies conducted by the NBEP with other partners estimate that there are only about 50 acres of eelgrass left in a bay that once had extensive beds. The loss of freshwater wetland habitat is not as well quantified. Both freshwater wetlands and coastal marshes have been impacted from nonpoint source pollution and sedimentation as well as lost to land development. But agencies, organizations, politicians, and citizens are responding to this problem at all levels. State agencies are collaborating with a wide range of partners to develop habitat restoration strategies for coastal habitats as well as freshwater wetlands. Mapping and prioritization projects are in various stages of completion for coastal and inland habitats. Nearly 100 specific restoration opportunities have been mapped and in recent years an increased number of projects have been completed. CRMC has distributed $250,000 in FY2003 to support 7 restoration projects and will be awarding grants again in FY2005. More funding is needed to facilitate habitat restoration and evaluate over time the ecological success of the projects.

2. Recommendations

The following list of recommendations outlines general actions that are deemed necessary to achieve the objectives of the CWA in Rhode Island waters.

a. The State Revolving Fund (SRF) has successfully become the major source of funding for municipal wastewater treatment and sewerage projects in Rhode Island. The State's 2000 Needs Survey identified $1.38 billion in wastewater construction over the next twenty years. This significantly exceeds the funds available through the SRF including leveraging. In order to meet these projected needs, greater funding of the SRF is necessary.

b. The cost of Combined Sewer Overflow mitigation represents a major portion of the future wastewater needs. Special funding, dedicated to CSOs, is needed to supplement annual SRF appropriations to facilitate the implementation of CSO abatement. These special funds should be administered through the SRF program to take advantage of the leveraging abilities of the SRF program.

c. The nutrient reduction strategy for the Upper Bay should be fully implemented to improve water quality.

d. Municipalities should continue to receive direction and assistance in achieving adequate levels of Operations and Maintenance to maintain the WWTFs constructed under the Clean Water Act (CWA).

e. Expansion of water quality monitoring to provide data for assessment of water quality of surface waters (both fresh and salt waters), including dissolved oxygen, nutrients, and biological parameters is needed in Rhode Island. Additional state funding is needed to fully implement the RI Water Monitoring Strategy. The RIEMC should be supported in its efforts to improve coordination and collaboration among monitoring programs.

f. Waters which fail to support designated uses should be further evaluated and restored through the development of TMDLs. Financial assistance for pollution abatement, such as the Bay and Watershed Restoration Fund, should be renewed as needed and targeted to support watershed restoration.

g. All communities which rely significantly on septic systems should develop and implement a local wastewater management program which provides technical or financial assistance and oversight as appropriate to address system maintenance, repair, and replacement needs in the community.

h. The State should develop policies to accomplish the phase out of cesspools and compel hook-ups to sewer systems where available.

i. DEM should continue to review and approve innovative and alternative technologies for on-site wastewater disposal and promote their appropriate application. A more systematic means to track the maintenance requirements of such systems and their performance over time needs to be developed. Use of nitrogen-removal systems should be mandated in sensitive environmental areas.

j. A Statewide policy to provide for safe and sanitary disposal of septage must be adopted.

k. A statewide comprehensive stormwater management strategy needs to be developed to insure the adequate control and treatment of runoff from both new and existing land uses. Integral to the strategy should be the application of low impact development techniques for new and redevelopment. The strategy should address coordination of stormwater-related permitting , the implementation of local stormwater management programs including Phase II requirements, and address the financial and technical assistance needs of local entities.

l. State support of growth management and nonpoint source pollution control efforts is necessary to prevent further water quality degradation to surface and ground water resources from stormwater runoff, septic systems, and other diffuse sources of pollution associated with development. Growth management strategies are needed to avoid exceeding sewerage system capacities in communities subject to development pressures. The state should continue to provide tools and training to assist municipalities in managing the environmental impacts of growth and provide incentives for communities to build local capacity to take advantage of innovative land use controls among other strategies.

m. Statewide policy/guidance needed in the areas of water conservation and water use (water withdrawals and out-of-basin transfers in relation to water/habitat quality). Work to develop streamflow standards should be finalized as part of the process of developing policies on water allocation.

n. The EPA should continue to foster "pollution prevention" and "source reduction" programs. The EPA should work with industrial trade groups to publicize "success stories" and develop implementation strategies.

o. EPA, DEM and others should work together to promote compliance with the no discharge designation granted for Rhode Island coastal waters.

p. Implementation of the state groundwater protection strategy should be continued with an emphasis on providing assistance to foster local protection programs and continued policy development to assure consistency and effectiveness among state regulations.

q. State and local governments must work cooperatively via the Wellhead Protection Program and Source Water Assessment Program to effectively prevent the degradation of groundwater resources that support drinking water supply uses. State capabilities to provide technical and financial assistance should be expanded to meet the needs of local governments and water suppliers.

r. Additional assessment is needed to determine the extent of nitrate contamination in groundwater throughout Rhode Island. Where elevated nitrogen concentrations have been detected in areas of active agriculture, additional research is needed to identify or refine the best management practices needed to reduce pollutant loading.

s. Discharges that pose a high risk for adversely affecting groundwater quality should continue to be eliminated under the closure procedures administered by the Underground Injection Control (UIC) Program. Best management practices should be encouraged at facilities to minimize pollution risks.

t. DEM should continue to pursue improvement to data management systems to allow more effective use of data and information and improve public access to such information. Linking databases via a common geographic identifier should continue to be pursued.

u. Rhode Island should develop a statewide strategy to protect and restore wetland resources. The framework would reflect both regulatory and non-regulatory activities with recommendations on improving protection or restoration.

v. DEM should continue to work with partners to secure a reliable and sustainable source of funding to support habitat restoration projects. A freshwater habitat restoration program should be institutionalized. State and local funds should be used to leverage federal funds that are or may become available for such purposes.

References

Rhode Island Senate Policy Office, “The Marine Cluster – An Investment Agenda for Rhode Island’s Marine Related Economy”, Report. July 2002.

III. SURFACE WATER ASSESSMENT

A. SURFACE WATER MONITORING PROGRAMS

The Rhode Island Water Monitoring Strategy (September 2005, http://www.ci.uri.edu/Projects/RI-Monitoring/Docs/DEM_WQ_Oct_14_05.pdf) outlines and documents the surface water monitoring and assessment programs that are needed for the state to achieve its goal of comprehensively assessing its waters. The DEM Office of Water Resource (DEM-OWR) has a primary role in implementing this strategy by both conducting monitoring programs and supporting monitoring by other entities. Collectively, the monitoring programs are aimed at gathering the ambient water quality to assess water quality conditions and support management decision-making. Among many applications, the data generated are used in establishing and reviewing the state's water quality standards, measuring progress toward achieving the state and federal water quality goals, and supplying information for use in development of permit limits for wastewater discharges and Total Maximum Daily Loads (TMDL's). A mix of monitoring strategies is employed to collect data from estuarine waters, freshwater rivers and streams, and lakes and ponds.

1. Estuarine & Coastal Monitoring Programs

Management needs pertaining to coastal waters, including Narragansett Bay, influence the selection of monitoring approaches. Efforts to measure water quality in Narragansett Bay on an on-going basis are relatively recent with several key program established only in the last decade. Current approaches constitute variations of fixed-site sampling designs with different locations, parameters and sample frequency being employed to support specific program needs. The programs are coordinated and in some cases designed to compliment each other to provide both spatial and temporal information. The adoption of a new criteria for dissolved oxygen (DO), which incorporate variable time periods of exposure to hypoxia, has emphasized the need for collection of continuous measurements of DO and related parameters. In addition to surveys pertaining to management of marine fisheries, the key components of the state's approach for monitoring coastal water quality include: (1) fixed station network, (2) dissolved oxygen surveys; (3) bacteriological monitoring (fixed-stations); (4) beaches program; (5) macroalgae surveys, (6) benthic monitoring and (7) submerged aquatic vegetation (SAV).

a. Fixed-Stations Network in Narragansett Bay:

The fixed-station network is an essential component of bay monitoring. A total of 13 stations are currently maintained in a collaborative effort by several agencies (Figure 3A-1, Table 3A-1). The stations are located strategically to transect the length of Narragansett Bay and serve as sentinels of changing conditions. There is a concentration of sites in the upper Bay purposefully located as a result of wastewater discharges and consideration of Bay hydrodynamics. Six stations are fixed to docks or piers; seven stations are attached to buoys and deployed at minimum seasonally (spring to fall). The buoys are normally removed in the winter to prevent ice and storm damage. The network is standardized to use YSI instrumentation and provides continuous data measurements collected every 15 minutes from a surface and bottom depths at most locations. The parameters measured at each station include: dissolved oxygen, temperature, salinity and chlorophyll. Turbidity is also measured at select sites. The station instruments are maintained with visits generally at least every two weeks. Some stations are equipped with telemetry that allows regular transmission of data, while others require manual downloading as part of the bi-weekly maintenance schedule.

The fixed-station network serves as the primary source of baseline data to characterize important aspects of Bay water quality. It should be maintained for the long-term in order to build datasets that will allow scientists to discern actual trends from the natural variability that occurs in estuarine ecosystems. Under the auspices of the Bay Window Program, the various agencies engaged in Bay water quality monitoring convened in 2004 to evaluate and plan for future expansion of the fixed station network. The participating agencies include DEM-OWR, URI-GSO, NBNERR, NBC and RWU as well and the NBEP and URI Coastal Institute, which provide support on data interpretation and distribution. Through a series of meetings that also involved key state water programs, a plan emerged for the long-term expansion of the network. It recommended that 19 stations be eventually deployed in order to provide more comprehensive coverage of the Bay. DEM-OWR added two stations in 2005 with funds from the NOAA Bay Window Program. Currently, there are more stations located in the upper Bay where changes in water quality are expected as the result of major improvements to the WWTFs, including the abatement of CSOs.

Since 2004, DEM-OWR, working with URI-GSO as its contractor, has relied on data from the fixed-station network to systematically track water quality conditions in the upper bay. When necessary, OWR staff review data daily from a subset of fixed-stations deemed most critical in terms of signaling hypoxia. The data is used in combination with other information available in DEM to provide weekly updates on water quality conditions and determine make decisions as to whether conditions indicated a need for more intensive monitoring (targeted dissolved oxygen surveys). DEM posts the updates and data summary charts its website at http://www.dem.ri.gov/bart/index.htm. This work is coordinated with the Bay Assessment and Response Team (BART) with the objective of providing information to local communities to support preparations for responding to possible events such as fish kills.

Figure 3A-1

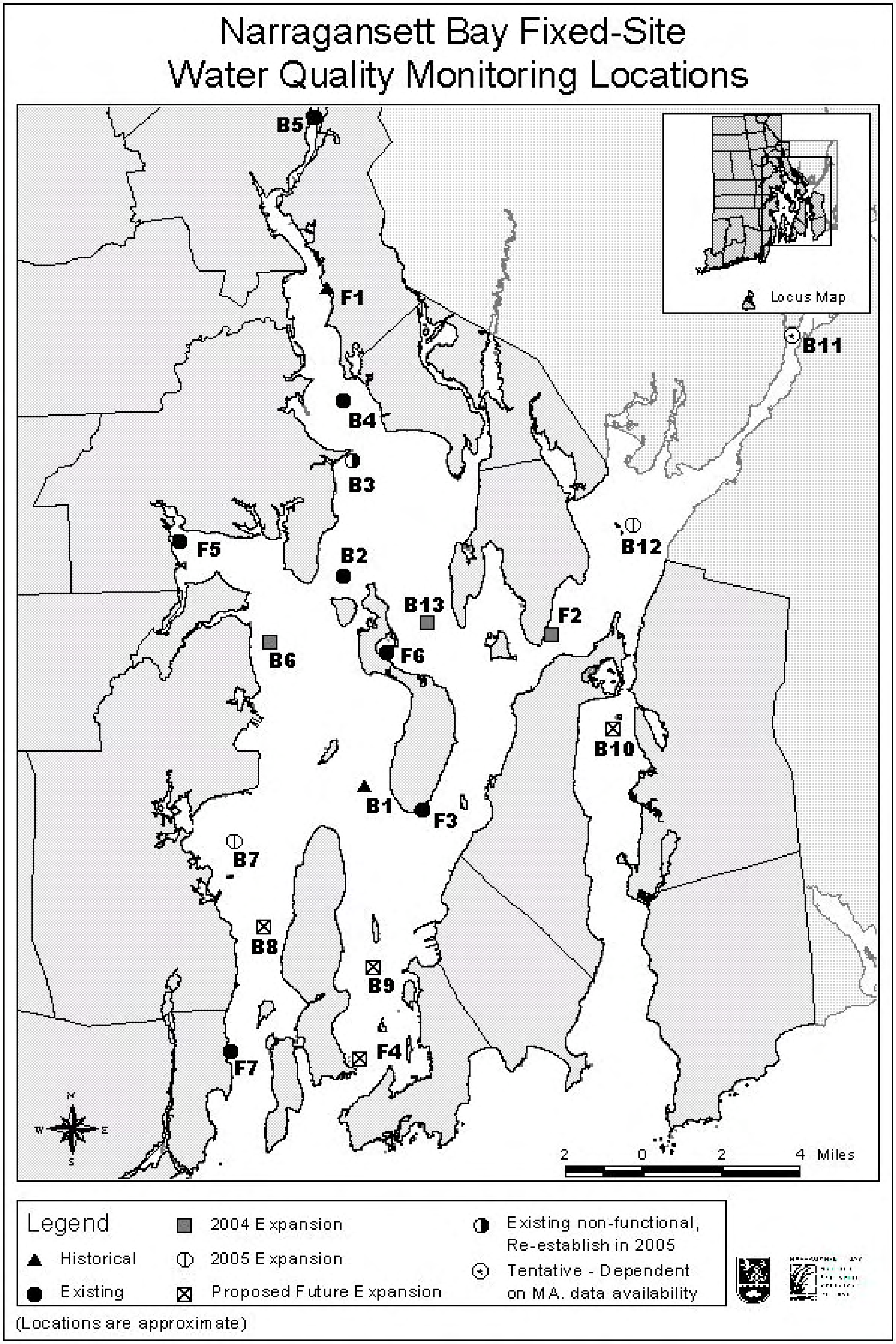

Narragansett Bay Fixed-Site
Water Quality Monitoring Locations
B5
F1
B4
B3
F5
B2
B13
F2
B6
F6
B12
B11
B10
B1
F3
B7
B8
B9
F4
F7
Locus Map
2 0 2 4 Miles
Legend
Historical
Existing
2004 Expansion
2005 Expansion
Proposed Future Expansion
Existing non-functional,
Re-establish in 2005
Tentative - Dependent
on MA. data availability
(Locations are approximate)

Table 3A-1. Fixed–Site Water Quality Monitoring Network in Narragansett Bay – 2006

Map Label (Refer to Figure 4)	Location	Station Type	Agency Servicing Station (a)	Sampling Locations	Telemetry	Data History	Comment
B5	Phillipsdale/ Seekonk River	Dock	NBC	Surface & Bottom	Yes	October 2001 - present	Seasonal
B4	Bullock's Reach (lower Providence River)	Buoy	NBC	Surface & Bottom	Yes	May 2001-present	Seasonal
B3	S. Conimicut Point	Buoy	URI-GSO DEM	Historical; replaced w/ new station in 2005	Yes	June 2005 - present	Seasonal
B2	N. Prudence	Buoy	URI-GSO DEM	Surface & Bottom	Yes	July 1999-present	Seasonal
B13	Poppasquash	Buoy	URI-GSO DEM	Surface & Bottom	Yes	July 2003-present	Seasonal
F5	Greenwich Bay (Greenwich Bay Marina)	Dock	URI-GSO DEM	Surface & Bottom	Yes – bottom only	June 2003 - present	Year-round
B6	Mount View	Buoy	URI-GSO DEM	Surface & Bottom	Yes	New	Seasonal
B7	Quonset Point	Buoy	URI-GSO DEM	Surface & Bottom	No	July 2005 - present	Seasonal
F6	Potter's Cove	Dock	NBNERR	One level	No	Dec 1995-present	Year-round
F3	T-Wharf	Dock	NBNERR	Surface & Bottom	No	July 2002-present (b)	Year-round
F7	URI GSO Dock	Dock	URI-GSO	One level	No	June 1994 - present	Year-round
F2	Roger Williams U.	Dock	RWU	Surface	Yes	2006 – present	Year-round
B12	Mt. Hope Bay	Buoy	URI-GSO DEM	Surface and Bottom	Yes	June 2005 - present	Seasonal
Future Expansion Needs							
F1	Pomham Rocks	Dock	TBD	Historical/ Future upgrade	Under Evaluation		
B10	Sakonnet River	Buoy	TBD	New			
B11	Upper Mt. Hope Bay (Massachusetts)	Buoy	TBD	New			
F4	Fort Wetherill	Dock	DEM – F&W	New			
B8	Lower West Passage	Buoy	TBD	New			
B9	Lower East Passage	Buoy	TBD	New			

a) Certain stations may have been maintained by different agencies in prior years. URI-GSO maintains a majority of the stations under an agreement with the DEM Office of Water Resources.
b) Data is available from September 1996 – July 2002 from a nearby location (B1).

b. Dissolved Oxygen Spatial Surveys in the Upper Half of the Bay

Spatial surveys of dissolved oxygen provide an important source of data that when used in combination with the fixed-site network helps characterize the extent of hypoxia in Narragansett Bay. The NBEP & NBNERR first organized surveys to measure overnight decreases in dissolved oxygen across the entire upper half of Narragansett Bay during 1999-2003. The surveys, conducted by volunteers, used multi-agency boat teams to cover large areas of the Bay simultaneously. This multi-state/multi-institution dissolved oxygen survey included volunteers from the USEPA Boston, the EPA Atlantic Ecology Division Lab, EPA Lexington Lab, the Narragansett Bay Commission, RIDEM Narragansett Bay Estuary Program & NBNERR, Roger Williams University, Brown University, U.S. Fish & Wildlife, URI, Save The Bay, YSI, Inc., MACZM and others. Following the close of the 2003 sampling season, the parties involved determined that the surveys could not be sustained on a volunteer basis and the NBEP and DEM have sought to enhance the state's capability to accomplish surveys cost-effectively via the acquisition of additional equipment, etc.

Surveys were conducted on a limited basis in Greenwich Bay during the summer of 2004. The NBEP, working with partners, initiated rapid assessment surveys in Greenwich Bay at 15 stations in the months of June, July and August with contributions of labor and boat access. IN 2005, the full DO surveys were re-instituted using new Sea-Bird SBE 19 Plus SEACAT profilers purchased with support from the NOAA Bay Window Project. In 2005, the NBEP working with Brown & DEM conducted 4 surveys of the upper Bay. In 2006, the program expanded to include three boats (Brown, NBEP/DEM, and Save The Bay/USDA) to sample about 75 stations covering the Providence River, Greenwich Bay, and the East and West Passages of Narragansett Bay. At each station we measured depth profiles of temperature, salinity, and dissolved oxygen. A map of stations is in Figure 3A-2.

The surveys focus on the warm summer months during neap tides when the risk of hypoxia is greatest. During the summer months, warm waters increase respiration rates and the Bay often has a layer of relatively warm and low salinity surface water overlying colder and saltier deep water. This low density surface layer creates stratification that can isolate the deep waters from sources of oxygen at the surface (the atmosphere or phytoplankton). Biochemical reactions associated with decaying plant matter, remove oxygen from the waters. This oxygen demand coupled with density stratification increases the risk of hypoxic conditions in the summer months, especially during neap tides when tidal mixing is low. For more information: http://www.geo.brown.edu/georesearch/insomniacs/.

Figure 3A-2. Map of Dissolved Oxygen Survey Stations

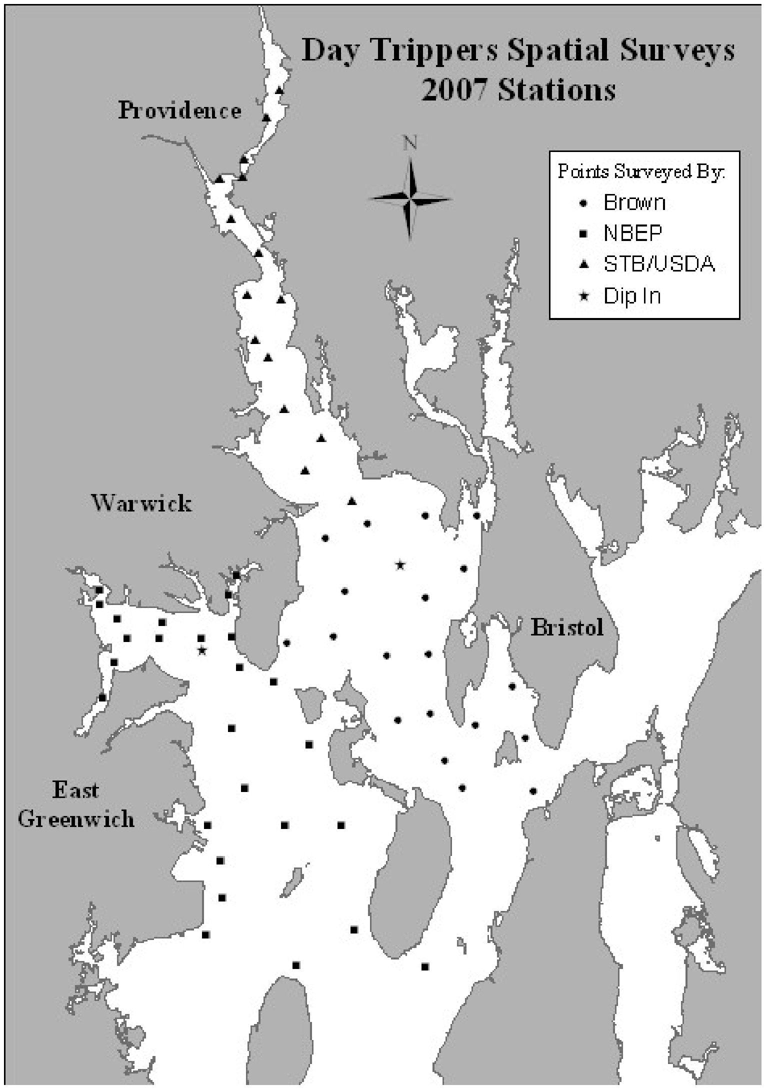


Figure courtesy of David Murray, Brown University

c. DEM Shellfish Monitoring Program

i. Monitoring for Pathogens

Among the state's coastal waters, all waters classified as SA and SA{b} are designated for shellfishing uses. This consists of 84,902 acres or about 85% of the total; which excludes Rhode Island Sound and Block Island Sound. Within designated shellfishing waters, 79%, or 66, 733 acres, are currently open with 21%, or 17,344 acres, closed permanently or managed conditionally. The DEM Shellfish Growing Area Monitoring Program provides an extensive dataset concerning pathogens in the Narragansett Bay, other embayments and coastal ponds. The program assures compliance with the USFDA National Shellfish Sanitation Program (NSSP) which regulates the interstate shellfish industry and enforces a national health standard among all shellfish producing states. As part of Rhode Island's agreement with USFDA, DEM, collects samples from 17 shellfish growing areas and analyzes for total and fecal coliform bacteria. The growing areas encompass all of Narragansett Bay and its shellfish harboring tributaries, all of the south shore coastal salt ponds, Little Narragansett Bay and Block Island. There are 303 fixed stations established in the program with from 9 to 39 stations sampled in each growing area. The frequency of sampling varies with the management status of the growing area. All open or conditional areas are sampled at least six times per year. With the exception of areas monitored by NBC, permanently closed areas are not as regularly sampled, which creates a gap in the data coverage. There are currently 32 permanently closed areas. A map of the status of shellfish areas, including closed areas, is available at http://www.dem.ri.gov/maps/mapfile/shellfsh.pdf. Pathogen data, and other data where relevant, supports assessment of the shellfishing use and decisions to open and close areas to shellfish harvesting. See Chapter III.H.2.d.

ii. Shoreline Surveys – Shellfish Growing Areas:

Another USFDA requirement of the NSSP involves shoreline surveys in which areas are inspected for potential pollution sources. These surveys are necessary to determine shellfish classification in a particular growing area and to locate all actual and potential bacterial sources. Such surveys involve an intense examination of the shoreline to identify all running pipes and tributaries for bacteriological quality as well as calculating flow rates, and then evaluating the impact upon specific growing areas. Inactive pipe sources and drainage ditches are also documented for future reference and evaluation. A shoreline survey must be performed every three years for each approved and conditionally approved growing area to meet NSSP criteria. Annual shoreline survey updates are also required each year for all approved and conditionally approved growing areas to ensure they are appropriately classified and to re-evaluate pollution sources previously identified. Water quality statistical analyses from routine sampling runs are required in conjunction with the status of any pollution sources identified during previous shoreline surveys. The Shoreline Survey Program is discussed in more detail in Chapter III.H.2.d.

iii. Harmful Phytoplankton

Harmful phytoplankton monitoring was added to the DEM Shellfish monitoring program in 2000. The introduction of this work serves a public health objective. The data provides a basis for targeting where shellfish meats should be collected for bioassay which determines the need for the closure of shellfish grounds due to the presence of Paralytic Shellfish Poisoning (PSP) and Amnesic Shellfish Poisoning (ASP). During its regular monitoring runs for pathogens, DEM –OWR collects two phytoplankton samples in the Bay or coastal ponds. The samples are analyzed and identified in the HEALTH laboratory as a means of screening for the presence of biotoxins. The identification is made using a microscope, identification keys and photographs provided by the FDA. When phytoplankton samples indicate the presence of certain species of concern, the information triggers collection of shellfish samples by DEM-F&W for analysis of their meats using mouse bioassay for red tide conditions, or high pressure liquid chromatography for amnesic shellfish poisoning. Rhode Island has never experienced an outbreak of harmful phytoplankton at levels sufficiently toxic to cause a shellfish closure. However, the need for vigilance was reinforced in 2005 when a large red tide event occurred in coastal waters ranging from Nova Scotia to Massachusetts (Chapter III.H.2.b). This event prompted an expansion of DEM sampling efforts in off-shore waters.

d. Bathing Beach Monitoring- Coastal Waters

For public health purposes, the HEALTH Bathing Beach Program ensures all coastal bathing beaches are sampled for enterococci. HEALTH currently licenses 70 coastal beaches. Among these, 20 are located in waters considered estuarine, while the remainders are adjacent to marine waters, notably Rhode Island and Block Island Sounds. With federal support via EPA EMPACT and BEACH Act grants, over the last five years HEALTH was able to develop and expand their program for coastal beaches to increase sampling frequency as well as investigation of pollution sources causing beach closures. A risk –based approach is used to determine sampling frequency which ranges from twice per season to weekly. HEALTH may also include near-shore and off-shore areas at selected beaches in order to discern of pathogens from CSOs from that of local sources. Regulations require HEALTH to ensure beach water meets bacteriological standards. Water sample results are compared with the state's water quality standards for swimming. As required in the federal BEACH Act, HEALTH changed its indicator bacteria from fecal coliform to enterococci in 2004. Any beaches exceeding the criteria are re-sampled immediately. HEALTH has the jurisdiction to close any licensed bathing area when there is a violation of the standard until the bacteria levels are within acceptable limits (see Chapter III.H.2.e).

Upon review of the water sample results, if any action is necessary the beach manager is notified and HEALTH's public notification procedures are followed. With EPA funding, HEALTH has improved public notification procedures and developed a web-site www.health.state.ri.us/environment/beaches . Current public notification procedures in place include: a 24 hour hotline; website; and a standard press release.

HEALTH requires sampling during the normal summer bathing season. In recognition of recreational activities occurring virtually year-round, the private organization Clean Ocean Access and a number of partners organized over 40 volunteers to monitor Easton's and Sachuset beaches on Aquidneck Island in the off-season

(October – May). This data supplements the DOH regular beach monitoring program and provides information that can be used to help assess water quality conditions for recreational activities conducted during these months. In 2006-2007, 759 samples were collected by volunteers and analyzed by the DOH laboratory for pathogens. The program is continuing in 2007-2008 in part with municipal support.

e. Macroalgae Surveys

Over the past few decades, large blooms of macroalgae have become common, widespread, and problematic in Narragansett Bay, but little is currently known about the distribution and movement of these macroalgal blooms. Increases in "green tides" (blooms of marine green macroalgae) in shallow nearshore habitats have become problematic worldwide. These blooms are frequently attributed to the eutrophication of coastal waters due primarily to anthropogenically-based nutrient additions of nitrogen and phosphorous (Fletcher 1996). High macroalgal densities, especially for nuisance species such as Ulva, can cause changes in the composition of sediment infaunal communities and create large piles of rotting biomass on beaches (Fletcher 1996, Raffaelli et al. 1998, Granger et al. 2000).

The RIDEM F&W has conducted seasonal trawls since 1979 across Narragansett Bay to track changes in benthic fish communities. In the last 10-15 years, excessive macroalgae biomass at many shallow (<6m) stations has obstructed the use of RIDEM's trawls, because the biomass causes premature closure of the nets (Tim Lynch, RIDEM F&W, pers. comm.). As a result, Greenwich Bay was eliminated from the trawl program, and, as of 2004, trawls were no longer attempted in waters north of a line from Rocky Point to North Point on Popasquash Point. This indicates that "green tides" are real, prolonged events in Narragansett Bay, which are likely increasing.

Monitoring areas with heavy macroalgal cover is important, because of the response of macroalgae to large local nutrient loads in shallow areas (such as the nutrients added by sewage treatment facilities) and the influence large macroalgal blooms can have in removing and sequestering nutrients from the water column. McGlathery et al. (1997) have shown that macroalgal mats can efficiently sequester nutrients normally cycling from the sediments into the overlying waters, significantly altering water column nutrient levels. These same areas can experience sudden decreases in dissolved oxygen at night due to increased respiration (McGlathery et al. 2001). Because of the nutrient sequestering ability, macroalgae may lag behind phytoplankton in response to changes in nutrient loads since some macroalgal species can sequester > a 5- day storage capacity (McGlathery et al. 2001).

The NBEP initiated baseline underwater video transect macroalgal surveys to test this methodology, concentrating on the upper areas of Narragansett Bay in 2005. Four surveys were conducted in summer 2005 (June, August, and Oct. 05). Results were mixed due to constraints of this methodology for Narragansett Bay waters: limited visibility affected video quality for macroalgal identification, and speed restrictions of < 1 knot for useful video clarity limited areal coverage based on these results and the limitations experienced from these methods, low altitude (400-500') aerial photography was deemed the most effective survey method for studying macroalgal distributions. In 2006, four low altitude helicopter surveys were completed within 1 hour of spring low tide for the Providence / Seekonk Rivers and the western shore of Narragansett Bay. A high-resolution (12 megapixel) digital wide-angle lens camera linked to a GPS and digital recording system was used in this collaborative effort with the USEPA AED Narragansett

Bay lab (Dr. G. Cicchetti). Photographs were taken every 10 seconds while the helicopter flew a steady course along the shoreline at ~ 500' altitude ant ~ 50mph. These surveys were highly successful at obtaining excellent quality digital photography showing distribution of macroalgae in the intertidal and near-subtidal zones for these areas. (Note: This effort was continued in 2007, with 5 surveys completed.) Photographs were analyzed, and density of macroalgae for red, brown and green macroalgal groups were recorded and typed into excel sheets along with photo ID and latitude-longitude.

f. Benthic Monitoring

Sessile fauna of the benthos can be easily re-sampled, and respond to conditions in the overlying water and desposited sediments (RIEMC 2005). They represent excellent biomarkers for monitoring anthropogenic and climate change over time. URI-GSO has been conducting benthic monitoring in Narragansett Bay since 1999 at selected locations in Narragansett Bay, both as part of its own activities and in collaboration with the EPA National Coastal Assessment program. Work will continue in June 2006 with the collection of cores from four locations.

g. Submerged Aquatic Vegetation & Coastal Wetlands

Another indicator of habitat quality in coastal waters is the presence of eelgrass beds. The NBEP, with partners, conducted a 1996 baseline survey of coastal habitats that identified 100 acres eelgrass beds, also known as submerged aquatic vegetation (SAVs), and 2,323 acres of salt marsh in and along Narragansett Bay. The remainder of the state (South Shore, Little Compton and Block Island) was mapped in 1999 and identified another 570 acres of eelgrass. Both surveys used aerial photography and photo-interpretation to ultimately produce maps that were published in atlases of coastal habitat. A new aerial overflight is scheduled for the summer of 2006 and will support an analysis of the loss and gains in habitat types; e.g. eelgrass beds for the intervening ten- year period. The flight is funded by RI Coastal and Estuary Habitat Restoration Trust Fund.

h. Related Research Activities

State monitoring programs have been supplemented by research programs, both short and long term, with URI-GSO playing a leading role. During the past decade, the Bay has been the focus of research by federal agencies including EPA-AED and NOAA-NMFS, both of which have facilities, located in Narragansett adjacent to the URI-GSO campus. Three notable programs which are generating water quality and other data include: (1) Bay Window Program (1998- present) and (2) Five-year Narragansett Bay Coastal Hypoxia Research Program (CHRP), both funded by NOAA and (3) EPA National Coastal Assessment Program (2000-2006). Within the Bay Window Program, NOAA- NMFS, in collaboration with DEM- Fish & Wildlife, conducts monthly surveys of zooplankton (tiny floating animals critical to the food chain) in the Bay using an advanced computer-controlled shuttle towed behind a boat. The device can move up and down the water column, sampling zooplankton while simultaneously measuring depth, salinity, temperature, dissolved oxygen (D.O.), pH, and chlorophyll *a* as a tow boat covers set transects of the Bay. The present transect layout covers the Providence River, Upper Bay, Mount Hope Bay, and the East and West Passages. With respect to water quality, the resulting dataset contributes to interpreting the spatial extent of hypoxia.

i. Volunteer Monitoring

As note above in the description of bathing beaches, there are volunteer-based monitoring programs generating additional data on coastal water conditions. Programs include those associated with URI-Watershed Watch, such as the Pondwatchers Program, which is believed to be the oldest volunteer monitoring group in the state, the Blue Water Task Force of the RI Surfriders Foundation and the effort underway in Greenwich Bay. Additionally, the Clean Ocean Access initiative on Aquidneck Island targets beach monitoring.

2. Freshwater Monitoring Programs

With respect to Rhode Island's freshwaters, prior 305(b) reports documented significant gaps in available data, especially with respect to rivers and streams. As a result, the 2005 RI Water Monitoring Strategy recommended both modifications to existing programs and an expansion of effort to reduce data gaps.

a. Monitoring Rivers and Streams: Background

With respect to rivers and streams, historically, the existing baseline monitoring programs utilized a fixed station approach wherein samples were collected over time from the same location. This approach, the most common practice among states, was used by DEM and its partners/contractors including URI, USGS, Roger Williams University and ESS Group, until 2004. One of the chief disadvantages of this approach is that it resulted in a large data gap concerning rivers and streams. To begin to address this, in the fall of 2004, DEM initiated a rotating basin approach to sampling a majority of rivers and streams within a watershed over a 12- month period. Couple with this approach was the continuation of data collection from fixed-stations on the state's largest rivers. For decades, the United States Geological Survey (USGS) has collected water quality and flow data from the state's largest rivers: the Blackstone, Pawtuxet and Pawcatuck as well as the Taunton River in Massachusetts, a tributary of Mt. Hope Bay. The quarterly sampling data has been relied upon by the state to estimate the nutrient loadings from rivers that discharge into coastal waters – most importantly the Upper Bay and little Narragansett Bay (off Westerly). The water quality component of this work was suspended in 2002 when DEM was unable to provide state matching funds to support the continuation of an agreement with USGS. This created a new critical data gap from the perspective of tracking the pollutant loadings, including nutrients, into coastal waters and disrupts data that could support long-term trend analysis. Note: Funds made available in late 2006 via the RI Bays, River and Watersheds Coordination Team were expected to re-institute data collection on both the Blackstone and Pawcatuck Rivers and increase the frequency of sampling to monthly.

Biological monitoring programs support assessments of the biological condition of a waterbody using biological surveys and other direct measures of resident biota in surface waters. The survival of a species or aquatic community is dependent upon favorable instream environmental conditions. The effects of pollutants are evidenced in the population of organisms, species composition and diversity, and the physiological condition of the natural aquatic communities. Two types of biological monitoring programs have been used to evaluate water quality in rivers and streams. Multiple plate artificial substrates have been used in deep rivers for the period 1974-2002. This long-term data collection was suspended following the retirement of the aquatic biologist who conducted this work in the DEM-OWR. EPA's Rapid Bioassessment Protocol (RBP) has been in use since 1991 on shallow (wadeable) streams and rivers. In addition, DEM-F&W has conducted fish population surveys across the state using a consistent protocol that involves electrofishing. Between 1993 and 2002, 83 lakes and 277 rivers and stream locations were surveyed and the data is in the process of being prepared for publication. DEM is exploring how this data might be applied to the water quality assessment process through the development of a fish index of biological integrity (IBI).

The current status of river and stream monitoring programs are described in more detail below.

b. Fixed Stations on Large Rivers (Non-wadeable)

As noted above, while DEM has shifted to a rotating basin approach with respect to ambient monitoring of rivers and streams, there remains a recognized need for maintaining more regular data collection from the state's largest rivers. This data is useful in evaluating longer-term trends and variations due to climatic variables. DEM's focus is on the state's largest rivers. These rivers constitute the largest tributaries into Narragansett Bay or other Rhode Island coastal waters and are the receiving waters for most of the WWTF effluent discharged into freshwaters. Past monitoring programs have indicated these rivers deliver the majority of nutrient pollutant loadings into Narragansett Bay relative to other smaller tributaries.

i. Water Chemistry & Sediments – USGS Monitoring on Non-wadeable Rivers

Historically, monitoring of water chemistry in large rivers had been conducted by the USGS via cost-sharing agreements with the DEM-OWR. Until October 2002, sampling occurred quarterly in the Blackstone, Pawtuxet, Pawcatuck and Taunton (MA) Rivers (MA). The monitoring involved water column and sediment testing with parameters selected for consistency USGS's national program requirements and protocols. Current agreements with USGS provide for sampling of five locations on the Blackstone and Pawtuxet Rivers. This constitutes only a portion of the minimum 9 stations that were recommended in the RI Water Monitoring Strategy as needed to meet critical data needs (Table 3A-2). The sampling protocol for this program involves monthly measurements for the core water quality parameters, with quarterly monitoring for metals. Additionally, flow is measured at each location (Table 3A-3). The data are made available via USGS publications, "Water Resources Data: Massachusetts and Rhode Island" and also via National Water Information System (NWIS), the national database managed by USGS, following quality assurance reviews.

Table 3A-2. Fixed-site Monitoring Stations on Large Rivers

Site	USGS Fixed Site Sampling Location	Period of Record – Water Quality Data	Rationale for Site Selection	Flow Measure
Active Stations per DEM agreement with USGS				
1	Blackstone River – Millville, MA USGS 01111230	1969-2002, 2007-present	Measures water quality near MA/RI border; allows estimates of contribution of pollutant loads from MA into Blackstone & Bay	Measured day of sampling.
2	Branch River – Forestdale, RI USGS 01111500	1954,1968, 1979-2002, 2007- present	Major tributary to Blackstone	Continuous gage station (1940 – present)
3	Blackstone River – Above Manville Dam USGS 01112900	1970, 1979-2002, 2007- present	Midway in the Blackstone (RI segment);downstream of the Woonsocket WWTF	Computed for day of sampling.
4	Blackstone River - Roosevelt Pawtucket USGS 01113895	2003- present	Approaching the mouth of the river; critical for measuring pollutant loadings into Bay	New 2003- present
5	Pawtuxet River – Cranston, RI USGS 01116500	1961-2002, 2007 - present	Near mouth of the Pawtuxet; critical for measuring pollutant loadings to the Bay	Continuous gage station (1939-present)
Other Stations Recommended for Routine Monitoring				
6	Pawtuxet River – Pawtuxet, USGS 01116617	1979-2002	Downstream of Cranston WWTF	Instantaneous at sampling
7	Pawtuxet River – To be determined (new site)	Future station	Upgradient of WWTF influences	TBD
8	Pawcatuck River –Westerly, RI USGS 01118500	1953,1963, 1976 to 2002*	Near mouth of the river; measures pollutant loading to Little Narragansett Bay	Continuous gage (1940-present)
9	Taunton River – East Bridgewater, MA USGS	1953, 1967-74, 1997-2002	Near mouth of the rivers; measures pollutant loadings into Mt. Hope Bay	Continuous gage station (1929-1976, 1985-88,1996-present)

* Monitoring at this station for selected parameters was renewed under an agreement between USGS & CT DEP.

Table 3A-3 Parameters measured at USGS Fixed Stations

Parameters	Sampling frequency 1999 - 2002 [A]	2007 - present [B]	Parameters	Sampling frequency 1999 - 2002 [A]	2007 - present [B]
WATER COLUMN SAMPLING			WATER COLUMN SAMPLING (continued)		
<u>Field determinations</u>			<u>Trace Elements</u>		
Stream flow	Quarterly	Monthly	Total manganese	Quarterly	—
Water temperature	Quarterly	Monthly	Dissolved selenium	Quarterly	—
Specific Conductance	Quarterly	Monthly	Dissolved silver	Quarterly	—
pH	Quarterly	Monthly	Dissolved chromium	Quarterly	—
Dissolved oxygen	Quarterly	Monthly	Total arsenic	Quarterly	—
Alkalinity	Quarterly	—	Dissolved zinc	Quarterly	Quarterly
			Dissolved cadmium	Quarterly	Quarterly
<u>Major nutrients</u>			Dissolved molybdenum	Quarterly	—
Dissolved nitrite	Quarterly	Monthly	Total iron	Quarterly	Quarterly
Dissolved nitrate	Quarterly	—	Total aluminum	Quarterly	—
Dissolved $NO_2 + NO_3$	Quarterly	Monthly	Dissolved copper	Quarterly	Quarterly
Dissolved ammonia	Quarterly	Monthly	Total mercury	Quarterly	Quarterly
Total nitrogen	—	Monthly	Dissolved lead	Quarterly	Quarterly
Total phosphorus	Quarterly	Monthly	Dissolved nickel	Quarterly	Quarterly
Total orthophosphate	Quarterly	Monthly	Hexavalent chromium	—	Quarterly
Total organic carbon (TOC)	Quarterly		Trivalent chromium	—	Quarterly
<u>Common constituents</u>			<u>Other Constituents</u>		
Dissolved calcium	Twice Yearly	Quarterly	Color	Twice Yearly	—
Dissolved magnesium	Twice Yearly	Quarterly	ROE at 105 °C total and suspended	Twice Yearly	—
Dissolved chloride	Twice Yearly	Quarterly	COD	Twice Yearly	—
Dissolved sulfate	Twice Yearly	—	Phenols, total	Twice Yearly	—
Dissolved potassium	Twice Yearly	—	Turbidity	Twice Yearly	Monthly
Dissolved fluoride	Twice Yearly	—	Suspended-sediment concentration	Quarterly	Monthly
Dissolved sodium	Twice Yearly	Quarterly	Total suspended sediment	—	Monthly
<u>Biological characteristics</u>					
Fecal coliform bacteria [C]	Quarterly	Monthly	STREAM BOTTOM SEDIMENTS		
E-Coli	Quarterly	—	<u>Organic compounds</u> [D]	Once Yearly [E]	—
Enterococci	—	Monthly			
5 day BOD	Quarterly	Monthly			

[A] Measured at the following stations: Branch River at Forestdale (RI), Pawtuxet River at Pawtuxet (RI), Pawtuxet River at Cranston (RI), Blackstone River at Manville (RI), Blackstone River at Millville (MA), Pawcatuck River at Westerly (RI), and Taunton River at East Bridgewater (MA)

[B] Measured at the following stations: Branch River at Forestdale (RI), Pawtuxet River at Pawtuxet (RI), Blackstone River at Pawtucket (RI), Blackstone River at Manville (RI), Blackstone River at Millville (MA)

[C] Analyses conducted at only two stations: Pawtuxet River at Pawtuxet, and Blackstone River at Pawtucket

[D] Organic compounds include: Total aldrin, Total chlordane, Total dieldrin, Total DDD, Total DDE, Total DDT, Total endosulfan, Total endrin, Total heptachlor, Total heptachlorepoxide, Total lindane, Total mirex, Total methoxychlor, Total PCB, Total PCN, Total perthane, Total toxaphene

[E] Measured once yearly during periods of low stream flow

ii. Fixed Stations – Non-wadeable Rivers - Artificial Substrate Monitoring:

The importance of biological assessments in the evaluation of water quality has long been recognized in Rhode Island. Biological assessments are evaluations of the biological condition of waterbodies using biological surveys and other direct measurements of resident biota in surface waters. Biological assessments are used to supplement physical and chemical water quality monitoring data. More specifically, the biological data can be used to identify long-term trends in water quality which reflect water pollution abatement efforts and/or needs. The survival of a species or aquatic community is dependent upon favorable instream environmental conditions. The effects of pollutants are evidenced in the population of organisms, species composition and diversity, and the physiological condition of natural aquatic communities.

In non-wadeable rivers, the Fullner multiple-plate artificial substrate with 14 plates has been used by DEM-OWR over 25 years to assess instream biological communities. Stations selected for this biological monitoring include those used for USGS trend chemical sampling (Table 3A-4). The purpose of this was to more closely relate chemical and biological data. This method has the advantage of providing a uniform sampling habitat for each station, thus reducing the problem caused by varying types of river bottom and depth. This sampling ended in 2002 due to the retirement of the OWR biologist who conducted the project. DEM is currently planning on re-instituting biological monitoring on large rivers in 2008.

Table 3.A-4 Biological River Stations (1999-2002)

River	Station	Location
Branch River	Forestdale	Rt. 146A
Blackstone River	Millville (MA)	Rt. 122
Blackstone River	Manville	Near Manville Dam
Pawtuxet River	Cranston Gage	
Pawtuxet River	Pawtuxet Village	Rt. 1A
Pawcatuck River	Westerly Gage	
Wood River	Control (Reference)	Skunk Hill Rd.

c. Fixed Stations - Chemical Monitoring – 1991-2004 (Wadeable)

In 1991, to supplement the limited number of river stations being monitored at the time, RIDEM developed a cooperative agreement with URI's Civil and Environmental Engineering Department to conduct an ambient monitoring program for rivers and streams in RI. During 1991, 1993, 1996, and 1998 through 2003 approximately twenty-five stations (Table 3A-5), selected from the forty-five Rapid Bioassessment Protocol (RBP) biological stations (see section III.A.2.d. below), were monitored under this program. Water quality samples from these 25 locations are collected on a quarterly (seasonal) basis. The grab samples are analyzed for trace metals, nutrients, dissolved oxygen and other parameters (Table 3A-6). In 2004, chemical baseline sampling was aligned to support the rotating basin approach described in Section III.A.2.e. below.

d. Fixed Stations – Rapid Biological Protocol (RBP) Monitoring (Wadeable)

To provide biological data on wadeable river and streams, DEM-OWR has supported the collection of data in accordance with EPA's Rapid Bioassessment Protocol (RBP) since 1991.The Rapid Bioassessment Protocol (RBP) involves an integrated assessment, comparing habitat (physical structure, flow regime) and biological measures with defined reference site conditions. From 1991 - 2001, a network of 45 stream riffle-area sites (Table 3A-5) were surveyed by Roger Williams University under contract with RIDEM. Each site was visited during the spring-summer season and macroinvertebrates are sampled (minimum 100 organisms per site visit where feasible). Data were analyzed using RBP I and II protocol which include varying degrees of field and laboratory organism identification. Data collected were compared with the reference station information to determine an assessment of the biological community.

In 2002, RWU chose not to continue its macroinvertebrate monitoring program and DEM subsequently contracted with ESS Group for technical services to support continued RBP monitoring at 45 stations statewide. At the same time, DEM began choosing new sampling locations in an effort to reduce the existing data gaps. In 2002, the Blackstone and Pawcatuck River watersheds were targeted with 20 new streams being sampled. Six (6) additional streams were added in other watersheds in 2003. In 2004, the biological sampling program was aligned with the rotating basin approach discussed below.

TABLE 3A-5 STREAM SAMPLING SITES FOR 1992 - 2001

BIOLOGICAL AND CHEMICAL BASELINE MONITORING

STREAM	TOWN	SAMPLING LOCATION	BIOLOGICAL MONITORING	CHEMICAL MONITORING
Abbot Run Brook (No)	Cumberland	Route 120	1992 - 2001	'91,'93,'96-'01
Abbot Run Brook (So)	No. Attleboro	Valley Rd.	1992 - 2001	'91,'93,'96-'01
Adamsville Brook	Adamsville	At USGS gage on Rt. 81 (Crandall Rd)	1992 - 2001	1991
Ashaway River	Hopkinton	At Rt. 216 below bridge	1992 - 2001	'91,'93,'96-'01
Bailey's Brook	Middletown	Kempenaar's Clambake (private rd)	1992 - 2001	'91,'93,'96-'01
Beaver River	Richmond	Shannock Hill Rd.	1992 - 2001	'91,'93,'96-'01
Big River	W. Greenwich	South side of Rt 3	1992 - 2001	'91,'93,'96-'01
Blackstone River	Lincoln	Below Manville Dam	1992 - 2001	-
Buckeye Brook	Warwick	Rt 117A at Lockwood Corner	1992 - 2001	-
Bucks Horn Brook	Coventry	At Lewis Farm Rd	1992 - 2001	'91,'93,'96-'01
Canonchet Brook	Hopkinton	Woodville\Alton Rd	1992 - 2001	'91,'93,'96-'01
Carr River	W. Greenwich	Burnt Saw Mill Rd	1992 - 2001	-
Chipuxet River	Exeter	Wolf Rocks Rd	1992 - 2001	'91,'93,'96-'01
Clear River	Burrillville	Victory Highway	1992 - 2001	'91,'93,'96-'01
Cold Brook	Little Compton	Pottersville Road	1992 - 2001	1991
Congdon Brook	W. Greenwich	At south side of bridge near old foundation	1992 - 2001	-
Dolly Cole Brook	Foster	Old Danielson Pike	1992 - 2001	-
Dundery Brook	Little Compton	Swamp Road	1992 - 2001	'91,'93,'96-'01
Fall River	Exeter	North of Route 165	1992 - 2001	'91,'93,'96-'01
Hardig Brook	Warwick	Toll Gate Rd near Little Gorton Pd	1992 - 2001	'93,'96-'01
Hemlock Brook	Foster	150 m W of Hemlock Rd bridge	1992 - 1995	-
Hunt River	E. Greenwich	Route 1	1992 - 2001	'91,'93,'96-'01
Jamestown Brook	Jamestown	Watson Farm Road	1992 - 1998, 2001	'91,'93,'96-'01
Keech Brook	Burrillville	At covered bridge in Geo. Washington Mgmt. Area	1992 - 2001	'91,'93,'96-'01
Kickamuit River	Swansea, MA	At Poverty Corner Road	1993 - 2001	-
Lawton Valley Brook	Portsmouth	Below Newport Res. Off Rt 114	1993 - 2001	-
Maidford River	Middletown	Prospect Avenue	1992 - 2001	'91,'93,'96-'01
Maskerchugg River	E. Greenwich	Route 1 before Goddard Park	-	'91,'93,'96-'01
Meadow Brook	Richmond	Pine Hill Rd (Carolina Management Area)	1992 - 2001	'91,'93,'96-'01
Moosup River	Coventry	At Rt 14 Bridge	1995 - 2001	-
Moswansicut Brook	Scituate	Near Rt. 116, west 80 m - below old stone bridge	1992 - 1995	-
Nipmuc River	Burrillville	South of Brook Road - Top Brk. Below pool	1992 - 2001	-
Nooseneck River	W. Greenwich	West side of Rt 3	1992 - 2001	-
Palmer River	Rehoboth,MA	At County Street	1995 - 1998	-
Parris Brook	Exeter	Blitzkreig Trail	1992 - 2001	'91,'93,'96-'01
Pascoag River	Burrillville	Grove St. bridge	1992 - 2001	'91,'93,'96-'01
Pawcatuck River	Westerly	Below White Rock Bridge	1993 - 2001	-
Pawtuxet River	Cranston	At USGS gage in Cranston	1992 - 2001	-
Queens River	Exeter	Liberty Road	1992 - 2001	'91,'93,'96-'01
Round Top Brook	Burrillville	Brook Road	1992 - 1993	'91,'93,'96-'01
Runnins River	Seekonk	At Rt 44 bridge	1993, 1995 - 2001	-
Rush Brook	Scituate	100 m W of Elmdale Bk	1992 - 1995	-
Saugatucket River	Wakefield	Rt 1A bridge	1992 - 2001	-
Silver Creek	Bristol	At Chestnut Street	1993 - 2001	-
Swamp Brook	Scituate	15 m NW of inflow pt. of Ponaganset Rv. into Scituate Res.	1992 - 1995	-
Ten Mile River	E. Providence	Broadway Bridge	1992 - 1998, 2001	-
Tomaquag Brook	Hopkinton	Chase Hill Rd	1992 - 2001	'91,'93,'96-'01
Wilbur Hollow Brook	Scituate	3 m N of culvert crossing on Old Plainfield Pike	1992 - 1995	-
Wood River	Richmond	North of Skunk Hill Rd off Old Nooseneck Road	1992 - 2001	'91,'93,'96-'01
Woonasquatucket River	Providence	Eagle Street Bridge	1992 - 2001	-

TABLE 3A-6

Parameters Measured in Ambient River Monitoring Programs

Parameters	URI Baseline Monitoring	Rotating Basin Approach
Field Determinations		
Instantaneous Flow	X	X
Water Temperature	X	X
Conductivity	X	X
pH	X	X
Dissolved Oxygen	X	X
Major Nutrients		
Ammonia as N (NH_3)	X	X
Nitrates as N (NO_3)	X	X
Total Nitrogen	—	X
Orthophosphate as P	X	X
Total Phosphorus	X	X
Biological Characteristics		
Fecal Coliform	X	X
Entercocci	—	X
Unfiltered BOD_5	X	X
Trace Elements		
Dissolved Cadmium	X	X
Dissolved Copper	X	X
Total Iron	X	X
Dissolved Lead	X	X
Common Constituents		
Chloride	X	X
Sodium	X	X
Hardness	X	X
Other Constituents		
Total Suspended Solids	X	X
Turbidity	X	X
Volatile Suspended Solids	X	—

e. Freshwater Rivers and Streams - Rotating Basin Approach

As mentioned above, to address large data gaps, DEM adopted a rotating basin approach to sampling rivers and streams in 2004. The approach integrates biological, chemical and physical monitoring to produce a more meaningful characterization of water quality conditions across a watershed. In terms of spatial scale and design, the sampling design involves an intensive data collection effort conducted at the 10-12 digit HUC watershed scale. Using a geometric design, stations are initially located to cover the basic layout and character of the watershed without being preoccupied by either point or nonpoint source pollution concerns. This provides an unbiased assessment of all influences on water quality. Stations then are added based upon management concerns; e.g. knowledge of pollution sources to provide additional needed data. When fully implemented, a portion of the state's watersheds would be sampled annually on a schedule aimed at covering the entire state every five years.

In 2004, this approach was piloted in the Wood River watershed and has been applied since to other watersheds as indicated in Figure 3A-3. In the Wood River Watershed, data was collected from 37 stations in a 90 square mile sub-basin. Chemical and physical monitoring was executed by URI –Civil Engineering under contract to DEM. Biological monitoring, using the RBP protocol, was executed by ESS group under contract to DEM. In 2005, the same arrangement was used to initiate sampling 45 stations in the Pawcatuck River Watershed excluding the Queens River sub-watershed. In the fall of 2006, the Queens River sub-watershed and a portion of the Pawtuxet River watershed were sampled in what constituted the start of the third cycle of the rotating basin approach. The parameters sampled are listed in Table 3A-6.

f. Stream Gage Monitoring Network

Characterizing water quality in rivers and streams requires information on streamflows. A network of 20 stream gages has been operated by the USGS under agreements with both the DEM and RI Water Resources Board. The gages record streamflows on a continuous basis and provide hydrologic information needed to help define, use and manage the state's water resources. The data generated from such a network is widely used in water resource programs for purposes related to water pollution control, managing water uses, and drought management. In April 2004, a joint WRB-DEM-USGS Streamflow Committee issued a report that recommended that the existing network of 20 long-term continuous gages be maintained and that 35 additional gages be activated on a prioritized basis. (DEM –WRB-USGS Streamflow Committee, April 2004). This corresponds roughly to having one gage permanently installed in each HUC 12 watershed area. Note: The availability of funding from the RI Bays, Rivers and Watersheds Coordination Team in later 2006 was expected to support expanding the network by three gages in 2007. See Table 3A-7 for a list of the network gages.

Figure 3A-3. Watershed Monitoring Under the Rotating Basin Approach

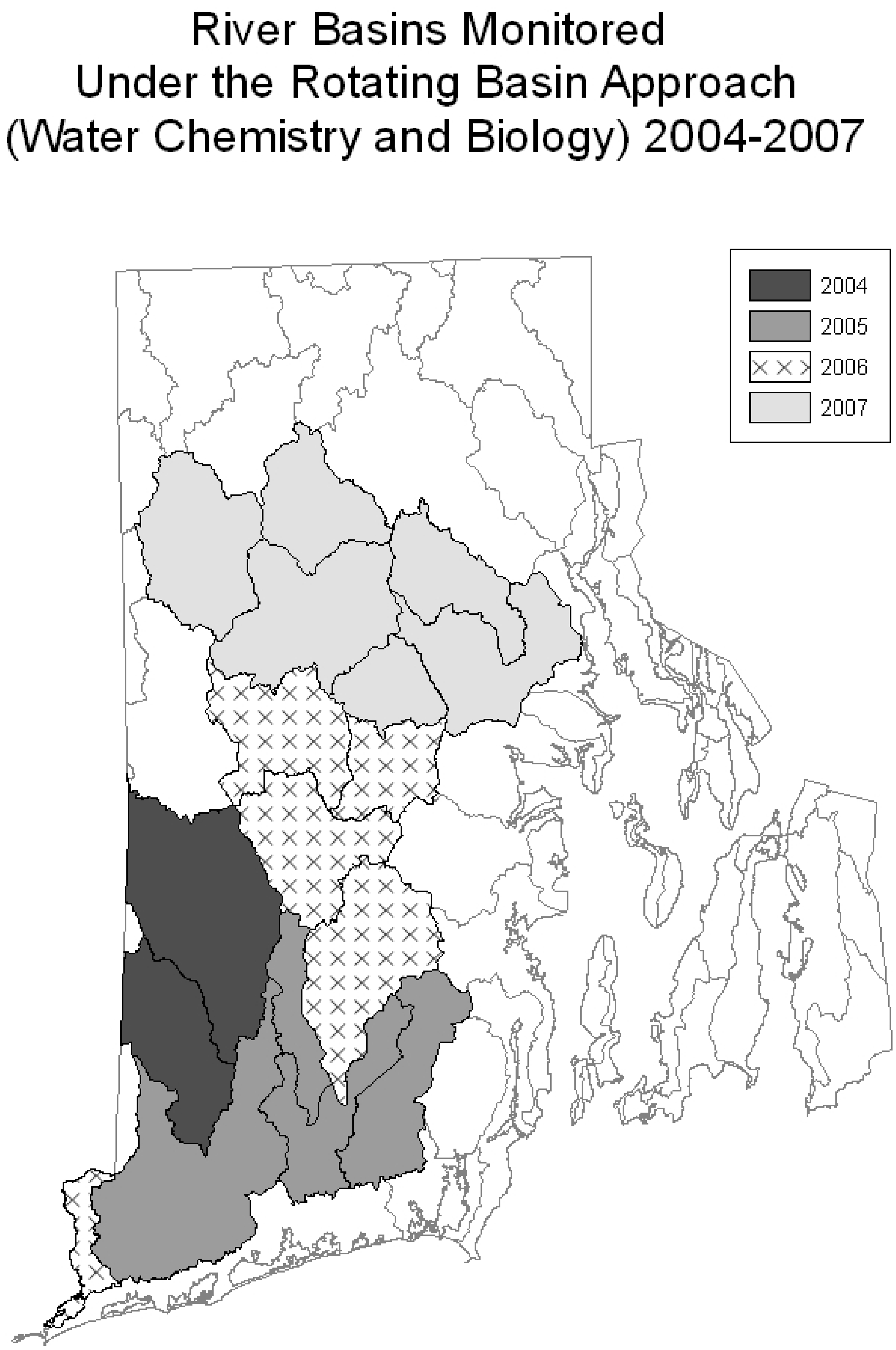


Table 3A-7.

List of Stream Gages

Status	Number	Watershed Location 12-digit HUC Name	Gage #	Potential Site Location	Existing Funding Source	Start of Period of Record	Real Time Data
E	1	Beaver River	01117468	Beaver River	WRB	1974	✔
E	2	Branch River	01111500	at Forestdale	RIDEM	1940	✔
E	3	Blackstone River - West River to Peters	01112500	Blackstone @ Woonsocket	Ocean State Power	1929	✔
E	4	Chipuxet River	01117350	Chipuxet River	WRB	58-60, 74	✔
E	5	Clear River	01111300	Nipmuc River	RIDEM	64-91, 93	
E	6	Hunt River	01117000	Hunt River	WRB	1940	✔
E	7	Millers River	01113695	Catamint Brook	RIDEM	1999	
E	8	Moshassuck	01114000	Moshassuck River	RIDEM	1963	✔
E	9	Pawcatuck Mainstem	01117500	Wood River Junction	USGS	1940	✔
E	10	Pawcatuck(Lower)	01118500	Westerly	WRB	1940	✔
E	11	Pawtuxet River Mainstem	01116500	Pawtuxet at Cranston	WRB	1939	✔
E	12	Pawtuxet River (South Branch)	01116000	South Branch - Pawtuxet	WRB	1940	✔
E	13	Ponagansett and Barden Reservoirs	01115187	Ponagansett River	RIDEM	1994	✔
E	14	Queen River	01117370	Liberty Lane	RIDEM	1998	✔
E	15	Regulating and Moswansicut Reservoir	01115098	Peeptoad Brook	Providence Water Supply Board	1994	
E	16	Ten Mile River	01109403	Ten Mile River	RIDEM	1986	✔
E	17	Usquepaug River	01117420	Usquepaug	WRB	58-60, 74	✔
E	18	Wood River(Upper)	01117800	Arcadia	WRB	64-81, 82	✔
E	19	Wood River (Lower)	01118000	Hope Valley	WRB	1941	✔
E	20	Woonasquatucket	01114500	Woonasquatucket River	RIDEM	1941	✔
E	21	Blackstone River	01113895	Blackstone @ Roosevelt	RIDEM*	03-05, 06	✔
E	22	Pawcatuck (Upper)	01117430	Pawcatuck @ Kenyon	RIDEM*	59-60, 02-04, 07	✔
E	23	Big River	01115800	Big River at Rt. 3	WRB	2007	✔
P	24	Nooseneck River	01115630	Nooseneck @ Rt. 3	WRB	63-81, 07	✔
E	25	Hunt River (Upper)	01116905	Hunt River	RIDEM*	2007	✔
E	26	Big River	01115770	Carr River	WRB	64-80, 06	✔
E	**27**	Big River	01115670	Congdon River	WRB	2006	✔
E	**28**	Big River	01115800	Big River near Nooseneck	WRB	2007	✔

Notes:

E = Existing: Existing gages determined to have the highest priority.

* Funds provide by the RI Bays, Rivers and Watersheds Coordination Team

g. Volunteer Monitoring – Rivers and Streams

Another source of data for assessment of rivers and streams is monitoring conducted by volunteers. Active volunteer programs are managed by both the URI Watershed Watch Program and the Blackstone River Coalition (BRC). In 2006, within Rhode Island, 11 sites on the Blackstone River were monitored via the BRC which has coordinated a bi-state volunteer monitoring program in the Blackstone watershed since 2004. In 2007, URI-WW reported dozens of sites being monitored on 2 rivers and streams in RI. These efforts typically sample core water chemistry parameters, including nutrients, and provide data that supplements that now being generated by the rotating basin approach.

h. Monitoring in Lakes and Ponds

i. URI Watershed Watch Volunteer Monitoring Program

The primary source of data concerning the condition of lakes and ponds is the University of Rhode Island Watershed Watch Program. Initiated in 1987, the program is a professionally supervised volunteer monitoring program that has steadily grown over the past decade. The program coordinates the training of volunteers and the subsequent field collection of samples from lakes for a seasonal period running from May to October. The program involves sampling for certain water chemistry parameters, including nutrients, water clarity and pathogens. The parameters are listed in Table 3A-8. In 1999, the DEM-OWR entered a five- year agreement with URI-WW to support the expansion of the number of lakes monitored. As of 2006, an additional 51 lakes were added to the program. More information including which lakes are included in the program is available at http://www.uri.edu/ce/wq/ww/index.htm. The data is used by DEM to support assessment decisions and characterize the trophic status of the lakes.

Table 3.A-8 Water Quality Parameters Measured by URI Watershed Watch Program for Lakes

Water Clarity (Secchi depth)	Chlorophyll *a*
Water Depth	Total and Dissolved Phosphorus
Temperature	Total, Nitrate-, and Ammonium- Nitrogen
Dissolved Oxygen (deep lakes)	Chloride
pH	Fecal coliform and E. coli bacteria
Alkalinity	

ii. Bathing Beaches

The HEALTH bathing beach program oversees sampling of 55 freshwater beaches located on lakes and ponds across the state. At these beaches the beach manager or owner is responsible for ensuring required sampling is conducted. Of the 55 freshwater beaches, four are classified as needing sampling on a weekly basis, while the remainder are sampled generally once per month (45 beaches) or less than once per month (6 beaches). The sampling provides data on the presence of enterococci which is an indicator of contamination.

3. Quality Assurance

Environmental Protection Agency (EPA) policy requires participation by all EPA regional offices, program offices, EPA laboratories, and states in a centrally managed Quality Assurance (QA) Program. As part of the QA Program, each state is required to develop a QA Program Plan and QA Project Plan(s) for assuring the reliability of monitoring and measurement data. RIDEM has developed a Quality Management Plan (QMP) to formally communicate that commitment and establish a process to ensure it is met. The QMP covers all of the data generation, data collection and management activities in the Offices of Air Resources, Compliance and Inspection, Water Resources, Waste Management, and Technical and Customer Assistance. In addition, Quality Assurance Project Plans (QAPPs) are developed for various projects conducted by and for the OWR.

For other information on Surface Water Monitoring see TMDL Development – Water Quality Assessments (Chapter II.B.3) and Point Source Control Monitoring Programs (Chapter II.B.4.b.)

References

Fletcher, R.L. 1996. The occurrence of "green tides" – a review. Pages 7-43 in W. Schramm and P.H. Nienhuis, editors. Marine Benthic Vegetation. Springer, New York.

Granger, S., M. Brush, B. Buckley, M. Traber, M. Richardson, and S.W. Nixon. 2000. An assessment of eutrophication in Greenwich Bay. M. Schwartz, editor. Restoring Water Quality in Greenwich Bay: A Whitepaper Series. Rhode Island Sea Grant, Narragansett, RI.

McGlathery, K.J., D. Krause-Jensen, S. Rysgaard, and P.B. Christensen. 1997. Patterns of ammonium uptake within dense mats of the filamentous macroalga Chaetomorpha linum. Aquatic Botany 59: 99-115.

McGlaathery, K.J., I.C. Anderson, and A.C. Tyler. 2001. Magnitude and variability of benthic and pelagic metabolism in a temperate coastal lagoon. Mar. Ecol. Prog. Series 216: 1-15.

Raffaelli, D. G., J.A. Raven, and L.A. Poole. 1998. Ecological impact of green macroalgal blooms. Pages 97-125 in A. D. Ansell, R.N. Gibson, and M. Barnes, editors. Oceanography and Marine Biology: an Annual Review. UCL Press, Philadelphia.

Rhode Island Environmental Monitoring Collaborative (RIEMC) Report to the Rhode Island Bays, Rivers, and Watersheds Coordination Team. 2005. Appendix B.2., Benthic Monitoring, C. Oviatt.

III. SURFACE WATER ASSESSMENT

B. Plan for Achieving Comprehensive Assessments

Monitoring and assessment are essential components of a comprehensive water quality program. Water monitoring, when based on a comprehensive and rigorous system of environmental indicators, is an essential component of the state's overall approach to protecting and restoring its vital water resources. To be used effectively, monitoring data must be accompanied by an integrated assessment or analysis process that provides needed meaning to the data. An effective water monitoring strategy is intended to achieve a better return on public and private investments in environmental protection, pollution control and natural resources management.

EPA has established a goal of comprehensively characterizing the waters of each state using a variety of sampling designs targeted to the condition of, and goals for, the waters. In Rhode Island, there continue to be significant gaps in data needed to characterize water quality conditions. According to this 2006 State of the State's Waters Report, data is lacking for 58% of RI's river and stream miles and 19 % of lake acreage. Additionally, little data is available on the presence of fish tissue contaminants in RI waters. To address these gaps, DEM, in collaboration with others, developed and has begun to implement a monitoring strategy aimed at supporting comprehensive assessments and providing the water quality data need for management decision-making across all water programs. Developed in response to EPA guidance as well as 2004 state laws establishing the Rhode Island Environmental Monitoring Collaborative, which consists of representatives of key state agencies involved in water monitoring programs and data management and dissemination. The RIEMC also works with a wide range of other interested entities including federal agencies, academic institutions, local entities including non-profits among others. The RI Water Monitoring Strategy, which reflects a collaborative approach involving DEM and many other entitles, was finalized in 2005 and is available at: http://www.ci.uri.edu/Projects/RI-Monitoring/Docs/DEM_WQ_Oct_14_05.pdf The strategy will be periodically updated to support an adaptive management approach.

The strategy incorporates water-related environmental indicators adapted from prior work conducted by the Partners for Narragansett Bay (PNB) and summarized in a report entitled " Ecological Indicators for Narragansett Bay and its Watershed" (Kleinschmidt, April 2003). The recommended indicators also reflect federal guidance regarding core and supplemental indicators. With respect to freshwaters, there is more emphasis being placed on biological indicators with an expectation that bio-assessment may better reflect the influences of multiple stressors upon aquatic biological communities. Over time the strategy will incorporate indicators and strategies related to landscape conditions, wetlands, groundwater and sediments.

The strategy identifies a mix of sampling designs that when fully implemented will support the goal of comprehensive assessment and provide data to meet the needs of state water program managers. As of 2006, progress has been made toward implementing several of the key monitoring strategies. With respect to Narragansett Bay , the fixed –station network , which provides continuous seasonal data, was expanded by several stations and the participating organizations instituted joint data-processing practices. In addition, the spatial surveys of hypoxia were re-instituted in 2005. Monthly monitoring of the largest tributaries into the upper bay region was instituted in February 2007 following an over four year interruption in the data record. This data is important for tracking trends in nutrient loadings into the upper Bay.

With respect to rivers and streams, in 2004 DEM shifted from reliance solely on a fixed-station monitoring approach to a rotating basin approach utilizing a geometric sampling design that is supplemented by additional targeted strategies. This approach is aimed at reducing the high percentage (58%) of river miles for which there is little to no data to support an assessment. Under the rotating basin approach, the state has been divided into seven assessment units consisting of watershed sub-basins. DEM has begun assessing these watersheds in a comprehensive manner that integrates biological, chemical and physical parameters. While the strategy recommended a schedule that would accomplish sampling watersheds once every five years, the resources available to support this work to date will not allow the State to meet that goal. The rotating basin approach is yielding more meaningful assessments that will facilitate the development of TMDLs and support other water protection programs. This approach has been supplemented with the maintenance of long-term monitoring at fixed-stations on two of the state's three largest rivers: Blackstone and Pawtuxet. As resources allow, the Pawcatuck River will be added. Additionally, using a targeted approach, DEM piloted a program to assess fish tissue contamination in rivers, streams and lakes. Rhode Island has historically lacked such a program and as a result there remains a large gap in the available data concerning fish tissue contamination.

With respect to lakes, the strategy recommended enhancing the capacity of the well-established URI-Watershed Watch Program that coordinates volunteer-based monitoring on a statewide basis. DEM provides support to this program which has expanded the number of lakes monitored.

III. SURFACE WATER ASSESSMENT

C. ASSESSMENT METHODOLOGY AND ASSUMPTIONS

1. Methodology for Determination of Use Support Status

The Assessment Methodology describes which monitoring activities are used and how resulting data and information are interpreted to calculate an assessment of water quality and determine the level of support of designated uses. As noted in Section II.B.2., the State has adopted water quality standards which define the water quality goals for the state's waters by deciding what their uses will be (designated uses), setting criteria necessary to protect those uses and by developing policies to prevent degradation of water quality. Within Rhode Island's Water Quality Regulations are *numeric* water quality criteria which represent parameter-specific thresholds for acceptable levels of substances (indicators) in waters of the state. For other parameters, the standard is more descriptive (*narrative*) in nature (e.g. "no toxics in toxic amounts").

All readily available water quality data and information from a variety of sources including state, federal and local agencies; universities and volunteer monitoring organizations, are considered for use in determining the waterbody assessment status. Prior to initiating data review, DEM solicits water quality data through verbal requests at meeting s and workshops, and through written requests to organizations, individuals, and agencies that potentially collect water quality data. A time schedule by which data must be submitted for consideration in developing the next 305(b) assessments and 303(d) list is noted in the data request. A cutoff date is necessary to ensure adequate time for staff to process, assess, and report the information by the EPA mandated deadlines. DEM will accept hard copy and/or electronic data and information from all projects. Electronic data are preferred due to the significant effort that may be needed to analyze large hard copy datasets.

The data are also evaluated for quality based upon QA/QC protocol followed, detection limits, frequency of sampling, etc. If the data collection and analysis does not include adequate QA/QC, the data may still be considered for the water quality assessments following a qualitative approach where the waterbody may be considered unassessed due to insufficient data or assessed as an evaluated assessment. The information will be used to help guide future monitoring activities under the Monitoring Strategy.

The ambient data collected by these various sources are compared to the water quality criteria and standards to evaluate for criteria exceedances. All of this data and information is then used to arrive upon an assessment and determine the level of use support. The specific criteria for determining status of the individual uses is described below in Section C.3, Use Support Categories.

Most of the baseline monitoring data utilized for the assessments consists of quarterly and seasonal sampling programs. As such, measurements of instantaneous concentrations (grab samples) for physical and chemical parameters were assumed to represent the averaging periods specified for ambient criteria. In addition, a single monitoring station is often considered representative of the waterbody for a distance upstream and downstream where no significant influences exist that might tend to change water quality or biological and habitat quality. For lakes, a single sampling station (generally collected at the deepest point of the lake) at which data is collected seasonally is considered representative for the entire lake. It is important to note that waterbodies were assessed based on either biological data only, chemical data only, or at some sites both chemical and biological data were available for the assessment. Aquatic Life Use assessments were often determined based upon only one or a few chemical (conventional and/or toxic) parameters for which ambient data was available. Generally assessments based upon such limited data were considered “evaluated” assessments.

2. Assessment Level

Assessed waters are those waterbodies for which the state makes use support decisions based on actual information. Such waters are not limited to waters that have been directly monitored since it is appropriate in many cases to make best professional judgements based on other information including extrapolating an assessment to apply to an up or down stream site. To encourage reporting on more waters, and to distinguish between assessment bases, EPA has subdivided the term "total assessed waters" into two categories and requests that assessments be classified as either:

i. Evaluated waters - those waterbodies for which the use support decision is based on information or data collected over 5 years ago; is based on qualitative information or BPJ; consists of infrequently collected data (less than quarterly sampling frequency for rivers and less than seasonally for lakes), limited data (single parameters), land use data, location of pollution sources, citizen complaints, non-quality assured citizen monitoring data, etc.

ii. Monitored waters - those waterbodies for which the use support decision is principally based on data collected within the previous 5 years with adequate QA/QC and a minimum of quarterly chemical sampling frequency for rivers, seasonally for biological data and lakes monitoring, includes: fixed and non-fixed station data, instream 24 hour survey sampling data, and artificial substrate or Rapid Bioassessment Protocol evaluations.

Table 3C-1 presents the 2006 summary of waterbody sizes monitored and evaluated.

TABLE 3C-1 2006 Summary of Waterbody Sizes Monitored and Evaluated

Waterbody Type	Units	Size Monitored	Size Evaluated	Total Assessed
River	Miles	523	103	626
Lake	Acres	12,353	4664	17,017
Estuarine	Square Miles	154.5	1.8	156.3

3. Use Support Categories

In accordance with Section 305(b) of the CWA, state's are required to survey their water quality for attainment of the fishable and swimmable goals of the Act. The attainment of the CWA goals is measured by determining how well waters support their designated uses. For the purposes of this report, the following five designated uses (See Table 3C-2) were evaluated:

- Aquatic Life
- Drinking Water Supply
- Fish Consumption
- Swimming/Recreation
- Shellfishing

Table 3C-2. Designated uses for surface waters as described in RI Water Quality Regulations and 305(b)/303(d) assessments.

305(b) Designated Use Description	RI WQ Regs Designated Use Description	Applicable Classification of Water	Designated Use Definition
Drinking Water Supply	Public Drinking Water Supply	AA (proposed)	The waterbody can supply safe drinking water with conventional treatment.
Swimming/Recreation	Primary Contact Recreation	A, B, B1, B{a}, B1{a}, SA, SA{b}, SB, SB{a}, SB1, SB1{a} (all surface waters)	Swimming, water skiing, surfing or other recreational activities in which there is prolonged and intimate contact by the human body with the water.
Swimming/Recreation	Secondary Contact Recreation	A, B, B1, B{a}, B1{a}, SA, SA{b}, SB, SB{a}, SB1, SB1{a}, SC (all surface waters)	Boating, canoeing, fishing, kayaking or other recreational activities in which there is minimal contact by the human body with the water and the probability of ingestion of the water is minimal.
Aquatic Life Support/ Fish, other Aquatic Life, and Wildlife	Fish and Wildlife Habitat	A, B, B1, B{a}, B1{a}, SA, SA{b}, SB, SB{a}, SB1, SB1{a}, SC (all surface waters)	Waters suitable for the protection, maintenance, and propagation of a viable community of aquatic life and wildlife.
Shellfishing/ Shellfish Consumption	Shellfish harvesting for direct human consumption.	SA, SA{b}	The waterbody supports a population of shellfish and is free from pathogens that could pose a human health risk to consumers
Fish Consumption	No specific analogous use, but implicit in “Fish and Wildlife Habitat”.	A, B, B1, B{a}, B1{a}, SA, SA{b}, SB, SB{a}, SB1, SB1{a}, SC (all surface waters)	The waterbody supports fish free from contamination that could pose a human health risk to consumers.

The ambient water quality data collected is compared to the water quality criteria and the results are used to determine attainment of the applicable designated uses for each waterbody. Table 3C-3 shows the designated use categories and the indicators used to assess attainment of each designated use.

Table 3C-3. Designated Uses and Indicators for Attainment Evaluations.

Designated Use	Indicators Evaluated For Attainment Of This Use
Drinking Water Supply	• Maximum Contaminant Levels (MCLs) (HEALTH) • Use advisories (HEALTH) • Treatment requirements (HEALTH)
Swimming/Primary and Secondary Recreation	• Fecal coliform bacteria (RI WQRegs); • Enterococci (EPA guidelines); • Minimum water quality general criteria and aesthetics (narrative criteria) (RI WQRegs) • Beach closure information (HEALTH)
Fish, other Aquatic Life, and Wildlife	• Conventional parameters (RI WQRegs) • Toxic parameters in water column (RI WQRegs) • Toxicity data (RI WQRegs) • Biological (macroinvertebrate) data (RI WQRegs) • Minimum water quality general criteria and aesthetics (narrative criteria) (RI WQRegs)
Shellfish Consumption	• Fecal coliform bacteria (RI WQRegs) • Shellfish consumption restrictions (RI Shellfish Growing Area Monitoring Program) • Minimum water quality general criteria and aesthetics (narrative criteria) (RI WQRegs)
Fish Consumption	• Fish consumption advisories for specific waterbodies (HEALTH)

Attainment status of the State's water quality standards is then used to categorize waters as "Fully", "Partially", or "Not" supporting specific designated uses. Partially and Not Supporting use assessments are collectively considered "Impaired" water quality conditions. Table 3C-4 gives a general description of the levels of use support.

TABLE 3C-4. LEVELS OF USE SUPPORT

USE SUPPORT LEVEL	WATER QUALITY CONDITION	DEFINITION
Fully Supporting	Excellent/Good	Water quality meets designated use criteria.
Fully Supporting but Threatened	Good	Water quality supports beneficial uses now but may not in the future unless action is taken.
Partially Supporting	Fair (impaired)	Water quality fails to meet designated use criteria at times.
Not Supporting	Poor (impaired)	Water quality frequently fails to meet designated use criteria.
Not Attainable	Poor	The state has performed a use attainability study and documented that use support is not achievable due to a natural condition or human activity that cannot be reversed without imposing widespread economic and social impacts.

Below is the general assessment methodology followed to evaluate water quality data for attainment of the water quality criteria and standards for each of the five designated uses, and the methodology for determining use support status.

i. Aquatic Life - Aquatic life use assessments are based on biological, habitat, chemical, physical, toxicity and other water quality indicators. As noted above, one or a combination of these data types can be used to conduct the Aquatic Life Use support assessment. Available water chemistry data are evaluated for conventional (dissolved oxygen, pH, temperature, secchi depth, chlorophyll a) and toxicant (priority pollutants) parameters. The concentrations detected are compared to applicable water quality criteria. For situations were the dissolved metal criteria is less than the quantitation level (QL), the QL is used to determine compliance. Biological data were evaluated based on physical habitat and biological (macroinvertebrate) community observations relative to reference stations. Dissolved oxygen (DO) levels in bottom waters of thermally stratified lakes may be naturally low. Therefore, best professional judgment of qualified professionals is used to interpret low DO levels in bottom waters of such lakes.

The use is considered **fully supporting** when the data indicate an attainment of aquatic life criteria (no more than one exceedance of the criteria in a three year period) and biological observations show no or slight evidence of community modifications. Minor exceedances of chemical criteria may be out-weighted by biosurvey results which demonstrate support of the use. The use is **partially supported** when the macroinvertebrate population indicates less than full support through any apparent moderate modification of the community relative to reference sites. Waterbodies are categorized as partially supporting the use if, for any one pollutant, there is an exceedance of the water quality criteria (acute or chronic) more than once in 3 years but in ≤ 10% of the samples. The use is considered **not supporting** if there is severe adverse modifications of the biological community and/or there are severe or frequent (>10% of the samples) violations of the chemical water quality criteria.

ii. Shellfishing - Shellfish harvesting use assessments are based on bacteriological (fecal coliform) monitoring data collected in waters designated for shellfishing use as supplied by DEM's NSSP-approved Shellfish Growing Area Monitoring Program. The protocol for shellfish harvesting use classification determinations is based upon the NSSP (National Shellfish Sanitation Program) requirements. The shellfish harvesting use classifications include Approved, Conditionally/Seasonally Approved, Conditionally Approved, Prohibited, Restricted, and Conditionally Restricted. In accordance with NSSP requirements, the geometric mean and variability of the fecal coliform levels for each station are compared to the shellfish use fecal coliform criteria (geometric mean of 14 and no more than 10% of the samples may exceed a MPN of 49) and revisions to shellfish harvesting classification are made where necessary. Sanitary shoreline surveys are an additional requirement of the NSSP. These surveys are conducted to locate actual and potential bacterial sources to growing areas.

The use is considered **fully supporting** when there are no shellfishing restrictions in effect. The use is **partially supported** when the waterbody has a seasonal or conditional closure associated with it. The use is **not supporting** when the waterbody is permanently closed to shellfishing.

In addition to the Shellfish Growing Area Monitoring Program's shellfish harvesting use classifications, there are two other circumstances which are taken into account for the 305(b) shellfish use assessment determinations. There are several Class SA estuarine areas that are closed to shellfishing strictly due to the presence of sanitary discharges (closed safety zones). In those areas where the actual water quality attains the shellfish standards, the shellfishing use is considered fully supporting. In addition, data collected throughout the year in Class SA{b} waters is evaluated for compliance with all criteria applicable to this water quality classification. Therefore, Class SA{b} waters may be designated Seasonally Approved under DEM's Shellfish Growing Area Monitoring Program requirements, however, they may not be in compliance with bacteriological data throughout the year which would be considered an impairment under the 305(b) shellfish use assessment.

iii. Drinking Water Supply - Drinking water use assessments are conducted by and based upon data supplied by HEALTH Office of Drinking Water Quality (DWQ). The data consists of ambient (source) water quality data, and information about the level of treatment required and finished water quality. The use support status is based on violations of the MCLs, use restrictions, and/or best professional judgement (BPJ) by the HEALTH DWQ staff. Waters are considered **fully supporting** when there were no violations of MCLs and no restrictions or advisories, and no requirement of more than conventional treatment**. Fully supporting but threatened** was applied to waters which meet criteria but where the integrity of the drinking water supply system is considered threatened by nonpoint sources of pollution, often resulting in occasional taste and odor problems and/or in waters where regulated contaminants are detected but not above the MCL. This category was applied to one drinking water supply where the naturally dark color of the reservoir, due to tannic acid staining, required additional treatment. The use is considered **partially supporting** where one or more parameters violate the MCLs, treatment beyond conventional treatment may be required, and frequent taste and odor problems occur. The use is considered **not supporting** if many and frequent violations of the MCLs are observed and one or more contamination-based closures of the source water occurred.

iv. Swimming - The assessment of swimming use is based on fecal coliform bacteria data. The use is considered **fully supporting** when the geometric mean of the fecal coliform criteria for swimming is met. **Partially supporting** is applied to waters where the geometric mean was met but more than 10% of samples exceeded 500 MPN per 100mL. The use is considered **not supporting** if the geometric mean was not met.

v. Fish Consumption – Fish consumption use support is determined by consumption advisories issued by HEALTH's Office of Environmental Risk Assessment. Consumption advisories are based on risk assessments conducted by HEALTH using fish tissue contaminant data collected from fish in Rhode Island waters. The use is considered **fully supporting** for a particular waterbody where fish tissue data collected in that waterbody do not result in consumption advisories for any fish species or any consumer group. The use is considered **partially supporting** for a particular water body where fish tissue data collected in that waterbody result in a limited consumption advisory (1 meal per week: 1 meal per month). The use is considered **not supporting** for a particular waterbody where fish tissue data collected in that waterbody result in a "no consumption" advisory.

Because the statewide freshwater advisory against consumption of fish species known to contain the most mercury, and the statewide saltwater advisory against consumption of fish known to contain mercury and PCBs, are precautionary, region-wide advisories and not based on any actual contaminant monitoring data collected within Rhode Island waters, these advisories are not reflected in the assessments of Fish Consumption Use.

4. Section 303(d) Waters

Section 303(d) of the CWA requires that each state identify waters for which existing required pollution controls are not stringent enough to achieve state water quality standards. These waters are referred to as "water quality limited" or “impaired”. DEM develops this list of impaired waters from the 305(b) water quality assessments. Any waterbody or waterbody segment that is assessed as not meeting its water quality standards under the 305(b) process, is placed on the 303(d) List. The 303(d) List provides an inventory of these waterbodies and the water quality impairment. States are required to rank their water quality-limited segments by priority and establish Total Maximum Daily Loads (TMDLs) for them. TMDLs describe the amount of each pollutant a waterbody can receive and not violate water quality standards. The TMDL process provides an analysis and identification of the causes (pollutants) of the impairment and relative contribution of each source of the impairment. The TMDL then establishes allocations for each source of pollution or stress as needed to attain water quality. Information about Rhode Island’s 303(d) List and TMDL Program can be found at http://www.dem.ri.gov/programs/benviron/water/quality/rest/index.htm.

III. SURFACE WATER ASSESSMENT

D. RIVERS AND STREAMS WATER QUALITY ASSESSMENT

1. Designated Use Support

Approximately 42% (626 miles) of the 1,498 river miles (total miles at 1:24,000 scale) in Rhode Island have been assessed for this report. Of the 626 river miles assessed, 84% (523 miles) are considered monitored while 16% (103 miles) are considered evaluated. Table 3D-1 presents a summary of the degree of use support and the river miles that are monitored and evaluated. Of the 626 miles assessed, the majority of river miles fully support all uses (384 miles, 61%). While 39% (242 miles) of the river miles assessed are considered impaired for one or more uses.

Table 3D-2 shows that data was available to assess 512 river miles for swimming use support. The data showed that 65% (334 miles) fully support the swimming use, and approximately 35% (178 miles) are considered impaired for swimming use.

Data was available to assess 594 river miles for aquatic life use support. The data showed that 74% (441 miles) of the river miles assessed fully support aquatic life needs. Approximately 26% (154 miles) are considered impaired for aquatic life uses.

Data was available to assess 50 river miles for fish consumption use support. The data showed that of the miles assessed, 45% (22.44 miles) fully support the fish consumption use and approximately 55% (28 miles) are considered impaired for fish consumption use.

Fifty-three (53) rivers and/or river segments reviewed for this report are located within Drinking Water Supply systems. These 53 rivers/river segments represents 114 river miles. Almost all of these rivers are considered unassessed for drinking water use. This is because the Department of Health only requires water quality data, to evaluate the source water, to be collected from the terminal reservoir of the system. The terminal reservoir is the location of the intake pumps. In general, sampling conducted elsewhere in the system has been determined by the DOH to be too limited in scope to use in conducting a drinking water use assessment. As shown in Table 3D-2, the 4.04 river miles assessed for drinking water use are fully supporting.

Table 3D-1 Summary of Fully Supporting, Threatened and Impaired Waters for Rivers and Streams
(miles)

Degree of Use Support	Assessment Category		Total Assessed Size
	Evaluated	Monitored	
Size Fully Supporting All Assessed Uses	101	283	384
Size Impaired for One or More Uses	2	240	242
Size Not Attainable for Any Use and Not Included in the Line Items Above	0	0	0
TOTAL ASSESSED	103	523	626

Table 3D-2 Individual Use Support Summary for Rivers
(miles)

USE	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	IMPAIRED	
				Size Partially Supporting	Size Not Supporting
AQUATIC LIFE SUPPORT	594.5	441	0	80.3	73.3
DRINKING WATER SUPPLY	4.04	4.04	0	0	0
FISH CONSUMPTION	50	22.4	0	18.3	9.3
SWIMMING	512	334	0	88.6	89.3

2. Causes and Sources of Impairment of Designated Uses

Causes and sources of impairment for assessed waters that do not fully support their designated uses are listed in Table 3D-3 and 3D-4, respectively. Causes are those pollutants or other stressors that contribute to the actual or threatened impairment of designated uses in a waterbody. Sources are the facilities or activities that contribute pollutants or stressors, resulting in impairment of designated uses in a waterbody. In general, the actual sources of impairment are not determined until a TMDL (total maximum daily load) is conducted on the waterbody. As such, most of the sources noted are just potential sources. If the waterbody specific information indicated impact on designated use as being high, it is indicated under the "major impact" column of Tables 3D-3 and 3D-4. If the impact was determined to be moderate, it is listed on the tables in the "moderate" impact column.

Pathogens are the major cause of non support for rivers and streams. Sources appear to be point and non-point sources such as CSOs, seepage from failing septic systems, runoff during storm events and natural sources such as wildlife and waterfowl.

Another significant cause of nonsupport for rivers and streams are biodiversity impacts. The biological monitoring conducted around the state is utilized exclusively at some locations to assess water quality. Impairment of the physical habitat and/or biological community appears to be generally due to nonpoint sources of pollution such as runoff. In addition, low flow conditions associated with drought years may alter the habitat and stress the biological community.

For rivers, another major impact is from the exceedance of the acute aquatic life criteria for metals. The sources are complex and vary from permitted industrial and municipal discharges to combined sewer overflows (CSOs) and stormdrains. Another potential source which is not routinely evaluated and characterized is contaminated sediments. Nonpoint sources such as urban runoff, and sources from outside of the state's borders are also significant contributors of metals to Rhode Island rivers.

In the majority of cases there is not enough data to link the causes of nonsupport to a source of the pollutant. Potential sources of nonsupport (Table 3D-4) are, however, noted to include both point sources (CSOs, municipal and industrial discharges) and nonpoint sources (urban runoff and highway runoff).

Table 3D-3. Miles of Rivers and Streams Impaired by Various Cause Categories

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate
AMMONIA (UNIONIZED)	16.6	
BIODIVERSITY IMPACTS	42.6	44.0
DIOXINS	7.7	
EXCESS ALGAL GROWTH/CHL-A	4.2	
METALS	38.4	91.3
NOXIOUS AQ. PLANTS native	1.6	
NUTRIENTS	18.2	11.0
LOW DO	25.9	13.3
PATHOGENS	46.7	127.0
PCBs	7.7	
UNKNOWN TOXICITY	5.4	1.8

Table 3D-4. Miles of Rivers and Streams Impaired by Various Source Categories

Source Category	Contribution to Impairment	
	Major	Moderate
AGRICULTURE		31.8
COMBINED SEWER OVERFLOW	8.9	1.6
CONSTRUCTION		4.0
CONTAMINATED SEDIMENTS	7.7	
GROUNDWATER LOADINGS	15.6	0.7
HYDROMODIFICATION	16.4	6.6
INDUSTRIAL POINT SOURCES	20.2	8.0
INTENSIVE ANIMAL FEEDING OPERATIONS		5.8
LAND DISPOSAL/SEPTIC SYSTEMS	31.1	34.4
MUNICIPAL POINT SOURCES	22.7	18.1
NATURAL SOURCES	3.7	36.1
RECREATIONAL AND TOURISM ACTIVITIES (non boating)		9.9
SEDIMENT RESUSPENSION	15.0	1.6
SOURCE UNKNOWN	20.5	91.5
URBAN RUNOFF/STORM SEWERS	30.2	127.8

III. SURFACE WATER ASSESSMENT

E. LAKE WATER QUALITY ASSESSMENT

1. Designated Use Support

Eighty-one percent (17,017 acres) of the 20,917 lake acres in Rhode Island, at a scale of 1:24,000, have been reviewed for this report. Of the 17,017 lake acres assessed, approximately 73% (12,353.5 acres) are considered monitored and approximately 27% (4,664.76 acres) are considered evaluated. Table 3E-1 presents a summary of the degree of use support and the lake acres that are monitored and evaluated. Of the 17,017 acres assessed, 68% (11,650 acres) fully support all designated uses and 0.03% (<5 acres) of the lake acres fully support all designated uses but are considered threatened. Approximately 32% (5,363 acres) of the lake acres assessed do not support their uses and are considered impaired for one or more uses.

Table 3E-2 shows that data was available to assess 15,271 acres for swimming use support. The data indicated that most lake acres fully support their swimming use (96%, 14,720 lake acres). Approximately 4% (551 acres) of lake acres assessed are considered impaired for the swimming use.

Data was available to assess 15,868 lake acres for aquatic life use support. Approximately 80% (12,636 acres) of the lake acres assessed fully support aquatic life needs. Approximately 20% (3,232 acres) of lake acres assessed are impaired for aquatic life uses.

Data was available to assess 3,124 lake acres (28 lakes) for fish consumption. Information for this assessment comes from the Department of Health (HEALTH), Office of Environmental Risk Assessment. Approximately 23% (732 acres) of the lake acres assessed fully support fish consumption use. HEALTH has issued a fish consumption advisory for 77% (2392 acres), which represents 20 lakes.

Forty-two (42) lakes assessed are used as drinking water supply sources. This represents 7,813 acres associated with the drinking water supply systems. Of these 7,813 acres, 5,484 acres (70%) are considered assessed for drinking water use for this report. The remaining 2,329 lake acres, or 30% were considered not assessed for drinking water use support. In general these 2,329 acres represent portions of the drinking water supply system that are upstream of the terminal reservoir. The terminal reservoir is the location within the drinking water supply system where the Department Of Health requires water samples to be collected. Some of these upstream waters are not monitored and are therefore, considered unassessed for drinking water use in this report. Ninety-nine percent (5,424 acres) of the drinking water supply lake acres assessed were found to be fully supporting, and less than 1% (<5 acres) of the drinking water supply lake acres assessed fully support uses but are threatened. Approximately 1% (55 acres) of drinking water supply lake acres assessed are considered impaired for the drinking water use.

Table 3E-1 Summary of Fully Supporting, Threatened, and Impaired Lakes (Acres)

Degree of Use Support	Assessment Category		Total Assessed Size
	Evaluated	Monitored	
Size Fully Supporting All Assessed Uses	4,253.41	7,396.36	11,649.77
Size Fully supporting All Assessed Uses but Threatened for at Least One Use	0	4.54	4.54
Size Impaired for One or More Uses	410.16	4,952.39	5,362.55
Size Not Attainable for Any Use and Not Included in the Line Items Above	0	0	0
TOTAL ASSESSED	4,663.57	12,353.29	17,016.86

Table 3E-2 Individual Use Support Assessment Summary for Lakes (Acres)

USE	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Partially Supporting	Size Not Supporting
AQUATIC LIFE SUPPORT	15,867.52	12,635.51	0	2,475.32	756.68
DRINKING WATER SUPPLY	5,483.97	5,424.46	4.54	54.97	0
FISH CONSUMPTION	3,123.76	732.02	0	1,812.06	579.67
SWIMMING	15,271.30	14,720.29	0	219.93	331.07

2. Causes and Sources of Impairment of Designated Use

Causes and sources for assessed waters that do not fully support their designated uses were determined and are listed in Tables 3E-3 and 3E-4, respectively. Causes are those pollutants or other stressors that contribute to the actual or threatened impairment of designated uses in a waterbody. Sources are the facilities or activities that contribute pollutants or stressors, resulting in impairment of designated uses in a waterbody. In general, the actual sources of impairment are not determined until a TMDL (total maximum daily load) is conducted on the waterbody. As such, most of the sources noted are just potential sources. If the waterbody-specific information indicated impact on designated use as being high, it is indicated under the "major impact" column on the tables below. If impact was listed as moderate it is listed here under "moderate" impact.

The “aging” process (eutrophication) is a natural process in the life of all freshwater lakes and ponds, but is often accelerated by human-related development in the watershed. Rapid eutrophication, with high inputs of nutrients and associated heavy algal blooms or bottom weed growth, eventually severely limit desirable recreational uses and result in low dissolved oxygen problems which limits the aquatic life uses.

As shown in Table 3E-3, the major causes of impairment for lakes are from nutrients, low dissolved oxygen and pathogens. Another major cause of non-support in terms of total acreage effected, is from metals. This major cause of impairment applies to 27 lakes and is primarily associated with elevated levels of mercury found in the fish in these ponds.

In the majority of cases there is not enough information to link the causes of impairment to a source of the pollutant. Potential sources of nonsupport are shown in Table 3E-4. The major potential sources of impairment are from urban runoff/storm sewers and land disposal, including onsite wastewater systems and landfills. Overall the sources of pollution are from nonpoint sources which can supply high nutrient inputs that cause algal blooms, low dissolved oxygen and severe eutrophication problems.

Table 3E-3 Total Size of Waters Impaired by Various Cause/Stressor Categories
Lakes (acres)

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate
BIODIVERSITY IMPACTS	38.0	537.8
EXCESS ALGAL GROWTH/CHL-A	86.9	1399.2
EXOTIC SPECIES		219.4
METALS	607.8	2432.5
PCBs		76.7
NOXIOUS AQUATIC PLANTS native		297.6
NUTRIENTS	271.4	1827.1
LOW DO	209.9	1257.3
PATHOGENS	59.3	491.7
CHLORIDES		26.3
SILTATION		109
SUSPENDED SOLIDS		26.3
TASTE AND ODOR		55
TURBIDITY		164

TABLE 3E-4 Total Sizes of Waters Impaired by Various Source Categories
Lakes (acres)

Source Category	Contribution to Impairment	
	Major	Moderate
AGRICULTURE		715.5
ATMOSPHERIC DEPOSITION		33.2
COMBINED SEWER OVERFLOW		38.0
CONSTRUCTION		143.4
GROUNDWATER LOADINGS		201.7
HABITAT MODIFICATION (other than hydromodification)		66.1
HYDROMODIFICATION		609.5
INDUSTRIAL POINT SOURCES		130.3
INTENSIVE ANIMAL FEEDING OPERATIONS		480.1
INTERNAL NUTRIENT CYCLING (primarily lakes)		224.4
LAND DISPOSAL		1011.6
MUNICIPAL POINT SOURCES		252.8
NATURAL SOURCES		257.0
RECREATIONAL AND TOURISM ACTIVITIES (non-boating)		308.0
SOURCE UNKNOWN	399.0	2582.0
URBAN RUNOFF/STORM SEWERS	29.4	2215.0

3. Clean Lakes Program

a. National Program - Background

The Clean Lakes Program was established in 1972, under the Federal Water Pollution Control Act, to provide financial and technical assistance to the States in restoring publicly-owned lakes. The early focus of the program was on research, development of lake restoration techniques, and evaluation on conditions (Lake Classification Studies). The Clean Lakes Program Regulations promulgated in 1980, redirected program activities to diagnose the current condition of individual lakes and their watersheds, determine the extent and sources of pollution, develop feasible lake restoration and protection plans (Phase I Diagnostic/Feasibility Studies) and to implement these plans (Phase II Restoration/Protection Implementation Projects).

With the passage of the 1987 Amendments to the Clean Water Act, EPA expanded the program to include Statewide assessments of lake conditions (Lake Water Quality Assessment grants). EPA also established Phase III Post-Implementation Monitoring studies to evaluate the longevity and effectiveness of various restoration and protection techniques implemented under Phase II grants. Unfortunately, Federal funding of the Clean Lakes Program ended with FY94 funds.

b. Rhode Island Program - Background

The State of Rhode Island does not have a formal comprehensive lakes-management program. The primary protection is provided by the RIDEM Water Quality Regulations; Best Management Practices such as buffers and setbacks required under RIDEM Wetlands Regulations; and Individual Septic Disposal System regulations. A small number of local (municipal) stormwater and/or nutrient loading ordinances exist at this time.

The RIDEM Nonpoint Source Pollution Management Plan is attempting to deal with control of NPS to all waterbodies, including lakes and ponds through educational outreach workshops, etc. Nonpoint (319) Federal funds are potentially available for implementation of some BMP's through the NPS Management Program if matching funds are available.

A list of publicly owned lakes in Rhode Island tracked for the 2006 305(b) cycle (generally lakes >10 acres), is presented in Table 3E-5 in fulfillment of Section 314 of the Clean Water Act of 1987. These lakes are considered to have legal public access, and are open to the general public or town citizenry for the recreational use(s) indicated. Lakes with privately-owned or for-profit access (e.g., private beaches, marinas, etc.), are not listed here. Therefore, this list should *not* be interpreted as a list of all Rhode Island recreational lake opportunities available to the general public. At present, there are 94 such public lakes, covering a total surface area of approximately 8,914 acres which have been reviewed for this report.

Before 1988, RIDEM had only extremely limited, or, more often, no information on water quality in most Rhode Island lakes and ponds. In order to rectify this situation, and to provide some minimal baseline data for water quality assessments, the RIDEM Division of Water Resources water quality planning section developed a limited baseline sampling contract with the U.S.G.S. for 1988 and 1989. Thirty-five (35) lakes/ponds were sampled once during summer stratification/bloom period (August), and again during fall overturn (October-November) over this two (2) year period. The list of lakes sampled, as well as water quality data results are available in the RIDEM 1990 305(b) report.

At the same time this sampling program was developing, the USEPA announced the availability of Federal grant money for Statewide assessments of lake water quality. Through the help and cooperation of the University faculty associated with the University of Rhode Island Water Resources Center, a successful grant application for these funds was developed. Funding was received in 1989 for a two (2) year (1989-1990) study by the URI Department of Natural Resources Science of 34 public lakes in the southern half of Rhode Island.

Using the data from these two (2) lake monitoring projects, RIDEM initiated the development of lake assessments for significant publicly-owned lakes in the 1990 305(b) report. From 1991 to 1994 (the last year of Federal Clean Lakes funding), RIDEM received Clean Lakes, Lake Water Quality Assessment grants and developed cooperative agreements with the URI Cooperative Extension Watershed Watch Program, to continue the water quality monitoring and assessment of public lakes in Rhode Island. Annual reports summarizing the results of monitoring for each Watershed Watch lake are available from RIDEM, OWR. From 1995 to 1999, the URI Watershed Watch program secured other funding to continue lake monitoring but continued to share that data with DEM to allow for the continuation of lake assessments in Rhode Island. As of 1999, DEM was able to resume funding to the Watershed Watch program and is currently working under a multiyear agreement with URI to ensure the continuation of funding for this program and an increase in the number of lakes monitored each year.

Table 3E-5. State of Rhode Island - 2006 Use Assessment for Publicly-Owned Lakes

Lake	Size **(Acres)**	**Trophic Class**	**Water Quality Class**	**Access/Use**	**Impairment/Cause**
Burrillville					
Wakefield Pond	75.07	O	B	SBLR*/WWF	
Wilson Reservoir	109.31	O	B	SBLR/WWF	
Pascoag Reservoir (Echo Lake)	349.07	O	B	SBLR/WWF	
Round Top State Pond	9.72	U	A	SFA/STK(B)	
Nichols Pond	21.02	U	B		
Spring Lake (Herring Pond	94.80	O	B	SBLR/TBH	
Wallum Lake (RI waters)	172.79	O	A	SMA*/SBLR(MA)/CWF/ STK(A)	
Slatersville Reservoir	218.87	M	B	SFA/WWF	Phosphorus, Pathogens Copper, Lead
Peck Pond	13.42	U	B	SMA/SP*/SBH/ STK(B)/WWF	
Barrington					
Echo Lake	24.39	U	B		
Prince's Pond (Tiffany Pond)	8.08	H	A		Phosphorus, Low DO, Excess algal growth
Brickyard Pond	84.06	M	B	TFA/WWF/STK(C)	Low DO, Phosphorus
Charlestown					
Watchaug Pond	567.92	M	B	SBLR/SP/SBH/ STK(B)/SMB/WWF	Mercury (fish tissue)
Coventry					
Carbuncle Pond	38.92	M	A	SMA/STK(B)/WWF	
Coventry Res. (Stump Pond)	168	O	B	SP/WWF	
Flat River Res. (Johnson Pond)	647.14	M/O	B	BLR/WWF	
Upper Dam Pond	20.49	E	B		Phosphorus
Tiogue Lake	233.9	O	B	SBLR/TBH/WWF/ SMBSP/WWF	Mercury (fish tissue)
Waterman Pond (Sisson Pond)	32.34	ME	A		

Table 3E.-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Cranston					
Meshanticut Pond	12.287	U	B	SP/WWF	
Randall Pond	34.439	M	B	WWF	
Spectacle Pond	38.807	E	B	WWF	Phosphorus, Excess algal growth
Fenner Pond	19.47	H	B		Phosphorus, Excess algal growth
J.L. Curran Res. (Fiskeville Res.)	46.228	M/O	B	SP/SBLR/WWF	Mercury (fish tissue)
Cumberland					
Valley Falls Pond	37.969	E	B1		Biodiversity impacts, Lead, Phosphorus, Low DO, Pathogens, Excess algal growth
East Providence					
Turner Reservoir (North & South)	214.783	E	B1/B		Phosphorus, Low DO, Pathogens, Copper, Lead
Exeter					
Beach Pond	142.74	O	B	SMA/SBLR/SBH/STK(A)	
Arcadia Pond (Browning Mill Pond)	50.025	M	B	SMA/SBH	Mercury (fish tissue)
Deep Pond	2.4385	M/E	A	SMA/STK(A)	Low DO, Phosphorus
Foster					
Shippee Saw Mill Pond	8.1869	M	A	SBLR/STK(A)	
Glocester					
Bowdish Reservoir	219.37	O	B	SMA/SBLR/SBH/WWF	Exotic Species
Burlingame Reservoir	67.243	U	B		
Clarksville Pond	15.026	U	B	SFA/SBLR	
Keech Pond	49.245	O	B	SBLR/WWF	
Ponagansett Reservoir	219.98	U	A	WWF	
Smith & Sayles Reservoir	172.74	O	B	SBLR/WWF	
Lake Washington	40.887	E	B	SBLR/WWF	
Waterman Reservoir	251.86	M	B	WWF	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Hopkinton					
Long Pond	20.194	O	B	SMA/WWF	
Ashville Pond	25.678	U	B	SMA/STK(B)/WWF/SMB	Mercury (fish tissue)
Ell Pond	4.8953	U	B		
Wyoming Pond	34.051	M	B	SBLR/STK(A)/WWF	Mercury (fish tissue)
Alton Pond	44.209	M	B	SBLR/STK(A)/WWF	Mercury (fish tissue)
Blue Pond	93.931	U	B	SBLR/WWF	
Locustville Pond	82.304	M	B	SBLR/SFA/WWF	Mercury (fish tissue)
Moscow Pond	16.48	M	B	SFA/WWF	
Johnston					
Oak Swamp Reservoir	109.36	O	B		
Almy Reservoir	52.928	M	B		
Lincoln					
Olney Pond	129.03	M	B	SP/SBLR/STK(A)/SBH/WWF	
Scott Pond	42.127	E	B		Low DO, Excess algal growth, Phosphorus
Handy Pond	8.0583	M	B	SFA	
Barney Pond	23.843	E	B	TFA/SP	Phosphorus
Little Compton					
Round Pond	34.25	E	A		Phosphorus
Newport					
Lily Pond	29.13	E	A		Phosphorus
Almy Pond	49.85	H	A		Phosphorus
North Kingstown					
Silver Spring Lake	18.747	M	B	SBLR/STK(A)/WWF	
Potowomut Pond	18.673	U	B	SFA	
Belleville Ponds	130.27	M	B	BLR(TOWN)/WWF	Phosphorus
Secret Lake	46.213	M	B	TFA/WWF	
Annaquatucket Mill Pond	6.3045	M	B	Alewife run/WWF	
North Providence					
Wenscott Reservoir	82.823	M	B	TBH/WWF	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
North Smithfield					
Tarkiln Pond	23	M	B	TFA/STK	
Primrose Pond	10.38	U	B		
New Shoreham					
Sachem Pond	79.925	U	A		
Pawtucket					
Slater Park Pond	21.357	H	B1	TFA/STK	Phosphorus, Pathogens, Excess algal growth
Portsmouth					
Saint Mary's Pond	112.06	U	A	SFA/STK	Biodiversity impacts
Providence					
Roger Williams Park Ponds	88.582	H	B	CITY PARK	Low DO, Phosphorus, Excess algal growth, Pathogens
Mashapaug Pond	76.746	H	B	SBLR/WWF	Phosphorus, Low DO, Excess algal growth, PCBs, Pathogens
Richmond					
Carolina Trout Pond	3.3039	M	A	SMA/STK(A)/WWF	
Meadowbrook Pond	23.063	M/E	A	SFA/STK(A)	Mercury (fish tissue)
Scituate					
Pine Swamp Pond	36.95	U	A		
South Kingstown					
Worden Pond	1,051.2	M	B	SBLR/WWF	
Barber Pond	28.159	M	B	SBLR/STK(B)/WWF	Low DO
Asa Pond	23.848	U	B		
Glen Rock Reservoir	30.251	M	B	WWF	
Silver Lake	44.783	O	B		
Peace Dale Reservoir	11.707	U	B		
Smithfield					
Tucker Pond	92.968	M	B	SBLRSTK(C)/WWF	Mercury (fish tissue)
Mountaindale Res.	10.421	U	B		
Slack Reservoir	133.61	M	B	TBH/WWF/SMB	
Woonasquatucket Res. (Stump Pond)	302.84	M	B	TFA	

Table 3E-5. Cont'd

Lake	Size (Acres)	Trophic Class	Water Quality Class	Access/Use	Impairment/Cause
Stillwater Pond	15.046	M	B		
Georgiaville Pond	96.907	M	B	TBH/WWF	
Tiverton					
Stafford Pond	480.13	M/E	A	SBLR/STK(A)/WWF/SMB	Excess algal growth, Phosphorus, Low DO
Warwick					
Sandy Pond, (Little Pond)	28.342	M	B	TBH	PS - Pathogens
Sand Pond (N. of Airport)	12.209	M	A	TBH	Low DO, Phosphorus
Gorton Pond	58.3	M	B	TBH/WWF/TOWN PARK	Excess algal growth, Phosphorus, Low DO
Posnegansett Pond	13.349	M	A	TBH	
Warwick Pond	84.716	E	B	TBH	Phosphorus, Excess algal growth, Low DO
Westerly					
Chapman Pond	172.77	M	B		Lead, Noxious aquatic plants
West Greenwich					
Breakheart Pond	43.792	O	A	SFA/STK/SBLR/WWF	
Mishnock Lake	47.029	O	B	TFA/WWF	
Tarbox Pond	19.902	M	A	SFA	

KEY for Table 3E-5:

SBH = State Beach

SBLR = State Boat Launching Ramp

SFA = State Fishing Access

SMA = State Mgt. Area

TFA = Town Fishing Access

SP = State Park

@ = abundant bottom vegetation

. = F&W Priority List

WWF = Warm Water Fishery

TBH = Town or City Beach

SMB = Small mouthed bass

STK = Stocked Trout

(A) = High fishing usage; (B) = Lower fishing usage; (C) = Low usage/Less suitable habitat

TROPHIC CLASSES: O = Oligotrophic; E = Eutrophic; H = Hypereutrophic; M = Mesotrophic; D = Dystrophic

4. Trophic Status

In addition to use support assessments, RIDEM assesses the trophic status of lakes. Table 3E-5 summarizes the trophic status of the public lakes and ponds that were assessed for this report. The data and determination of trophic status for the public lakes comes from the Watershed Watch monitoring program. The trophic status of lakes is based on the Carlson Index for chlorophyll a, secchi depth, and phosphorous using the following:

Water Quality Measurement or Term	Oligotrophic Low Nutrient enrichment	**Mesotrophic** Average Nutrient enrichment	**Eutrophic** Above average nutrient enrichment
Secchi Depth Transparency	greater than 4 meters greater than 13 feet	2 - 4 meters 6.3 - 13 feet	less than 2 meters less than 6.3 feet
Chlorophyll Content	less than 2.6 ppb	2.6 - 7.2 ppb	more than 7.2 ppb
Phosphorus Content	less than 12 ppb	12 - 24 ppb	more than 24 ppb
Trophic State Index	less than 40	40 - 50	more than 50

It should be kept in mind that trophic status can be very dynamic, with parameters such as secchi and chlorophyll altering rapidly (within weeks or less) often due to rainfall totals. With the extensive monitoring data from the Watershed Watch program, 144 lakes, representing 17,017 acres, are considered assessed for the 2006 305(b) assessments.

A summary of the number of lakes classified within each trophic group for public lakes is shown in Table 3E-6 and for private lakes in Table 3E-7. There are 22 lakes within the current database for which we do not have access information. It is obvious from Tables 3E-6 and 3E-7 that the majority of Rhode Island lakes fall into the mesotrophic classification range. The specific trophic classification for each public lake, as well as size, use classification, public access, and use impairment (if any), are provided in Table 3E-5.

Table 3E-6 Summary of trophic status for Rhode Island Public Lakes/Ponds 2006

Trophic Status	Number of Lakes	Acreage of Lakes
Oligotrophic	16	2052.2
Meso/Oligo	2	693.4
Mesotrophic	36	3,987.8
Meso/Eutrophic	4	538.0
Eutrophic	12	643.7
Hypereutrophic	5	187.3
Unknown	19	811.5
Total Number of Lakes	94	8914

Table 3E-7 Summary of trophic status for Rhode Island Private Lakes/Ponds 2006

Trophic Status	Number of Lakes	Acreage of Lakes
Oligotrophic	10	729.0
Oligo/Meso	1	45.6
Mesotrophic	12	978.6
Meso/Eutrophic	1	143.4
Eutrophic	3	174.8
Unknown	58	7075.3
Total Number of Lakes	85	9,146.6

5. Control Methods and Restoration/Protection Efforts

a. General

As there are very few direct discharges into lakes, protecting and restoring lake water quality is focused on reducing non-point sources of pollution. Although Rhode Island does not have a formally established lake management program, lakes are protected by the RIDEM Water Quality Regulations and other water pollution control regulatory programs including those that address stormwater discharges. The Rhode Island Water Quality Regulations contain a total phosphorous limit of 0.025 mg/l in any lake or pond. The Regulations also include a narrative limitation on the allowable concentration of nutrients so as not to cause undesirable or nuisance aquatic species associated with cultural eutrophication. DEM has initiated work on the development of refined nutrient criteria for lakes and ponds to ensure that nutrient criteria are adequately protective.

TMDL water quality restoration plans have been completed for Stafford Pond, Yawgoo Pond, Barber Pond and the Kickemuit Reservoir as of the end of 2006. These plans identify actions that are needed to reduce pollutant loadings to the lakes as well as manage the lake to improve water quality. The DEM Nonpoint Source Program, in combination with state bond funds when available, makes grants available on a competitive basis to assist municipalities and others in implementing TMDL restoration actions. Projects receiving 319 funds to control nonpoint source pollutant loadings into lakes that have been completed include improved stormwater BMPs adjacent to Stafford Pond, Wallum Lake, Easton's Pond , Watchaug Pond, and Robin Hollow Pond. The Stafford Pond Project is further described below.

In recent years, there has been growing awareness of and public concern with the issue of nuisance aquatic plant control and management in lakes. Excessive growth of aquatic plants can be encouraged by nutrients, but also occurs as the result of the establishment and spread of aquatic invasive species. DEM is currently working on guidance to promote local aquatic plant management plans as the most effective approach for identifying the control and mitigation actions that will be most effective in managing aquatic plant problems. In many cases, management actions will need to be repeated to be effective, and thus lake management requires long-term commitment.

b. Stafford Pond Project

Stafford Pond is a 480 acre water body located in Tiverton, R.I. which serves as a drinking water supply for residents of Tiverton and Portsmouth, R.I. Following frequent algal blooms, leading to taste and odor problems for the local water supplier, a TMDL was developed for Stafford Pond. Water quality investigations performed as part of

TMDL development identified that the algal blooms are a result of high phosphorus loadings, principally coming from a local dairy farm. Additional sources include residential land uses and storm drains. The DEM Nonpoint Source Program provided funding for the Rhode Island Department of Transportation to retrofit its stormwater drains to improve treatment. In coordination with the Natural Resources Conservation Service, DEM provided financial assistance for implementation of BMPs for the farm in order to reduce the loadings of phosphorus into the pond. Follow-up monitoring indicates some form of in-lake treatment may be needed to eliminate the high phosphorus levels that have built-up in the pond over time. Stafford Pond water quality does not yet meet Rhode Island water quality standards.

c. Clean Lakes Assessment Projects

RIDEM was awarded Federal Clean Lakes grants between 1988-1994 when Federal funding of the Clean Lakes Program ended. Table 3E-8 summarizes the description and type of Clean Lakes Projects that were completed by RIDEM. Below is a more detailed description of the Clean Lakes Statewide Assessment Projects.

i. QA/QC Project - A Statewide Lake Assessment grant to increase Quality Assurance/Quality Control for the URI-led Watershed Watch volunteer lake monitoring program, was received in 1991. URI provided the required 50% State match. The objective of this project was to create a permanent QA/QC program for volunteer monitoring of water quality in lakes with public access in the State. An Advanced Training for Water Quality Monitors program was developed with an academic (classroom and field laboratory) stage and a QA/QC monitoring stage. The project had hoped to add 10 publicly-owned lakes to those already monitored under the Watershed Watch program, utilizing members of the Bass Anglers Sportmen's Society (BASS). Overall, four to five (4-5) out of those additional 10 lakes were monitored sufficiently to calculate seasonal means and trophic status. Monitored parameters for this project included secchi depth (weekly); dissolved oxygen and chlorophyll a (bi-weekly); and pH, alkalinity, Na + Cl, Ca + Mg, total phosphorous and nitrogen, total solids and E. coli on a tri-seasonal basis.

ii. Data Management Project - The RIDEM, Office of Water Resources, (OWR) received a Clean Lakes Assessment grant in 1992 to develop and implement a data management system to store and analyze lake water quality monitoring data. The purpose of this data management system is to support the USEPA's Water Body System (WBS) by providing summaries of raw monitoring data from which assessments of the overall health of the lake can be developed. OWR staff developed a Microsoft Access water quality database to house the raw water quality data and a MS Access WBS database to maintain the assessment information.

iii. Macrophytes Project - The RIDEM, Office of Water Resources (OWR), in cooperation with URI's Watershed Watch Program, received a Lake Water Quality Assessment grant in 1993. There were three (3) primary goals for this grant:

- to actively recruit organizations interested in water quality monitoring in public lakes;
- to expand the number of public lakes monitored by volunteers in the Rhode Island Watershed Watch program; and
- to initiate monitoring of rooted aquatic plants in public lakes by volunteers to improve trophic status classifications.

To actively recruit organizations interested in monitoring lake water quality, the Watershed Watch Program held a day-long conference. The overall goal of the conference was public education as well as to increase participation, in terms of both numbers of volunteers and of public lakes, in the URI Watershed Watch Program. Over

80 people attended the conference and nearly 60 individuals signed up for a field training session, with the majority actually attending one of the sessions. This conference was so successful, both for recruitment and as an educational platform, that it was decided to continue it on an annual basis.

A goal of a 40% increase in the number of public lakes monitored by URIWW volunteers was set. The lakes to be targeted for monitoring were determined through consultation with RIDEM, OWR staff. To guide the selection process the OWR developed a list of public lakes with presumed accessibility by boat or canoe. The choice of these locations was based upon OWR's 1991 Priority List for Lake Assessment. Final lake selection was determined by successful recruitment and training of volunteers. Volunteers were successfully recruited for, and trained to monitor 17 additional public lakes. This represented an increase of nearly 50% over the number of public lakes in the program in 1992.

A six session program to train volunteers to identify and delineate freshwater aquatic macrophytes was developed. The curriculum was designed to provide participants with the skills necessary to complete aquatic plant surveys while teaching basic macrophyte ecology. An aquatic plant survey manual, pictorial guide and key to common freshwater aquatic plants of Rhode Island and other resource materials were developed for use in the training program. The goal of the course was to enable volunteers to map the type and distribution of aquatic plants on the lakes they monitor.

iv. <u>Dissolved Oxygen Project</u>- The RIDEM, Office of Water Resources, in conjunction with URI's Watershed Watch Program, received a 1994 Clean Lakes Water Quality Assessment grant. The primary goals of the project were:

- to train volunteers to obtain dissolved oxygen profiles on RI Watershed Watch public lakes with depths greater than five (5) meters;
- expand volunteer monitoring of public lakes and ponds and of incoming tributaries to public lakes and ponds currently in the RI Watershed Watch program;
- to delineate and digitize sub-watershed boundaries for RI Watershed Watch public access lakes; and
- to work with volunteers and local lake and watershed organizations to initiate a series of watershed-based public education materials (brochures) which integrate RI Watershed Watch lake and tributary data (and water quality data from other sources) with locally available historical and cultural information.

Table 3E-8 Clean Lakes Program Projects

Type of Project	Number of Ongoing Projects	Number of Completed Projects
Demonstration Projects		1
Phase 1 Projects		2
Phase 2 Projects		
Phase 3 Projects		
LWQA Annual grant projects		4

6. Impaired and Threatened Lakes

Of the 144 lakes and ponds assessed for this report, approximately 38% (55 lakes) are considered impaired. As noted previously, waters that are assessed as impaired under the 305(b) process are placed on the state's 303(d) List of impaired waters. Once on the 303(d) List, waters are prioritized and scheduled for TMDL work. The 55 lakes mentioned are on RI's 2006 303(d) List.

In addition to fish consumption and drinking water advisories, water quality criteria for DO, metals, bacteria, and phosphorus serve as the basis for impairment determinations in the lake assessment process. The state's narrative standards are used to assess for excess algal growth, biodiversity impacts, siltation, suspended solids and taste and odor. As Tables 3E-3 and 3E-5 indicate, most lakes in RI are considered impaired due to nutrients and the associated excess algal growth and low DO conditions. Elevated pathogens, biodiversity impacts and metals are also causes of impairment in RI lakes.

Elevated nutrient levels affect 2,099 acres on 31 lakes assessed. Excess algal growth are noted in 18 lakes. These conditions affect water clarity and often recreational use of lakes and ponds. Too much algae can also have detrimental effects on aquatic ecosystems.

Low dissolved oxygen impairs 17 lakes assessed. This impairment generally shows up as hypoxic or anoxic conditions from the thermocline to the lake bottom. This low DO condition below the thermocline can often be the natural result of the shape and size of a lake. It can be difficult, therefore, to determine if the reason for the impairment is due to natural causes or anthropogenic causes which should be addressed under the TMDL program. Landuse information and best professional judgment from the Watershed Watch staff assists with these assessment decisions.

7. Acid Effects on Lakes

In the late 1970's and early 1980's as concern about surface water acidification and its effects on fish populations increased, the Rhode Island Division of Fish and Wildlife initiated a study to develop an inventory of lake and stream buffering capacities to determine which waters were most susceptible to acidification. This study continued between 1983 and 1986 where the RIDEM, Division of Fish, Wildlife and Estuarine Research sampled 78 lakes and ponds as well as 42 streams for pH and alkalinity. This study is reported in the 1987 RI Division of Fish and Wildlife, Fisheries Report No. 8, "A survey of Rhode Island surface water pH and alkalinity." The purpose of this study was to determine the general fish habitat suitability in surface waters in Rhode Island, based upon current pH levels and to establish a baseline inventory of pH and alkalinity data. It became clear from this study that many freshwater ponds and lakes located in the western part of the state, in the central area of Conanicut Island, and in the eastern parts of Tiverton and Little Compton are highly susceptible to acidification due to the poor buffering capacity (<2.5 mg $CaCO_3$/l) of these regions. The geology of these areas is dominated by poorly buffering granitic bedrock.

A 5 year follow-up study was initiated in 1988 to measure changes in pH and total alkalinity over time in 10 selected low alkalinity lakes and ponds and to investigate any corresponding changes in fish populations. The data from this report is summarized in Lapin, W.J., Acidification Monitoring, December 1996, Project #F-20-R-37. All ten sites showed a slight increase in pH over the course of the study from a mean of 5.298 pH units to a mean of 5.625 pH units. Total alkalinity increased in 9 of the 10 sites over the study period from a mean of 0.069 mg $CaCO_3$/l to a mean of 0.478 mg $CaCO_3$/l. All of the sites displayed a typical seasonal pattern of high summer pH and alkalinity and lower winter values. Since the lakes and ponds monitored in the study were among those found to be most susceptible to acidification, it was determined that no significant increase in surface water acidification took place in any Rhode Island lakes and ponds during the study period. In addition, several species of fish were abundant in each of the lakes and ponds studied and, therefore, it was surmised that acidification of Rhode Island lakes does not appear to pose any immediate threat to any of the state's freshwater fish populations.

To continue the evaluation of lake acidification in RI lakes, the URI Watershed Watch Program collects data on pH and alkalinity in the lakes monitored under their program. The Watershed Watch Program determined that, in general, pH increases from south to north in the Watershed Watch monitoring locations; the lowest pH values are found in southern RI and the highest in northern RI. Measurements for locations with several years of data have remained extremely stable. In most cases, the areas of low acidity and poor buffering capacity correspond to areas where the bedrock geology is dominated by granitic rock, suggesting that the low acidity is at least in part a function of natural conditions in the area. A summary of the number of lakes assessed for and impacted by high acidity is presented in Table 3E-9.

Table 3E-9. Acid Effects on Lakes

	Number of Lakes	Acreage of Lakes
Assessed for Acidity	101	10,360
Impacted by High Acidity	0	0
Vulnerable to Acidity	0	0

8. Toxic Effects on Lakes

The main focus on lakes and ponds in RI has been centered on trophic indices, pH, bacteria levels, nutrient loading and eutrophication. Levels of toxic parameters in the water column are not evaluated on a regular basis in RI lakes and ponds. Monitoring of fish tissue for mercury levels has been conducted in a few lakes around the state and, due to overall limited monitoring of toxics in lakes, is the primary cause of impairments in lakes due to toxic parameters.

9. Trends in Lake Water Quality

Although there is up to 16 years of water quality data for various public lakes and ponds in Rhode Island, there does not appear to be a statewide or watershed-wide trend in lake water quality over this period time. The Watershed Watch Program has stated that over the years they have at times begun to see a "trend" with three years of data in a given lake but then subsequent years' data do not follow the "trend". The appearance of any "trends" has been highly variable and weather dependent. The Watershed Watch Program's annual reports do summarize the lake-specific water quality data and, where available, note any "trends" in water quality for that lake. In general, the majority of lakes monitored by Watershed Watch fall into the stable trend category.

Although exact trends cannot be ascertained, it can be stated that many lakes in developed watersheds do exhibit impaired water quality. It can be surmised that unless proper runoff and nutrient controls are implemented, a trend of accelerated eutrophication and deterioration of water quality due to nonpoint sources of pollution will become apparent.

III. SURFACE WATER ASSESSMENT

F. ESTUARY AND COASTAL ASSESSMENT

1. Designated Use Support

All of the 156.38 square miles of estuarine waters were reviewed for this report. Over 99% (156.33 square miles) of the estuarine waters have enough data to be considered assessed for this report. Of those areas 99% (154.51 square miles) are considered monitored and approximately 1% (1.81 square miles) are considered evaluated. It is important to note that the large percent of estuarine waters considered assessed (99%, 156.33 square miles) are, in general, only monitored for pathogens by the RIDEM Shellfish Monitoring Program. Therefore, the majority of Rhode Island's estuarine waters have current monitoring data for pathogens to assess for swimming and shellfishing use support status but limited or old (evaluated) monitoring data to assess for aquatic life use support. Recent dissolved oxygen data collected by fixed station buoys, seasonal bay-wide sampling, and periodic bay-wide transects, are becoming available and will be used to evaluate these areas of the bay for aquatic life use support.

Table 3F-1 presents a summary of the degree of use support and the estuarine areas that are monitored and evaluated. Just over 69% (108.6 square miles) of the estuarine waters fully support *all* assessed. Approximately 30% (47.7 square miles) of the estuarine waters assessed are considered impaired for one or more uses.

Data was available to assess 155.85 square miles of estuarine waters for swimming use. As Table 3F-2 shows, most estuarine waters assessed support their swimming uses (90%, 140.3 square miles). Approximately 10% (15.55 square miles) of the estuarine waters assessed are considered impaired for the swimming use due to violations of fecal coliform criteria.

Data was available to assess 116.53 square miles of estuarine waters for aquatic life use. For aquatic life use, the majority of estuarine waters assessed fully support aquatic life needs (64%, 74.61 square miles). Approximately 36% (42 square miles) of the estuarine waters assessed are impaired for aquatic life uses.

The estuarine waters classified as SA and SA{b} are designated for shellfishing use. Excluding Rhode Island Sound and Block Island Sound, this represents approximately 133 square miles. Data was available to asses 131.41 square miles of SA and SA{b} waters for their shellfishing use support status. The majority of Class SA and SA{b} waters (79%, 104.3 square miles) fully support the shellfishing use. Partial support of the shellfishing use occurs in approximately 16% (20.9 square miles) of the estuarine waters. In general, this 20.9 square miles encompasses areas with a seasonal or conditional shellfish closures. Approximately 5% (6.2 square miles) of the Class SA and SA{b} estuarine waters are permanently closed to shellfishing and are considered not supporting the shellfishing use.

Rhode Island has 78.62 coastal shoreline miles. The coastal shoreline is defined as a line along the coast from Westerly to Point Judith, up to the mouth of the Narrow (Pettaquamscutt) River, across to Beavertail on Jamestown, across to Brenton Point in Newport and along the Newport coast to Sachuest Point, across to Sakonnet Point in Little Compton and along the coast in Little Compton to the Rhode Island/Massachusetts border. Bacteria data was available to assess the entire coastal shoreline for swimming and shellfishing use support status. All 78.62 miles were assessed as fully supporting both swimming and shellfishing uses.

Table 3F-1. Summary of Fully Supporting, Threatened and Impaired Waters in Estuarine Waters (square miles)

Degree of Use Support	Assessment Category		Total Assessed
	Evaluated	Monitored	
Size Fully Supporting All Uses Assessed	0.66	107.94	108.60
Size Fully Supporting all Assessed Uses but Threatened for at Least One Use	0	0	0
Size Impaired for One or More Uses	1.15	46.58	47.73
Size Not Attainable for Any Use and Not Included in the Line Items Above	0	0	0
TOTAL ASSESSED	1.81	154.51	156.33

Table 3F-2 Individual Use Support Summary for Estuarine Waters (square miles)

Individual Use	Size Assessed	Size Fully Supporting	Size Fully Supporting but Threatened	Size Partially Supporting	Size Not Supporting
Aquatic Life	116.53	74.61	0	5.28	36.65
Shellfishing	131.41	104.28	0	20.88	6.24
Swimming	155.85	140.30	0	9.81	5.74

2. Causes and Sources of Impairment of Designated Uses

Causes and sources of impairment for assessed waters that do not fully support their designated uses are listed in Tables 3F-3 and 3F-4, respectively. Causes are those pollutants or other stressors that contribute to the actual or threatened impairment of designated uses in a waterbody. Sources are the facilities or activities that contribute pollutants or stressors, resulting in impairment of designated uses in a waterbody. In general, the actual sources of impairment are not determined until a TMDL (total maximum daily load) is conducted on the waterbody. As such, most of the sources listed are just potential sources. If the waterbody specific information indicated impact on designated use as being high, it is indicated under the "major impact" column of Table 3F-3 and 3F-4. If the impact was determined to be moderate, it is listed on the tables in the "moderate" impact column.

The major impacts on designated uses for the estuarine waters of Rhode Island are due to bacterial contamination, low dissolved oxygen, and nutrient enrichment. The major sources of bacterial contamination are due to combined sewer overflows (CSOs). CSOs, urban runoff and point source discharges are sources of the nutrient enrichment and low dissolved oxygen problem in the Upper Bay and coves. This water quality problem, while not fully characterized, indicates that nutrients are linked to adverse impacts of reduced dissolved oxygen levels.

Table 3F-3. Square Miles of Estuarine Waters Impaired by Various Cause/Stressor Categories

Cause/Stressor Category	Size of Waters by Contribution to Impairment	
	Major	Moderate
BIODIVERSITY IMPACTS	10.72	
EXCESS ALGAL GROWTH/CHL-A	5.74	0.32
NUTRIENTS	6.23	33.30
LOW DO	16.79	24.21
PATHOGENS	13.82	27.97
THERMAL MODIFICATIONS	9.82	
TOTAL TOXICS	0.99	
UNKNOWN TOXICITY	0.03	

Table 3F-4. Square Miles of Estuarine Waters Potentially Impaired by Various Source Categories

Source Category	Potential Contribution to Impairment	
	Major	Moderate
AGRICULTURE		2.55
COMBINED SEWER OVERFLOW	24.28	
CONTAMINATED SEDIMENTS	0.90	
GROUNDWATER LOADINGS		3.50
INDUSTRIAL POINT SOURCES	9.82	
INTENSIVE ANIMAL FEEDING OPERATIONS		0.73
SEPTIC SYSTEMS	1.22	5.65
MARINAS AND RECREATIONAL BOATING	1.79	5.26
MUNICIPAL POINT SOURCES	14.45	5.22
NATURAL SOURCES	0.69	3.12
SOURCE UNKNOWN	1.89	1.47
URBAN RUNOFF/STORM SEWERS	31.44	13.93

3. Narragansett Bay

a. Background

Narragansett Bay encompasses 147 square miles – a majority of which are within Rhode Island. In contrast the Bay watershed - 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 (see Figure 3F-1). Sixty percent (60%) of the Bay basin lies within Massachusetts, extending up to the headwaters of the Blackstone and Taunton Rivers. The sheer size of the watershed and the fact that it includes 100 communities in two states increases the difficulty in controlling pollutants entering the Bay from both point and nonpoint sources.

The Narragansett Bay watershed is one of the most densely populated estuarine systems in the country with an overall density recently estimated at 1,125 people per square mile (2000 census data). Most of the wastewater flow generated in the basin is treated by one of the 33 wastewater treatment facilities in the basin. Since the population and industrial centers continue 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, and Taunton Rivers as well as via direct discharges into the estuarine Providence and Seekonk Rivers. While water quality problems in the urban centers are dominated by point sources (WWTFs, CSOs), degradation in other coves and embayments in the Bay is largely attributable to nonpoint sources of pollution.; e.g. stormwater discharges.

Located in proximity to the birthplace of the industrial revolution, Narragansett Bay and its major tributaries have endured over two hundred years of pollution resulting from human activities. The state's industrial heritage and dense urbanization is reflected in a general pollutant gradient that improves as one moves from the head of the Bay, including the Providence River, south toward Rhode Island Sound. Various research studies, as well as the baseline characterization studies by the Narragansett Bay Estuary Program (NBEP) conducted between 1985-1991, have documented this general trend. The NBEP studies, as well as subsequent monitoring and research, provided the information that became the basis for the "Narragansett Bay Water Quality Status and Trends Report 2000." It summarized the major pollution issues in Narragansett Bay as follows:

- In general there is a clear North-South pollution gradient in the Bay, with the highest levels of pollution in the urbanized Providence/Seekonk tidal rivers and the Fall River/Taunton River areas, and slightly lower levels in the urbanizing areas of Greenwich Bay and the upper Bay (between Conimicut Point and Prudence Island). Poorly flushed coves and harbors may also experience localized impacts from pollutants.

- The upgrading of wastewater treatment facilities (WWTFs) has reduced the biochemical oxygen demand (BOD) that these facilities had placed on the Bay's ecosystem. However, WWTFs remain a primary source of nutrient pollutant loadings to the Bay through both direct discharges and indirectly via discharge into the Bay's major tributaries including the Blackstone, Pawtuxet and Taunton Rivers. Note: Researchers have more recently estimated that WWTFs are responsible for 62-73% of the total loading of nitrogen to the entire Bay (Pryor et al., 2007).

- Combined sewer overflows remain a major source of bacteriological contamination in the Bay contributing to shellfish closures. Nonpoint sources, such as stormwater runoff, septic systems, or discharges from boats, are the primary potential sources in coastal waters not affected by the CSOs.

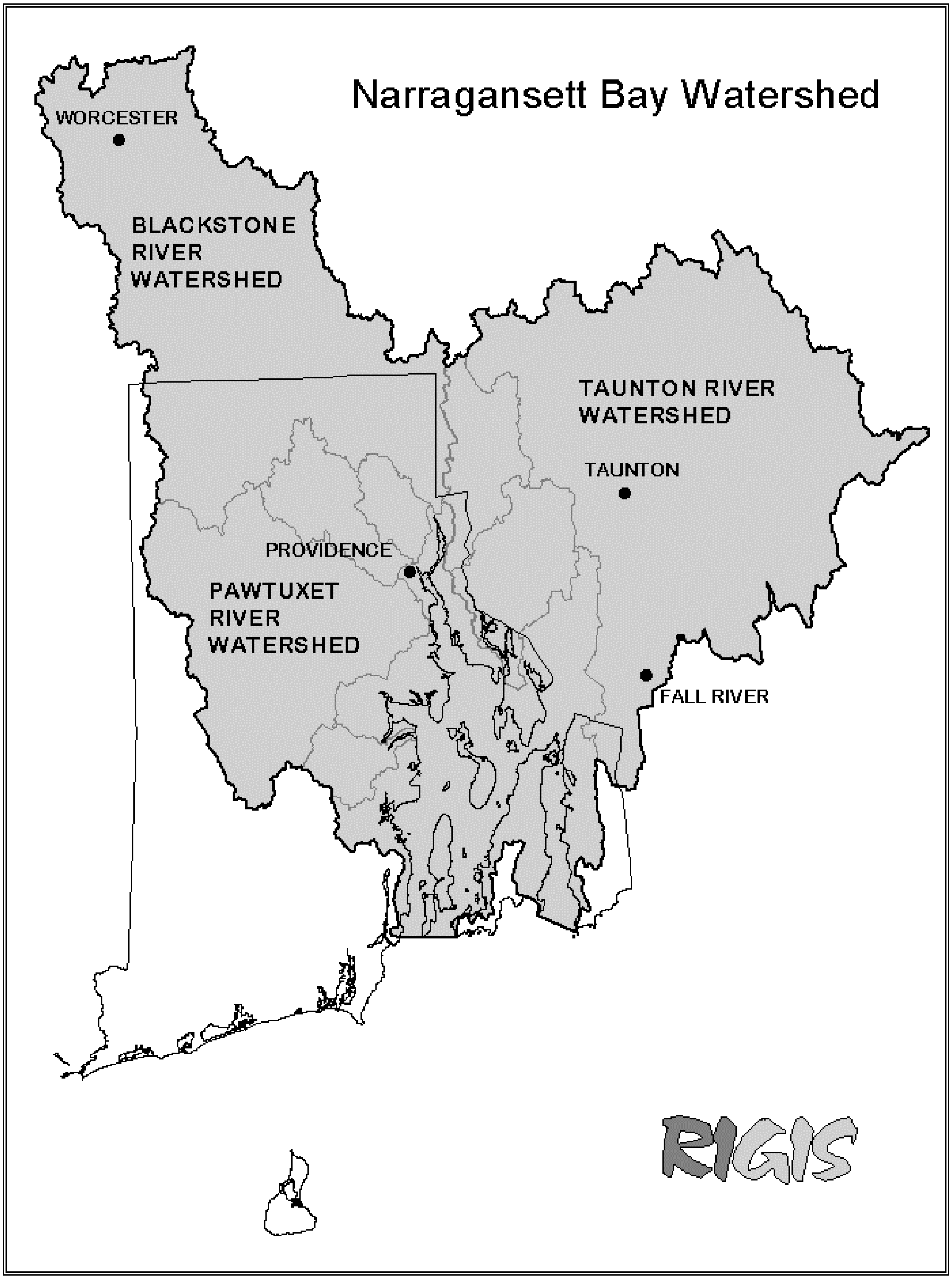
- Industrial pretreatment requirements have resulted in a reduction of metals discharged in wastewater. The elimination of lead from gasoline has also had a significant in reducing the input of this toxic metal to the Bay.

Since 2000, an expansion of monitoring programs by state managers and researchers has improved the understanding of water quality conditions in Narragansett Bay and the factors that influence the variable conditions. Data has revealed that in addition to the general north to south declining gradient of pollution, Narragansett Bay exhibits four regions that help to characterize water quality conditions. The report of the 2004 Rhode Island Seagrant symposium (RI Sea Grant 2005) on the state of science of nutrients in the Bay identified the four regions as the Providence River estuary, upper bay, middle bay and lower bay. This improved understanding of how the Bay is functioning provides insights useful to the characterization of water quality impairments.

b. Description Of Priority Water Quality Problems

In general, Narragansett Bay has been considered a moderately well-mixed estuary not subject to seasonal stratification outside of the Providence River. Implementation of the Clean Water Act programs over the past 30 years has proved largely successful in controlling and reducing both conventional and toxic pollutant loadings. However, on-going ambient monitoring clearly documents continuing water quality problems related to excess nutrients and hypoxia and pathogens. This is reflected in the recognized impairments for coastal waters on the state's list of impaired waters. The priority water quality problems, described further below, include: hypoxia (low dissolved oxygen conditions), (2) pathogens, and (3) historical contamination of sediments with toxics.

FIGURE 3F-1 Narragansett Bay Watershed map



c. Nutrient Enrichment & Hypoxia

Eutrophication is a process in which the addition of nutrients to water bodies stimulates algal growth. Excess nutrients can trigger more serious problems including the loss of submerged aquatic vegetation and low dissolved oxygen levels, known as hypoxia. (Bricker et al., 1999) While many factors contribute to hypoxia in a shallow estuary, including temperature, winds, currents and precipitation, it is now widely accepted that human activities have accelerated eutrophication in many coastal ecosystems through excessive nutrient pollutant loadings. Excess nutrients from the watershed, delivered via sewage treatment plant effluents, stormwater run-off or septic system leachate, may trigger microscopic algal blooms as well as the growth of macroalgae (seaweed). Most algae grow very quickly (days to weeks) then die and sink, decomposing on the floor of the Bay in a bacterial process that consumes oxygen. The oxygen removed by decomposition results in less oxygen available to other organisms living near the bottom. Under certain circumstances the depletion of oxygen can be rapid and result in fish kills. Persistent hypoxia is a priority concern because of its adverse impact on marine life and its potential to change the Bay's ecosystem.

During the last decade, expanded monitoring programs by both the state and researchers are generating data that are improving the understanding of the occurrence of hypoxia in Narragansett Bay. As expected, the data are revealing that in general hypoxia, while variable year to year, is most prevalent in the Seekonk River, Providence River, upper Bay and Greenwich Bay regions. In an analysis of dissolved oxygen survey results from 2001-2002, Deacutis et al (2006) reported that the expression of symptoms of nutrient overload in the Bay was greater than previously recognized. This characterization of the Bay is consistent with the national assessments by NOAA. In its most recent national review of eutrophication in estuaries, NOAA categorized Narragansett Bay as exhibiting expressions of a highly eutrophic ecosystem. This constituted a worsening condition over the prior 1999 assessment (Bricker et al., 2007).

There is a consensus that the hypoxia is most prevalent in regions of the Bay that are more strongly stratified; e.g. the Providence-Seekonk Rivers, as well as Greenwich Bay, which is shallow compared to other regions of the Bay. The middle of the Bay appears to be a region of exchange of water between the upper and lower portions of the Bay that experiences episodes of hypoxia with less frequency.

DEM has been concerned about hypoxia in the Providence and Seekonk Rivers for well over a decade. Prior assessments of Narragansett Bay documented hypoxia impairments in the Providence –Seekonk Rivers and the upper Bay region in 1994 and led to additional water quality restoration studies beginning in 1995. This work and subsequent monitoring have documented seasonal low oxygen as well as occasional anoxia at the fixed –site network stations maintained by the Narragansett Bay Commission in both the Providence and Seekonk Rivers. Data available for 2001- 2006 for the Bullocks Reach Station in the Providence River documented with the exception of one year, a range of 13-48 hypoxic events, defined as any 24- hour period with an average dissolved oxygen concentration of less than 2.9 mg/l. (Note: 2.9 mg/l is one of the thresholds in the revised DO criteria as specified in the state water quality criteria.) At the Bullock's station, no major hypoxic events were documented in 2004 which was attributed to less stratification, lower temperatures and reduced river flows. During the same period in Greenwich Bay, 39 hypoxic events were documented (Stoffel et al., 2007).

Work in the Providence and Seekonk Rivers refined the understanding of the relative importance of the rivers, wastewater treatment facilities (WWTFs) and nonpoint sources towards the total loadings of nutrients to upper Narragansett Bay. DEM-OWR found that WWTFs, both via direct discharges from two NBC facilities and via other WWTF discharges into the Blackstone, Ten Mile and Pawtuxet Rivers, were the predominant source of nutrients to the Providence and Seekonk Rivers.

Beginning in 1998, WWTFs that were required to upgrade their facilities to reduce ammonia or to meet other requirements agreed to reduce nitrogen as well. As a result, by 2006, improvements at 8 WWTFs resulted in a 35% reduction in nitrogen loadings from the 11 RI facilities contributing to the upper Bay based on current WWTF flows. Two of these eight facilities (NBC Bucklin Point and Woonsocket) require additional modifications to achieve their permit limits of 5 mg/l. Status of the three remaining facilities is as follows: NBC Fields Point is in the processing of designing upgrades to achieve 5 mg/l (seasonal), East Providence has submitted a facilities plan to DEM and limits for the Warren WWTF are anticipated. To further control loadings to the Seekonk River, DEM has advocated strongly for comparable reductions from several Massachusetts WWTFs located upstream on the Blackstone and Ten Mile Rivers, the largest of which is the Upper Blackstone Water Pollutant Abatement District WWTF that serves the Worcester area.

The 2003 fish kill brought public attention to the problem of hypoxia in Greenwich Bay. Aware of the water quality problems before this, as noted above, DEM has previously been working with the East Greenwich WWTF to incorporate upgrades to achieve nutrient removal. The advanced treatment went on-line in 2006 and has been reliably meeting an effluent limit of 5 mg/l total nitrogen (seasonal). Data from the fixed-station in Greenwich Bay indicate the western section of this embayment is highly vulnerable to persistent seasonal hypoxia.

Following the fish kill, new monitoring stations deployed in the east and west passages have indicated that a larger portion of the bay can be affected by hypoxia under certain conditions; e.g. stratification, lack of mixing, etc. Stations at Poppasquash, Mt. View and off Quonset Point have all recorded low levels of dissolved oxygen on occasion; albeit significantly less frequently than the stations in the Providence – Seekonk Rivers and Greenwich Bay. This characterization is consistent with this area functioning as a middle bay region. Further data collection and analysis is needed to determine if water quality violations are occurring. (Note: In October 2007, based on an analysis of fixed-site network data and related sources of DO data, DEM-OWR indicated it had identified an additional 7.62 square miles of the upper and middle bay impaired by hypoxia.)

DEM has documented hypoxia as a water quality impairment in several other locations in Narragansett Bay. Outside of the Providence River and Greenwich Bay regions, DEM has documented impairments in portions of Mt. Hope Bay, Palmer River, Wickford Harbor and Potter's Cove. These areas presently suffer from seasonal dissolved oxygen depletion, algal blooms and occasional fish kills related to excess nutrients. Further evidence of eutrophication has been experienced by some coastal communities in changes in the marine communities to less desirable pollutant tolerant species due to excess nutrients, which cause excessive growth of algae and/or benthic "nuisance" seaweeds like sea lettuce (*Ulva*); and habitat loss/ degradation of coastal wetlands and high quality bottom habitat such as eelgrass beds.

d. Pathogens

Another priority water quality concern in Rhode Island coastal waters is bacteriological contamination. Most disease-causing bacteria that present a public health concern in water are associated with the feces of warm-blooded animals. The presence of bacteria in unacceptable concentrations triggers the closure of shellfishing grounds and bathing beaches advisories which restrict recreational uses of the Bay.

The primary sources of such bacteria in Narragansett Bay are combined sewer overflows, wastewater treatment systems, stormwater runoff, cesspools and septic systems and boats. In the Providence River region, NBC has estimated that 66 CSOs discharge after rain events over 2 billion gallons of untreated combined wastewater annually. CSOs also affect Newport Harbor and Mt. Hope Bay (Fall River area). Wastewater treatment facilities generally have employed effective disinfection to minimize the discharge of pathogens. However, sewer system overflows (SSOs) from pump stations, sewer lines or WWTF bypasses discharge untreated wastewater. DEM received 70 and 114 reports of SSOs in 2005 and 2006 respectively; resulting in the release of millions of gallons of untreated wastewaters. In these urban areas, stormwater impacts, especially WWTF bypasses and CSOs, represent the major sources of human fecal waste.

DEM has documented impairments due to pathogens in several other coastal water locations not known to be affected by CSOs. In TMDLs done to date for some of these areas, stormwater discharges have proven to be the primary means that pathogens are transported from the watershed to these waters. Other possible sources which may be locally important include failing septic systems or improper sewage discharges from boats. Additionally, waterfowl, wildlife and pet waste are also potential sources.

At the present time, approximately 20 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 a portion of Mount Hope Bay have been permanently closed to shellfish harvesting since the 1940s. The upper Narragansett Bay, a portion of Mt. Hope Bay, the Kickemuit River, and Greenwich Bay are routinely closed following rain storms because of CSO discharges of untreated sewage or increasing levels of fecal coliform bacterial contamination from various nonpoint sources.

Abating pathogens will require that plans for abating CSOs are fully implemented, stormwater management programs are strengthened, cesspools and septic systems upgraded where needed and that other best management practices are adopted to curb nonpoint sources of pathogens (agricultural BMPs, pet waste management, etc.)

e. Toxic Pollutants

Researchers continue to confirm the success achieved over the last decade in terms of decreasing levels of toxics, especially heavy metals, due most likely to better (secondary) treatment and removal of suspended solids at the WWTFs (metals tend to attach to such particles), as well as progress within industrial pretreatment programs.

Sediment data (1997-98) was acquired for 43 stations in the Bay, providing an integrated picture of recently deposited sediment pollutant loads. In addition, comparison of data from 20 of these stations with data from sediment samples taken for the original Narragansett Bay characterization study (1988-89) (and performed by the same researchers; Drs. King and Quinn, URI/GSO) provide an indication of pollutant loading trends over the last 10 years.

Results from King et al. (1998) show major decreases since the 1988-89 samples for trace metal concentrations in all metals analyzed in surface sediment samples taken from the most industrially-impacted areas of the Bay, the Providence / Seekonk tidal Rivers and the Taunton River (Mount Hope Bay). See Figure 3F-2. Stations from mid Bay areas showed little change or small increases in metals for the recent sampling, and followed the overall pollution gradient noted in the original Bay characterization study: greatest sediment pollution concentrations are always in the most industrialized/urbanized areas (e.g., Providence/ Seekonk Rivers) of the upper Bay, and decrease rapidly as one moves down bay. Measurements of Simultaneously Extracted Metal (SEM) concentrations and Acid Volatile Sulfides (AVS) indicate that the trace metals are not likely to be bioavailable at the stations with highest metal concentrations unless they become oxidized by human activities such as dredging.

The decrease in concentrations of metals in the most polluted stations from the recent (1997-8) sediment data has lowered the upper range seen in surface sediment concentrations for these metals, although highest levels are still nearest the major loading sources (major wastewater treatment facilities (WWTFs) and industrialized river mouths). This trend of decreasing metal concentrations likely reflects both the success of WWTF pretreatment programs and the decrease in the number of metal discharges from industries such as jewelry and electroplating due to the shift in the global manufacturing economy over the last 20 years. The small increases in metals in the sediments of the mid Bay areas may reflect atmospheric loadings of metals to the Bay as well as redistribution of upper Bay sediments by severe storms..

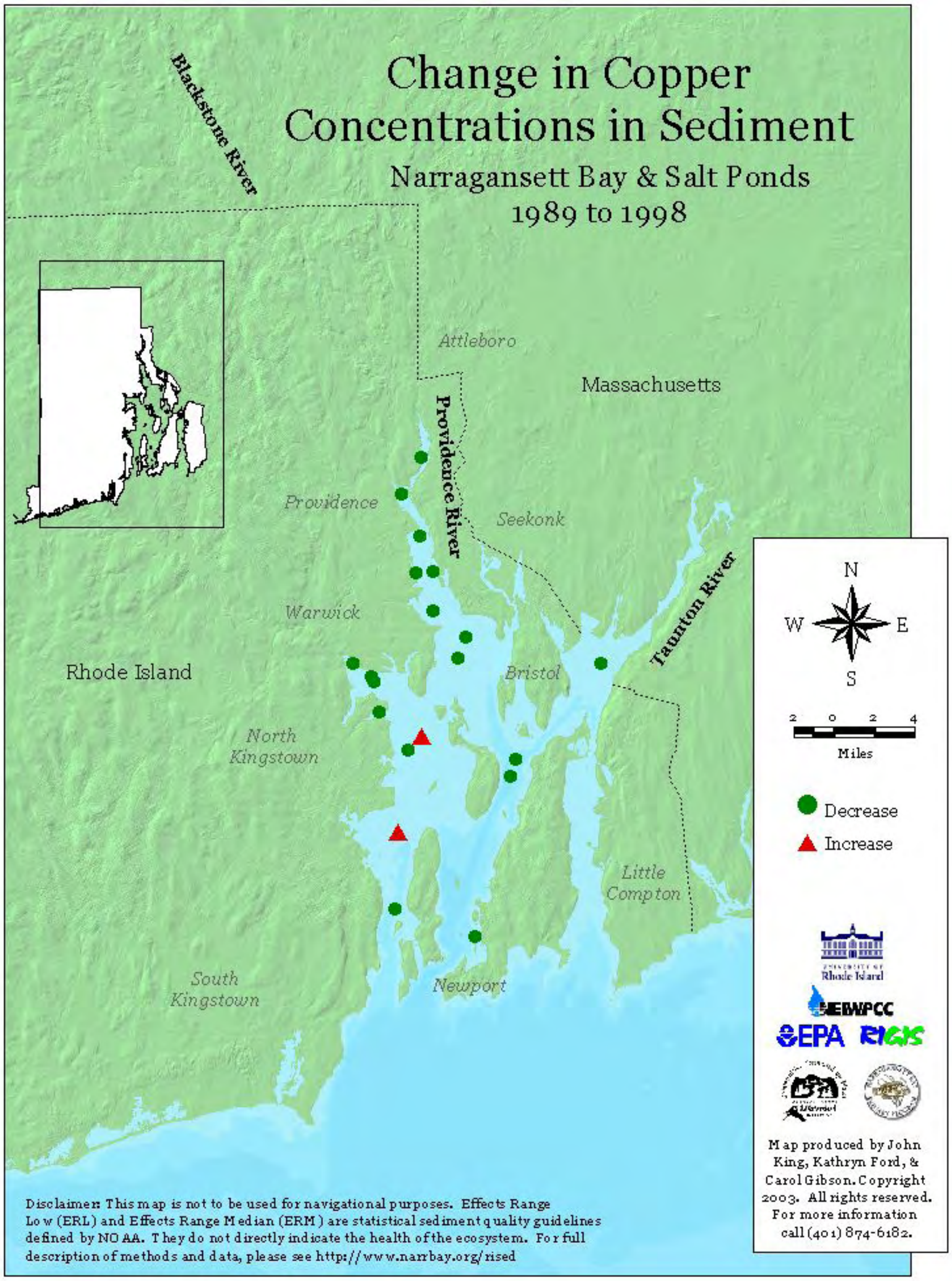
For all organics analyzed (PAHs, PCBs, OCPs, TPH), concentrations in the surface sediments followed the same gradient as described above, with greatest levels found associated with urban sources and industrialized river mouths in the upper reaches of Narragansett Bay. These organic pollutants also showed a decrease in surface sediment concentrations at many upper Bay stations since 1988-89, and significant decreases at stations closest to WWTF discharges. These results likely reflect the improvement in secondary treatment achieved over the last decade at the major WWTFs, another success story for the federal Clean Water Act, and a strong positive step towards recuperation of these areas as projected by the Comprehensive Conservation and Management Plan if treatment levels were improved at the WWTFs.

Meanwhile, NBC has documented a decrease of over 90% in total metal loadings in their effluent from the Field's Point WWTF since 1981which corresponds to the implementation of industrial pretreatment. Continued progress within the pretreatment programs, as well as continued vigilance with level of treatment at the WWTFs should ensure that this trend is not reversed. DEM removed the metals impairment for the Providence River in 2004. State initiatives such as mandatory recycling and toxics source reduction programs are expected to further reduce pollutant inputs.

DEM has documented water quality impairments due to metals in the Bay's major tributaries, including the Blackstone, Pawtuxet, Woonasquatucket, and Ten Mile Rivers, which continue to exceed federal and state water quality standards designed to protect aquatic life from exposure to toxic pollutants.

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 shellfish harvesting due to sewage contamination. However, the presence and persistence of certain toxic pollutants in the environment are likely to contribute to habitat degradation, especially within the vicinity of highly contaminated sediment "hot spots". In addition, the presence of such contaminated sediments in the Providence River basin and other commercially important ports and harbors complicates decision-making about disposal of sediments removed during maintenance dredging necessary to support navigation, shipping, and boating activity. A concerted effort needs to be maintained to reduce use and disposal of toxic pollutants through continuing source reduction and pretreatment efforts by industry. The importance of stormwater sources of toxic contaminants also needs to be seriously dealt with through stormwater treatment designs to remove sediments carrying the pollutants to the rivers and the Bay.

Figure 3F-2.


Change in Copper Concentrations in Sediment
Narragansett Bay & Salt Ponds
1989 to 1998
Blackstone River
Attleboro
Massachusetts
Providence River
Providence
Seekonk
Warwick
Taunton River
Rhode Island
Bristol
North Kingstown
Little Compton
South Kingstown
Newport
N
W
E
S
2 0 2 4
Miles
Decrease
Increase
Disclaimer: This map is not to be used for navigational purposes. Effects Range Low (ERL) and Effects Range Median (ERM) are statistical sediment quality guidelines defined by NOAA. They do not directly indicate the health of the ecosystem. For full description of methods and data, please see http://www.narrbay.org/rised
Map produced by John King, Kathryn Ford, & Carol Gibson. Copyright 2003. All rights reserved. For more information call (401) 874-6182.

f. Living Resources

Data describing the biological resources of the Narragansett Bay can be used as indicators of estuarine ecosystem health. Both Rhode Island and Massachusetts have experienced declines and collapses of important fisheries such as the Winter Flounder in recent years. 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 complex factors and changes in their environment, including subtle shifts in average and maximum/minimum Summer and Winter water temperatures, changes in natural populations of predators and/or prey of the young of these species, overfishing, physical obstruction of river flow and drainage, destruction and loss of key subtidal habitats such as eelgrass beds, and pollution. Additionally, introduced non-indigenous species such as the Asian shore crab (Hemigrapsus sanguiness) are showing up in the Bay with unknown ecological consequences.

A concerted regional effort will be necessary to effectively manage and sustain commercial and recreational harvests of 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. A failure to fully identify and protect critical habitat areas in and around the Bay's shore, will likely result in the loss of biological diversity, sustainable ecosystem function, and human use and enjoyment of these resources.

Table 3F-5 lists the extent of coastal and Bay habitat in acres based on analysis done of 1996 color aerial photos of Narragansett Bay and nearshore areas. Note that there were less than 100 acres of eelgrass, a critical habitat for fish and shellfish, left in the Bay. Eelgrass has been eliminated from the upper Bay. Historical evidence suggests that there were once hundreds of acres of this vital habitat across the Bay. Note: Submerged aquatic vegetation was remapped in 2006 with results released in 2007. Eelgrass increased to slightly double the original 1996 estimate for the Bay, but differences in ground-truthing techniques may account for a part of the increase. There may be an actual slight increase, but all of the increased eelgrass is located in the lower half of the Bay. Eelgrass has not moved above the mid Prudence Island area.

Table 3F-5

Acreage Summary of
Estuarine and Marine Habitats Inventoried
in Narragansett Bay Project Area - 1996

Habitat Type	**Area in Acres**
Open Water	124,259.4
High Salt Marsh	2,708.7
Beaches	1,450.5
Rocky Shores	573.3
Tidal Flats	568.6
Low Salt Marsh	443.2
Brackish Marsh	427.6
High Scrub-Shrub Marsh	159.3
Eelgrass Beds	99.5
Pannes & Pools	46.3
Dunes	43.0
Artificial Jetties & Breakwaters	23.1
Oyster Reefs	9.0
Stream Beds	3.5
TOTAL	130,815.0

Source: *Report on the Analysis of True Color Aerial Photographs to Map Submerged Aquatic Vegetation and Coastal Resource Areas in Narragansett Bay Tidal Waters and Nearshore Areas, Rhode Island and Massachusetts*. Prepared by Irene Huber, Natural Resources Assessment Group, University of Massachusetts, November 1999. Narragansett Bay Estuary Program Report No. 117.

4. Coastal Ponds

The southern shoreline of Rhode Island is dotted with ponds known as salt ponds. Most of these ponds are separated from Rhode Island Sound by thin barrier beaches that are interrupted by inlets that allow for an exchange of water and sediment between the ponds and the Sound. Rhode Island's salt ponds provide critical habitat for marine life and other wildlife, including migrating birds. The salt ponds are generally shallow are attract a variety of recreational users as well as shellfishing and aquaculture activity.

The watersheds of the salt ponds are largely unsewered and water quality impairments are the result of nonpoint sources of pollution. Four salt ponds are listed as impaired for pathogens (three in south county and the Great Salt Pond on Block Island). The draft TMDL for Pt. Judith Pond concerning pathogens found that elevated concentrations of bacteria were in the upper reaches of the pond in the vicinity of the outlet of the Saugatucket River. Conditions generally improved moving down the pond although a few other areas of localized elevated concentrations were detected. Elevated bacteria levels have resulted in Green Hill Pond being closed to shellfishing since 1994. A TMDL has also been completed for Green Hill and Ninigret Ponds with a variety of recommendations to address the multiple non-point sources of pathogen pollutant loadings.

The salt pond ecosystems are also sensitive to pollutant loadings of nitrogen. Researchers and state managers have collaborated on various studies to characterize the South County salt ponds over the past three decades. Recognition of the threat of further eutrophication of the ponds given continuing growth in the watershed prompted efforts by state and local government to take measures to control pollution via limiting growth, promoting environmentally sound land use, strengthening septic system maintenance programs, improving treatment of stormwater and promoting best management practices for other sources of nitrogen including fertilizers and agricultural practices. Recent work by URI-GSO researchers (Nixon and Buckley, 2007) and consultants for DEM reviewed estimates of relative contributions of nitrogen to the ponds and identified septic systems as the predominant source in the watersheds of several salt ponds. Note: Effective 1/1/2008, DEM regulations were revised to mandate that nitrogen reducing treatment technologies be used in on-site wastewater disposal systems in the watersheds of the salt ponds in South County and in the Narrow River watershed. Further actions will be needed to achieve water quality restoration and protection goals in the salt ponds.

5. Marine Sanitation Devices (MSDs)

The Rhode Island marine areas have experienced a rapid expansion of moorings and marinas in the last ten years, with the number of boats on Rhode Island waters having more than doubled. Approximately 134,000 boats are of a size to have marine sanitation devices (MSDs) on board which are potential sources of bacterial contamination. Legislation was passed in 2005 creating a MSD inspection program. Full service marinas and Harbor Masters will be the primary inspectors of vessels with MSDs. The State law gives powers to boating safety officers, local harbor masters and the police to enforce MSD laws.

In Rhode Island, if a vessel has a marine head (toilet) installed on board, it must be U.S. Coast Guard-certified and a type authorized in the area where it will be operated. There are three types of USCG certified marine sanitation devices: Type I, II or III.

Type I - Flow-through; effluent USCG certified to 100 fecal coliform/100 ml with no visible floating solids.
Type II - Flow-through; effluent USCG certified to 200 fecal coliform/100 ml, 150 mg/1 total suspended solid standard.
Type III - USCG certified to no discharge standard (holding tank).

Under the federal Clean Water Act it is illegal to discharge untreated (raw) sewage from a vessel within 3 miles of shore (the territorial waters) of the United States, the Great Lakes and navigable rivers. On August 10, 1998 the state of Rhode Island took a step toward ensuring better water quality in marine waters by designating their coastal waters as a No Discharge Area (see next section). The Rhode Island waters include territorial seas within three miles of shore, including all of Narragansett Bay. A No Discharge Area is a designated body of water in which the discharge of *treated* and *untreated* boat sewage is prohibited (this does not include greywater or sink water). It is the Department's goal to promote the use of Type III (MSDs) through the declaration of no discharge areas. Complying with vessel sewage discharge laws and regulations, and using pumpout facilities, are a necessary step to protect public health, water quality, and the marine environment.

6. Marine Pump-out Facilities and No Discharge Area Designation

A Narragansett Bay Marina Pumpout Siting Plan was developed by NBEP staff. With an estimated 160 private marinas, yacht clubs, boat yards, town docks, and launching ramps operating in the Bay, and over 31,000 registered boats (2006) being served. The RIDEM Office of Water Resources, has continued to obtain funding through the Federal Clean Vessel Act grant program and has overseen the construction and operation of the established of pump-out facilities throughout the marine waters of Rhode Island. The support of the Rhode Island Marine Trades Association (RIMTA) has made a large commitment to RI’s no discharge program and should be recognized as a major contributor to the success of the program. Rhode Island now has a total of 62 pumpout facilities from Providence to Block Island. These include shoreside facilities as well as mobile pump-out boats. A map of the locations and listing of addresses of the RI pumpout facilities can be found on the RIDEM website at http://www.dem.ri.gov/programs/benviron/water/shellfsh/pump/index.htm.

References

Bricker, S.B., C.G. Clement, D.E. Pirhalla, S.P. Orlando, and D.R.G. Farrow. 1999. National Estuarine Eutrophication Assessment: Effects of Nutrient Enrichment in the Nation's Estuaries. Silver Spring, MD: National Oceanic and Atmospheric Administration (NOAA), National Ocean Service.71 pp.

Bricker, S., B. Longstaff, W. Dennison, A. Jones, K. Boicourt, C. Wicks and J. Woerner. 2007. Effects of Nutrients Enrichment in the Nation's Estuaries: A Decade of Change. National Oceanic and Atmospheric Administration (NOAA). Coastal Ocean Program Decision Analysis Series No. 26, National Centers for Coastal Ocean Science, Silver Spring, MD. 322 pp.

Deacutis, C., D. Murray, W. Prell, E. Saarman and L. Korhun. 2006. "Hypoxia in the Upper half of Narragansett Bay, RI, during August 2001 and 2002" Northeastern Naturalist 13 (Special Issue 4): 178-198.

King, J., C. Gibson, E. Lacey and J. Peck. 1998. "Trace Metal Contaminants in the Sediments of Narragansett Bay". Report of results to CMER, NOAA NMFS, December 1998.

Nixon, S.W. and Buckley, B.A. 2007. "Nitrogen Inputs to Rhode Island Coastal Salt Ponds – Too Much of a Good Thing", URI-GSO, White Paper prepared for the RI Coastal Resources Management Council, Spring 2007.

Pryor, D. E. Saarman, D. Murray and W. Prell. 2007. "Nitrogen Loading from Wastewater Treatment Plants to Upper Narragansett Bay", Brown University, Narragansett Bay Estuary Program Report 2007-126.

Rhode Island Sea Grant. 2005. " State of Science on Nutrients in Narragansett Bay: Findings and Recommendations from the Rhode Island Sea Grant 2004 Science Symposium.", July 2005.

RIDEM-NBEP & NBNERR. 2000. "Narragansett Bay Water Quality: Status and Trends 2000". Report, April 2000.

Stoffel, H., D.L. Codiga, C. Deacutis, S. Kiernan and C.A. Oviatt. 2007. " Characterizing Hypoxic Events in Narragansett Bay RI Using Time Series Data", URI-Graduate School of Oceanography & RIDEM, Poster presentation, Estuarine Research Foundation Conference, November 2007.

III. SURFACE WATER ASSESSMENT

G. WETLANDS

1. Extent of Wetlands Resources

According to the Rhode Island Geographic Information System (RIGIS) data approximately 18.4% of the state area (127,721 acres) is wetland and deepwater habitat (Cowardin et al. 1979). There are approximately 92,536 acres of palustrine wetland, 17,518 acres of lacustrine wetland and deepwater habitat, 1839 acres classified as riverine, and 15,827 acres of marine/estuarine wetland. Palustrine wetlands represent 13.3% of the State's surface area; lacustrine areas represent 2.5%; riverine areas represent 0.3% and marine/estuarine areas represent 2.3% of Rhode Island's area. These figures do not include the areas of Narragansett Bay and the Pawcatuck River Estuary. Wetland classes and their approximate acreages are listed in Table 3G-1. The most abundant wetland type in Rhode Island is palustrine forested wetland, commonly known as wooded swamp, dominated by red maple (*Acer rubrum*) or Atlantic white cedar (*Chamaecyparis thyoides*) trees.

Table 3G-1. Wetlands and Deepwater Habitats of Rhode Island (RIGIS 1988)

WETLAND TYPE	AREA (acres)
Riverine Nontidal Open Water	1832
Lacustrine Open Water	17,518
Palustrine Open Water	4481
Palustrine Emergent Wetland: Marsh/Wet Meadow	4341
Palustrine Emergent Wetland: Emergent Fen or Bog	229
Palustrine Scrub-Shrub Wetland: Shrub Swamp	9606
Palustrine Scrub-Shrub Wetland: Shrub Fen or Bog	2060
Palustrine Forested Wetland: Deciduous	60,694
Palustrine Forested Wetland: Coniferous	10,900
Palustrine Forested Wetland: Dead	225
Riverine Tidal Open Water	7.4
Estuarine Open Water	8175
Estuarine Emergent Wetland	4014
Estuarine Scrub-Shrub Wetland	93
Marine/Estuarine Rocky Shore	671
Marine/Estuarine Unconsolidated Shore	2874
TOTAL AREA	127,721 acres

Source: RIGIS. Data based on photo-interpretation of 1988 1:24,000 scale black and white aerial photographs, minimum map unit ¼ acre.

The above information represents approximate present wetland acreage. Information regarding historical acreage is not readily available.

The Narragansett Bay Estuary Program (NBEP) organized and implemented a collaborative mapping project to determine the abundance and distribution of coastal habitats in Narragansett Bay. True color aerial photographs taken in July 1996 were used to develop Geographic Information System (GIS) maps of eelgrass beds (*Zostera marina*), salt marshes, brackish marshes, beaches, rocky shores, tidal flats, and oyster reefs. The project area is defined as the tidal waters and nearshore areas north of a line extending from Pt. Judith, Narragansett to Sakonnet Point, Little Compton, R.I. A summary of the coastal habitat areas is presented in Table 3G-2. The digital habitat coverages are available through RIGIS. Data from this project have been applied to new studies to identify and prioritize habitat restoration sites and analyze coastal wetland trends in the Bay. Funding was provided by the DEM Aqua Fund, the NBEP, the U.S. EPA, and Save the Bay.

Table 3G-2. Summary of Coastal Habitats in Narragansett Bay (RI and MA)

HABITAT TYPE	AREA (acres)
Open Water	124,222.4
High Salt Marsh	2,708.7
Beaches	1,450.5
Rocky Shores	573.3
Tidal Flats	568.6
Low Salt Marsh	443.2
Brackish Marsh	427.6
High Scrub-Shrub Marsh	159.3
Eelgrass Beds	99.5
Pannes & Pools	46.3
Dunes	43.0
Artificial Jetties & Breakwaters	23.1
Oyster Reefs	9.0
Stream Beds	3.5
TOTAL AREA………	130,778 acres

Source: *Report on the Analysis of True Color Aerial Photographs to Map Submerged Aquatic Vegetation and Coastal Resource Areas in Narragansett Bay Tidal Waters and Nearshore Areas, Rhode Island and Massachusetts*. Prepared by I. Huber, Natural Resources Assessment Group, University of Massachusetts, November 1999. Narragansett Bay Estuary Program Report No. 99-117.

The NBEP has also released a CD-ROM product entitled the *Narragansett Bay Coastal Wetland Restoration Analysis-Inventory of Potential Restoration Sites, Wetland Buffers, and Hardened Shorelines*, which contains printable GIS maps, acreage summaries, technical reports, and downloadable spatial data on coastal wetlands and shoreline conditions for 26 Bay communities in Rhode Island and Massachusetts. Refer to the Narragansett Bay Estuary Program Report No. 04-121.

The NBEP has coordinated a similar cooperative mapping project in the South Shore, Little Compton and Block Island. True color aerial photographs taken in June 1999 were used for the delineations. The project area encompasses the South Shore coastal ponds, the Pawcatuck River and Little Narragansett Bay, Little Compton (southern shoreline), and Block Island tidal and near shore areas. Project partners include the U.S. Fish and Wildlife Service, University of Massachusetts, and the University of Rhode Island Environmental Data Center. The data from this project is available through RIGIS. This work provides the foundation for the identification of potential coastal wetland restoration projects. Funding was provided by the R.I. Oil Spill Prevention, Administration, and Response Fund, EPA, Region 1, and NBEP.

Table 3G-3. Includes a summary of the project results.

Table 3G-3. Summary of Coastal Habitats in South Shore RI

HABITAT TYPE	AREA (acres)
Open Water	112,964.7
High Salt Marsh	1,425.6
Beaches	856.1
Rocky Shores	191.4
Tidal Flats	1,621.5
Low Salt Marsh	70.2
Brackish Marsh	293.8
High Scrub-Shrub Marsh and Brackish Scrub-shrub Marsh	113.6
Eelgrass Beds	570.3
Dunes	244.5
Artificial Jetties & Breakwaters	19.3
Oyster Reefs	4.4
Stream Beds	6.3
Pools	116.9
Coastal Bank	84.6

TOTAL AREA……… 118,583.2 acres

Source: *Report on the Analysis of True Color Aerial Photographs to Map Submerged Aquatic Vegetation, Coastal Wetlands, Deepwater Habitats and Coastal Features in Southern Rhode Island and Southeastern Connecticut*. Prepared by I. Huber, Natural Resources Assessment Group, University of Massachusetts, November 2003. Refer to Narragansett Bay Estuary Program Report No. 04-122.

a. Freshwater Wetlands – State Regulations

Rhode Island was among the first states to pass legislation to protect freshwater wetlands. The Rhode Island Freshwater Wetlands Act (R.I.G.L. Sections 2-1-18 et seq.) was enacted in July 1971. The Act describes the public policy of the State of Rhode Island and Providence

Plantations to preserve, protect, and restore the purity and integrity of the State's freshwater wetlands in order to protect the health, welfare and general well being of the public. The Act and the *Rules and Regulations Governing the Administration and Enforcement of the Freshwater Wetlands Act* describe the wetland functions and values that are regulated and protected: floodwater storage, groundwater recharge, wildlife habitat, recreation, and water quality improvement.

The Department of Environmental Management (DEM) and the Coastal Resources Management Council (CRMC) are both charged with regulation of freshwater wetlands, DEM through the Act and CRMC through R.I.G.L. Chap. 46-23-6. The DEM Office of Water Resources (OWR) Wetland Permitting Program and the Office of Compliance and Inspection Wetland Enforcement Program currently administer and enforce the Act and the *Rules and Regulations*. In general, approval is required for any activity that may alter the character of any freshwater wetland. Applicants are required to avoid and minimize all impacts to wetlands and no random, unnecessary or undesirable alteration of wetlands is permitted.

Freshwater wetlands in Rhode Island include: swamps, marshes, ponds, bogs, the area of land within 50 feet of these wetlands (perimeter wetland), 100-year floodplain; all rivers, streams, and intermittent streams; 100 foot and 200 foot riverbanks depending upon whether the associated flowing body of water is less than or greater than 10 feet in width, areas subject to flooding and storm flowage; any forested, shrub or emergent wetland; and special aquatic sites (vernal pools). In general, approval is required for any project or activity which would excavate, drain, fill, deposit material or effluent, divert flow into or out of, dike, dam, divert, change, add to or take from, or otherwise alter the character of any freshwater wetland. Exempt activities as specified by law or rule and carried out in a manner which is protective of wetland functions and values do not need a specific written approval. Certain projects including new farm roads, new farm ponds and drainage structures for agricultural purposes carried out by farmers are handled by DEM's Division of Agriculture. The Division of Agriculture coordinates the review and evaluation of such projects to ensure that such projects represent insignificant alterations to freshwater wetlands.

Implementation of the Wetland Task Force Final Report (March 2001) administrative, policy, regulatory, and outreach recommendations has remained a high priority for DEM. With EPA Region 1 support and through the New England Interstate Water Pollution Control Commission (NEIWPCC), DEM obtained contractual assistance to implement both outreach and regulatory recommendations in a multi-year plan that is still ongoing. The award of additional EPA wetland grants in FY05 will continue to support implementation of the Wetland Task Force recommendations, including an investigation of permit compliance over time, integration of the most up to date science into decision making, and improved protection of isolated wetlands.

DEM continued to work toward completion of Phase 2/3 wetland rules which, while primarily structural and organizational, will include added provisions aimed at improving the application process. (Note: wetland regulations were adopted in June 2007)

DEM and CRMC renegotiated the Programmatic General Permit (PGP) with the Army Corps of Engineers, New England District and with other federal agencies in 2001. The PGP facilitates a coordinated federal and state review of applications involving deposition of dredged or fill material in state waters, including wetlands. The PGP enables applicants to submit a single application to the State agency to obtain both State and federal wetland permits. The new 5-year agreement became effective in February of 2002. No substantive changes were made to the freshwater aspect of the PGP.

During calendar years 2001-2003, the DEM Wetlands Permitting Program issued 338,314 and 326 new permits respectively. In each of these years, 95% of the permits were for projects involving insignificant impacts to regulated wetlands; with a total of 42 applications requiring formal permits for significant alterations. There were four emergency permit issued during this 3-year period. The greatest number of new permits was issued for residential development, including new residential lots, modifications to already developed lots, residential subdivisions, and apartments or condominiums. Permits for residential development represented 53% of the permits issued in 2001-2002 and jumped to 60% in 2003.

During calendar years 2001-2003 the Wetland Compliance Program received 1,539 wetland-related complaints and issued 325 actions, e.g., warning letters, Notices of Intent to Enforce, and Notices of Violation. The Compliance Program determined 474 or 31% of the complaints to be unfounded. A total of 2,766 inspections were completed during this period. A large majority of enforcement actions are resolved without the need for adjudication or court action. Besides seeking informal resolution of all enforcement actions, the DEM uses alternative dispute resolution to resolve violations. When necessary, cases are referred to the Attorney General's Office for prosecution.

In 2003 several important cases were decided, most notable is the DEM versus E. V. Davis case, which had been ongoing since 1987. The original court order from 1987 was amended in 2003 to provide for creation of wetlands on the property. The restoration had been completed including removal of millions of tires from the site including from wetlands. The site was targeted not only by DEM, but also by the EPA as a Superfund site. The case represents a large effort in terms of hours invested by DEM.

Also, as part of proactive restoration planning, a study was conducted of 26 sites where restoration of wetland had been conducted through enforcement actions (Cavallaro and Golet 2002). The study found that wetland hydrology and hydrophytic vegetation were present at almost 90% of the sites and the wetlands were performing one function, although the restored wetland types generally differed from the wetland types that were destroyed. The study also found that invasive species were present at 52% of the sites, especially at sites surrounded by high-density development. The percentage cover of invasive species tended to increase with age.

b. Coastal Wetlands – State Regulations

Coastal wetlands in Rhode Island are regulated by the CRMC through the Coastal Resources Management Program (CRMP) and Special Area Management Plans (SAMP). The Rhode Island General Assembly established the Council in 1971 for the purpose of managing the coastal resources of the State, including the barrier beaches of the southern coast, Rhode Island and Block Island Sounds, and Narragansett Bay. Activities proposed in Rhode Island's tidal waters, on shorelines abutting tidal waters and coastal ponds, as well as activities within 200-feet of coastal features (beaches, dunes, wetlands, cliffs, bluffs, embankments, rocky shores, and manmade shorelines) require a CRMC approval (Assent). A variety of industrial activities proposed inland of the coastal zone that may impact coastal resources may also require a CRMC Assent. Projects that are proposed in the poorly flushed estuaries of the Narrow River and the south shore coastal ponds and that meet given size thresholds trigger a SAMP review by CRMC.

There are approximately 3700 acres of salt marsh in Rhode Island, approximately 10% of which are considered fringe marshes less than 5 yards wide (CRMP). Approximately 90% of Rhode Island's salt marshes abut tidal waters designated Type 1 (Conservation) and Type 2 (Low Intensity Uses) by the CRMP. CRMP policies and regulations governing Type 1 areas prohibit alteration of coastal wetlands, while policies for Type 2 marshes allow only minimal alterations in association with dock construction and other low-intensity uses. CRMC staff report that the policies are generally effective in avoiding further loss of coastal wetlands. Specific figures of wetland loss are not available due to data system constraints.

c. US Army Corps of Engineers (ACOE) - Programmatic General Permit (PGP Process)

As a result of cooperative efforts between the DEM OWR,CRMC and the Army Corps of Engineers (ACOE), a programmatic general permit

(PGP) process was implemented in Rhode Island in February 1997. This process replaced the Nationwide Permits Process previously implemented by ACOE in accordance with Section 404 of the Federal Clean Water Act. Under the PGP, projects are categorized as I or II. Category I projects represent minor impacts to State waters and are non-reporting to the ACOE. Category II projects represent more than minor impacts to State waters and must be reviewed at a monthly screening meeting where appropriate State and Federal agencies review the project. If the project is determined to meet all appropriate state and federal regulations, agencies can determine compliance with Section 404 at the meetings. For both category I and II projects, the appropriate State agency, either the DEM, Freshwater Wetlands Program, or the CRMC, can issue the ACOE's PGP, along with the appropriate state permit. For both Category I and II applications, a separate state Water Quality Certification approval is required in accordance with the State Water Quality Regulations. For projects that fall under the ACOE Individual Permit process, the ACOE maintains its established permitting process. For these applications, a separate state Water Quality Certification is also required. To date, the process has successfully streamlined the multi-agency permitting process and facilitated coordination.

2. Development and Enforcement of Wetland Water Quality Standards

a. Wetlands Water Quality Standards

The term "waters of the state" include both freshwater and coastal wetlands. Accordingly the Surface Water Quality Regulations including the surface water classifications, standards and criteria, (Table 3G-4) pertain to all wetlands.

TABLE 3G-4. Development of State Wetland Water Quality Standards

	In Place	Under Development	Proposed
Use Classification	X		
Narrative Biocriteria	X		
Numeric Biocriteria			
Antidegradation	X		
Implementation Method	Section 401 State Wetland Permit		

Biomonitoring or bioassessment is a method by which scientists study natural systems to determine their ecological health. Currently, Rhode Island uses biomonitoring to assess the health of flowing rivers and streams using macroinvertebrate data as an ecological indicator. With support of the EPA, Region 1, and with NEIWPCC assistance, the

Wetlands Program has developed a draft of a freshwater wetland monitoring and assessment plan for the State. Currently there is no routine wetland monitoring in RI, but some research based monitoring occurs. There is a growing need to monitor state wetlands for complex problems. The wetland monitoring and assessment plan will be one element of an overall water monitoring strategy, recently completed by DEM.

During development of the wetland monitoring and plan, DEM assessed available data, identified and prioritized data needs, identified methods and protocols, and provided estimates of resources needed for implementation. The initial draft plan was reviewed by wetland partners in June 2005. Comments were incorporated, and a second draft was developed. The draft plan will be posted on the DEM website and distributed to and reviewed by the RI Environmental Monitoring Collaborative (RIEMC) and the Scientific Advisory Committee (SAC). Final completion of the plan is expected in June 2006.

A three-tiered approach to monitoring, advocated by EPA, will be used to address RI wetland monitoring objectives, identified by partners. The three-tiered approach includes a landscape assessment (Level 1), which offers a preliminary view of wetland condition using GIS; a rapid field assessment (Level 2), which involves relatively simple methods to gather field data in a half-day's time; and a more intensive site assessment approach (Level 3), in which one or more biological assemblages, as well as physical and chemical parameters, are studied to better describe the existing condition of the wetland.

The goal of wetland monitoring and assessment in RI is to improve protection and management of wetlands. DEM and partners have identified the following long term and short-term objectives.

Long-term objectives:

- Develop a database of information necessary to evaluate trends in wetland condition.
- Identify causes and sources of wetland degradation including cumulative impacts to wetlands.
- Identify program and policy changes needed to improve overall wetland condition statewide.
- Evaluate the effectiveness of wetland management and protection programs with respect to wetland condition.

Short-term objectives:

- Prioritize wetlands (and adjacent upland habitat) for protection through open space.
- Develop and implement methods for monitoring impacts to wetlands due to water withdrawals.
- Monitor and assess impacts to wetlands due to loss and

degradation of adjacent upland habitat (buffer zones).

- Monitor location and extent to which invasive species are present and affecting wetland condition.

Development of wetland water quality standards was not identified as a priority and RI has not committed to the development of standards at this time.

In the first year of implementation (FY05 grant) existing RIGIS data is being used to develop a landscape of profile of wetlands Statewide and to characterize wetlands near water withdrawal sites. Concurrently, DEM with a dedicated workgroup will review and test existing rapid assessment methods in the field beginning at water withdrawal sites.

b. Section 401 Water Quality Certification Program

OWR enforces the water quality standards through the Water Quality Certification program as provided for in the Rhode Island Water Quality Regulations for Water Pollution Control. Certain proposed activities require an applicant to obtain approval from the Water Quality Certification Program. Such approval certifies that the proposed project does not violate the State Water Quality Regulations. Rule 13 of the State Water Quality Regulations defines these activities to include federal projects, as defined in Section 401 of the Clean Water Act, and certain projects located wholly or partly in the coastal zone. These projects include dredging and possibly dredged material disposal, filling of Waters of the State, site disturbances which have the potential to contribute increased pollutants to a Water of the State, (specifically residential development of six or more units, any commercial, industrial, state, or municipal land development, or any project which disturbs five or more acres), marina construction or expansion, flow alterations, Harbor Management Plans, and point source discharges. In addition to Rule 13 requirements, a Water Quality compliance review or Water Quality Certification is required for certain proposed activities associated with inland waters that fall under the jurisdiction of the Freshwater Wetlands Program and/or the ACOE PGP process.

The WQC evaluation is performed using the Antidegradation Policy provisions of the Water Quality Regulations as guidance to determine compliance with these regulations. The Antidegradation Policy is based on the Federal Antidegradation Policy requirements (40 CFR, 131.12) and adopted under the authority of Chapter 46-12, 42-17.1, and 42-35 of the General Laws of Rhode Island, as amended. The provisions of the state Antidegradation Policy have as their objective the maintenance and protection of various levels of water quality and uses. This policy consists of three tiers of water quality protection; tiers 1, 2, and 3. Antidegradation is one of the minimum elements required in state water quality standards and applies to any new or increased activity that could lower water quality. Antidegradation requires that all existing uses are to be maintained in State waters. Tier 3 criteria reserved for Special Resource Protection Waters (SRPWs). Tier 3 prohibits any permanent lowering of water quality in high quality waters designated as Outstanding Natural Resource Waters. This policy has been referenced as grounds to denial and approval of proposed alterations to the State's freshwater or coastal wetlands.

3. Integrity of Wetlands

a. Freshwater Wetlands Loss and Restoration

Historic freshwater wetland loss in Rhode Island, as reported in U.S. Fish and Wildlife Service publication *Wetlands Loss in the United States 1780's to 1980's* (Dahl 1990) was estimated to be 37%, although the methodology used to generate this figure is flawed (F. Golet, University of Rhode Island Department of Natural Resources Science; pers. comm., 1999). In the Providence metropolitan area, major historic wetland losses can be attributed to urbanization. In the more rural parts of the State, transportation projects and residential development have been the primary causes of wetland loss both historically and in more recent times. Parkhurst (1977) found that highway construction and residential development caused the greatest amount of wetland loss in South Kingstown between the years 1939 and 1972. Wetland loss due to agriculture in Rhode Island has been relatively minor compared to other parts of the country.

In addition to wetland loss there has historically been conversion of wetlands from one class to another, with the construction of dams being the primary mechanism. The construction of dams has resulted in the conversion of palustrine vegetated wetlands and riverine wetlands to open water and deepwater habitats. Over time, areas of palustrine vegetated wetland have developed at the edges of the impoundments.

Computerized tracking of physical losses and gains went on line in January 1998 however the DEM system experienced some reporting inconsistencies during 2001 through 2003. According to the ACOE New England Division the total permitted freshwater and tidal wetland loss was 4.7 acres during that period. Most losses resulted from unavoidable crossings of wetlands to otherwise developable land.

During 2002-2003, the Office of Water Resources, in coordination with the Office of Compliance and Inspection increased the inspections of properties with wetland permits to make sure property owners were in compliance. Permitting staff conducted 235 compliance inspections and OCI added 147.

Based upon enforcement activities, the Wetlands Compliance

Program determined that during 2001-2003, the unauthorized losses for wetlands and perimeter areas were 22.6 acres and 30.6 acres respectively, for a total of 53.2 acres. While the regulatory program is successful in minimizing permitted wetland losses through strong avoidance requirements the extent of unauthorized alterations are at unacceptable levels.

It is DEM policy to pursue restoration wherever feasible and as a result of enforcement activities, during the 2001-2003 period a total of 8.6 acres of wetland and 13.3 acres of buffer areas were reported restored. Note that these figures reflect restorations completed in 2001-2003 that may have been identified in prior years.

With the assistance of an EPA 104(b)3 wetlands grant DEM and the University of Rhode Island completed a two phase project to develop and apply methods for the identification and prioritization of proactive freshwater wetlands restoration opportunities. In Phase 1, methods were developed and in Phase 2, the methods were applied throughout the Woonasquatucket River watershed.

The project resulted in development of the *Wetland Restoration Plan for the Woonasquatucket River Watershed* (Golet, et al, 2002), which was completed in November 2002 and the related website which debuted in January of 2003. DEM, EPA, and URI in partnership with the Woonasquatucket River Watershed Council and officials from the six watershed cities and towns collaborated on the project. This study identified 77 potential wetland restoration sites and 239 potential buffer restoration sites. The sites were prioritized based on the ability, if restored, to perform one or more of the following wetland functions: flood abatement, water quality improvement, wildlife habitat, fish habitat, and heritage. Each site was ranked on its ability to perform each function and/or multiple functions. The website displays the *Wetland Restoration Plan*, databases of potential wetland and buffer restoration sites, and interactive mapping of the sites. The website can be viewed at: http://www.state.ri.us/dem/programs/benviron/water/wetlands/wetplan.htm.

Implementation of the Plan is being led by the Woonasquatucket Watershed Council. A huge challenge is the fact the over 90 percent of the potential wetland and buffer restoration sites are on private property.

The Department previously reported about the several restoration projects on public properties moving forward during 2002 and 2003 including Mountaindale Reservoir and Whipple Field; both located in Smithfield. The Department understands that both of these projects were modified due to unforeseen hurdles during the implementation phases.

A large showcase proactive wetland enhancement and restoration project was completed in July of 2003 at the site of the former Lonsdale

Drive-In, along the Blackstone River in Lincoln. Funding for the project came primarily from the Army Corps of Engineers, with additional monies from DEM, the Rhode Island Corporate Wetlands Restoration Partnership, and the Rhode Island Habitat Restoration Team.

The Lonsdale site was originally a floodplain, which was developed as an outdoor drive-in movie theater in the early 1950's. Approximately 20 acres of the 37-acre site were paved to construct the drive-in that eventually closed in the early 1980's. In 1998, the State of Rhode Island purchased the site with the intention of restoring wetlands and riparian habitat. The restored Lonsdale site now includes a 7-acre wetland complex of forested, scrub/shrub, wet meadow, emergent and open water wetland, in addition to almost 10 acres of restored upland grassy area. (McGinn, personal communication, 5/4/04).

b. Coastal Wetlands Loss and Restoration

It is generally accepted that the historical loss of coastal wetlands in Rhode Island has been substantial. As a result, in recent years, there has been growing interest in facilitating coastal habitat restoration. The most significant project to date has been a multi-year and multi-agency, 1.9 million dollar salt marsh restoration at the DEM-owned Galilee Bird Sanctuary in Narragansett that resulted in the restoration of 84 acres of salt marsh and 14 acres of new open tidal channels. More recently, numerous partners have teamed to complete coastal wetland restoration projects at Common Fence Point, Portsmouth; Sachusett Point National Wildlife Refuge, Middletown; and Mosquito Beach, New Shoreham.

The Narragansett Bay Estuary Program coordinated a cooperative project funded by DEM's Aqua Fund Program and U.S. EPA to identify coastal wetland sites for potential restoration in the vicinity of Narragansett Bay. The results of the Coastal Habitat Inventory for Narragansett Bay provided the foundation for this work. Using aerial photo interpretation and field work 236 project sites were inventoried totaling over 4000 acres having some potential for restoration. The GIS maps and database will facilitate the efforts of decision-makers to locate and prioritize wetlands that are practical and feasible to restore. Project partners include the U.S. Fish and Wildlife Service, University of Massachusetts, University of Rhode Island Environmental Data Center, and Save the Bay. Another project funded by the U.S. EPA will provide an historical assessment of changes or trends in coastal wetlands and their buffers between the 1950's and 1990's, and back to the 1930's in selected sites. Digital information from these projects will be available through RIGIS.

In July 2000, the DEM NBEP embarked on a two-year partnership project with CRMC, Save the Bay, and the NOAA Coastal Services

Center in Charleston, S.C to develop the Coastal Habitat Restoration Plan and Information System. This resulted in the development of a Web-based tool to promote and facilitate restoration of Rhode Island's coastal habitats. The System combines information on coastal habitats and restoration sites with a decision-making model, allowing users to select and prioritize coastal habitat restoration projects. The intended audience includes state and local agencies, community groups, municipalities, academic institutions, policy-makers and the public. The system was used to develop a statewide coastal habitat restoration plan for Rhode Island and, it is expected, will enhance the state's capacity for undertaking restoration at all scales. It is anticipated that, in addition to improving restoration planning and capacity in Rhode Island, the system can be applied to other geographic areas with an interest in promoting stakeholder involvement in regional restoration planning.

In 2002, the legislature acted to create the Coastal and Estuary Habitat Restoration Program and Trust Fund. The purpose of the program is to facilitate the design, planning, construction and monitoring of coastal and estuarine restoration projects by providing grants and technical assistance. The program is administered by CRMC with technical support from the RI Habitat Restoration Team.

In 2002, grants totaling about $250,000 supported the following restoration projects:

1. Lonsdale Drive-in Wetlands Restoration, Lincoln– RIDEM, $153,000
2. Field's Point Marsh Restoration, Providence– Save The Bay, $24,000
3. Narragansett Bay Seagrass Restoration – Save The Bay/URI-GSO, $29,000
4. Stillhouse Cove Salt Marsh Restoration - City of Cranston, $7,000
5. Palmer Avenue Salt Marsh Restoration – Warren Land Conservation Trust, $14,000
6. Mussachuck Creek Salt Marsh and Anadromous Fish Habitat Restoration –(self-regulating tide gate) – Barrington, RI Country Club, $9,000
7. Napatree Dunes Restoration, Westerly – NOAA/Watch Hill Fire District, $6,000

In 2005, the Trust Fund funded the following projects totaling approximately $250,000:

1.	Walker Farm Salt Marsh Restoration	$30,000
2.	Factory Brook Fishway	$35,000
3.	RI Coastal Wetlands Inventory	$14,725
4.	Mapping Submerged Aquatic Vegetation in Narragansett Bay	$50,000
5.	Kickemuit Reservoir Fish Ladder	$40,187
6.	Town Pond (Boyd's Marsh) Salt Marsh	

Restoration $80,000

4. Additional Wetland Protection Activities

a. Protection of Wetlands Via Acquisition

An additional means of protecting wetlands is through acquisition. The DEM Office of Planning and Development (P&D) includes wetland protection within its coordination of state land acquisition programs and open space grants. The DEM Office of Planning and Development Land Acquisition Program acquired 47 new properties totaling 3,598 acres during 2002-2003 and approximately 35% of the area is considered wetland. The program, working with partners, uses state bond funds supplemented by other sources such as U.S. Fish & Wildlife funded, North American Waterfowl Conservation Act grants.

b. Local Protection Projects

Several EPA-sponsored local protection grant projects have been completed. Since completion, several Towns have continued to use the project results for implementation of wetland protection, conservation and restoration. Three new projects were competitively awarded in 2005.

c. Outreach and Education

Outreach continued to be an important focus during the reporting period. The majority of the outreach activities are in support of the regulatory program, in order to help explain and clarify the Rules and the application requirements. Other projects also support general wetland education, protection and restoration, many of which were a direct result of Task Force recommendations.

The primary outreach project during this reporting period has been the ongoing development of the draft *Wetland Best Management Practices Manual*. The objective of the Manual is to provide a better understanding of acceptable and wetland-friendly designs and practices that can be used when designing a project for submittal to DEM. The draft Manual includes avoidance and minimization techniques for specific project design types as well as broad topics that are applicable to any project. This Manual is being developed with a DEM technical team in response to suggestions emanating from the Task Force.

III. SURFACE WATER ASSESSMENT

H. PUBLIC HEALTH/AQUATIC LIFE CONCERNS

1. Size of Waters Affected by Toxicants

As part of the CWA-mandated triennial water quality standards and criteria review, OWR finalized and adopted changes to the Water Quality Regulations in August 1997. The revisions to the Water Quality Regulations included adoption of updated aquatic life criteria, human health criteria, and dissolved criteria for metals. These criteria for the "priority pollutants" are consistent with the national criteria published by EPA pursuant to Section 304(a) of the CWA. RIDEM is currently finalizing a triennial review of the water quality standards and regulations which are proposing adoption of updated standards.

The surface water monitoring program, discussed in Chapter III.A, includes sampling for many of these toxic pollutants. However, not all waters assessed for this report are monitored or even evaluated for toxic impacts. In fact, sampling for toxics in the water column is focused on rivers and streams while limited for lakes/ponds and estuarine waters. Current water column toxics data is limited to 103 rivers and only seven estuarine areas. Only 44 lakes have been monitored for toxics in either the water column or fish tissue. This data gap in toxics monitoring has been addressed in the state's Water Monitoring Strategy.

Table 3H-1 indicates the size of Rhode Island waters assessed for toxics and of those waters, the size with elevated levels of toxics. In most cases, metals are the toxic parameters of greatest concern. For lakes, most of the elevated toxicants are mercury found in fish tissue. Waterbodies assessed as impaired due to violations of toxics criteria have been included on the state's 303(d) list of impaired waters.

Table 3H-1 Size of Waters Affected by Toxic Substances

Waterbody Type	Size Monitored for Toxicants	Size with Elevated Levels of Toxicants
Estuarine (sq. miles)	11.45	0
Lakes (acres)	4485.0	3117.0
Rivers (miles)	365.3	161.7

2. Public Health/Aquatic Life Impacts

a. Fishing Advisories/Bans

All states in the northeast have issued fish advisories for mercury and other contaminants, warning residents, particularly children and pregnant women, to limit ingestion of certain fish species or fish caught in particular waterbodies. Unlike other northeast states, Rhode Island has not supported a routine surveillance program for fish tissue. To fill this data gap, DEM's recently released Water Monitoring Strategy recommends that fish tissue be assessed systematically within the proposed rotating basin approach.

The current health advisories regarding fish consumption, issued by HEALTH Office of Environmental Risk Assessment, are based largely on data derived from other entities, primarily research conducted by the EPA Aquatic Ecology Division at its Narragansett Laboratory. Only a small number of waterbodies and fish, however, have been tested for contaminants. These tests, along with more thorough testing across New England, show that fish can contain unsafe levels of mercury, dioxins and polychlorinated biphenyls (PCBs). Based on these test results, in April 2002, HEALTH issued the following fish consumption advisories and advise on mercury in fish which are still in affect: (http://www.health.ri.gov/environment/risk/fish.php)

<u>When Fishing In Saltwater</u>
- Flounder, haddock and most other saltwater fish you can catch in the Bay and Ocean are low in mercury and safe to eat.
- Young children and women who are pregnant, nursing or planning to have a baby in the coming year, should not eat shark, swordfish, bluefish and striped bass.
- Clams, crabs and other shellfish are low in mercury.

<u>When Fishing In Freshwater</u>
- Young children and women who are pregnant, nursing or planning to have a baby in the coming year should not eat freshwater fish from Rhode Island ponds, lakes, or rivers. Choose trout from stocked waters or saltwater fish instead.
- Others can safely eat one meal of most freshwater fish per week if they know where to fish and what kinds of fish are safe to catch and eat.
- Avoid fish with the most mercury (bass, pike, pickerel).
- Fish for stocked trout.
- With the exception of trout, do not eat any fish from the lower Woonasquatucket River, Yawgoog, Wincheck, and Meadowbrook Ponds; and Quidnick Reservoir.
- Vary where you fish and what kind of fish you eat.
- Choose smaller fish to eat (according to the DEM's allowable size limit regulations).
- Limit eel and black crappie taken from all ponds, and all fish from Tucker, Yawgoo and Watchaug Ponds, to one meal per month.
- Preliminary data from a Pan Fish Study completed in 1998 indicates relatively high levels of mercury in fish from Barber Pond, Bowdish Reservoir, Curran Reservoir, Echo Lake, Indian Lake and School House Pond.
- Preliminary assessments of fish from Mashapaug Pond indicate elevated levels of several contaminants, warranting further study. For the Woonasquatucket River, Mashapaug Pond and other urban rivers and ponds, fishing can still be enjoyed by those who "catch and release".

b. Red Tide

During Spring 2005 the largest bloom of red tide since 1972 occurred along the New England coast. Paralytic shellfish poison (PSP) toxin (red tide) from the dinoflagellate Alexandrium tamarense accumulate in filter feeding shellfish such as clams, mussels and oysters making them unsafe for people to eat. This red tide bloom, which began in late April 2005, led to the closing of shellfishing beds throughout Maine, New Hampshire and Massachusetts. While no shellfish beds within Rhode Island waters were affected, RIDEM and HEALTH, as a precautionary measure, filed regulations prohibiting federally permitted vessels from landing shellfish in Rhode Island if they have passed through or harvested from offshore waters that are currently closed to shellfishing due to red tide.

The presence of red tide is monitored by testing waters for the organism and by testing shellfish meats for the toxicity. A multi-state, multi-agency effort was implemented to monitor the spread and toxicity of the red tide bloom along the New England coast. Researchers in Massachusetts, led by the Woods Hole Oceanographic Institute (WHOI) with funding from the National Oceanographic and Atmospheric Administration NOAA), tested the ocean waters off eastern and southern Massachusetts, and Massachusetts officials performed toxicity testing of locally collected shellfish meats. In Rhode Island, officials from DEM and HEALTH, working in coordination with researchers from the University of Rhode Island, Graduate School of Oceanography, expanded routine monitoring efforts within Rhode Island waters to protect public health and the integrity of the state's shellfish industry from any potential impacts associated with the red tide outbreak. These efforts included additional water column sampling for PSP within Narragansett Bay and offshore waters, and toxicity testing of meats from shellfish collected in waters along the RI/MA border.

The algae Alexandrium tamarense occurs naturally throughout the waters of New England however it typically develops into large blooms only in waters off Maine and Canada. Although the exact triggers for a large scale red tide bloom are unknown, researchers note that the northerly and easterly current and wind patterns observed during the spring 2005 might have pushed the algae into nearshore waters of southern New England. In addition, the elevated levels of precipitation during the winter and spring flushed more fresh water and nutrients into the coastal region, creating prime conditions for the bloom.

RIDEM and HEALTH will initiate the routine annual phytoplankton sampling of Rhode Island waters in April and continue until November to correspond with the seasonal presence of Alexandrium. RIDEM and HEALTH will be in communication with federal and nearby state agencies to be prepared for monitoring and responding to a bloom in RI waters.

c. Fish Kills

i. Fish Kills 2005-2006

A procedural policy is in place to streamline RIDEM response to fish kills, and to delegate authority and tasks between RIDEM's Division of Fish and Wildlife (DFW) and RIDEM's Office of Water Resources (OWR). In general, DFW fisheries biologists investigate fish kills and the OWR personnel are contacted immediately if evidence indicates a possible pollution-related event.

During 2005-2006, 8 fish kill events occurred in Rhode Island waters (Table 3H-2). None of these events have been linked to toxic pollutants as the cause of the fish kill.

Table 3H-2 2005-2006 Fish Kills

Date	Location	City	Species affected	Number affected	Cause of kill
7/24/2005	Old Mill Cove	Warwick	Soft shell clam	200,000	Natural occurrence/overcrowding
9/3/2005	Brushneck Cove	Warwick	Atlantic menhaden	376,200	Juvenile menhaden were pushed into the cove by large gamefish and became stranded during the outgoing tide.
9/16/2005	Blackstone River	Pawtucket	Atlantic menhaden, Hickory shad, White perch, Summer flounder, Pumpkinseed, Striped bass	2,000,000+	Low oxygen levels, coupled with a low spring tide event trapped millions of fish directly below the dam.
9/25/2005	Woonasquatucket River	Providence	Atlantic menhaden, White sucker, Striped bass, Four spine stickleback, White perch, Blue crab, Green crab	4,500	This kill was caused by a combination of factors including stagnant, oxygen depleted water, a large algal bloom and an abundance of fish.
10/3/2005	Narragansett Bay	Newport	Northern Sea Star	230	Sea stars became stranded at high tide line when the tide receded. Approximately 30 sea stars were dead/decaying, however 200 were still alive and were placed back in the water.
10/17/2005	Sabin Pt.	E.Providence	Northern Sea Star	Unknown	Possible overcrowding or stranded during ebb tide.
6/1/2006	Gaspee Point	Warwick	Northern Sea Star	100	Natural occurrence/Sea stars became stranded as high tide receded.
8/2/2006	Rocky Point	Warwick	Northern Sea Star	3,500	Increased water temperature and low oxygen levels likely contributed to this event.

ii. Greenwich Bay Fish Kill - August 2003

On August 20, 2003 about one million fish, primarily juvenile menhaden, washed ashore along Greenwich Bay in Apponaug Cove and Greenwich Cove in Warwick. A massive slick of dead fish, extending from Cedar Tree Point to Buttonwoods, was also observed that afternoon. In addition to the juvenile menhaden, several hundred small crabs and some larger blue crabs, horseshoe crabs, grass shrimp, blackfish, and American eels were also observed along the shore or floating at the surface. The fish kill was followed a week later by a massive die-off of juvenile soft-shell clams. Discolored water and noxious odors also permeated the western shore of the bay.

In response to this severe event, Governor Carcieri directed DEM to assess the causes and impact of the fish kill in Greenwich Bay. The Department submitted a detailed report to the Governor in September 2003 that reflected some important long-term challenges affecting the health of the Narragansett Bay, and made recommendations that would prevent, or at least minimize, the recurrence of a similar event. The report can be found on DEM's website at http://www.dem.ri.gov/pubs/fishkill.pdf.

A major finding of the DEM report was that the fish kill was not a simple or isolated event. It was part of a much larger event going on in Greenwich Bay and other parts of Narragansett Bay in 2003, and part of a trend that has been observed for many preceding years and will likely continue. The fish kill was caused by the absence of dissolved oxygen (anoxia) in the waters of Greenwich Bay, particularly in its deeper waters and near its western shore. The condition caused fish and other marine animals living in these areas of the bay to suffocate. This conclusion was based on continuous measurements made by DEM in the western bay before the event was reported, and by surveys made throughout the bay on the day the kill was first reported. While the immediate cause for the kill was lack of oxygen, there is a broad and complex range of factors resulting in a severe and prolonged pattern of oxygen depletion. They include factors that cannot be controlled, at least not quickly or directly, such as rain, wind, temperature, geology and hydrodynamics. They also include pollution from various sources, including effluent from wastewater treatment facilities and septic systems, storm water runoff and groundwater flow from polluted areas, and possibly discharge from vessels using the Bay.

The DEM report noted that although Rhode Island has had much success in improving water quality in Narragansett Bay, events like the Greenwich Bay fish kill demonstrate that the progress made to date is not sufficient. The report made recommendations in several areas and actions to initiate implementation many of these since 2004 was undertaken. Selected examples include:

- New Funding for Pollution Abatement: the $8.5 million in state Narragansett Bay and Watersheds Restoration bond funds passed by voters in 2004 and DEM has developed rules to distribute grants for local projects.
- Accelerate nutrient upgrades: DEM issued permits to accelerate nutrient upgrades at two sewage treatment facilities (Fields Point & East Providence) and state law was amended to adopt of a goal of 50% reduction in nutrient pollutant loadings from WWTFs in the upper Bay.
- Improve septic system management: The City of Warwick continued to sewers extensions to neighborhoods with failing septic systems and hundreds of other systems have been repaired or upgraded.

• Improve storm water management: Both DEM and CRMC continue to develop new policies to require stormwater treatment and funds have been targeted to the City of Warwick for retrofitting selected existing drainage systems.
• Improve monitoring and assessment: DEM coordinated the expansion of the fixed-site network in Narragansett Bay and volunteers initiated a monitoring program for estuarine waters in Greenwich Bay in 2004.

Following the fish kill and an increased number of beach closures in 2003, the legislature as well as the Governor undertook several initiatives. Governor Carcieri organized the Narragansett Bay and Watershed Planning Commission. This Commission formed ten panels consisting of over 160 experts to review various issues and make recommendations for improved management of the Bay and its watershed. The Rhode Island Senate Joint Committees on Government Oversight and Environment and Agriculture conducted hearings on the management of Narragansett Bay and the House of Representatives established the Bay Trust Study Commission. These three initiatives produced reports that led to the passage of legislation in June 2004 aimed at strengthening the management of Narragansett Bay and its watershed by formation of a Coordination Team and the RI Monitoring Collaborative. The Coordination Team was organized in 2004and is currently working toward completion of a systems-level plan for management of Narragansett Bay and the state's rivers and watersheds. Through the Coordination Team, new funding was secured ($250,000) in 2006 that was directed to improving environmental and economic monitoring programs.

d. Shellfish Restrictions/Closures Currently in Effect

i. Shellfish Growing Area Monitoring Program

The Shellfish Growing Area Monitoring Program is part of the State of Rhode Island's agreement with the United States Food and Drug Administration's National Shellfish Sanitation Program (NSSP). The purpose of this program is to maintain national health standards by regulating the interstate shellfish industry. The NSSP is designed to oversee the management programs in shellfish producing states and to enforce and maintain an industry standard. As part of this agreement, the State of Rhode Island is required to conduct continuous bacteriological monitoring of the shellfish harboring waters of the state, in order to maintain certification of these waters for shellfish harvesting for direct human consumption. Rhode Island collects samples from 17 separate shellfish growing areas. These growing areas encompass all of Narragansett Bay and its shellfish harboring tributaries, all the south shore coastal salt ponds, Little Narragansett Bay, Block Island, and the Off Shore area. Each of the 17 growing areas incorporate anywhere from nine to 39 fixed sampling stations. Collecting bacteriological samples at all stations in one growing area on one day is considered one monitoring run.

Water samples are collected monthly at the stations in the Upper Narragansett Bay. For the 2004 sampling season, twelve sample runs were made providing approximately 132 samples. For the 2005 sampling season, characterized by several more extended wet weather periods than normal, eleven sampling runs were made providing approximately 121 samples. The results are used to manage the conditionally approved shellfish growing area in the Upper Narragansett Bay.

Greenwich Bay, Mount Hope Bay and the Kickamuit River have been operating on a conditionally approved basis for the past several years. These areas are closed for a period of seven days following a wet weather event totaling 0.5" or greater. The areas are to be sampled monthly when they are open for shellfishing. Greenwich Bay is also an official management area overseen by the Division of Fish and Wildlife which restricts harvesting yield during the adverse winter season. The commercial harvesting of shellfish in Greenwich Bay is restricted to Mondays, Wednesdays and Fridays from 8AM to noon from mid-December through April. Pollution restrictions supercede management restrictions. The twenty monitoring stations located in Greenwich Bay were sampled twelve times in both 2004 and 2005. These runs provided approximately 240 samples each year. The results are used to manage Greenwich Bay as a conditionally-approved shellfish growing area.

Mount Hope Bay and the Kickamuit River are also managed, on a conditionally-approved basis. The Kickamuit River was sampled 12 times per year in 2004 and 2005 at the 10 monitoring stations located in the growing area. This sampling provided approximately 120 samples per year. Mount Hope Bay was also sampled 12 times per year in 2004 and 2005 at the16 monitoring stations located in this growing area. This sampling provided approximately 192 samples per year. Both growing areas are sampled at the same time, and the results are used to manage the Mount Hope Bay/Kickamuit River conditionally-approved shellfish growing areas. The closure rates for the conditionally managed areas; Upper Narragansett Bay, Greenwich Bay, Mt. Hope Bay, and Kickamuit River, are shown in Table 3H-3.

The other shellfish growing areas in Rhode Island are not subject to the volume and number of sewage discharges that effect the Upper Narragansett Bay, or the predictable nonpoint source impact that effects the Warren and Barrington Rivers, Greenwich Bay, Kickamuit River and Mt. Hope Bay. Accordingly, these other shellfish growing areas are monitored less frequently. In March 1981, the sampling program was expanded and has continued through the present. More recently, the emphasis has shifted to a trend-oriented monitoring program based on a random sampling methodology. At present, those growing areas that are approved for shellfish harvesting are sampled a minimum of six times a year. An attempt is made to sample growing areas a minimum of once a year where shellfish harvesting is prohibited. Due to the lack of potential pollution sources impacting the Off Shore growing area, it is classified as remote and therefore is required to be sampled only twice a year.

After collection, the water samples are returned to the RI Department of Health laboratory for analysis. The result of this analysis is a measure of the most probable number (MPN) of total and fecal coliform bacteria. Fecal coliforms are found in wastes from warm-blooded organisms. These bacteria are nonpathogenic (non-disease causing). Fecal coliforms do, however, serve as an indicator organism for the possible presence of other potentially pathogenic, sewage-associated microorganisms which can cause such diseases as cholera, hepatitis, and gastroenteritis. These diseases may be contracted by consuming sewage-contaminated shellfish. The State retains its certification by restricting shellfish harvesting to those areas that maintain total and fecal coliform levels below certain statistical parameters established by the State and agreed to by the FDA. Rhode Island, with the consent of the FDA, recognizes the following six different classifications of shellfish growing areas:

> Approved - This status allows unrestricted harvesting of shellfish (unless restricted by conservation closures) for direct human consumption and is only allowed in areas free from harmful levels of pollution.

Conditionally Approved/Seasonal - This status prohibits shellfishing only during the summer months (Memorial Day weekend through Columbus Day weekend) due to the potential pollution from concentrations of boats with marine toilets during the boating season, and also areas with elevated bacteriological levels due to suspected nonpoint septic system leachate from summer residences.

Conditionally Approved - These areas change in quality due to rainfall-related problems such as combined sewer overflow discharge and/or sewerage system failures. These areas are from time to time found to be in an unsatisfactory condition for the taking of shellfish for human consumption and are then declared to be polluted and closed. In most cases, closure for seven days occurs following a rain event of greater than 0.5" within a 24-hour period in the Providence area. Notice of conditional closures is advertised in a daily newspaper in Providence.

Prohibited - This status prohibits the harvesting of shellfish on a year-round basis due to the presence of pollution during significant periods of the year.

Conditionally Restricted - These areas are used for shellfish relays only.

Remote - These areas have no human habitation and are not impacted by any actual or potential pollution sources.

ii. Changes in Shellfish Growing Area Status : May 2005

DEM announces seasonal shellfish closures and any changes to shellfish closure status, annually in May. The seasonal closures are made every year during the summer months because of increased marine activity. In addition to seasonal closures, DEM announces classification changes made based upon the results of the Department's routine monitoring program. The changes made for the calendar years beginning May 2005 are detailed below and summarized in Table 3H-4.

In 2005, three approved and/or conditionally approved stations that were previously in compliance with the shellfish program requirements, were closed due to exceedances of the bacterial standard. These closures included the upper portion of the Kickemuit River (44.3 acres), Trims Pond, located in the southern portion of Block Island's Great Salt Pond (14.9 acres), and an extension south of the closure line of Upper Point Judith Pond (51.6 acres).

A summary of total acreages for all marine areas in Rhode Island and their NSSP classification as of May 2005 is listed in Table 3H-5. Maps and descriptions of the Shellfish Closure Areas can be found on DEM's website at http://www.dem.ri.gov/programs/benviron/water/shellfsh/clos/index.htm. It is important to note that some of the closed shellfish areas described in Table 3H-5 and shown on the Shellfish Closure Area maps include waters classified as SB or SB1. While Class SB and SB1 waters are not designated for shellfishing use, incorporating them into the description of shellfish closure areas allows for siting of enforceable shellfish closure lines and for ease of informing the public via maps, of closed areas whether the closure is due to pollution or a designated classification.

Table 3H-3
Closure-Rates* for Conditionally Managed Areas, 1995-2005

Year	1995				1996				1997				1998				1999				2000			
	AREA				AREA				AREA				AREA				AREA				AREA			
Growing Area	A	B	G Bay	Mt. Hope/ Kick*	A	B	G Bay	Mt. Hope/ Kick*	A	B	G Bay	Mt. Hope/ Kick*	A	B	G Bay*	Mt. Hope/ Kick*	A	B	G Bay	Mt Hope/ Kick	A	B	G Bay	Mt Hope/ Kick
# Days Closed/ Year	205	76	205	256	252	107	184	197	219	76	177	184	244	123	201	210	224	99	166	192	229	124	164	169
% of Year Closed	56%	21%	56%	70%	69%	29%	50%	54%	60%	21%	49%	50%	67%	34%	55%	58%	61%	27%	46%	53%	63%	34%	45%	46%

Year	2001				2002				2003				2004				2005			
Growing Area	AREA				AREA				AREA				AREA							
	A	B	Greenwich Bay*	Mt. Hope/ Kick*	A	B	Greenwich Bay	Mt. Hope/ Kick	A	B	Greenwich Bay	Mt. Hope/ Kick	A	B	Greenwich Bay	Mt. Hope/ Kick*	A	B	Greenwich Bay	Mt. Hope/Kick*
# Days Closed/ Year	200	88	152	156	224	111	185	197	231	117	174	184	223	88	183.5	183	233	92	183	197.5
% of Year Closed	55%	24%	42%	43%	61%	30%	51%	54%	63%	32%	47.7	50%	61%	24%	50%	50%	64%	25%	50%	54%

June 1, 1990 - The Conditional Area was Divided into Areas A and B and Operated as Follows:

Area A - One-Half Inch (½") Rainfall or 0.5 mg By-Pass = Seven (7) Day Closure
Area A & B - One Inch (1") Rainfall = Seven (7) Day Closure
Areas A & B - Greater than 3" (>3") Rainfall = 10 Day Closure
Greenwich Bay/Mt. Hope Bay/Kickemuit River - One-Half Inch (½") Rainfall = Seven (7) Day Closure

* = These values represent closures based on predictable pollution impacts and management policies.

- G Bay = Greenwich Bay
- Kick. = Kickemuit River

TABLE 3H-4
CHANGES IN STATUS OF SHELLFISH GROWING AREAS
2005

Area	**Reason for Change**	**Change**	Year	Acres Affected
Kickemuit River	Bacteria monitoring results exceed shellfish standard	Conditionally Approved to Prohibited	2005	(-)44.3
Point Judith Pond	Bacteria monitoring results exceed shellfish standard	Approved to Prohibited	2005	(-)51.6
Trims Pond	Bacteria monitoring results exceed shellfish standard	Conditionally Approved to Prohibited	2005	(-)14.9

CHANGES IN STATUS OF SHELLFISH GROWING AREAS

	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Total Acres Improved:	2267	239	566	9	18	43	19	19	0	48	0
Newly Restricted:	6929	567	124	524	0	0	80	276	235	2	110.8

TABLE 3H-5

Present Shellfishing Status of Rhode Island Marine Waters
May 2005 - May2006
(numbers in parentheses refer to the shellfish closure identification number as noted on the May 2005 Shellfish Closure Area maps)

Area	STATUS (ACRES)			
	Approved	Conditionally Approved	Conditionally Approved/ Seasonal	Prohibited
Great Salt Pond, Block Island	200		424.77 (#36)	14.9 (#12A)
Old Harbor, Block Island				1407.43 (#12)
Block Island Coastal Waters	61417			
Winnapaug Pond, Westerly	476			
Quonochontaug Pond, Westerly/Charlestown	747			
Ninigret Pond, Charlestown	1547.5			101.2 (#32)
Green Hill Pond, So. Kingstown				420.4 (#32)
Trustom Pond, So. Kingstown	181			
Pt. Judith Pond, South Kingstown/Narragansett	1138.8			433.25 (#15, 15A, 16, 17, 18, 19)
Potter Pond, So. Kingstown	321			
Scarborough, Narragansett				1599.04 (#23)
Tuckers Dock, Narragansett				678.73 (#22)
Pettaquamscutt River, So. Kingstown/Narragansett/ No. Kingstown				617.89 (#31)
RI Sound & Mouth of Narragansett Bay	131274			
Little Narragansett Bay and Tidal Pawcatuck River				923.94 (#14)
U.R.I. Bay Campus & EPA Lab, Narragansett				19.73 (#26)
Wickford Harbor, North Kingstown			214.41 (#41)	229.97 (#27)
Bissel Cove, No. Kingstown				74.31 (#30)
Quonset Point, North Kingstown				1320.45 (#28)
Davisville, No. Kingstown				66.07 (#29)

Table 3H-5 continued

Area	STATUS (ACRES)			
	Approved	Conditionally Approved	Conditionally Approved/ Seasonal	Prohibited
Allen Harbor, No. & Little Allen's Harbor, North Kingstown				82.25 (#1)
Fry's Pond				8.49 (#33)
Greenwich Bay		1947.37 (#46)		
Greenwich Cove, East Greenwich				285.39 (#8)
Apponaug Cove and Baker Creek, Warwick				515.7 (#2)
Brush Neck Cove, Warwick				127.91 (#7)
Old Warwick Cove, Warwick				150.06 (#13)
Potowomut River, North Kingstown/East Greenwich	203.6			
Upper Narragansett Bay		9677.66 (#44 & 45)		
Providence River				6084.23 (#21)
Warren, Barrington & Palmer Rivers				1377.24 (#25)
Potter Cove, Prudence Island			105.27 (#39)	
Bristol Harbor, Bristol			94.47 (#37)	666.80 (#3)
Melville, Portsmouth				347.33 (#6)
Carr Point, South				65.68 (35)
Gould Island, East Passage				16.92 (#5)
Newport Harbor and Coddington Cove				4827.52 (#4)
Castle Hill				3.73 (#34)
East Ferry, Jamestown				809.45 (#9)
West Ferry, Jamestown			234.49 (#38)	

Table 3H-5 continued

Area	STATUS (ACRES)			
	Approved	Conditionally Approved	Conditionally Approved/ Seasonal	Prohibited
East Passage	14344.5			
West Passage	23583			
Sakonnet River	12,562			
Sakonnet Harbor			25.13 (#40)	
Nannaquaket Pond, Tiverton	200.58			4.13 (#20)
Nannaquaket Pond Channel, Tiverton				10.17 (#20)
The Cove, Portsmouth	183.17			114.02 (#11)
Kickamuit River, Bristol/Warren		464.71 (#47)	86.54 (#42 & 43)	
Mt. Hope Bay, including Island Park, Portsmouth		1804.63 (#47)		4891.03 (#10)
TOTAL ACRES of CLOSURE AREAS	24,839715	13,850.07	1,185.08	28,339.66
% OF TOTAL ACRES	85.1%	47%	0.4%	9.7%

iii. Shoreline Surveys

Shoreline surveys are an additional requirement of the National Shellfish Sanitation Program (NSSP). These surveys are necessary to determine shellfish classification in a particular growing area and to locate all actual and potential bacterial sources. A sanitary survey must be made of each growing area prior to approval of the area as a source of direct consumption of shellfish or a relaying operation. The sanitary surveys are updated annually and triennially (every three (3) years). Once every 12 years the sanitary shoreline survey must be completely redone. The annual survey requires a written update and field review of any changes in actual pollution sources that have the potential to impact a growing area and a review of the analytical results of the routine bacteriological sampling of the growing area. The triennial reevaluation survey requires a written report that addresses all pollution sources identified in the growing area. The effect of the sources on the growing is evaluated and documented. As in the annual survey the routine bacteriological sampling results are also factored in. The twelve-year sanitary shoreline survey requires a complete sanitary shoreline survey of both open and closed areas of the growing area. Such surveys involve an intense examination of the shoreline to identify all running pipes and tributaries for bacteriological quality as well as calculating flow rates, and then evaluating the impact upon specific growing areas. Inactive pipe sources and drainage ditches are also documented for future reference and evaluation. The twelve-year survey includes statistical data review, new shoreline survey information, meteorological characteristics, hydrographic evaluations including time of travel estimates known for bacterial pollution sources with the potential to impact the area and dilution estimates for all known bacterial point sources. Table 3H-6 describes the areas surveyed in 2004 and 2005 and scheduled for 2006.

Table 3H-6 Sanitary Shoreline Surveys Conducted in 2004-2005

Growing Area	Area Surveyed	Description	Annual	Triennial	12 Year
1	Upper Bay	The waters south of a line between Conimicut Point and Nyatt Points, and north of Warwick, Providence and Poppasquash Points	2005	2004	
3	East Middle Bay	The waters east of Prudence Island and west of the Mt. Hope Bridge	2005	2004	
4	Sakonnet River	The waters south of the Rt. 24 bridge and north of a line between Sachuset and Sakonnet points	2004 2005		Sch. 2006
5	Kickemuit River	The waters north of “The Narrows” in Bristol	2004	2005	
6	East Passage	The waters south of Prudence Island between the east shore of Jamestown and the west shore of Aquidneck Island	2004 2005		Sch. 2006
7	West Passage	The waters south of a line from Quonset Pt to the north end of Jamestown, between the east shore of North and South Kingston and the west shore of Jamestown to the southerly tip of Jamestown	2004		2005
8	Greenwich Bay	The waters of Greenwich Bay west of a line between Sandy and Warwick Points		2004	2005
9	West Middle Bay	The waters west of Prudence Island south of Greenwich Bay and the Upper Bay between the west shore of North Kingston and the east shore of Prudence Island	2005	2004	
11QW	Quonochontaug and Winnapaug Ponds	The waters of Quonochontaug and Winnapaug Ponds	2004	2005	
11NG	Ninigret and Green Hill Ponds	The waters of Ninigret and Green Hill Ponds	2004	2005	
13	Block Island	The waters of Great Salt Pond and the shores of Block Island	2004 2005		Sch. 2006
14	Offshore	The southern shores of Rhode Island from Napatree Point westerly to the Mass state line in the vicinity of Quicksand Point	2004 2005		Sch. 2006
17	Mt. Hope Bay	The waters of Mt. Hope Bay south of the Mass state line and east of the Mt. Hope bridge and north of the Rt. 24 bridge.	2004	2005	

e. Restrictions on Bathing Areas

The Rhode Island Department of Health (HEALTH) is responsible for the licensing and regulating of bathing beach facilities in the State of Rhode Island. With help from the United States Environmental Protection Agency (USEPA), HEALTH monitors all 118 licensed beaches throughout the state. Licensed beaches include salt and freshwater, as well as public and private facilities. HEALTH has the authority to close licensed beaches in Rhode Island, along with municipalities for town beaches. Swimming advisories are generally issued when a possible source of pollution has been identified, or bacteria criteria have been exceeded. As required in the federal BEACH Act, HEALTH changed its indicator bacteria from fecal coliform to enterococci in 2004. Therefore, the 2005 beach season represents the first season a direct comparison of beach closures utilizing enterococci as an indicator can be made. Advisories are also issued when a swimming-related illness has been reported in a designated area.

The 2005 bathing season saw a decrease in beach closures and closure days from the 2004 season. Whereas 122 beach closure days were recorded for 2004 (Table 3H-7), only 65 beach closure days were recorded for 2005 (Table 3H-8). The intensity and total volume of rainfall was lower during the summer of 2005 (June 1 to August 31) than the summer of 2004. Total rainfall decreased 43% from 10.99 inches in 2004 to 6.24 inches in 2005. Additionally, significant rainfall (>.50" in a 24-hour period from June 1-August 31 at TF Green) fell from 9 instances in 2004 to 4 instances in 2005. Furthermore, with the addition of USEPA BEACH Grants HEALTH was able to focus monitoring efforts in areas of greatest concern and target sample collection for times when high bacteria counts are most likely to be present. More information about the HEALTH Bathing Beach Program can be found at http://www.ribeaches.org/index.cfm

Table 3H-7

Rhode Island Department of Health
Office of Food Protection/Bathing Beaches Program

Beach Closures
2004

Beach	# of Days Closed	Waterbody Name	Problems
Atlantic Beach Club	11	Atlantic Ocean	Stormwater, CSO
Aquapaug Scout Reservation	2	Worden Pond	Unknown
Barrington Town Beach	4	Narragansett Bay	Stormwater
Bristol Town Beach	3	Narragansett Bay	Stormwater, wildlife
Camp Grosvenor	7	Narrow River	Stormwater, wildlife
Camp Massasoit	8	Oak Swamp Res.	Unknown
City Park	5	Brushneck Cove	Stormwater, wildlife
Colwell's Camp Ground	3	Flat River Res.	Unknown
Conimicut Point	5	Narragansett Bay	Stormwater, CSO, wildlife
Dyer Woods Nudist Campground	14	Gosham Farm Pond	Unknown
Easton's Beach	7	Atlantic Ocean	Stormwater, CSO
Fort Adams	5	Narragansett Bay	Stormwater, unknown
Govenor Notte Park	5	Wenscott Pond	Stormwater, wildlife
Kent County YMCA	4	Cedar Pond	Stormwater, wildlife
King Park	8	Narragansett Bay	Stormwater, CSO
North Kingstown Town Beach	7	Narragansett Bay	Stormwater
Oakland Beach	11	Greenwich Bay	Stormwater, wildlife
Scarborough State Beach North	3	Atlantic Ocean	Stormwater
Scarborough State Beach South	3	Atlantic Ocean	Stormwater
Worden Pond Family Campground	7	Worden Pond	Unknown
Total # of Closure Days:	**122**		

Table 3H-8

Rhode Island Department of Health
Office of Food Protection/Bathing Beaches Program

Beach Closures
2005

Beach	# of Days Closed	Waterbody Name	Problems
Atlantic Beach Club	2	Atlantic Ocean	Stormwater
Aquapaug Scout Reservation	2	Worden's Pond	Unknown
Barrington Town Beach	3	Narragansett Bay	Stormwater, wildlife
Bristol Town Beach	1	Narragansett Bay	Stormwater, wildlife
Camp Grosvenor	4	Narrow River	Stormwater, wildlife
City Park	7	Brushneck Cove	Stormwater, wildlife
Conimicut Point	21	Narragansett Bay	Stormwater, wildlife, CSO
Easton's Beach	2	Atlantic Ocean	Stormwater
Fort Adams	1	Narragansett Bay	Stormwater, wildlife
Goddard Park	2	Greenwich Bay	Stormwater, wildlife
Gorton Pond	1	Gorton Pond	Unknown
Govenor Notte Park	1	Wenscott Res.	Wildlife
Holiday Acres	3	Coomer's Pond	Unknown
Ninigret Park	1	Little Ninigret Pond	Unknown
Oakland Beach	7	Greenwich Bay	Stormwater, wildlife
Scarborough State Beach North	2	Atlantic Ocean	Stormwater
Scarborough State Beach South	2	Atlantic Ocean	Stormwater
Third Beach	2	Sakonnet River	Stormwater, wildlife
Warren Town Beach	1	Warren River	Stormwater
Total # of Closure Days:	**65**		

f. Restrictions on Surface Drinking Water Supplies

The Rhode Island Department of Health (RIDOH), Office of Drinking Water Quality is delegated to administer the EPA's Safe Drinking Water Act. The Office of Drinking Water Quality (DWQ) monitors approximately 482 public water systems, which include surface and groundwater supplies. DWQ primarily monitors waters within the distribution system to evaluate for compliance. The larger public drinking water suppliers monitor the source waters for several parameters to adjust treatment levels as necessary for compliance. More information about HEALTH's DWQ program can be found at http://www.health.ri.gov/environment/dwq/index.php.

Since RIDOH requires filtration and disinfection for all surface waters, this report assesses surface water quality from the perspective of whether or not the water source required more than reasonable treatment. According to DWQ, there have been no closures of public drinking water systems during 2004 due to water quality problems in the surface water supply.

Summaries of drinking water use assessments are shown in Table 3H-9 for rivers and streams and in Table 3H-10 for lakes and reservoirs.

Fifty-three (53) rivers and/or river segments reviewed for this report are located within Drinking Water Supply systems. These 53 rivers represents 114 river miles. Almost all of these rivers are considered unassessed for drinking water use. This is because the Department of Health only requires water quality data, to evaluate the source water, to be collected from the terminal reservoir of the system. The terminal reservoir is the location of the intake pumps. In general, sampling conducted elsewhere in the source waters of the system has been determined by the DOH to be too limited in scope to use in conducting a drinking water use assessment.

Forty-two (42) lakes assessed are used as drinking water supply sources. This represents 7,813 acres associated with the drinking water supply systems. Of these 7,813 acres, 5,484 acres (70%) are considered assessed for drinking water use for this report. The remaining 2,329 lake acres, or 30% were considered not assessed for drinking water use support. In general these 2,329 acres represent portions of the drinking water supply system that are upstream of the terminal reservoir. The terminal reservoir is the location within the drinking water supply system where the Department of Health requires the water samples to be collected. Some of these upstream waters are not monitored or have only limited monitoring and are, therefore, considered unassessed for this report. Ninety-nine percent (5,424 acres) of the drinking water supply lake acres assessed were found to be fully supporting, and less than 1% (<5 acres) of the lake acres assessed fully support drinking water uses but are threatened. Approximately 1% (55 acres) of drinking water supply lake acres assessed are considered impaired for the drinking water use.

Table 3H-9 Summary of Drinking Water Use Assessments for Rivers and Streams

Total Miles Designated for Drinking Water Use ____114.4__ Total Miles Assessed for Drinking Water Use ______4.04_				
Miles Fully Supporting Drinking Water Use	4.04	% of Waters Assessed Fully Supporting Drinking Water Use	100%	**Contaminants**
Miles Fully supporting but Threatened for Drinking Water Use		% Fully Supporting but Threatened for Drinking Water Use		
Miles Partially Supporting Drinking Water Use		% Partially Supporting Drinking Water Use		
Miles Not Supporting Drinking Water Use		% Not Supporting Drinking Water Use		

Table 3H-10 Summary of Drinking Water Use Assessments for Lakes and Reservoirs

Total Waterbody Area Designated for Drinking Water Use ____7,813.47 Total Waterbody Area Assessed for Drinking Water Use _____5484___				
Acres Fully Supporting Drinking Water Use	5424.46	% of Waters Assessed Fully Supporting Drinking Water Use	98.9%	**Contaminants**
Acres Fully supporting but Threatened for Drinking Water Use	4.54	% Fully supporting but Threatened for Drinking Water Use	0.1%	Natural dark (tannic) color
Acres Partially Supporting Drinking Water Use	54.97	% Partially Supporting Drinking Water Use	1%	Nutrients, excess algal growth, taste and odor, turbidity
Miles Not Supporting Drinking Water Use	0	% Not Supporting Drinking Water Use	0	

IV. GROUNDWATER QUALITY

A. INTRODUCTION

In Rhode Island, groundwater is a locally abundant and widely used resource. Approximately 26% of the state's population is supplied with drinking water from public and private wells (Solley et al 1998). Groundwater resources are expected to meet a substantial part of the state's future water supply needs. Groundwater quality in most parts of the state is suitable for human consumption and other uses without treatment. Furthermore, protection of groundwater quality is important to protect surface water quality, since during dry periods, water in streams is derived almost entirely from groundwater.

Rhode Island's groundwater resources are extremely vulnerable to contamination because of the generally shallow depth to groundwater, aquifer permeability, and the general absence of subsurface confining layers. Preventing groundwater pollution must be a priority if the long-term quality of the State's groundwater resources is to be protected.

Over 100 different contaminants have been detected in Rhode Island groundwater, with the most common being petroleum products, organic solvents, nitrate and historically the pesticide aldicarb (Temik). Contaminant sources include leaking underground fuel storage tanks, hazardous and industrial waste disposal sites, illegal or improper waste disposal, chemical and oil spills, landfills, septic systems, road salt storage and application practices, and fertilizer and pesticide applications. Most groundwater contamination problems occur on a localized basis originating from a specific source.

The Department of Environmental Management (DEM) is continuing to implement and refine a comprehensive groundwater protection program to prevent further degradation of the state's valuable groundwater resources.

KEY FINDINGS FROM THE 2006 REPORT

* Groundwater remains an important component of the total volume of freshwater used in RI. The US Geological Survey estimates that 27 million gallons per day of groundwater were are used in the state. This constitutes 21% of the total freshwater used. Approximately 26% of the state's population obtains its drinking water from groundwater sources.

* Groundwater in Rhode Island is generally free of pollutants. Over 90% of the state is classified as suitable for drinking water use and other uses without treatment.

* Nitrate concentrations in public wells remained consistent with previous assessments with the annual percentage of public wells that exceeded 5 mg/l averaging 3% over this assessment period. Nitrate has been documented at concentrations in monitoring wells and private wells above the drinking water standard in the immediate vicinity of turf farms in southern RI.

* Data on sodium concentrations in public wells revealed that the annual percentage of wells that exceeded 20 mg/l during this assessment period averaged 31% (ranging from (30% to 37%) compared to the previous assessment period from July 1995 to June 1999 where the average was 21% (ranging from 17% to 24%).

* Public well data indicates that groundwater resources are vulnerable to contamination by volatile organic compounds (VOCs). The most frequently detected VOC continues to be methyl tertiary butyl ether (MTBE), a gasoline additive. Typically, 15% to 25% of the public wells tested for VOCs during this reporting period had positive detections, which is consistent with previous reporting periods**.**

* Well closures -- of all the community and non-transient non-community wells in service at one point during the period from July 1999 to December 2005, one stratified drift municipal well was closed due to a leaking underground storage tank and 3 bedrock wells at an apartment complex were closed to due high arsenic concentrations.

* The leading cause of <u>new</u> groundwater contamination incidents reported to DEM continues to be the release of petroleum products stored in underground storage tanks.

B. GROUNDWATER USE

The US Geological Survey compiles water use data nationally every five years, and the information provided here on groundwater use is taken from the latest compilation in "Estimated Use of Water in the United States in 2000" (Hutson et. al 2004) The US Geological Survey estimates that for 2000, 28.6 million gallons of groundwater was used per day in the state. This accounts for 21% of the total volume of freshwater used in Rhode Island on a daily basis (138 million gallons per day (mgd)).

In the previous US Geological Survey report on water use for 1995 (Solley et al 1998), it was estimated that 26% of Rhode Island's population depends on groundwater for domestic water use. Unfortunately, due to the nature of the data collection for public suppliers in the 2000 USGS report on water use, it is not possible to estimate the population dependent on groundwater for domestic water use. However, due to the fairly consistent nature of the other groundwater use data in comparing the reports on water use from 1995 to 2000, an estimated 26% percent of the state's population dependent on groundwater for domestic use is still reasonable. Domestic water use includes water for normal household purposes such as drinking, food preparation, bathing, washing clothes and dishes, flushing toilets and watering lawns and gardens. The 2000 water use report does identify 127,000 people in Rhode Island dependent on an on-site private well.

Approximately two-thirds of Rhode Island municipalities utilize groundwater from public and/or private wells for all or a portion of their water supply needs. As of September 2005 there were 647 public wells in Rhode Island (RI Department of Health, Division of Drinking Water Quality). 170 of these wells are community wells, which serve residential populations of 25 persons or greater. The remaining 477 wells are non-community wells supplying schools, places of employment, hotels, restaurants, etc. Water provided by public water systems in Rhode Island amounted to 119 mgd, which is 86% of all freshwater used. Of this amount, 17 mgd was from groundwater (14%).

C. GROUNDWATER RESOURCES

Overview

Rhode Island's groundwater is contained in two types of aquifers: glacial deposits and bedrock. The unconsolidated glacial deposits overlie the bedrock and consist of stratified drift and glacial till. (See Figure 4-1 for a distribution of glacial deposits.) Groundwater moves readily between the stratified drift, till and bedrock aquifers and there is also a close hydraulic connection between these aquifers and the surface waters.

The state's most significant and productive aquifers are located in areas of stratified drift, which underlie approximately one-third of the state. Stratified drift consists primarily of well-sorted layers of silt, sand and gravel laid down by glacial meltwater streams. These deposits are usually located in existing stream valleys and in some cases they fill preglacial bedrock valleys. The stratified drift deposits are commonly 75 to 100 feet thick near the center of these valleys. Well yields vary depending on the thickness and permeability ranging from a few gallons per minute (gpm) to 1500 gpm, which is equivalent to approximately 2 million gallons per day.

In the 1970s the Rhode Island Water Resources Board mapped 22 groundwater reservoirs, which are the portions of the state's stratified drift aquifers that have the greatest potential for supplying future and existing public water systems with large quantities of groundwater. Groundwater reservoirs are defined as those areas of stratified drift with a saturated thickness of 40 feet or greater and a transmissivity of 4,000 ft. sq./day or greater. DEM modified the delineations for three of these groundwater reservoirs using more recently available information. DEM has mapped the critical portions of the recharge areas to the groundwater reservoirs using a modified version of a method developed by the U.S. Geological Survey (Trench and Morrissey, 1985; RIDEM 1991) (Figure 4-2). The groundwater reservoirs and the critical portions of their recharge areas are one component of the groundwater classified GAA, the highest protection class.

Glacial till, a second type of aquifer, typically consists of unsorted boulders, gravel, sand, silt and clay. The average thickness of till is 20 feet and it has a very low permeability. Wells dug in till have very low yields, generally less than 2 gpm, and often go dry during the summer months. Till deposits are not a suitable water supply source, and they function primarily to recharge underlying bedrock or downgradient stratified drift aquifers.

The third type of aquifer is the bedrock aquifer. In Rhode Island, bedrock consists mainly of granitic and gneissic rock with metamorphosed sedimentary rock found near Narragansett Bay. Groundwater in bedrock is stored and transmitted through fractures in the rock. Most bedrock wells yield less than 10 gpm. The U.S. Geological Survey (Johnston 1985) reports that over 90 percent of the wells drilled in bedrock provide an adequate yield for domestic water use. The majority of active private wells in Rhode Island are believed to be drilled into bedrock.

Background Groundwater Quality

The natural background quality of Rhode Island groundwater is considered excellent and suitable for human consumption. This is to be expected given that significant portions of the state depend on on-site private wells where the groundwater is not treated. This assessment may change in the future as decisions concerning the acceptable level of radon in drinking water are finalized, as will be discussed below.

The information available on natural background groundwater quality discussed herein is taken exclusively from the US Geological Survey (USGS) National Water Summary 1986 - Groundwater Quality (Johnston and Barlow 1988). Natural groundwater quality varies with local geologic conditions, and the data from the US Geological Survey is limited to dissolved solids, hardness, nitrate, iron, and manganese.

Stratified Drift Aquifers

Groundwater in the stratified drift aquifers has dissolved solids concentrations generally less than 100 mg/l. Concentrations are higher where there is infiltration from surface waters, on Block Island due to saline water, and where the stratified drift overlies sedimentary rocks

Figure 4-1

Glacial Deposits

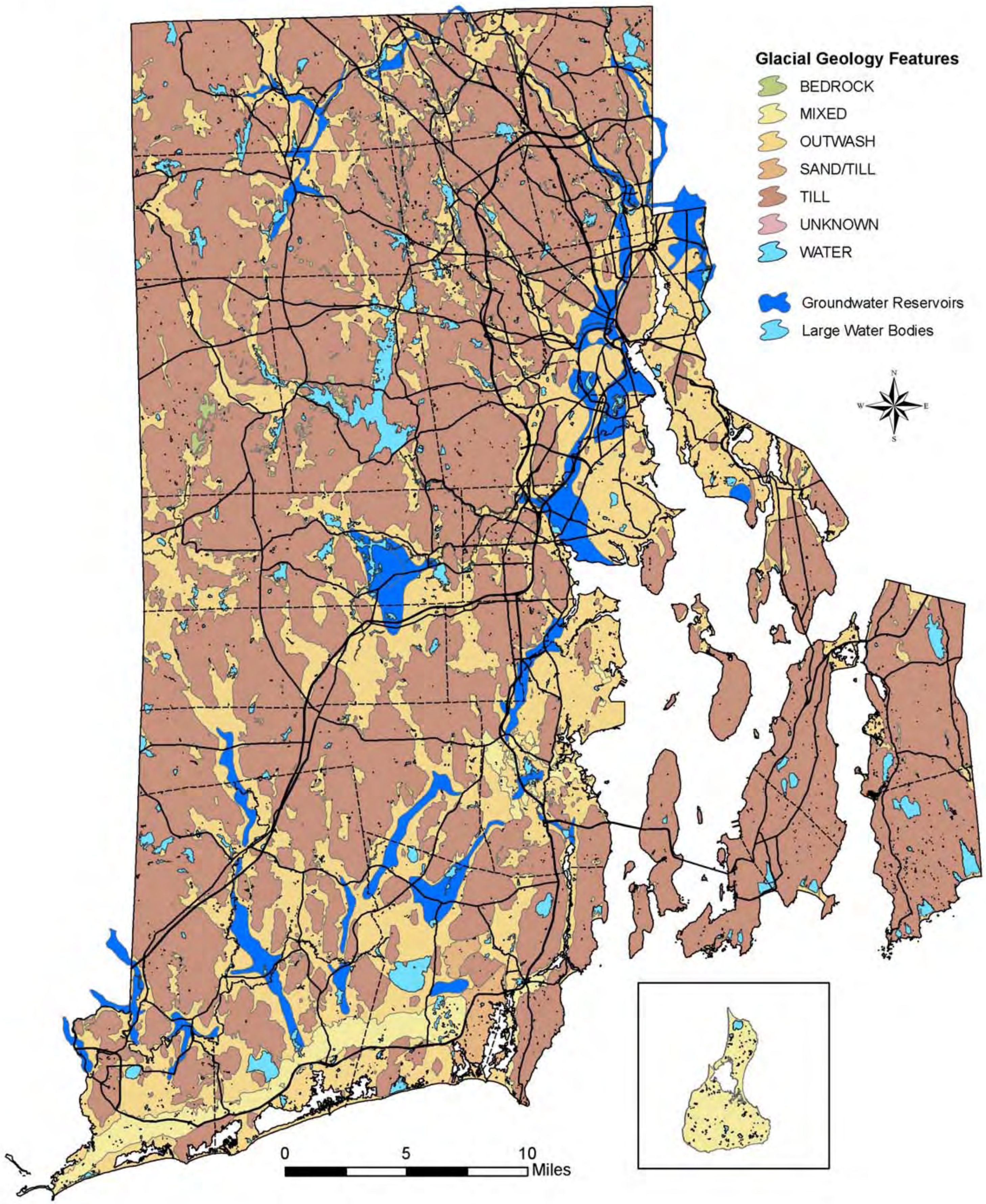
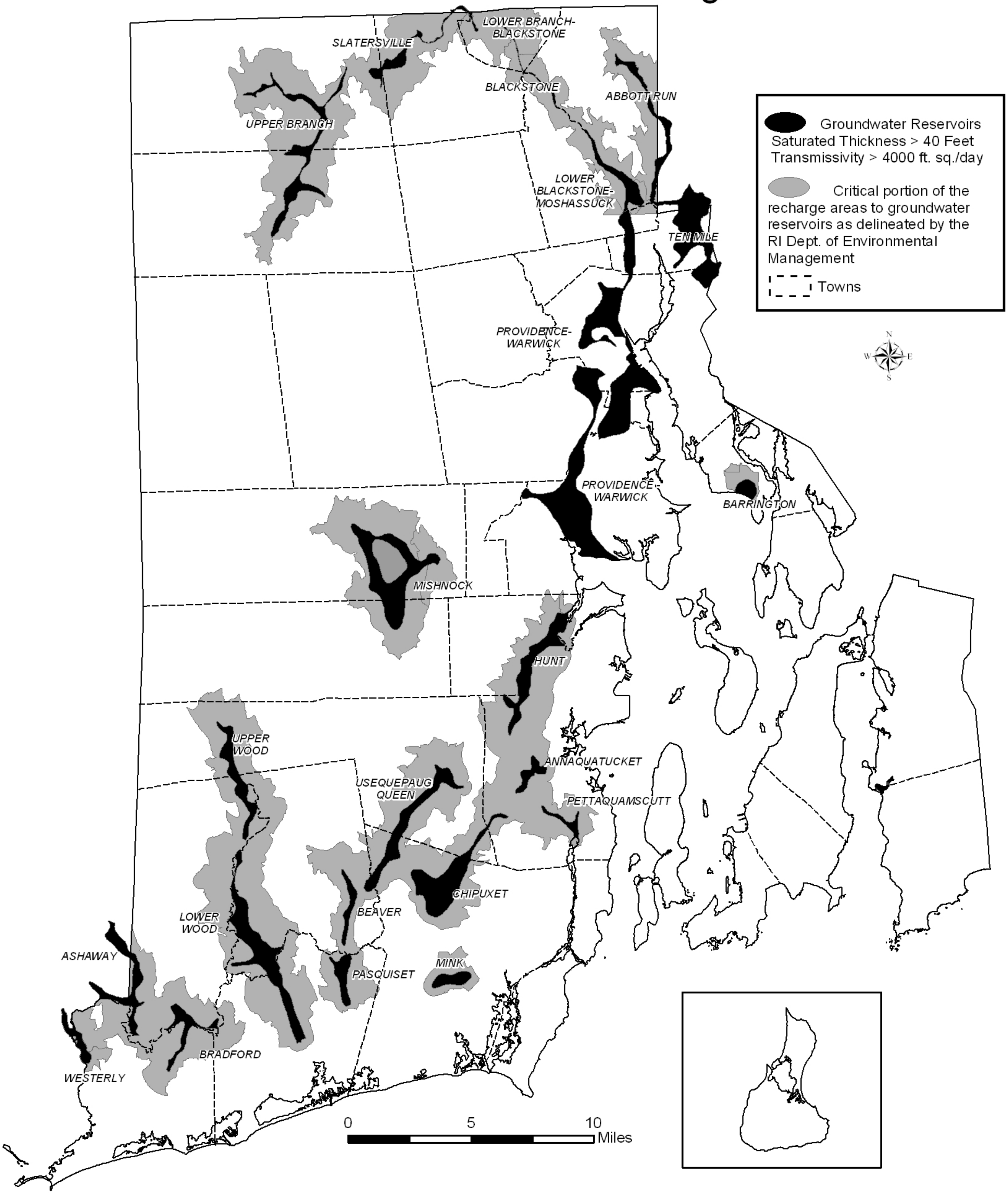


Figure 4 - 2 Groundwater Reservoirs and the Critical Portions of Their Recharge Areas



(generally near Narragansett Bay). Groundwater is soft in most parts of the state due to the underlying granite bedrock.

Concentrations of iron and manganese are generally less than the secondary drinking water standards of .3 mg/l and .05 mg/l, respectively. Manganese concentrations can exceed .05 mg/l where pumping from wells located near surface waters has caused significant infiltration of surface water.

The concentrations of nitrate in groundwater in areas unaffected by human activities is likely to be less than .2 mg/l. This is the case in the upper Wood River basin where most of the land area is undeveloped and is managed by the state. Concentrations of nitrate in groundwater in most areas, assuming some human impacts, are expected to be less than 2 mg/l.

Bedrock Aquifers

The median concentrations of dissolved solids, hardness, and nitrate were 125, 66, and 2 mg/l, respectively, in samples from crystalline bedrock and 156, 95, and .3 mg/l, respectively, from sedimentary bedrock. The median concentration of iron was .07 mg/l from crystalline bedrock and .2 mg/l in samples from sedimentary bedrock.

Radon

Radon is a naturally occurring gas derived from the radioactive decay of uranium. Radon is soluble in groundwater, and it is most common where the underlying bedrock is granite and granite gneiss. Sand and gravel deposits derived from this bedrock can also be presumed to contain radon. The primary health concern from radon is in indoor air, most of which comes from the soil beneath the structure. Radon from drinking water is a smaller source of radon in indoor air (1-2%). Ingestion of drinking water with radon presents a health risk, but at a much lower level than the risk from inhalation of radon. The US EPA has proposed new regulations to protect the public from radon exposure that establishes 2 levels: a MCL of 300 pCi/l and an alternative maximum contaminant level of 4,000 pCi/l that can be used in conjunction with an EPA approved multimedia mitigation program for radon.

A study at the University of Rhode Island (Ruderman 1996) analyzed 101 groundwater samples for radon in the Pawcatuck River basin. Only two samples had concentrations less than 500 pCi/l. Forty-three samples exceeded 3,000 pCi/l, and 19 samples exceeded 10,000 pCi/l.

Radon was included in a portion of the DEM Private Well Survey conducted in the late 1980s. A total of 303 wells (310 analyses including duplicates) in 19 different areas throughout the state were tested for radon. The results for radon in groundwater range from 140 - 49,080 pCi/l. Table 4-1 summarizes the number of analyses that fall above specific radon concentrations in the Private Well Survey.

Table 4-1. Radon Concentrations from the DEM Private Well Survey

Radon Concentration in Groundwater (pCi/l)	Total Number of Analyses Above the Concentration
> 200	305
> 300	302
> 500	291
> 2,000	203
> 10,000	38
> 20,000	16
> 40,000	2

Wellhead Protection Areas

As part of the state's Wellhead Protection Program, DEM has delineated the wellhead protection areas (WHPAs) for the 647 public wells in Rhode Island (as of September 2005). A wellhead protection area is the critical portion of the area through which water moves underground to a public well. (See Figure 4-3.)

The WHPA delineation methodology differs depending if the well is completed in bedrock or stratified drift. The WHPA for bedrock wells is a circle with the radius dependent on the well's pump rate. The smallest circle used has a radius of 1,750 feet based on a 10 gallon per minute pump rate, and this is commonly applied to the transient non-community wells. The WHPA for stratified drift wells is a curve in the stratified drift generated by an analytical model with hydrogeologic/topographic mapping in the upgradient till.

These initial DEM WHPA delineations are based on reasonably available hydrogeologic information and the well characteristics. Due to the varied conditions across the state, the DEM method was better suited to some areas than others. Therefore, from the time of the initial adoption of the WHPAs, DEM recognized the need and benefit for revisions to these WHPAs (referred to as refined WHPAs) employing more advanced methodologies. As of January 2006, 25 WHPAs have been refined. These refined WHPAs include 3 wellfields (6 wells) that were delineated by the USGS with funds from the RI Department of Health Source Water Assessment Program (Friesz 2004). The US Geological Survey is in the process of delineating refined WHPAs for an additional 4 wellfields (15 wells) using source water assessment funds.

The WHPAs cover 99,949 acres (14.5% of the state's land area) in 31 communities. The WHPA delineations for Rhode Island wells also include 1,710 acres in Connecticut and Massachusetts due to wells located along the state border. WHPAs for community wells cover 35,075 acres or about 5% of the state. Individual WHPAs range in size from approximately 16 acres (the smallest) to 2234 acres (the largest). The communities with the highest percentage of land area designated as WHPAs are New Shoreham (40%), Charlestown (33%), North Smithfield (28%), and Glocester (24%).

Figure 4-3

Wellhead Protection Areas

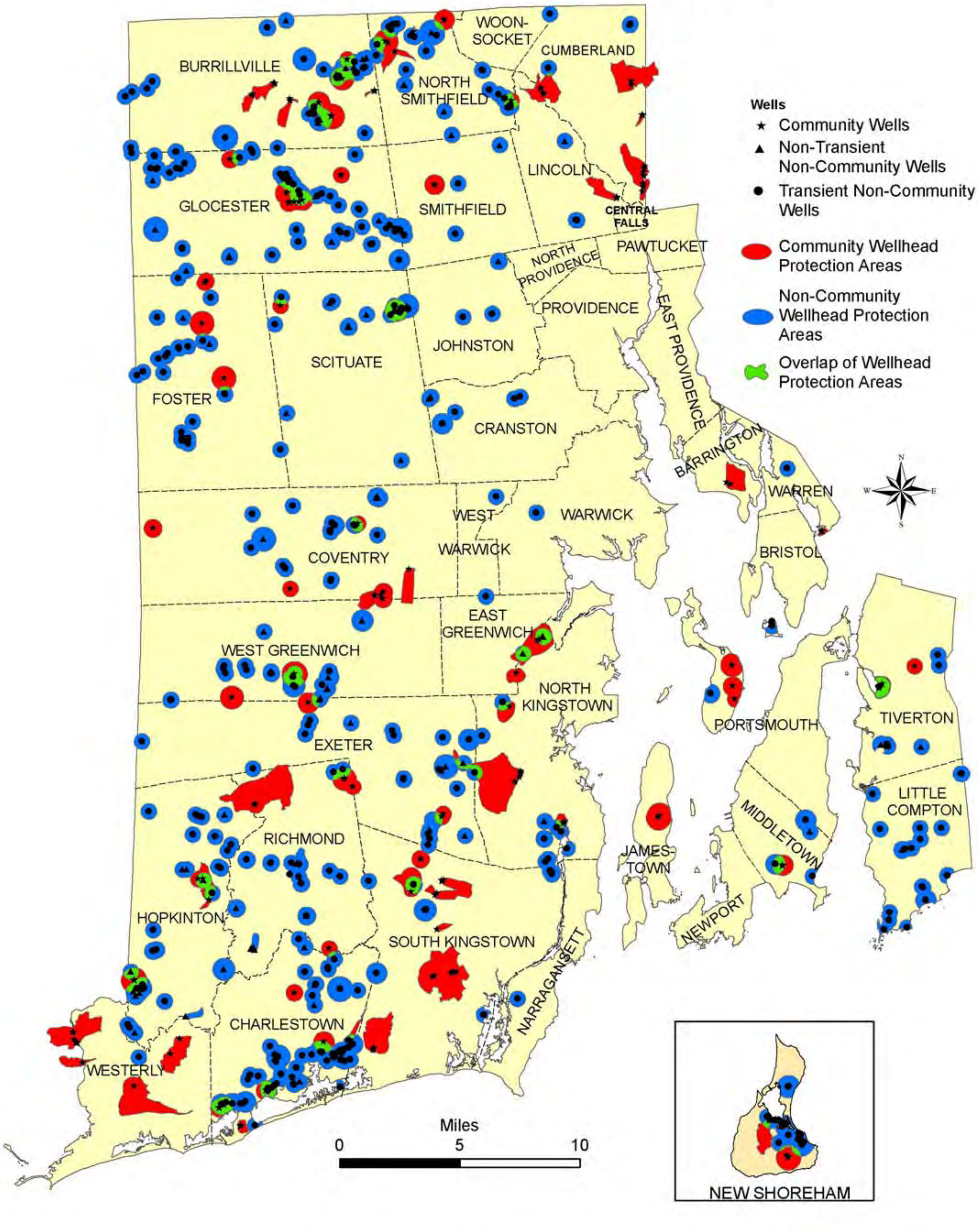
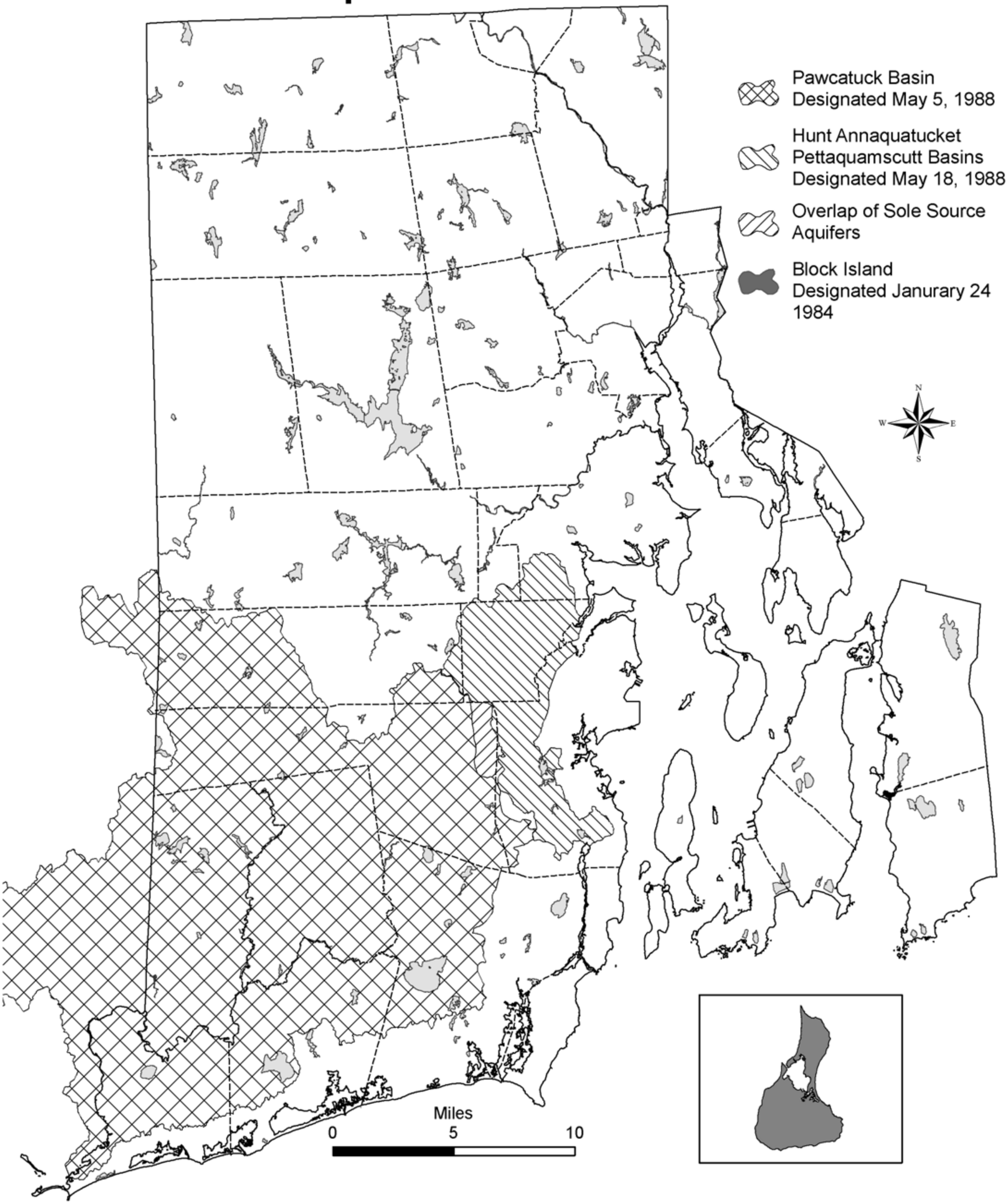


Figure 4-4

US EPA Designated Sole Source Aquifers in Rhode Island



Sole Source Aquifers

Several areas of the state are entirely dependent on groundwater as a water source. This is the current situation in the towns of Little Compton, Westerly, Hopkinton, Richmond, Charlestown, South Kingstown, Narragansett, North Kingstown, Exeter, Foster, Scituate, Glocester, Burrillville, and West Greenwich.

In recognition that certain areas are dependent on groundwater, the U.S. Environmental Protection Agency (EPA) administers a sole source aquifer (SSA) program under authority of the Safe Drinking Water Act. To qualify as a SSA, an area must rely on groundwater for more than 50% of its drinking water supply and have no feasible supply alternatives, among other requirements. Block Island was designated a sole source aquifer in 1984. Two additional sole source aquifers were designated in Rhode Island in 1988 - the Pawcatuck Basin Aquifer System and the Hunt-Annaquatucket-Pettaquamscutt Aquifer System. The Pawcatuck SSA covers 295 square miles, and it encompasses part or all of ten towns in Rhode Island and four towns in Connecticut. The Hunt-Annaquatucket-Pettaquamscutt SSA covers 41 square miles located primarily in North Kingstown and East Greenwich. (See Figure 4-4.)

D. GROUNDWATER QUALITY ASSESSMENT - OVERVIEW

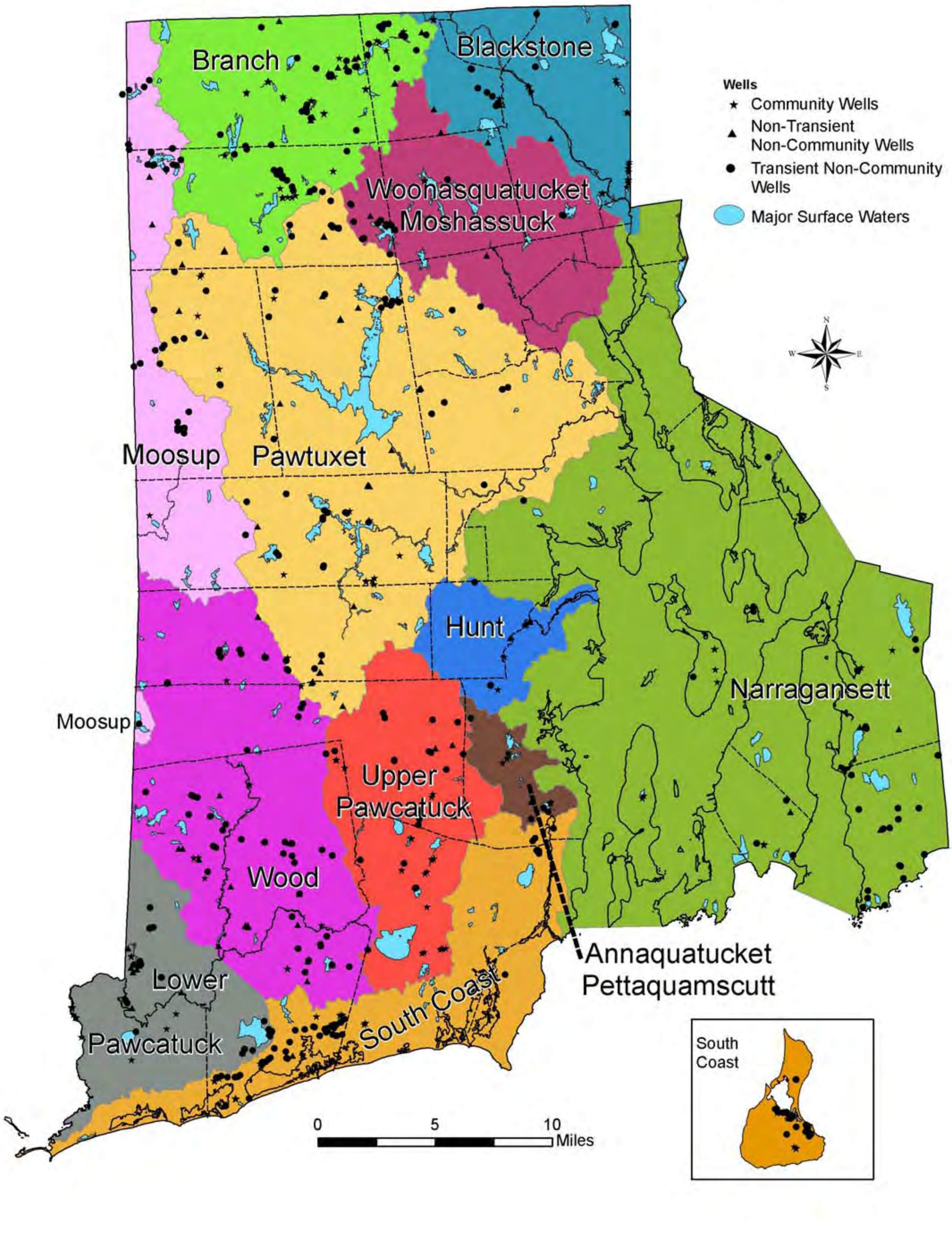
Rhode Island does not have a system of groundwater monitoring wells established for ambient groundwater quality monitoring. Therefore, groundwater quality data from public wells is used to assess groundwater quality in Rhode Island for this report. Public well data (see Section E) is considered to be the best indicator available for groundwater quality assessment, since these wells are regularly sampled for numerous parameters and they are widely distributed throughout those parts of the state dependent on groundwater for drinking water. Groundwater quality data available to the state from individual private home wells is a less reliable indicator since the majority of the wells sampled are in response to a known or suspected source of groundwater contamination.

The well data used for this assessment is collected by the Rhode Island Department of Health. Drinking water quality standards, which are commonly referred to as maximum contaminant levels (MCLs), have been established by the US EPA and adopted by the RI Department of Health. In addition, health advisories (HAs) are used by the Department of Health for contaminants for which no MCL has been established. The maximum contaminant levels and health advisories are used in this report to evaluate the water quality data from public wells.

In addition to public well data, information on sources of groundwater contamination has also been used as an indicator of the condition of and the threat to the state's groundwater resources. These sources are discussed in Section F. Monitoring well data from specific groundwater investigations and site assessments at known and suspected sources of contamination have not been analyzed. Compiling data from the hundreds of monitoring wells and samples taken to identify groundwater contamination problems would not provide useful information to characterize the overall groundwater quality in the state. Rather, DEM believes that tracking and reporting the number of sites that present a potential threat and those that have impacted groundwater is a more useful indicator.

Figure 4-5

Groundwater Assessment Areas



The state has been divided into 12 groundwater assessment areas (as in the previous 305(b) reports), which are shown in Figure 4-5. Since the major aquifers in Rhode Island are so closely hydrologically connected to surface waters, the assessment area boundaries were delineated using surface water basins and sub-basins in a manner that most reasonably recognized the major aquifers. Using surface water basins and sub-basins will also facilitate a more comprehensive approach to watershed management and overall water quality data analysis. The twelve assessment areas are: Annaquatucket-Pettaquamscutt, Blackstone, Branch, Hunt, Lower Pawcatuck, Moosup, Narragansett Bay, Pawtuxet, South Coast, Upper Pawcatuck, Wood, Woonasquatucket-Moshassuck.

E. PUBLIC WELL DATA

There is often confusion about the term "public well." Wells at hundreds of private establishments along with the major municipal wells are all by definition public wells. A public well supplies water to a public water system that is regulated by the Rhode Island Department of Health. These systems must meet specific water quality standards established by the federal government and enforced b the Department of Health. A public water system provides drinking water to 15 or more service connections or, regularly serves an average of at least 25 individuals daily at least 60 days of the year. Three categories of public water systems have been established:

* Community water system:
    - serves year-round residents;
    - at least 15 service connections or at least 25 individuals;
    - municipal wells and wells serving nursing homes, condominiums, and mobile home parks, etc.

* Non-transient non-community (NTNC) system:
    - regularly serves at least 25 of the same persons (not residents) over 6 months of the year;
    - schools and places of employment.

* Transient non-community system:
    - does not regularly serve the same persons;
    - does serve at least 25 people at least 60 days of the year;
    - restaurants and hotels.

The water quality testing requirements for community systems and non-transient non-community systems are the same. The requirements for transient non-community systems are much less extensive. The Department of Health data is collected on the basis of the state fiscal year, which is from July 1 to June 30. <u>The public well data that was evaluated for this report is from the 5 fiscal years covering the period from July 1, 1999 to June 30, 2004.</u>

It is difficult to make direct comparisons from year-to-year using the data collected by the Department of Health because different parameters have different sampling requirements. Therefore, with the exception of nitrate, the same wells are not necessarily tested every year for the same parameters that are discussed in this document. The Department of Health should be contacted for an explanation of the water quality sampling requirements.

In this section, statewide summary information is provided for volatile organic compounds (VOCs), pesticides, nitrate, and sodium. The data is compiled on the basis of groundwater assessment areas in the Appendix to this chapter (Appendix has data for synthetic organic compounds (SOCs) for each assessment area that includes the pesticides).

Of all the community and non-transient non-community wells in service at one point during the period from July 1999 to December 2005, one stratified drift municipal well was closed due to a leaking underground storage tank and 3 bedrock wells at an apartment complex were closed to due high arsenic concentrations, thought to be caused at least in part by the former use of arsenic as a pesticide at a nearby orchard.

Volatile Organic Compounds

Volatile organic compounds (VOCs) are tested in samples taken from community and non-transient non-community wells. Methyl tertiary butyl ether (MTBE) has been the most frequently detected VOC in each of the 5 years in this reporting period, as it was in the previous reporting period (See Table 4-2).

VOCs are a continuing source of concern with typically 15-25% of the wells sampled annually having detections of VOCs. See Table 4-3 and Figure 4-6 for a summary of VOC data from public wells over the past 13 years. During this reporting period, 4 wells had concentrations exceeding a MCL/HA, and MTBE was the cause in all of them.

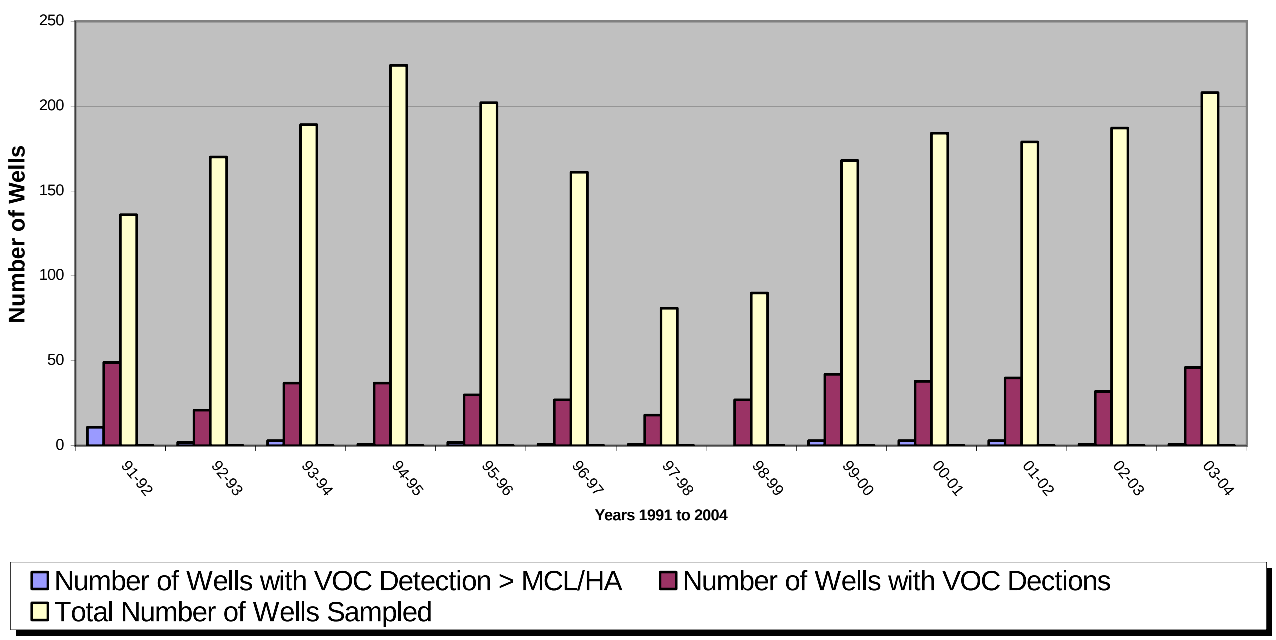
Table 4-2. Most Commonly Detected VOCs in Community and Non-Transient Non-Community Public Water Supply Wells – July 1995 to June 2004

Volatile Organic Compound	Number of Wells								
	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04
Methyl tertiary butyl ether	8	11	11	18	26	23	22	17	25
Tetrachlorethene	4	4	4	3	4	2	2	3	4
Trichloroethene	3	2	3	3	7	3	2	3	3
1,1,1-Trichloroethane	8	6	5	7	6	7	5	3	2

Table 4-3. VOC Detections in Community and Non-Transient Non-Community Public Water Supply Wells -- July 1991 to June 2004

Years 1991-2004	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01	01-02	02-03	03-04
Number of Wells with VOC Detection > MCL/HA	11	2	3	1	2	1	1	0	2	3	3	1	1
Number of Wells with VOC Detections (Includes >MCL/HA)	49	21	37	37	30	27	18	27	41	38	40	32	46
Total Number of Wells Sampled	136	170	189	224	202	161	81	90	168	184	179	187	208
Percent of Wells with VOC Detections	36%	12%	20%	17%	15%	17%	22%	30%	24%	21%	22%	17%	22%

Figure 4-6. Summary of VOC Data from Public Wells



Nitrate and Sodium

Previous 305(b) assessments of public well data for nitrates and sodium only evaluated community and non-transient non-community wells. Transient wells were included in the review of public wells for this assessment period – July 1999 to June 2004. The difference in the number of wells is most dramatic for the nitrate data.

Nitrate is contributed to groundwater primarily from septic systems and fertilizers (see Table 4-4). Five mg/l of nitrate, one-half the MCL, is often used as a threshold for determining acceptable impacts to groundwater from existing and proposed development. The annual percentage of wells that exceeded 5 mg/l during this assessment period averaged 3%. On an annual basis, 88% to 91% of the wells had concentrations less than 3.0 mg/l over these 5 years. This is consistent with data from previous assessments. The highest concentration detected was 15.7 mg/l.

An elevated concentration of sodium in public wells in RI has been caused primarily by road salt applications and saltwater intrusion. The US EPA has established 20 mg/l as the concentration in drinking water to protect individuals on a 500 mg/day restricted sodium diet. The annual percentage of wells that exceeded 20 mg/l during this assessment period averaged 31% (ranging from (30% to 37%) compared to the previous assessment period from July 1995 to June 1999 where the average was 21% (ranging from 17% to 24%)(see Table 4-5).

Table 4-4. Nitrate Data from Public Wells: July 1995 to June 1999 Community and Non-Transient Non-Community Wells; July 1999 to June 2004 All Public Wells

Nitrate Concentration mg/l	Number of Wells								
	07/01/95 - 06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	72	87	84	72	208	181	169	181	180
0.21 - 3.0	103	102	113	105	302	318	330	322	315
3.1 – 4.9	17	15	14	12	38	43	37	40	52
5.0 – 10.0	8	8	10	9	26	11	15	11	15
≥ 10.0	2	1	1	2	5	3	5	1	0
Total	202	213	222	200	579	556	556	555	562

Table 4-5. Sodium Data from Public Wells: July 1995 to June 1999 Community and Non-Transient Non-Community Wells; July 1999 to June 2004 All Public Wells

Sodium Concentration mg/l	Number of Wells								
	07/01/95-06/30/96	07/01/96-06/30/97	07/01/97-06/30/98	07/01/98-06/30/99	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤10	56	48	51	50	50	46	43	50	42
10.1-20.0	54	51	58	60	53	61	56	53	56
20.1-100	21	26	28	32	44	38	46	46	56
≥100	2	1	0	2	1	0	5	1	1
Total	133	126	137	144	148	145	150	150	155

Pesticides

The DEM Division of Agriculture has analyzed the Department of Health's pesticide data for public water supplies (wells and surface water watersheds) for the period of 1993 through December 2005. Only community and non-transient non-community water supplies are tested for pesticides. Over that period, pesticide or pesticide degradates have been detected in the following:

26 stratified drift wells (25 community, 1 non-transient non-community)
18 bedrock wells (5 community, 13 non-transient non-community)
6 surface water reservoirs (all community)

These water supplies were tested for 29 different pesticides by the Department of Health (see list of 29 in Table 4-6).

Table 4-6 identifies the 29 pesticides that have been detected in public water supplies from 1993 through 2005. 41% of the pesticides detected are classified as "general use pesticides", which are products available to farmers, pest control applicators and homeowners that do not require any additional use restrictions other than what is required on the label. 31% of the pesticides detected are classified as "restricted use pesticides" which can only be applied by certified trained pesticide applicators and may require additional use restrictions beyond label requirements. 28% of the pesticides are currently banned for use in Rhode Island. Observations from this table:

- No pesticide was detected above the drinking water standard.

- The maximum concentration that was detected exceeded 50% of the drinking water standard for only 2 chemicals – aldicarb sulfone and aldicarb sulfoxide, both of which are degradates of the banned pesticide aldicarb (which was not detected). In the 1980s aldicarb presented a serious groundwater contamination problem in Rhode Island. Once its use was banned, groundwater concentrations of aldicarb rapidly decreased and the detections were limited to its degradates. The Department of Health stopped testing for aldicarb and its degradates in 2002. From 1993 to 2002, aldicarb degradates were detected in wells at 5 different public water systems. Four of these 5 systems had no detections by the late 1990s. One system had concentrations generally less than one in 2002.

- Only 3 other pesticides had maximum detections exceeding 25% of the drinking water standard. Two of these, dinoseb and ethylenedibromide are banned chemicals. Ethylenedibromide was detected in one well in 1995. Dinoseb was detected in one well in 1993. The third, simazine, is a widely used general use herbicide. Of the 31 detections, 29 were in a surface water supply system and these were the detections that exceeded 25% of the drinking water standard. Simazine has been detected in 2 non-transient non-community wells at concentrations of .21 and .15 ppb, far below the 4 ppb standard.

The pesticides of most current concern are atrazine, dacthal (and its degradates labeled as DCPA degradates in Table 4-6), metalochlor, and simazine. Excluding aldicarb degradates (see discussion above), these 4 pesticides have by far the greatest number of detections. However, all have been found in groundwater at very low concentrations. All four pesticides are herbicides. The number of public wells that have had detections of these pesticides are as follows:

Atrazine – 5 public wells

Dacthal and it degradates – 25 public wells (23 of these are stratified drift wells)
Metolachlor – 6 public wells
Simazine – 2 public wells (see discussion above)

Table 4-6. Pesticide Detections in Public Water Supplies (Wells and Water Supply Watersheds) from 1993-2005.

Chemical	Pesticide Classifica-tion (Note 1)	Number of Detect-ions	Average Concent-ration (ppb)	MCL or HA (ppb)	Maximum Concentra-tion Detected (ppb)	Percent of MCL/HA for Maximum Concentration Detected
Alachlor	R	2	0.1300	2	0.15	7.50%
Aldicarb Sulfone	B	12	0.6458	3	2	66.67%
Aldicarb Sulfoxide	B	15	0.8627	4	3	75.00%
Anthracene	G	1	0.1000	10000	0.1	0.00%
Atrazine	R	26	0.1646	3	0.48	16.00%
Carbaryl	G	1	0.6800	700	0.12	0.02%
Carbofuran	R	1	0.1400	40	0.05	0.13%
Chlordane	B	1	0.3700	20	0.37	1.85%
Dacthal	G	55	4.4814	70	4.4	6.29%
DCPA Degradates (Mono-, Di-Acid)	G	25	7.3720	5000	30.1	0.60%
Dibromochloropropane	G	1	0.0200	0.2	0.02	10.00%
Dicamba	G	2	2.4150	200	3.68	1.84%
Dieldrin	B	4	0.0750	2	0.12	6.00%
Dinoseb	B	1	0.2000	0.7	0.2	28.57%
Endrin	B	1	0.0050	2	0.005	0.25%
Ethylenedibromide	B	1	0.0200	0.05	0.02	40.00%
Heptachlor Epoxide	R	1	0.0050	0.2	0.005	2.50%
Isophorone	G	2	0.0850	100	0.11	0.11%
Lindane	R	1	0.0270	0.2	0.027	13.50%
Methomyl	R	1	0.3700	200	0.37	0.19%
Methoxychlor	G	1	0.1400	40	0.14	0.35%
Metolachlor	G	53	0.2887	100	1.3	1.30%
Oxamyl	R	1	1.2000	200	1.2	0.60%
Pentachlorophenol	R	1	0.2000	1	0.2	20.00%
Picloram	R	2	0.1050	500	0.11	0.02%
Propachlor (Ramrod)	G	1	0.1100	90	0.11	0.12%
Simazine	G	31	0.3168	4	1.47	36.75%
Total Aldicarbs	B	3	2.8000	7	0.14	2.00%
2,4-D	G	1	0.3400	70	0.34	0.49%

Note 1: R = restricted use; B = banned; G = general use.

E. GROUNDWATER POLLUTION SOURCES

This section describes the variety of pollution sources that threaten Rhode Island's groundwater resources. DEM has identified the 10 highest priority sources of groundwater contamination in Table 4-7 using an EPA format from earlier 305(b) reports. The sources in this table are not ranked, but as the discussion in this section of the report will show, underground storage tanks are the major threat to the state's groundwater resources.

Table 4-7. Major Sources of Groundwater Contamination

Contamination Source	Ten Highest Priority Sources (✓)	Factors Considered in Selecting a Contaminant Source[1]	Contaminants [2]
Agricultural Activities			
Agricultural chemical facilities			
Animal feed lots			
Drainage wells			
Fertilizer applications	✓	D, B, C, H	E
Irrigation practices			
Pesticide applications			
On-farm agricultural mixing and loading procedures			
Land application of manure (unregulated)			
Storage and Treatment Activities			
Land application			
Material stockpiles			
Storage tanks (above ground)			
Storage tanks (underground)	✓	A, D, G	D
Surface impoundments			
Waste piles			
Waste tailings			
Disposal Activities			
Deep injection wells			
Landfills	✓	A	C, H, B, A
Septic systems	✓	D, B, C, A, H	E, J, K, L
Shallow injection wells	✓	D, A	C, D, H
Other			
Hazardous waste generators			
Hazardous waste sites	✓	A	C, D, H
Large industrial facilities	✓	A	C, D, H
Material transfer operations			
Mining and mine drainage			
Pipelines and sewer lines			
Salt storage and road salting	✓	D, C, B, A	G
Salt water intrusion			
Spills	✓	D, A, B, C	D, C
Transportation of materials			
Urban runoff			
Small scale manufacturing and repair shops	✓	A, C, D, H	C, D, H
Other sources (please specify)			

Notes for Table 4-7:
(1) Factors used in selecting a contaminant source. They are indicated in the table in the order of importance.

A - Human health and/or environmental risk (toxicity)
B - Size of the population at risk
C - Location of the sources relative to drinking water sources
D - Number and/or size of contaminant sources
E - Hydrogeologic sensitivity
F - State findings, other findings
G - Documented from mandatory reporting
H - Geographic distribution/occurrence

(2) Contaminants/classes of contaminants considered to be associated with each of the sources checked:

A - Inorganic pesticides	G - Salinity/brine
B - Organic pesticides	H - Metals
C - Halogenated solvents	I - Radionuclides
D - Petroleum compounds	J - Bacteria
E - Nitrate	K - Protozoa
F - Fluoride	L - Viruses

Leaking Underground Storage Tanks

As of September 2005, a total of 3,043 actively used underground storage tanks (USTs) were registered with the DEM. This is a decrease of 12% from the number reported in 2000. The main products stored in the tanks are gasoline (42%), #2 heating oil (39%), and diesel fuel (12%) (Figure 4-7). The USTs are located at 1630 facilities throughout the state. Commercial/industrial sites and gasoline retailers account for 34% (553 facilities) and 25% (413 facilities) respectively of the total. Approximately 15% (238) of the facilities are government owned. Education facilities make up 12% (188), private residences 7% (107), while the remaining 8% are such facilities as churches, farms, multiple residences, and hospitals.

These UST registration numbers do not include the thousands of home heating oil tanks that are less than 1,100 gallons in volume and therefore not directly regulated by DEM. As would be expected, most tanks are found in the more heavily developed urban and suburban areas of the state.

Leaking USTs (LUSTs), primarily from motor fuel facilities, have caused serious groundwater pollution problems in Rhode Island. As of January 30, 2006, 1684 LUST sites have been identified since 1985. 501 new sites were identified from September 1999 to January 2006. While 37% of these sites were addressed by soil removal alone, the remainder required further field investigation and these have been classified as either active or inactive based on the status of the remediation efforts. Active sites account for 20% and inactive sites 43% of the total sites. There has been a significant increase in the number of site closures as evidenced by the September 1999 data (from the 2000 305b report). The number of inactive sites increased by 420 over the period 1999 to 2006 and the number of active sites decreased by 203 (Table 4-8)

1260 of the 1684 LUST sites have been mapped. Of these 1260 sites, 54 are in community

WHPAs and 100 are in non-community (transient and non-transient) WHPAs (see Table 4-9). Over the past 6 years, only 3 new LUST sites have been identified in community WHPAs and 5 and in non-community WHPAs. Table 4-10 provides the numbers of LUST sites by groundwater assessment area, and Table 4-11 shows the number of LUST sites by community.

Table 4- 8. LUST Site Status from Previous 305b Reports

LUST Status	1992	1994	1996	2000	2006
Active	155 (51%)	255 (50%)	384 (44%)	543 (46%)	340 (20%)
Inactive	148 (49%)	83 (16%)	204 (24%)	248 (21%)	720 (43%)
Soil Removal Only	Not determined	173 (34%)	275 (32%)	392 (33%)	624 (37%)
Total	303	511	863	1183	1684

Figure 4-7.

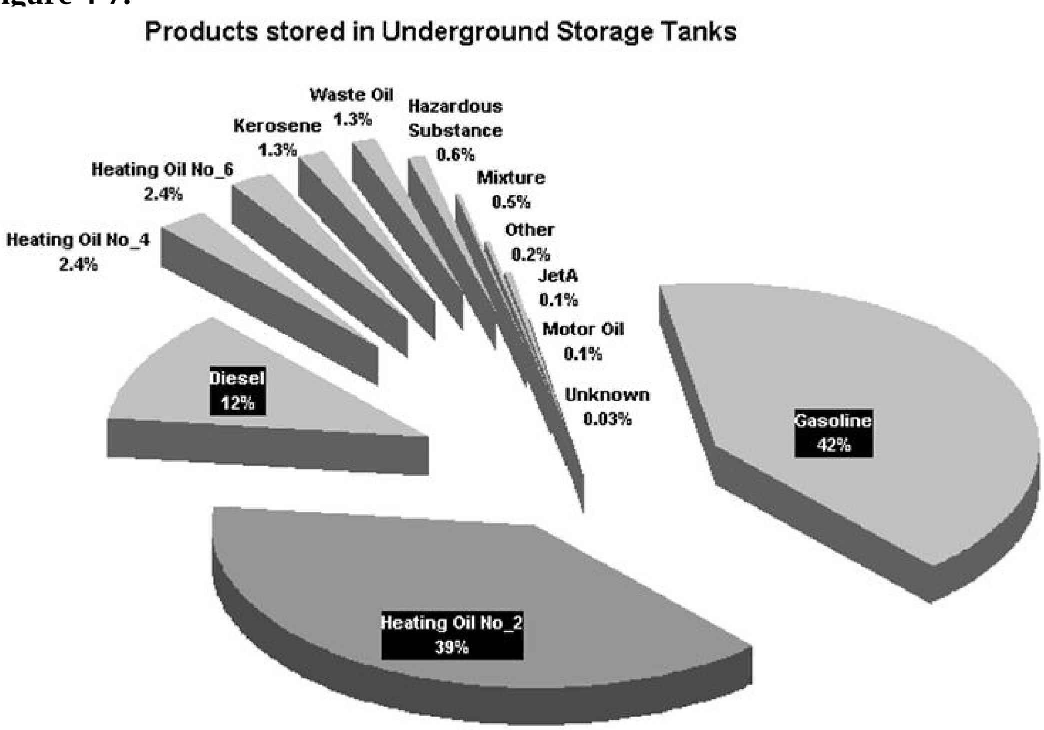


Table 4-9. LUSTs in Wellhead Protection Areas
(Note: Data based on most recently available GIS coverage.)

LUST Status	Number of LUST Sites in Community WHPAs		Number of LUST Sites in Non-Community WHPAs	
	2000	**2006**	**2000**	**2006**
Active	25	14	59	34
Inactive	13	24	17	41
Soil Removal Only	13	16	19	25
Total	51	54	95	100

Table 4-10. LUSTs in Groundwater Assessment Areas
(Note: Data based on most recently available GIS coverage. Totals do not match the totals in Table 4-8.)

Groundwater Assessment Areas	Active	Inactive	SRO*	Total
Annaquatucket-Pettaquamscutt	0	2	2	4
Blackstone	21	40	59	120
Branch	12	22	5	39
Hunt	5	9	4	18
Lower Pawtucket	8	19	8	35
Moosup	5	2	1	8
Narragansett Bay	79	242	212	533
Pawtuxet	39	100	92	231
South Coast	12	31	27	70
Upper Pawcatuck	6	5	8	19
Wood	5	5	4	14
Woonasquatucket-Moshassuck	20	88	61	169
Total	**212**	**565**	**483**	**1260**

* SRO means soil removal only.

Table 4-11. Leaking Underground Storage Tank Sites by Municipality (January 30, 2006)

Community*	Active	Inactive	SRO**	Total
Barrington	4	8	4	16
Bristol	5	15	16	36
Burrillville	6	18	4	27
Central Falls	3	8	10	21
Charlestown	2	7	3	12
Coventry	6	21	10	37
Cranston	22	33	44	89
Cumberland	11	22	23	56
E.Greenwich	3	10	6	19
E.Providence	12	45	41	98
Exeter	3	2	4	9
Foster	4	3	2	9
Glocester	4	5	1	10
Hopkinton	2	6	6	14
Jamestown	2	5	3	10
Johnston	11	17	19	47
Lincoln	6	16	10	32
Little Compton	3	6	1	10
Middletown	11	24	32	67
Narragansett	7	9	8	74
New Shoreham	4	3	1	8
Newport	13	35	31	79
N. Kingstown	10	24	17	51
N. Providence	2	23	7	32
N. Smithfield	8	13	4	25
Pawtucket	18	42	38	98
Portsmouth	2	13	15	30
Providence	52	93	94	239
Richmond	6	3	2	11
Scituate	5	11	4	20
Smithfield	8	17	8	33
S. Kingstown	11	30	23	64
Tiverton	6	10	7	23
Warren	12	11	19	41
Warwick	24	48	46	119
W. Greenwich	0	5	4	9
W. Warwick	11	22	19	52
Westerly	8	22	8	38
Woonsocket	13	15	30	58
Total	340	720	624	1684

*Communities in bold are entirely dependent on groundwater for their drinking water supply.
**SRO means soil removal only.

Waste/Remediation Sites

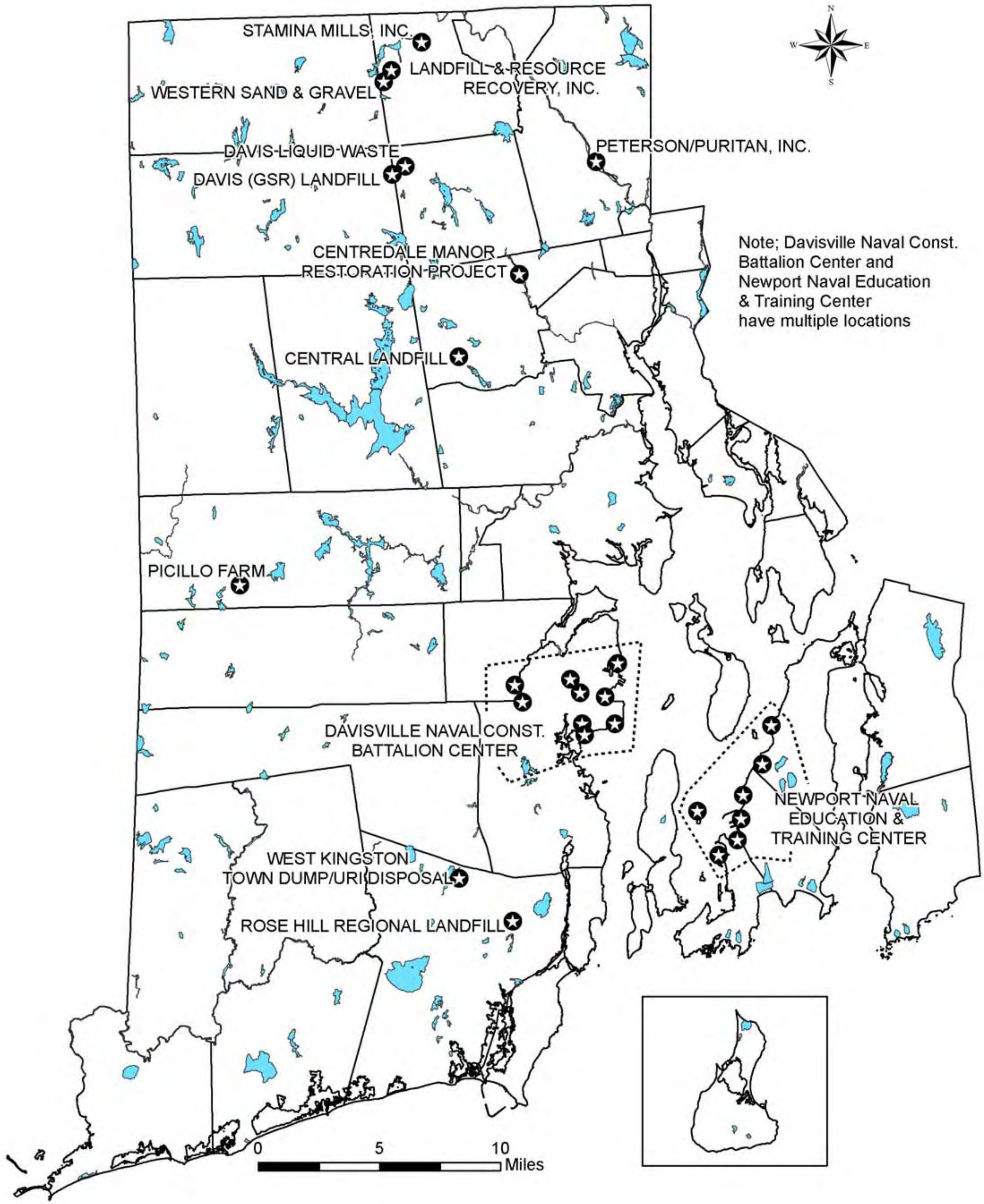
This category includes a variety of different sources of known and potential groundwater contamination resulting from waste disposal (legal, illegal and accidental). The list includes waste disposal facilities, such as inactive landfills, transfer stations, compost facilities, and it also includes remediation sites where there has been a release from a spill, leak, or illegal disposal. Although the threat of groundwater contamination exists or existed at all the facilities tabulated, it is not possible for this report to identify those sites that have had groundwater contamination. Some sites are licensed facilities where the threat of contamination exists due to the nature of the materials at the facilities. Many remediation sites may have been spills where groundwater was not impacted and the site efforts involved soil remediation only. Thirteen sites are included on the Superfund National Priorities List (NPL sites) (see Figure 4-8). All of these Superfund sites are known to have contaminated groundwater, primarily with volatile organic compounds. Table 4-12 provides a breakdown of the location of the waste/remediation sites.

Table 4-12. Waste/Remediation Sites in Groundwater Assessment Areas

Groundwater Assessment Area	Total Number of Waste/Remediation Sites	NPL Sites
Annaquatucket-Pettaquamscutt	10	0
Blackstone	157	1
Branch	65	3
Hunt	37	0
Lower Pawcatuck	25	0
Moosup	7	1
Narragansett Bay	663	2
Pawtuxet	289	1
South Coast	46	1
Upper Pawcatuck	24	1
Wood	34	0
Woonasquatucket-Moshassuck	255	3
Total	**288**	**13**

Figure 4-8

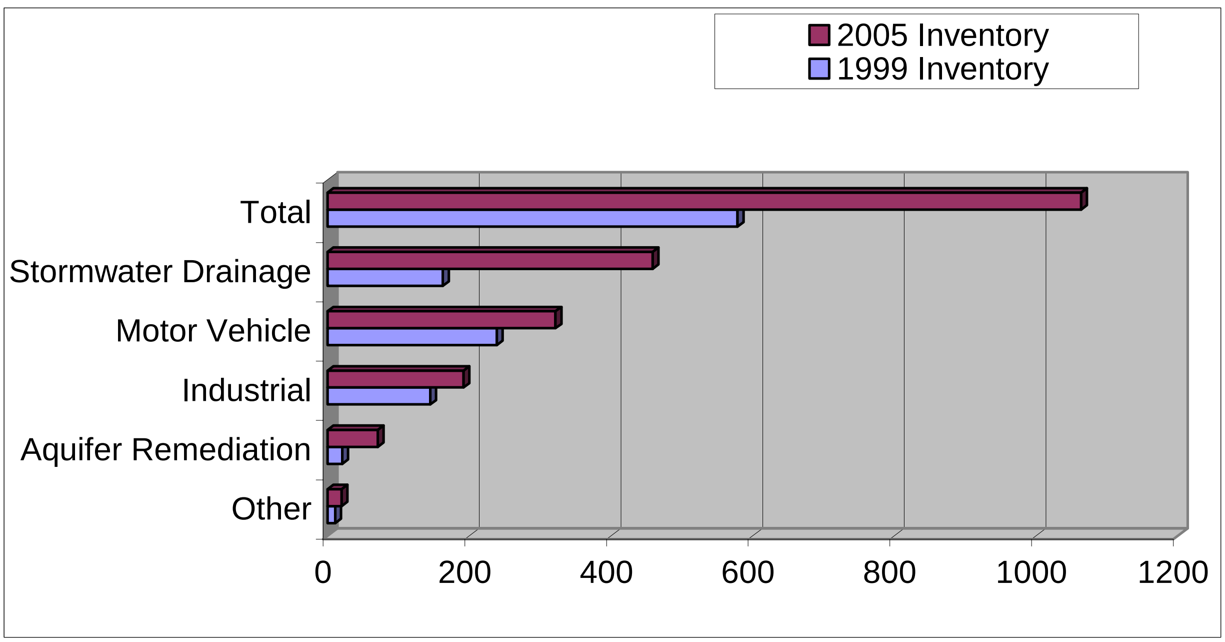
National Priorities List in Rhode Island



Subsurface Discharges
Underground Injection Control Sites

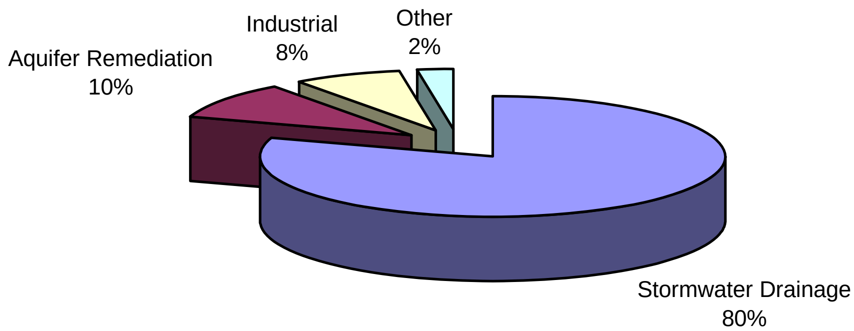
The Rhode Island Underground Injection Control (UIC) Program Rules and Regulations require that any facility seeking to dispose of wastewater and other fluids (including some gases) through underground injection wells or similar subsurface leaching systems must first obtain approval from the Department's UIC Program. Rhode Island is one of more than 30 states that locally-administer the UIC Program, which was established under the federal Safe Drinking Water Act to ensure the protection of existing and potential underground sources of drinking water. The majority of UIC wells operating in Rhode Island are technically not true "injection" wells, but are typically low-tech gravity-fed systems such as drywells, leachfields, galleys, etc., which dispose of non-hazardous wastes from multiple sources. As of December 2005, over 2200 facilities with active, formerly active, or suspected underground discharges have been investigated by the state UIC Program. More than 1000 facilities are currently regulated through one or more of the program's permitting, monitoring, closure or enforcement activities. Figure 4-9 shows the relative changes within the UIC facility inventory by well/waste type since the last 305(b) reporting of this information.

Figure 4-9. Change in the Number of Regulated UIC Facilities in RI 1999- 2005



The Department has issued approvals for UIC wells at 538 facilities statewide for the discharge or injection of fluids such as industrial wastewater from manufacturing facilities, treated groundwater from properties undergoing remedial activities, and stormwater runoff from roadways and facility parking areas (see Figure 4-10). All facilities identified as having a potentially high-risk discharge are also required by approval to monitor the discharge and/or site groundwater on a fixed schedule to ensure compliance with established groundwater quality standards.

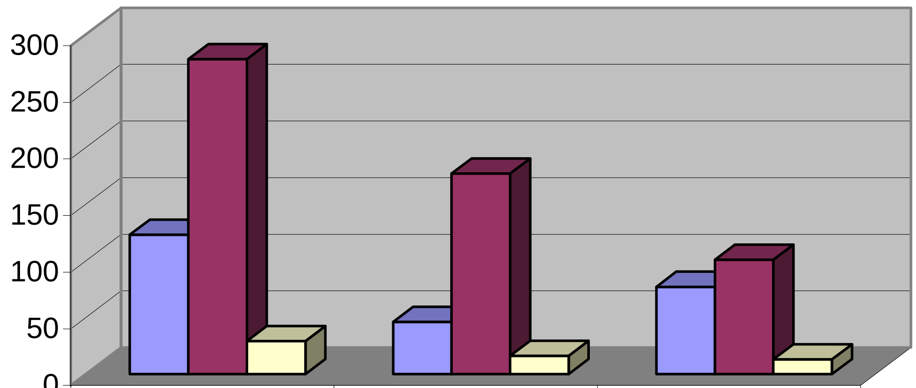
Figure 4-10. Percentage of UIC Discharges Approved in RI by Well Type



Although the review and permitting of non-industrial stormwater drainage to UIC wells has in the past few years required more dedication of staff resources (see Figure 4-9), the RI UIC Program continues to actively pursue and investigate all unauthorized discharges referred to the program, particularly those related to high-risk activities. As part of a larger federal effort to ban the most high-risk UIC discharges nationwide, primarily those associated with motor vehicle maintenance activities, the RI UIC Program has actively investigated hundreds of facilities in an effort to identify maintenance bay floor drain systems that discharge to unauthorized UIC wells. The federal ban on these UIC wells and the active investigations within the state aimed at facilities where motor vehicle maintenance activities have occurred has resulted in the closure of existing UIC wells and removal of associated contaminated soil at more than 450 facilities. The major contaminants of concern identified through these UIC well closure activities have included petroleum products, inorganic compounds, and chlorinated solvents and their breakdown products. Where UIC wells have impacted groundwater resources and additional remedial activities may be warranted, the facilities are typically referred to the Department's Office of Waste Management, Site Remediation Program for any necessary action.

Though not mandated, these statewide investigations and subsequent closures of high-risk UIC wells were initiated in the most sensitive groundwater resource areas (including all wellhead protection and groundwater-based source water protection areas) and account for more than 55 percent of all closures completed within the state. Figure 4-11 provides a breakdown of types of UIC well closures performed to date and their location relative to the state's sensitive groundwater resources. While the Department has not actively investigated the occurrence of UIC wells in the less sensitive GB groundwater areas, nearly as many unauthorized discharges in these areas are typically identified to the RI UIC Program through referrals. Although the GB groundwater areas account for only 10 percent of the state's geographic area, they include the more developed urban areas that, as population centers with access to public water and sewers utilities, are most amenable to development and the associated support services that are necessary to this population. While it is expected that most of the existing UIC wells in use at motor vehicle related facilities have been identified, investigated and regulated in the most sensitive groundwater areas, the discovery of many more is expected in the state's GB areas as this population becomes better educated to the UIC Program requirements.

Figure 4-11. UIC Wells Closed in RI by Well Type and Groundwater Classification



	Total	WHPA/GAA/GA	GB
Industrial	123	46	77
Motor Vehicle	278	177	101
Other	29	16	13

In an effort to continue the regulatory compliance for those unauthorized UIC wells considered to be high-risk to existing and potential drinking water supplies, future investigations of industrial process-related disposal wells are anticipated in the state’s most sensitive groundwater areas, as staff resources allow.

Septic Systems

Septic systems are a widespread potential source of groundwater pollution. DEM has standards for the design, construction and installation of septic systems and has a well established program for permitting all new construction, repairs and alterations of septic systems. Each septic system creates its own small area of degraded groundwater quality that in most cases poses no problems for on-site drinking water wells and nearby surface waters. However, there are instances of well contamination and impacted surface waters suspected to be caused by septic systems, many of which are likely to be substandard systems. The primary pollution concerns are nitrates, bacteria and viruses from human waste and toxic chemicals from the improper disposal of hazardous chemicals. DEM estimates that there are 157,000 septic systems in Rhode Island.

Road Salt Storage and Application

Wherever road salt (sodium chloride) has been stored improperly for extended periods of time, groundwater is likely to be adversely impacted. The degree of degradation is dependent on the management practices employed at the site. Mitigating measures to prevent groundwater contamination from road salt storage sites include covering the salt piles, placing them on impermeable surfaces and containing the salt-laden runoff from the site.

A DEM survey conducted during the winter of 2005-2006 identified 19 active state owned salt storage sites in Rhode Island. Eighteen of these sites are in areas where the groundwater is classified GAA or GA. The remaining site is located where the groundwater is classified GB. Recognizing the potential threat that the salt piles pose to the state's water resources, the Rhode Island Department of Transportation has constructed salt storage structures for 11 of the sites.

Twenty-nine active municipal salt storage sites were identified in the recent survey. Twenty-five of these sites are in areas where the groundwater is classified GAA or GA, and 4 are in areas where the groundwater is classified GB. Seventeen of these municipal salt storage piles are under permanent cover.

There are additional salt storage piles located throughout the state under the control of private individuals and companies. No attempt has been made to inventory these salt piles, and there have been no reported incidents of groundwater contamination due to these private sector salt piles.

DEM passed amendments to the “Rules and Regulations for Groundwater Quality” in 2005 to address the issue of water resources contamination from salt storage. At locations where road salt was stored over groundwater classified GAA or GA prior to the regulations, any future storage must be covered with at minimum a tarp. Salt storage at new locations where the groundwater is classified GAA or GA must be within a weatherproof structure (unless the volume stored is less than 100 cubic yards in which case a tarp is acceptable), on an impermeable base and runoff must be controlled by best management practices.

Application of road salt on both state and local roads has also caused groundwater contamination, leading to replacement of private wells. Many public wells are located in close proximity to major roads and a number of these wells have levels of sodium approaching or exceeding 20 mg/l. Road salt is also suspected as the source of the destruction of nursery stock being irrigated from a well with a high salt content.

Pesticides and Fertilizers

Information on pesticide use collected by the DEM Division of Agriculture is derived from certified applicator reporting on use of restricted use pesticides. All other pesticides (“general use pesticides”) do not have to be reported. As described in the “State of Rhode Island Pesticide, Fertilizer, and Water Resources Assessment” (1998)(referred to as the “Assessment”), the result is an incomplete picture of pesticide use in the state. The “Assessment” revealed that 223 pesticides were reported applied in the State from 1989 – 1996. Pesticides are divided into four categories (listed in order of frequency applied): insecticides, herbicides, fungicides, and others.

Of the three primary nutrients in plant fertilizers - nitrogen, phosphorous and potassium - nitrogen is the only one considered a threat to groundwater quality. Nitrogen, as nitrate, is soluble and moves freely with the groundwater. In response to elevated concentrations of nitrate detected in US Geological Survey monitoring wells near turf fields in southern RI, DEM Division of Agriculture began a program to regularly sample these wells. These turf fields are located over a deep stratified drift aquifer with significant coarse sediments. Eighteen monitoring wells and 5 farm home wells were sampled at first monthly, then every other month from 1999 through 2005.

A total of 925 groundwater samples were collected. Of these samples 298 (32%) exceeded 10 mg/l, 279 (30%)had concentrations between 5 and 10 mg/l and 348 (38%) had concentrations less than 5 mg/l. Table 4-13 shows the annual average nitrate concentration for each well. Disregarding the 5 monitoring wells that were sampled in 1999 only, 5 wells have a 7 year average between 5 and 10 mg/l and 5 wells have a 7 year average greater than 10 mg/l. The wells are located in different settings relative to groundwater flow, proximity to turf fields and depths. Several conclusions can be drawn from the data:

- -Concentrations in the wells have over time have shown a slight upward trend.
- -The data exhibits a pattern through the year with higher concentrations generally in the late Spring and Fall (see Figure 4-12 showing the monthly averages over the sampling period).
- -Nitrogen contamination is not limited to the shallow groundwater. Significant concentrations appear at depth as evidenced by the well cluster RIW782-784 (782 is screened at 21 feet, 784 at 43 feet and 783 at 89 feet), which has nitrate concentrations going from shallow well to deeper well as follows: 11.94, 14.83, 11.49. This well cluster is located immediately downgradient of a large acreage of turf.

DEM Division of Agriculture has met regularly with the farmers in the affected area to discuss the results and the need for alternative farming practices to limit the loss of nitrogen. Several farmers have responded by using organic fertilizers. DEM is continuing this groundwater sampling program.

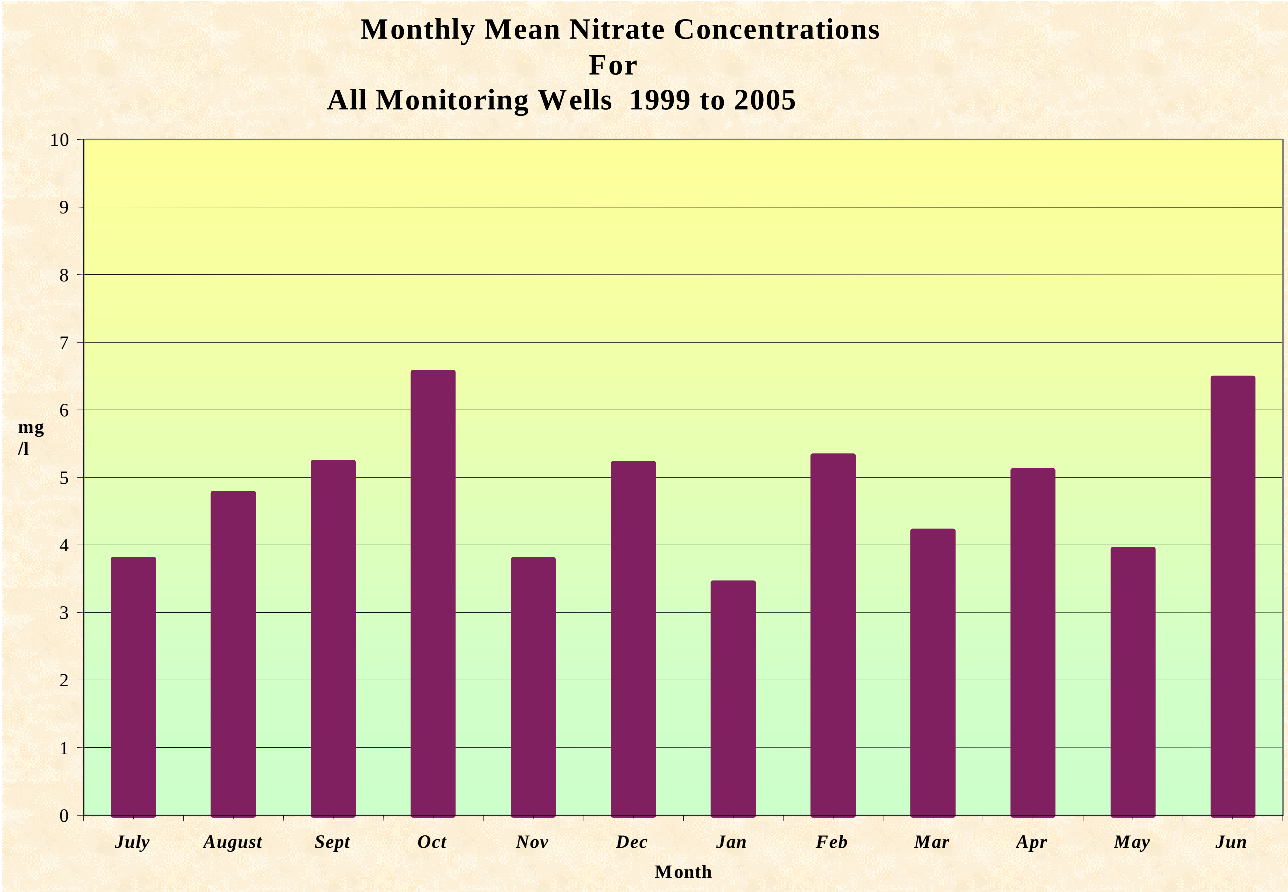
In 2004, DEM identified homeowners near the turf fields that were potentially at risk of nitrate contamination in their private wells and inquired if they wanted DEM to test their well. Twenty-two homeowner wells were tested. Five wells had a nitrate concentration between 5 and 10 mg/l and 2 wells had a concentration exceeding 10 mg/l, with the highest concentration being 15.3 mg/l.

Because of Rhode Island’s relatively small percentage of land area in agriculture, agricultural use of fertilizers and pesticides is less of a statewide threat than residential use. Homeowner use is reported by the Division of Agriculture as accounting for approximately 80% of the total fertilizer tonnage used in the state. Homeowner use of pesticides does not require reporting. As a result, homeowners represent the largest unregulated group of pesticide applicators in the state. In 1988, the DEM Division of Agriculture conducted a survey of household pesticide users. As discussed in "Rhode Island's Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer" (1996), 49% of the 300 households surveyed reported applying pesticides to their property. Of these applications, 37% were of the type most likely to affect groundwater (20% lawn care, 9% ornamentals, 7% vegetables, and 1% termites). Homeowners must recognize their responsibility in preventing groundwater quality degradation from nitrate fertilization and pesticide application.

Table 4-13. Average Nitrate Concentrations

	Average Nitrate Concentrations (mg/l)							
Well Number	**1999**	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**7 Year Average**
RIH001	1.33	2.18	5.14	4.4	4.24	5.11	5.38	3.97
RIH002	5.98	8.65	6.8	5.2	17.95	8.67	8.04	8.76
RIH003	5.35	5.83	7.6	7.03	8.26	6.05	5.75	6.55
RIH004	7.78	6.48	5.58	4.53	3.12	3.7	3.28	4.92
RIH005			2.78	2.1	2.41	3.18	2.85	2.66
RIW681	11.13							11.13
RIW682	8.5							8.50
RIW685	8.24							8.24
RIW686	15.82							15.82
RIW687	13.15							13.15
RIW780	6.72	8.15	7.06	9.85	5.32	6.51	10.02	7.66
RIW781	5.18	6.83	10.55	6.6	6.49	11.79	10.22	8.24
RIW782	11.71	11.4	11.89	12.45	11.66	12.12	12.38	11.94
RIW783	12.88	12.54	11.89	11.95	10.58	10.53	10.04	11.49
RIW784	9.44	10.48	12.56	17.27	22.2	18.4	13.49	14.83
RIW785	4.49	9.88	5.48					6.62
SNW1193	0.07	0.88	0.059	0.12	0.05	0.07	0.05	0.19
SNW1194	3.18	11.91	14.57	11.96	10.2	10.82	15.83	11.21
SNW1195	5	4.59	3.03	4.68	4.65	5.93	6.7	4.94
SNW1196	2	2.19	2.27	1.77	3.41	3.51	3.09	2.61
SNW1199	8.48	7.17	12.36	12.1	11.64	8.83	12.56	10.45
SNW1202	0.39	0.15	0.07	0.06	0.07	0.06	0.06	0.12
SNW1203	6.38	4.8	4.95	4.85	4.44	4.5	4.82	4.96

Figure 4-12.



G. GROUNDWATER PROTECTION PROGRAM

The Rhode Island Groundwater Protection Act of 1985 (Title 46 Chapter 13.1) set forth for the first time a vigorous policy for protecting the groundwater resources of the State. The Act established that it is state policy "to restore and maintain the quality of groundwater to a quality consistent with its use for drinking supplies and designated beneficial uses" and to restore all groundwater of the state to the extent practicable to a quality consistent with this policy (46-13.1-2(4)). In addition, the Act prohibits the introduction of "pollutants into the groundwater of the state in concentrations which are known to be toxic, carcinogenic, mutagenic, or teratogenic", and mandates "to the maximum extent practical, efforts shall be made to require the removal of such pollutants from discharges where such discharges are shown to have already occurred" (46-13.1-2(5)).

The state of Rhode Island administers a number of different programs with groundwater protection as either the sole objective or one of several objectives. These programs work cooperatively with the federal programs. A list of the state regulations that have groundwater protection provisions is provided in Table 4-14. The remainder of this section will describe three state programs that establish a framework for groundwater protection in Rhode Island.

Table 4-14. Rhode Island Regulations with Groundwater Protection Provisions

Rules and Regulations for Groundwater Quality (DEM)
Regulations for Underground Storage Facilities Used for Petroleum Products and Hazardous Materials (DEM)
Underground Injection Control Program Rules and Regulations (DEM)
Rules and Regulations Establishing Minimum Standards Relating to Location, Design, Construction and Maintenance of Individual Sewage Disposal Systems (DEM)
Oil Pollution Control Regulations (DEM)
Rules and Regulations for Solid Waste Management Facilities (DEM)
Rules and Regulations for Hazardous Waste Generation, Transportation, Storage, and Disposal (DEM)
Rules and Regulations Pertaining to the Disposal, Utilization, and Transportation of Wastewater Treatment Facility Sludge (DEM)
Rules and Regulations for the Investigation and Remediation of Hazardous Materials Releases (DEM)
Rules and Regulations Relating to Pesticides (DEM)
Rules and Regulations for Dredging and the Management of Dredged Material (DEM)
Regulations that Address Groundwater as a Source of Drinking Water Supply:
Rules and Regulations Governing the Enforcement of Chapter 46-13.2 Relating to the Drilling of Drinking Water Wells (DEM) (Note: regulations address private well installation)
Rules and Regulations Pertaining to Public Drinking Water (Department of Health)
Rules and Procedures for Water Supply System Management Planning (RI Water Resources Board)

Groundwater Classification and Standards

The Groundwater Protection Act mandated the development and implementation of a statewide groundwater classification system. The DEM "Rules and Regulations for Groundwater Quality," promulgated in 1992, classified the state's groundwater resources into four classes and established groundwater quality standards for each class. The classification system provides a means for setting priorities in the State's regulatory and enforcement programs. Classification determines the degree of protection and the clean-up goals. The four classes are designated GAA, GA, GB, and GC. See Figure 4-13 for a map of the groundwater classification delineations in Rhode Island.

Groundwater classified GAA and GA is known or presumed to be suitable for drinking water use, and is to be protected to maintain drinking water quality. Groundwater classified GAA, the highest protection class, includes the state's major stratified drift aquifers, wellhead protection areas for community water supply wells, and Block Island. GAA classified groundwater underlies approximately 20% of the state. Groundwater classified GA is also known or presumed to be suitable for drinking water use, but it is not within one of the priority areas designated GAA. GA classified groundwater underlies approximately 70% of the state.

Groundwater classified GB and GC is known or presumed to be unsuitable for drinking water use without treatment. The areas where groundwater is classified GB (9% of the state) are primarily the major urban centers of the state. Public water is available where groundwater is classified GB. Although there is no goal to restore groundwater classified GB to drinking water quality, groundwater remediation is often required to protect public health and the environment. Groundwater classified GC is limited to the current DEM permitted waste disposal area at the two remaining active solid waste landfills (RI Resource Recovery Central Landfill and the Tiverton Landfill).

Wellhead Protection/Source Water Assessment Programs

Over the past 20 years, the federal Safe Drinking Water Act established first the Wellhead Protection Program (administered by DEM) and then the Source Water Assessment Program (administered by the Department of Health) to protect the quality of water supplied by public water systems. These programs, along with other protection planning efforts in RI have coordinated closely over the years resulting in the approach described below.

DEM is responsible for designating the Wellhead Protection Areas (WHPAs) and incorporating these areas into the various regulatory programs. As an example: source control regulations are more stringent in WHPAs, facilities are often prohibited in WHPAs, and WHPAs are used to set enforcement priorities.

The Department of Health, Office of Drinking Water Quality's Source Water Assessment Program has produced source assessments for all public water supply sources within the state's boundaries, and for several located in neighboring states. All were released to the public in 2003. Assessment results showed that while RI's drinking water is of high quality now, most water supplies are at risk from commercial and residential development pressures. Since the assessments were released, the program has focused on providing local governments, suppliers and residents with the technical information and administrative tools necessary to use local authorities and initiatives to protect groundwater quality in WHPAs.

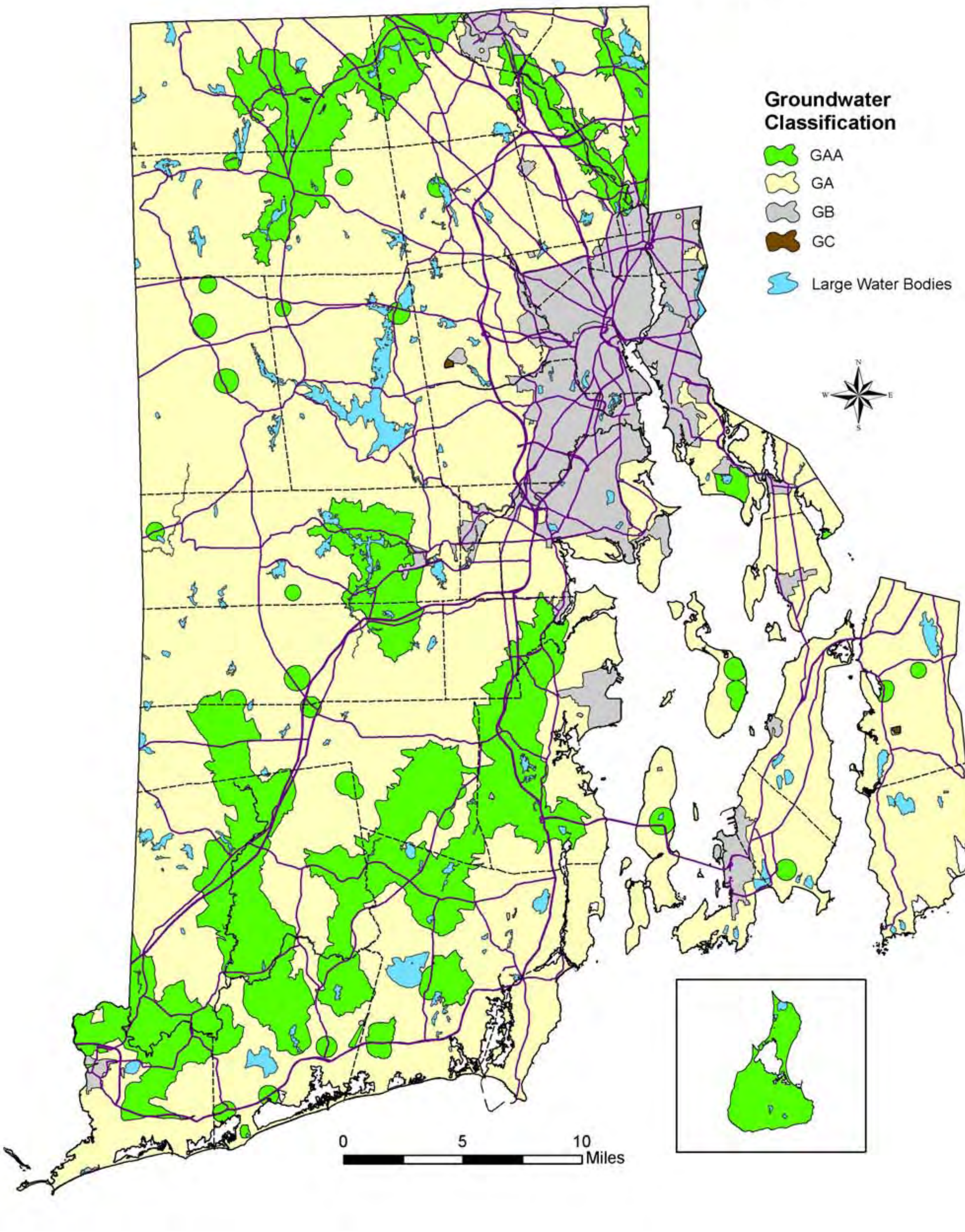
At the supplier and local government level, plans are required by state laws and regulations to address groundwater protection. Large water suppliers in RI (those that provide more than 50 million gallons of water per year) are required by the RI Water Resources Board to prepare Water Supply System Management Plans that include a section on efforts by the supplier to protect their water source. DEM and the Department of Health review these plans. Municipalities are required to prepare local comprehensive plans that are consistent with DEM's goals and policies. The DEM goals and policies for groundwater protection require that communities include in their comprehensive plan a pollution threat assessment, strategies for groundwater protection and a procedure for implementing these strategies.

Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer

The DEM Division of Agriculture has developed "Rhode Island's Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer" (1996). This is a statewide strategy to prevent the contamination of groundwater by pesticides and nitrogenous fertilizers originating from agriculture, landscape, and ornamental uses. The Plan outlines an approach to site specific monitoring and the actions that will be taken in response to contamination. A "State of Rhode Island Pesticide, Fertilizer and Water Resource Assessment" was completed in 1998 to provide baseline information upon which individual Pesticide State Management Plans can be developed.

Figure 4-13

Groundwater Classification



REFERENCES

Friesz, P.J. 2004. Delineation of Areas Contributing Recharge to Selected Public-Supply Wells in Glacial Valley-Fill and Wetland Settings, Rhode Island. U.S. Geological Survey Scientific Investigations Report 2004-5070.

Hutson, S.E., N.L. Barber, J.F. Kenny, K.S. Linsey, D.S. Lumia and M.A. Maupin. 2004. Estimated Use of Water in the United States in 2000. US Geological Survey Circular 1268.

Johnston, H.E. 1985. Rhode Island Groundwater Resources. In National Water Summary 1984: Hydrologic Events, Selected Water-Quality Trends, and Groundwater Resources. U.S. Geological Survey Water Supply Paper 2275.

Johnston, H.E. and P.M. Barlow. 1988. Rhode Island Groundwater Quality. In National Water Summary 1986: Hydrologic Events and Groundwater Quality. U.S. Geological Survey Water Supply Paper 2325.

Rhode Island Department of Environmental Management. 1990. Private Well Survey.

-------. 1991. Policies and Procedures for Mapping Recharge Areas to Groundwater Reservoirs for GAA Classification.

-------. 1996. Rhode Island's Management Plan for the Protection of Groundwater from Pesticides and Nitrogenous Fertilizer.

-------. 1998. State of Rhode Island Pesticide, Fertilizer, and Water Resource Assessment.

Rhode Island Department of Health. 1989. Policy and Explanation of Regulatory Approach Regarding Contamination of Drinking Water By Sodium, November 28, 1989.

-------. 1999. Source Water Assessment Plan.

Ruderman, N.C. 1996. Hydrogeologic Controls on the Distribution of Radon in Glacial Aquifers of Southern Rhode Island. Unpublished M.S. Thesis, University of Rhode Island.

Solley, W.B., R.R. Pierce, and H.A. Perlman. 1998. Estimated Use of Water in the United States in 1995. U.S. Geological Survey Circular 1200.

United States Department of Commerce. 1993. 1990 Census of Housing, Detailed Housing Characteristics, Rhode Island, CH-2-41.

APPENDIX

PUBLIC WELL MONITORING SUMMARY FOR GROUNDWATER ASSESSMENT AREAS

July 1, 1999 – June 30, 2004

Groundwater Assessment Area: Annaquatucket - Pettaquamscutt

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	9	9	0	0
07/01/00-06/30/01	10	8	2	0
07/01/01-06/30/02	11	11	0	0
07/01/02-06/30/03	11	11	0	0
07/01/03-06/30/04	7	7	0	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	12	10	2	0
07/01/00-06/30/01	2	2	0	0
07/01/01-06/30/02	11	9	2	0
07/01/02-06/30/03	12	9	3	0
07/01/03-06/30/04	4	3	1	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	8	7	7	6	6
0.21 - 3.0	7	7	6	5	4
3.1 – 4.9	0	1	0	0	2
5.0 – 10.0	0	0	0	0	0
≥ 10.0	0	0	0	0	0
Total	15	15	13	11	12

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	0	0	0	0	0
10.1 – 20.0	5	5	5	5	5
20.1 – 100	5	5	4	4	5
≥ 100.0	0	0	0	0	0
Total	10	10	9	9	10

Groundwater Assessment Area: Blackstone

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	12	10	2	0
07/01/00-06/30/01	14	13	1	0
07/01/01-06/30/02	14	14	0	0
07/01/02-06/30/03	14	13	1	0
07/01/03-06/30/04	16	14	2	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	14	13	1	0
07/01/00-06/30/01	10	7	3	0
07/01/01-06/30/02	15	13	2	0
07/01/02-06/30/03	14	13	1	0
07/01/03-06/30/04	14	11	3	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	8	6	4	6	8
0.21 - 3.0	22	18	24	18	15
3.1 – 4.9	2	5	2	5	7
5.0 – 10.0	0	0	0	1	1
≥ 10.0	0	0	0	0	0
Total	32	29	31	30	31

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	1	4	2	1	1
10.1 – 20.0	9	11	10	10	8
20.1 – 100	5	2	5	6	9
≥ 100.0	0	0	0	0	0
Total	15	17	17	17	18

Groundwater Assessment Area: Branch

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	38	27	10	1
07/01/00-06/30/01	37	28	8	1
07/01/01-06/30/02	49	33	14	2
07/01/02-06/30/03	37	29	8	0
07/01/03-06/30/04	50	35	15	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	16	15	1	0
07/01/00-06/30/01	22	20	2	0
07/01/01-06/30/02	2	2	0	0
07/01/02-06/30/03	17	16	1	0
07/01/03-06/30/04	19	19	0	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	45	29	30	31	33
0.21 - 3.0	42	51	50	50	44
3.1 – 4.9	2	2	2	3	6
5.0 – 10.0	3	2	2	0	0
≥ 10.0	0	0	0	0	0
Total	92	84	84	84	83

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	14	11	12	15	13
10.1 – 20.0	7	8	7	3	6
20.1 – 100	5	7	8	8	8
≥ 100.0	0	0	1	1	0
Total	26	26	28	27	27

Groundwater Assessment Area: Hunt

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	21	16	5	0
07/01/00-06/30/01	15	12	3	0
07/01/01-06/30/02	18	16	2	0
07/01/02-06/30/03	18	16	2	0
07/01/03-06/30/04	14	12	2	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	13	13	0	0
07/01/00-06/30/01	1	1	0	0
07/01/01-06/30/02	13	13	0	0
07/01/02-06/30/03	13	13	0	0
07/01/03-06/30/04	5	5	0	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	7	5	0	0	1
0.21 - 3.0	14	14	9	9	4
3.1 – 4.9	0	3	1	0	4
5.0 – 10.0	1	0	0	0	0
≥ 10.0	0	0	0	0	
Total	22	22	10	9	9

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	0	0	0	0	0
10.1 – 20.0	1	0	0	0	1
20.1 – 100	6	4	7	7	9
≥ 100.0	0	0	0	0	0
Total	7	4	7	7	10

Groundwater Assessment Area: Lower Pawcatuck

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	21	16	5	0
07/01/00-06/30/01	11	9	2	0
07/01/01-06/30/02	7	5	2	0
07/01/02-06/30/03	12	8	4	0
07/01/03-06/30/04	15	10	5	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	3	3	0	0
07/01/00-06/30/01	1	1	0	0
07/01/01-06/30/02	0	0	0	0
07/01/02-06/30/03	2	2	0	0
07/01/03-06/30/04	4	4	0	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	5	6	4	6	6
0.21 - 3.0	27	29	32	27	30
3.1 – 4.9	1	2	2	3	1
5.0 – 10.0	4	2	1	1	1
≥ 10.0	0	0	0	0	0
Total	37	39	39	37	38

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	2	4	1	1	1
10.1 – 20.0	10	8	7	7	8
20.1 – 100	1	1	3	2	3
≥ 100.0	0	0	0	0	0

Total	13	13	11	10	12

Groundwater Assessment Area: Moosup

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	2	2	0	0
07/01/00-06/30/01	3	3	0	0
07/01/01-06/30/02	1	1	0	0
07/01/02-06/30/03	2	2	0	0
07/01/03-06/30/04	4	3	1	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	0	0	0	0
07/01/00-06/30/01	0	0	0	0
07/01/01-06/30/02	0	0	0	0
07/01/02-06/30/03	0	0	0	0
07/01/03-06/30/04	0	0	0	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	21	17	16	17	15
0.21 - 3.0	8	11	15	10	12
3.1 – 4.9	0	0	1	1	1
5.0 – 10.0	1	0	0	0	0
≥ 10.0	0	0	0	0	0
Total	30	28	32	28	28

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	1	1	1	2	1
10.1 – 20.0	0	0	0	0	0
20.1 – 100	0	0	0	0	0
≥ 100.0	0	0	0	0	0
Total	1	1	1	2	1

Groundwater Assessment Area: Narragansett Bay

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	16	10	6	0
07/01/00-06/30/01	10	6	4	0
07/01/01-06/30/02	12	10	2	0
07/01/02-06/30/03	14	11	3	0
07/01/03-06/30/04	15	11	4	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	8	7	1	0
07/01/00-06/30/01	3	2	1	0
07/01/01-06/30/02	6	5	1	0
07/01/02-06/30/03	6	5	1	0
07/01/03-06/30/04	8	7	1	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	12	16	16	15	16
0.21 - 3.0	17	18	22	20	21
3.1 – 4.9	3	6	5	4	5
5.0 – 10.0	5	3	2	3	3
≥ 10.0	2	1	1	0	0
Total	39	44	46	42	45

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	2	2	3	2	2
10.1 – 20.0	4	3	5	3	4
20.1 – 100	6	6	2	6	5
≥ 100.0	1	0	3	0	0
Total	13	11	13	11	11

Groundwater Assessment Area: Pawtuxet

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	23	19	4	0
07/01/00-06/30/01	33	31	2	0
07/01/01-06/30/02	31	26	5	0
07/01/02-06/30/03	22	19	6	0
07/01/03-06/30/04	49	39	10	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	4	4	0	0
07/01/00-06/30/01	15	14	1	0
07/01/01-06/30/02	11	11	0	0
07/01/02-06/30/03	5	5	0	0
07/01/03-06/30/04	15	11	4	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	45	41	39	41	41
0.21 - 3.0	47	48	53	44	47
3.1 – 4.9	6	5	5	6	6
5.0 – 10.0	4	2	4	3	4
≥ 10.0	0	0	0	0	0
Total	102	96	101	94	98

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	7	3	5	6	6
10.1 – 20.0	2	4	2	3	4
20.1 – 100	6	4	7	4	4
≥ 100.0	0	0	0	0	0
Total	15	11	14	13	14

Groundwater Assessment Area: South Coast

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	12	10	0	1
07/01/00-06/30/01	17	12	4	1
07/01/01-06/30/02	16	12	3	1
07/01/02-06/30/03	25	21	3	1
07/01/03-06/30/04	21	18	2	1

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	6	6	0	0
07/01/00-06/30/01	9	8	1	0
07/01/01-06/30/02	6	6	0	0
07/01/02-06/30/03	9	9	0	0
07/01/03-06/30/04	13	12	1	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	12	15	16	16	12
0.21 - 3.0	44	47	45	54	55
3.1 – 4.9	14	11	9	10	10
5.0 – 10.0	3	1	4	1	3
≥ 10.0	1	1	2	1	0
Total	74	75	76	82	80

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	7	6	4	5	4
10.1 – 20.0	5	10	9	10	8
20.1 – 100	4	3	4	3	5
≥ 100.0	0	0	0	0	1
Total	16	19	17	18	18

Groundwater Assessment Area: Upper Pawcatuck

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	17	14	3	0
07/01/00-06/30/01	14	11	3	0
07/01/01-06/30/02	14	10	4	0
07/01/02-06/30/03	28	24	4	0
07/01/03-06/30/04	16	13	3	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	20	16	4	0
07/01/00-06/30/01	5	5	0	0
07/01/01-06/30/02	5	4	1	0
07/01/02-06/30/03	26	16	10	0
07/01/03-06/30/04	18	13	5	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	11	11	9	12	12
0.21 - 3.0	24	26	27	30	26
3.1 – 4.9	3	2	3	2	3
5.0 – 10.0	3	0	0	0	0
≥ 10.0	0	0	0	0	0
Total	41	39	39	44	41

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	12	12	12	13	12
10.1 – 20.0	4	4	4	5	4
20.1 – 100	3	3	2	3	4

≥ 100.0	0	0	1	0	0
Total	19	19	19	21	20

Groundwater Assessment Area: Wood

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	16	13	3	0
07/01/00-06/30/01	24	18	5	1
07/01/01-06/30/02	21	14	7	0
07/01/02-06/30/03	15	13	2	0
07/01/03-06/30/04	27	22	5	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	0	0	0	0
07/01/00-06/30/01	12	11	1	0
07/01/01-06/30/02	2	2	0	0
07/01/02-06/30/03	0	0	0	0
07/01/03-06/30/04	17	13	4	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	26	21	23	26	24
0.21 - 3.0	37	37	37	42	44
3.1 – 4.9	4	1	2	4	5
5.0 – 10.0	1	1	1	2	3
≥ 10.0	2	1	2	0	0
Total	70	61	64	74	76

Sodium					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04

≤ 10.0	3	3	1	4	1
10.1 – 20.0	6	6	7	6	6
20.1 – 100	2	3	4	3	2
≥ 100.0	0	0	0	0	0
Total	11	12	12	13	9

Groundwater Assessment Area: Woonasquatucket - Moshassuck

VOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	4	2	2	0
07/01/00-06/30/01	3	3	0	0
07/01/01-06/30/02	2	2	0	0
07/01/02-06/30/03	2	2	0	0
07/01/03-06/30/04	3	3	0	0

SOC				
	Total Number of Wells Sampled	Wells With No Detection	Wells With Detection Less Than MCL/HA	Wells With Detection Equal or Greater than MCL/HA
07/01/99-06/30/00	1	1	0	0
07/01/00-06/30/01	3	3	0	0
07/01/01-06/30/02	1	1	0	0
07/01/02-06/30/03	1	1	0	0
07/01/03-06/30/04	3	3	0	0

Nitrate					
Concentration (mg/l)	Number of Wells				
	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 0.20	8	7	6	5	6
0.21 - 3.0	13	11	10	13	13
3.1 – 4.9	3	5	5	2	2
5.0 – 10.0	1	0	1	0	0
≥ 10.0	0	0	0	0	0
Total	25	24	22	20	21

Sodium	
Concentration	Number of Wells

(mg/l)	07/01/99-06/30/00	07/01/00-06/30/01	07/01/01-06/30/02	07/01/02-06/30/03	07/01/03-06/30/04
≤ 10.0	1	0	2	1	0
10.1 – 20.0	0	2	0	1	2
20.1 – 100	1	0	0	0	0
≥ 100.0	0	0	0	0	0
Total	2	2	2	2	2