SUMMARY AND CONCLUSIONS

This report describes the physical, cultural, and biological features (termed the environmental settings) of the NAWQA Program's New England Coastal Basins 23,000-mi^2 study area in Maine, Massachusetts, New Hampshire, and Rhode Island. The study area includes the Kennebec, Androscoggin, Saco, Charles, Blackstone, Taunton, and Pawcatuck River Basins, as well as smaller coastal drainage basins. The information in this report will be used to design a monitoring program that will assess how environmental settings influence ground- and surface-water quality.

The study area is divided among two physiographic provinces: the New England Physiographic Province and the Atlantic Coastal Plains. Most of the study area (97 percent) is in the New England Physiographic Province. Only the offshore islands of southern Massachusetts and Rhode Island are part of the Atlantic Coastal Plain Province. The climate is continental because of prevailing westerly winds, although the climate of the coastal areas is influenced by the Atlantic Ocean. Precipitation usually is abundant throughout the year and averages 42 in/yr in some low-lying areas to greater than 60 in/yr on the higher peaks of the White Mountains. Snowfall averages from 20 to 110 in/yr from south to north, respectively. Approximately 1/2 to 2/3 percent of the precipitation that falls becomes runoff in streams. Average temperature for July was 70.3°F and average temperature for January was 23.5°F for the period 1961-90. Winter temperatures have greater variability throughout the study area than summer temperatures based on monthly average temperatures.

There are several hundred different geologic formations in the study area, each distinguished by rock type and age. These rocks consist primarily of high and low-grade metamorphic, igneous, and some sedimentary rocks and include granite, schist, gneiss, quartzite, and calc-silicate. The rocks are complexly deformed. The chemical composition of these units is highly varied. Unconsolidated glacial deposits of till and stratified drift overlie fractured crystalline bedrock in most of the study area. Stratified drift fills most major river valleys and forms almost a complete cover over southeastern Massachusetts (Cape Cod) and the offshore islands of Martha's Vineyard and Nantucket.

Stratified-drift aquifers and fractured-crystalline bedrock aquifers are the most important aquifer systems. Till is the most widely distributed glacial deposit, but is the least important aquifer system. High-yielding, stratified-drift aquifers are an important source of ground water for municipal, commercial, and industrial users. Fractured bedrock aquifers are an important source of ground water for domestic users in rural areas. Stratified-drift deposits cover 21 percent of the study area; coverage ranges from 3.7 percent in the Kennebec River Basin to 53 percent in the Southern coastal Basins. Two types of stratified-drift deposits, ice-contact and outwash, comprise the most productive aquifers in the study area. Hydraulic conductivity of stratified-drift deposits is generally many magnitudes higher than that of till or fractured bedrock.

Soils differ considerably from one another because of the physiography, complex bedrock geology, and the different types of glacial deposits. The type of soils found include spodosols, inceptisols, and histosols. Areas of poorly drained soils, where the soil type is often clayey, are in the coastal zone north of Boston, Mass., and in the northern inland areas of Maine. Moderately-well to well drained soils are present in the upland areas and in areas of stratified-drift deposits (most of the main valleys), as well as areas of high slopes, such as the White Mountains. Very well drained soils are in the sandy outwash plains and end moraines of Cape Cod, Martha's Vineyard, Nantucket, and Block Island.

The USGS currently (1998) operates 90 streamflow-gaging stations in the study area. The largest measured mean annual streamflow is 7,628 ft^3/s on the Kennebec River at Waterville, Maine. Streamflow is highest in April. Fall rains produce a secondary peak in many rivers and streams. The variability in flow from month to month decreases in rivers with a large degree of regulation.

Flows in most of the medium-sized rivers and all of the large rivers are partially to completely regulated. There are more than 1,600 dams that are used for recreation, water supply, hydroelectric power generation, irrigation, flood control, or other purposes (though some are not currently active). Natural lakes and wetlands are abundant in northern New England, providing large amounts of storage for floods and maintaining flows during the drier summer months. The Kennebec River Basin has the greatest amount of lakes, reservoirs, and wetlands compared to the other river basins.

The study area has been delineated into the Northeastern Highlands, Northeastern Coastal Zone, and the Middle Atlantic Coastal Plain ecoregions. Comprising 54 percent of the study area, the Northeastern Highlands are mountainous, contain large tracts of northern hardwood and spruce-fir forests, and have spodosol soils. The Northeastern Coastal Zone has low hills, urban and agriculture lands, inceptisol soils, and covers 42.5 percent of the study area. The Middle Atlantic Coastal Plain, covering only 3.5 percent, has flat plains, woodland and oak/hickory/pine forests with some croplands and pasture.

Most of the major rivers contain cold-water fish communities in headwaters and upstream sections of the main rivers. In downstream sections near the coast, fish communities are generally warm-water types. Habitat modifications, dams and impoundments, the introduction of non-native species, and water pollution have all modified the native fish communities.

In 1990, population was about 7.78 million, an increase of 14 percent from 1970. Population density is low (5 persons per mi^2) in the mountainous areas of northern New Hampshire and Maine and high (more than 13,000 persons per mi^2) in the Boston metropolitan area of eastern Massachusetts.

Land use and land cover is primarily forest land (74 percent), urban land (11 percent), surface-water bodies (8 percent), and agricultural land (6 percent). Land use is predominantly forest cover in the northern sections of Maine and New Hampshire, densely populated urban areas near the metropolitan cities of Boston and Providence, Rhode Island, and small agricultural areas scattered throughout the lowland and coastal areas.

The forest-products industry and recreation are the primary economic activities in the forest lands in northern New Hampshire and northern Maine. The largest public land area is the White Mountain National Forest, which covers 892 mi^2 in the headwater regions of the Merrimack, Androscoggin, and Saco Rivers. Paper and timber companies own most of the commercial forest lands as large tracts in northern New England. Individuals own the commercial forest lands as small tracts in southern New England. Major agricultural activities include growing hay, corn, potatoes, fruits and vegetables, and raising cattle and dairy cows. Cranberry farming in Barnstable County, Mass. produces 40 percent of the Nation's crop. In 1991, nitrogen fertilizer use ranged from near zero lbs/ac in Suffolk County, Mass. to 13.5 lbs/ac in Plymouth County, Mass. In 1991, phosphorus (as phosphate) fertilizer use ranged from near zero lbs/ac in Suffolk County to 6.1 lbs/ac in Newport County, R.I.

About 11 percent of the study area is classified as urban. In the densely populated urban areas, water is generally supplied by public and private utilities, and sanitary-sewer collection systems transport waste water to treatment facilities. In 1990, 190 municipal waste-water-treatment facilities returned an average of 1,055.3 Mgal/d of treated waste water back to rivers, streams, and coastal waters in the study area.

In 1992, about 12.3 million pounds of toxic chemicals were released to the environment in the States of Maine, Massachusetts, New Hampshire, and Rhode Island. In 1997, there were over 14,000 hazardous-waste sites in the study area. Almost 95 percent of these sites were managed under the USEPA's Resource Conservation and Recovery Act program.

Surface and ground waters are withdrawn primarily for domestic, thermoelectric, commercial, and industrial uses. The total amount of water withdrawals in 1995 was about 1,430 Mgal/d, with 31 percent derived from ground-water sources and 69 percent from surface-water sources.

Surface-water-quality conditions vary greatly. Surface waters naturally have low concentrations of dissolved and suspended solids, sediments, and nutrients when compared to other surface waters nationally. The presence of extensive forest cover and wetlands, thin soils in many areas, and crystalline bedrock, all contribute to low constituent concentrations.

Human activities have had a profound effect on surface-water quality. For more than 200 years, the damming of rivers, and the disposal of wastes from pulp and paper mills, lumber mills, textile and tanning factories, and untreated sewage disposal made some of the rivers among the most polluted in the United States. Improvements in wastewater treatment for industrial and municipal wastewater discharges during the past 30 years have led to major water-quality improvements in many streams. Some of the important sources of present water-quality degradation include industrial and municipal wastewater discharges, combined sewer overflows, hydrologic

modifications from dams and water diversions, and runoff from agricultural and urban land uses.

The quality of water in stratified-drift aquifers is different than the quality of water from bedrock aquifers. Water in stratified drift is usually slightly acidic and has small concentrations of dissolved solids, calcium carbonate, and nutrients. Water in fractured bedrock generally is slightly basic and has greater concentrations of dissolved solids and calcium carbonate than water in stratified drift. Water in stratified drift and fractured bedrock have concentrations of iron and manganese that frequently exceed State and Federal safe-drinking-water regulations. Arsenic and radon are present in water from bedrock aquifers. The most frequently detected ground-water contaminants are volatile organic compounds, petroleum-related products, nitrates, and chloride and sodium. Causes for this contamination include leaking storage tanks, accidental spills, landfills, road salting, and septic systems.

Toxic compounds and trace elements in fish tissue, at levels dangerous for human consumption have been identified throughout the study area. Concentrations of dioxin in the tissue of fish from the Androscoggin and Kennebec Rivers have resulted in fish-consumption advisories by the States of Maine and New Hampshire. Recently, fish-consumption advisories have been issued in Maine, Massachusetts, and New Hampshire as a result of elevated concentrations of mercury in fish tissue.