RHODE ISLAND
Ground-Water Quality

In 1985, 24 percent of Rhode Island's nearly 1 million people (fig. 1) obtained their drinking supplies from ground water. Most of this water was pumped from public-supply wells completed in principal stratified-drift aquifers (fig. 2). The quality of ground water in most parts of the State is suitable for human consumption and other uses with little or no treatment. Typically, ground water in the State has dissolved-solids concentrations smaller than 200 mg/L (milligrams per liter) and is soft (hardness less than 60 mg/L as calcium carbonate), slightly acidic (pH 5.5 to 7.0), and cold (10 to 12° Celsius). However, Rhode Island's ground water is very vulnerable to contamination because it occurs nearly everywhere under unconfined conditions and because the water table commonly is less than 20 feet beneath the land surface. Locally, the quality of ground water has been moderately to severely degraded (fig. 3).

Infiltration of water from streams is induced near many excessively pumped public-supply and industrial wells, so that the quality of ground water pumped from such wells may be affected by the quality of streamflow. Fortunately, the quality of water in most streams is sufficiently good that few problems of well-water quality have resulted from stream infiltration.

The quality of ground water has been degraded severely at several locations by landfill leachate, spills of hazardous and nonhazardous chemicals, seepage from wastewater lagoons, leaks from buried fuel tanks, leaching of deicing salts from highway runoff and salt-storage facilities, leaching of applied fertilizers and pesticides, and seepage of septic-system effluent. Since 1975, the water from 9 public-supply wells and more than 250 domestic wells has become unsuitable for human consumption as a result of contamination by hazardous chemicals.

The percentage of the State's land area, beneath which the quality of ground water has been made unsuitable for drinking and other uses, is relatively small. Ground-water contamination from most sources, such as lagoons, landfills, and buried tanks, typically is confined to cigar-shaped plumes only a few hundred feet wide and a few thousand feet long. Thicknesses and depths of these plumes differ considerably. Most contaminant plumes discharge to streams, ponds, springs, swamps, and other areas of natural ground-water discharge.

Maintaining the quality of the State's ground-water resources for use as a source of drinking water requires careful management. The Rhode Island Department of Environmental Management (RIDEM) presently (1986) is developing a strategy to manage and protect this resource under the authority of the 1985 State Ground-Water Protection Act.

WATER QUALITY IN PRINCIPAL AQUIFERS

Ground water in Rhode Island is present in two types of aquifers—unconsolidated Pleistocene glacial deposits and consolidated Paleozoic bedrock (figs. 2*A*, 2*B*). The glacial deposits, which overlie and largely conceal bedrock, are divided into stratified drift and till. Stratified drift consists of interbedded lenses of stratified and sorted gravel, sand, and silt. Till consists of a poorly sorted mixture of boulders, gravel, sand, silt, and some clay. Stratified drift constitutes the principal aquifer. Till and bedrock constitute minor, but important, aquifers that provide small supplies to homes. Most domestic wells in Rhode Island obtain water from bedrock aquifers.

Although both consolidated and unconsolidated rocks have been subdivided into a large number of rock types, most of them are composed of relatively insoluble minerals—chiefly quartz and feldspar. As a consequence, ground water in Rhode Island typically has small concentrations of dissolved solids, generally less than 200 mg/L, and its chemical character does not differ greatly among rock units.

BACKGROUND WATER QUALITY

A graphic summary of selected water-quality variables compiled from the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE) is presented in figure 2*C*. The summary is based on dissolved-solids, hardness, nitrate (as nitrogen), iron, and manganese analyses of water samples collected from about 1950 to 1983 from selected parts of stratified-drift aquifers in Rhode Island. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant in drinking-water supplies as established by the U.S. Environmental Protection Agency (1986a,b). The primary maximum contaminant level standards are health related and are legally enforceable. The secondary maximum contaminant level standards apply to esthetic qualities and are recommended guidelines. The primary drinking-water standards include a maximum concentration of 10 mg/L nitrate (as nitrogen), and the secondary drinking-water standards include maximum concentrations of 500 mg/L dissolved solids, 300 μg/L (micrograms per liter) iron, and 50 μg/L manganese.

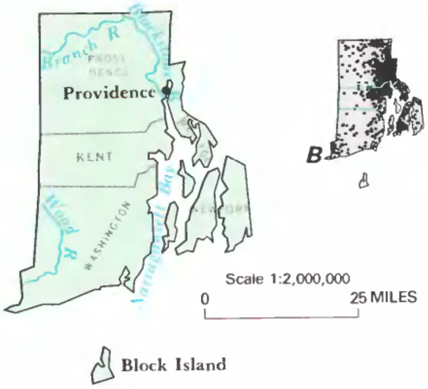

Figure 1. Selected geographic features and 1985 population distribution in Rhode Island. *A*, Counties, selected cities, and major rivers. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted to the 1985 U.S. Bureau of the Census data for county populations.)

Stratified-Drift Aquifers

Stratified drift mantles the bedrock surface in about one-third of the State, chiefly in valleys. These deposits are commonly 75 to 125 feet thick. The thickest and most transmissive parts of the stratified-drift aquifers can yield as much as 700 gal/min (gallons per minute) to wells. Aquifers in 21 areas have been designated by the State as ground-water reservoirs (Rhode Island Statewide Planning Program, 1979) in recognition of their importance as existing and potential sources of public water supply.

The quality of water from stratified-drift aquifers in seven river basins is shown in figure 2*C*. The locations of these aquifers are shown in figure 2*A*. Also shown is the quality of ground water on Block Island, where till and stratified drift overlie unconsolidated sand and clay of Cretaceous age. Most of the analyses for Block Island are believed to be for water from glacial sediments. However, because of the complex lithology at Block Island, the source rock for several samples is not known.

The quality of ground water in the upper Wood River basin (fig. 2*A*, 2*C*; aquifer 6), much of which is undeveloped land managed by the State, probably is most representative of the quality of predevelopment ground water in Rhode Island. The quality of ground water in the other river basins and on Block Island has been affected to a greater degree by human activities.

Dissolved-solids concentrations in ground water generally were less than 100 mg/L, which is significantly smaller than the drinking-water standard of 500 mg/L. The largest median (50th-percentile) concentrations of dissolved solids shown in figure 2*C* were for ground water from wells in the Branch-Blackstone River basin (aquifer 1) and on Block Island (aquifer 8). In the Branch-Blackstone basin, the large median concentration of dissolved solids in ground water results from infiltration of water from the Blackstone River, which is affected by municipal- and industrial-waste discharges (Johnston and Dickerman, 1974b, pl. 2). On Block Island, increased concentrations of dissolved solids result from movement of saline water, which surrounds and underlies the island, toward intakes of the wells. In the Providence area, where stratified drift overlies and is partly derived from sedimentary rocks, a few analyses of water from wells indicated that dissolved-solids concentrations in ground water may be larger there than in most other areas of Rhode Island.

Water from the stratified-drift aquifers that are underlain by granitic bedrock is soft in most parts of Rhode Island. Exceptions occur in the Branch-Blackstone basin, where infiltration from the Blackstone River has increased water hardness from some municipal and industrial wells. Ground water also is hard at many locations in the Providence area.

Concentrations of nitrate (as nitrogen) in ground water in areas that are relatively unaffected by human activities, such as the upper Wood River basin (figs. 2*A*,*C*), are likely to be smaller than 0.2 mg/L. Concentrations of nitrate in ground water in developed areas, where ground water is affected by wastes discharged from individual sewage-disposal systems and by fertilizers, are likely to be somewhat larger. Locally, concentrations exceed the primary

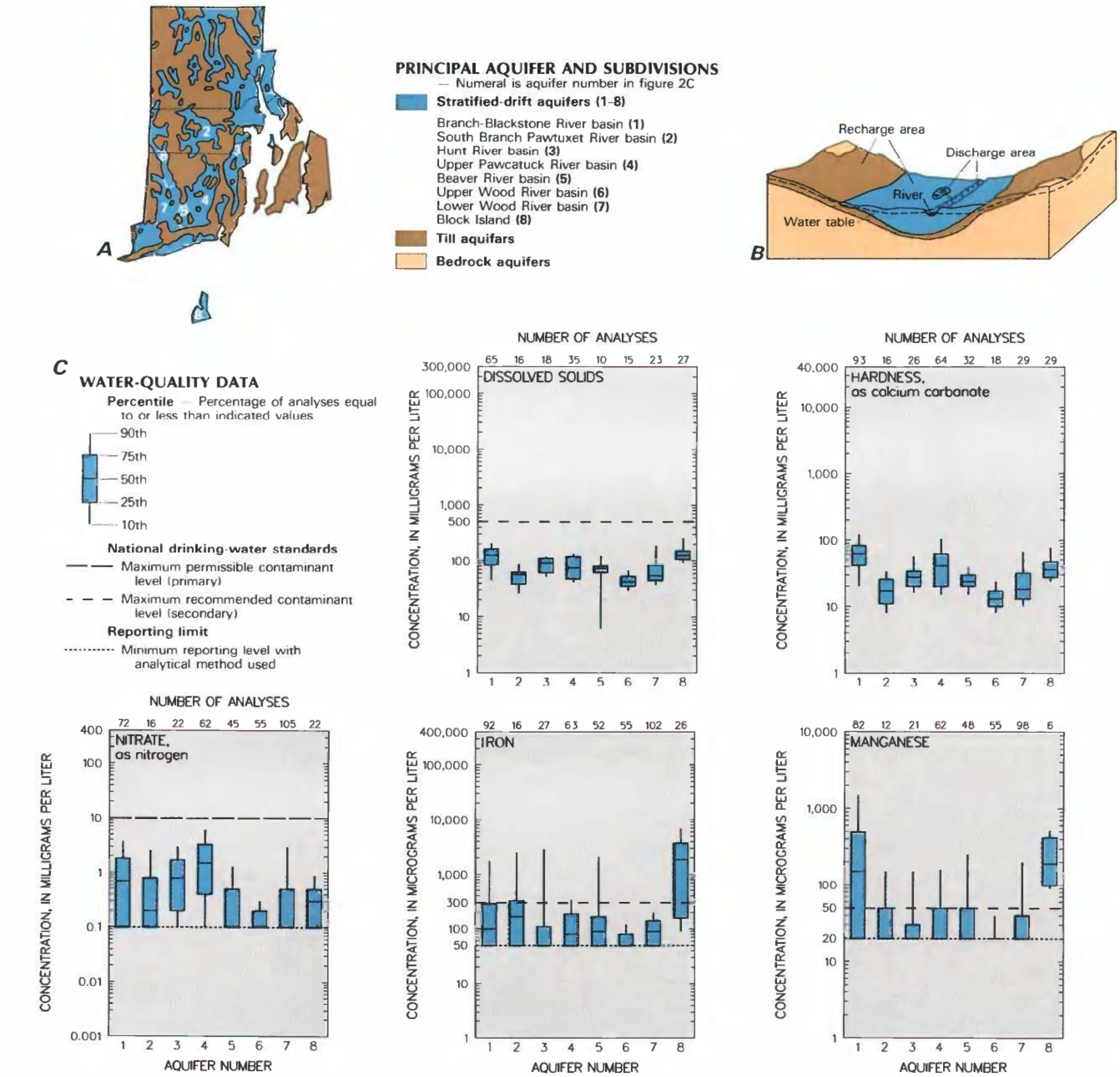

Figure 2. Principal aquifers and related water-quality data in Rhode Island. *A*, Principal aquifers. *B*, Generalized block diagram. *C*, Selected water-quality constituents and properties as of 1950-83. (Sources: *A*, U.S. Geological Survey, 1985. *B*, Modified from U.S. Geological Survey, 1985. *C*, Analyses compiled from U.S. Geological Survey files and reports; national drinking water standards from U.S. Environmental Protection Agency, 1986a,b).

drinking-water standard of 10 mg/L. Available data suggest, however, that in most areas concentrations of nitrate probably do not exceed 2 mg/L.

Concentrations of iron generally do not exceed the standard of 300 μg/L recommended for public drinking-water supplies (fig. 2*C*). Exceptions are ground water from the mixed deposits on Block Island, where concentrations of iron commonly exceed 300 μg/L), and from stratified drift in the Providence area where concentrations locally exceed 300 μg/L.

Concentrations of manganese in water pumped from newly developed wells are generally less than 50 μg/L, which is the secondary drinking-water standard. However, in several areas where prolonged pumping from public and industrial-supply wells has caused substantial infiltration of surface water from nearby rivers and ponds, concentrations of manganese commonly exceed 50 μg/L.

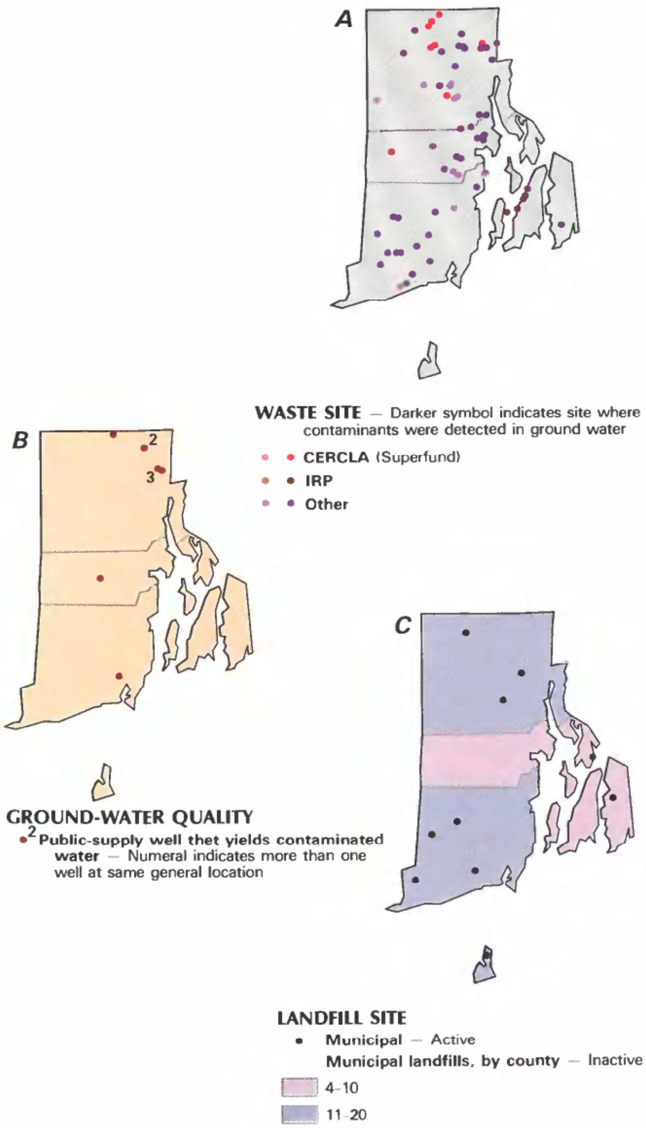

Figure 3. Selected waste sites and ground-water-quality information in Rhode Island. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, as of April 1986; Department of Defense Installation Restoration Program (IRP) sites, as of September 1985; and other selected waste sites, as of April 1986. *B*, Distribution of wells that yield contaminated water, as of February 1986. *C*, Active and inactive publicly owned landfills, as of April 1986. (Sources: *A*, Rhode Island Department of Environmental Management, 1986a; U.S. Department of Defense, 1986. *B*, Rhode Island Department of Environmental Management, 1986a. *C*, Rhode Island Department of Environmental Management, 1986a.)

Ten percent of these wells have yielded water containing manganese concentrations greater than 1,500 μg/L. The cause of manganese enrichment with time in well water is attributed mainly to infiltration of water with small amounts of dissolved oxygen (Johnston and Dickerman, 1974b; Silvey and Johnston, 1977).

Till Aquifers

Glacial till covers bedrock in about two-thirds of the State, chiefly in the upland areas. Average thickness of the till is about 20 feet. Till aquifers once were tapped by many large-diameter dug wells that provided small, commonly unreliable, yields to much of the State's population. Many older homes still obtain water from the till aquifers. However, because wells in till may become dry during droughts and because these wells are more susceptible to contamination from individual sewage-disposal systems, most have been abandoned in favor of deeper wells drilled into bedrock.

In a statewide reconnaissance completed in the early 1950's, data were summarized for 15 wells in till aquifers (Allen, 1953, table 10). Median concentrations for dissolved solids, hardness, and nitrate were 68, 32, and 1.3 mg/L, respectively. The median concentration for iron was 40 μg/L.

Bedrock Aquifers

Bedrock aquifers in Rhode Island are composed of igneous, metamorphic, and consolidated sedimentary rocks that store and transmit water through a network of narrow, widely spaced fractures. Significantly indurated to largely metamorphosed sedimentary rocks (conglomerate, sandstone, shale, and some coal) of Pennsylvanian age underlie Narragansett Bay and adjacent land areas. Crystalline igneous and metamorphic rocks that are mostly of granitic composition underlie the southeasternmost part of the State and most of the area west of Narragansett Bay. These bedrock units generally yield less than 20 gal/min to wells usually 100 to 300 feet deep. Most of the 9 percent of the State's population not served by public-supply systems obtain their water from wells that penetrate bedrock aquifers.

Water quality in bedrock aquifers was determined for 26 wells in crystalline bedrock and 19 wells in sedimentary bedrock in the statewide reconnaissance by Allen (1953, table 10). Some samples were analyzed by the Rhode Island Department of Health (RIDH) and, in some instances, may have been submitted for analysis because contamination was suspected. 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 0.3 mg/L, respectively, in samples from sedimentary bedrock. The slightly larger concentrations of dissolved solids and hardness in water from sedimentary rocks reflect the slightly greater solubility of minerals composing these rocks. The median concentration of iron was 70 μg/L in samples from crystalline bedrock and 200 μg/L in samples from sedimentary bedrock.

Effects of Land Use on Water Quality

The quality of ground water in many areas of Rhode Island has been degraded to varying degrees by land-use activities. In most areas degradation of ground-water quality, although measurable, has not impaired its suitability for drinking and most other uses. Locally, however, the effects of waste disposal, agriculture, and urbanization have made ground water unsuitable for drinking and most other uses.

The principal sources of ground-water contaminants are waste-disposal sites, underground fuel-storage tanks, surface impoundments of liquid wastes, solid-waste landfills, septic systems and cesspools, storage areas for highway deicing salt, and oil and chemical spills (Rhode Island Department of Environmental Management, 1986a, p. D–1). The principal ground-water contaminants derived from these sources are volatile organic chemicals, pesticides, metals, nitrate, sodium, and chloride (Rhode Island Department of Environmental Management, 1986a, p. D-3, table 14). In addition, manganese concentrations have increased to the level that they exceed the standard for drinking water (50 μg/L) in some excessively pumped industrial- and public-supply wells that induce infiltration of surface water.

Waste-Disposal Sites

Hazardous chemicals have been found in ground water at or near 27 sites in Rhode Island (Rhode Island Department of Environmental Management, 1986a, table 12) and are suspected of being present at many others. There is a potential for ground-water contamination by hazardous wastes at more than 200 sites (A.M. Good, Rhode Island Department of Environmental Management, oral commun., 1986). Eight hazardous-waste sites on the U.S. Environmental Protection Agency's (EPA) National Priorities List (NPL) are being studied under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980. Hazardous substances deposited at the CERCLA sites (fig. 3*A*) include motor oils, plating wastes, industrial oils and emulsions, solvents, and lacquers. Hazardous organic-chemical contaminants most commonly found in ground water at these sites include benzene, chloroform, methylene chloride, tetrachloroethylene, 1,1,1-trichloroethane, trichloroethylene, and toluene. Hazardous metals commonly found include arsenic, cadmium, chromium, and lead. There are no disposal sites in Rhode Island licensed under the Resource Conservation and Recovery Act (RCRA) of 1976.

As of September 1985, 12 hazardous-waste sites at 2 facilities in Rhode Island had been identified by the U.S. Department of Defense (1986) as part of their Installation Restoration Program (IRP) as having potential for contamination. The IRP, established in 1976, parallels the EPA CERCLA (Superfund) program. The EPA presently ranks these sites under a hazard ranking system and may include them in the NPL. Of the 12 sites in the program, 3 sites contained contaminants but did not present a hazard to people or the environment. Three sites at one facility (fig. 3*A*) were considered to present a hazard significant enough to warrant response action in accordance with CERCLA. No remedial actions at any of these sites have been completed under the program.

Nine public-supply wells have been contaminated by hazardous chemicals (fig. 3*B*)—eight by organic solvents and one by the pesticide aldicarb—and have been removed from service (Rhode Island Department of Environmental Management, 1986a, table 11). Water samples from 437 of 1,092 private wells tested within one-half mile of 27 known hazardous-waste sites have been contaminated by hazardous chemicals (Rhode Island Department of Environmental Management, 1986a, table 12). Seventy-one of these wells have yielded water with concentrations of hazardous chemicals, mainly organic solvents, that exceeded EPA advisory limits for drinking water. However, the hazardous-waste sites have not been determined to be the source of the contaminants in all instances. Septic-system effluent could be the source of some of the hazardous chemicals found in water from some private wells because several common household products that may enter septic systems contain the same chemicals.

Of the approximately 70 solid-waste landfills in Rhode Island, 52 are publicly owned. Only 10 of the publicly owned landfills were active in 1986 (fig. 3*C*). Contamination of ground water by landfill leachate has been documented at 30 landfills (Rhode Island Department of Environmental Management, 1986a, table 10). Ground water beneath and downgradient from landfills typically contains increased concentrations of dissolved solids, iron, manganese, and chloride. Mercury and phenols also have been detected at many sites. The areal extent of ground water contaminated by leachate from landfills is only a small percentage of the State's total land area. Nevertheless, their potential for degrading the quality of drinking-water supplies is substantial. Sixteen landfills overlie major ground-water reservoirs, and 11 lie within the drainage areas of these reservoirs (Rhode Island Statewide Planning Program, 1978, p. 9).

A statewide survey has identified 145 surface impoundments into which wastes were being discharged (Rhode Island Department of Environmental Management, 1979, p. 18). Most of the 107 industrial, 21 municipal, and 17 agricultural impoundments were unlined lagoons that allowed contaminated water to seep into ground water. Three-quarters of these impoundments were located in permeable stratified drift. Wastes discharged to industrial impoundments included alkaline tumbling waste, light oily waste, degreasing agents, acid or alkaline rinse waters, and dye waste mixed with sanitary waste. Wastes discharged to municipal impoundments were either water-purification sludge or septic-tank sludge. Animal wastes were discharged to agricultural impoundments.

Leakage from a lined lagoon at a now-closed uranium recovery plant in Washington County resulted in development of a plume of radioactively contaminated ground water between the plant and the nearby Pawcatuck River, into which the ground water discharges. Contamination from the plume has not been detected in the river. The contaminant plume, which is about 300 feet wide, 2,300 feet long, and 80 feet thick, is within a stratified-drift aquifer (fig. 2*A*, aquifer 7) and constitutes a potential source of contamination of public water supply for southern Rhode Island. Principal radioactive contaminants in the plume are strontium-90 and technetium-99; other major contaminants are nitrate, boron, and potassium (Ryan and Kipp, 1985, p. 21). It will require an estimated 6 to 18 years before the concentration of strontium-90 decreases to levels that are acceptable in public-drinking water supplies (Kipp and others, 1986, p. 528).

Disposal of commercial and industrial wastewater to leach fields and dry wells also is a source of ground-water contamination, but its extent and severity have not been documented (E. Panciera, Rhode Island Department of Environmental Management, oral commun., 1987).

Agricultural Practices

Leaching of chemicals applied to commercially cultivated land has caused local contamination of ground water in southern Rhode Island by the pesticide aldicarb and by nitrate. Since 1984, the RIDH has tested water from 980 drinking-water wells near potato fields where aldicarb was applied; aldicarb was detected in 169 of the wells (J. Boghosian, Rhode Island Department of Health, oral commun., 1986). Sixty-nine of the wells that yield contaminated water are in Washington County; 100 are in Newport County. One of the wells that yields contaminated water was part of a public-supply system that supplies water to about 20,000 people in Washington County. In water samples from 42 of the wells that yield contaminated water, concentrations of aldicarb have exceeded a proposed recommended EPA maximum contaminant level for drinking water of 9 μg/L (U.S. Environmental Protection Agency, 1985).

Leaching of inorganic nitrogen fertilizers applied to fields in Washington County has increased nitrate (as nitrogen) concentrations in nearby ground water substantially above background levels. Locally, concentrations exceed 10 mg/L (Johnston and Dickerman, 1984). Although cultivated land accounts for only 5 percent (31,000 acres) of the State's land area (Volpe, 1986, p. 8), much cultivated land is in Washington County where it overlies major stratified-drift aquifers.

Urbanization

Contamination of ground water by petroleum products that have leaked from buried storage tanks has been confirmed or is suspected at 25 sites in Rhode Island (D. Sheldon, Rhode Island Department of Environmental Management, oral commun., 1986). The potential for additional contamination of ground water by these products is considerable because aging petroleum-storage tanks are scattered throughout the State. Damage to water supplies resulting from contamination by petroleum products, as with many other hazardous materials, can be difficult and expensive to remedy. For example, leakage for several years from one or more buried fuel-storage tanks at gasoline stations in a Washington County community contaminated 29 nearby private drinking-water wells. The contamination necessitated development, in 1984–85, of a new public water-supply system to serve the people affected (Rhode Island Department of Environmental Management, 1986a, table 12).

In 1984, the RIDEM identified 32 salt-storage sites that were uncovered or had a permeable base. Contamination of ground water by sodium chloride has been documented at 10 of these sites (Rhode Island Department of Environmental Management, 1986a, p. D–3). Sodium-chloride contamination of water from private wells located near highways has been reported, but the extent and severity of such contamination are not known.

Effluent from individual sewage-disposal systems, which serve about one-third of the State's population, contributes significant quantities of nitrate and other contaminants to ground water. Summaries of water-quality tests by the RIDH for 1975 to 1985 indicate that nitrate (as nitrogen) exceeded 10 mg/L in water samples from about 2 percent of about 1,000 private wells tested annually. Nitrate in some samples may have been derived from lawn fertilizers. Of the 1,700 tons of nitrogen added to Rhode Island soils annually as fertilizer, more than one-half is estimated to have been applied to home lawns (S.M. Volpe, Rhode Island Department of Environmental Management, oral commun., 1986).

Bacteriological contamination of well supplies has been caused also by effluent from individual sewage-disposal systems. In water from private wells tested by the RIDH between 1975 and 1985, concentrations of bacteria in excess of State drinking-water standards were detected, on the average, in nearly 40 percent of the samples from shallow dug wells, and in about 8 percent of the samples from deeper driven and drilled wells. The percentage of wells yielding bacterially contaminated water might be smaller if samples had been collected from wells selected at random. Some water samples tested by RIDH are submitted for analysis because contamination is suspected, either because of taste and odor problems or because bacterial contamination was detected previously.

POTENTIAL FOR WATER-QUALITY CHANGES

Because of the enactment and anticipated vigorous enforcement of a variety of State laws regarding ground-water quality, that quality is expected to remain about the same or improve in the future.

The Ground-Water Protection Act (Rhode Island General Laws (R.I.G.L.) 46–13.1) passed in 1985 establishes a policy of maintaining and restoring ground-water quality in Rhode Island. Implementation of this policy and enforcement of Federal, State and local laws, regulations, and zoning ordinances are expected to maintain or improve the future quality of ground water in Rhode Island.

Enforcement of State laws relating to siting of hazardous-waste and refuse-disposal sites (R.I.G.L. 23–19.1–32 and R.I.G.L. 23–18.9) will decrease potential contamination of ground water from these sources by effectively decreasing the number of new facilities. In 1986, Rhode Island had no active hazardous-waste disposal sites and 10 active solid-waste disposal sites (fig. 3*C*).

Introduction of State regulations in 1985 that provide for registration of underground tanks used to store petroleum products and hazardous materials also should be effective in decreasing ground-water contamination from leaking underground tanks. The regulations include stringent requirements for design and construction of tanks, leak detection, and closure procedures.

State regulation of waste discharges to streams already has improved water quality in many streams and may prevent further degradation of the quality in most others. As a result, the quality of water pumped from many wells that induce infiltration from streams may be expected to remain about the same or to improve.

GROUND-WATER-QUALITY MANAGEMENT

In 1983, the State's Water Pollution Control Act (R.I.G.L. 46–12–28) was amended to include ground water as "waters of the State" and to give the RIDEM authority to regulate and control pollution of ground water. In 1984, the RIDEM became lead agency for developing a comprehensive strategy to protect the quality of the State's ground-water resources. Authority to undertake specific tasks leading to development of this strategy was provided in the 1985 Ground Water Protection Act. The tasks include conducting studies of the availability and use of the State's ground-water resources, classifying ground water, establishing standards for ground-water protection, and recommending land-use controls that will provide for protection of ground-water quality. The RIDEM currently (1986) is undertaking these tasks.

Through its authority to regulate the direct discharge of industrial and commercial wastewater to ground water, the siting and construction of landfills and individual sewage-disposal systems, the commercial use of pesticides, and the construction, maintenance, and closure of underground storage tanks, the RIDEM indirectly controls several land-use activities that contaminate ground water. The authority of RIDEM to control stream pollution also is important in controlling the quality of water in wells that induce infiltration from streams.

The State Underground Injection Control Program is the principal mechanism for controlling the direct discharge of industrial and commercial wastewater to ground water by way of pits, ponds, lagoons, leach fields, wells, and other means. The rules and regulations for this program became effective in May 1984. These regulations prohibit discharge to ground water of any water containing hazardous waste and are being used to control discharge of water containing nonhazardous wastes at more than 60 locations (D. Sheldon, Rhode Island Department of Environmental Management, oral commun., 1987).

Primary control of land-use activities that may adversely affect the quality of ground water resides with the State's 39 cities and towns which have authority to establish land-use restrictions under the State's zoning enabling act (R.I.G.L. 45–24). Six towns already have amended their zoning ordinances to include overlay districts that prohibit land uses considered potentially harmful to the quality of ground water where underlying aquifers are actual or potential sources of public-water supply (E. Panicera, Rhode Island Department of Environmental Management, written commun., 1986). Several municipalities also have increased minimum lot-size requirements for new residential construction, in part, to limit ground-water contamination by septic-system effluent. New minimum lot sizes range from 2 to 5 acres.

The ground-water protection program being developed under provisions of the 1985 legislation calls for the RIDEM to classify ground-water sources into four categories (GAA, GA, GB and GC). These, like the somewhat similar categories into which Rhode Island stream segments have been classified, are intended as standards of ground-water quality to be maintained for selected uses. Ground-water class GAA is suitable for public drinking-water supply without treatment. Class GA is possibly suitable for public or private drinking-water supply without treatment. Class GB is possibly unsuitable for public or private drinking-water supply without treatment, owing to known or presumed degradation. Class GC is suitable for certain waste-disposal practices because past or present land use, or hydrogeologic conditions, render the ground water more suitable for receiving permitted discharges than for development as public or private water supplies.

To assist in the implementation and management of its ground-water protection program, the RIDEM is developing a computerized Geographic Information System (GIS). When operational, the GIS will be used to integrate and manipulate environmental data geographically and to display them in graphs and on maps. The GIS is expected to provide rapid updating of a variety of environmental maps, such as those showing actual or potential sources of ground-water contamination. These maps can be overlain on computerized ground-water-classification maps to assess where measures need to be taken to protect ground water.

One goal of the State ground-water protection program will be to provide the greatest degree of protection for stratified-drift aquifers that constitute actual or potential sources of public water supply. In addition to State protection efforts, cities and towns will be encouraged to enact protective zoning ordinances covering these aquifers and their recharge areas.

Data on ground-water quality needed to support a ground-water protection program in Rhode Island are available, but many are not in computerized data bases. The RIDH periodically monitors the quality of water from more than 400 public-supply wells scattered throughout the State. These wells constitute a network for monitoring trends in the ambient quality of ground water. The RIDH also periodically tests for aldicarb in water from almost 1,000 private wells located near commercially cultivated land, and for organic and other hazardous chemicals in water from more than 1,000 private wells near hazardous-waste sites. Sampling frequency for private wells under RIDH monitoring programs ranges from semiannual to annual.

A certain amount of ground-water contamination is unavoidable and will occur as a consequence of selected land uses. Nevertheless, if the laws, regulations, and management practices described here continue to be implemented effectively by State and local governments, the quality of ground water in most areas of Rhode Island can remain suitable for drinking with little or no treatment.

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