GEORGIA
Ground-Water Quality

Ground water in Georgia is of good quality and is suitable for most uses. It provides drinking water to more than 2.6 million people, or almost one-half the total population of the State (fig. 1). About one-third of the 2.6 million people are supplied by domestic wells in rural areas, and two-thirds are supplied by public ground-water systems. Most ground-water withdrawals are in the southern part of the State, where the aquifers (fig. 2) are very productive.

Constituent concentrations in ground water generally do not exceed the maximum contaminant levels established for drinking water by the Georgia Department of Natural Resources (1977) and the U.S. Environmental Protection Agency (EPA). There is no evidence of any significant deterioration of public drinking-water supplies in the State. Only a few occurrences of human-related ground-water contamination have been detected, primarily in the more densely populated parts of the State (figs. 3, 4).

The Georgia Environmental Protection Division (GEPD) of the Department of Natural Resources and its branches are responsible for enforcing all State surface-water, ground-water, and water-quality laws. In 1984, the Division developed and implemented a comprehensive ground-water management plan for Georgia. The plan identified key activities already being performed to control and regulate potential pollution sources, and it included a monitoring program to provide water-quality and water-quantity data for the State's principal aquifers. Water quality in Georgia's aquifers is monitored through several networks. The GEPD has a cooperative program with the U.S. Geological Survey that provides data and interpretive information needed to manage the quality and quantity of ground water in the State.

WATER QUALITY IN PRINCIPAL AQUIFERS

Georgia has six principal aquifers—the Floridan aquifer system, the Claiborne and Clayton aquifers, the Cretaceous aquifer system, and the Paleozoic and crystalline rock aquifers (figs. 2*A*, 2*B*). The differing geologic character of the aquifers results in differences in natural ground-water quality from one part of the State to another.

The principal aquifers are overlain by water-table aquifers in surficial deposits that yield sufficient quantities of water for domestic supplies, primarily in rural areas. Most of the water is of good quality for most uses and can be used without treatment.

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 (as calcium carbonate), nitrate (as nitrogen), chloride, and iron analyses of water samples collected from 1938 to 1985 from the principal aquifers in Georgia. Percentiles of these variables are compared to national standards that specify the maximum concentration or level of a contaminant in drinking-water supply as established by the U.S. Environmental Protection Agency (1986 a,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 maximum concentrations of 10 mg/L (milligrams per liter) nitrate (as nitrogen), and the secondary drinking-water standards include maximum concentrations of

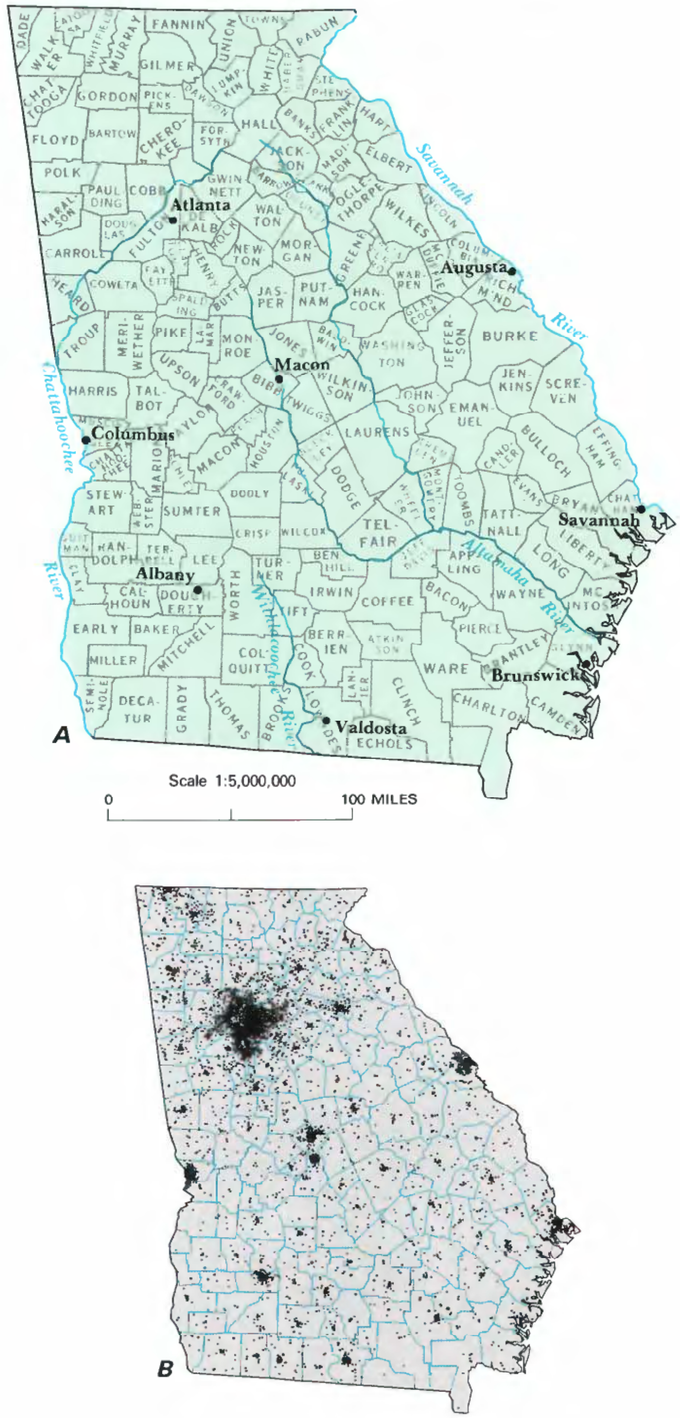

Figure 1. Selected geographic features and 1985 population distribution in Georgia. *A*, Counties, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted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

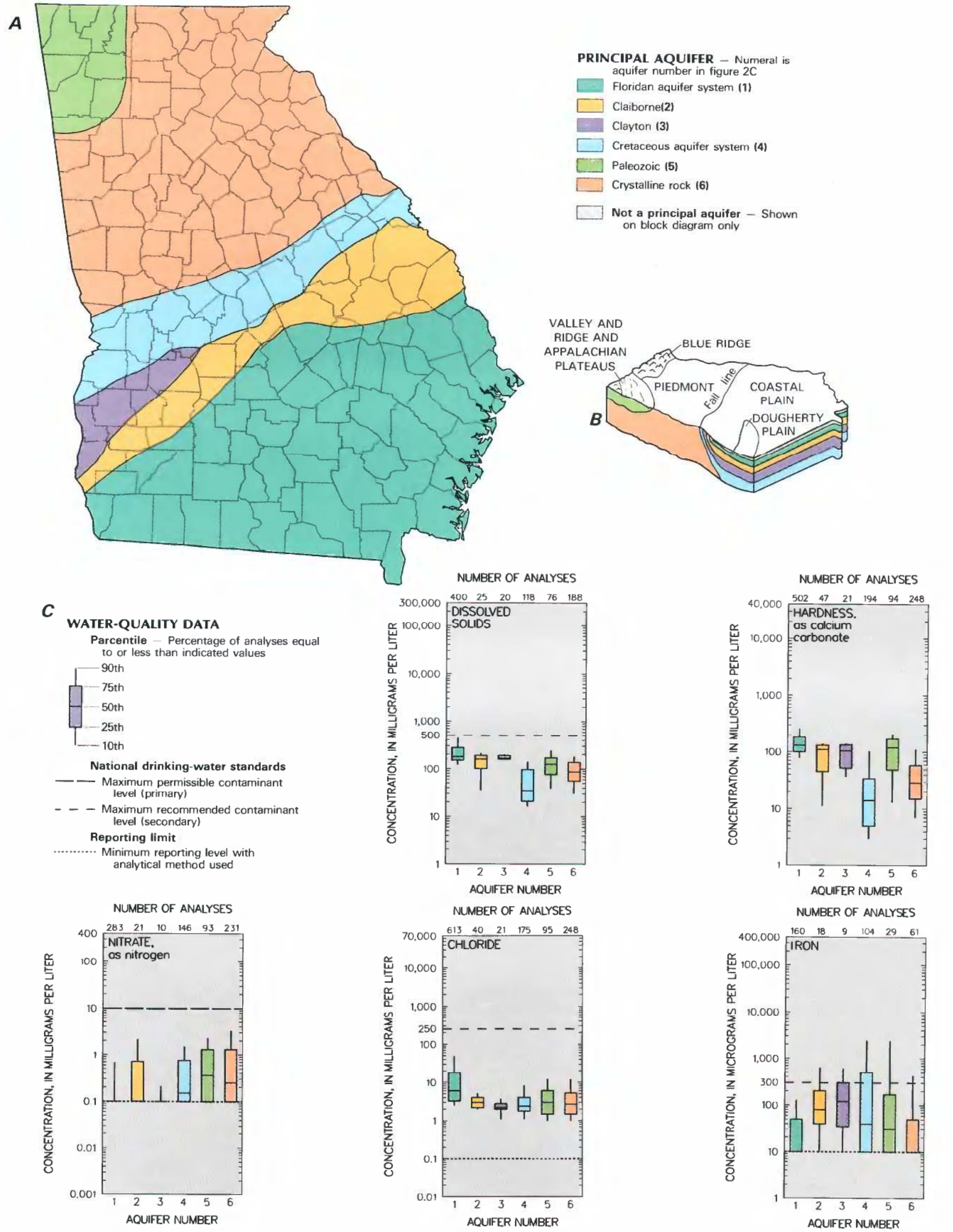

Figure 2. Principal aquifers and related water-quality data in Georgia. *A*, Principal aquifers. *B*, Block diagram showing principal aquifers and physiographic divisions. *C* Selected water-quality constituents and properties, as of 1985. (Sources: *A*, J.S. Clarke, U.S. Geological Survey, written commun., 1984. *B*, Modified from Pierce and others, 1984. *C*, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

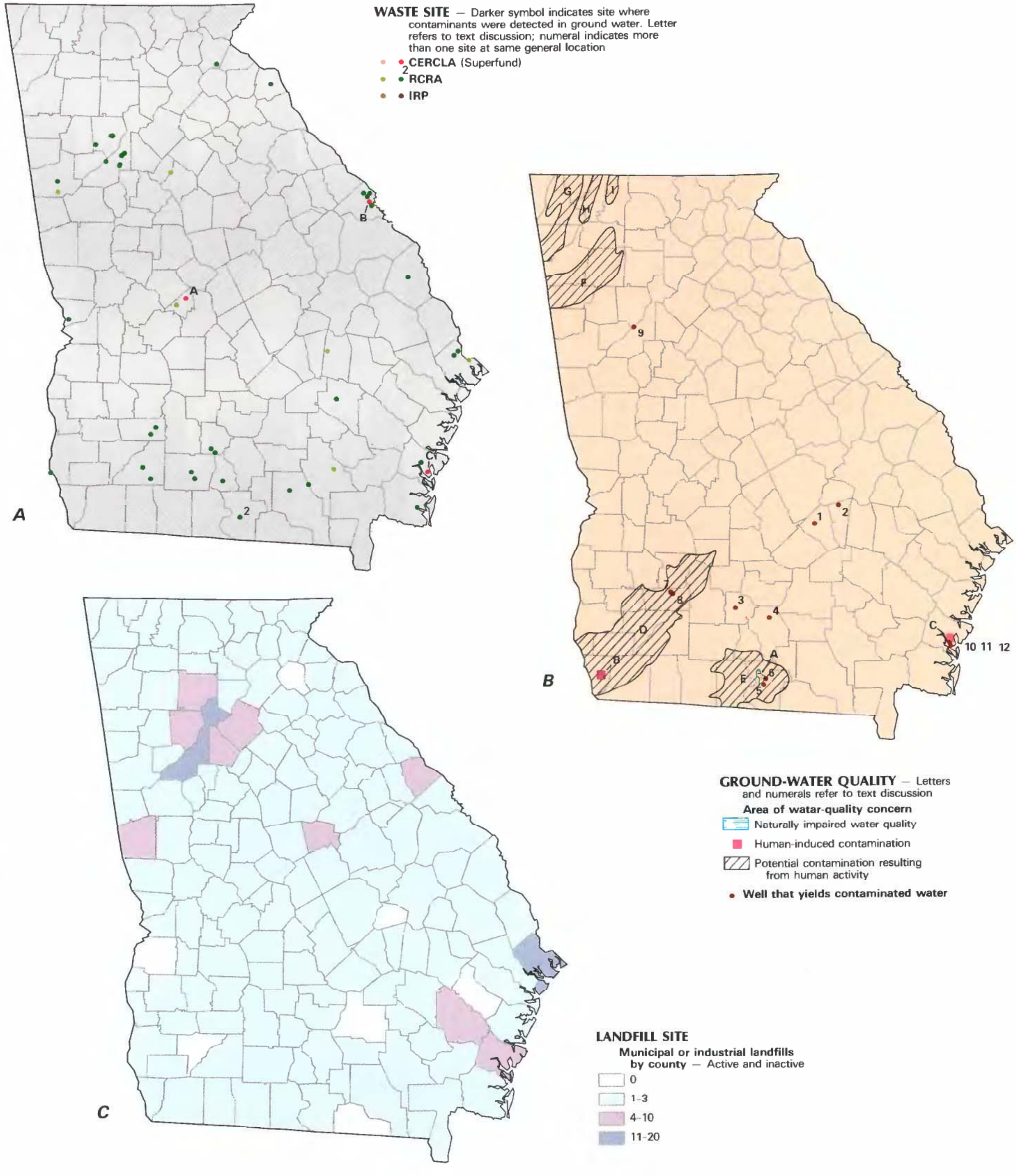

Figure 3. Selected waste sites and ground-water-quality information in Georgia. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites, as of September 1986; Resource Conservation and Recovery Act (RCRA) sites, as of September 1986; Department of Defense Installation Restoration Program (IRP) sites, as of February 1986; and other selected waste sites, as of September 1986. *B*, Areas of naturally impaired water quality, areas of human-induced and potential contamination, as of September 1986. *C*, Municipal and industrial landfills, and distribution of wells that yield contaminated water, as of September 1986. (Sources: *A*, J.R. Kaduck, Georgia Environmental Protection Division, oral commun., 1986; U.S. Department of Defense, 1986. *B*, J.S. Clarke, U.S. Geological Survey, written commun., 1986. *C*, J.W. Dunbar, Georgia Environmental Protection Division, written commun., 1986.)

500 mg/L dissolved solids, 250 mg/L chloride, and 300 μg/L (micrograms per liter) iron.

The summary characterizes the variability of the chemical quality of water from the State's principal aquifers. The data are presented without distinction as to sample depth within the aquifers, and the median concentration for a site was used where more than one analysis was available. In each of the principal aquifers, median concentrations of these constituents are less than standards set by the GEPD and the EPA. Median concentrations of dissolved solids and hardness are smallest in the Cretaceous aquifer system and largest in the Floridan aquifer system.

Floridan Aquifer System

The Floridan aquifer system is one of the most productive ground-water reservoirs in the United States and is the principal source of ground water in southern Georgia. More than 600 Mgal/d (million gallons per day) is withdrawn from the aquifer system for irrigation, industrial, public, and rural-domestic supply (U.S. Geological Survey, 1985, p. 179). The aquifer system consists of limestone, dolomite, and calcareous sand, and yields a calcium bicarbonate type water. The water ranges from soft to very hard—about 4 to 2,550 mg/L as calcium carbonate. Among the six principal aquifers, the Floridan aquifer system has the largest median concentrations (fig. 2*C*) of hardness (130 mg/L), dissolved solids (176 mg/L), and chloride (6.0 mg/L). Concentrations of nitrate shown in figure 2*C* do not exceed the primary drinking-water standard of 10 mg/L, but in some analyses the concentrations were as large as 17.0 mg/L. The median concentration of iron (fig. 2*C*) is less than the detection limit (10 μg/L); however, the water from some wells had concentrations as large as 1,200 μg/L.

Naturally occurring constituents in ground water have resulted in unsatisfactory water quality in a few small areas of the Floridan aquifer system. Between 1980 and 1985, community water-supply wells in Wheeler, Montgomery, Tift, and Berrien Counties (fig. 3*B*, wells 1, 2, 3, and 4) were reconstructed to exclude water-bearing zones in the aquifer system in which the levels of natural radioactivity exceeded Georgia's drinking-water standards for combined radium-226 and radium-228 of 5 pCi/L (picocuries per liter) and gross alpha particle activity of 15 pCi/L (S.S. McFadden, Georgia Environmental Protection Division, oral commun., 1984).

North of Valdosta, Lowndes County, direct recharge of the aquifer by the Withlacoochee River has introduced significant levels of color and organic matter that, when combined with aquifer water, have produced hydrogen sulfide (fig. 3*B*, area A). According to Krause (1979, p. 31), river water recharging the Floridan aquifer system generally exceeds secondary drinking-water standards for color (15 color units).

Although not a threat to public health, significant levels of color and hydrogen sulfide are present in water being withdrawn by some public supply, rural-domestic, and industrial wells in the Valdosta area. Since 1975, two city of Valdosta wells have been abandoned because the color intensity exceeded the drinking-water standard (fig. 3*B*, wells 5 and 6). In 1975, the color intensity of the well water ranged from 0 to 90 platinum-cobalt units (color units), and the hydrogen sulfide concentration ranged from about 0.1 to 3.0 mg/L (Krause, 1976, p. 6; 1979, table 2). Results of a survey during 1982–85 indicate that water-quality conditions in the area have not changed appreciably since 1975.

Claiborne Aquifer

The Claiborne aquifer is an important source of water in southwestern Georgia, where it supplied an estimated 36 Mgal/d during 1980, primarily for irrigation. The sand and sandy limestone aquifer yields water that ranges from soft to hard (6 to about 160 mg/L). Median values (fig. 2*C*) of dissolved solids (160 mg/L), chloride (3.0 mg/L), and iron (80 μg/L) do not exceed drinking-water standards established by the GEPD and the EPA. Concentrations of nitrate do not exceed the established primary drinking-water standard of 10 mg/L and range from the detection limit (0.1 mg/L) to about 3.6 mg/L.

Clayton Aquifer

The Clayton aquifer consists primarily of limestone and calcareous sand and is an important source of water in southwestern Georgia. During 1980, the aquifer supplied an estimated 20 Mgal/d, primarily for public supply and for irrigation (Clarke and others, 1984, sheet 6). Water from the aquifer generally is a calcium bicarbonate type and is classified as soft to hard (about 26 to 150 mg/L). Near the pumping center at Albany, Dougherty County, the water is a sodium bicarbonate type, which may indicate that water from the underlying Providence aquifer (Cretaceous aquifer system) is leaking upward into the Clayton aquifer (Clarke and others, 1984, sheet 6).

Concentrations of dissolved constituents generally do not exceed State and Federal drinking-water standards. Median values (fig. 2*C*) are 165 mg/L dissolved solids, 2.2 mg/L chloride, and 120 μg/L iron. In part of Randolph County, however, concentrations of dissolved iron are as much as 620 μg/L, which exceeds the secondary drinking-water standard of 300 μg/L. The concentration of dissolved nitrate does not exceed the drinking-water standard and ranges from the detection limit (0.1 mg/L) to about 0.22 mg/L.

Cretaceous Aquifer System

The Cretaceous aquifer system is a major source of water in the northern one-third of the Coastal Plain where it supplied an estimated 128 Mgal/d during 1980, primarily for industrial and public-supply use. The aquifer system consists of sand and gravel and includes the Providence aquifer in the southwestern part of the State and the Dublin, Midville, and Dublin-Midville aquifer systems in the east-central part (Clarke and others, 1986, p. 32). Water from the aquifer system (fig. 2*C*) is a soft (median hardness is 14 mg/L), sodium bicarbonate type that has little dissolved solids (median concentration is 35 mg/L). Concentrations of dissolved constituents generally do not exceed State and national drinking-water standards. Median concentrations of dissolved nitrate and chloride are 0.15 and 2.4 mg/L, respectively. Although the median value for iron is 40 μg/L, in much of east-central Georgia concentrations exceed the standard (300 μg/L) for drinking water (Clarke and others, 1985, p. 47). In part of the outcrop area, the water is naturally corrosive because it has low pH and a large dissolved-oxygen concentration.

Paleozoic Aquifers

The Paleozoic aquifers consist of sandstone, shale, limestone, and dolomite, and water is stored in joints, fractures, and solution openings in the bedrock. An estimated 33 Mgal/d was withdrawn from the aquifers during 1980, about half of which was for industrial supply. Water from wells and springs completed in the Paleozoic aquifers ranges from soft to very hard (6 to about 1,100 mg/L). Median dissolved-solids and chloride concentrations (fig. 2*C*) are 126 and 3.0 mg/L, respectively. The median nitrate concentration is 0.36 mg/L. The median iron concentration is 30 μg/L but iron concentrations as large as 11,000 μg/L occur in water from some wells.

Crystalline Rock Aquifers

The crystalline rock aquifers of the Piedmont province (fig. 2*B*) yielded an estimated 99 Mgal/d during 1980, primarily for rural supply (U.S. Geological Survey, 1985, p. 182). Water from the aquifers is a calcium bicarbonate type that is soft to very hard (about

1 to 855 mg/L). Median concentrations (fig. 2C) of dissolved solids and chloride are 87 and 2.7 mg/L, respectively. The median nitrate concentration is 0.25 mg/L. The median concentration of iron is 10 μg/L, but iron concentrations as large as 14,000 μg/L occur in some wells. Water-quality problems in the aquifers generally are limited to areas where naturally occurring iron concentrations are larger than the 300-μg/L standard for drinking water.

EFFECTS OF LAND USE ON WATER QUALITY

The State's ground water is of good quality overall; however, in a few small areas, ground-water-quality problems have resulted from agricultural practices, waste disposal, urbanization, and ground-water withdrawals. Water-quality changes attributed to agricultural practices (McConnell and others, 1984, p. 17) and ground-water withdrawals (Wait and Gregg, 1973, p. 65) have been documented by the U.S. Geological Survey in cooperation with the GEPD, EPA, and other agencies. Localized water-quality degradation attributed to waste disposal and urban activities has been detected.

Agricultural Practices

In a study conducted by the U.S. Geological Survey in cooperation with the EPA during August 1983, ethylene dibromide (EDB) was detected in a 4-square-mile area of the Floridan aquifer system in an intensively farmed part of central Seminole County (fig. 3*B*, area B). A soil fumigant, EDB was applied extensively until its use was banned by the EPA in September 1983. Results of the study indicate that EDB applied to the soils may have moved downward through the surficial material into the aquifer system. Water samples from 6 of 19 wells completed in the Floridan aquifer system contained EDB. Five of the samples that contained EDB were from irrigation wells, and one was from a rural-domestic well. Concentrations of EDB ranged from about 0.01 to 11.8 μg/L (McConnell and others, 1984, p. 15). Additional water samples collected during 1985 indicated that the area of contamination was approximately the same as in 1983 but that EDB concentrations had decreased. A survey conducted by the GEPD during October 1983 found no trace of EDB in any of the 21 community water systems sampled in Seminole County (John Fernstrom, Georgia Environmental Protection Division, oral commun., October 1986).

Waste Disposal

Hazardous waste is treated, stored, or disposed at 100 facilities regulated by the Federal Resource Conservation and Recovery Act (RCRA). As of September 1986, 37 land-disposal sites and 5 sites where spills or other waste releases have occurred were being monitored for ground-water quality (fig. 3*A*). The GEPD has determined that some contamination of shallow ground water has occurred at 35 of the 42 sites (J.R. Kaduck, Georgia Environmental Protection Division, oral commun., 1986). Five additional sites regulated by the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) of 1980 either have been proposed or have met requirements for the EPA's National Priorities List (NPL) of hazardous-waste sites (U.S. Environmental Protection Agency, 1986c). Contaminants have been detected in the shallow ground water at each of the five sites. The three CERCLA sites on the NPL are shown in figure 3*A*. No leachates from any of the RCRA or CERCLA sites have contaminated any public water-supply wells.

As of September 1985, 86 hazardous-waste sites at 6 facilities in Georgia had been identified by the U.S. Department of Defense (DOD) as part of their Installation Restoration Program (IRP) as having potential for contamination (U.S. Department of Defense, 1986). The IRP, established in 1976, parallels the EPA Superfund program under CERCLA. EPA presently ranks these sites under the hazard ranking system and may include them in the NPL. Of the 86 sites in the program, 22 sites contained contaminants but did not present a hazard to the environment. Eleven sites at 3 facilities (fig. 3*A*) were considered to present a hazard significant enough to warrant response action in accordance with CERCLA. The remaining sites were scheduled for confirmation studies to determine if remedial action is required. No leachates from any of the IRP sites have contaminated any public water-supply wells.

Small concentrations of pesticides have been detected in one private well located downgradient from the Powersville, Peach County, CERCLA site (fig. 3*A*, site A) (D. Bracket, Georgia Environmental Protection Division, oral commun., 1986). This CERCLA site, which was a municipal landfill and a pesticide disposal area, is in a sparsely populated part of the recharge area of the Providence aquifer (Cretaceous aquifer system).

At Augusta (population 47,500), Richmond County, concentrations of arsenic that exceed the 0.05-mg/L primary drinking-water standard were detected (T.W. Watson, Georgia Environmental Protection Division, oral commun., 1986) beneath an industrial landfill (fig. 3*A*, site B). This CERCLA site is in the recharge area of the Dublin-Midville aquifer system (Cretaceous aquifer system). Because a corrective-action program has removed the source, arsenic concentrations can be expected to decrease.

At Brunswick, Glynn County, concentrations of toxaphene larger than the 5-μg/L primary drinking-water standard were detected in the surficial aquifer at an industrial landfill (D. Bracket, Georgia Environmental Protection Division, oral commun., 1986) that is included on the NPL list (fig. 3*A*, site C). The site is on the outskirts of the city of Brunswick (population 37,480) and overlies a surficial water-table aquifer that is not used as a source of drinking water.

In addition to the disposal sites described above, Georgia has about 265 municipal and industrial landfill sites (fig. 3*C*), of which about 50 are monitored for water-quality changes (J. W. Dunbar, Georgia Environmental Protection Division, written commun., 1986). As expected, most landfills are near the largest population centers of Atlanta, Fulton County, and Savannah, Chatham County. Monitoring, to date, does not indicate any significant ground-water contamination near any landfill in Georgia.

Urbanization

At Albany (population 73,900), Dougherty County, volatile organic compounds (VOC) were detected during late 1985 in two monitoring wells—one completed in the Floridan aquifer system and one completed in the underlying Claiborne aquifer (fig. 3*B*, wells 7 and 8). The wells are in the recharge area of the Floridan aquifer system. Concentrations of VOC did not exceed the EPA's proposed maximum contaminant levels, but the concentration of tetrachloroethylene exceeded their proposed recommended maximum contaminant level of zero for drinking water (K.R. Davis, Georgia Environmental Protection Division, written commun., 1986). A search of the area by GEPD revealed no likely source of contamination. Subsequent sampling and analysis during the summer of 1986 indicated small levels of contaminants in the Floridan well but did not show any in the Claiborne well (K.R. Davis, Georgia Environmental Protection Division, oral commun., 1986). There is no indication that the contaminants have affected any public water-supply wells.

In Fulton County, VOC were detected in a well completed in the crystalline rock aquifers (fig. 3*B*, well 9). Concentrations of the VOC trichloroethylene and 1,1-Dichloroethene exceeded the EPA's proposed maximum contaminant levels of 0 and 7 μg/L, respectively, for drinking water, and the concentration of tetrachloroethylene exceeded the proposed recommended maximum contaminant level of zero for drinking water (K.R. Davis, Georgia Environmental Protection Division, written commun., 1986). The well is near an industrial complex that may be the source of the contaminants. Ground water is not used for drinking in this area.

Ground-Water Withdrawals

The chloride concentration in water from the Floridan aquifer system in the Brunswick area has been monitored monthly or semiannually since the late 1950's. Since monitoring began, the chloride concentration has increased in part of Brunswick from about 20 mg/L to much more than the secondary drinking-water standard of 250 mg/L, largely as a result of movement of more saline water into the area due to ground-water withdrawals. Elsewhere in Brunswick, the chloride concentration does not exceed the drinking-water standard. Examples of the effects of ground-water withdrawals on chloride concentrations in the Floridan aquifer system in the Brunswick area are shown in figure 4.

Since pumping began in the late 1800's, the ground-water level in the Floridan aquifer system at Brunswick has declined as much as 65 feet. This water-level decline has allowed briny water from deep zones to migrate upward in the aquifer system at three known locations and move downgradient toward the centers of pumping. At two locations in Brunswick, the chloride concentration in the upper part of the aquifer system has increased to more than 2,000 mg/L (Clarke and others, 1986, p. 148). During the past 10 years, the city of Brunswick, whose water system serves a population of about 37,500, has abandoned three wells (fig. 3*B*, wells 10, 11, 12) because chloride concentrations exceeded the 250-mg/L drinking-water standard (fig. 3*B*, area C). Because saltwater intrusion is induced largely by pumping, the GEPD worked with local industries to achieve voluntary decreases in water use. The resulting 10-Mgal/d decrease in pumping caused a water-level rise that slowed the increase in chloride concentration (fig. 4). By 1984, the chloride concentration began to decrease (H.E. Gill, U.S. Geological Survey, oral commun., 1986).

Potential for Water-Quality Changes

Georgia's aquifers are most susceptible to contamination from surface sources in recharge areas; the GEPD has taken the position that these areas warrant special protection efforts. Potential sources of contaminants include landfills and hazardous-waste sites, waste impoundments, and infiltration of agricultural chemicals applied to farmland. In the Coastal Plain and Valley and Ridge provinces (fig. 2*B*), the recharge areas of the various aquifers tend to be more areally extensive than in the Piedmont and Blue Ridge provinces. For this reason, the potential for contamination in the Coastal Plain and Valley and Ridge provinces is greater.

In recharge areas of the Cretaceous aquifer system, extremely permeable, sandy soils provide little protection against leakage from surface waste impoundments and landfills. The potential for contamination is greater near the urbanized areas of Columbus, Macon, and Augusta (fig. 1*A*) than in the rural parts of the Cretaceous recharge area. For the Floridan aquifer system, the risk of aquifer contamination is greatest in the intensely farmed Dougherty Plain District (fig. 3*B*, area D) where the soils are very permeable and sinkholes connect the aquifer with the land surface. The potential for aquifer contamination also is great in the Valdosta area (fig. 3*B*, area E), where sinkholes are numerous and where water from the Withlacoochee River directly recharges the Floridan aquifer system.

In the Valley and Ridge province, the Paleozoic aquifers are susceptable to contamination in limited areas where sinkholes have developed or where bedrock is exposed at the surface or is covered by a thin layer of soil (fig. 3*B*, areas F, G, H, and I). In the Piedmont province, the crystalline rock aquifers are vulnerable to contamination where they are exposed and where the protective layer of saprolite is thin and permeable.

Along the coast, the potential for saltwater intrusion in the Floridan aquifer system has been minimized by GEPD management practices that limit increases in ground-water withdrawals. However, if withdrawals were to increase in Georgia or in adjacent parts of Florida or South Carolina, the potential for saltwater intrusion would increase.

The use of agricultural chemicals has increased substantially in the last decade and probably will continue to increase. Irrigated farmland in Georgia increased from 300,000 acres during 1975 to 1,080,000 acres during 1985 (R.R. Pierce, U.S. Geological Survey, oral commun., 1986). Further, the demand for agricultural products is projected to increase through the end of the century (University of Georgia, 1986), and crop production likely will increase to meet the demand. As farming intensifies through the use of irrigation systems and the planting of several crops each year, ground-water contamination by agricultural chemicals could become a problem.

GROUND-WATER-QUALITY MANAGEMENT

Through comprehensive laws and regulatory activities, the GEPD has significant control programs to prevent new ground-water contamination and to require remedial action in the few situations where contamination exists. Furthermore, the Division regulates municipal and industrial ground-water withdrawals exceeding 100,000 gal/d. Activities having the potential to affect ground water, such as wastewater treatment, landfill operation, hazardous-waste management, underground injection, surface mining, and oil and gas and other types of drilling, are all managed by the GEPD under existing laws. In addition, the Well Standards Act of 1985 provides for the licensing of drillers and for the proper construction, grouting, location, maintenance, operation, and abandonment of wells.

In 1984, a ground-water management plan for Georgia was developed and implemented by the GEPD. This plan provided for improved coordination of all the activities listed above, in addition to establishing a comprehensive ground-water-quality monitoring program. The Division also is preparing a recharge-area protection plan that will prevent degradation of the State's aquifers. The State's management strategy includes aquifer mapping, which has been completed through cooperative efforts between the GEPD and the U.S. Geological Survey and through the State's Underground Injection Control (UIC) program. Information on water-resource conditions in parts of the State, including ground-water contamination, is distributed to the public through the GEPD and local water-management plans.

The GEPD has long recognized that saltwater intrusion may be induced by pumping anywhere along the Georgia coast. To prevent more saltwater from moving into freshwater zones, the Division has instituted several comprehensive ground-water management practices. Ground-water management plans for the Savannah area will not permit future industrial withdrawals and will limit municipal withdrawals. A similar managment plan is in preparation for the Brunswick area. The GEPD, in cooperation with the U.S. Geological Survey, is conducting studies to assess the effect of increased water use on the quantity and quality of ground water in the coastal area of Georgia. The studies will use ground-water flow models to improve definition of the ground-water flow system and to assess the effect of geologic faults on that system.

Water quality in Georgia's aquifers is monitored through several networks:

- The GEPD has monitored more than 3,200 public-water systems statewide since the early 1970's on a frequency that varies from monthly to biannually.
- The U.S. Geological Survey has monitored the chloride concentration in the Floridan aquifer system at Brunswick, in cooperation with the city of Brunswick and with Glynn

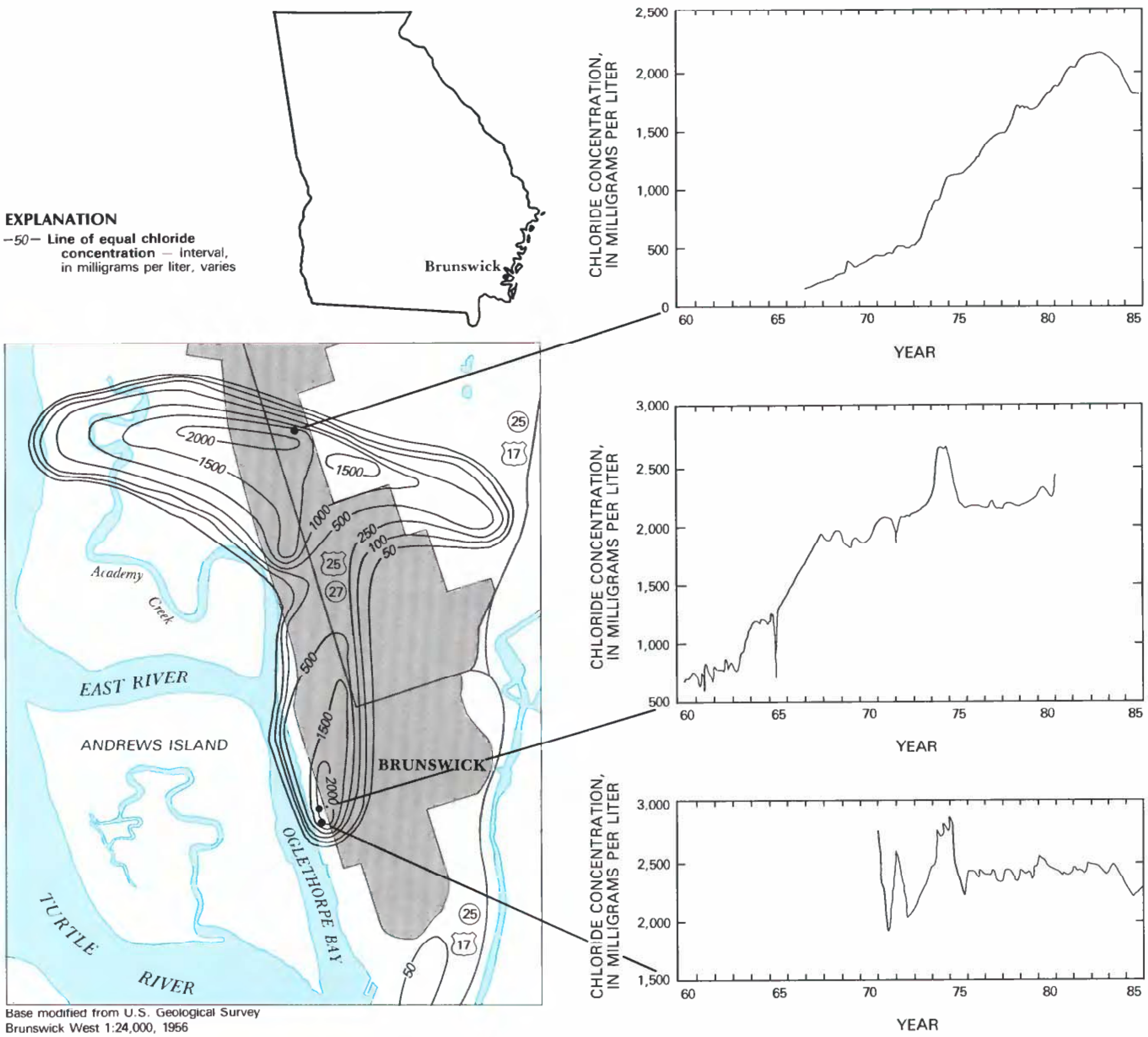

Figure 4. Chloride concentration (October-November 1985) and change in chloride concentration (1960-85) in the Floridan aquifer system in the Brunswick area, Georgia. (Source: Modified from Clarke and others, 1986.)

County, since the late 1950's. At Savannah, the chloride concentration has been monitored by the U.S. Geological Survey from the late 1960's to 1984 in cooperation with the city of Savannah and Chatham County, and since 1984 in cooperation with the GEPD. Currently, 90 wells in the Brunswick area are monitored semiannually, and 11 in the Savannah area are monitored monthly.

- Water quality in 127 wells completed in the State's principal aquifers has been monitored by the GEPD since 1984 on an annual and semiannual basis. Samples are analyzed for standard constituents, organics, priority pollutants, and trace metals.

- Under the Hazardous Waste Management Act and the Georgia Solid Waste Management Act, the GEPD has overseen water-quality monitoring by operators at RCRA-regulated hazardous-waste sites, at CERCLA-regulated hazardous-waste sites, and at municipal and industrial landfills since the late 1970's. Samples are collected on schedules that range from monthly to annually.

In addition to the sampling networks described above, the GEPD has a cooperative program with the U.S Geological Survey that provides data and interpretive information needed to manage the quality and quantity of ground water in the State. Several studies conducted through this cooperative program have provided necessary information on the State's aquifers, including aquifer mapping, aquifer characteristics, flow characteristics and direction, and water quality. Although much information is known about the State's principal aquifers in the Coastal Plain (fig. 2*B*), additional information on these aquifers is needed, and significant additional information on aquifers in the Piedmont, Blue Ridge, and Valley and Ridge provinces is needed. The GEPD initiated in 1987 a 5-year plan to investigate the ground-water resources of northern Georgia. In addition, more data are needed for the shallow water-table aquifers (those less than 100 feet deep), which are the most vulnerable to contamination from the surface.

SELECTED REFERENCES

Clarke, J.S., Brooks, Rebekah, and Faye, R.E., 1985, Hydrogeology of the Dublin and Midville aquifer systems of east-central Georgia: Georgia Geologic Survey Information Circular 74, 62 p.

Clarke, J.S., Faye, R.E., and Brooks, Rebekah, 1984, Hydrogeology of the Clayton aquifer of southwest Georgia: Georgia Geologic Survey Hydrologic Atlas 13, 6 sheets.

Clarke, J.S., Joiner, C.N., Longsworth, S.A., McFadden, K.W., and Peck, M.F., 1986, Ground-water data for Georgia, 1985: U.S. Geological Survey Open-File Report 86-304, 59 p.

Cressler, C.W., Thurmond, C.J., and Hester, W.G., 1983, Ground water in the Greater Atlanta region, Georgia: Georgia Geologic Survey Information Circular 63, 144 p.

Georgia Department of Natural Resources, 1977, Rules for safe drinking water: Atlanta, Environmental Protection Division, Chapter 391-3-5, p. 601-657.

Krause, R.E., 1976, Occurrence and distribution of color and hydrogen sulfide in water from the principal artesian aquifer in the Valdosta area, Georgia: U.S. Geological Survey Open-File Report 76-378, 11 p.

_____ 1979, Geohydrology of Brooks, Lowndes, and western Echols Counties, Georgia: U.S. Geological Survey Water-Resources Investigations Report 78-117, 48 p.

McConnell, J.B., Hicks, D.W., Lowe, L.E., Cohen, S.Z., and Jovanovich, A.P., 1984, Investigation of ethylene dibromide (EDB) in ground water in Seminole County, Georgia: U.S. Geological Survey Circular 933, 20 p.

Pierce, R.R., Barber, N.L., and Stiles, H.R., 1984, Georgia irrigation, 1970-80—A decade of growth: U.S. Geological Survey Water-Resources Investigations Report 83-4177, 29 p.

University of Georgia, 1986, Georgia—2000: Athens, University of Georgia, Vinson Institute of Government, 49 p.

U.S. Department of Defense, 1986, Information paper—Status of the Department of Defense Installation and Restoration Program: Washington, D.C., Office of the Assistant Secretary of Defense (Acquisition and Logistics), 35 p.

U.S. Environmental Protection Agency, 1986a, Maximum contaminant levels (subpart B of part 141, National interim primary drinking-water regulations): U.S Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 524-528.

_____ 1986b, Secondary maximum contaminant levels (section 143.3 of part 143, National secondary drinking-water regulations): U.S. Code of Federal Regulations, Title 40, Parts 100 to 149, revised July 1, 1986, p. 587-590.

_____ 1986c, Amendment to National Oil and Hazardous Substances Contingency Plan, national priorities list, final rule and proposed rule: Federal Register, v. 51, no. 111, June 10, 1986, p. 21053-21112.

U.S. Geological Survey, 1985, National water summary 1984—Hydrologic events, selected water-quality trends, and ground-water resources: U.S. Geological Survey Water-Supply Paper 2275, 467 p.

Wait, R.L., and Gregg, D.O., 1973, Hydrology and chloride contamination of the principal artesian aquifer in Glynn County, Georgia: Georgia Geologic Survey Hydrologic Report 1, 93 p.

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