KANSAS GROUND-WATER QUALITY

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FOREWORD

This report contains summary information on ground-water quality in one of the 50 States, Puerto Rico, the Virgin Islands, or the Trust Territories of the Pacific Islands, Saipan, Guam, and American Samoa. The material is extracted from the manuscript of the *1986 National Water Summary*, and with the exception of the illustrations, which will be reproduced in multi-color in the *1986 National Water Summary*, the format and content of this report is identical to the State ground-water-quality descriptions to be published in the *1986 National Water Summary*. Release of this information before formal publication in the *1986 National Water Summary* permits the earliest access by the public.

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KANSAS
Ground-Water Quality

Ground water is the principal source of supply for more than 500 public-water-supply systems in Kansas, including that of the largest city, Wichita. Ground water also is the primary source of self-supplied rural-domestic water. About 60 percent of the State's 2.45 million people drink ground water. (See population distribution in figure 1.) About 90 percent of the irrigation water and about 75 percent of the self-supplied industrial water used in the State is ground water.

Most ground water in Kansas contains less than 1,000 mg/L (milligrams per liter) dissolved solids and does not exceed the drinking-water standards established by the State in 1982 (Kansas Administrative Regulations 28–15–11 through 28–15–20). Locally, each of the aquifers may yield water with dissolved-solids concentrations that exceed 1,000 mg/L. Nearly all the ground water in the State is hard to very hard (hardness more than 120 mg/L as calcium carbonate). (See figure 2*C*.)

Changes in ground-water quality in several areas of the State can be associated with human activities—mineral extraction, oil production, waste disposal, and agriculture. Problems with contamination of ground water associated with the production of oil and gas are widespread. Contamination of ground water from waste disposal has been identified chiefly in and near the major population centers. (See figures 2 and 3.) Adverse effects from agricultural practices have not been studied extensively; however, investigations (Spruill, 1985) indicate increased concentrations of inorganic compounds in water from alluvial aquifers in north-central Kansas as a result of irrigation return flows. Pesticides have been detected in ground water in at least one area in northern Sedgwick County. In addition, some alluvial aquifers are affected by natural sources of saline water and brine.

During 1976, Kansas agencies established a ground-water-quality monitoring network in cooperation with the U.S. Geological Survey. The network now (1986) includes 250 wells that are sampled annually. The sampling program includes routine analysis for major ions and analysis of selected samples for trace elements, organic compounds, and radionuclides.

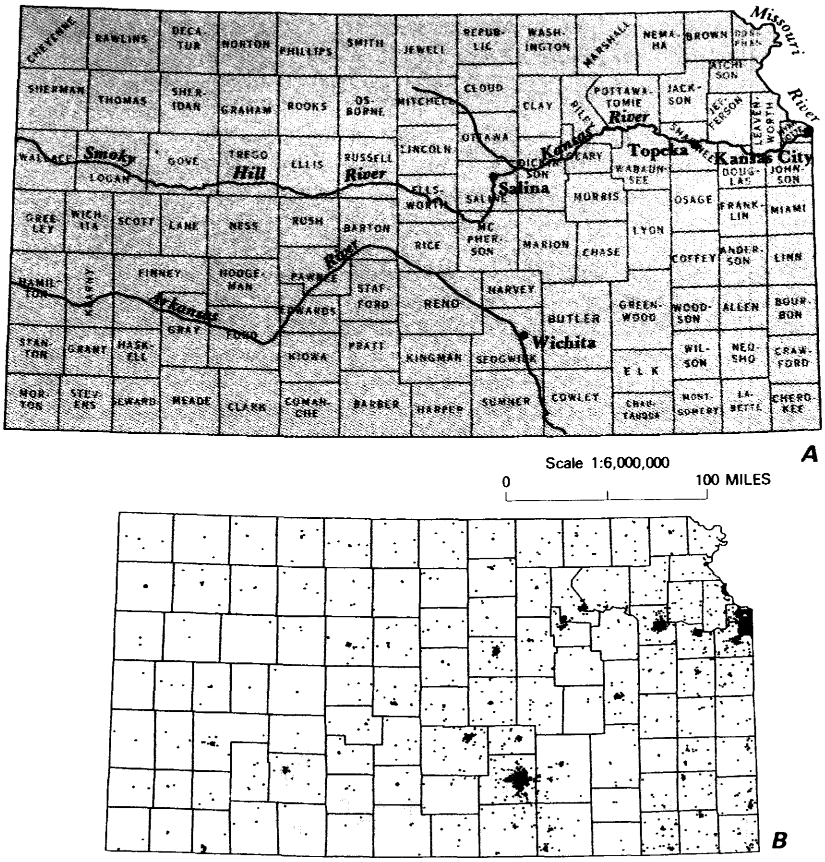

Figure 1. Selected geographic features and 1985 population distribution in Kansas. *A*, Counties, selected cities, and major drainages. *B*, Population distribution, 1985; each dot on the map represents 1,000 people. (Source: *B*, Data from U.S. Bureau of the Census 1980 decennial census files, adjusted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

WATER QUALITY IN PRINCIPAL AQUIFERS

Kansas has seven principal aquifers, all with differing water quality. These principal aquifers can be divided into two groups—unconsolidated deposits of Cenozoic age (alluvial, glacial-drift, and High Plains aquifers) and consolidated rocks of Mesozoic and Paleozoic age (Great Plains, Chase and Council Grove, Douglas, and Ozark aquifers). The geographic distribution of the seven aquifers is shown in figure 2*A*; a description of each aquifer is given by the U.S. Geological Survey (1985, p. 217–220). Vertical relations among the principal aquifers are shown by the hydrogeologic section (fig. 2*B*). About 95 percent of the ground water used in Kansas is from the aquifers in unconsolidated deposits, and about 90 percent of the withdrawal is from the High Plains aquifer.

BACKGROUND WATER QUALITY

A statistical summary of concentration of dissolved solids, hardness (as calcium carbonate), nitrate plus nitrite (as nitrogen), fluoride, and chloride in water from the principal aquifers is shown in figure 2*C*. The water samples were collected during the period 1965 to 1985 from a variety of wells and test holes; no distinction was made between samples collected from different depth intervals within the same aquifer.

Figure 2*C* is based on selected chemical data available in the U.S. Geological Survey's National Water Data Storage and Retrieval System (WATSTORE). Percentiles of the variables are compared to national standards established by the U.S. Environmental Protection Agency (1986a,b) that specify the maximum concentration or level of a contaminant in a drinking-water supply. 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.

Alluvial Aquifers

Most water from the alluvial aquifers contained less than 1,000 mg/L dissolved solids. Locally, concentrations of dissolved solids larger than 9,000 mg/L may be caused by inflow of saline water from underlying consolidated rocks. Typically, the water was very hard; the median concentration of hardness was 400 mg/L.

Maximum concentrations of nitrate plus nitrite and fluoride did not exceed the primary drinking-water standards, whereas the maximum chloride concentration exceeded the secondary standard. Water from these aquifers is used primarily for public supplies and industry.

The quality of water in several of the alluvial aquifers is impaired by inflow of saline or briny water from underlying consolidated rocks (fig. 3*B*) (Hargadine and others, 1978; Gillespie and Hargadine, 1981; Gogel, 1981). Locally, confined water that contains significantly large concentrations of calcium, sodium, sulfate, and chloride is under higher hydraulic head than that in the overlying alluvium. In these areas, the saline or briny water may move upward through the confining layer and enter the alluvial aquifers. An example of such degradation in the Smoky Hill River valley near Salina is shown in figure 4. Water withdrawals from the alluvial aquifers may lower the hydraulic head in these aquifers causing upwelling of saline water and aggravation of the problem.

Glacial-Drift Aquifers

Water from the glacial-drift aquifers contained smaller concentrations of dissolved solids and chloride and slightly larger concentrations of fluoride than water from the alluvial aquifers. The water was very hard (median hardness was 270 mg/L), and nitrate plus nitrite concentrations in 10 percent of the samples analyzed were larger than 10 mg/L. The principal withdrawal of water from the aquifers is from shallow wells for self-supplied rural-domestic use. Water from deep wells may have concentrations of dissolved solids larger than 700 mg/L.

High Plains Aquifer

The High Plains aquifer yields water with the smallest concentrations of dissolved solids in Kansas; the median concentration of dissolved solids was 340 mg/L. Water from the High Plains aquifer typically is hard to very hard; only 25 percent of the samples had hardness concentrations less than 180 mg/L. Most concentrations of nitrate plus nitrite and fluoride do not exceed the drinking-water standards. Although samples from a few wells had large concentrations of chloride (the maximum for 773 samples was 440 mg/L), fewer than 10 percent of the samples contained more than 70 mg/L. Most of the water pumped from the High Plains aquifer is used for irrigation, but the aquifer also supplies water for public supply and industrial use in the Wichita area as well as for many smaller cities and rural domestic users.

Great Plains Aquifer

Water from the Great Plains aquifer is more variable in quality than water from unconsolidated deposits. Where the aquifer crops out at the land surface or is directly overlain by unconsolidated Cenozoic deposits, the water contains less than 500 mg/L dissolved solids and is used for irrigation, public, and rural-domestic supplies. Concentrations of all constituents, particularly chloride and sodium, increase with depth or increase where the aquifer is overlain by younger Cretaceous rocks; water from the aquifer in the northwest part of the area shown in figure 2*A* commonly is too saline for human use.

Chase and Council Grove Aquifer

Water from the Chase and Council Grove aquifer is suitable for most uses but is very hard (90 percent of samples had hardness concentrations larger than 180 mg/L). Most nitrate plus nitrite concentrations were within the acceptable range for drinking water. Fluoride concentrations generally were less than 1 mg/L. The water in the aquifer is used primarily for rural-domestic and public supplies. Some wells in the southern part of the area yield water with more than 2,000 mg/L dissolved solids; locally, sulfate concentrations are undesirably large. West of the area shown in figure 2*A* the aquifer water is unused because it is briny, with chloride concentrations larger than 10,000 mg/L.

Douglas Aquifer

Water from the Douglas aquifer is used for rural-domestic and public supplies by a few communities where the aquifer is at or near land surface. Dissolved-solids concentrations in these areas were smaller than 500 mg/L, but hardness typically exceeded 180 mg/L. Nitrate-plus-nitrite concentrations were variable; too few data are available to include a summary of nitrate plus nitrite in figure 2*C*, but the concentration exceeded 30 mg/L in 1 sample. Away from the outcrop area, water from the Douglas aquifer is likely to be saline, with dissolved-solids concentrations larger than 2,000 mg/L.

Ozark Aquifer

Water from the Ozark aquifer is variable in quality. The median concentration of dissolved solids in 41 samples was 1,000 mg/L. Locally in southeastern Kansas, the water is used for rural-domestic and public supplies. As is most ground water in Kansas, the water from this aquifer is very hard (hardness exceeded 200 mg/L in 90 percent of the samples). No exceptionally large concentrations of nitrate plus nitrite were reported, but the number of samples available (7) was considered too small to summarize in figure 2*C*. Fluoride concentrations in most samples were less than 2 mg/L. Northwest of the area shown in figure 2*A*, chloride concentrations in excess of 20,000 mg/L have been noted.

Effects of Land Use on Water Quality

Water quality has changed in some areas of Kansas because of the effects of mineral extraction, waste disposal, and agricultural practices. In addition, shallow aquifers have been contaminated locally by spills and by leaks from pipelines and storage tanks. Most of the sites in the "other site" category shown in figure 3*A* are of this type; where ground water has been contaminated from these sites, the area of contamination rarely exceeds 1 or 2 square miles.

Mineral Extraction

Drainage from abandoned lead-zinc and coal mines has caused water-quality changes in southeastern Kansas. Water in the mine shafts contains large concentrations of iron, manganese, zinc, and other trace elements and large concentrations of dissolved solids (principally sulfate). Values of pH as low as 2.2 were reported by Spruill (1984). Surface-water supplies and shallow alluvial aquifers (too small to show in figure 2*A*) have been affected. The entire area of Cherokee County is included in the National Priorities List of hazardous-waste sites under the Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA) (U.S. Environmental Protection Agency, 1986c). Although the Ozark aquifer, which underlies this area, probably has not been affected by mine drainage because it is deeply buried, the potential exists for contamination by leakage through drill holes and fractures.

Brines associated with the production of oil and gas have caused local contamination of freshwater aquifers in several areas in Kansas. Principal sources of contamination are leakage from brine-retention ponds and interaquifer movement of brines through improperly abandoned wells or test holes. Contamination by chloride is associated with oil production in Harvey County northwest of Wichita.

Waste Disposal

Six CERCLA (Superfund) sites, 113 sites investigated by the Kansas Department of Health and Environment under the Resource Conservation and Recovery Act (RCRA), and 5 Underground Injection Control (UIC) wells are shown in figure 3*A*. Most of these sites involve disposal of industrial wastes. RCRA sites are concentrated near the major population and industrial centers of Wichita (Sedgwick County), Topeka (Shawnee County), and Kansas City (Johnson, Leavenworth, and Wyandotte Counties). Wastes present at the CERCLA and RCRA sites include arsenic, chromium, lead, and other trace elements; petroleum products; volatile organic compounds (VOC); and agricultural chemicals. Areas of known and potential ground-water contamination from these sources are shown in figure 3*B*. Kansas has 5 UIC wells using on-site deep-well disposal of hazardous waste. Waste disposed of in these wells consists of ignitables, cooling water blow-down containing chromium, spent antimony catalyst from fluoromethane production, aqueous solution containing methylene chloride, and chloroform. No known contamination problems exist at these sites.

In addition to industrial waste-disposal sites, 104 active county and municipal landfills in Kansas that are monitored by the Kansas Department of Health and Environment are shown in figure 3*C*. Also shown are 281 closed and abandoned landfills that were identified from county highway maps. Few data are available to evaluate the effects of these closed landfills on local ground-water quality.

Agriculture

Few studies have been conducted to determine the effect of irrigation on ground-water quality in Kansas. Irrigation is not practiced extensively in the eastern one-third of the State, and water quality in the glacial-drift, Chase and Council Grove, Douglas, and Ozark aquifers is unlikely to be affected by irrigation. The Ozark aquifer also is protected by the thickness of the overlying units.

Spruill (1985) attributed increased concentrations of calcium, sodium, sulfate, chloride, and dissolved solids in alluvial aquifers in north-central Kansas to irrigation return flows. However, analyses for pesticides for which primary drinking-water standards have been established indicated no contamination of ground water by these compounds.

Investigations to determine the effect of agricultural practices on the quality of water in the High Plains aquifer in western Kansas began in 1984. Although concentrations of sodium and bicarbonate have increased as a result of irrigation, insecticides and herbicides were not detected or were detected in only trace concentrations (J.K. Stamer, U.S. Geological Survey, oral commun., 1986).

Recent investigations have detected herbicides in water from the High Plains aquifer in north-central Sedgwick County (H.E. Bevans, U.S. Geological Survey, oral commun., 1986). These findings are of concern to State and local officials because the city of Wichita uses water from this aquifer as a principal source of public supply.

POTENTIAL FOR WATER-QUALITY CHANGES

Available water supplies in most of the irrigated areas of Kansas are almost completely appropriated, and irrigation is unlikely to increase greatly. However, the potential for additional contamination of ground water from agricultural practices remains. The movement of pesticides through the unsaturated zone is poorly understood, and investigations to determine their effect on ground-water quality continue. Declining water levels caused by withdrawals for irrigation also offer the potential for contamination of freshwater aquifers by underlying brines. Disposal and management of oil and gas production wastes are regulated by the State, but such regulation is sometimes difficult to enforce, particularly where large areas are involved. Disposal of oil-field brines remains a potential source of contamination.

GROUND-WATER-QUALITY MANAGEMENT

The principal State agencies with regulatory authority over matters of ground-water quality are the Kansas Corporation Commission (KCC) and the Kansas Department of Health and Environment (KDHE). The KCC enforces regulation of oil and gas exploration and production, with a statutory mandate [Kansas Statutes Annotated (KSA) 55–115 and the following] to protect the quality of fresh ground-water supplies. It also is responsible for locating and plugging abandoned oil and gas wells (KSA 55–1003 and the following).

The KDHE is responsible for developing water-quality-management plans, monitoring waste-disposal sites, monitoring public-water supplies, licensing well drillers, and responding to emergency water-contamination problems (KSA 65–161 and the following, 82a–1035 through 1038, 82a–1201 and the following).

The Kansas State Board of Agriculture, Division of Water Resources, is responsible for the administration of water rights. The Division of Water Resources and the five local Groundwater Management Districts have authority to instigate controls on withdrawals in areas where ground-water quality is deteriorating. The Board of Agriculture also regulates and monitors the use of agricultural chemicals. The Kansas Geological Survey conducts studies and research on ground-water availability and quality, and performs ground-water investigations on a service or contractual basis for other State agencies.

Kansas has established State drinking-water standards that are used in the assessment of ground-water quality (Kansas Administrative Regulations 28–15–11 through 28–15–20). A ground-water-quality monitoring network was established in 1976, in cooperation with the U.S. Geological Survey, to monitor background quality. About 250 wells in the network are sampled each year and analyzed for major ions, trace elements, radionuclides, and selected organic compounds. In addition, the KDHE obtains a sample annually from the distribution systems of each of the 525 public supplies that use ground water. These samples are analyzed for major ions and bacterial content, and every 3 years a sample is analyzed for trace elements and radionuclides. The Department also conducts studies of specific areas of known or potential ground-water contamination in cooperation with the Kansas Geological Survey and the U.S. Geological Survey.

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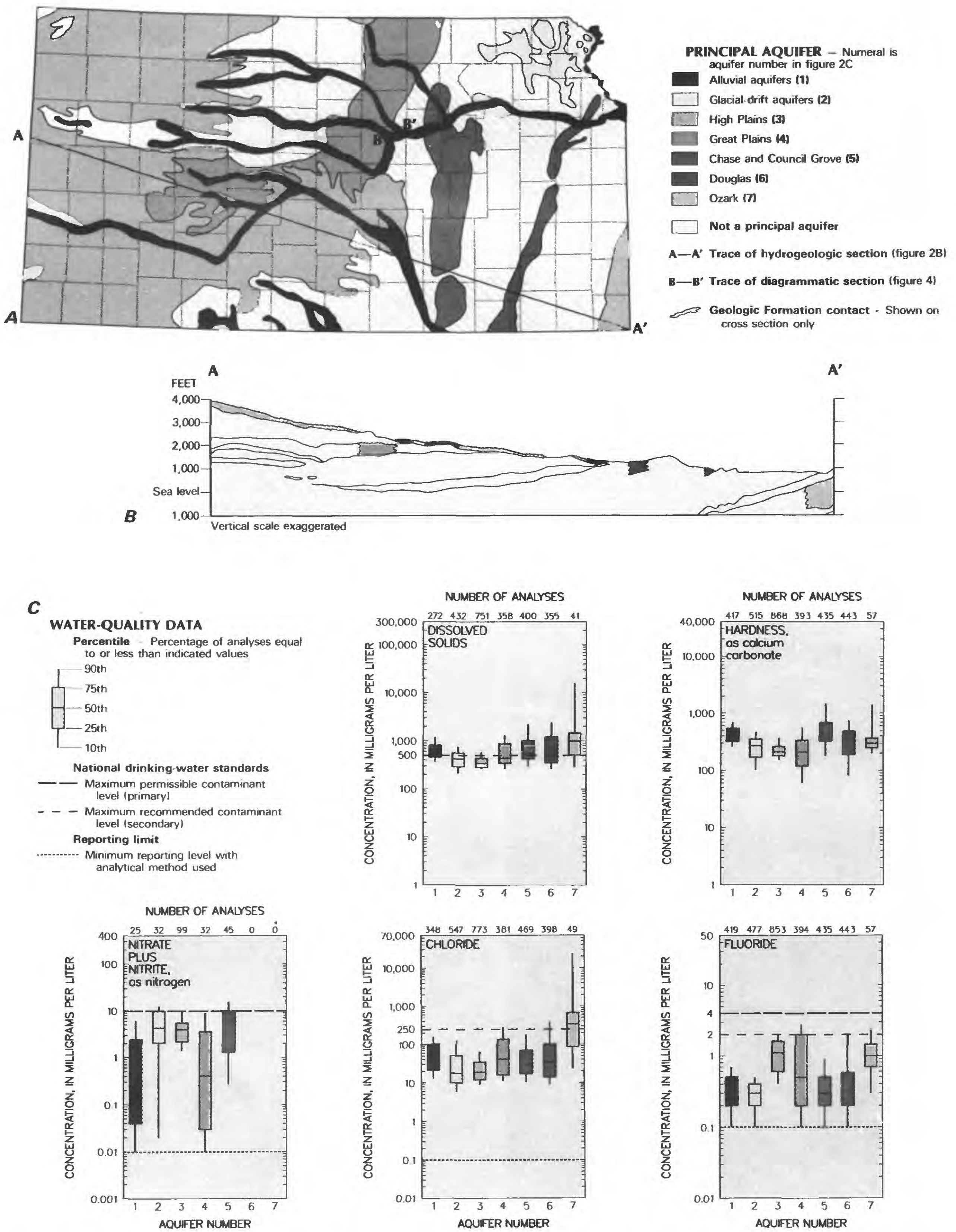

Figure 2. **Principal aquifers and related water-quality data in Kansas.** *A*, Principal aquifers. *B*, Generalized hydrogeologic section. *C*, Selected water-quality constituents and properties, as of 1965–85. (Sources: *A*, Bayne, 1975; Luckey and others, 1981. *B*, Data from U.S. Geological Survey files. *C*, Analyses compiled from U.S. Geological Survey files; national drinking-water standards from U.S. Environmental Protection Agency, 1986a,b.)

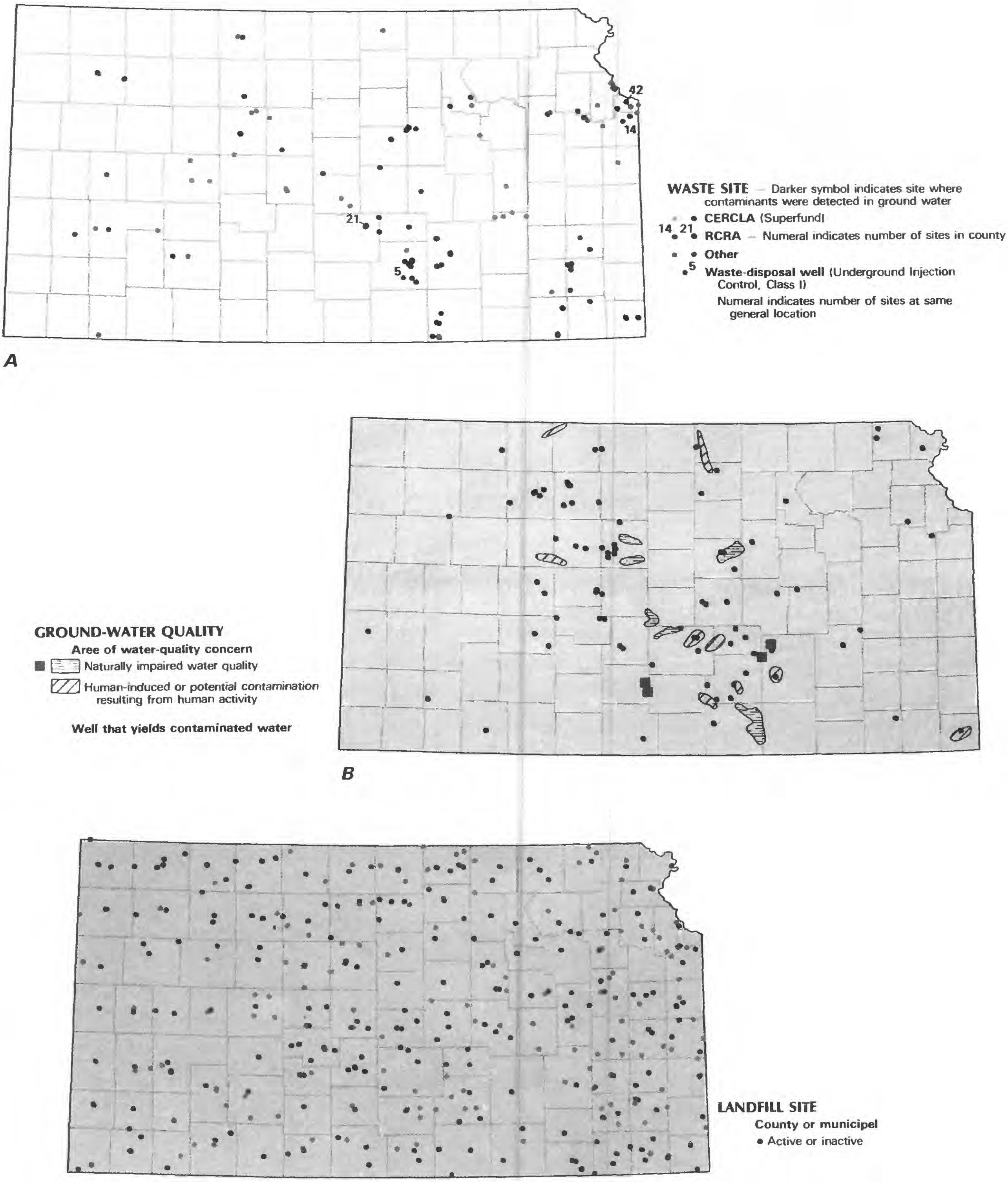

Figure 3. Selected waste sites and ground-water-quality information in Kansas. *A*, Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) sites; Resource, Conservation and Recovery Act (RCRA) sites; and other selected waste sites, as of 1986. *B*, Areas of naturally impaired water quality, areas of human-induced or potential contamination, and distribution of wells that yield contaminated water, as 1986. *C*, County and municipal landfills, as of 1986. (Sources: *A*, U.S. Environmental Protection Agency, 1986c; Kansas Department of Health and Environment, unpublished data. *B*, Kansas Department of Health and Environment, unpublished data; Gillespie and Hargadine, 1981; Gogel, 1981; Spruill, 1985. *C*, Kansas Department of Health and Environment, 1985, and unpublished data.)

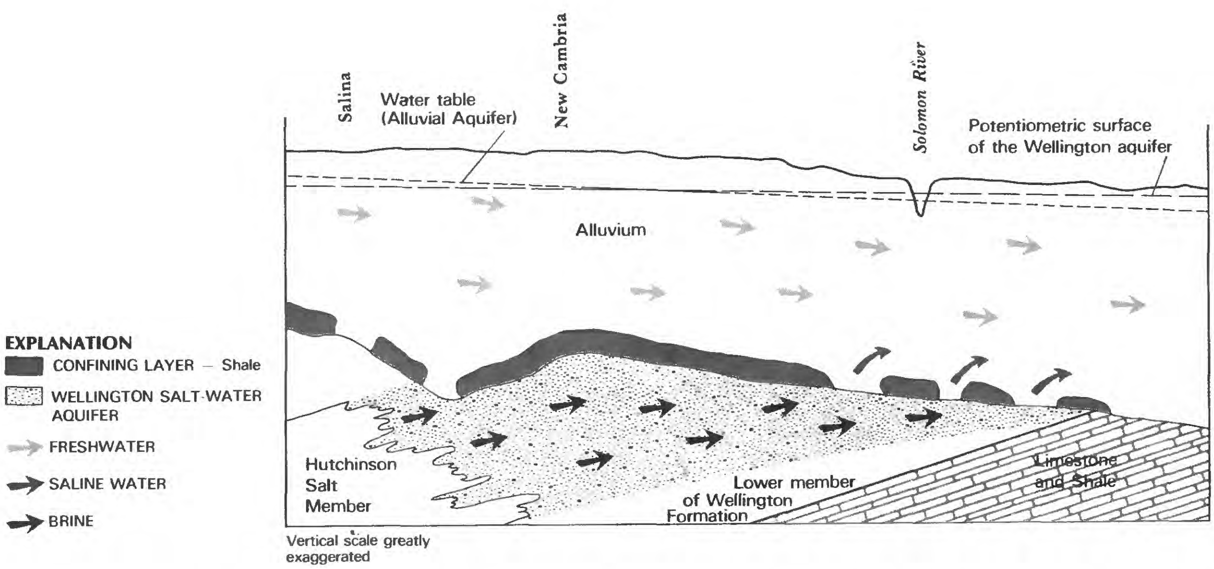

Figure 4. Diagrammatic section along the Smoky Hill River valley showing patterns of ground-water flow that introduce saline water into the alluvial aquifer. (Source: modified from Gillespie and Hargadine, 1981, fig. 10.)