WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN KANSAS--FISCAL YEARS 1989, 1990, AND 1991

Compiled by L.J. Combs and K.A. Powell

U.S. GEOLOGICAL SURVEY
Open-File Report 92-90

Lawrence, Kansas
1992

U.S. DEPARTMENT OF THE INTERIOR

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U.S. GEOLOGICAL SURVEY

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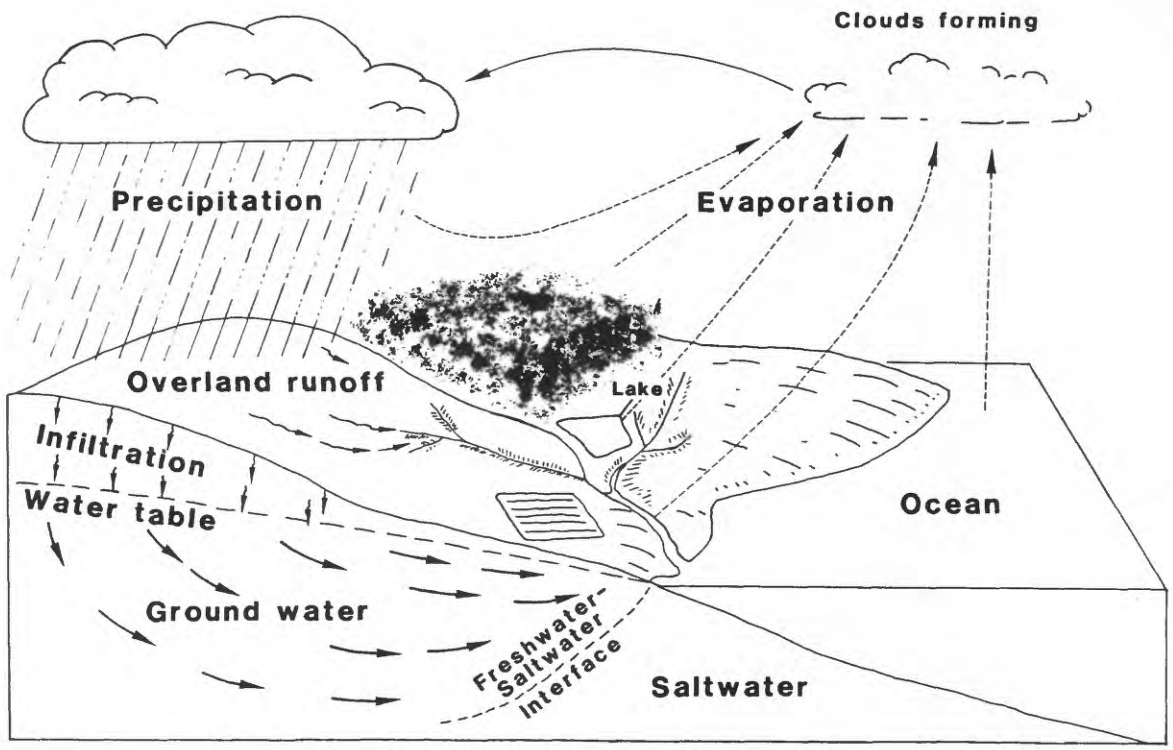
Office of U.S. Geological Survey in Lawrence, Kansas.

CONVERSION FACTORS

Multiply		*To obtain*
foot	0.3048	meter
mile	1.609	kilometer
acre	0.4047	hectare
square mile	2.590	square kilometer
pound	0.4536	kilogram



Hydrologic cycle.

WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN KANSAS-- FISCAL YEARS 1989, 1990, AND 1991

Compiled by

L. J. Combs and K.A. Powell

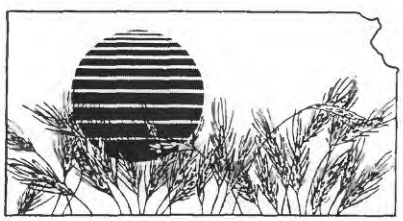
ABSTRACT

The principal mission of the U.S. Geological Survey, Water Resources Division, in Kansas is to investigate the occurrence, quantity, quality, distribution, and movement of surface and ground water throughout the State. Primary activities include the systematic collection, analysis, and interpretation of hydrologic data, evaluation of water demands, and water-resources research. Four types of hydrologic investigations are conducted: (1) data-collection activities, (2) statewide or regional investigations, (3) local or areal investigations, and (4) research. These studies are funded through joint-funding agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal funds.

Forty water-related studies were ongoing during fiscal years 1989 through 1991 in Kansas. This report describes for each study the problem that initiated the study, the objectives of the study, the approach designed to achieve the objectives, and significant milestones and publications that resulted during fiscal years 1989-91. Information on more than 1,800 data-collection stations in Kansas is presented in maps and tables. A list of 81 reports and abstracts published or released by the U.S. Geological Survey, its cooperators, or technical and scientific organizations during calendar years 1989, 1990, and 1991 is provided.

INTRODUCTION

The Organic Act of March 3, 1879, established the U.S. Geological Survey as a separate Bureau of the U.S. Department of the Interior. The Survey's principal mission became (1) the classification and survey of public lands, (2) the examination of the geologic structure and the mineral resources of the national domain, and (3) the determination of the water resources of the United States. Seven years later, in 1886, the first water-resources investigation by the U.S. Geological Survey in Kansas was completed by A.C. Peale. A joint-funding agreement with the Kansas State Board of Irrigation and Surveys established the first streamflow-gaging stations in western Kansas during 1895. The gaging program was extended to eastern Kansas in 1899.



From these early beginnings, the U.S. Geological Survey has expanded its work in Kansas to meet the growing demand for scientific data by Federal, State, and local agencies for use in the management of one of the State's most precious resources--water. The Kansas District, with headquarters in Lawrence and a field office in Garden City (fig. 1), investigates the occurrence, quantity, quality, distribution, and movement of surface and ground water. Its activities include the systematic collection, analysis, and interpretation of data; the investigation of water demand for public supply, industrial, domestic, and agricultural purposes; and the

research and development of new techniques to improve the scientific basis of data collection and investigative principles.

Hydrologic-data collection and analyses and investigative studies are conducted at project offices in Lawrence and Garden City. Hydrologic-data management, the District's sediment and organic geochemistry research laboratories, computer applications, and the scientific publications section are located at the District office in Lawrence. The percentage of Survey personnel in the Kansas District by job category for fiscal years 1989 and 1990 is shown in figure 2. The fiscal year (FY) for Federal-government operations extends from October 1 of each year to September 30 of the following year. In publications of the U.S. Geological Survey, this time period is also known as a water year.

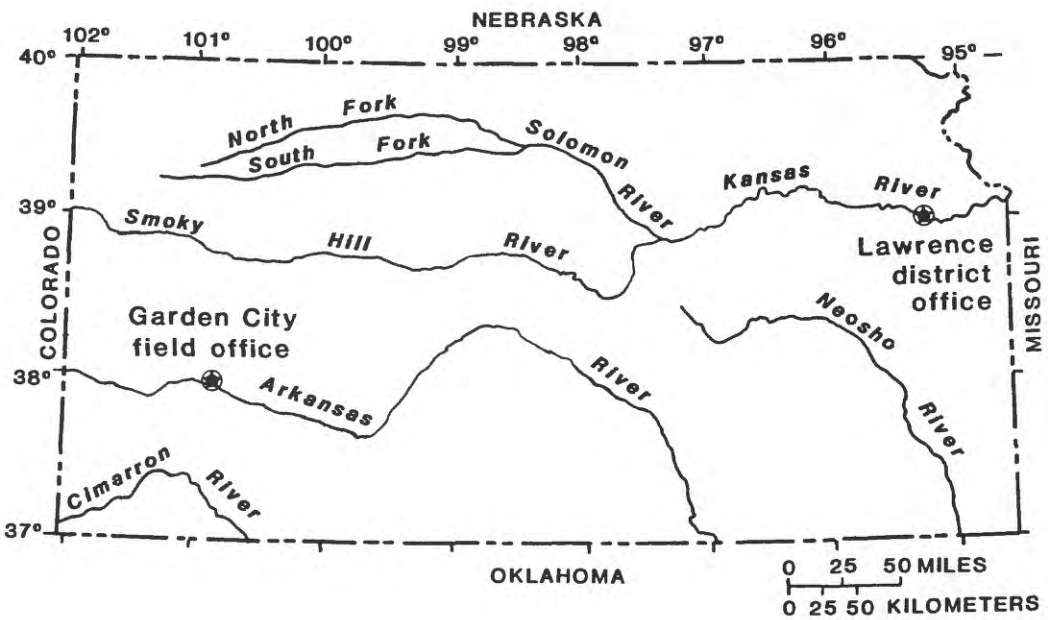


Figure 1. Location of offices of the U.S. Geological Survey in Kansas.

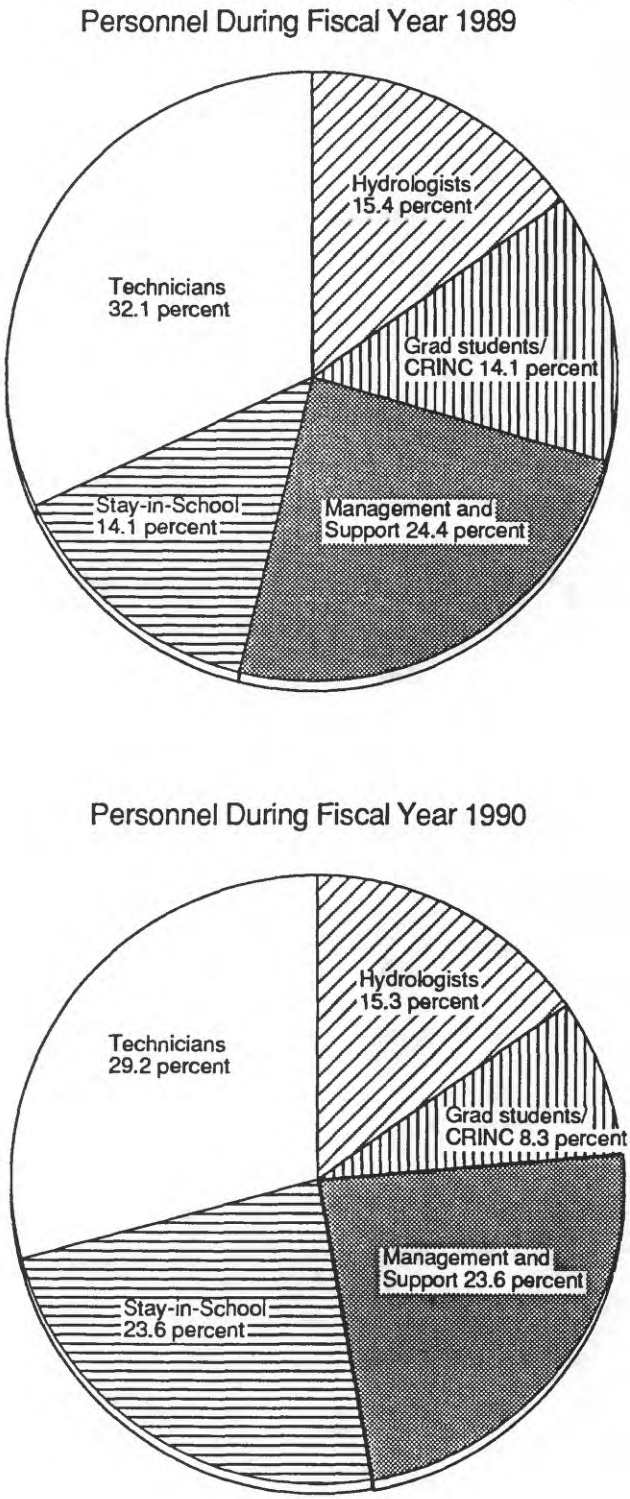


Figure 2. Percentage of Survey personnel in Kansas District by job category, fiscal years 1989, 1990, and 1991.

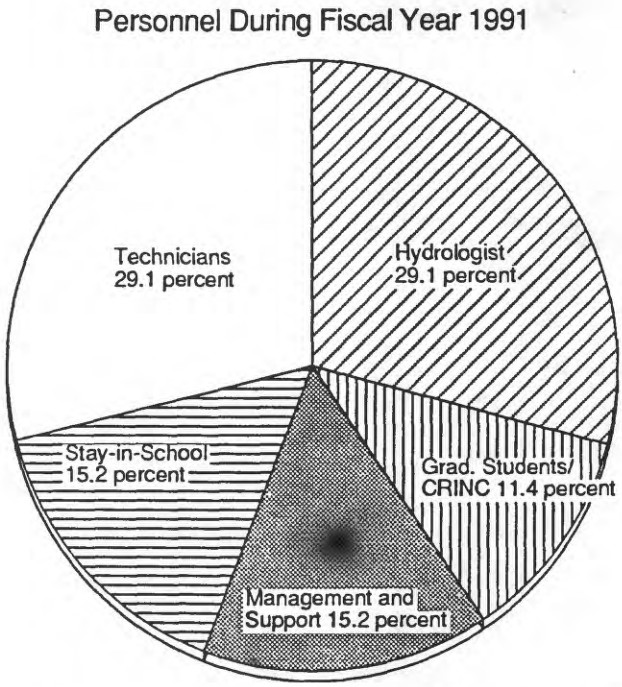


Figure 2. Percentage of Survey personnel in Kansas District by job category, fiscal years 1989, 1990, and 1991--Continued

PROGRAM FUNDING AND COOPERATION

Money for program operation of the U.S. Geological Survey in Kansas comes from joint-funding agreements with State and local agencies, transfer of funds from other Federal agencies, and direct Federal appropriations to the U.S. Geological Survey. Distribution of funding for program operation in FY89-91 is illustrated in figure 3. Those agencies having joint-funding agreements with the U.S. Geological Survey in Kansas during the 1989, 1990, and 1991 fiscal years were:

State and local agencies

Arkansas River Compact Administration
City of Emporia
City of Hays
City of Kansas City, Kansas
City of Olathe
City of Wichita
Equus Beds Groundwater Management District No. 2
Geary County
Harvey County
Iowa Tribe of Kansas and Nebraska
Kansas Department of Health and Environment
Kansas Department of Transportation
Kansas Geological Survey
Kansas State Board of Agriculture, Division of Water Resources
Kansas State University
Kansas Water Office
Kickapoo Tribe of Kansas

Linn County
Prairie Band of Potawatomie
Reno County
Sac and Fox Tribe of Missouri
Sedgwick County
Sumner County
University of Kansas, Center for Research
Western Kansas Groundwater Management District No. 1
Wyandotte County

State and local agencies--Continued

U.S. Bureau of Indian Affairs
U.S. Bureau of Reclamation
U.S. Department of Agriculture, Agricultural Research Service
U.S. Department of Agriculture, Soil Conservation Service
U.S. Department of Army, Corps of Engineers
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Federal agencies

PUBLICATIONS

Water-resources data and the results of hydrologic investigations in Kansas are published or released either by the U.S. Geological Survey, by cooperating agencies, or by journals of technical and scientific organizations. Requests for such information and for publications resulting from past or present investigations of the U.S. Geological Survey in Kansas should be addressed to one of the following:

District Chief
U.S. Geological Survey
Water Resources Division
4821 Quail Crest Place
Lawrence, Kansas 66049-3839
Telephone: (913) 842-9909

Office Chief
U.S. Geological Survey
Water Resources Division
206 Fulton Terrace
Garden City, Kansas 67846
Telephone: (316) 275-4123

U.S. Geological Survey
Open-File Reports
Box 25425
Earth Science Information Center
Denver, Colorado 80225
Telephone: (303) 236-7476

During calendar years 1989-91, personnel of the U.S. Geological Survey in Kansas authored or coauthored 81 water-related reports and abstracts. This total included 47 interpretive reports, 7 data reports, and 27 abstracts. A complete listing of these reports and abstracts begins on page 86.

The U.S. Geological Survey also conducts an extensive mapping program in Kansas from its regional office in Rolla, Missouri. Standard topographic quadrangle maps published in the 7 1/2- and 15-minute series provide coverage for the entire State. Land-use and land-cover maps and associated digital map data are also available at a scale of 1:250,000. County-wide metric topographic maps (1:50,000 and 1:100,000 scale) and 7 1/2-minute slope maps

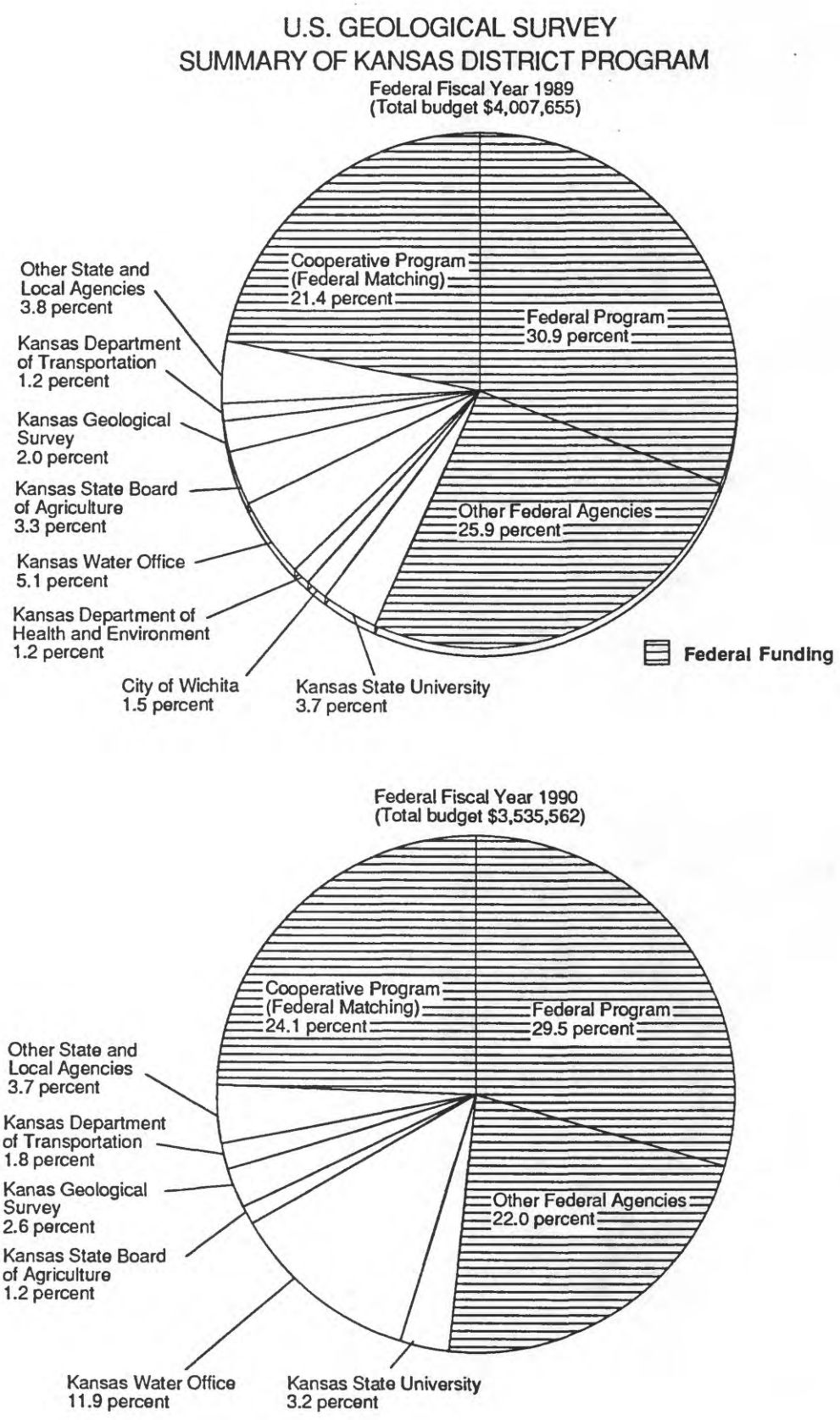


Figure 3. Distribution of funding for the water-resources program of the U.S. Geological Survey in Kansas, fiscal years 1989, 1990, and 1991.

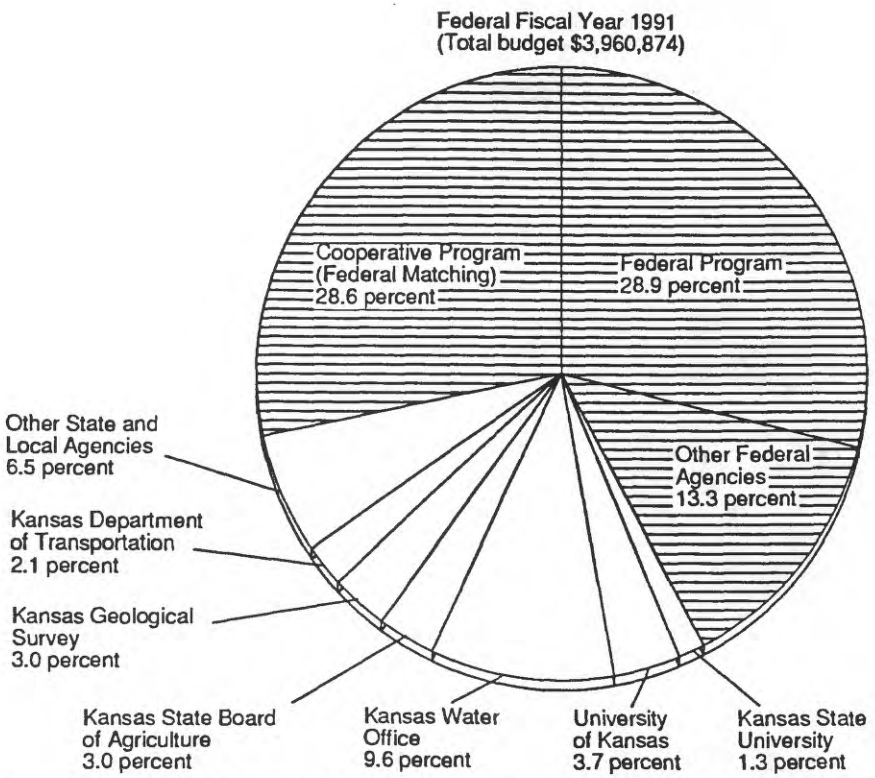


Figure 3. Distribution of funding for the water-resources program of the U.S. Geological Survey in Kansas, fiscal years 1989, 1990, and 1991--Continued.

PUBLICATIONS--Continued

are available only for selected areas. To obtain an index or to purchase these maps, contact:

Kansas Geological Survey
Publications Sales
1930 Constant Avenue - Campus West
Lawrence, Kansas 66046
Telephone (913) 864-3965

For additional information on the U.S. Geological Survey's mapping program in Kansas, contact:

Mid-Continent National Cartographic
Information Center
U.S. Geological Survey
1400 Independence Road
Rolla, Missouri 65401
Telephone (314) 341-0851

Studies in Kansas to investigate the frequency and extent of flooding have resulted in delineation of the 100-year flood boundary on selected topographic quadrangle maps (fig. 4). These maps are available from the Kansas District office in Lawrence.

EDUCATIONAL OUTREACH

Elementary and Secondary Education

The President of the United States has called for every sector of America to make a concerted effort to improve pre-college education. The U.S. Department of the Interior supports President Bush's goal of raising the standards of education and making quality education accessible to all Americans. The U.S. Geological Survey is participating in this effort by providing leadership to

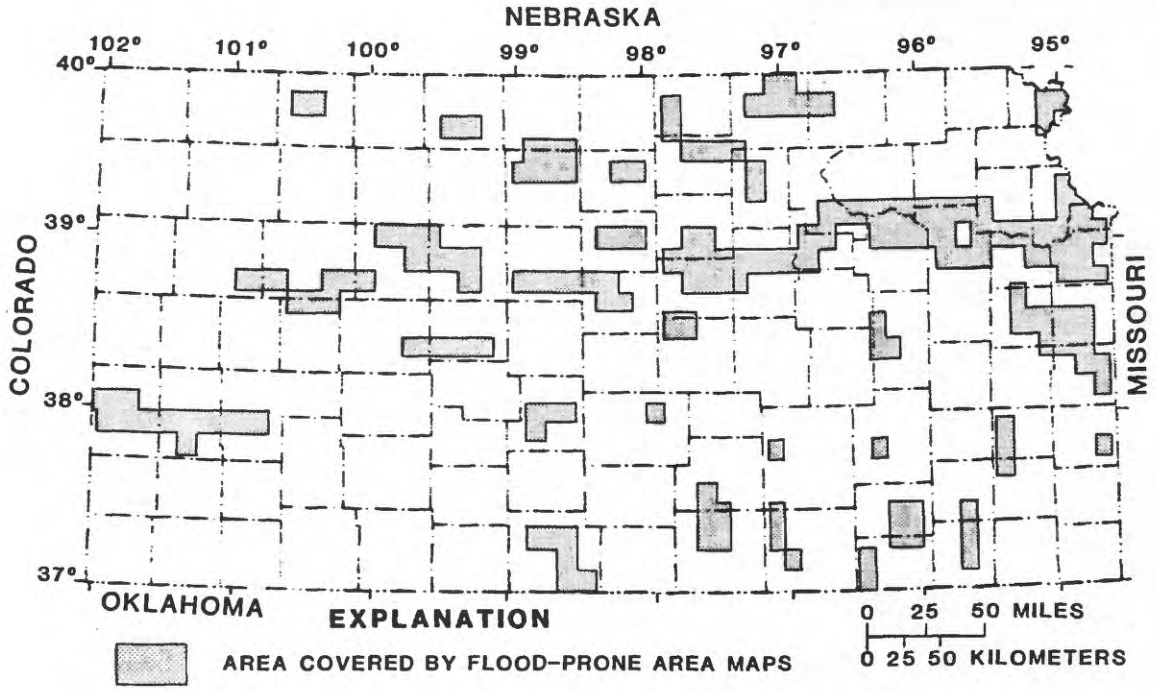


Figure 4. Availability of flood-prone area maps.

Elementary and Secondary Education--Continued

support the development of Earth-science literacy in elementary and secondary schools.

As one phase of this initiative, the U.S. Geological Survey entered into an agreement with the U.S. Bureau of Indian Affairs (BIA) in 1990 to provide Earth-science information and appropriate resources for educational outreach to Native Americans. As part of this effort, the Kansas District of the U.S. Geological Survey participated in the BIA's Math/Science Institute Summer Workshop on June 18 and July 16, 1990, at Haskell Indian Junior College in Lawrence, Kans. District staff presented eight workshop sessions on resources that the U.S. Geological Survey has available to help educators teach science to their students. The resources discussed included U.S. Geological Survey publications (general-interest pamphlets, maps, posters, and reports), films, videos, personnel (as speakers and resource people), and the Volunteer for Science Program (where teachers can gain practical experience in the Earth sciences by participating in scientific research). A total of about 200 elementary and secondary teachers and principals employed by BIA participated in the workshop sessions.

The U.S. Geological Survey in Kansas is also an active participant in the "Partnership in Education" program in which local-organization, business, and government-agency volunteers share their fields of expertise with elementary and secondary schools of the community. During fiscal years 1989-91, Survey personnel presented talks and demonstrations to 3rd, 5th, and 6th graders at Deerfield Elementary School in Lawrence and Overbrook Middle School in Overbrook, Kansas. Topics discussed included: (1) collection of Earth-science data by the U.S. Geological Survey, (2)

water pollution, (3) droughts, and (4) volcanoes. Survey personnel also served as Science Fair judges for Lawrence-area schools.

Colleges and Universities

The U.S. Geological Survey in Kansas and departments and agencies throughout the Federal government have supported student employment under the Stay-In-School Program for many years. This program has as its major objective the employment of needy students, giving them a chance to work in Federal agencies so that they can resume or continue their educations without the interruptions caused by financial pressures. The Stay-In-School Program is designed to benefit students who are in high school or who are continuing their educations immediately after high school. During fiscal years 1989-91, a total of 39 stay-in-school students were employed by the Kansas District as well as 8 graduate students paid with project funds.

During fiscal years 1989-91, staff members of the Kansas District were actively involved in curriculum development for a graduate research seminar in Civil Engineering and shared joint-teaching duties for a graduate seminar for the Kansas Water Resources Research Institute, and gave lectures on hydrology and ground-water modeling to science and engineering students at the University of Kansas in Lawrence. Kansas District staff also participated in career fairs sponsored by Haskell Indian Junior College (Lawrence), the University of Kansas (Lawrence), and Kansas State University (Manhattan).

Education Materials

In support of President Bush's emphasis on science and mathematics education, the U.S. Geological Survey continues to develop educational materials for students in kindergarten through senior high school. Materials include lectures, lesson plans, slides, posters, and student activities. Educational materials are available from several outlets. Help in choosing the most appropriate outlet may be obtained from the Kansas District office in Lawrence (telephone: 913-842-9909).

The Books and Open-File Reports Section of the U.S. Geological Survey is a mail-order outlet that distributes the following kinds of book products: (1) books in the formal series, such as U.S. Geological Survey Bulletins, Professional Papers, Water-Supply Papers, Techniques of Water-Resources Investigations, Circulars, special books, and catalogs; (2) popular publications of general interest, such as leaflets, pamphlets, posters, and booklets; (3) single copies of "Earthquake and Volcanoes," and "Preliminary Determination of Epicenters"; and (4) miscellaneous reports, including some that are no longer available from the Superintendent of Documents. The Books and Open-File Reports Section is also a mail-order facility for microfiche and paper copies of most U.S. Geological Survey Open-File Reports as well as the primary distribution center for new Water-Resources Investigations Reports.

Education Materials--Continued

USGS Books and Sales
Federal Center, Box 25425
Building 810
Denver, Colorado 80225
(303) 236-7476

The Visual Information Services Group provides Earth-science movies and videos on a free-loan, short-term (2- to 3-day) basis to educational institutions, professional and scientific societies, civic and industrial groups, and other such establishments.

Visual Information Services Group
U.S. Geological Survey
790 National Center
Reston, VA 22092
(703) 648-4376

Exhibits illustrating recent work in cartography, geography, geology, water resources, and other aspects of U.S. Geological Survey research can be requested from the USGS Exhibits Committee for display at professional meetings and technical conferences.

Chairman, USGS Exhibits Committee
U.S. Geological Survey
790 National Center
Reston, VA 22092
(703) 648-4357

Exhibits illustrating recent work in water-resources research in Kansas can be requested from the Publications Section of the U.S. Geological Survey in Lawrence, Kans.

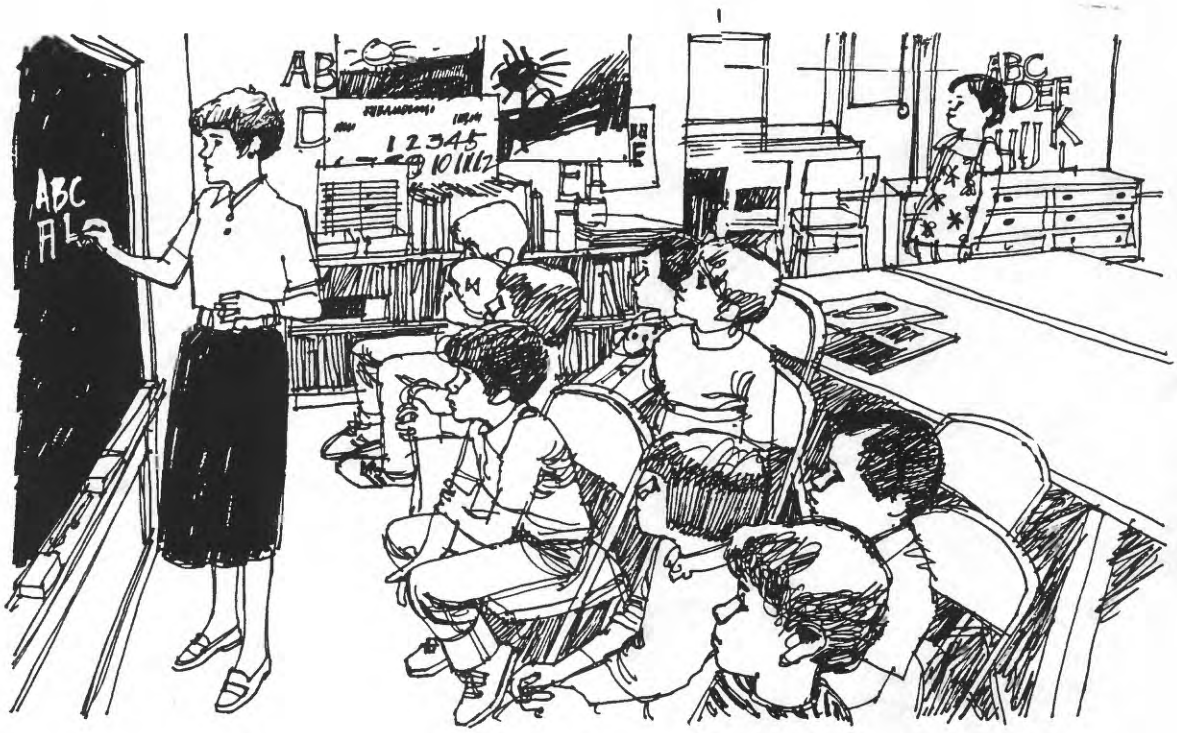
Publications Section
U.S. Geological Survey
Water Resources Division
4821 Quail Crest Place
Lawrence, KS 66049-3839
(913) 842-9909

Packets of teaching aids, which differ according to subject, grade level, and geographic location, are available from the Geologic Inquiries Group and the National Cartographic Information Center. These packets include lists of reference materials, various maps and map indices, and a selection of general interest publications. Requests for teachers packets should be sent on school letterhead and should indicate the grade level and subject of interest. The Geologic Inquiries Group compiles two packets: (1) "Selected Packet of Geologic Teaching Aids," for elementary- and secondary-school teachers of general science courses, and (2) "Teachers Packet of Geologic Materials," for secondary-school and college teachers of Earth-science courses.

Geologic Inquiries Group
U.S. Geological Survey
907 National Center
Reston, VA 22092
(703) 648-4383

The National Cartographic Information Center compiles specialized packets emphasizing mapping. Requests for packets should include specific details about the needs and (or) interests of a particular class.

National Cartographic Information Center
U.S. Geological Survey
507 National Center
Room 1-C-107
12201 Sunrise Valley Drive
Reston, VA 22092
(703) 648-5963



DATA-COLLECTION PROGRAMS

Throughout its long history of service, one mission of the U.S. Geological Survey, Water Resources Division, has been the comprehensive and systematic collection of hydrologic data and the timely release of such data for public use. To help provide this service, a network of hydrologic-data stations is maintained throughout Kansas to obtain records of (1) stage, discharge, chemical quality, and sediment yield of streams; (2) stage and content of lakes and reservoirs; (3) precipitation; and (4) water levels and chemical quality of ground water.

Systematically and routinely, the U.S. Geological Survey gathers data from more than 1,800 hydrologic stations in Kansas. The backbone of the system is a network of 164 automated streamflow-gaging stations. Measurements taken at most automated data-collection stations are punched on paper tapes that are retrieved during visits to each site at intervals of 6 weeks or more. Although the measurements are recorded at the hydrologic station in a timely manner, the manual retrieval of data generally means a timelag of 6 weeks or more in the dissemination of data.

A major objective of the U.S. Geological Survey in Kansas is to decrease the amount of time between the collection and dissemination of hydrologic data. Of the 164 automated streamflow-gaging stations in Kansas, 22 are linked via telephone lines for immediate retrieval of current stream stages. Even more detailed, real-time data are available from 121 hydrologic stations via satellite transmission to computer-receiving stations. Those hydrologic stations equipped with satellite-transmission facilities are shown in figure 5.

Hydrologic data collected in Kansas as part of the water-resources-data network are published annually in a comprehensive report entitled "Water Resources Data for Kansas, Water Year 19--." Each water-data report carries an identification number consisting of the two-letter state abbreviation, the last two digits of the water year, and the volume number. For example, the report for the 1990 water year is identified as "U.S. Geological Survey Water-Data Report KS-90-1." Reports for each water year are released the following calendar year. Water-data reports are available from the U.S. Geological Survey office in Lawrence, Kansas, or from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161.

Hydrologic data also are stored in both current and historical computer files in the U.S. Geological Survey's National Water-Data Storage and Retrieval System (WATSTORE). The data are available for water planning and management in machine-readable form, computer-printed tables or graphs, statistical analyses, and digital plots. Local assistance in the acquisition of computer services is available from the Kansas District office in Lawrence.

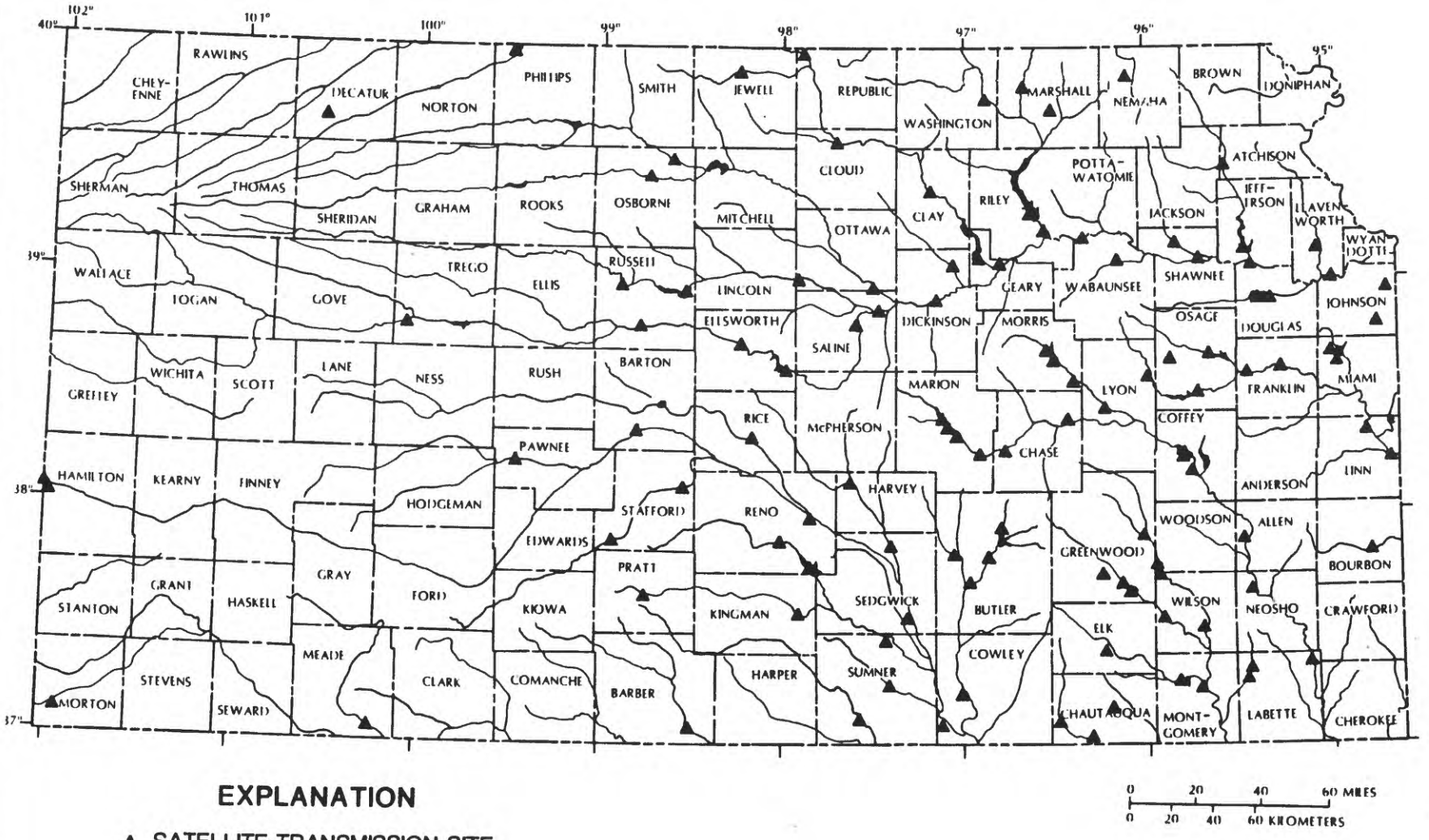


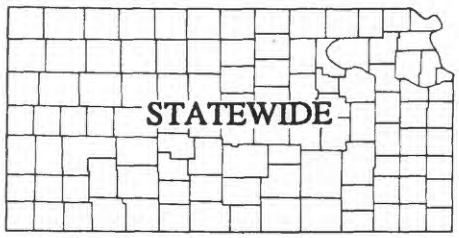
Figure 5. Location of satellite-transmission sites for 1991 water year.

PROJECT TITLE: Surface-water data program

PROJECT NUMBER: KS-001

COOPERATING AGENCY: Multi-agency

PROJECT CHIEF: C. O. Geiger



KS001

Problem--Surface-water information is needed for purposes of surveillance, planning, design, hazard warning, operation, and management in such water-related fields as water supply, hydroelectric power, flood control, irrigation, flood-plain management, and water-resources development. To provide this information, an appropriate and comprehensive data base is necessary.

Objectives--Collect surface-water data sufficient to satisfy needs for current uses, such as (1) assessment of water resources, (2) operation of reservoirs or for industrial supplies, (3) forecasting, (4) pollution control and disposal of wastes, (5) discharge data to accompany water-quality measurements, (6) compact and legal requirements, and (7) research or special studies.

Collect data necessary for analytical studies to define, for any location, the statistical properties of, and trends in, the occurrence of water in streams, lakes, and reservoirs for use in planning and design.

Approach--A network of gaging stations (figs. 6, 7, and 8; and tables 1, 2, and 3 at the end of this report) is maintained to provide surface-water data for management and operation, for determination of long-term trends, and for research and special studies. Data are collected on stage and discharge of streams or canals, on stage, surface area, and content of lakes and reservoirs, and on precipitation. The network of stations is reviewed periodically to ensure the collection of meaningful and worthwhile data.

Significant milestones--During the 1991 water year, 134 complete-record streamflow-gaging stations (table 1), 36 partial-record stations (table 2), and 13 precipitation stations (table 3) provided surface-water data throughout the State. Data on stage, surface area, and content of 24 lakes and reservoirs (table 1) also were collected. One continuous-record streamflow-gaging station was installed on October 1, 1990.

Reports

Geiger, C.O., Lacock, D.L., Merry, C.E., and Schneider, D.R, 1989, Water resources data, Kansas, water year 1988: U.S. Geological Survey Water-Data Report KS-88-1, 490 p.

Geiger, C.O., Lacock, D.L., Schneider, D.R., Carlson, M.D., and Merry, C.E., 1990, Water resources data, Kansas, water year 1989: U.S. Geological Survey Water-Data Report KS-89-1, 457 p.

Geiger, C.O., Lacock, D.L., Schneider, D.R., Carlson, M.D., and Pabst, B.J., 1991, Water resources data, Kansas, water year 1990: U.S. Geological Survey Water-Data Report KS-90-1, 370 p.

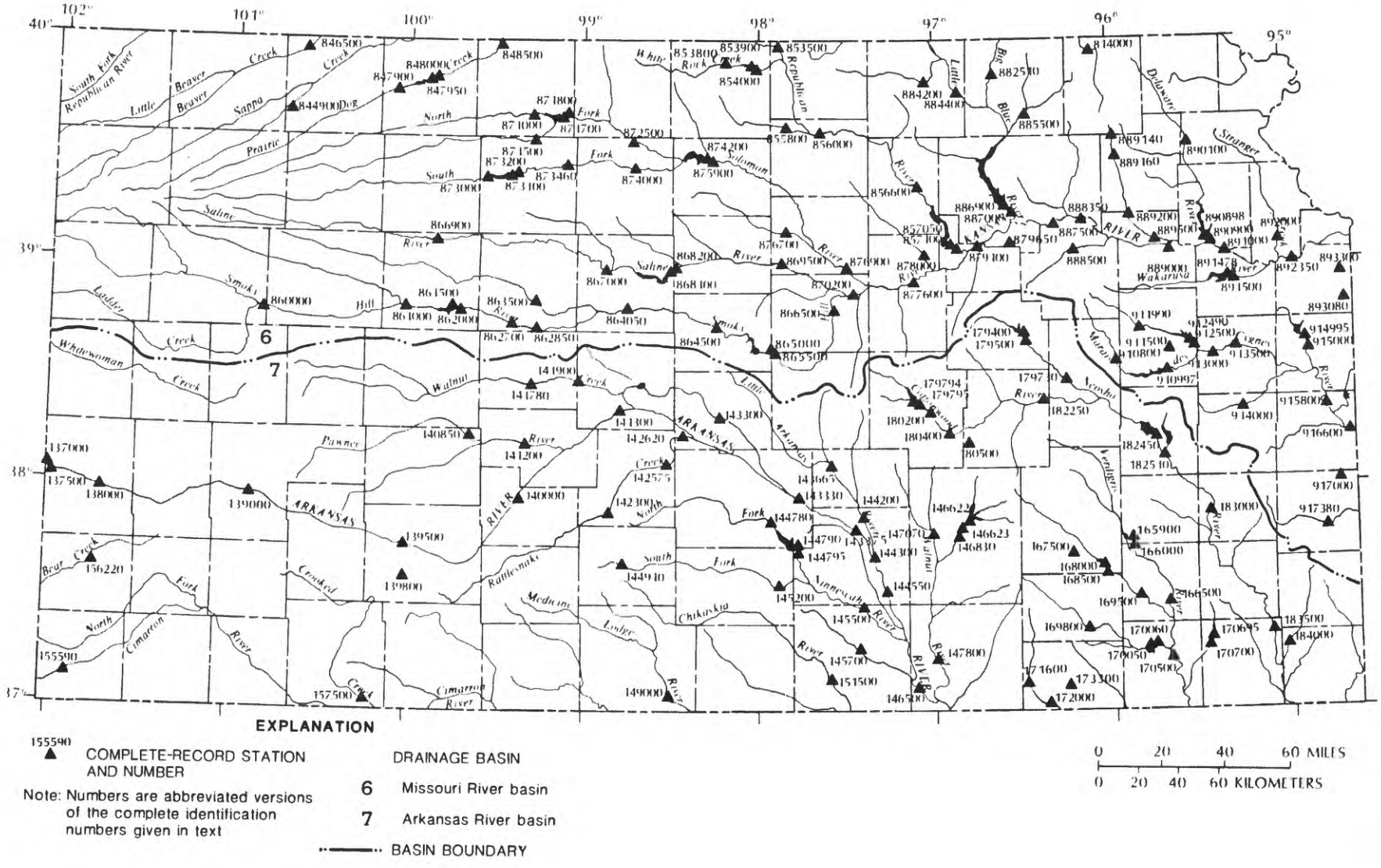


Figure 6. Location of complete-record streamflow-gaging stations, 1991 water year.

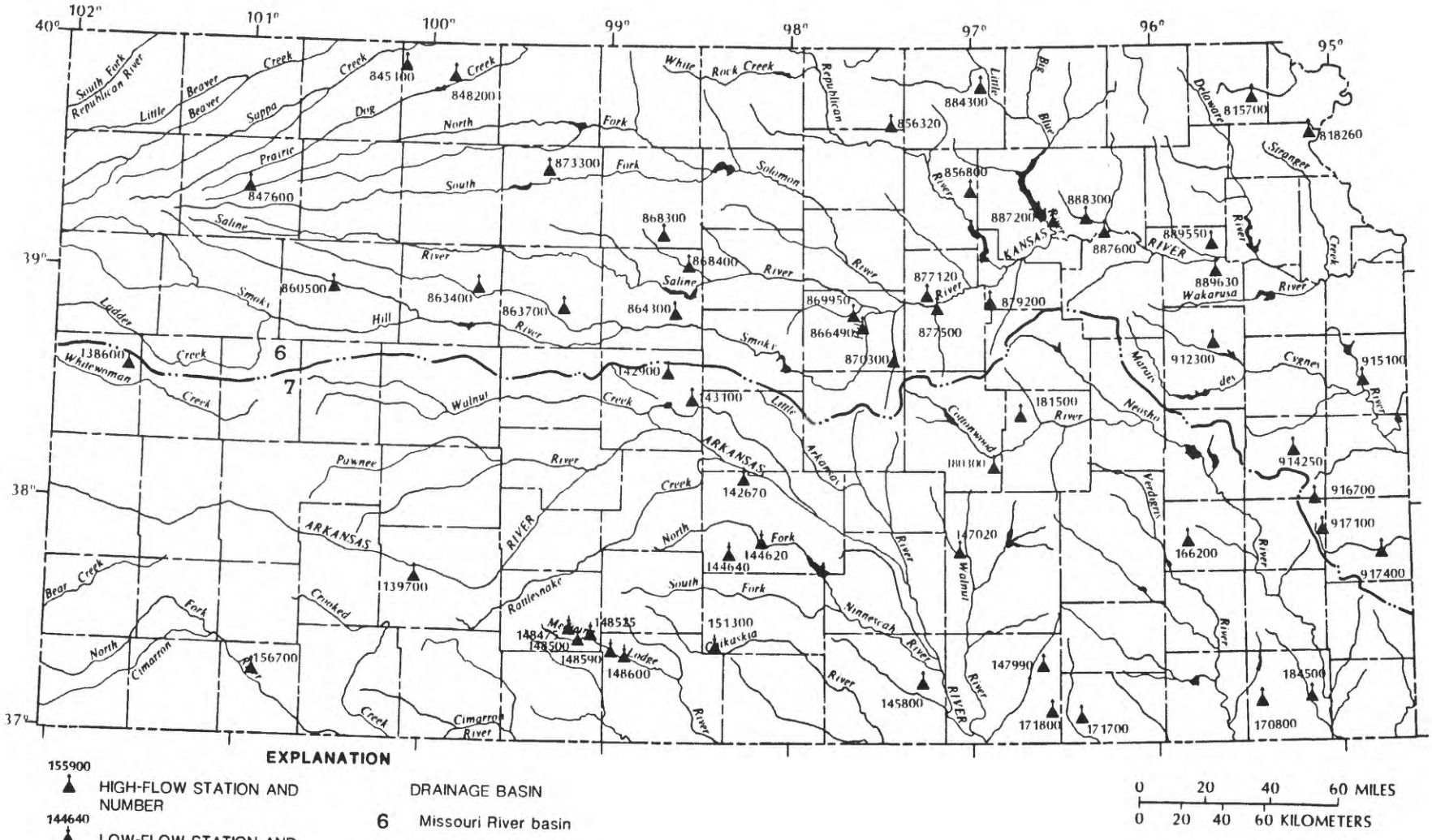


Figure 7. Location of partial-record streamflow-gaging stations, 1991 water year.

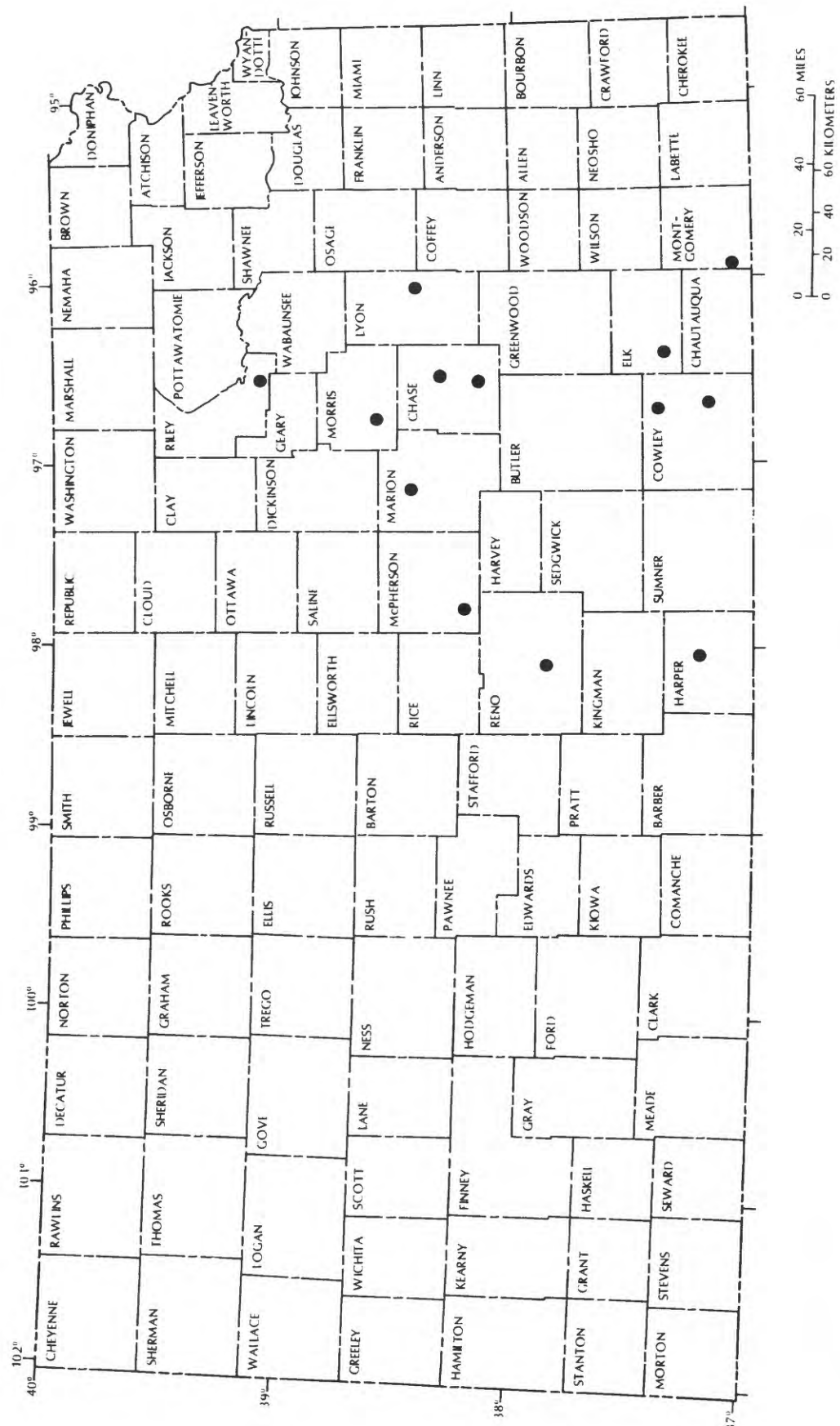
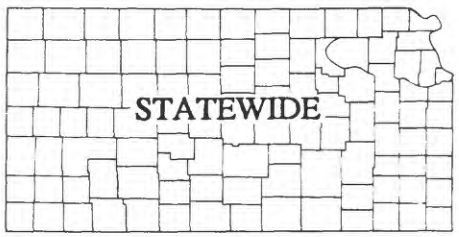


Figure 8. Location of recording precipitation stations, 1991 water year.



KS002

PROJECT TITLE: Ground-water data program

PROJECT NUMBER: KS-002

COOPERATING AGENCY: Multi-agency

PROJECT CHIEF: C. O. Geiger

Problem--Long-term water-level records are needed to: (1) evaluate the effects of climatic variations on the recharge to and discharge from ground-water systems in Kansas, (2) provide a data base from which to measure the effects of development, (3) assist in the prediction of future supplies, and (4) provide data for management of the resource.

Objectives--Collect water-level data sufficient to provide a minimum long-term data base so that the general response of the hydrologic system to natural climatic variations and induced stresses is known and so that potential problems can be defined early enough to allow proper planning and management.

Provide a data base against which the short-term records acquired in areal studies can be analyzed. This analysis must: (1) provide an assessment of the ground-water resources, (2) allow predictions of future conditions, (3) detect and define pollution and supply problems, and (4) provide the data base necessary for management of the resource.

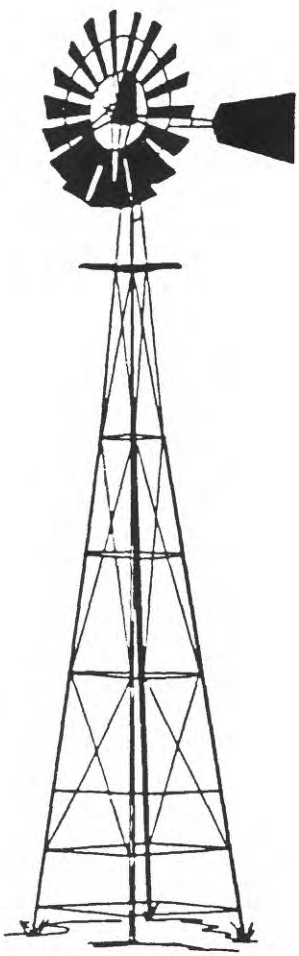
Approach--A network of observation wells (fig. 9 and table 4 at the end of this report) is measured to provide a data base for monitoring the general response of ground-water systems to natural climatic variations and to stresses of pumpage. A long-term record of water-level measurements, in conjunction with a description of the hydrologic system, provides data for proper planning and management, and for scientific investigations.

Significant milestones--Ground-water levels were measured in approximately 1,625 observation wells during the 1991 water year.

Reports

Buddemeier, R.W., Shamsnia, Saeed, Woods, John, and McClain, T.J., 1991, January 1990 Kansas water levels and data related to water-level change: Kansas Geological Survey Open-File Report 91-12, 129 p.

Townsend, Margaret, Shaukat, Nadeem, Healy, John, and McClain, Tom, 1989, January 1989 Kansas water levels and data related to water-level changes: Kansas Geological Survey Ground-Water Series 10, 127 p.



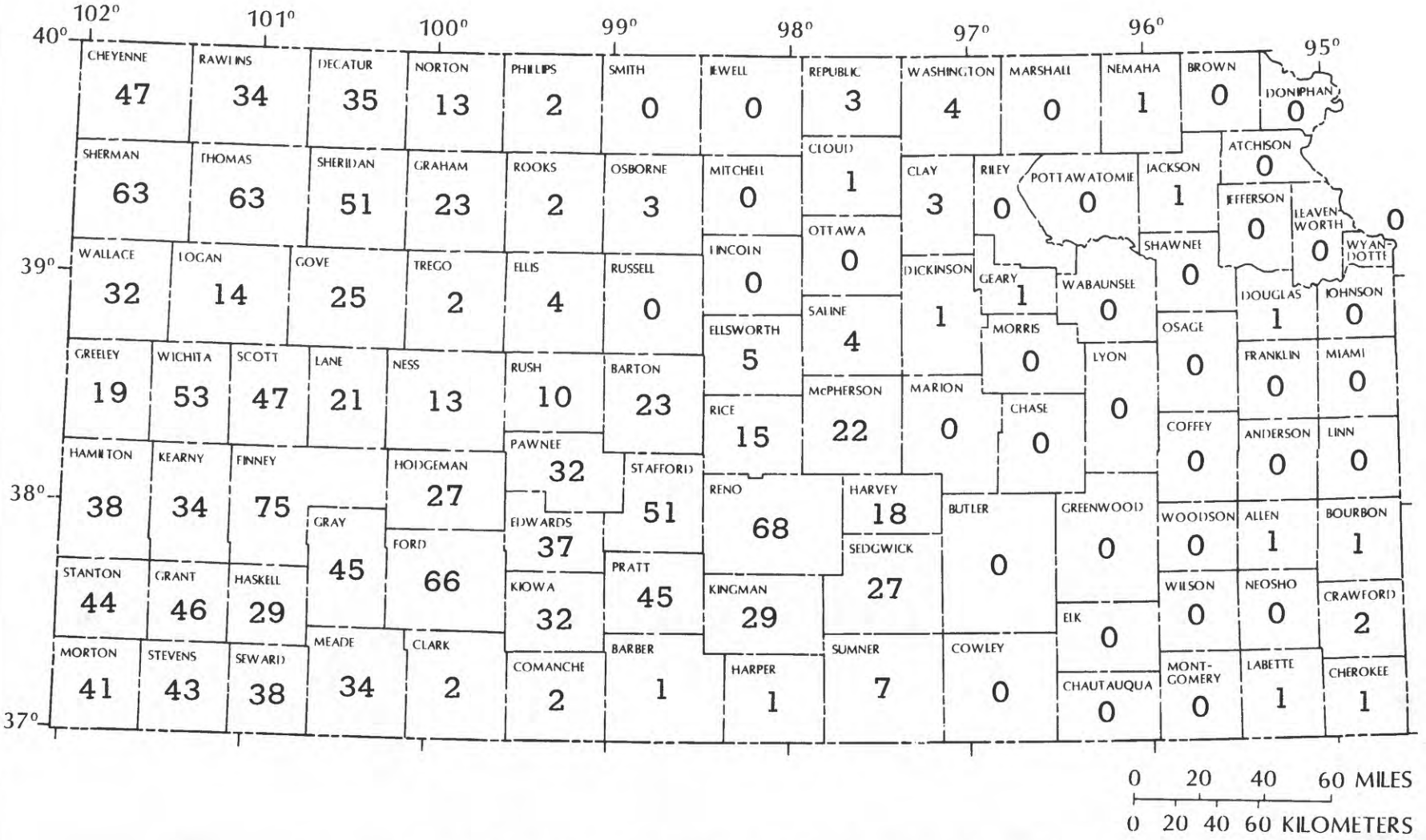


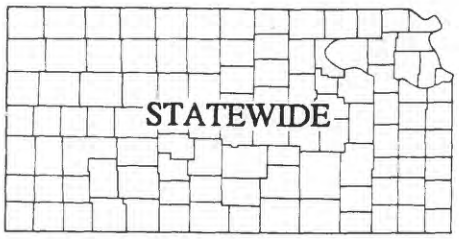
Figure 9. Number of ground-water-level observation wells per county, 1991 water year.

PROJECT TITLE: Water-quality data program

PROJECT NUMBER: KS-003

COOPERATING AGENCY: Multi-agency

PROJECT CHIEF: C. O. Geiger



Problem--Water-resources planning and water-quality assessment require a national data base of relatively standardized information. For intelligent planning and realistic assessment of the water resource, the chemical and physical quality of the rivers, streams, lakes, and reservoirs, as well as major ground-water systems, must be defined and monitored.

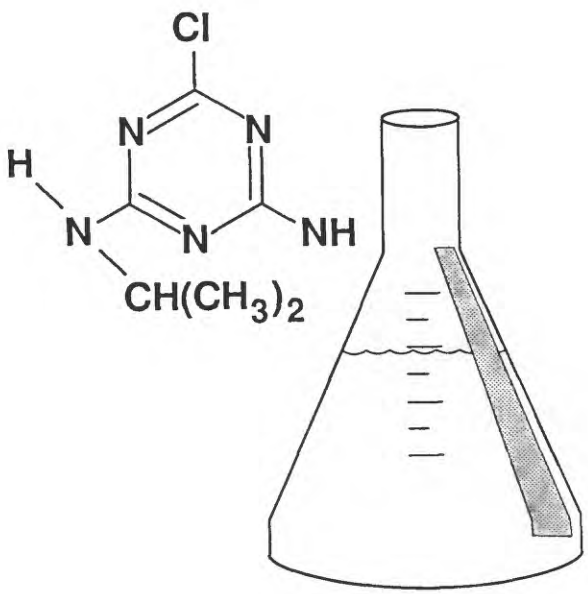
Objectives--Primary objectives of the network are to: (1) provide a national data base of water-quality information for State, local, or Federal planning and action programs; (2) depict areal variability of streamflow- and water-quality conditions nationwide on a year-by-year basis; and (3) detect and assess long-term changes in streamflow and water quality.

Approach--Surface-water-quality stations (fig. 10 and table 5 at the end of this report) are maintained to monitor long-term and short-term trends related to changes in streamflow, reservoir operation, and local or regional pollution. In addition, a network for collection of surface-water-quality data, identified as the National Stream-Quality Accounting Network (NASQAN), is designed by the U.S. Geological Survey to meet many of the information demands of agencies or groups involved in national or regional water-quality planning and management. Water samples are collected at a few regular surface-water stations, as a Federal interagency activity, for monitoring the concentration and distribution of pesticides in streams where potential contamination could result from continued or future application of the commonly used insecticides and herbicides.

Water-quality samples also are collected from a network of wells (fig. 11 and table 6 at the end of this report) to determine the chemical characteristics of water in the principal aquifers and to assess the suitability of the water for use in domestic and municipal supplies. The data also are used to establish an adequate data base for monitoring changes in water quality according to the provisions of the Safe Drinking Water Act of 1974 (Public Law 93-523). Other samples of water from various geologic formations at selected locations are analyzed for interpretive hydrologic investigations. The joint-funding agreement for this phase of the

water-quality data program ended in FY 89 and was not renewed.

Significant milestones--During the 1991 fiscal year, water-quality data were collected at seven complete-record streamflow-gaging stations and eight partial-record stations on a regular scheduled basis. Five of these stations were in the National Stream-Quality Accounting Network, and one station was in the Hydrologic Benchmark Network. During the 1989 fiscal year, chemical analyses were determined on samples from approximately 210 wells.



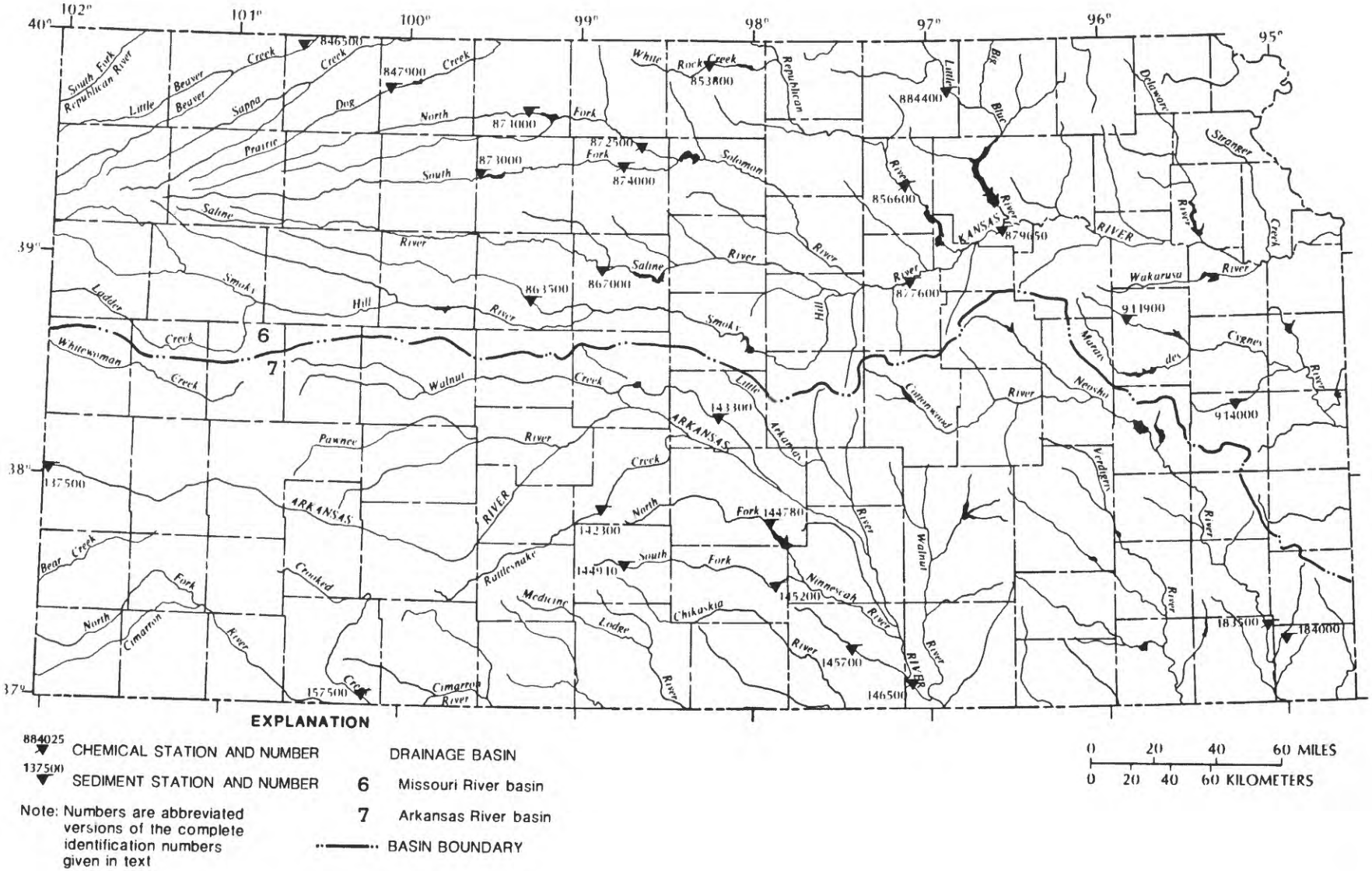


Figure 10. Location of surface-water-quality gaging stations, 1991 water year.

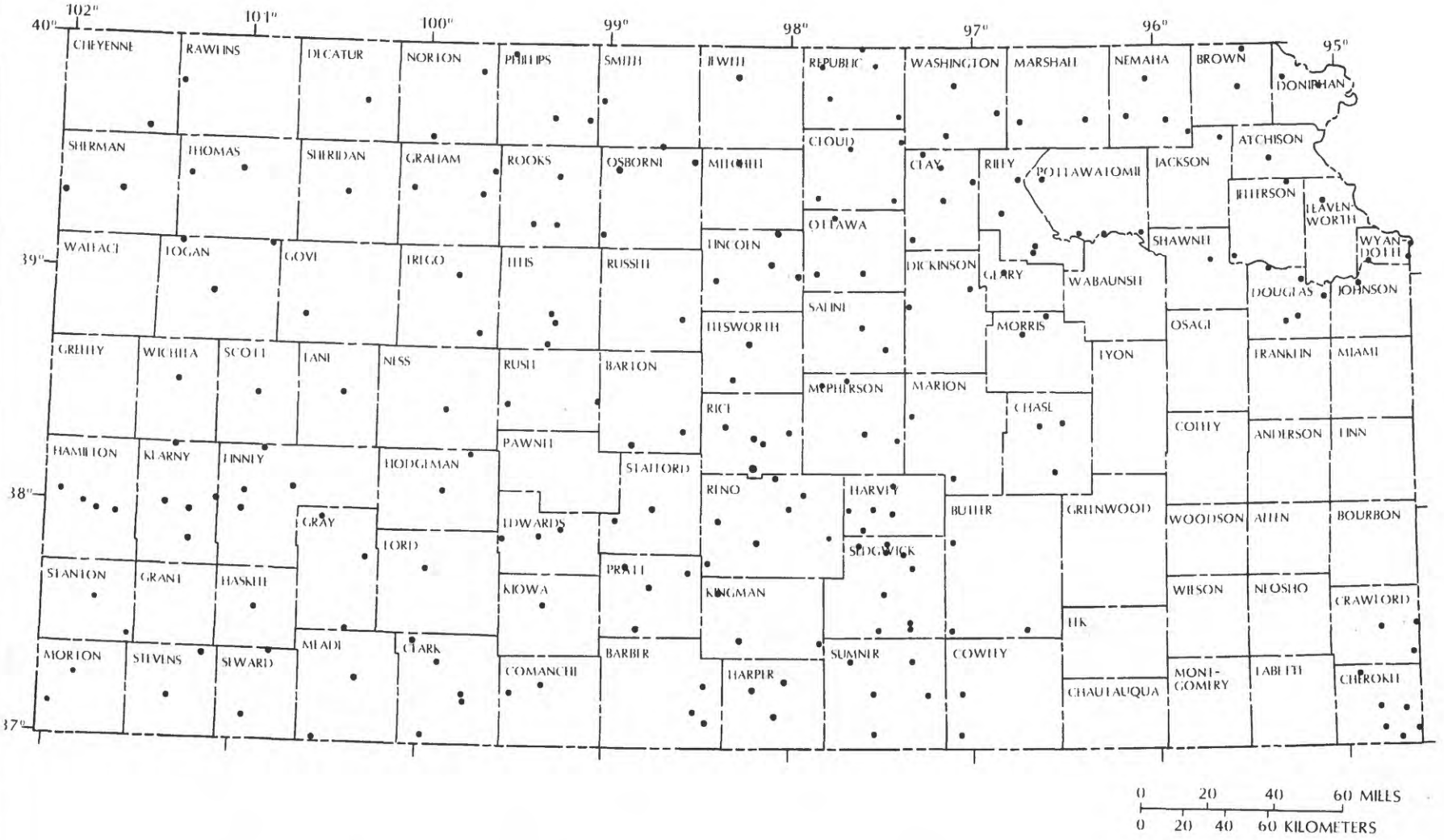


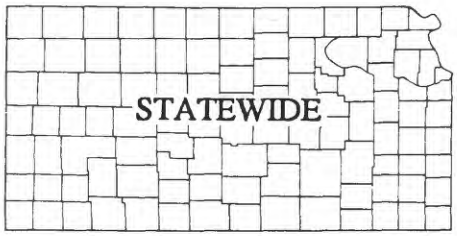
Figure 11. Location of ground-water-quality sampling sites, 1989 water year.

PROJECT TITLE: Sediment data program

PROJECT NUMBER: KS-004

COOPERATING AGENCY: Multi-agency

PROJECT CHIEF: C.O. Geiger



Problem--Sediment concentrations and discharges in rivers and streams must be defined and monitored in order to make a comprehensive water-quality assessment of the Nation's water resources.

Objectives--The primary objective of this project is to provide a national data base of standardized sediment information for use in State, local, and Federal planning and action programs.

Approach--A network of sediment stations (as shown in figure 10 and listed in table 5 at the end of this report) has been established to provide spatial and temporal averages and trends in concentration, discharge, and particle size of sediment being transported by rivers and streams. In addition, periodic measurements are made of the particle-size distribution of suspended sediment and bed material.

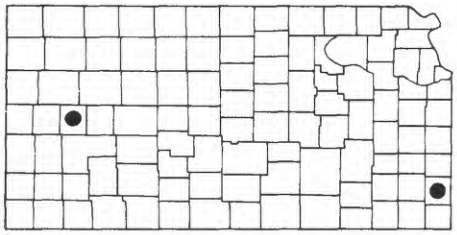
Significant milestones--During the 1991 fiscal year, water samples were collected at 17 sites for analyses and determination of suspended-sediment discharge.

PROJECT TITLE: National Atmospheric Deposition Program

PROJECT NUMBER: KS-005

COOPERATING AGENCY: Federal

PROJECT CHIEF: C.O. Geiger



Problem--In recent decades human activities have greatly increased both the abundance of substances dispersed in the atmosphere and their effect on the biosphere of the earth. These changes have resulted mainly from increases in: (1) combustion of fossil fuels in power production, space heating, and transportation; (2) emissions of dust, aerosols, and gases from industrial and land-management activities; (3) use of fertilizers and other chemicals in intensive agriculture and forestry; and (4) decomposition and combustion of industrial, urban, and agricultural wastes.

Objectives--Primary objectives of this program are to: (1) establish a National Atmospheric Deposition Network to determine spatial and temporal trends in the supply of beneficial nutrient elements and injurious substances in precipitation and dry particulate matter; and (2) determine the relative importance and contribution of precipitation, dry particulate matter, aerosols, and gases to total atmospheric deposition.

Approach--Sites in Kansas, located on the index map above, are equipped with identical collectors of wet and dry deposition, a recording rain gage, and pH and specific-conductance meters. Samples of precipitation are collected at each site on a weekly basis. During the first phase of network operations, analyses are made for specific conductance, pH, acidity or alkalinity, calcium, magnesium, potassium, sulfate, chloride, nitrate, ammonia, and phosphate. Later, certain additional analyses are added, including boron, bromide, cadmium, copper, fluoride, iodide, iron, lead, manganese, mercury, molybdenum, nickel, vanadium, and zinc. Pesticides and radioactive materials are also analyzed. To ensure that the data are of sufficient quality to provide maximum credibility for a wide variety of fundamental research and mission-oriented purposes, a Quality Assurance Committee oversees the operations.

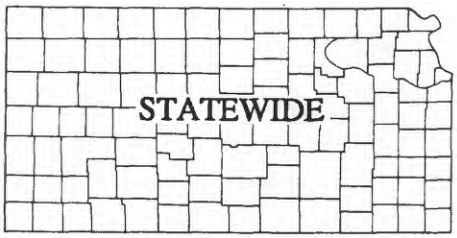
Significant milestones--During the 1991 water year, data were collected at two sites (see index map) as part of the National Trends Network and National Atmospheric Deposition Program (NTN and NADP).

PROJECT TITLE: Water Use

PROJECT NUMBER: KS-007

COOPERATING AGENCY: Division of Water Resources, Kansas State Board of agriculture

PROJECT CHIEF: J.F. Kenny



KS007

Problem--Uses of Kansas water and competition among types of uses are increasing each year. State water-rights agencies need detailed information about water use to effectively manage the resource. As part of the National Water-Use Program in Kansas, a State-operated and maintained water-use and water-rights data base was developed. To facilitate the progress of the water-use program in Kansas and to ensure that the resulting State data base addresses the needs of the National Water-Use Program, it is important for the U.S. Geological Survey to participate in the State data base.

Objective--The primary objective of the project is to maintain an automated State water-use and water-rights data base. The data base serves the dual functions of a management tool for administering water rights within the State and of acting as a repository for water-use data to meet State and National needs.

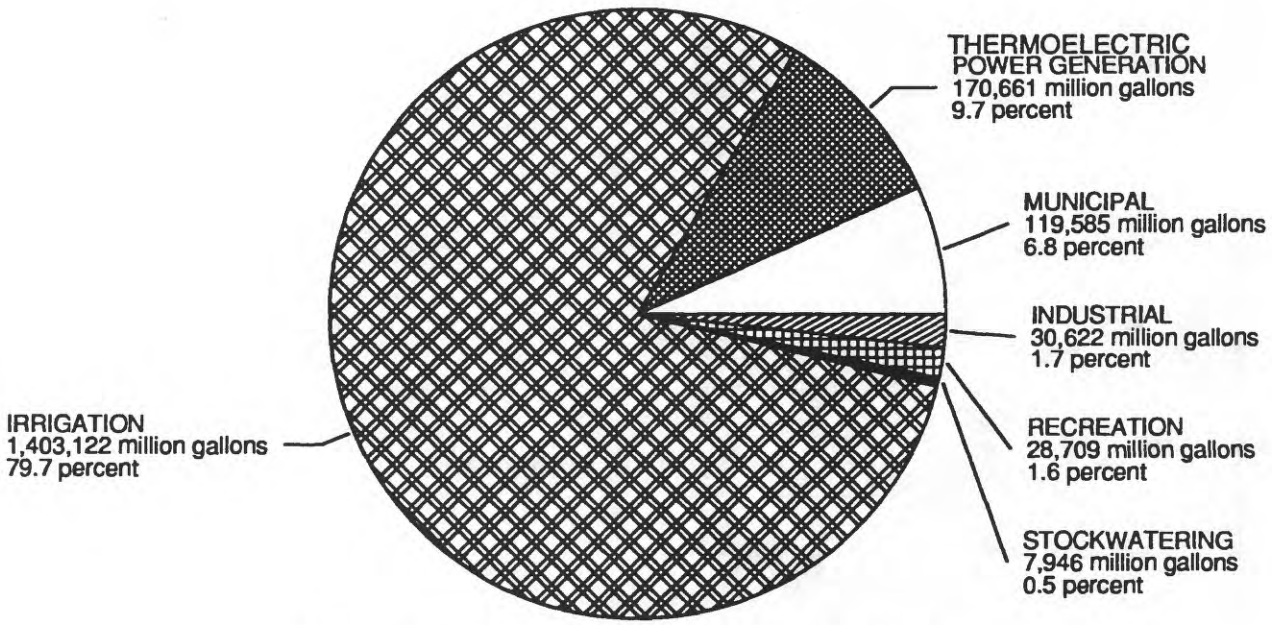
Approach--The data base was developed by the Kansas Department of Administration, Division of Information Systems and Computing. Data capture, preparation, and input are handled by the Division of Water Resources, Kansas State Board of Agriculture. U.S. Geological Survey personnel work with the Division of Water Resources to provide for data exchange between the completed State data base and the National Water-Use Data System.

Significant milestones--A report depicting water use in Kansas for 1987 was published. Reported water-use data for 1988 and 1989 were obtained from the Division of Water Resources for storage in a U.S. Geological Survey data base. Compilations for the 1990 National water-use report, "Estimated Use of Water in the United States," were begun. Assistance was provided to the Kansas Water Office and the Division of Water Resources in editing and processing municipal water-use reports. A data base of water withdrawals reported for 1990 was created.

Reports

Baker, C.H., Jr., and Kenny, J.F., 1990, Kansas water supply and use, *in* National water summary 1987--Water supply and use: U.S. Geological Survey Water-Supply Paper 2350, p. 259-266.

Kenny, J.F., 1991, Reported water use in Kansas, 1987: U.S. Geological Survey Open-File Report 91-212, 39 p.



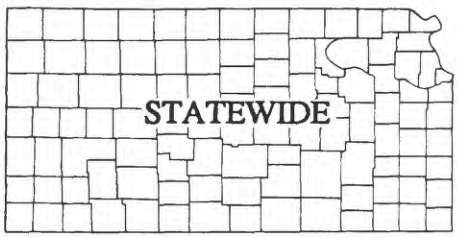
NOTE: A total of 13.6 million gallons of water reported for domestic use in 1987 is not shown in diagram.

HYDROLOGIC INVESTIGATIONS

Hydrologic investigations provide water-resources information that is valuable for a variety of uses by Federal, State, and local agencies, by the general public, and by universities and the consulting community. These investigations may include regional, State, county, and site-specific studies, as well as applied research. Some of the anticipated uses of the results of these investigations include: (1) general resources information and definition of hydrologic systems; (2) water supply (planning and development); (3) protection and conservation of resources; (4) pollution detection, control, abatement, and enforcement; (5) bridge, culvert, and highway design; (6) public safety (flood warnings and flood-plain delineation); (7) salinity control and abatement; (8) hazardous-waste disposal; (9) land management; and (10) fish and wildlife resources management. These investigations help to assess the State's water resources in terms of quantity, quality, and use of water, and to develop the knowledge and hydrologic understanding necessary to predict the consequences of alternative plans and policies for water development and use.

Automated weather station.

Neutron meter for measuring soil moisture.



KS00201

PROJECT TITLE:
Evaluation of Ground-Water-Quality Network

PROJECT NUMBER:
KS-00201

COOPERATING AGENCY:
Kansas Department of Health and Environment

PROJECT CHIEF:
T.B. Spruill

Problem--Data on the chemical quality of ground water is needed from a statewide network of wells (see project KS-003) in response to State and Federal regulations imposed by the Safe Drinking Water Act of 1974 (Public Law 93-523). These data are necessary for effective management decisions regarding the State's water resources. A continuing evaluation of the adequacy of the network is needed for monitoring water quality in the principal aquifers of the State.

Objective--The primary objectives of the project are to: (1) evaluate the chemical-quality data to determine the adequacy of the network for describing baseline ground-water quality, (2) detect pollution of the principal aquifers in the State, and (3) determine the significance of the data with respect to State and Federal drinking-water regulations imposed by the Safe Drinking Water Act.

Approach--Routinely collect water samples for chemical analysis from a statewide network of about 250 wells. The sampled wells provide baseline data for determining the general chemical quality of water in the principal aquifers and provide a basis for detecting possible long-term changes in regional ground-water quality. Interpret sampled data and evaluate adequacy of the data for detecting changes in chemical quality and regional occurrence of pollution.

Significant milestones--A report, "Monitoring regional ground-water quality--Statistical considerations and description of a monitoring network in Kansas," was approved for release. State funding for this project ended in FY89.

Reports

Spruill, T.B., 1990, Monitoring regional ground-water quality--Statistical considerations and description of a monitoring network in Kansas: U.S. Geological Survey Water-Resources Investigations Report 90-4159, 41 p.

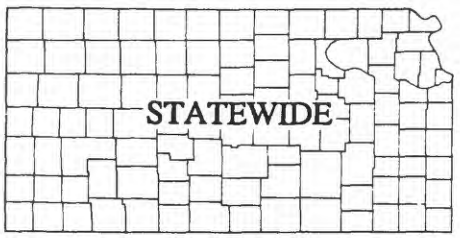
Spruill, T.B., and Candela, Lucila, 1990, Two approaches to design of monitoring networks: Ground Water, v. 28, no. 3, p. 430-442.

PROJECT TITLE: Flood hydrology and hydraulics for transportation applications

PROJECT NUMBER: KS-010

COOPERATING AGENCY: Kansas Department of Transportation

PROJECT CHIEF: R.W. Clement



Problem--There is continuing need for adequately defined flood-frequency characteristics and evaluation of the scour potential at existing and future bridge sites on Kansas streams. Streamflow records, including records of annual peak discharges, have been collected on Kansas streams since 1895. The current peak-discharge gaging network includes continuous-record and partial-record (crest-stage gage) stations that are operated by the U.S. Geological Survey in cooperation with State and other Federal agencies. Included is a subnetwork of 30 crest-stage gaging stations operated in cooperation with the Kansas Department of Transportation. There is a significant lack of data concerning bridge-scour potential on streams in Kansas.

Objectives--The objectives of this program are to: (1) maintain an effective peak-flow data-collection network of partial-record (crest-stage gage) stations; (2) evaluate the flood-frequency characteristics on the streams of Kansas through analysis of peak-flow data collected under this and other programs; and (3) provide bridge-scour data and analysis to assist in the evaluation of bridge-scour potential at existing and future bridge sites on Kansas highways.

Approach--The approaches to meeting specific objectives are to operate a partial-record (crest-stage gage) network of 30 stations to provide data on flood discharges from small drainage areas. Similar basic data for larger drainage areas are available from the gaging-station network operated by the U.S. Geological Survey. Flood-frequency characteristics are determined for each location from these data within the State using state-of-the-art statistical methods. Scour potential (depth of local and constriction scour) at bridge sites is evaluated through analysis of the hydrologic characteristics (magnitude and frequency of a design flood) as applied to specific hydraulic characteristics of a bridge, stream channel, and the fluvial characteristics of the sediments associated with the stream.

Significant milestones--Analysis of flood magnitude and frequency for all streamflow-gaging stations in Kansas where data are available through the 1990 water year has begun. The resulting

data report, requested by the cooperator, will include peak-flow data and the tabular and graphical results of the analysis.

Reports

Clement, R.W., 1991, Kansas floods and droughts, *in* Paulson, R.W., Chase, E.B., Roberts, R.S., and Moody, D.W., compilers, National water summary 1988-89--Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper 2375, p. 287-294.

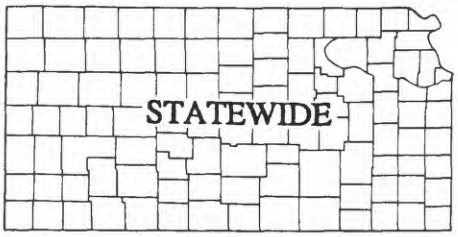
Jordan, P.R., and Jennings, M.E., 1991, Quantification of floods and droughts, *in* Paulson, R.W., Chase, E.B., Roberts, R.S., and Moody, D.W., compilers, National water summary 1988-89--Hydrologic events and floods and droughts: U.S. Geological Survey Water-Supply Paper, 2375, p. 158-161.

PROJECT TITLE: Central Midwest regional aquifer-system analysis, Kansas

PROJECT NUMBER: KS-111

COOPERATING AGENCY: Federal

PROJECT CHIEF: R.J. Wolf



Problem--The hydrology of the freshwater, brackish-water, and saline-water aquifer systems in rocks of Cambrian through Early Cretaceous age is not well defined. Because of the increased demand for water from the overlying High Plains aquifer in western Kansas, aquifers in this deeper rock system are being looked upon as a potential source of additional water supply. In addition, increased pumpage in eastern Kansas has caused saline-water encroachment into aquifers of this rock system. Added to these problems are those resulting from injection of industrial wastes and oil-field brine into these rocks.

Objectives--The objectives of this project are to: (1) describe the hydrology of the freshwater, brackish-water, and saline-water aquifer systems in rocks of Cambrian through Early Cretaceous age; (2) create a regional data base for the rock systems and describe present and potential problems associated with current and future water use; and (3) evaluate the aquifer-system's response to future stresses.

Approach--A search of the available literature was made to determine the extent of geologic interpretations and available data. Data were compiled to establish a data base of regional significance that included detailed lithologic descriptions for selected wells, water-quality information, hydraulic characteristics of the rock systems, and information on water use, waste disposal, and brine injection. Appropriate maps were prepared for steady-state digital-model construction to test the conceptual flow system and to define additional data needs to calibrate a digital model capable of simulating the flow system.

Significant milestones--All reports for this project, including nine chapters of a U.S. Geological Survey Hydrologic Investigations Atlas have been approved for release. Project is complete, and report preparation for publication continues.

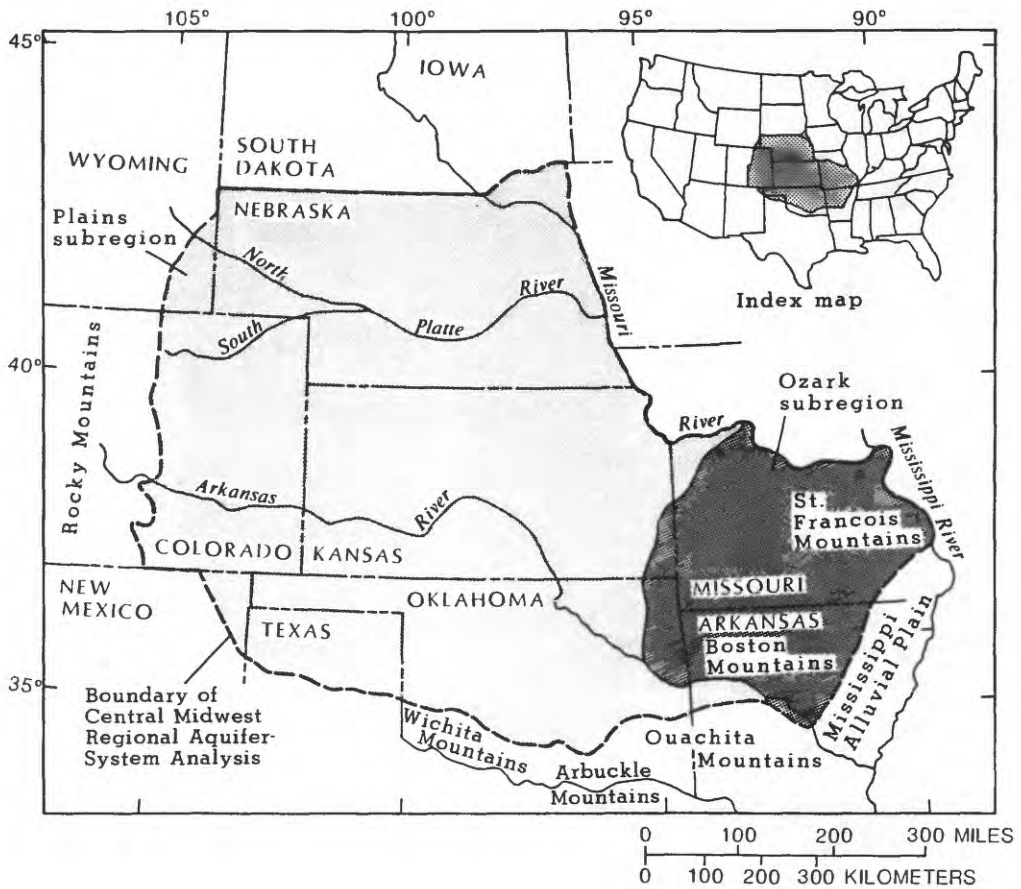
Reports

Helgesen, J.O., and Hansen, C.V., 1989, Description of data files compiled for the Central Midwest regional aquifer-system analysis: U.S. Geological Survey Open-File Report 89-42, 37 p.

Helgesen, J.O., and Leonard, R.B., 1989, Geohydrology of the Great Plains aquifer system, *in* Swain, L.A., and Johnson, A.I., eds., Regional aquifer systems of the United States--Aquifers of the midwestern area: American Water Resources Association, AWRA Monograph Series No. 13, p. 179-190.

Spinazola, J.M., Hansen, C.V.,Underwood, E.J., Kenny, J.F., and Wolf, R.J., 1987, Index to selected machine-readable geohydrologic data for Precambrian through Cretaceous rocks in Kansas: U.S. Geological Survey Open-File Report 87-396, 31 p.

Wolf, R.J., Hansen, C.V., McGovern, H.E., and Spinazola, J.M., 1990, Geohydrologic systems in Kansas with emphasis on systems in Upper Cambrian through Lower Cretaceous rocks: U.S. Geological Survey Hydrologic Investigations Atlas HA-722-A, scales 1:1,500,000 and 1:2,000,000, 2 sheets.

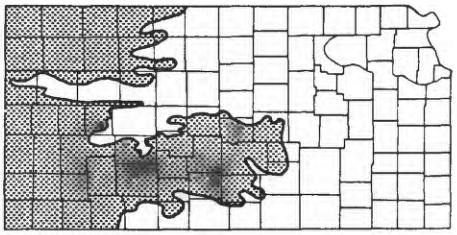


PROJECT TITLE: Water quality in High Plains aquifer, western Kansas, related to irrigated and nonirrigated agricultural land use and petroleum production

PROJECT NUMBER: KS-135

COOPERATING AGENCY: Federal

PROJECT CHIEF: J.O. Helgesen



KS135

Problem--Little is known about the contamination of the High Plains aquifer by organic compounds. Agricultural chemicals applied at land surface to control weeds and insects are potentially hazardous to human health as they infiltrate to the water table. Contamination by oil-field brines presents yet another hazard. Sample collection and data interpretation with special emphasis on the relation of organic substances in ground water to agricultural use and oil-field brines are needed.

Objectives--The primary objective of the project is to provide the water samples and analyses needed to describe the current quality of water associated with major types of land use in the High Plains of Kansas (irrigated and dryland farming and petroleum production). Special attention to analysis of organic substances is needed because of the present lack of this information. Project results are expected to define water-quality and land-use relations that will have transfer value to other areas of similar climate and geohydrology.

Approach--An initial reconnaissance phase involved selection of study areas and some collection and analysis of samples. More intensive areal sampling and (or) site-specific experimental sampling followed. Statistical techniques were employed for network design and for analysis and interpretation of results. Site-specific experiments examined hydrologic factors affecting water quality to better guide sampling and definition of regional conditions. Observation wells were installed to the extent necessary to provide optimum sampling locations. Results were described in interim and final reports.

Significant milestones--The project is complete. All reports published except final report.

Reports

Helgesen, J.O., 1990, Effects of agricultural and petroleum-production land use on water quality in the High Plains aquifer, south-central Kansas (abstract): Ground Water, v. 28, no. 5, p. 795.

__1991, Effects of land use on ground-water quality, south-central Kansas (abstract): Proceedings of 8th Annual Water and the Future of Kansas--Water in Conflict, March 4-5, 1991, Manhattan, Kans., p. 40.

Helgesen, J.O., and Perry, C.A., 1990, Occurrence of pesticides in ground water: Proceedings of 7th Annual Water and the Future of Kansas Conference, Manhattan, Kansas, March 7-8, 1990, p. 22.

Helgesen, J.O., and Rutledge, A.T., 1989, Relations between land use and water quality in the High Plains aquifer of south-central Kansas, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic-Substances Hydrology Program--Proceedings of the technical meeting, Phoenix, Arizona, September 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 523-530.

Helgesen, J.O., Stullken, L.E., and Rutledge, A.T., 1991, Overview of nonpoint-source contamination of the High Plains aquifer in south-central Kansas, *in* Mallard, G.E., and Aronson, D.A., compilers, Abstracts of the Technical Meeting, U.S. Geological Survey Toxic Substances Hydrology Program, Monterey, Calif., March 11-15, 1991: U.S. Geological Survey Open-File Report 91-88, p. 46.

Helgesen, J.O., and Thurman, E.M., 1988, Trace organic compounds in ground water in south-central Kansas as inferred from gas chromatography with flame-ionization detection: American Chemical Society, Division of Environmental Chemistry, v. 28, no. 2, p. 9-12.

Huntzinger, T.L., and Stullken, L.E., 1988 [1989], An experiment in representative ground-water sampling for water-quality analysis: U.S. Geological Survey Water-Resources Investigations Report 88-4178, 12 p.

Rutledge, A.T., 1988, An axisymmetric model to simulate drawdown within and around a pumping well, *in* Program of International Conference on Advances in Ground-Water Hydrology: American Institute of Hydrology, Tampa, Florida, November 16-18, 1988, p. 15.

__1991, An axisymmetric finite-difference flow model to simulate drawdown in and around a pumped well: U.S. Geological Survey Water-Resources Investigations Report 90-4098, 33 p.

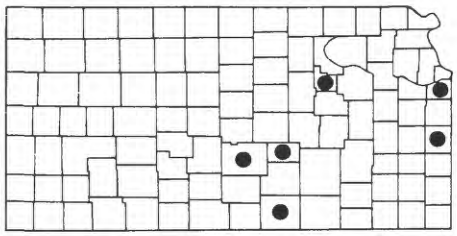
Rutledge, A.T., and Helgesen, J.O., 1989a, Transport of chloride and atrazine through the unsaturated zone beneath two irrigated fields in south-central Kansas, *in* Pederson, G.L., and Smith, M.M., compilers, U.S. Geological Survey Second National Symposium on Water Quality--Abstracts of the technical sessions, Orlando, Florida, November 12-17, 1989: U.S. Geological Survey Open-File Report 89-409, p. 81.

___1989b, Use of a simplified transport model for pesticides in the unsaturated zone, *in* Mallard, G.E., and Ragone, S.E., eds., U.S. Geological Survey Toxic-Substances Hydrology Program--Proceedings of the technical meeting, Phoenix, Arizona, September 26-30, 1988: U.S. Geological Survey Water-Resources Investigations Report 88-4220, p. 523-530.

___1990, Characterization of ground-water flow and chemical transport beneath two irrigated fields in south-central Kansas, 1988: U.S. Geological Survey Water-Resources Investigations Report 90-4065, 37 p.

__1991, Steady-state unsaturated-zone model to simulate pesticide transport: U.S.Geological Survey Water-Resources Investigations Report 90-4164, 13 p.

Stullken, L.E., Stamer, J.K., and Carr, J.E., 1987, Reconnaissance of water quality in the High Plains aquifer beneath agricultural lands, south-central Kansas: U.S. Geological Survey Water-Resources Investigations Report 87-4003, 25 p.



KS138

PROJECT TITLE:
Geohydrologic evaluation of hazardous-waste sites in selected areas of Kansas

PROJECT NUMBER: KS-138

COOPERATING AGENCY:
Cities of Emporia, Olathe, and Kansas City, Kansas, and Geary, Harvey, Linn, Reno, Sumner, and Wyandotte Counties

PROJECT CHIEF:
N.C. Myers

Problem--Hazardous-waste sites can pose significant risks to public health and the quality of the environment. At least 201 potential hazardous-waste sites have been identified in Kansas (Kansas Department of Health and Environment, written commun., 1983). The State has performed an initial assessment of 81 sites. A need exists to document which of the remaining sites in Kansas have contaminated ground and surface water and to identify those sites that warrant intensive geohydrologic investigation.

Objectives--Primary objectives of the study are to: (1) compile site-history, hydrogeologic, and chemical-quality information to document possible ground- and surface-water contamination at selected hazardous-waste sites in Kansas; (2) identify principal chemical contaminants that may be associated with specific types of hazardous-waste sites (county, municipal, industrial, and so forth) in specific areas of the State; and (3) determine principal geochemical and hydrogeologic factors that affect the mobility of major chemical contaminants from hazardous-waste sites in selected areas of the State.

Approach--Information will be collected for each site, including types of waste stored, mode of storage, time of storage, and geology. Surface geophysical methods will be used to detect possible contaminant plumes. Water samples, water levels, and geophysical logs will be obtained from piezometers. Water samples will be analyzed for major cations and anions, nitrate and ammonia nitrogen, trace elements, total organic carbon, and specific organic compounds. Principal contaminants associated with each waste-site category will be identified.

Significant milestones--Hydrologic investigations at seven public landfills were completed, and reports were published for three of the landfills. Reports are progressing for four additional public landfills. Ongoing monitoring is continuing at two of the landfill sites.

Reports

Falwell, Ronald, Bigsby, P.R., and Myers, N.C., 1990, Hydrogeology and ground-water-quality conditions at the Linn County landfill, eastern Kansas, 1988-89: U.S. Geological Survey Water-Resources Investigations Report 90-4117, 48 p.

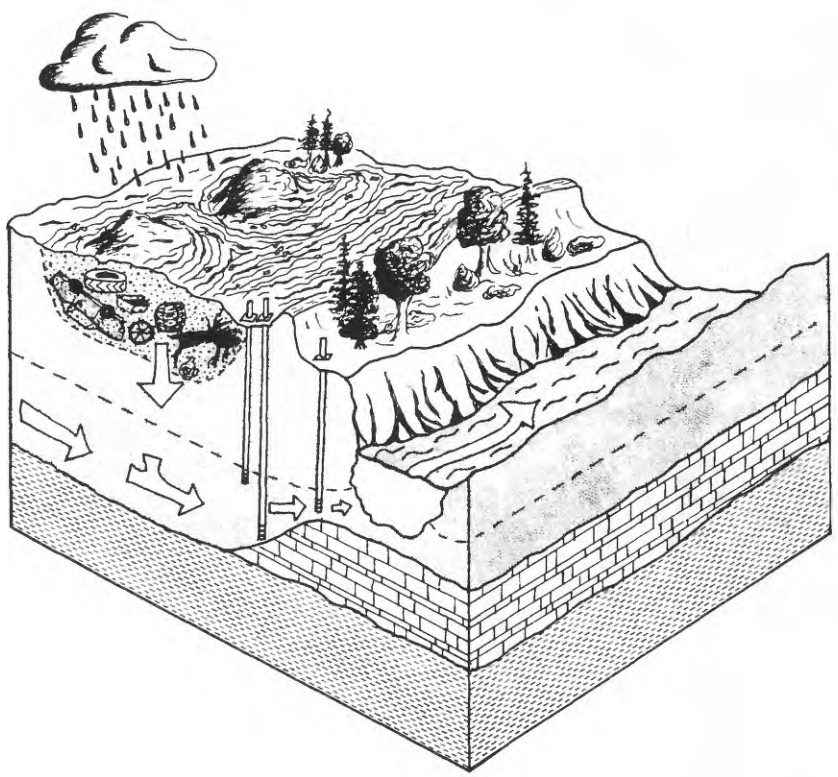
Hart, R.J., and Spruill, T.B., 1988, Description and hydrogeologic evaluation of nine hazardous-waste sites in Kansas, 1984-86: U.S. Geological Survey Water-Resources Investigations Report 88-4015, 73 p.

Myers, N.C., and Bigsby, P.R., 1989, Hydrogeology and ground-water-quality conditions at the Geary County Landfill, northeast Kansas, 1988: U.S. Geological Survey Water-Resources Investigations Report 89-4114, 41 p.

___1990, Hydrogeology and ground-water-quality conditions at the Emporia-Lyon County Landfill, eastern Kansas, 1988: U.S. Geological Survey Water-Resources Investigations Report 90-4043, 42 p.

Perry, C.A., and Hart, R.J., 1985a, Installation of observation wells on hazardous-waste sites in Kansas using a hollow-stem auger: Ground Water Monitoring Review, Fall 1985, v. 5, no. 4, p. 70-73.

__1985b, Installation of observation wells on hazardous-waste sites in Kansas using a hollow-stem auger: Proceedings of the Southern Regional Ground Water Conference, San Antonio, Texas, p. 173-179.

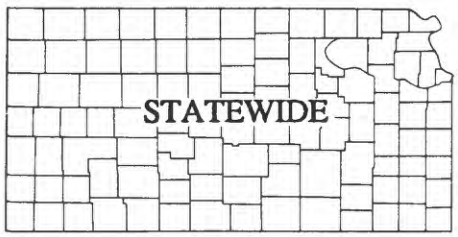


PROJECT TITLE: Movement and persistence of agricultural pesticides in the saturated and unsaturated zones in Kansas

PROJECT NUMBER: KS-151

COOPERATING AGENCY: Kansas Department of Health and Environment

PROJECT CHIEF: C.A. Perry



KS151

Problem--Intrusion of agricultural pesticides into the subsurface environment is occurring, and residues of these toxic organics have been detected in some aquifers in Kansas. The extent of this problem is unknown, and the physical processes involved in the movement and persistence of the pesticides are not defined. To improve understanding of the dynamics and fate of pesticides in the field, research is needed.

Objectives--The primary objectives of the project are to: (1) define the movement and persistence of pesticides from the land surface down into the ground-water system for major agricultural areas within the State, (2) determine current pesticide distribution, (3) determine infiltration and recharge rates of pesticide leaching, (4) determine actual field-decay rates, and (5) compare findings with estimates from the U.S. Environmental Protection Agency's pesticide root zone model (PRZM) and "Leaching Evaluation of Agricultural Chemicals Handbook."

Approach--Several sites were selected for intensive study of the movement and persistence of pesticides in Kansas. Pertinent data were collected from several Kansas State University Agronomy Farms and Experimental Stations. Soil and ground-water samples were analyzed for pesticides and degradation products, and these analyses were related to the physical characteristics of the sampling sites, including climate, infiltration of water, soil temperature, particle size, pH, soil type, and moisture, and application rates. Actual measurements of pesticide movement and persistence were compared with theoretical estimates.

Significant milestones--Four reports have been approved for publication. The project is complete.

Reports

Perry, C.A., 1990, Source, extent, and degradation of herbicides in a shallow aquifer near Hesston, Kansas: U.S. Geological Survey Water-Resources Investigations Report 90-4019, 24 p.

__1991a, Observed and simulated distribution of selected herbicides in silty loam, sandy loam, and clay soil profiles near Topeka, Kansas, 1986-88: U.S. Geological Survey Water-Resources Investigations Report 91-4017, 61 p.

__1991b, Some guidelines for onsite studies of pesticide leaching in the unsaturated andsaturated zones: U.S. Geological Survey Water-Resources Investigations Report 91-4075, 38 p.

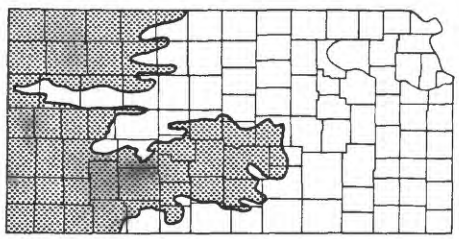
Perry, C.A., and Anderson, M.R., 1991, Statistical comparison of selected chemical constituents in water from chemigation and conventional irrigation wells in Kansas, 1987: U.S. Geological Survey Water-Resources Investigations Report 91-4049, 1 sheet.

PROJECT TITLE:
Monitoring ground-water conditions in the High Plains aquifer in Kansas

PROJECT NUMBER: KS-160

COOPERATING AGENCY:
Federal

PROJECT CHIEF:
J.B. Gillespie



KS160

Problem--In response to concern about ground-water-level declines in the High Plains aquifer, Congress has directed the U.S. Geological Survey to expand its capability of monitoring ground-water levels in the aquifer and to make the information available in annual reports.

Objectives--The objectives of the project are to: (1) develop the capability of more adequately monitoring water levels in the High Plains aquifer in Kansas and (2) provide the regional staff in Denver, Colo., with water-level data and other information necessary for their preparation of the Congressionally mandated annual report about ground-water conditions in the High Plains aquifer.

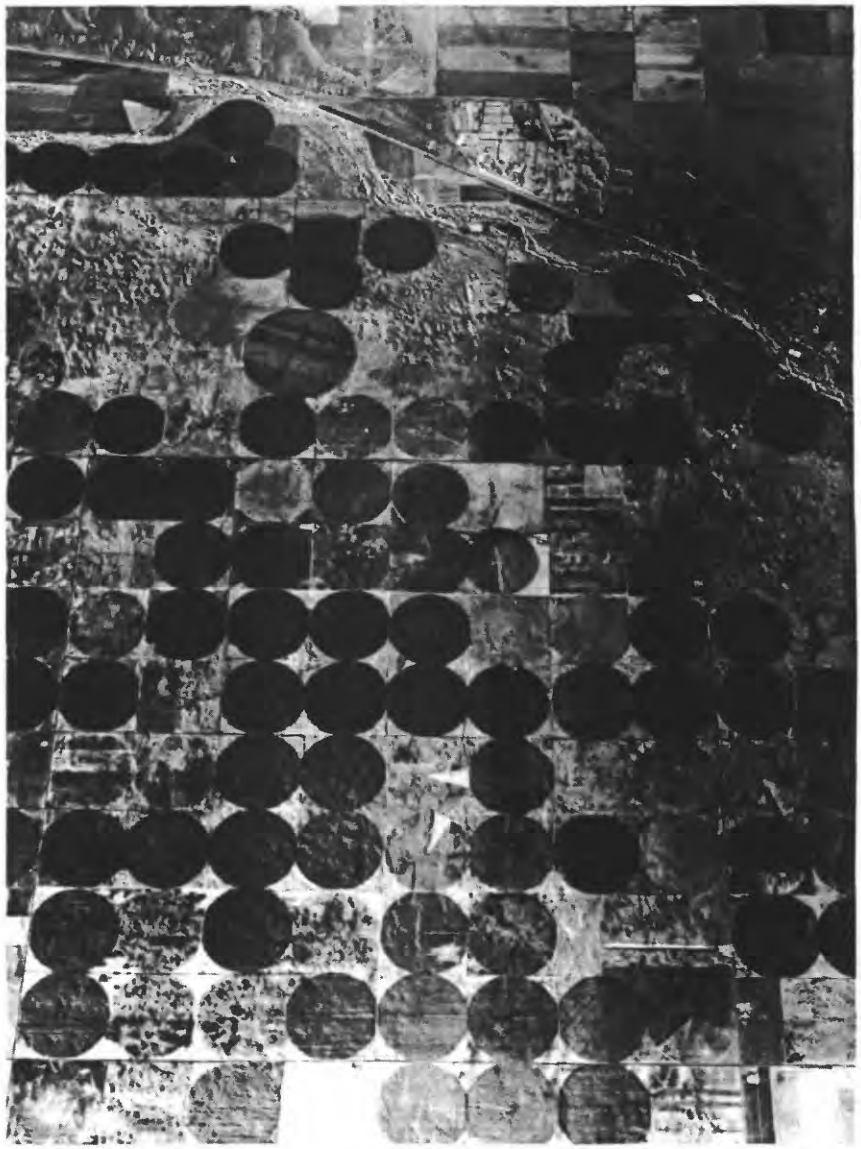
Approach--Review data from U.S. Geological Survey and local agency observation-well networks to determine if data obtained is adequate for defining areal and temporal water-level changes. Work with local agencies to expand the U.S. Geological Survey's capability of monitoring water-level changes in the High Plains aquifer. Evaluate, analyze, and interpret water-level data so that the information can be made readily available to the public.

Significant milestones--About 500 observation wells were added to the Kansas ground-water data base. Subsequent ground-water-level data from these wells are added annually to the data base and provided to the regional staff in Denver for compilation of an annual report. The Kansas state summary for the report "Water-level changes in the High Plains aquifer--Predevelopment to 1990," was submitted for Director's approval and publication in U.S. Geological Survey Water-Resources Investigations Report 91-4165.

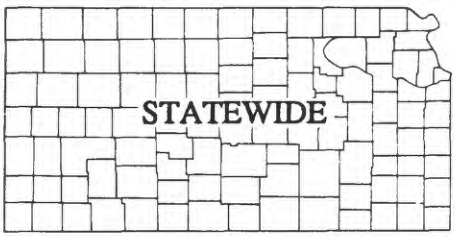
Reports

Dugan, J.T., Schild, D.E., and Kastner, W.M., 1990, Water-level changes in the High Plains aquifer underlying parts of South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas--Predevelopment through nonirrigation season 1988-89: U.S. Geological Survey Water-Resources Investigations Report 90-4153, 29 p.

Kastner, W.M., Schild, D.E., and Spahr, D.S., 1989, Water-level changes in High Plains aquifer underlying parts of South Dakota, Wyoming, Nebraska, Colorado, Kansas, New Mexico, Oklahoma, and Texas--Predevelopment through nonirrigation season 1987-88: U.S. Geological Survey Water-Resources Investigations Report 89-4073, 61 p.



Center-pivot irrigation systems, southeast of Garden City (Photograph courtesy of the Kansas Applied Remote Sensing Program, Lawrence, Kansas).



KS170

PROJECT TITLE: Effects of grain-storage facilities on ground-water quality in Kansas

PROJECT NUMBER: KS-170

COOPERATING AGENCY: U.S. Environmental Protection Agency

PROJECT CHIEF: C.V. Hansen

Problem--In 1986, the U.S. Environmental Protection Agency (EPA) traced the source of carbon-tetrachloride contamination of the ground water used for public supply in Waverly, Nebraska, to the site of a former U.S. Department of Agriculture (USDA) grain-storage facility. Carbon tetrachloride was a common ingredient of grain fumigants used during the 1950's and 1960's. Because concern that there may be similar sites in Kansas, the EPA requested that the U.S. Geological Survey (USGS) assess the possible contamination of public ground-water supplies in Kansas by grain-storage chemicals.

Objectives--The objective of this project was to compile available information on grain-storage facilities and public ground-water supplies in Kansas in order to identify factors that correlate with sites being (or not being) a possible source of contamination.

Approach--Information about location, capacity, building history, types of chemicals used, and the period when each type of fumigant was used were compiled for grain-storage facilities. Information on public-water supplies included well locations and water-quality analyses. Because of the limited time available for completion of this project, no new data, such as test wells or water-quality analyses, were collected. The compiled data were analyzed for possible correlations between the chemicals used in grain-storage facilities and the detection of the chemicals in public-water supplies. All data are stored in a computer data base that can be accessed by a geographic information system (GIS) for presentation and analysis.

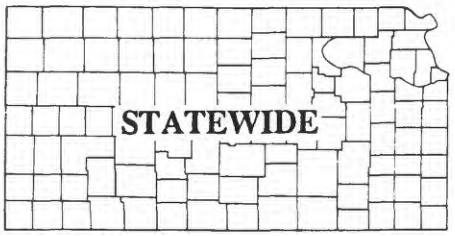
Significant milestones--A GIS-based demonstration using data from an EPA contractor's report on USDA grain-bin locations and public-water-supply analyses in Iowa, Kansas, Missouri, and Nebraska was created. Data about existing commercial grain-storage facilities and public-water-supply analyses and locations were compiled for Kansas and entered into the GIS data base. Information about stored-grain pesticides was compiled and reviewed. A proposal for outlining a more detailed approach to the study of potential contamination of ground water by grain-storage pesticides was coordinated and presented to EPA. A letter summarizing the project was submitted to EPA. The project is now complete.

PROJECT TITLE: Administrative Information Systems (AIS) software development and implementation

PROJECT NUMBER: KS-172

COOPERATING AGENCY: Federal

PROJECT CHIEF: S.J. Brady



KS172

Problem--The PRIME[1] minicomputers, on which reside the Water Resources Division administrative systems, are to be phased out between 1991 and 1993. Administrative systems will have to be moved to the new platform, which consists of a distributed network of Data General Aviion Unix workstations. The proprietary software, INFO, used by the administrative systems will not be available on the new workstations. The relational data-base management systems INGRES will be available on the Aviion.

Over the last several years, automated systems have been developed in the U.S. Geological Survey to assist Water Resources Division (WRD) personnel in accomplishing their mission. Included among these division and bureau systems are the Administrative Financial Management System (AFIMS), Career Documentation Profile (CDP), Management Information System (MIS), Payroll and Personnel System (PAY/PERS), and the recently implemented Federal Financial System (FFS). There are useful data and features within each of these systems. However, the evolution of these basically autonomous systems has created a situation of duplicate data entry, disjointedness, and in some cases, cumbersome operation. There exists the need to integrate and enhance these systems in order to meet the increasing requirements for useful and timely administrative information for Survey personnel at all levels.

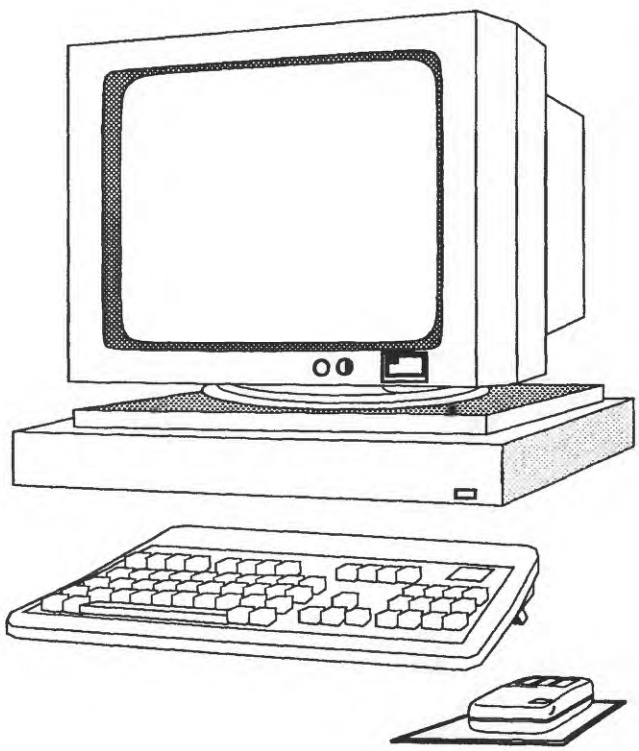
Objectives--The goal of the AIS effort is to develop and implement a flexible administrative information data-management and processing system; one that can be easily changed and expanded in a rapidly changing technological and political environment. The new system will be distributed across a national network of 32-bit microprocessors utilizing local-area network (LAN) and wide-area network (WAN) technology. The AIS will also interface with other systems within the Water Resources Division; with systems maintained by other USGS divisions, such as the Federal Financial System, the Personnel Action System (PAS), and the Property/ Vehicle System; with any other Bureau administrative system that

[1] The use of trade names in this report is for identification purpose only and does not imply endorsement by the U.S. Geological Survey.

may be identified by the User Work Groups; and with other Federal agency (OFA) systems, such as the U.S. Bureau of Reclamation (BOR) PAY/PERS system.

Approach--On February 28, 1990, members of the Assistant Chief Hydrologist for Operations staff met to discuss the migration of Water Resources Division administrative systems to the Data General Unix environment. The items addressed at this meeting were: (1) the Branch of Administrative Management Systems Strategic Information Systems Planning for FY90 through FY94, (2) the formation of a planning team who would take the Strategic Plan and ensure that all administrative areas of concern to the Division were properly addressed, (3) the formation of a Steering Committee for Administrative issues, (4) the impact of the National Water Information Systems II (NWIS-II) on administrative functions and the need to coordinate all development efforts with NWIS-II to ensure proper integration of the scientific and business data bases, (5) the importance of having the Strategic Planning Group look at the Division's overall information needs and not just those of NWIS-II, (6) the need for a Program Manager, and (7) the creation of administrative User Work Groups with the charge for describing their administrative requirements. These requirements will form the basis for the design and development of the new Administrative Information System (AIS).

Significant milestones--Twelve User Work Group reports with user requirements for the AIS were completed by August 31, 1991. The AIS System Requirements Specifications (SRS) were completed by September 30, 1991.

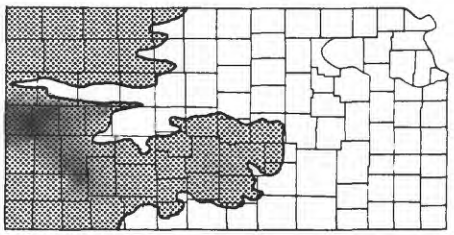


PROJECT TITLE:
Application of GIS for information retrieval and technical evaluation of agricultural water use and availability in the Kansas High Plains

PROJECT NUMBER: KS-175

COOPERATING AGENCY:
Kansas State Board of Agriculture, Division of Water Resources

PROJECT CHIEF:
K.E. Juracek



KS175

Problem--A geographic information system (GIS) is needed to provide information for water-allocation planning within the State. The framework for and selected components of a GIS-based information system that addresses water use and availability for irrigated agriculture in the Kansas High Plains need to be developed.

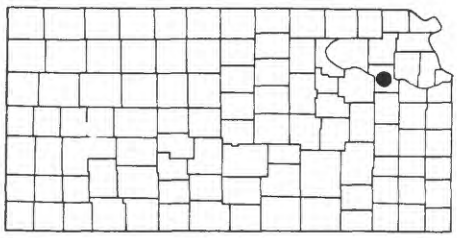
Objectives--The objectives of the project are to: (1) create GIS data sets from existing data bases; (2) enhance or modify existing data bases to meet analytical requirements; (3) develop or utilize existing interfaces between GIS data sets and computational and display software; and (4) develop or utilize existing computational, graphical, and spatial analytical software to perform various analyses concerning the use and availability of water for irrigated agriculture in the Kansas High Plains.

Approach--Existing software and available data bases will be utilized where appropriate. Customized analysis and display capabilities will be developed. Emphasis will be given to the development of the system framework and selected analytical capabilities. In selected areas, enhancements or additions will be made to some data sets to provide for more complete analyses.

Significant milestones--A GIS application, entitled WIMAS (Water Information Management and Analysis System), was developed to provide customized data retrieval, analysis, and display capabilities to assist in water-use studies and ground-water appropriation decision making. Automated procedures provided summaries of annual water-use data by county and basin. Other automated procedures evaluated location-specific restrictions to determine if a ground-water-right application could be approved.

REPORTS

Juracek, K.E., 1991, Application of geographic information system technology to ground-water management in Kansas: Programs of abstracts, 36th Annual Midwest Ground Water Conference, Indianapolis, Ind., October 9-11, 1991, p. 74.



KS142

PROJECT TITLE: Instrumentation of a dry-pond detention structure for determining effects on the quality of urban runoff

PROJECT NUMBER: KS-142

COOPERATING AGENCY: Federal

PROJECT CHIEF: L. M. Pope

Problem--Temporary storage of urban runoff in dry-pond detention structures is known to be an effective method of controlling flooding in urban areas; however, the effect that "dry-pond" detention has on urban-runoff water quality is poorly understood. Flow-monitoring and sampling instrumentation of "dry-pond" inflows and outflows require sophistication and state-of-the-art technology, particularly for in-pipe flows. Monitoring and sampling flows in storm-sewer pipes require custom design, installation, maintenance of flumes, constrictions, velocity meters, and automatic equipment, all of which are time consuming and expensive.

Objective--The objectives of the project are to instrument, operate, and maintain the necessary flumes, constrictions, velocity meters, and automatic-sampling equipment to monitor and sample flows in two inflow and one outflow storm-sewer pipes to a dry-pond detention structure in Topeka, Kansas.

Approach--All necessary pipe diameters, lengths, and slopes were measured at the study site. Instrumentation was fabricated by the U.S. Geological Survey's Hydrologic Instrumentation Facility in Stennis Space Center, Mississippi. Instrumentation was installed and operated in conjunction with a rainfall- and urban-runoff study for 2.5 years. Necessary and preventive maintenance were performed throughout the duration of the study.

Significant milestones--Equipment operation and data collection have been completed.

Reports

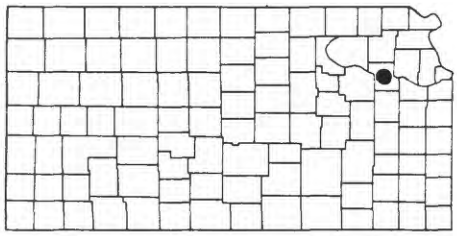
Pope, L.M., Jennings, M.E., and Thibodeaux, K.G., 1988, Instrumentation for a dry-pond detention study, *in* Proceedings of 1988 National Conference on Hydraulic Engineering: American Society of Civil Engineers, Colorado Springs, Colo., August 8-12, 1988, p. 84-89.

PROJECT TITLE:
Evaluation of the effects of dry-pond detention storage on the quality of runoff from urban areas

PROJECT NUMBER: KS-143

COOPERATING AGENCY:
Kansas Department of Health and Environment

PROJECT CHIEF: L. M. Pope



Problem--Runoff from urban areas may contain relatively large concentrations of trace elements, such as cadmium, chromium, copper, lead, mercury, and zinc, as well as other water-quality constituents, such as biochemical oxygen demand (BOD), chemical oxygen demand (COD), total organic carbon (TOC), various nutrients, and suspended sediment. Temporary storage of urban runoff in dry-pond detention structures is known to be an effective method of controlling flooding in urban areas; however, the effects that the ponds have on decreasing the concentrations and loads of undesirable water-quality constituents are less clear and in need of further research.

Objectives--The primary objective of this study was to evaluate the effects of dry-pond detention storage on the quality of storm runoff from urban areas in the Topeka metropolitan area. A secondary objective was to evaluate procedures for predicting loads of selected water-quality constituents in storm runoff from storm-related characteristics.

Approach--Discharge and water-quality data were collected at sites on the inflows and outflow of a selected "dry pond." Each of these sites was instrumented with continuously recording, flow- and automatic-sampling equipment as described in project KS-142. Also, physiographic, land-use, climatic, and storm-characteristic data were collected at the study location. Total loads of selected constituents will be compared graphically and statistically to determine the effects of detention storage. Multiple regression analysis will be used to define relations between storm loads and storm characteristics.

Significant milestones--Data collection has been completed. Project was suspended at the end of the 1990 fiscal year.

Reports

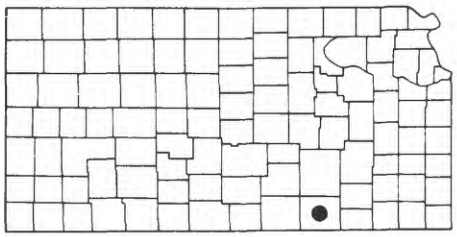
Pope, L.M., and Hess, L.G., 1989, Load detention efficiencies in a dry-pond basin, *in* Roesner, L.A., Urbonas, Ben, and Sonnen, M.B. eds., Design of urban runoff quality controls: Proceedings of Engineering Foundation Conference on Current Practice and Design Criteria for Urban Quality Control, American Society of Civil Engineers, July 10-15, 1988, Potosi, Mo., p. 258-267.

PROJECT TITLE:
Reconnaissance of Arkansas City Dump Site, Arkansas City, Kansas

PROJECT NUMBER: KS-147

COOPERATING AGENCY:
Kansas Department of Health and Environment

PROJECT CHIEF:
T. B. Spruill



KS147

Problem--The Arkansas City Dump Site has been used as a city landfill as well as for disposal of wastes from an oil refinery. Carcinogenic polyaromatic hydrocarbons and large concentrations of chloride, sulfate, nitrate, and lead have been detected in soil and ground-water samples onsite. Available information is inadequate to define the source and extent of soil and water contamination. Before environmental hazards may be fully evaluated, composition, quantity, and mobility of the wastes need to be characterized. In addition, the relation between the aquifer and the Arkansas River needs to be determined, and initial estimates of soil and water contamination made.

Objectives--Objectives of the project are to: (1) identify the location, extent, and volume of the principal sources of waste on the site; (2) define the chemical and physical characteristics of the wastes; (3) evaluate possible alternatives regarding remedial action for known waste sites; (4) obtain preliminary information on the extent of soil and ground-water contamination on and adjacent to the site; (5) define the hydrology of the immediate vicinity; and (6) determine possible effects of seepage from the site on the Arkansas River.

Approach--Surface and subsurface waste boundaries were located by magnetometer surveys and test-hole drilling. The chemical and physical characteristics of wastes from the site and of soil and water samples were determined. The source and extent of contamination and factors governing contaminant mobility were determined. Samples from the Arkansas River up- and downstream from the waste site were collected to determine the effect of the site on river-water quality.

Significant milestones--The project and reports are complete.

Reports

Spruill, T.B., 1987, Effects of wastes from an abandoned oil refinery on ground-water quality in an alluvial aquifer: Proceedings of the 1987 Hazardous Waste ResearchConference, Manhattan, Kansas, May 20, 1987.

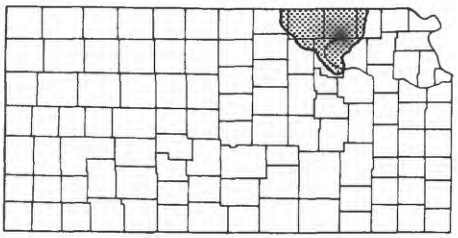
__1988, Use of total organic carbon as an indicator of contamination from an oil refinery, south-central Kansas: Ground-Water Monitoring Review, v. 8, no. 3, p. 76-82.

PROJECT TITLE:
Occurrence of agricultural pesticides in the Tuttle Creek Lake-stream system, Kansas

PROJECT NUMBER: KS-150

COOPERATING AGENCY:
Kansas Department of Health and Environment

PROJECT CHIEF:
H. E. Bevans



KS150

Problem--Pesticides have been detected in Kansas lakes and streams that are current or future sources of public-water supplies. Atrazine, the most extensively used agricultural pesticide in Kansas, has been reported to occur in concentrations as large as 27 micrograms per liter in Tuttle Creek Lake. Although the long-term effects of atrazine and other pesticides on human health have not been fully determined, these pesticides pose a potential threat to the quality of water in lakes that provide public-water supplies. Additionally, the presence of pesticides in lake water may affect phytoplankton productivity.

Objectives--This investigation of the occurrence of agricultural pesticides in the Tuttle Creek Lake-stream system will be directed towards (1) documenting the occurrence of pesticides in the lake-stream system, (2) describing the transport of pesticides through the lake-stream system, and (3) determining the effects of atrazine on photosynthesis and carbon uptake of lake phytoplankton.

Approach--Samples of water-sediment mixture were collected during a 1-year period from Tuttle Creek Lake, lake tributaries, and the lake outflow. Concentrations of total pesticides, total organic carbon, and suspended sediment were determined for all samples. Dissolved concentrations of pesticides and organic carbon also were determined for the Big Blue River, the principal lake tributary. Experiments were conducted using Tuttle Creek Lake samples and samples from a control lake, where pesticides were not detected, to determine the effects of atrazine on lake phytoplankton. Interpretations of these data were used to meet study objectives.

Significant milestones--The project is complete, and the report is pending Director's approval.

Reports

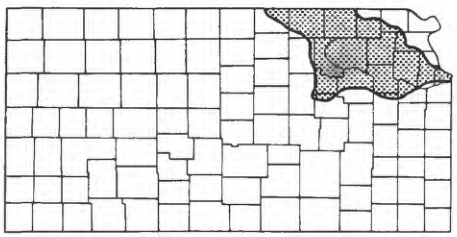
Bevans, H.E., 1987, Occurrence of agricultural pesticides in Tuttle Creek Lake, Kansas, in Program of Regional Symposium on Lake and Reservoir Management: The Ohio Lake Management Society and the North American Lake Management Society, Columbus, Ohio, May 4-5, 1987, p. 11.

PROJECT TITLE: Surface-water-quality assessment of the lower Kansas River basin, Kansas and Nebraska

PROJECT NUMBER: KS-152

COOPERATING AGENCY: Federal

PROJECT CHIEF: J. K. Stamer



KS152

Problem--Protecting and increasing the supply of good quality water is a national priority. The Nation's Midwest is a very productive agricultural grain belt. The lower Kansas River drainage is typical of this midwestern agricultural region that includes irrigated and nonirrigated land. The basin is also representative of water use--principally for irrigation, municipal, and industrial purposes. An assessment of the water quality and quantity of water in the lower Kansas River basin, which includes the Big Blue River basin in Nebraska and Kansas, is important.

Objectives--The objectives of the assessment are to: (1) define the existing water quality of the lower Kansas River basin, its major tributaries, and selected reservoirs; (2) determine trends in water quality of the lower Kansas River basin, its major tributaries, and selected reservoirs; and (3) define human and natural factors, to the extent possible, that affect water quality or its trends.

Approach--The approach is divided into three elements: (1) Fixed-station studies to assess average annual constituent transport and water-quality trends; (2) synoptic studies to determine the surface-water quantity and quality during low flows and to determine trace elements and organic residues in the streambed sediments during low flows; and (3) intensive subbasin or river-reach studies to define cause-effect relations, depending on time and resource constraints.

Significant milestones--Seasonal low-flow synoptic sampling for major ions, nutrients, sediment, and selected pesticides has been completed. Sampling of fixed stations has continued. Several oral presentations about analysis of pre-project and project data have been presented to external and internal peer groups. A report on the analysis of available data has been completed. A data report on trace elements in streambed sediments has been published. Results indicate large concentrations of some pesticides and nutrients in the upper part of the basin and in northeast Kansas, large sediment yields in northeast part of basin, and large concentrations of sodium and dissolved solids along the main stem of the Kansas River during low flow. Progress continues on an additional 10 reports resulting from the initial pilot phase of this study.

Reports

Jordan, P.R., and Stamer, J.K., eds., 1991, Surface water-quality assessment of the lower Kansas River basin, Kansas and Nebraska--Analysis of available data through 1986: U.S. Geological Survey Open-File Report 91-75 (pending publication as Water-Supply Paper 2352-B), 172 p.

Stamer, J.K., 1991, An investigation summary concerning pesticides in lower Kansas River basin in Kansas and Nebraska (abstract): Proceedings of 8th Annual Water and the Future of Kansas--Water in Conflict, March 4-5, 1991, Manhattan, Kansas, p. 45-46.

Stamer, J.K., Jordan, P.R., Engberg, R.A., and Dugan, J.T., 1987, Surface water-quality assessment of the lower Kansas River basin, Kansas and Nebraska--Project description: U.S. Geological Survey Open-File Report 87-105, 36 p.

Stamer, J.K., Pope, L.M., and Zelt, R.B.,1990a, Occurrence and distribution of pesticides in the lower Kansas River basin in Kansas and Nebraska: Proceedings of 7th Annual Water and the Future of Kansas Conference, Manhattan, Kansas, March 7-8, 1990, p. 25-26.

___1990b, Occurrence and distribution of pesticides in the inflows and outflows of reservoirs in northeast Kansas: Kansas Academy of Science, abstracts, v. 9, p. 60.

Tanner, D.Q., Sanzolone, R.F., and Zelt, R.B., 1990, Surface-water-quality assessment of the lower Kansas River basin, Kansas and Nebraska--Concentrations of major metals and trace elements in streambed sediments, 1987: U.S. Geological Survey Open-File Report 90-581, 73 p.

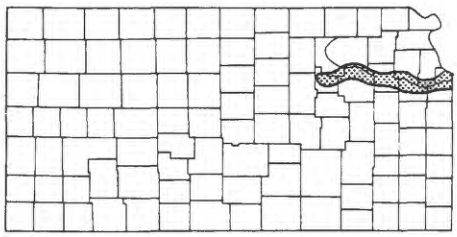
Zelt, R.B., 1991, GIS technology used to manage and analyze hydrologic information: GIS World, August 1991, p. 70-73.

PROJECT TITLE: Ground-water and surface-water relations in the Kansas River alluvium

PROJECT NUMBER: KS-153

COOPERATING AGENCY: U.S. Bureau of Reclamation

PROJECT CHIEF: R. J. Wolf



KS153

Problem--The State of Kansas is developing a water-management plan for the Kansas River as a part of the purchase of water stored in Federal reservoirs. The effect of pumpage from the river valley alluvium on releases from the reservoir in time of drought needs to be determined. The area of study will be the valley alluvium along the main stem of the Kansas River.

Objectives--The study will provide information needed to anticipate the effects of ground-water pumpage on reservoir releases. The primary objective of the study is to determine the effects of pumping on streamflows during low-flow periods and transit losses and traveltimes of reservoir releases.

Approach--Documentation of ground-water levels and streamflows will be used to determine the interaction between the river and the alluvial aquifer. Various analytical and digital-modeling techniques will be used to quantify the effects of pumpage on the river during low-flow periods. Synoptic studies of stream discharge along the river will be conducted to determine the transit losses and traveltimes during reservoir releases at low flow.

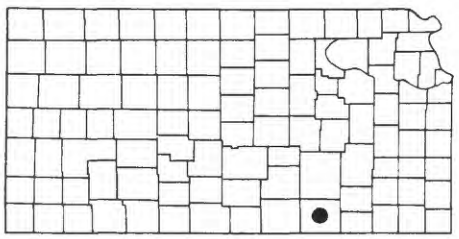
Significant milestones--A finite-element model of the Wamego-to-Topeka reach was calibrated using data for 1948-87. Hypothetical simulations were made for low, average, and high precipitation and streamflow conditions, and variations of 1987 pumpage. Simulated reservoir releases were made for hypothetical drought conditions. Traveltimes of reservoir releases were determined for isolated actual releases during periods of low flow. Project is complete except report. Additional modeling work suggested by colleague reviewers has been completed.

PROJECT TITLE: Processes affecting movement of leachate from oil-refinery wastes in an alluvial-aquifer system

PROJECT NUMBER: KS-154

COOPERATING AGENCY: Kansas Department of Health and Environment

PROJECT CHIEF: J.O. Helgesen



KS154

Problem--Kansas has approximately 45 of the more than 900 operating and abandoned oil-refinery sites in the Nation. Many are located over alluvial aquifers near water supplies. Less stringent environmental restrictions in the past have allowed disposal of acid sludge composed of organic compounds in open pits. Preliminary investigations at some sites in Kansas indicate extensive surface-water, ground-water, and soil contamination, which may result in significant health risks.

Objectives--The objectives of the project are to; (1) determine the major environmental and geochemical factors that affect the movement of refinery wastes; (2) define the characteristics of contamination and the relative persistence of selected organic compounds; and (3) describe potential hydraulic and geochemical processes that may be taking place.

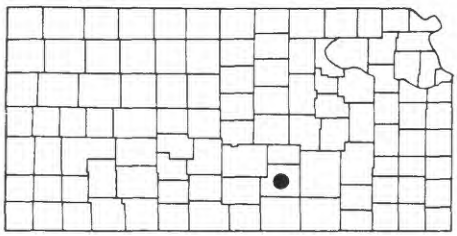
Approach --The approach was to document the types of compounds and their relative locations on a site near Arkansas City, Kansas. Data were collected on organic-compound concentrations in the water and on the soil and aquifer materials. Anticipated geochemical and transport processes were verified from interpretation of data and hydrologic knowledge of the area.

Significant milestones--Project complete. All reports published except journal article.

Reports

Spruill, T.B., 1989, Transport of organic contaminants in ground water beneath an abandoned oil refinery, *in* Pederson, G.L., and Smith, M.M., compilers, U.S. Geological Survey Second National Symposium on Water Quality--Abstracts of the technical sessions, Orlando, Florida, November 12-17, 1989: U.S. Geological Survey Open-File Report 89-409, p. 95.

___1990, Preliminary evaluation of the effects of an abandoned oil refinery on chemical quality of water in the Arkansas River valley, Arkansas City, Kansas, 1985-86: U.S. Geological Survey Water-Resources Investigations Report 89-4190, 53 p.



KS155

PROJECT TITLE: Example demonstration of procedures for delineating wellhead-protection areas around a Midwest public ground-water supply site

PROJECT NUMBER: KS-155

COOPERATING AGENCY: U.S. Environmental Protection Agency

PROJECT CHIEF: C.V. Hansen

Problem--Many of the public-water supplies in the Midwest obtain water from relatively shallow aquifers that are particularly vulnerable to contamination. The U.S. Environmental Protection Agency is involved in defining strategies that will delineate those areas around public-supply wells to be protected from contamination. Application of these strategies needs to be demonstrated at an existing site.

Objectives--The study will outline appropriate methods and data required to delineate the wellhead-protection area around a Midwest public ground-water supply site. Additionally, the utility of a geographic information system (GIS) in the delineation and display of the wellhead-protection area and associated information will be demonstrated.

Approach--Methods described by the U.S. Environmental Protection Agency in "Guidelines for Delineation of Wellhead Protection Areas" and other sources for delineating the wellhead-protection areas around public-supply wells were evaluated for their appropriateness to the Mt. Hope, Kansas, example. Information from recent studies around Mt. Hope was used. The information was compiled, and each selected method's resulting wellhead-protection areas were displayed through the use of ARC/INFO, a geographic information system.

Significant milestones--Project is complete.

Reports

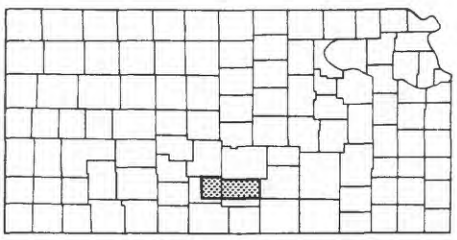
Hansen, C.V., 1991, Description and evaluation of selected methods used to delineate wellhead-protection areas around public-supply wells near Mt. Hope, Kansas: U.S. Geological Survey Water-Resources Investigations Report 90-4102, 39 p.

PROJECT TITLE: Saline ground-water discharge to the South Fork Ninnescah River in Pratt and Kingman Counties, south-central Kansas

PROJECT NUMBER: KS-162

COOPERATING AGENCY: City of Wichita, Sedgwick County

PROJECT CHIEF: J.B. Gillespie



Problem--The Wichita metropolitan area has some concern about future water supplies. One potential source of supply is the South Fork Ninnescah River. However, between Pratt and Kingman, saline ground water is discharged to the river. Chloride concentrations downstream in the river are more than 250 milligrams per liter for 70 percent of the time and commonly exceed 500 milligrams per liter. The source of the saline water is rocks of Permian age that underlie about 50 to 250 feet of alluvium in the area.

Objectives--The objectives of the project are to: (1) determine the location and extent of saline ground-water discharge to the river, (2) identify the source and approximate flow rates of the saline water, (3) define the characteristics of movement and mixing of the freshwater and saline water, and (4) provide a comparative evaluation of selected measures that might be taken to abate the salinity problem.

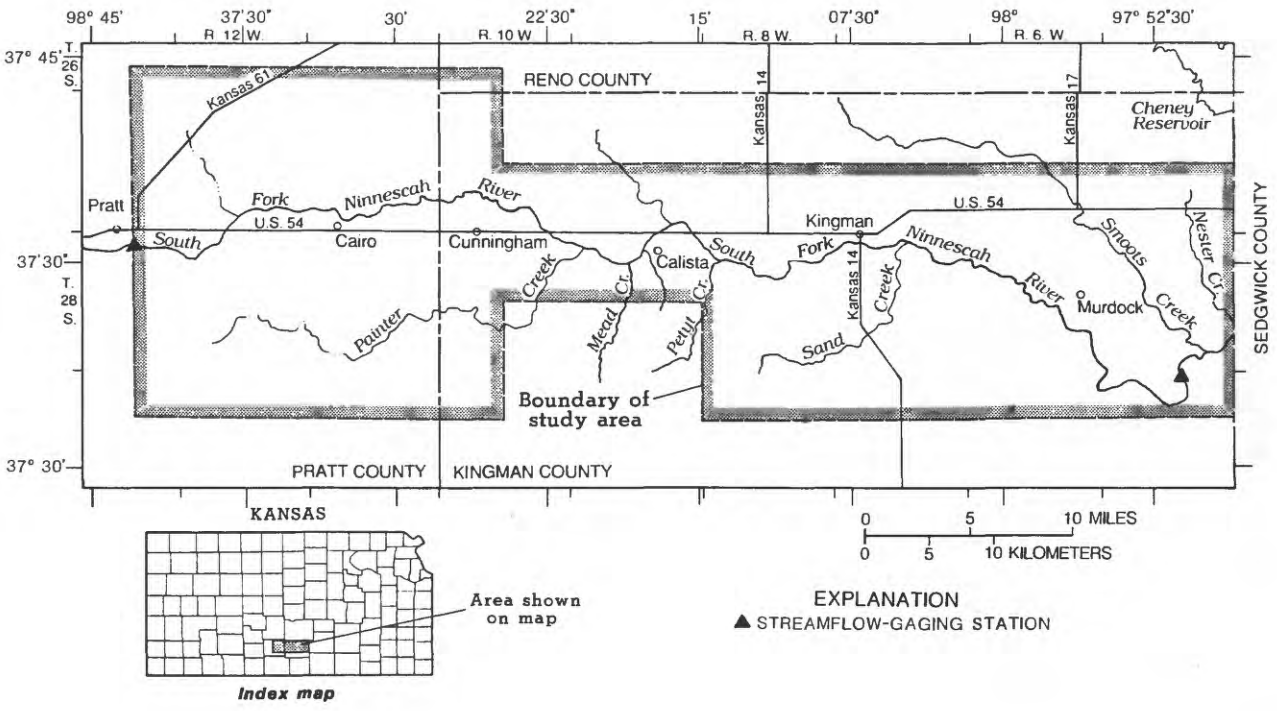
Approach--The literature and data bases were searched for all pertinent information. Low flows were measured, and water-quality samples were collected to determine the reach in which saline ground water is discharging to the river. Existing wells were used, and additional wells were drilled in the area of saline ground-water discharge. Aquifer tests were conducted to determine aquifer properties, and ground-water samples were analyzed to determine the distribution and location of the saline water. Water-quality modeling or analytical techniques were used to estimate saline-water discharge and the effects of various pumping alternatives that could potentially intercept the saline water before it enters the river.

Significant milestones--Fifty-three monitoring wells were installed in the Permian rocks and alluvium at 16 sites. Water-quality samples were collected from all monitoring wells and other selected sites. Electromagnetic terrain-conductivity surveys were conducted in the river valley and along 6 miles of the South Fork of the Ninnescah River. Maps showing the altitude of the top of the Stone Corral Formation and thickness of the Ninnescah Salt were compiled.

A geohydrologic data report was published. Project is complete except for final interpretive report, which is in review.

Reports

Gillespie, J.B., Hargadine, G.D., Myers, N.C., and Hargadine, D.A., 1991, Geohydrologic data for the South Fork Ninnescah River valley and adjacent plains in Pratt and Kingman Counties, south-central Kansas: U.S. Geological Survey Open-File Report 91-186, 55 p.

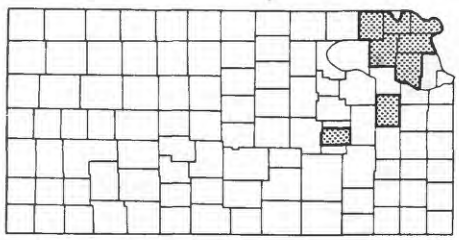


PROJECT TITLE: Soils data base for part of northeast Kansas

PROJECT NUMBER: KS-163

COOPERATING AGENCY: U.S. Soil Conservation Service

PROJECT CHIEF: C.V. Hansen



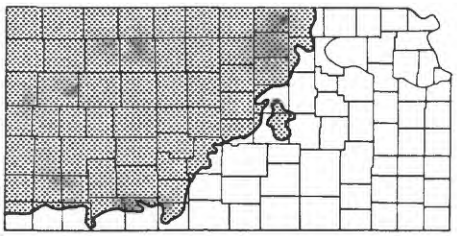
Problem--Part of the mission of the U.S. Soil Conservation Service (SCS) is to protect the Nation's soils for future generations. To develop and implement a program to accomplish this goal requires spatial data relating to crops, soils, topography, climate, and water resources. At present, these data are not available in an automated form that will allow rapid access and facilitate decision making. The soils in northeast Kansas in Atchison, Doniphan, Jackson, Jefferson, Nemaha, Osage, and parts of Brown and Marion Counties are of special concern to the U.S. Soil Conservation Service.

Objectives--Soils data, both in map and tabular forms, were automated through the use of the ARC/INFO geographic information system for Atchison, Doniphan, Jackson, Jefferson, Nemaha, Osage, and parts of Brown and Marion Counties.

Approach--The soil maps were digitized using ARC/INFO. The associated soil attributes were brought into ARC/INFO and linked to the digitized soil maps.

Significant milestones--Manual digitizing and attribute assignment to 12 soil quadrangles (7 1/2-minute, scale 1:24,000) were completed. Scan digitizing and attribute assignment for nine additional quadrangles of soils data were completed. Tapes of 21 digital soil quadrangles were sent to and accepted by the SCS. Results of comparison of different methods for digitizing soils data (manual digitizing of photo-mosaiced quadrangles, scan digitizing, and rubbersheeting of original unrectified quadrangles) were presented to the SCS. Scan digitizing of soils data is both time and cost effective and more accurate.

Project is complete.



KS164

PROJECT TITLE: Water resources potential of the Dakota aquifer in Kansas

PROJECT NUMBER: KS-164

COOPERATING AGENCY: Kansas Geological Survey

PROJECT CHIEF: R.J. Wolf

Problem--The Dakota aquifer is the second most extensive aquifer in Kansas after the High Plains aquifer. In the near future, depletion of the High Plains aquifer due to overdevelopment may cause a critical water shortage in parts of western Kansas. The Dakota aquifer will be the next available source of water for this region and is already providing water for parts of southwestern and central Kansas. At present, insufficient information concerning the quantity and quality of Dakota water limits the ability of State water planners to evaluate this aquifer as a future major source of water. A sound technical basis is needed on which future water-management and planning efforts can depend.

Objectives--This study was developed to assemble and summarize all current information pertaining to the Dakota aquifer in Kansas. Collective analysis of all information will provide preliminary interpretations and a planning base for long-term investigation of the Dakota aquifer, which is an important need as identified by all agencies that are responsible for Kansas' water resources.

Approach--All data will be assembled and compiled into consistent formats in a data-base management system with geographic information system (GIS) capabilities. Sources of data will include the U.S. Geological Survey (USGS) Regional Aquifer System Analysis (RASA) data base and files, State-agency data, and public and private petroleum-data sources. Synthesis of all data and previous interpretive information will provide descriptions (using maps, sections, tabulations, statistical analyses) of current statewide knowledge of the aquifer. Application of a GIS will provide coverages for the geometry, depth, and hydraulic properties of the aquifer. This will facilitate development of "baseline" interpretations of the system and help identify needs to guide future work. Data are expected to be sufficient in southwestern Kansas to enable formulation of a preliminary three-dimensional flow model of that part of the system.

Significant milestones--Funding for FY89 dictated that information be collected and evaluated on energy used in pumping water from the Dakota and how it compares with pumping water from the Dakota-High Plains aquifer in combination. Pumping-

plant tests were conducted on about 80 large-capacity wells. This work was conducted by Kansas State University's Agricultural Extension Service. Results were analyzed, and a report was prepared by the Kansas Geological Survey.

In FY90, data retrievals from the U.S. Geological Survey's Ground-Water Site Inventory (GWSI) data base were made for the Dakota aquifer area of Kansas and for the two southeastern counties of Colorado. In Kansas, data from 80 sites with multiple-measurement water levels were retrieved; 1,017 sites had single (inventory) measurements, and 182 sites had no measurements. In the southeast Colorado counties, there were 101 multiple-measurement sites, 197 single-measurement sites, and 13 no-measurement sites. Driller's logs were obtained from the Colorado State Engineer's office. Bedrock water levels were plotted on a base map of the study area, and water-quality data were compiled for adjacent counties in Colorado and Nebraska. Water levels measured by cooperating agencies in spring 1990 at about 98 sites in Prowers and Baca Counties, Colorado, were included as part of a mass measurement of water levels in aquifers in Lower Cretaceous rocks throughout Kansas and southeastern Colorado.

In FY91, additional GWSI retrievals were completed and transferred on magnetic tape to the Kansas Geological Survey. Contract specifications were written for drilling sites in Finney and Stanton Counties for aquifer tests. Discussions and plans for digital modeling of the aquifer were held with the Kansas Geological Survey. Special water-quality samples for selected radiochemical constituents were collected.

Reports

Macfarlane, P.A., Whittemore, D.O., Butler, J.J., Jr., Wade, Alan, Coleman, J., Townsend, M.A., Meehan, T.J., Doveton, J.H., Bohling, G.C., Macpherson, G.L., and Hamilton, V.J., 1991, The FY90 annual report of the Dakota aquifer program--Executive summary: Kansas Geological Survey Open-File Report 91-1, 9 p.

Macfarlane, P.A., Whittemore, D.O., Townsend, M.A., Butler, J.J., Jr., Doveton, J.H., Hamilton, V.J., Coleman, J., Chu, T.M., Wade, Alan, and Macpherson, G.L., 1991, The Dakota aquifer program--Annual report, FY90: Kansas Geological Survey Open-File Report 91-1, 42 p.

Macfarlane, P.A., Whittemore, D.O., Townsend, M.A., Doveton, J.H., Hamilton, V.J., Coyle, W.G., III, Wade, A., Macpherson, G.L., and Black, R.D., 1989, The Dakota aquifer program--Annual report, FY89: Kansas Geological Survey Open-File Report 90-27 and 90-27a (report map plates), 301 p.

Macfarlane, P.A., Wade, Alan, Doveton, J.H., and Hamilton, V.J., 1991, Revised stratigraphic interpretation and implications for pre-Graneros paleogeography from test-hole drilling in central Kansas: Kansas Geological Survey Open-File Report 91-1A, 73 p.

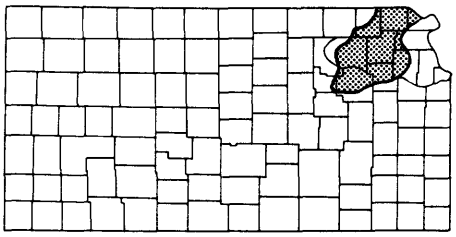
Wade, Alan, 1991, Determination of aquifer properties of the Dakota aquifer in Washington County, Kansas, from a pumping test: Kansas Geological Survey Open-File Report 91-1E, 62 p.

PROJECT TITLE: Water resources of northeast Kansas

PROJECT NUMBER: KS-165 and KS-167

COOPERATING AGENCY: U.S. Bureau of Indian Affairs and Iowa Tribe of Kansas and Nebraska, Kickapoo Tribe of Kansas, Prairie Band of Potawatomie, and Sac and Fox Tribe of Missouri

PROJECT CHIEF: T.J. Trombley



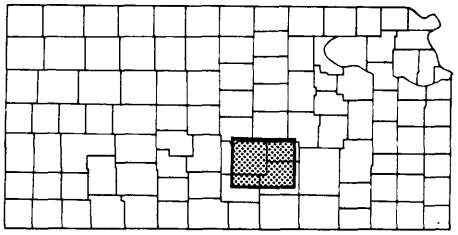
KS165 & 167

Problem--Water-related data for the Kickapoo, Potawatomie, Iowa, and Sac and Fox Indian tribes in northeast Kansas are needed for water-resources management. An assessment of water resources would include descriptions of surface and ground water; summaries of existing information on quantity, quality, and use of the water; and collection of additional information as needed to supplement existing data. This information will be useful to the tribal councils, the U.S. Bureau of Indian Affairs, and other State and Federal agencies.

Objectives--The objectives of the projects are to: (1) compile and evaluate existing information on the extent of water resources; (2) identify deficiencies in data on surface- and ground-water resources and water use; and (3) acquire additional data needed to describe the predevelopment water resources of these areas and to define current water uses and availability.

Approach--Water-resources-related information will be mapped, and available water data within the study area will be retrieved using automated data-aquisition and processing system (ADAPS) programs. Current and historic data on streamflows, well measurements, and water quality will be evaluated for consistency of coverage and data needs. Additional data will be collected by the U.S. Geological Survey to supplement data on surface water, ground water, water quality, and water use. The water resources will be appraised for availability, suitability, and dependability.

Significant milestones--Water-quality data (92 constituents) have been compiled from 116 stream sites with 6,802 analyses available and 1,831 wells with 1,831 available analyses. The data are being analyzed for areal and temporal trends. The site locations for wells in the study area have been updated using a computer program that computes latitude and longitude from land-net locations. A report has been approved as a study description, and a data report listing available water-resources data is being compiled.



KS169

PROJECT TITLE: Effects of the Arkansas River on the *Equus* beds aquifer adjacent to the Arkansas River between Hutchinson and Wichita in south-central Kansas

PROJECT NUMBER: KS-169

COOPERATING AGENCY: Kansas Water Office

PROJECT CHIEF: N.C. Myers

Problem--Water in the Arkansas River has dissolved-solids concentrations that are large in comparison to the ground water in the adjacent *Equus* beds aquifer. The *Equus* beds aquifer is an important source of water for municipal, industrial, and irrigation usage. Continuing development of the *Equus* beds aquifer near the Arkansas River could have a detrimental effect on the quality of water in the aquifer if lowered ground-water levels cause river water to seep into the aquifer. In addition, withdrawals of large quantities of ground water from the aquifer could reduce flows in the river below acceptable levels.

Objectives--The objectives of this study are to: (1) define the flow system between the Arkansas River and the adjacent *Equus* beds aquifer and (2) define the water-quality profile between the Arkansas River and the adjacent *Equus* beds aquifer in the reach from Hutchinson to Wichita, Kansas.

Approach--An interpretation of the stream-aquifer relation will be made based on results of past studies and the analysis of data collected during this study. A series of nested wells will be drilled in cross sections across and parallel to the Arkansas River to develop hydrogeologic and water-quality profiles across and along the river. A ground-water flow model will be developed to simulate the stream-aquifer relation. If the modeling successfully represents the stream-aquifer interaction, the model would be used to project the effects that various stresses on the system could have on the stream-aquifer system. In addition, a particle-tracking program could be used to simulate the flow path of chloride between the stream and aquifer.

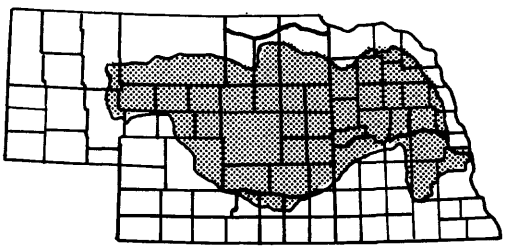
Significant milestones--Nested monitoring wells have been installed at 49 sites along the Arkansas River. Water samples from the wells have been analyzed for common inorganic ions and metals. Water levels in these wells are being measured on a monthly or quarterly basis. Digital water-level recorders have been installed on wells near the river. A computer model of ground-water flow has been developed as well as a computer program to simulate movement of chloride mass through the *Equus* beds aquifer using particle-tracking results.

PROJECT TITLE: Central Nebraska river basins water-quality assessment

PROJECT NUMBER: KS-171

COOPERATING AGENCY: Federal

PROJECT CHIEF: T.L. Huntzinger



Problem--The Central Nebraska Basins, which include the Platte and Loup River systems, is a significant resource to the State and to users downstream who are affected by it. Hydrologically, the area is an integrated stream and water-table aquifer system with reservoir control and pumpage for irrigation and public-water supplies. Economically, the area is primarily agricultural and, therefore, has the potential for depletion of ground-water supplies and contamination from agricultural chemicals. Current information indicates large nitrate and pesticide concentrations in the water. The Platte River is located within the Central Flyway of migratory birds and is a major stopover for waterfowl, including endangered species, such as the whooping crane. There is concern that decreased streamflow and deteriorating water quality will have a negative affect on this wildlife resource.

Objectives--The objectives of the project are to access the water-quality conditions in the lower Platte River basin. Maximum use of existing data will: (1) provide a description of current water-quality conditions and trends in water quality, including sources of contamination, and (2) conceptually describe apparent relations between water-quality conditions and natural and human factors. Additional analyses and data will: (1) verify the description of water-quality conditions, (2) define long-term trends in water quality, (3) reduce the uncertainty of the described water-quality conditions, (4) increase knowledge of the important water-quality issues in the basin, and (5) improve the understanding of the relations between causative factors and water quality.

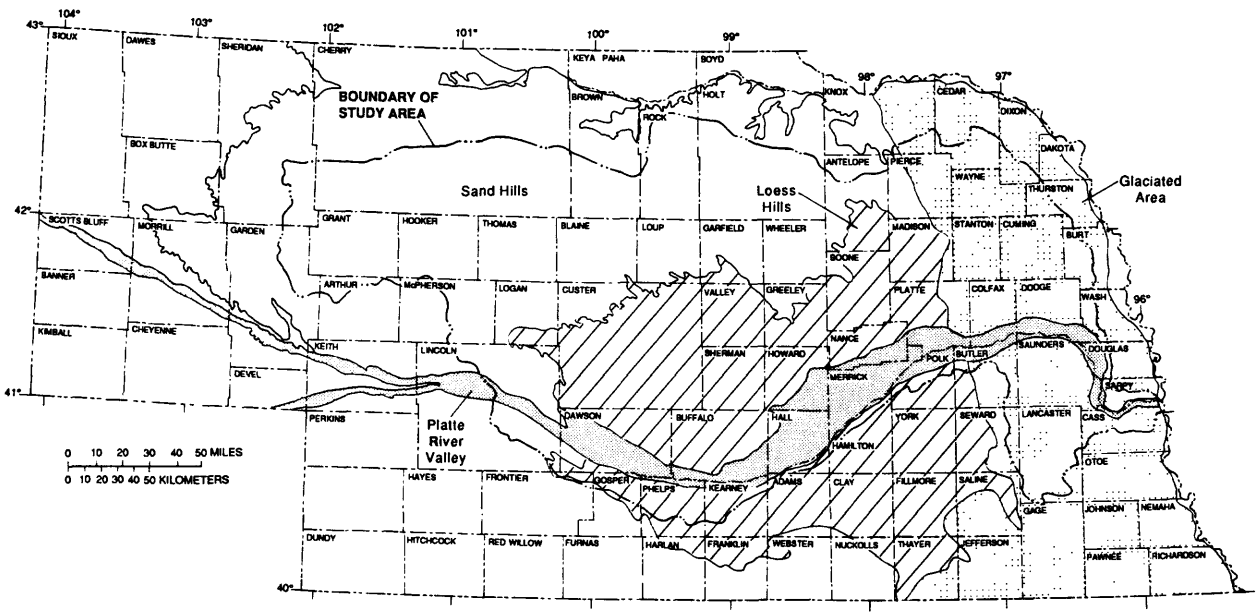
Approach--The water-quality assessment of the lower Platte River basin will include four distinct components that relate to a quantitative description of the water-quality conditions and characteristics of the basin: (1) A thorough compilation, analysis, and interpretation of existing hydrologic data will be performed; (2) the analysis will provide the basis for developing the strategy for obtaining specific additional hydrologic data that will be used to define areal and temporal distribution of water quality; (3) ancillary information will be obtained that will provide the most reliable information about current water-quality conditions and trends and their relationship to human and natural factors; and (4)

hydrologic processes may be investigated in more detail in smaller areas on river reaches that relate to the solution of critical water-quality problems in the river basin based on analyses of available data or collection of new data.

Significant milestones--Staffing for the project was completed as planned for fiscal year 1991. All major hydrologic data sets were obtained. Plans for the summary of available data are underway. An extensive list of publications was compiled for the Platte River basin. The first draft of the work plan was completed.

Reports

Huntzinger, T.L., 1991, National water-quality assessment program--The Central Nebraska Basins: U.S. Geological Survey Open-File Report 91-97, 2 p. (Water Fact Sheet)



PROJECT TITLE: Organic geochemistry of natural and polluted water--Nonpoint-source contamination

PROJECT NUMBER: KS-156

COOPERATING AGENCY: U.S. Agricultural Research Service

PROJECT CHIEF: E.M. Thurman

Problem--The midcontinent area of the United States, especially Kansas, Nebraska, and Iowa, uses many herbicides to control weeds that affect corn, sorghum, and soybean production. The result is that large quantities of herbicides (2 to 5 pounds per acre) are used annually in these States. Numerous reports indicate the contamination of rivers, reservoirs, and ground water by herbicides. To assess the effect of nonpoint-source pollution on surface and ground water and to develop management strategies, the compounds that cause nonpoint-source contamination need to be determined and linked to both geochemical and hydrologic processes.

Objectives--The objectives of this research are to: (1) investigate the amount, distribution, geochemistry, and transport of nonpoint-source pollutants (herbicides, degradation products, adjuvants, and fertilizers) at field scales in the midcontinent, where problems are most acute, and to tie research with modeling efforts of other agencies, using computer models such as GLEAMS and PRZM; and (2) identify "fingerprint" compounds that indicate agricultural and urban sources of nonpoint-source pollution and to link this research with hydrologic information and management models of nonpoint-source pollution, such as large-scale (regional) data bases, which then could be used to formulate strategies for the abatement of nonpoint-source pollution.

Approach--The approach consists of three parts that will be implemented in the midwestern United States:

1. Herbicide runoff in streams will be collected at 150 sites for three time periods to measure large-scale variation.

2. Herbicides in storm runoff will be determined using immunoassay and gas chromatography/mass spectrometry. Research will include recording of storm runoff, measurement of degradation products in storm runoff, and model simulation of storm runoff.

3. Chemical modeling of nonpoint-source contamination will be accomplished by combining knowledge of the chemistry of nonpoint-source pollutants with the large data base on the distribution of herbicides and related chemicals (nitrogen) available from the U.S. Geological Survey.

Significant milestones--Atrazine and alachlor are major herbicides in surface and ground water of the Midwest. Concentrations are less than 1.0 microgram per liter in the spring before application to fields and increase to 10 to 50 micrograms per liter after application. These values exceed State and Federal drinking-water regulations and pose health hazards and water-quality problems to many townships in the Midwest. A survey of herbicides in rainwater of the midcontinent United States has begun. Work continues on reports and journal articles.

Reports

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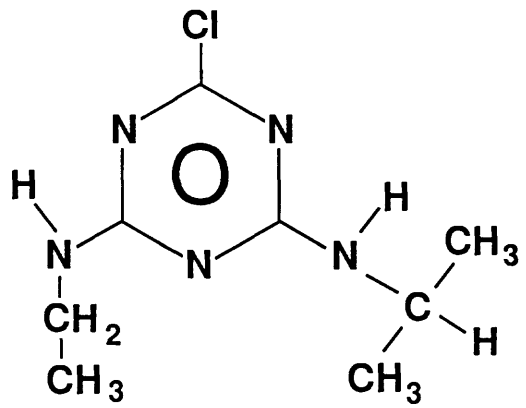

PROJECT TITLE: Chemical and microbial degradation rates of atrazine in ground-water systems

PROJECT NUMBER: KS-157

COOPERATING AGENCY: Kansas State University

PROJECT CHIEF: C.A. Perry

Problem--Little is known about atrazine degradation rates or degradation pathways (chemical, microbiological, or both) in ground water. This information is essential to understanding the transport, persistence, and long-term effects of atrazine in ground-water systems. Also, an understanding of the physical, chemical, and microbial factors that affect the degradation of atrazine in the unsaturated zone and their relation to each other are important in protecting midcontinent environments.

Objectives--The overall objective of this research is to define the persistence and long-term effects of atrazine in ground-water systems and overlying soils typical of midcontinent environments. Specific objectives are to: (1) determine the degradation rates in ground-water systems, (2) determine the principal degradation pathways (chemical or microbiological), (3) determine, to the extent possible, the principal degradation products of atrazine in ground water, and (4) conduct a parallel study of atrazine in unsaturated soil environments.

Approach--Define a representative shallow aquifer and overlying soil properties, including ranges of temperature, moisture content (soil), pH, organic-matter content, soil texture, oxide concentrations, minerology, and fertility. Determine hypothetical ranges of properties for the midcontinent United States. Complete literature review of degradation rates and pathways and compare these with laboratory experiments involving saturated and unsaturated aquifer material and soils. Emphasis will be placed on the effect of microbes on degradation.

Significant milestones--Column studies were performed with aquifer material and native ground water spiked with atrazine and alachlor under various conditions. Two master's theses have been written at Kansas State University (Manhattan) on the basis of these experiments, and a journal article was published in the "Journal of Environmental Quality." Project is complete.

Reports

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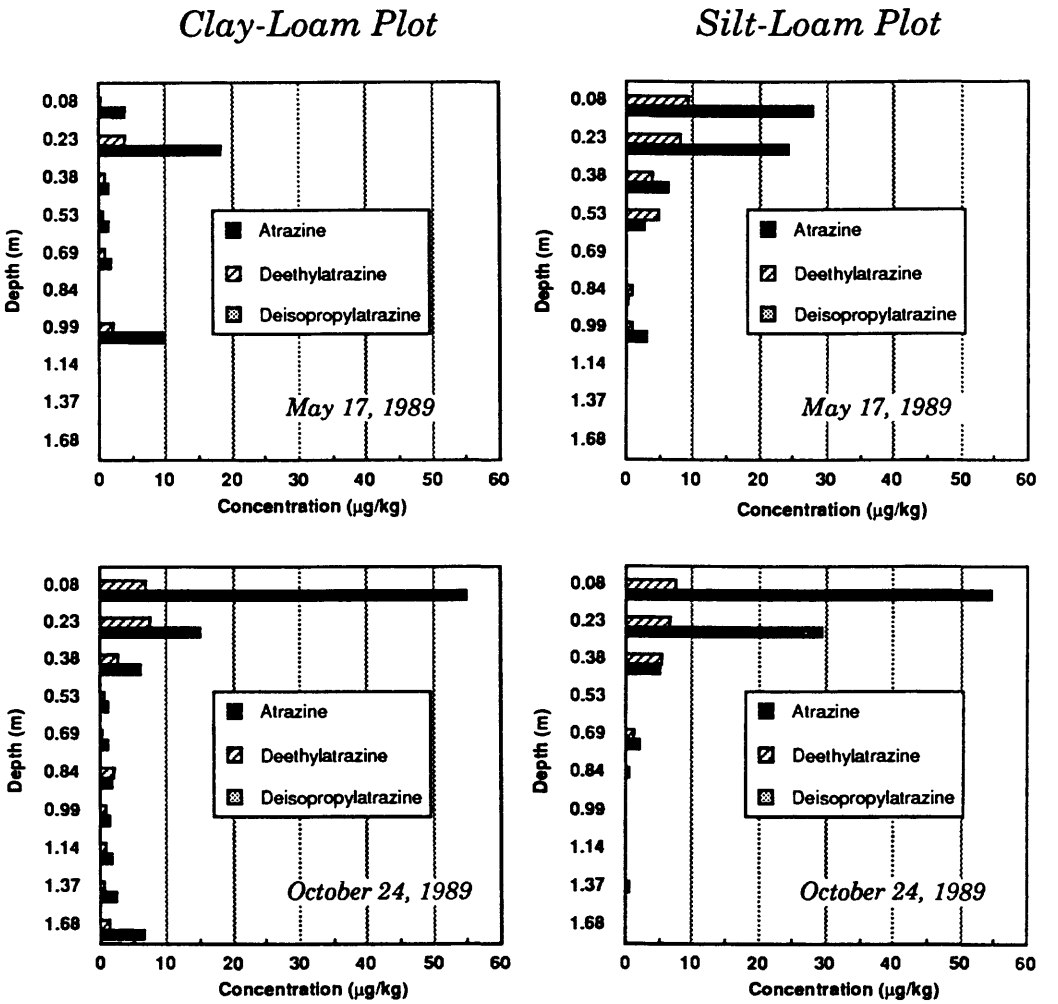

Concentrations of atrazine, deethylatrazine, and deisopropylatrazine in soil cores collected from clay- and silt-loam plots, May 17 and October 24, 1989.

PROJECT TITLE: Data analysis by expert system

PROJECT NUMBER: KS-158

COOPERATING AGENCY: Federal

PROJECT CHIEF: E.M. Thurman

KS158

Problem--Large data bases of both chemical determinations and hydrologic measurements exist in each U.S. Geological Survey office. These data bases are used in studies of water quality, but their use requires time-intensive efforts. The graphical plotting of both chemical and hydrologic data takes considerable time and effort. Yet graphical analysis of data is a powerful tool in understanding scientific processes at work.

The problem is to decrease the time needed for graphical and some statistical analyses of the water-quality and hydrologic data available from project studies as well as from data-base information presently available. Furthermore, expert advise on water quality takes time to implement for large sets of data.

Objectives--The objective of this research is to develop an expert system on a desktop workstation that is an intelligent data analyzer (IDA). The IDA will rapidly analyze chemical and hydrologic data from its data base using the color graphics of the workstation to enhance relations among variables (for example, water quality, hydrology, and mass transport). Some limited expert-system advice will be given on water quality by the IDA.

Approach--The approach consists of three parts:

1. Develop the prototype IDA on a Sun color workstation using the chemical and hydrologic data from the study of the Cedar River in Iowa.

2. The prototype will be coded and implemented to do histograms, bar charts, and scatter diagrams of the water-quality data in a series of stacked windows. This will allow the user to view an entire data set graphically in approximately 1 hour (normally a 1-week job). Hydrographs and mass-transport calculations also will be done on the IDA.

3. Test prototype and complete project report.

Significant milestones--Software to analyze chemical data from rivers has been developed for use on SUN workstations. The software is currently available on the Cedar River data set.

Reports

Thurman, E.M., Squillace, P.J., Strzepek, K.M., and Garcia, L., 1988, Intelligent data analyzer--Herbicide transport in the Cedar River, Iowa, *in* Preprints of papers presented at the 196th ACS National Meeting: American Chemical Society, Los Angeles, Calif., September 25-30, 1988, v. 28, no. 2, p. 13-15.

PROJECT TITLE: Effects of soil and crop management on atrazine movement in soil water

PROJECT NUMBER: KS-159

COOPERATING AGENCY: Kansas State University

PROJECT CHIEF: C.A. Perry

Problem--Atrazine has been detected in both ground and surface water in Kansas. The source of this contamination is predominantly the agricultural regions devoted to production of corn, sorghum, or wheat. Information is needed at the initiation point concerning the initial transport of the herbicide into the surface-drainage pattern or into the ground-water system. The effects of soil-particle size, field slope, and tillage techniques need to be studied.

Objectives--Measure the flux of atrazine and the degradation product, hydroxy-atrazine, through the unsaturated zone to the water table and determine the relation of this flux to tillage practice, land slope, soil texture, and time. Apply the U.S. Department of Agriculture's computer model GLEAMS to the experimental plots for verification. Information from the plots will be used to broaden the scope of the model for application to watersheds on the scale of acres to square miles.

Approach--Field experiments will be conducted at the Kansas River Valley Experimental Farm near Topeka. Plots of corn about 50 by 100 feet in size will be used for the experiments. Field plots will include eight combinations of the following factors: (1) land slope, 0 and 0.2 percent; (2) soil texture, clay and silt loam; and (3) tillage, clean and residue conservation. Soil water will be sampled using a suction lysimeter. For each plot, soil water will be sampled at depths of 2, 3, 4, 6, 12, and 15 feet, and at the water table.

Soil-water samples will be analyzed for atrazine before application of the herbicide to determine background concentrations. Two sets of samples will be collected the first month and one set each for the next 3 months after application. A potassium chloride tracer will be used to follow the movement of the atrazine. An irrigation system designed specifically for controlled plot experiments will apply water to the plots. Runoff water will be sampled for sediment and atrazine.

Significant milestones--Data were gathered in the experimental sampler for five events during the 1989 season. Concentrations of herbicides were very similar to those obtained in the 1988 season.

One master's thesis at Kansas State University (Manhattan) and two journal articles have been written on the basis of data gathered from this experiment. One journal article has been approved for publication in "Analytical Chemistry," and one article is in review. The project is complete.

Reports

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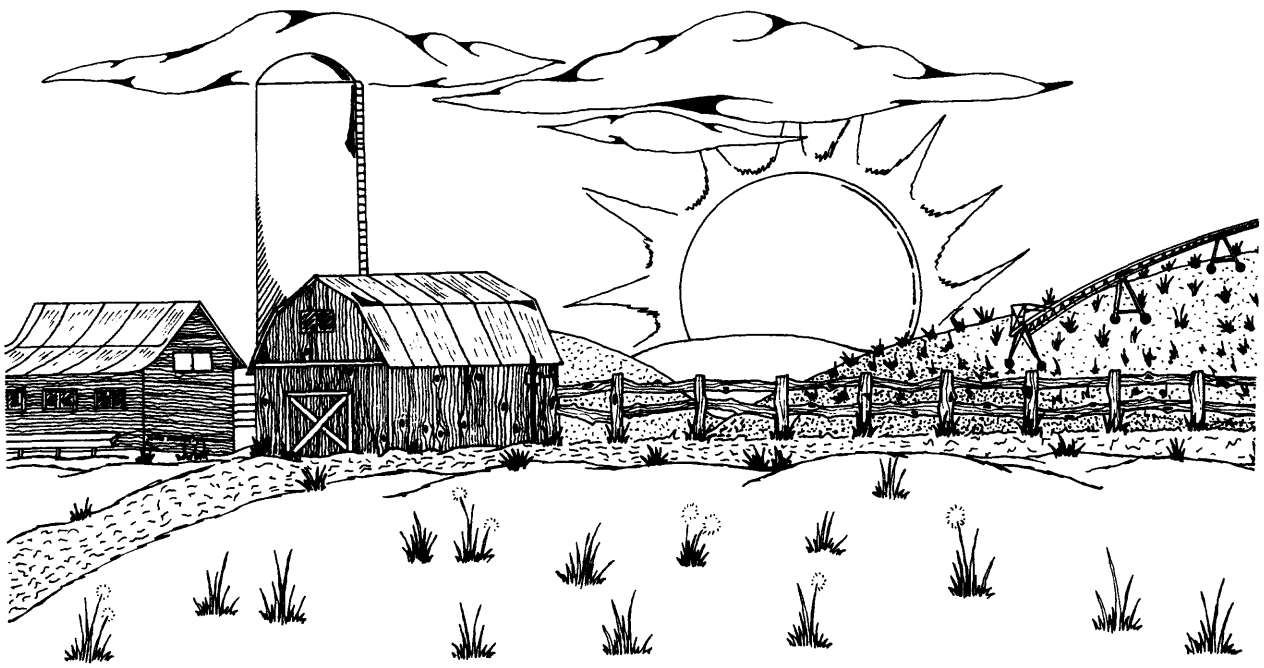
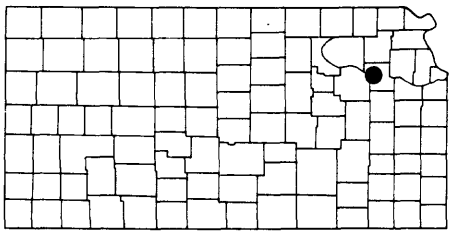


PROJECT TITLE:
Evaluating field-scale pesticide movement in surface and ground water

PROJECT NUMBER:
KS-15901

COOPERATING AGENCY:
Kansas State University

PROJECT CHIEF: L.M. Pope



KS15901

Problem--Nonpoint-source contamination of surface and ground water from agricultural land in the midwest United States has emerged as a National issue. In the lower Kansas River basin, surface water frequently has contained concentrations of soluble herbicides, such as atrazine, in excess of the Maximum Contaminant Level established by the U.S. Environmental Protection Agency. Data collected at sites that drain land principally in row crop indicate that atrazine concentrations in water resulting from surface runoff often exceed 10 µg/L (micrograms per liter) during the 2 months following application. Additionally, concentrations of atrazine in base flow, predominately ground water, are largest in areas of greatest application. The purpose of this study is to determine the potential to mitigate or aggravate the transport of pesticides into surface and ground water by commonly used agricultural and land-management practices. Unless research can find a scientific solution to the safe and effective use of pesticides, such as atrazine, it could be banned from agricultural use. The economic effect of an atrazine ban on growers would be significant because its nearest competitor cost almost twice as much.

Objectives--The objectives of this study are to: (1) Measure pesticide and specific metabolites and suspended-sediment concentrations in surface runoff between a clean-tilled, nonterraced cornfield and a terraced cornfield, both of which are planted up-and-down the slope; (2) compare the amount of atrazine in surface runoff to the amount that has been applied on both the terraced and nonterraced fields; and (3) evaluate the difference in infiltration volume and soil water quality between the terraced and nonterraced fields.

Approach--Surface-water flows from each field are measured with commercially available Parshall-type flumes. Approach hydraulic head is measured by pneumatic-bubble orifices continuously monitored by a multichannel data-acquisition system and recorded on solid-state storage modules. Samples of surface-water runoff are collected automatically throughout the duration of storms by refrigerated samplers with a 24-discrete-sample capacity. Discrete samples from each storm will be composited into a one storm-event

sample. For the first few storms after pesticide application, discrete samples also will be analyzed. The U.S. Geological Survey research laboratory in Lawrence, Kans., will analyze the samples for concentrations of dissolved and suspended atrazine and alachlor, two dealkylated degradation products of atrazine, and a principal degradation product of alachlor. To determine soil water quality, a nest of suction lysimeters were installed just upfield of each terrace and in the nonterraced field. Each nest contains three lysimeters set a 2, 4, and 6 feet below the land surface.

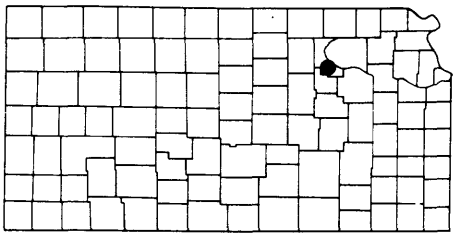
Significant milestones--During FY91, all flumes, samplers, and instruments were installed. Samples of runoff were collected for each storm beginning immediately after pesticide application. This is a multiyear project. Subsequent years will evaluate different agricultural practices.

PROJECT TITLE: Flux of dissolved organic carbon in ground water of the Kings Creek watershed (Konza Prairie)

PROJECT NUMBER: KS-161

COOPERATING AGENCY: Kansas State University

PROJECT CHIEF: E.M. Thurman



KS161

Problem--The flux of dissolved organic carbon in a prairie ecosystem is a function of the primary production of prairie grasses, such as Big Bluestem (*Andropogon gerardi*), of the conversion of this biomass to soil organic matter, and of its transport through the unsaturated zone, ground water, and streams. The flux of dissolved nutrients, such as dissolved organic carbon, has received considerable attention and study in forested streams, but much less is known of the nature, movement, and fate of dissolved organic carbon in prairie streams. This study proposes to follow the movement of dissolved organic carbon through soil profiles, soil water, the unsaturated zone, ground water, and streams of a prairie region in order to understand the organic geochemistry of carbon flux in prairie hydrologic systems.

Objectives -- The objectives of this project are to:

1. Determine the ground-water flow through the riparian zone of the Kings Creek watershed in order to estimate the flow of dissolved organic carbon transported by ground water from the watershed. Kings Creek is instrumented for measurement of surface water, and only the ground-water component islacking.

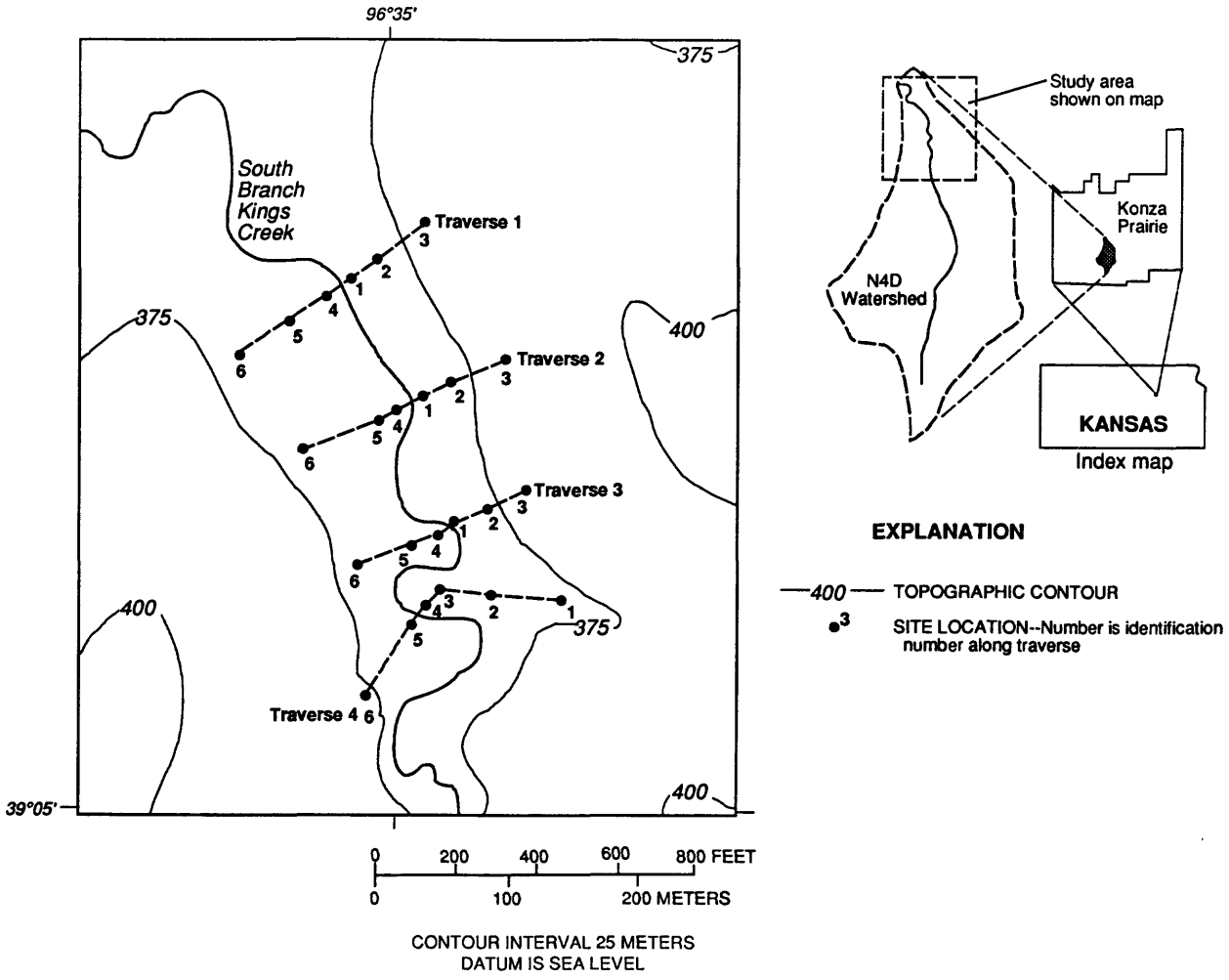
2. Measure the amount (concentration and flux) of dissolved organic carbon moving through soils of the Konza Prairie.

3. Measure the volume of ground water transported annually in the saturated flow in the riparian zone of the stream and the amount (mass) of dissolved organic carbon also transported.

Approach--To measure the amount of dissolved-organic-carbon flux through soil, a part of the Kings Creek watershed will be instrumented with lysimeters and ground-water observation wells, as well as stream gaging of South Branch Kings Creek. The amount of ground-water flux will be estimated on the basis of measurements of recharge and water budgets. The purpose of this part of the study is to characterize the hydrologic regime with estimates of water flow, both direction and quantity. Secondly, in order to calculate the amount of dissolved-organic-carbon flux in soil water, stream water, and ground water, dissolved organic carbon will be measured in each of these three environments and

combined with estimates of flow for flux calculations. Standard methods of dissolved-organic-carbon determinations will be used. Finally, a simple conceptual model of dissolved-organic-carbon flux will be constructed from the study of the hydrologic-geochemical system.

Significant milestones--Twenty ground-water wells and 60 soil lysimeters were installed at the Konza Prairie to study natural organic compounds in ground water. The dissolved-organic-carbon concentrations have been measured and tabulated for all sites. Soil water contains considerably larger dissolved-organic-carbon concentrations than ground water. During FY91, fire damaged all lysimeters. Lysimeters are being repaired or replaced for further isolation and characterization of humic substances. Project is complete except report.



PROJECT TITLE: Origin and chemistry of natural surfactants in streams

PROJECT NUMBER: KS-168

COOPERATING AGENCY: Federal

PROJECT CHIEF: E.M. Thurman

KS168

Problem--The problem is to understand the chemical nature of natural foams (surfactants) on streams and rivers and to demonstrate with chemical analysis that synthetic detergents are significantly different in chemical structure than natural foams.

Objectives--The objectives of the research are to: (1) develop a simple sampling scheme for natural foam in streams, (2) characterize the natural foams from a mountain stream and an algae pond with chemical analysis, and (3) show that natural foam is chemically different than synthetic foam.

Approach --The approach to the problem involves: (1) sampling of foam from two sources--a mountain stream and an algae pond; (2) separation of foam with Ron Miles apparatus; (3) collapse of the foam and chemical analysis for percent carbon, carbohydrate content, and humic content; and (4) performance of fast-atom bombardment/mass spectrometry on synthetic components.

Significant milestones--Surfactant samples have been collected from two sites. They are a surfactant sample from Como Creek, a mountain stream in Colorado, and an algae-derived foam from a sample from Clinton Lake in Kansas. Characterization of surfactants in the two samples is complete, and a master's thesis and journal article are being written on the results. Project complete except for reports.

PROJECT TITLE:
Atrazine occurrence in ground water--Point source versus nonpoint sources

PROJECT NUMBER: KS-173

COOPERATING AGENCY:
Kansas State Board of Agriculture, Division of Water Resources

PROJECT CHIEF:
E.M. Thurman

Problem--To correct problems caused by herbicide contamination of ground water, it is important to be able to distinguish point-source contamination from nonpoint source. Point source is the incorrect usage of herbicide, such as a spill, whereas nonpoint source is the correct application of herbicide to a field. Being able to distinguish these two sources will allow regulations about herbicides to be formed that are reasonable both for the farmer and the chemical manufacturer.

Objectives--The objectives of the project are to distinguish whether ground-water contamination by herbicides has occurred because of correct applications of herbicides (nonpoint-source contamination) or because of incorrect application, spillage, or disposal of herbicides (point-source contamination).

Approach--The approach consists of measuring the parent herbicide (atrazine) and a major degradation project (deethylatrazine) in ground water that has been contaminated both by point sources (spills) and nonpoint sources (field dissipation) and determine if the ratio of deethylatrazine to atrazine, called the DAR, is different. The hypothesis is that the DAR will be small for point-source and large for nonpoint-source contamination. This hypothesis will be tested at 5 to 10 locations.

Significant milestones--A field study was done at the Kansas State Agricultural farm near Topeka, Kansas. To date it has been learned that the DAR is from 0.5 to greater than 1.0, and deethylatrazine is the main degradation product. Thus, this is the first confirmation of the use of the DAR for the identification of nonpoint-source contamination.

PROJECT TITLE: Progression of climate patterns across North America which affects water availability and its relation to systematic global energy inputs

PROJECT NUMBER: KS-174

COOPERATING AGENCY: University of Kansas Center for Research

PROJECT CHIEF: C.A. Perry

KS174

Problem--Water availability at any one location in North America is quite variable and dependent upon many factors. Shortages or excesses of water in regional water budgets can create problems in public drinking-water supplies, both quantity and quality, and in water supplies for irrigation, hydroelectric-power production, and in damage from floods. Hydrologic processes tend to lessen short-term climatic variability but can retain long-term trends or fluctuations in water availability in a regional sense. Estimates of water availability are needed in time frames that exceed established weather-prediction capabilities. Analysis of hydroclimatic information may provide a means to obtain these estimates.

Objectives--The objective of this research is to test the hypothesis that a periodic progression of climatic patterns across North America exists, evidenced by regional deviations in streamflow, ground-water levels, and other climatic data. The progression of patterns would include an analysis of teleconnections between different regions throughout North America. A consequent objective would be to determine if a relation exists between the climatic patterns and global-energy input. The global-energy input would be a function of solar-constant fluctuations and their effect on sea-surface temperatures.

Approach--Hydroclimatic data will be examined for approximately 16 selected areas located throughout the United States. Special emphasis will be placed on the northwest one-fourth of the country. This data will include information from the U.S. Geological Survey's Hydro-Climatic Data Network (HCDN), temperature, precipitation, and geopotential atmospheric heights for North America. The available data will be collated for the selected areas and analyzed for trends and periodic fluctuations using Fourier analysis and neural networking. Trends and periodicity-phase shifting for each selected area will be examined for teleconnections to the other regions and with solar-constant variations to demonstrate a possible mechanism for climatic change.

Significant milestones--Annual irradiance differences were correlated to 344 regions of annual precipitation values for seven

lag times. Sea-surface temperatures were correlated with jet-stream wind speeds and direction. Jet-stream latitude was correlated with precipitation. Precipitation at Pacific Ocean stations was examined.

Reports

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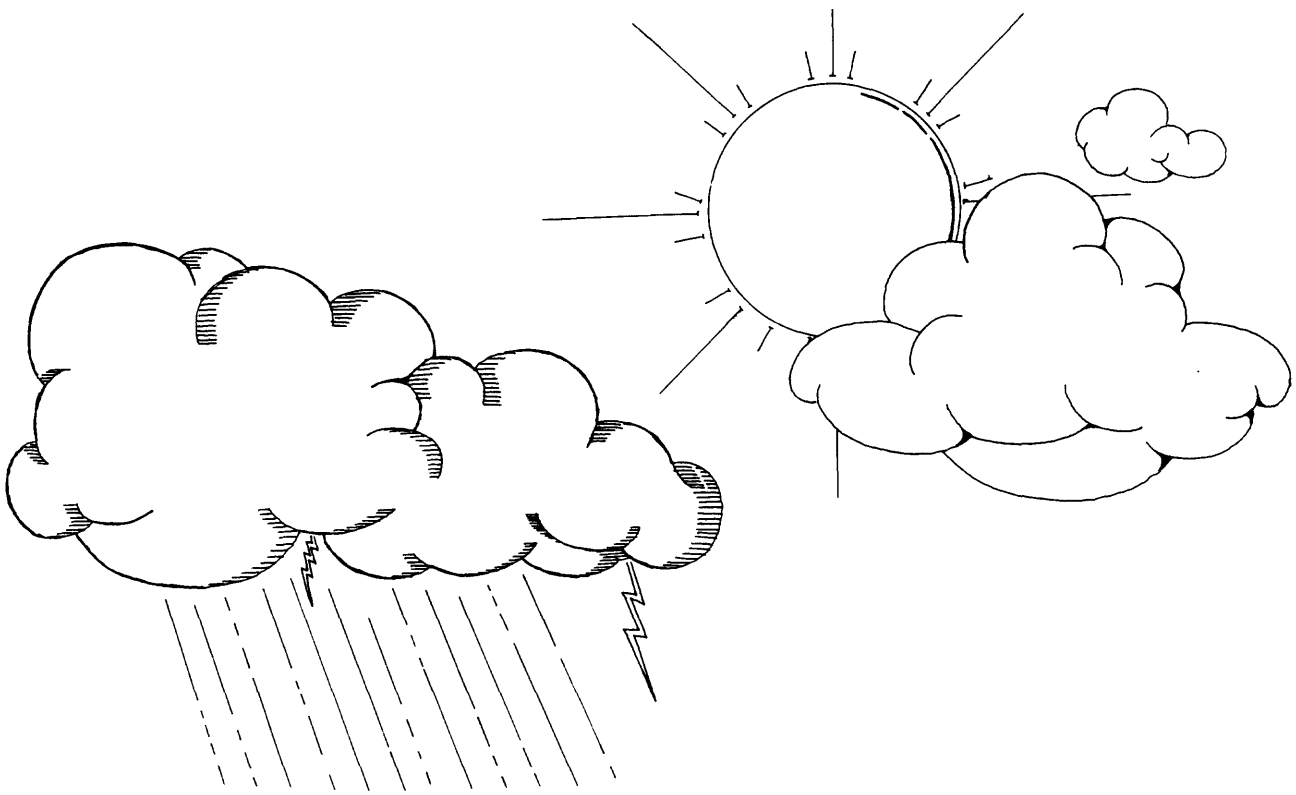

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HYDROLOGIC-DATA STATIONS IN KANSAS, 1989 THROUGH 1991 WATER YEARS

Explanation of Table Symbols
Surface-Water Stations

Station Purpose, Complete-Record Gaging Stations

B	-	Benchmark.
C	-	Current purpose station.
F	-	Flood forecast (also used by National Weather Service).
H	-	A hydrologic station to meet objectives of defining regional streamflow characteristics.
I	-	Interstate compact.
L	-	Long-term trend station to meet objectives of measuring principal unregulated streams.
P	-	Principal-stream station to meet objectives of measuring principal unregulated streams.
R	-	A station required for systems analysis of a regulated stream to meet objectives of defining regulated flow.

Type of Gage, Complete-Record Gaging Station

A	-	Precipitation gage	R	-	Graphic recorder
B	-	Bubble gage	S	-	Satellite-access telemetering equipment
C	-	Cableway	T	-	Telephone-access telemetering equipment
D	-	Digital recorder (stage)	W	-	Artifical control
Dp	-	Digital recorder (precipitation)			

Sampling Purpose, Water-Quality Stations

CHEM	Chemical analysis: cations, anions, nutrients
METAL	Trace metals analysis
BIOL	Biological analysis: phytoplankton, periphyton
TOC	Total-organic-carbon determination
SED	Suspended sediment: concentration, discharge, particle size
BED	Bed material: particle size
COLI	Coliform count: total fecal, fecal streptococcal
FIELD	Field measurements: discharge, water temperature, alkalinity, specific conductance, pH, dissolved oxygen

Cooperator or Supporting Program

CBR	Collection of basic records (Federal)
COMP	Arkansas River Compact Administration
DWR	Kansas State Board of Agriculture, Division of Water Resources
HAYS	City of Hays
KC-CE	Kansas City District, U.S. Army Corps of Engineers
KDHE	Kansas Department of Health and Environment
KDOT	Kansas Department of Transportation
KWO	Kansas Water Office
T-CE	Tulsa District, U.S. Army Corps of Engineers
USBR	U.S. Bureau of Reclamation
WICHITA	City of Wichita

Ground-Water Wells

Well Numbers

Well numbers in these listings indicate the location of wells according to a modified version of a system of land subdivisions by the U.S. Bureau of Land Management (fig. 12). An example of a typical well number is 21S 34W 16AADA 02 in Finney County. The first two digits indicate the township, which in Kansas are nearly all south of the 40th parallel base line. The second two digits indicate the range east (E) or west (W) of the sixth principal meridian. The last two digits indicate the section in which the well is located. The first letter following the section number denotes the quarter section or 160-acre tract; the second, the quarter-quarter section or 40-acre tract; the third, the quarter-quarter-quarter section or 10-acre tract; and the fourth, when used, the quarter-quarter-quarter-quarter section or 2 1/2-acre tract. The quarter sections, quarter-quarter sections, and so forth, are designated A, B, C, and D in a counterclockwise direction, beginning with A in the northeast quadrant. Wells located within the smallest subdivision indicated are numbered serially.

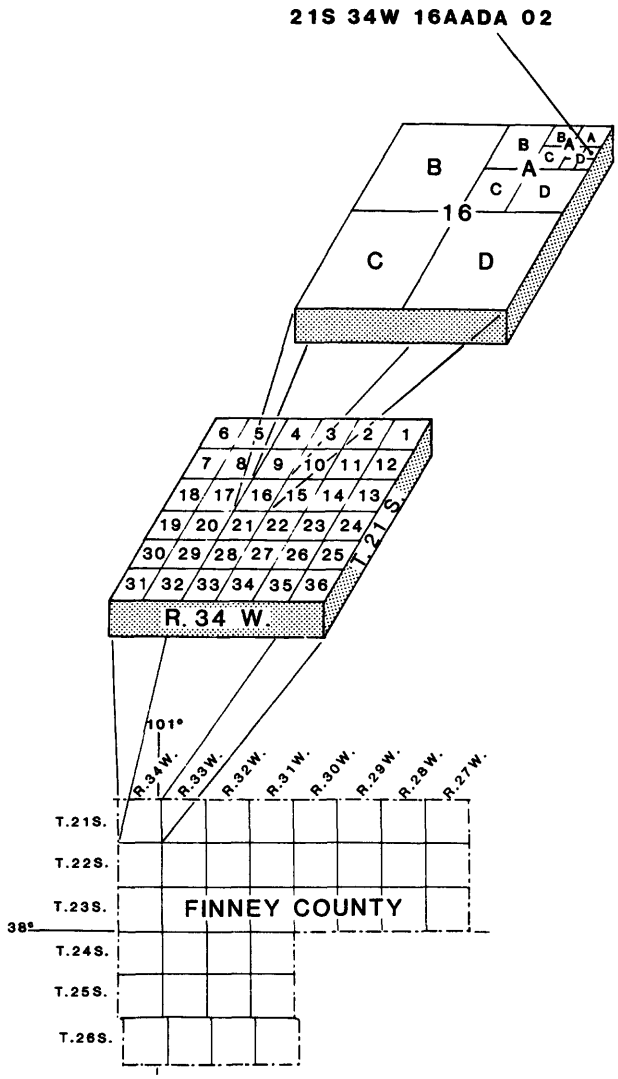

Figure 12. Well-numbering system.

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
		Missouri River basin					
06-							
8140	Turkey Cr. nr Seneca	C,F,L,P	20	1S	12E	ABDRS	KWO
8449	S. Fk. Sappa Cr. nr Achilles	H,L	29	4S	30W	ABDRS	KWO
8465	Beaver Cr. at Cedar Bluffs	C,I,L,P	10	1S	29W	BDRT	CBR
8479	Prairie Dog Cr. ab Keith Sebelius Lake	C,L,P	23	3S	25W	BCDRW	KWO/ KC-CE
84795	Keith Sebelius Lake nr Norton		8	3S	23W	BR	KWO
8480	Prairie Dog Cr. at Norton	C,R	9	3S	23W	BDRW	KWO
8485	Prairie Dog Cr. nr Woodruff	C,I,L,R	9	1S	19W	ABDRS	CBR/ KC-CE
8535	Republican R. nr Hardy, Nebr.	C,I,R	6	1S	5W	BDRT	CBR
8538	White Rock Cr. nr Burr Oak	C,L,P	7	2S	8W	ABDRS	KC-CE
8539	Lovewell Res. nr Lovewell		6	2S	6W	BR	KWO
8540	White Rock Cr. at Lovewell	C,R	17	2S	6W	BDRW	KWO
8560	Republican R. at Concordia	C,R	28	5S	3W	ABDRST	KC-CE
8566	Republican R. at Clay Center	C,R	17	8S	3E	ABDRS	KC-CE
85705	Milford Lake nr Junction City		20	11S	5E	RS	KC-CE
8571	Republican R. bl Milford Dam	C,R	--	--	--	BCDRT	KC-CE
8600	Smoky Hill R. at Elkader	C,L,P	34	14S	32W	BDR	KWO
8610	Smoky Hill R. nr Arnold	C,P	29	14S	24W	ABDRS	KWO/ KC-CE
8615	Cedar Bluff Res. nr Ellis		36	14S	22W	BR	KWO
8627	Smoky Hill R. nr Schoenchen	C,F,R	25	15S	19W	BDR	KWO
86285	Smoky Hill R. bl Schoenchen	C,R	27	15S	18W	BDR	HAYS
8635	Big Cr. nr Hays	C,F,L	30	14S	17W	BDRT	KWO
86405	Smoky Hill R. nr Bunker Hill	C,R	33	14S	13W	ABDRS	KC-CE
8645	Smoky Hill R. at Ellsworth	C,R	20	15S	8W	ABDRS	KC-CE
8650	Kanopolis Lake nr Kanopolis		3	17S	6W	ABRS	KC-CE
8655	Smoky Hill R. nr Langley	C,R	35	16S	6W	BDRT	KC-CE
8665	Smoky Hill R. nr Mentor	C,R	29	14S	2W	ABDRS	KC-CE
8669	Saline R. nr WaKeeney	H,P	10	11S	23W	BDR	KWO
8670	Saline R. nr Russell	C,F,L	34	12S	14W	ABDRS	KWO/ KC-CE

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
8681	Wilson Lake nr Wilson		36	12S	11W	ARS	KC-CE
8682	Saline R. at Wilson Dam	C,R	25	12S	11W	BDRT	KC-CE
8695	Saline R. at Tescott	C,F,R	16	12S	5W	ABDRS	KWO/ KC-CE
8702	Smoky Hill R. at New Cambria	C,R	1	14S	2W	BDRS	CBR/ KC-CE
8710	N. Fk. Solomon R. at Glade	C,P	25	4S	18W	BDR	KWO/KC-CE
8715	Bow Cr. nr Stockton	C,F,L	1	6S	18W	BDR	KWO
8717	Kirwin Res. at Kirwin		33	4S	16W	BR	KWO
8718	N. Fk. Solomon R. at Kirwin	C,R	33	4S	16W	DR	KWO
8725	N. Fk. Solomon R. at Portis	C,R	5	6S	12W	BDRS	KC-CE
8730	S. Fk. Solomon R. ab Webster Res.	C,P	8	8S	20W	BDR	KWO/KC-CE
8731	Webster Res. nr Stockton		27	7S	19W	BR	KWO
8732	S. Fk. Solomon R. bl Webster Res.	C,R	26	7S	19W	BCDR	KWO
87346	S. Fk. Solomon R. at Woodston	C,R	16	7S	16W	BDR	CBR
8740	S. Fk. Solomon R. at Osborne	C,F,R	20	7S	12W	ABDRS	KWO/KC-CE
8742	Waconda Lake at Glen Elder		27	6S	9W	BR	USBR
8759	Solomon R. nr Glen Elder	C,F,R	2	7S	9W	BCDRW	KWO
876070	Solomon R. nr Simpson	C,R	7	8S	5W	BDRS	KC-CE
8767	Salt Cr. nr Ada	C,F	36	10S	5W	BDRT	KWO
8769	Solomon R. at Niles	C,R	31	12S	1W	ABDRS	KC-CE
8776	Smoky Hill R. at Enterprise	C,R	20	13S	3E	ABDRS	KC-CE
8780	Chapman Cr. nr Chapman	F,L	1	12S	3E	ABDRS	KWO
8791	Kansas R. at Ft. Riley	C,R	33	11S	6E	BDRST	KC-CE
87965	Kings Cr. nr Manhattan	B	18	11S	8E	BCDRDp	CBR
88251	Big Blue R. at Marysville	C,P	32	25S	7E	ABDRS	KC-CE
8842	Mill Cr. at Washington	F,H	1	3S	3E	BDRT	KWO
8844	Little Blue R. nr Barnes	C,P	22	3S	5E	ABDRS	KC-CE
8855	Black Vermillion R. nr Frankfort	C,P	20	4S	9E	BDRS	KC-CE

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
8869	Tuttle Creek Lake nr Manhattan		24	9S	7E	ABRS	KC-CE
8870	Big Blue R. nr Manhattan	C,R	30	9S	8E	BDRT	KC-CE
8875	Kansas R. at Wamego	C,R	9	10S	10E	ABDRS	KC-CE
88835	Kansas R. nr Belvue	C	13	10S	11E	BDRT	DWR
8885	Mill Cr. nr Paxico	C,F,L	27	11S	11E	ABDRS	KWO
8890	Kansas R. at Topeka	C,R	28	11S	16E	ABDRS	KC-CE
88914	Soldier Cr. nr Soldier	C,H	4	6S	13E	BDR	KWO
88916	Soldier Cr. nr Circleville	C,H	10	7S	13E	BDR	KWO
8892	Soldier Cr. nr Delia	C,H	8	10S	14E	BDR	KWO
8895	Soldier Cr. nr Topeka	C,P	14	11S	15E	ABDRS	KC-CE
8901	Delaware R. nr Muscotah	C,L	16	6S	17E	ABDRS	KC-CE
890898	Perry Lake nr Perry		9	11S	18E	ARS	KC-CE
8909	Delaware R. bl Perry Dam	C,R	9	11S	18E	CR	KC-CE
8910	Kansas R. at Lecompton	C,R	35	11S	18E	BDRS	KC-CE
891478	Clinton Lake nr Lawrence		8	13S	19E	ABRS	KC-CE
8915	Wakarusa R. nr Lawrence	C,R	23	13S	19E	ABDRS	KC-CE
8920	Stranger Cr. nr Tonganoxie	C,L	7	11S	22E	ABDRS	KC-CE
89235	Kansas R. at DeSoto	C,F,R	28	12S	22E	ABDRS	KWO/ KC-CE
89308	Blue R. nr Stanley	C,H	19	14S	25E	ABDRS	KWO/KC-CE
8933	Indian Cr. at Overland Park	C,H	6	13S	25E	ABDRS	KWO
9108	Marais des Cygnes R. nr Reading	C,P	15	17S	13E	BDRS	KC-CE
910997	Melvern Lake nr Melvern		1	18S	15E	ARS	KC-CE
9115	Salt Cr. nr Lyndon	C,F,L	34	16S	16E	BDRT	KWO
9119	Dragoon Cr. nr Burlingame	C,H	27	15S	14E	ABDRS	KC-CE
91249	Pomona Lake nr Quenemo		19	16S	17E	ARS	KC-CE
9125	Hundred and Ten Mile Cr. nr Quenemo	C,R	20	16S	17E	BCDRT	KC-CE
9130	Marais des Cygnes R. nr Pomona	C,R	7	17S	18E	BDRST	KC-CE
9135	Marais des Cygnes R. nr Ottawa	C,R	36	16S	19E	ABDRST	KC-CE

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
9140	Pottawatomie Cr. nr Garnett	C,F,L	6	20S	20E	BDRT	KWO
914995	Hillsdale Lake nr Hillsdale		17	16S	23E	ABRS	KC-CE
9150	Big Bull Cr. nr Hillsdale	C,R	20	16S	23E	BCDRT	KC-CE
9158	Marais des Cygnes R. at at La Cygne	C,R	32	19S	24E	ABDRS	KWO
9166	Marais des Cygnes R. nr Kansas-Missouri State Line	C,F,R	16	21S	25E	ABDRS	KWO/ KC-CE
9170	Little Osage R. at Fulton	C,F,L	25	23S	24E	BDRT	KWO
91738	Marmaton R. nr Marmaton	C,F,L	4	26S	24E	BCDRS	KWO/KC-CE
	Arkansas River basin						
07-							
1370	Frontier Ditch nr Coolidge	C,I	21	23S	43W	BDRSW	CBR/ COMP
1375	Arkansas R. nr Coolidge	C,I,R	26	23S	43W	BDRS	CBR/ COMP
1380	Arkansas R. at Syracuse	C,F,R	18	24S	40W	BDRT	KWO
1390	Arkansas R. at Garden City	C,F,R	19	24S	32W	BDRT	KWO
1395	Arkansas R. at Dodge City	C,R	35	26S	25W	BDRT	T-CE/CBR
1400	Arkansas R. nr Kinsley	C,R	26	24S	19W	BDRT	KWO
14085	Pawnee R. nr Burdett	H,L,P	21	21S	21W	BDR	KWO
1412	Pawnee R. nr Larned	C,F,L,P	30	21S	18W	ABDRS	KWO
1413	Arkansas R. at Great Bend	C,R	33	19S	13W	ABDRS	T-CE
14178	Walnut Cr. nr Rush Center	C,H,P	24	18S	19W	BDR	KWO
1419	Walnut Cr. at Albert	C,L,P	29	18S	15W	BDR	KWO
1423	Rattlesnake Cr. nr Macksville	H,P	16	25S	14W	BDR	KWO
142575	Rattlesnake Cr. nr Zenith	H,P	26	22S	11W	ABDRS	KWO
14262	Rattlesnake Cr. nr Raymond	H,P	15	21S	10W	BDRT	KWO
1433	Cow Creek nr Lyons	C,F,L,R	15	20S	8W	ABDRS	KWO/ T-CE
14333	Arkansas R. nr Hutchinson	C,F,R	21	24S	4W	ABDRS	KWO/ T-CE
143375	Arkansas R. nr Maize	C	23	26S	1W	BDR	USBR
143665	Little Ark. R. at Alta Mills	H,P	30	22S	2W	BDRS	KWO

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
1442	Little Ark. R. at Valley Center (floodway)		34	25S	1W	BR	KWO
1442	Little Ark. R. at Valley Center (main stem)	C,L	36	25S	1W	ABDRS	KWO
1443	Arkansas R. at Wichita (floodway)		11	27S	1W	BR	KWO
1443	Arkansas R. at Wichita (main stem)	C,F,P	5	28S	1E	BDR	KWO
14455	Arkansas R. at Derby	C,P	12	29S	1E	ABDRS	T-CE
14478	N. Fk. Ninnescah R. ab Cheney Reservoir	C,P	25	25S	6W	ABDRS	WICHITA
14479	Cheney Reservoir nr Cheney		6	27S	4W	ABRS	WICHITA/ T-CE
144795	N. Fk. Ninnescah R. at Cheney Dam	C,R	6	27S	4W	BDRW	WICHITA
14491	S. Fk. Ninnescah R. nr Pratt	H,P	2	28S	13W	ABDRS	KWO/ T-CE
1452	S. Fk. Ninnescah R. nr Murdock	C,F,L	34	28S	5W	ABDRS	KWO/ T-CE
1455	Ninnescah R. nr Peck	C,R	10	30S	1W	ABDRS	T-CE
1457	Slate Creek at Wellington	H,P	23	32S	1W	ABDRS	KWO/ T-CE
1465	Arkansas R. at Arkansas City	C,L,P	35	34S	3E	ABDRS	T-CE
146622	El Dorado Lake nr El Dorado		30	25S	6E	ARS	T-CE
14683	Walnut R. at Hwy. 54 east of El Dorado	C,R	1	26S	5E	ABDRS	T-CE
14707	Whitewater R. at Towanda	C,F,P	8	26S	4E	ABDRS	KWO/ T-CE
1478	Walnut R. at Winfield	C,L	33	32S	4E	ABDRS	T-CE
1490	Medicine Lodge R. nr Kiowa	L,P	36	34S	11W	ABDRS	KWO
1515	Chikaskia R. nr Corbin	F,P	36	33S	3W	ABDRS	KWO
15559	Cimarron R. nr Elkhart	H	4	34S	42W	ABDRS	KWO
15622	Bear Cr. nr Johnson	H	12	28S	41W	BDR	KWO

Table 1. *Complete-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 6)	Station name	Station purpose	Location Sec.	T.	R.	Type of gage	Coop. or support
1575	Crooked Cr. nr Nye	F,L	1	35S	27W	BDR	KWO
16575	Verdigris R. nr Virgil	C,P	19	24S	13E	ABDRS	T-CE
1659	Toronto Lake nr Toronto		36	26S	13E	ARTS	T-CE
1660	Verdigris R. nr Coyville	C,R	8	27S	14E	ABDRS	T-CE
1665	Verdigris R. nr Altoona	C,R	29	29S	16E	ABDRS	T-CE
1675	Otter Cr. at Climax	H,L	8	27S	11E	ABDRS	KWO
1680	Fall River Lake nr Fall River		3	28S	12E	ABRS	T-CE
1695	Fall R. at Fredonia	C,R	24	29S	14E	ABDRS	T-CE
1698	Elk R. at Elk Falls	C,H	3	31S	11E	ABDRS	KWO/T-CE
17005	Elk City Lake nr Independence		9	32S	15E	ABRS	T-CE
17006	Elk R. bl Elk City Lake	C,R	9	32S	15E	BDR	T-CE
1705	Verdigris R. at Independence	C,R	32	32S	16E	ABDRS	T-CE
170695	Big Hill Lake nr Cherryvale		7	32S	18E	ABRS	T-CE
1707	Big Hill Cr. nr Cherryvale	C,H	7	32S	18E	ABDRS	T-CE
1716	Caney R. nr Cedar Vale	C	11	34S	8E	ABDRS	T-CE
1720	Caney R. nr Elgin	C,L	16	35S	10E	ABDRS	KWO/T-CE
1733	Middle Caney Cr. at Sedan	C	3	34S	11E	ABDRS	T-CE
1794	Council Grove Lake nr Council Grove		10	16S	8E	ABRS	T-CE
1795	Neosho R. at Council Grove	C,R	14	16S	8E	ABDRS	T-CE
17973	Neosho R. nr Americus	C,R	24	18S	10E	ABDRS	T-CE
179794	Marion Lake nr Marion		27	19S	3E	ABRS	T-CE
179795	Cottonwood R. bl Marion Lake	C,R	27	19S	3E	ABCDRS	T-CE
1802	Cottonwood R. at Marion	C,R	31	19S	4E	ABDRS	T-CE
1804	Cottonwood R. nr Florence	C,R	10	21S	5E	ABDRS	T-CE
1805	Cedar Cr. nr Cedar Point	C,L	25	21S	5E	BDRS	KWO
18225	Cottonwood R. nr Plymouth	C,R	13	19S	9E	ABDRS	T-CE
18245	John Redmond Res. nr Burlington		9	21S	15E	ABRS	T-CE
18251	Neosho R. at Burlington	C,R	26	21S	15E	ABDRS	T-CE
1830	Neosho R. nr Iola	C,L,R	9	25S	18E	ABCDRS	T-CE
1835	Neosho R. nr Parsons	C,F,L,R	33	31S	21E	ABDRSW	KWO/T-CE
1840	Lightning Cr. nr McCune	H,L,P	7	32S	22E	BDR	KWO

Table 2. *Partial-record streamflow-gaging stations, 1991 water year*

High Flow

Ident. no. (fig. 7)	Station name	Location Sec.	T.	R.	Coop. or support
	Missouri River basin				
06-					
8157	Buttermilk Cr. nr Willis	30	3S	18E	KDOT
81826	White Clay Cr. at Atchison	1	6S	20E	KC-CE
8451	Long Branch Draw nr Norcatur	6	2S	25W	KDOT
8476	Prairie Dog Cr. trib. at Colby	6	8S	33W	KDOT
85632	Elk Cr. at Clyde	26	5S	1W	KC-CE
8634	Big Cr. trib. nr Ogallah	11	13S	22W	KDOT
8637	Big Cr. trib. nr Hays	7	14S	17W	KDOT
8643	Smoky Hill R. trib. at Dorrance	12	14S	12W	KDOT
86649	Dry Cr. at Mentor	24	15S	3W	KC-CE
8683	Coon Cr. trib. nr Luray	19	10S	12W	KDOT
86995	Mulberry Cr. nr Salina	9	14S	3W	KC-CE
8733	Ash Cr. trib. nr Stockton	18	7S	18W	KDOT
87712	Mud Cr. at Abilene	17	13S	2E	KC-CE

Table 2. *Partial-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 7)	Station name	Location Sec.	T.	R.	Coop. or support
06-					
8843	Mill Cr. trib. nr Washington	5	3S	4E	KDOT
8872	Cedar Cr. nr Manhattan	19	9S	8E	KDOT
88955	Indian Cr. nr Topeka	5	11S	16E	KC-CE
88963	Shunganunga Cr. at Topeka	6	12S	16E	KC-CE
9123	Dragoon Cr. trib. nr Lyndon	6	16S	16E	KDOT
91425	S. Fk. Pottawatomie Cr. trib. nr Garnett	7	21S	20E	KDOT
9151	Big Bull Cr. at Paola	17	17S	23E	KC-CE
9167	Middle Cr. nr Kincaid	11	23S	20E	KDOT
9174	Marmaton R. trib. nr Fort Scott	9	26S	24E	KDOT
	Arkansas River basin				
07-					
1386	White Woman Cr. trib. nr Selkirk	34	17S	39W	KDOT
1397	Arkansas R. trib. nr Dodge City	11	27S	25W	KDOT
1431	Little Cheyenne Cr. trib. nr Claflin	28	18S	11W	KDOT
14702	Whitewater R. trib. nr Towanda	26	25S	3E	KDOT
14799	Cedar Cr. trib. nr Cambridge	26	31S	7E	KDOT
1567	Cimarron R. trib. nr Satanta	17	32S	33W	KDOT
1662	Sandy Cr. nr Yates Center	26	25S	14E	KDOT

Table 2. *Partial-record streamflow-gaging stations, 1991 water year*--Continued

Ident. no. (fig. 7)	Station name	Location Sec.	T.	R.	Coop. or support
	Low Flow				
	Arkansas River basin				
07-					
14267	Peace Cr. nr Sterling	7	22S	8W	KWO
14462	N. Fk. Ninnescah R. ab Silver Cr. nr Arlington	25	25S	8W	KWO
148475	Thompson Cr. nr Belvidere	6	30S	16W	KWO
1485	Spring Cr. nr Belvidere	4	30S	16W	KWO
148525	Soldier Cr. nr Belvidere	14	30S	16W	KWO
14859	Turkey Cr. nr Sun City	2	31S	15W	KWO
1486	Medicine Lodge R. at Sun City	2	31S	15W	KWO
1513	Chikaskia R. at Spivey	14	30S	8W	KWO

Table 3. *Precipitation-record gaging stations, 1991 water year*

Ident. no. (fig. 8)	Station name	Location Sec.	T.	R.	Type of Gage	Coop. or support
	Missouri River basin					
06-						
87965	Kings Cr. nr Manhattan	18	11S	8E	D	CBR
	Arkansas River basin					
07-						
143633	at Inman	16	21S	4W	S	T-CE
1446	at Arlington	10	25S	8W	S	T-CE
14758	at Atlanta	16	30S	6E	S	T-CE
14809	at Dexter	13	33S	6E	S	T-CE
151675	at Harper	11	32S	7W	S	T-CE
17159	at Grenola	17	31S	9E	S	T-CE
17355	at Havana	13	34S	13E	S	T-CE
17978	at Durham	4	18S	2E	S	T-CE
18185	nr Diamond Springs	15	17S	6E	S	T-CE
18199	at Cottonwood Falls	29	19S	8E	S	T-CE
18209	nr Matfield Green	30	21S	8E	S	T-CE
18238	at Neosho Rapids	29	19S	13E	S	T-CE

Table 4. *Ground-water-level observation wells, 1991 water year*

County	Well number
Allen	24S 18E 28CDD 01
Barber	32S 12W 04DBC 01
Barton	18S 14W 27CDD 01
	18S 15W 28CCC 03
	19S 11W 19BDD 01
	19S 11W 26BDA 01
	19S 12W 06ADA 01
	19S 12W 28DBC 01
	19S 13W 08BAD 01
	19S 13W 33DDB 01
	19S 14W 06BBB 01
	19S 14W 23BBD 01
	19S 14W 29DDB 01
	19S 14W 36BBC 01
	20S 11W 06CCC 01
	20S 11W 26AAC 01
	20S 12W 03DAC 01
	20S 12W 06AAC 01
	20S 12W 23CCA 01
	20S 13W 17DDC 01
	20S 13W 24DCB 01
	20S 14W 22DCB 01
	20S 15W 24DBD 01
	20S 15W 33ADD 01
Bourbon	25S 24E 36AAC 01
Cherokee	34S 24E 36BBA 01
Cheyenne	01S 38W 02CDC 01
	01S 38W 08DCC 01
	01S 38W 30BDC 01
	01S 39W 25CBC 01
	02S 37W 33DCC 01
	02S 39W 27BBB 01
	02S 40W 28DBA 01
	02S 40W 32BCB 01
	02S 41W 27BBD 01
	02S 41W 33DBC 01
Cheyenne (continued)	03S 37W 19BBC 01
	03S 37W 21DDD 01
	03S 37W 36ADB 01
	03S 38W 04BCC 01
	03S 38W 21BCB 01
	03S 38W 25BBB 01
	03S 39W 04CCC 01
	03S 39W 20DAC 01
	03S 39W 24DDD 01
	03S 39W 32BDB 01
	03S 40W 09BAA 02
	03S 40W 35AAC 01
	03S 41W 33ABB 01
	03S 42W 04AAA 01
	03S 42W 26CCD 01
	04S 37W 17AAC 01
	04S 37W 25DCA 01
	04S 38W 04BAC 01
	04S 38W 20CCC 01
	04S 38W 21ADC 01
	04S 40W 22BCB 01
	04S 41W 16DAA 01
	04S 41W 23AAA 01
	04S 41W 25BCB 01
	04S 41W 31ACA 01
	04S 42W 02BCC 01
	04S 42W 16CCD 01
	05S 37W 15DBB 01
	05S 38W 13BAD 01
	05S 38W 22ACB 01
	05S 39W 06DAA 01
	05S 39W 11CBC 01
	05S 39W 18CCC 01
	05S 39W 25CDA 01
	05S 40W 14BCD 01
	05S 41W 20DAA 01
	05S 42W 14DCC 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Clark	30S 23W 06AAA 01
	33S 22W 30CBC 01
Clay	06S 01E 02BCD 01
	06S 02E 29DAC 01
	08S 02E 02CCA 01
Cloud	05S 02W 01BAC 01
Comanche	31S 18W 19ACB 01
	32S 18W 03DAC 01
Crawford	29S 23E 24DBA 01
	29S 24E 11ADD 01
Decatur	01S 26W 18DDB 01
	01S 29W 03DDB 01
	01S 29W 19BDD 01
	01S 30W 34DDD 01
	02S 26W 11BBA 01
	02S 28W 13ABA 01
	02S 30W 23ADD 01
	03S 26W 30CBB 02
	03S 27W 32ABA 01
	03S 28W 06DCB 01
	03S 28W 32BCA 01
	03S 29W 12BBA 01
	03S 29W 17DCB 01
	03S 29W 31DCC 01
	03S 30W 03CBA 01
	03S 30W 26BBB 01
	04S 26W 08DDD 01
	04S 26W 19DCA 01
	04S 27W 17DAC 01
	04S 27W 33BBB 01
	04S 28W 15AAA 01
	04S 28W 30DDD 01
	04S 30W 07BBB 01
	05S 26W 05ADD 01
	05S 26W 26DDA 01
	05S 26W 33DCC 01
Decatur (continued)	05S 27W 21CCA 01
	05S 28W 07BBC 01
	05S 28W 10BBB 01
	05S 28W 14ADD 01
	05S 28W 17DAC 01
	05S 29W 11BAA 01
	05S 29W 22CBB 01
	05S 30W 15CCB 01
	05S 30W 35BCB 01
Dickinson	13S 01E 26DDC 01
Douglas	12S 20E 07CBC 01
	12S 20E 17CCB 01
	15S 19E 15AAD 01
Edwards	23S 19W 22CCC 01
	24S 16W 12CBC 01
	24S 16W 12CCC 01
	24S 17W 20ADC 01
	24S 17W 24DDD 01
	24S 18W 13DAC 01
	24S 18W 17ABD 01
	24S 18W 28DAC 01
	24S 18W 36DDC 01
	24S 19W 34ADD 01
	25S 16W 02BBB 01
	25S 16W 27AAC 01
	25S 16W 31DCC 01
	25S 17W 01DAB 01
	25S 17W 17AAC 01
	25S 17W 31BBD 01
	25S 18W 09AAA 01
	25S 18W 20AAB 01
	25S 18W 33CDC 01
	25S 19W 08BDD 01
	25S 19W 26DDB 01
	25S 19W 31CAB 01
	25S 20W 03BCD 01
	25S 20W 34CCC 01
	26S 16W 10CCC 01
	26S 16W 31CCA 01
	26S 16W 34ABC 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Edwards (continued)	26S 17W 04AAC 01
	26S 17W 14BAA 01
	26S 17W 33DDB 01
	26S 18W 15DCB 01
	26S 18W 31CCC 01
	26S 19W 12ABB 02
	26S 19W 16BCB 01
	26S 19W 31BAC 01
	26S 19W 34BBD 01
	26S 20W 20BBC 01
Ellis	13S 18W 29CCC 01
	14S 18W 12AAD 01
	15S 18W 25CCD 01
	15S 19W 25CAB 01
Ellsworth	17S 09W 20BCD 01
	17S 09W 21BCC 01
	17S 09W 28CBB 02
	17S 09W 31AAB 01
	17S 09W 31ADC 01
Finney	21S 30W 05BBB 01
	21S 31W 08ABB 01
	21S 31W 26CCC 01
	21S 32W 08ABD 01
	21S 32W 20CBD 01
	21S 32W 26DAA 01
	21S 33W 07DDAA01
	21S 33W 29BBC 01
	21S 34W 14DBB 01
	21S 34W 16AADA02
	22S 27W 14ADC 01
	22S 31W 08CCC 01
	22S 31W 16ADD 01
	22S 31W 29DCC 01
	22S 32W 08ACB 01
	22S 32W 21CDC 01
	22S 33W 22BAA 01
	22S 33W 36AAA 02
	22S 34W 08BCB 01
	22S 34W 10AAA 01
	22S 34W 18CDD 01
Finney (continued)	22S 34W 26CCC 01
	23S 27W 22DAB 01
	23S 28W 22DCD 01
	23S 28W 34DDC 01
	23S 29W 30BBB 01
	23S 29W 34CDD 01
	23S 30W 04ACC 01
	23S 30W 19CCB 01
	23S 31W 03DCD 01
	23S 31W 17ABA 01
	23S 31W 35CCC 01
	23S 32W 11ADC 01
	23S 32W 31CBD 01
	23S 33W 17BBB 01
	23S 33W 26ABB 01
	23S 33W 28CDC 01
	23S 34W 17CCC 01
	23S 34W 21DDC 01
	24S 31W 27CCB 01
	24S 32W 03DAC 01
	24S 32W 35DD 01
	24S 33W 09CCD 01
	24S 33W 09CCD 02
	24S 33W 09CCD 03
	24S 33W 18BDB 02
	24S 33W 19DBB 02
	24S 33W 22BCC 01
	24S 33W 22DCA 01
	24S 33W 28DAA 01
	24S 33W 31CCA 01
	24S 33W 34CAC 01
	24S 34W 01BCBB01
	25S 31W 21CAB 01
	25S 31W 35DBA 01
	25S 32W 22DBC 01
	25S 32W 31DDC 01
	25S 32W 35ADB 01
	25S 33W 03BCC 01
	25S 33W 05ABD 01
	25S 33W 09ABD 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Finney (continued)	25S 33W 15DAC 01
	25S 33W 16DCC 01
	25S 33W 17DBD 01
	25S 33W 33CDA 01
	25S 33W 35DBD 01
	25S 34W 06AAA 01
	25S 34W 10ABB 01
	25S 34W 34DBD 01
	26S 31W 01DDA 01
	26S 31W 06BBBB01
	26S 31W 31CDC 01
	26S 31W 36CAB 01
	26S 32W 22ABB 01
	26S 33W 17DBD 01
	26S 33W 26ABB 01
	26S 34W 05ADC 01
	26S 34W 21BBD 01
Ford	25S 22W 20AAA 01
	25S 22W 27CCD 01
	25S 23W 11CCC 01
	25S 23W 12BBB 01
	25S 23W 14ADD 01
	25S 25W 32CDD 01
	25S 25W 32DAD 01
	25S 26W 25CDD 01
	25S 26W 30ABC 01
	26S 21W 17DBC 01
	26S 21W 23ADA 01
	26S 21W 25CCC 01
	26S 22W 21DCD 01
	26S 23W 02ABB 01
	26S 23W 10DAD 01
	26S 24W 29DDD 01
	26S 24W 31DDA 01
	26S 24W 32CBA 01
	26S 24W 33CDA 01
	26S 25W 16DCC 01

County	Well number
Ford (continued)	26S 26W 18CCB 01
	26S 26W 32DCC 01
	26S 26W 36DCC 01
	27S 21W 10DBB 01
	27S 22W 09DAB 01
	27S 23W 24BCB 01
	27S 23W 28AAA 01
	27S 23W 36CCC 01
	27S 24W 03BBD 01
	27S 24W 03CDD 01
	27S 24W 04BBC 01
	27S 24W 09AAD 01
	27S 24W 16BDB 01
	27S 24W 26DAA 01
	27S 25W 09ACA 01
	27S 25W 25BBB 01
	28S 21W 10DDD 01
	28S 21W 23DBC 01
	28S 21W 25ABB 01
	28S 22W 05ADD 01
	28S 22W 12CAC 01
	28S 22W 32BAB 01
	28S 23W 18BAB 01
	28S 23W 24ABB 01
	28S 24W 08DCC 01
	28S 24W 22CDA 01
	28S 24W 35CAB 01
	28S 25W 06ABB 01
	28S 25W 19BBB 01
	28S 26W 06AAB 01
	28S 26W 10BAA 01
	28S 26W 13CAA 01
	29S 21W 05BBB 01
	29S 21W 20CAD 01
	29S 22W 17DAD 01
	29S 22W 36ACA 01
	29S 23W 12BAC 01
	29S 24W 01ABA 01
	29S 24W 13BCA 01
	29S 24W 18BAA 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Ford (continued)	29S 25W 03ADA 01
	29S 25W 10BBBC01
	29S 26W 01CDD 01
	29S 26W 20BDD 01
	29S 26W 29ABB 01
	29S 26W 36BBB 01
Geary	11S 06E 27CBB 01
Gove	11S 26W 04CDC 01
	11S 27W 04CCD 01
	11S 27W 04CDC 01
	11S 27W 13ABB 01
	11S 27W 36BCC 01
	11S 28W 08AAA 01
	11S 28W 17DDC 01
	11S 28W 26ABA 01
	11S 29W 04DAD 01
	11S 29W 33BBA 01
	11S 30W 27ABB 01
	11S 30W 28CBA 01
	11S 30W 36CBB 01
	11S 31W 12AAB 01
	11S 31W 27ADC 01
	11S 31W 35BDC 01
	12S 26W 12BCC 01
	12S 27W 10CCB 01
	12S 27W 12ABB 01
	12S 28W 07DDD 01
	12S 28W 12DDD 01
	12S 29W 36CCC 01
	13S 26W 20CBC 01
	13S 27W 16CA 02
	13S 28W 14AC 01
Graham	06S 21W 19CDC 01
	06S 22W 19CCC 01
	06S 22W 28ACA 01
	06S 23W 13BBB 01
	06S 23W 17CCA 01
	06S 24W 14AAA 01
	06S 24W 28BAB 01
Graham (continued)	06S 24W 35DDD 01
	06S 25W 12CCC 01
	06S 25W 28CBC 01
	07S 22W 10BBC 01
	07S 22W 19BBB 01
	07S 23W 17BBC 01
	07S 24W 08CBA 01
	07S 25W 24BBB 01
	07S 25W 33DDD 01
	08S 21W 17ABB 01
	08S 22W 18CDC 01
	08S 24W 23ACC 01
	08S 25W 24BAB 01
	09S 22W 19BBB 01
	09S 24W 22BAA 01
	09S 25W 14DDD 01
Grant	27S 35W 17ADD 01
	27S 35W 25BDC 01
	27S 36W 18DCB 01
	27S 36W 21DCC 01
	27S 36W 25CC 01
	27S 37W 04ABB 01
	27S 37W 11ABA 01
	27S 37W 16AAD 01
	27S 37W 21BDD 01
	27S 38W 12ADC 01
	27S 38W 15BBB 01
	27S 38W 22CBB 01
	27S 38W 23CBB 01
	28S 35W 03DBB 01
	28S 35W 05BCC 01
	28S 35W 15CBB 01
	28S 35W 36ABC 01
	28S 36W 02CDD 02
	28S 36W 18ABC 01
	28S 36W 21CDD 01
	28S 37W 02BBB 04
	28S 37W 10BCD 02
	28S 38W 12BCB 01
	28S 38W 12DDD 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Grant (continued)	28S 38W 17AAA 01
	28S 38W 33BDB 01
	29S 35W 07CBD 01
	29S 35W 24BAA 01
	29S 35W 28ACC 01
	29S 36W 19BCB 01
	29S 36W 33ADB 01
	29S 37W 03CDB 01
	29S 37W 08CBA 01
	29S 37W 29BBA 01
	29S 38W 20CDC 01
	29S 38W 35CCD 01
	30S 35W 02DBC 01
	30S 35W 19BCD 01
	30S 36W 01BBB 01
	30S 36W 04ABB 01
	30S 36W 32BBC 01
	30S 37W 02BAA 02
	30S 37W 03DBA 01
	30S 37W 20CBC 01
	30S 38W 13CCC 01
	30S 38W 15DBC 01
	30S 38W 30ACA 01
Gray	24S 27W 08CCC 01
	24S 27W 14ABB 01
	24S 27W 29BCC 01
	24S 28W 28BBA 01
	24S 28W 31DD 01
	24S 29W 16DCA 01
	24S 29W 18CCB 01
	24S 30W 15CCC 01
	24S 30W 33ADD 01
	25S 27W 33ABB 01
	25S 29W 07BCB 01
	25S 29W 14ABB 01
	25S 29W 27CCB 01
	25S 30W 20BCB 01
	26S 27W 13BBC 01
	26S 27W 27CDD 01
	26S 28W 06DDB 01
	26S 29W 15BCA 01
	26S 29W 35CCC 01
Gray (continued)	26S 30W 01ABC 01
	26S 30W 24DDD 01
	27S 27W 01BAA 01
	27S 27W 07ADC 01
	27S 27W 10CDB 01
	27S 27W 25CCD 01
	27S 28W 05AAA 01
	27S 28W 30CCA 01
	27S 29W 27CAA 01
	27S 30W 08BBB 01
	27S 30W 23BBA 01
	27S 30W 34CCC 01
	28S 27W 03BBB 01
	28S 28W 07CDD 01
	28S 28W 20ADD 02
	28S 29W 16ACC 01
	28S 30W 10DDD 01
	28S 30W 17BBA 01
	28S 30W 24BAB 01
	29S 27W 30BCC 01
	29S 28W 28CDC 01
	29S 29W 10ABB 01
	29S 29W 27BCB 01
	29S 30W 22BBC 01
	29S 30W 35ACD 01
Greeley	16S 39W 02BDC 01
	16S 39W 22DCB 01
	16S 40W 15ACC 01
	16S 40W 17CBC 01
	16S 40W 26ADA 01
	16S 41W 20BAD 01
	16S 41W 33AAB 01
	16S 42W 22BCB 01
	17S 39W 02BAA 01
	17S 39W 22ABB 01
	17S 39W 34CCB 01
	17S 40W 15CCB 01
	17S 40W 17BBA 01
	17S 40W 31BBA 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Greeley (continued)	17S 42W 27CBB 01
	18S 39W 07BBD 01
	18S 39W 19CDA 01
	18S 39W 23CCB 01
	18S 39W 24AAC 01
Hamilton	21S 39W 07CBA 01
	22S 39W 03BBB 01
	23S 39W 15ADD 01
	23S 40W 29DDB 01
	23S 42W 19CBB 01
	23S 42W 26DCA 01
	23S 42W 27DDB 01
	23S 42W 34CBB 01
	23S 43W 21ABA 01
	23S 43W 23BCB 01
	23S 43W 25CBD 02
	23S 43W 26BCC 01
	24S 39W 19CBC 01
	24S 39W 22CCB 01
	24S 39W 35BAC 01
	24S 39W 35CBA 01
	24S 40W 07CBB 01
	24S 40W 17BBB 01
	24S 40W 23AAB 01
	24S 40W 31BBB 01
	24S 41W 01DAD 01
	24S 42W 04AAD 01
	24S 42W 28DDD 01
	24S 43W 14CBB 01
	25S 39W 02CAD 01
	25S 39W 23BDD 01
	25S 40W 01CA 01
	25S 40W 26BBB 01
	25S 43W 03ABB 01
	25S 43W 21AAB 01
	25S 43W 25CCD 01
	26S 41W 20BCD 01
	26S 41W 32DDB 01
	26S 41W 36CCC 01
Hamilton (continued)	26S 42W 10BB 02
	26S 42W 17CBB 01
	26S 42W 22DCC 01
	26S 43W 10DBB 01
	26S 43W 25DCC 01
Harper	32S 06W 01DDD 01
Harvey	22S 02W 05CBD 01
	22S 03W 02DCD 01
	22S 03W 29BAD 01
	22S 03W 35AAA 01
	23S 01W 19AAC 01
	23S 01W 28AAD 01
	23S 02W 22CCD 01
	23S 02W 34DCC 01
	23S 03W 06DDD 01
	23S 03W 14AAC 01
	23S 03W 32DCC 02
	24S 01W 05AAB 01
	24S 01W 19BCC 01
	24S 01W 22BCC 01
	24S 02W 16BAA 01
	24S 02W 28DDD 01
	24S 03W 14BBB 01
Haskell	27S 31W 24CDC 01
	27S 31W 31BCC 01
	27S 32W 03CBB 01
	27S 32W 06CBB 01
	27S 32W 19CCD 01
	27S 33W 29DAA 01
	27S 34W 16DDD 01
	27S 34W 28DAA 02
	28S 31W 35CCB 01
	28S 32W 18BBB 01
	28S 32W 24BCC 01
	28S 33W 20DDD 01
	28S 33W 29CD 01
	28S 34W 13BBB 01
	28S 34W 15DAB 01
	29S 31W 09CB 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Haskell (continued)	29S 31W 34BCA 01
	29S 32W 04AAA 01
	29S 32W 19CCC 01
	29S 32W 26CBB 02
	29S 33W 01AAB 01
	29S 33W 28BCB 01
	29S 33W 34DDD 01
	29S 34W 11CCC 01
	30S 31W 24BBC 01
	30S 31W 26ABB 01
	30S 32W 11BBB 01
	30S 32W 31BAB 01
	30S 33W 06DBD 01
	30S 34W 05BBB 01
	30S 34W 30ADD 02
Hodgeman	21S 22W 12BCB 01
	22S 22W 13CCC 01
	22S 23W 31ADD 01
	22S 24W 14BBC 01
	22S 24W 15BDA 01
	22S 24W 16ADB 02
	22S 24W 24DDD 01
	22S 24W 25DDC 01
	22S 24W 26DDA 01
	22S 24W 35DAC 01
	23S 22W 07DAA 01
	23S 23W 04AAD 01
	23S 23W 04DCA 01
	23S 23W 12ABD 01
	23S 24W 11DAA 01
	23S 25W 22DBB 01
	23S 26W 07CCC 01
	23S 26W 20CCC 01
	23S 26W 26AAD 01
	23S 26W 31CDD 01
	24S 21W 20CBB 01
	24S 23W 03CCC 01
	24S 23W 06AAB 01
	24S 24W 02CCC 01
	24S 24W 20CCC 01
Hodgeman (continued)	24S 25W 22BAB 01
	24S 26W 35CBC 01
Jackson	06S 15E 27BAB 01
Jefferson	11S 16E 25CBA 01
	11S 17E 27BBC 01
	11S 18E 08DAC 01
	11S 19E 29CCA 01
Johnson	12S 22E 25BCCB01
	12S 22E 29BBD 01
Kearny	22S 35W 23CDD 01
	22S 36W 28DCC 01
	22S 37W 34BBC 01
	23S 35W 05ACC 01
	23S 35W 12CCC 01
	23S 35W 16BBC 01
	23S 35W 25BBB 02
	23S 36W 04CBB 01
	23S 36W 32BBB 01
	23S 36W 35BBB 01
	23S 37W 04ABC 01
	23S 37W 19CCC 01
	23S 37W 28CCB 01
	24S 35W 09CCC 01
	24S 35W 13CCC 02
	24S 35W 24BCB 01
	24S 36W 23CBB 02
	25S 35W 02BAA 01
	25S 35W 04BDD 01
	25S 35W 17AAA 01
	25S 35W 26BAB 01
	25S 36W 14B 01
	25S 36W 28BBD 01
	25S 36W 35CCA 01
	25S 37W 15ABA 02
	25S 37W 25BAD 02
	25S 38W 02BDA 01
	25S 38W 08CAA 01
	25S 38W 20ACC 01
	25S 38W 26ACC 01
	26S 35W 06ACC 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Kearny (continued)	26S 35W 29BBD 01
	26S 36W 22CCA 01
	26S 37W 06ACB 01
Kingman	27S 05W 24CDC 01
	27S 05W 33ABB 02
	27S 06W 12CCD 01
	27S 06W 16CCB 01
	27S 07W 03ADC 01
	27S 07W 23BCC 01
	27S 08W 14DDC 01
	27S 08W 17DAB 01
	27S 08W 25DAD 01
	27S 08W 28DAA 01
	27S 08W 35CBC 01
	27S 09W 15ABA 01
	27S 09W 29AAA 01
	27S 10W 03DDD 01
	27S 10W 17DDD 01
	27S 10W 24DAD 01
	28S 07W 29CDD 01
	28S 07W 35CCD 01
	28S 08W 21BBB 01
	28S 08W 26ABC 01
	28S 09W 01BCC 01
	28S 09W 21AAA 01
	28S 09W 29CCC 01
	28S 09W 34AAB 01
	28S 10W 16BCB 01
	29S 10W 19DDB 01
	30S 10W 05BBD 01
	30S 10W 28DAC 01
Kiowa	27S 16W 10BAC 01
	27S 16W 19BBD 01
	27S 16W 28CDD 01
	27S 17W 21ADC 01
	27S 18W 13AAA 01
	27S 18W 18DDC 01
	27S 18W 22ADC 01
	27S 18W 36CCA 01
	27S 19W 28CBD 01
	27S 20W 26ABD 01
	27S 20W 32ABD 01

County	Well number
Kiowa (continued)	28S 16W 12BCA 01
	28S 16W 17AAC 01
	28S 16W 31DCA 01
	28S 17W 01CAB 01
	28S 17W 05DDB 01
	28S 17W 15DDB 01
	28S 18W 09BAC 01
	28S 18W 19CCB 01
	28S 18W 25CAC 01
	28S 19W 10AAC 01
	28S 19W 30CBC 01
	28S 19W 33CBD 01
	28S 20W 12BBD 01
	28S 20W 30ACA 01
	29S 16W 02ADB 01
	29S 17W 04ABC 01
	29S 17W 12DAA 01
	29S 18W 02ACC 01
	29S 18W 07BBD 01
	29S 19W 22BAA 01
	29S 20W 11CDD 01
Labette	31S 21E 15CCC 02
Lane	16S 29W 26CCD 01
	16S 29W 33BAB 01
	16S 30W 24DCC 01
	16S 30W 29CDD 01
	16S 30W 34DAB 01
	17S 27W 20CCC 01
	17S 27W 26CCC 01
	17S 28W 07BBB 01
	17S 28W 15BBC 01
	17S 28W 26ABB 01
	17S 28W 34CBB 01
	17S 29W 10BAC 01
	17S 29W 36BAA 01
	17S 30W 13CBB 01
	17S 30W 20BBB 01
	18S 27W 13CCC 01
	18S 28W 18ACC 01
	18S 29W 04DAD 01
	18S 30W 02AAA 01
	18S 30W 04BAB 01
	18S 30W 23AAA 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Leavenworth	12S 22E 21BCD 01
	12S 22E 22CAA 01
Logan	11S 32W 04ACD 01
	11S 32W 19AAB 01
	11S 32W 31CCD 01
	11S 32W 36ABA 01
	11S 33W 10BDD 01
	11S 33W 14DCC 01
	11S 34W 13AAB 01
	11S 34W 16CDB 01
	11S 35W 01DCC 01
	11S 36W 06ADD 02
	11S 37W 01DCD 01
	13S 36W 20CCB 01
	15S 37W 29AAA 01
McPherson	17S 04W 25DDD 01
	17S 05W 07CBB 01
	17S 05W 22BAA 01
	18S 03W 30CCC 01
	18S 04W 21CCC 01
	19S 01W 32DAC 01
	19S 03W 16BCB 01
	19S 03W 31BBA 01
	19S 04W 15AAC 01
	20S 01W 22BBB 01
	20S 01W 29DDD 01
	20S 03W 22DAA 01
	20S 03W 30BBA 01
	20S 04W 15BDD 01
	20S 04W 27DAC 01
	21S 02W 12BBB 01
	21S 02W 28CBA 01
	21S 02W 36ACA 01
	21S 03W 06CBD 01
	21S 03W 22BBB 01
	21S 03W 33BBC 01
	21S 04W 26CDC 01
Meade	30S 26W 04CBB 01
	30S 26W 13ABB 01
	30S 26W 32DDD 01
	30S 27W 20ABA 01
	30S 27W 23ABB 01
	30S 27W 27BBB 01
	30S 27W 32DDD 01
	30S 28W 17ABB 01
	30S 28W 33AAA 01
	30S 29W 23CAD 01
	30S 29W 28BBB 01
	30S 30W 06CCC 01
	30S 30W 28ABB 01
	31S 26W 30BBB 01
	31S 27W 20AAA 02
	31S 28W 02CCC 01
	31S 28W 10BCB 01
	31S 28W 26ABB 01
	31S 29W 02DBB 01
	31S 29W 25AAA 02
	31S 29W 30AAA 01
	31S 30W 16BBC 01
	32S 28W 04ADD 01
	32S 29W 05CC 01
	32S 29W 27AAB 02
	32S 30W 09CCC 01
	32S 30W 28BBC 01
	33S 28W 29BCB 01
	33S 29W 36AAB 01
	33S 30W 21ACC 01
	33S 30W 35CBB 01
	34S 28W 05BDA 01
	34S 30W 22CBC 01
	35S 30W 10CDA 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Morton	31S 39W 18CCC 01
	31S 39W 33BCC 01
	31S 40W 01DA 01
	31S 40W 29ABB 01
	31S 41W 07CDD 01
	31S 41W 31CBB 01
	31S 42W 29AAB 01
	31S 43W 03CB 01
	31S 43W 14DDC 01
	32S 40W 07BDC 01
	32S 40W 21ADB 01
	32S 41W 15CDC 01
	32S 41W 35DCC 01
	32S 42W 14CCC 01
	32S 42W 21BCC 01
	32S 42W 26CDD 01
	32S 43W 08CBD 01
	32S 43W 17DCC 01
	32S 43W 28BBC 01
	33S 39W 04DBB 01
	33S 39W 16ABB 01
	33S 40W 27CCC 01
	33S 41W 03AAD 01
	33S 41W 33DDD 01
	33S 42W 05DCC 01
	33S 42W 21BCB 01
	33S 43W 08BDA 01
	33S 43W 09DBA 01
	34S 39W 06CCA 01
	34S 40W 16ABB 01
	34S 41W 26DCD 01
	34S 41W 28CBA 01
	34S 42W 05BDC 01
	34S 42W 22CDB 01
	34S 43W 07BDD 01
	35S 39W 06CDD 01
	35S 40W 03BBB 02
	35S 41W 16CCD 01
Morton (continued)	35S 42W 02DBB 01
	35S 43W 04AAC 01
	35S 43W 13BDB 01
Nemaha	05S 11E 10ADB 01
Ness	16S 24W 15ABB 01
	16S 26W 24DDA 01
	18S 21W 25AAB 01
	18S 21W 31CAA 01
	18S 24W 36ADB 01
	18S 25W 33BBC 01
	18S 26W 06BAB 02
	19S 23W 01CCB 01
	19S 23W 08CBB 01
	20S 22W 20CCC 01
	20S 22W 35BCC 01
	20S 23W 32CDA 01
	20S 26W 07BDC 01
Norton	01S 21W 17AAA 01
	01S 23W 15AAA 01
	01S 24W 13BCB 01
	01S 25W 25BBB 01
	02S 21W 33CCC 01
	02S 23W 22AAA 01
	02S 25W 14AAA 01
	04S 23W 03DDD 01
	04S 23W 26CCC 01
	04S 25W 13CCC 01
	05S 21W 10AAA 01
	05S 22W 18CCD 01
	05S 24W 21AAA 01
Osborne	06S 12W 23CDC 01
	07S 12W 28ABA 01
	07S 15W 10CCC 01
Pawnee	21S 15W 11CBB 01
	21S 15W 17CCC 01
	21S 15W 31BAD 01
	21S 16W 14ADC 01
	21S 18W 32DAA 01
	21S 19W 27CCC 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number	County	Well number
Pawnee (continued)	21S 19W 30BCC 01	Pratt	26S 11W 01DDB 01
	21S 20W 29BBB 01		26S 11W 27AAC 01
	22S 15W 03AAA 01		26S 11W 29BCB 01
	22S 15W 03AAA 02		26S 12W 02ABA 01
	22S 15W 09CCA 01		26S 12W 17CCA 01
	22S 15W 13DCA 01		26S 12W 34CDC 01
	22S 15W 33DDD 01		26S 12W 34CDC 02
	22S 16W 03CBC 02		26S 13W 16DAA 01
	22S 16W 06BBA 01		26S 13W 19BBD 01
	22S 16W 23AAA 01		26S 13W 34BCB 01
	22S 16W 32CDD 01		26S 14W 17DCB 01
	22S 17W 05BBC 02		26S 15W 01AAB 01
	22S 17W 18AAD 01		26S 15W 17BBC 01
	22S 17W 24CBC 01		27S 11W 12CBC 01
	22S 17W 27BAB 01		27S 11W 31DAA 01
	22S 19W 07AAA 01		27S 12W 12DAA 01
	22S 19W 10BBA 01		27S 12W 33CBA 01
	23S 15W 12DDB 01		27S 13W 13DDC 01
	23S 15W 21DCC 01		27S 14W 03DAC 01
	23S 16W 11CDC 01		27S 14W 12DDD 01
	23S 16W 35CCD 02		27S 14W 21CAB 01
	23S 17W 10CDB 01		27S 15W 02ABC 01
	23S 17W 25ADC 01		27S 15W 05CDB 01
	23S 17W 33CCA 01		27S 15W 32CCA 01
	23S 18W 28DAD 01		27S 15W 36ADD 01
	23S 18W 36DAC 01		28S 11W 12ACC 01
Phillips	04S 18W 23CDC 01		28S 11W 20CAC 01
	04S 19W 35DDD 01		28S 12W 21BAD 01
			28S 12W 34CCC 01
Pottawatomie	09S 11E 19CDB 01		28S 13W 02DDC 01
	09S 11E 27CAA 01		28S 13W 17AAA 01
	09S 11E 31DCC 01		28S 13W 26DCB 01
	09S 11E 32ADC 01		28S 14W 14CCC 01
	09S 11E 34CAB 01		28S 15W 23CCD 01
	09S 11E 35DDD 01		29S 11W 06AAA 01
	10S 08E 14CBA 01		29S 11W 09ADD 01
	10S 10E 10DBC 01		29S 11W 29AAD 01
	10S 11E 01CBC 01		29S 12W 20CCD 01
	10S 11E 03BCA 01		29S 13W 12ABB 01
	10S 11E 04ACB 01		29S 13W 31CAA 01
	10S 12E 07BBC 01		29S 14W 12ABB 01
			29S 14W 17DBD 01
			29S 15W 02CCA 01
			29S 15W 18ADA 01
			29S 15W 25AAB 02

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number	County	Well number
Rawlins	01S 33W 29CCC 01	Reno	22S 04W 12CDA 01
	02S 31W 03CAD 01		22S 04W 32BBC 01
	02S 32W 20DCD 01		22S 05W 17BCC 01
	02S 33W 26DCC 01		22S 06W 18BCB 01
	02S 35W 13ABB 01		22S 06W 28CCB 01
	02S 35W 34CAA 01		22S 07W 17DCB 01
	02S 36W 13DDD 01		22S 08W 09DBB 01
	02S 36W 36BAA 01		22S 08W 23DAD 01
	03S 31W 07CBD 01		22S 08W 33CCD 01
	03S 31W 23BBB 01		22S 09W 03BBD 01
	03S 33W 03DCC 01		22S 09W 17BAB 01
	03S 33W 08CDC 01		22S 09W 25BBA 01
	03S 34W 03ABB 01		22S 10W 02DCC 01
	03S 34W 26BAC 01		22S 10W 08BBB 01
	03S 35W 24CBB 01		22S 10W 30DAA 01
	03S 36W 14CBB 01		23S 04W 03BAB 02
	03S 36W 17CCC 01		23S 04W 16BBB 01
	03S 36W 21DBC 01		23S 04W 30BAA 01
	04S 31W 16ABD 01		23S 05W 05DDC 01
	04S 33W 10ABC 01		23S 06W 15BAC 01
	04S 33W 18DDA 01		23S 06W 31DCB 01
	04S 33W 28DCA 01		23S 07W 01ABA 01
	04S 34W 33CBC 01		23S 07W 05ABA 01
	04S 35W 06DCD 01		23S 07W 13DDD 01
	04S 35W 29DDD 01		23S 08W 18AAD 01
	04S 36W 23CBB 01		23S 09W 05CBD 01
	04S 36W 23DCA 01		23S 09W 21DDB 01
	05S 31W 10DDA 01		23S 09W 35CCC 01
	05S 31W 20CCA 01		23S 10W 02BAB 01
	05S 32W 14CDD 01		23S 10W 25CAC 01
	05S 33W 29BDA 01		23S 10W 29DCA 01
	05S 34W 01BBB 01		24S 04W 05CDB 01
	05S 34W 28ADC 01		24S 04W 14DAC 01
	05S 35W 12BCC 01		24S 04W 25BBD 01
	05S 35W 30CBC 01		24S 04W 31DAB 01
	05S 36W 21BCD 01		24S 05W 10CCA 01
			24S 06W 03AAB 01
			24S 06W 23CBA 01
			24S 07W 08ADA 01
			24S 07W 28AAA 01
			24S 08W 04AB 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Reno (continued)	24S 08W 18BAC 01
	24S 08W 34DAC 01
	24S 09W 19DDB 01
	24S 10W 06DBB 01
	24S 10W 17DDC 01
	24S 10W 31CBC 01
	25S 04W 02ABB 01
	25S 07W 07BBD 01
	25S 07W 36CCC 01
	25S 08W 19ADB 01
	25S 09W 01DCD 01
	25S 09W 17BBC 01
	25S 09W 30DDA 01
	25S 10W 14BBB 01
	25S 10W 19ABD 01
	26S 06W 13BAB 01
	26S 06W 34BBC 01
	26S 07W 12DCC 01
	26S 07W 21DDC 01
	26S 08W 06DCC 01
	26S 08W 30DAA 01
	26S 08W 30DCB 01
	26S 09W 10DDB 01
	26S 09W 18AAA 01
	26S 09W 31DCC 01
	26S 09W 34DBD 01
	26S 10W 18CDC 01
	26S 10W 32BBD 01
Republic	01S 03W 01CCA 01
	01S 03W 09CBD 01
	01S 04W 15AAA 01
Rice	18S 09W 04BCC 01
	18S 10W 24BBB 01
	20S 08W 22AAA 01
	20S 09W 12DDA 01
	20S 09W 28ACD 01
	20S 10W 27BBB 01
	20S 10W 36ACD 01
	21S 07W 04AAC 01
	21S 07W 26CBD 01
	21S 08W 09CBD 01
	21S 08W 25ABB 01
Rice (continued)	21S 08W 32DBB 01
	21S 09W 02DDA 01
	21S 09W 15AAC 02
	21S 10W 16CDC 01
Riley	10S 09E 17BDD 01
Rooks	07S 17W 24BBC 01
	07S 19W 23CDB 01
Rush	18S 16W 18DAB 01
	18S 16W 23DCC 01
	18S 16W 23DCC 02
	18S 17W 14CCC 01
	18S 17W 22AAD 01
	18S 17W 23BCC 01
	18S 18W 27AAC 01
	18S 19W 20ADD 01
	18S 20W 14CCC 01
	18S 20W 19AAD 01
Saline	13S 01W 23BCB 02
	13S 02W 33DDC 01
	16S 02W 18CCC 01
	16S 03W 33DCD 01
Scott	16S 31W 17DDD 01
	16S 31W 31BCB 01
	16S 32W 16BCA 01
	16S 33W 19CBB 01
	16S 33W 33BAA 01
	16S 34W 09CCB 01
	16S 34W 29CBB 01
	17S 31W 04DCC 01
	17S 31W 19CDA 01
	17S 31W 35CCB 01
	17S 32W 16BBB 01
	17S 32W 27BBB 01
	17S 32W 31BCB 01
	17S 33W 07BBA 01
	17S 33W 14ACB 01
	17S 34W 06BCB 01
	17S 34W 16ACB 01
	17S 34W 25DBB 01
	18S 31W 24BCB 01
	18S 31W 27ABA 01
	18S 32W 14BBB 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Scott (continued)	18S 32W 17ABA 02
	18S 33W 03CCB 01
	18S 33W 05CCC 01
	18S 33W 11ABB 01
	18S 33W 15DDD 01
	8S 33W 25BBB 01
	18S 33W 34ADB 01
	18S 34W 05CBB 01
	18S 34W 25BBD 01
	18S 34W 34BBC 01
	19S 32W 06CCB 01
	19S 32W 32ACB 01
	19S 33W 06DBB 01
	19S 33W 12DDC 01
	19S 33W 15DBD 01
	19S 33W 29CBB 02
	19S 34W 19DCCC01
	20S 32W 16DAD 01
	20S 32W 30BCD 01
	20S 33W 02DBB 01
	20S 33W 09BBB 01
	20S 33W 17BAB 01
	20S 33W 21ABD 01
	20S 33W 35DBA 01
	20S 34W 15BAA 01
	20S 34W 36CCD 01
Sedgwick	25S 01W 07ABD 01
	25S 01W 26DBD 01
	25S 01W 28DBA 01
	25S 02W 16DDA 01
	25S 02W 23DBD 01
	25S 03W 03DDD 01
	25S 03W 15CCC 01
	26S 01W 12BAD 01
	26S 01W 19ABA 01
	26S 01W 31CCC 02
	26S 01W 31CCD 01
	26S 02W 02DDD 02
	26S 02W 07AAA 02
	26S 02W 08AAB 01
	26S 02W 10DAA 01
Sedgwick (continued)	26S 02W 14DDD 01
	26S 02W 15DBB 01
	26S 02W 23CCC 01
	26S 02W 29AAA 01
	26S 03W 02AAC 01
	28S 01W 11BCB 01
	28S 01W 15ACA 02
	28S 01W 36BAB 01
	29S 01E 16DDD 01
Seward	31S 31W 08BCC 01
	31S 31W 13BBC 01
	31S 31W 32DCC 01
	31S 32W 03DAD 01
	31S 32W 31BBB 01
	31S 33W 06CBD 01
	31S 33W 20DBB 01
	31S 34W 18BBB 01
	32S 31W 02BBB 01
	32S 31W 08BBB 01
	32S 31W 26CAA 01
	32S 32W 14BBB 01
	32S 32W 19BAB 01
	32S 33W 04BAA 01
	32S 33W 32DBD 01
	32S 34W 10DAA 01
	32S 34W 17DCC 01
	32S 34W 32BBB 01
	33S 31W 09AAB 01
	33S 31W 28DDB 01
	33S 32W 28CDD 02
	33S 33W 12AAD 01
	33S 33W 20BCC 01
	33S 33W 25DCC 01
	33S 34W 17DCC 01
	34S 31W 30BBB 01
	34S 32W 29BAA 01
	34S 32W 35ADA 01
	34S 33W 04BCD 01
	34S 33W 07CCB 01
	34S 34W 16DAA 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Seward (continued)	34S 34W 26BCA 01
	35S 31W 10AAC 01
	35S 31W 18BBA 01
	35S 32W 06CBB 01
	35S 33W 16BCA 01
	35S 34W 03CBC 01
	35S 34W 10BBB 01
Shawnee	11S 12E 01ABA 01
	11S 13E 04ADA 01
	11S 14E 13BBB 01
	11S 14E 15ABB 01
	11S 14E 18CBB 01
	11S 14E 22CCC 01
	11S 15E 13DBC 01
	11S 15E 16DCA 01
	11S 15E 23DBD 02
	11S 16E 29ACA 01
Sheridan	06S 26W 26CBB 01
	06S 27W 05CBB 01
	06S 27W 08DCA 01
	06S 27W 19ADC 01
	06S 27W 27BCC 01
	06S 29W 10DBC 01
	06S 29W 24ABB 01
	06S 29W 33CDA 01
	06S 30W 13BAA 01
	06S 30W 14CCD 01
	07S 26W 06AAB 01
	07S 26W 12BAC 01
	07S 26W 19BBC 01
	07S 26W 28CAB 01
	07S 27W 22DAC 01
	07S 28W 08BDC 01
	07S 28W 21ABB 01
	07S 28W 36ABA 01
	07S 29W 05BBB 01
	07S 29W 27CCC 01
Sheridan (continued)	07S 29W 30ABA 01
	07S 30W 08CBB 01
	08S 26W 14DAA 01
	08S 27W 11DCD 01
	08S 27W 35CBB 01
	08S 28W 09ABC 01
	08S 28W 11DAA 01
	08S 29W 01DCB 01
	08S 30W 11CBC 01
	08S 30W 13DAA 01
	08S 30W 30ABC 01
	09S 26W 22BBB 01
	09S 27W 12CCC 01
	09S 27W 19DDD 01
	09S 27W 27DAA 01
	09S 28W 04BCC 01
	09S 29W 03AAA 01
	09S 29W 17BAB 01
	09S 29W 26BAA 01
	09S 30W 03AAB 02
	09S 30W 35BBB 01
	10S 26W 08BAA 01
	10S 26W 12AAD 01
	10S 27W 20CBC 01
	10S 27W 22DBA 01
	10S 28W 05DDB 01
	10S 28W 29DAA 01
	10S 29W 02DDD 01
	10S 29W 20CAA 01
	10S 30W 08DDD 01
	10S 30W 12ADA 01
Sherman	06S 37W 07BBA 01
	06S 37W 16CDD 01
	06S 37W 19ABB 01
	06S 38W 09ABD 01
	06S 39W 09DDD 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Sherman (continued)	06S 40W 10AAC 01
	06S 40W 13CBC 01
	06S 40W 30DCC 01
	06S 41W 19DBD 01
	06S 41W 27DBD 01
	06S 42W 02AAA 01
	06S 42W 08CBB 01
	06S 42W 22DCC 01
	06S 42W 30ADA 01
	07S 37W 04BBC 01
	07S 37W 05CCB 01
	07S 38W 28DAA 01
	07S 39W 01DCD 01
	07S 39W 09BBB 01
	07S 39W 24BAA 01
	07S 40W 06ADB 01
	07S 40W 29BBA 01
	07S 40W 35BBB 01
	07S 40W 36BAB 01
	07S 41W 07BCB 01
	07S 41W 28DBB 01
	07S 42W 07DAA 01
	07S 42W 17CCC 01
	07S 42W 27AAB 01
	08S 37W 03ADB 01
	08S 37W 21CCC 01
	08S 37W 32ABB 01
	08S 38W 17CDD 01
	08S 38W 24AAB 01
	08S 39W 15CCC 01
	08S 40W 12DBA 01
	08S 40W 17CDB 01
	08S 40W 20CCC 01
	08S 40W 25AAC 01
	08S 41W 17CBA 01
	08S 41W 25BBC 01
	08S 42W 15DDB 01
	08S 42W 31DCD 01
	09S 37W 07DDB 01
Sherman (continued)	09S 38W 13BCC 01
	09S 39W 01DBA 01
	09S 39W 02BAB 01
	09S 39W 10CCB 01
	09S 39W 19CCC 01
	09S 40W 13CDC 01
	09S 40W 29BBB 01
	09S 41W 05DCC 01
	09S 41W 14BBC 01
	09S 41W 28AAA 01
	09S 41W 34BAB 01
	09S 42W 08AAA 01
	09S 42W 14AAA 01
	09S 42W 29CBB 01
	09S 42W 35ABB 01
	10S 37W 23ABB 01
	10S 40W 10ADC 01
	10S 41W 15CAD 01
	10S 42W 20ABB 01
	10S 42W 21BBB 01
	10S 42W 24BAB 01
Stafford	21S 11W 07BBB 01
	21S 12W 10CDD 01
	21S 13W 05CBD 02
	21S 13W 27DDD 02
	21S 14W 22AAC 01
	21S 14W 32BAC 01
	22S 11W 07BBB 01
	22S 12W 05BBD 01
	22S 12W 30BBD 01
	22S 12W 36BBB 02
	22S 13W 05CBC 01
	22S 13W 12CAC 01
	22S 13W 29DAD 01
	22S 14W 14CCA 01
	22S 14W 35DDB 01
	23S 11W 02BBB 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Stafford (continued)	23S 11W 22BCC 01
	23S 11W 36CCA 01
	23S 12W 07DBD 01
	23S 12W 22BCC 01
	23S 12W 36BBC 01
	23S 13W 08CCB 01
	23S 13W 30CBB 01
	23S 13W 35CCA 01
	23S 14W 15ADD 01
	23S 14W 30BBB 01
	24S 11W 14CAB 01
	24S 11W 17DDB 01
	24S 12W 04CDB 01
	24S 12W 17CAB 01
	24S 12W 34ABC 01
	24S 13W 16ACA 01
	24S 13W 20CDD 01
	24S 13W 36DDD 01
	24S 14W 17AAC 01
	24S 14W 31BBD 01
	24S 15W 10BAB 01
	24S 15W 32DBC 01
	25S 11W 02ACB 01
	25S 11W 23DDD 01
	25S 12W 11AAA 01
	25S 12W 16DCA 01
	25S 12W 24DDB 01
	25S 13W 16AAC 01
	25S 13W 31DDA 01
	25S 13W 36DCC 01
	25S 14W 04AAD 01
	25S 14W 21DDB 01
	25S 14W 30CDB 01
	25S 15W 11BCB 01
	25S 15W 29BBD 01
Stanton	27S 39W 02BBB 01
	27S 39W 27BBA 01
	27S 40W 07ABB 01
	27S 40W 16CCC 01
	27S 40W 25CBC 01
Stanton (continued)	27S 41W 07DCC 01
	27S 41W 31CCB 02
	27S 41W 35CCC 01
	27S 42W 17CCC 01
	27S 42W 31CCC 01
	27S 43W 02BBD 01
	28S 39W 14BBC 01
	28S 39W 16CCC 01
	28S 39W 33ACC 01
	28S 39W 36ABB 01
	28S 40W 04CCC 01
	28S 40W 12DDD 02
	28S 40W 23ACC 01
	28S 40W 32CCB 01
	28S 41W 02CCC 01
	28S 41W 31BDD 01
	28S 41W 34BDD 01
	28S 42W 06DBB 01
	28S 42W 08CCC 01
	28S 42W 20BCC 01
	28S 42W 32BBB 01
	29S 39W 17BCB 01
	29S 39W 21DBD 01
	29S 39W 24DDA 01
	29S 40W 28ABB 01
	29S 41W 13ACC 01
	29S 41W 31CBD 01
	29S 42W 08CDC 01
	29S 42W 24CCC 01
	29S 43W 33CDB 01
	30S 39W 18BBB 01
	30S 39W 23BBB 01
	30S 40W 12BBB 01
	30S 40W 24CDC 01
	30S 40W 33CCB 01
	30S 41W 13CCC 02
	30S 41W 23DDB 01
	30S 42W 12ACC 01
	30S 42W 16BDB 01
	30S 43W 34BBB 01
	30S 43W 36BB 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Stevens	31S 35W 15BAA 01
	31S 35W 19CCC 01
	31S 35W 26DCC 01
	31S 36W 02CDD 01
	31S 36W 27BCB 01
	31S 37W 09BCC 01
	31S 37W 22BCC 01
	31S 37W 30DDB 01
	31S 38W 17CDA 01
	31S 39W 23BBB 01
	32S 35W 08DDD 01
	32S 36W 21AAC 01
	32S 37W 10DCC 01
	32S 37W 26BAC 01
	32S 38W 11ADA 01
	32S 38W 23BDD 01
	32S 39W 02BBB 01
	32S 39W 14DDD 01
	33S 35W 23CBB 01
	33S 36W 03ACA 01
	33S 36W 26DDD 01
	33S 37W 17CCC 01
	33S 37W 23CDB 01
	33S 38W 06AAB 01
	33S 38W 10ACC 01
	33S 38W 20DAD 01
	34S 35W 03DCC 01
	34S 35W 07CBB 01
	34S 35W 26ACC 01
	34S 36W 10CAC 01
	34S 36W 21DBD 01
	34S 37W 08DAC 01
	34S 37W 27ABC 01
	34S 37W 29BBD 01
	34S 37W 35AAD 01
	34S 38W 02ADC 01
	34S 38W 34CAA 01
	34S 39W 02CCA 01
	34S 39W 15CAD 01
	35S 35W 15BCC 01
Stevens (continued)	35S 36W 01AAA 01
	35S 36W 15AAD 01
	35S 37W 16BCC 01
	35S 39W 10CAD 01
Sumner	30S 04W 21CBB 01
	30S 04W 34BAA 01
	31S 04W 01BBB 01
	31S 04W 01DAC 01
	31S 04W 02BBB 01
Thomas	06S 31W 03ADB 01
	06S 31W 33CCD 01
	06S 32W 12CBC 01
	06S 32W 29CDC 01
	06S 33W 07BBB 01
	06S 33W 23DDD 01
	06S 34W 01DDD 01
	06S 34W 11CDD 01
	06S 34W 17CBC 01
	06S 34W 22DCA 01
	06S 34W 31CDB 01
	06S 35W 02CDD 01
	06S 35W 26ACB 01
	06S 36W 06BCD 01
	06S 36W 11ACC 01
	06S 36W 30DCB 01
	06S 36W 34DDB 01
	07S 31W 01DCA 01
	07S 32W 07ACA 01
	07S 32W 13AAA 01
	07S 32W 33BCB 01
	07S 33W 07BDA 01
	07S 33W 35ADD 01
	07S 34W 25AAA 01
	07S 34W 26DBD 01
	07S 35W 09CCC 01
	07S 36W 17CCC 01
	07S 36W 35CBB 01
	08S 31W 03CDD 01
	08S 31W 20CDD 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Thomas (continued)	08S 32W 07BAA 01
	08S 32W 12DBC 01
	08S 32W 27DAB 01
	08S 33W 34BBC 01
	08S 34W 01BAC 01
	08S 34W 06CBC 01
	08S 34W 23CBD 01
	08S 34W 29CCC 01
	08S 35W 04CCC 01
	08S 36W 15CBB 01
	08S 36W 18ABA 02
	08S 36W 31BCD 01
	09S 31W 10BBB 01
	09S 31W 17CCC 01
	09S 31W 36AAB 01
	09S 32W 03AAA 01
	09S 32W 27BCD 01
	09S 33W 35AAD 01
	09S 34W 11CCC 01
	09S 34W 12ADA 01
	09S 34W 17ABA 01
	09S 35W 32DAA 01
	10S 31W 26AAA 01
	10S 31W 29AAB 01
	10S 32W 11BAA 01
	10S 32W 29DCB 01
	10S 33W 03DBC 01
	10S 33W 06BBC 01
	10S 33W 19CBD 01
	10S 34W 12BCD 01
	10S 34W 29BBC 01
	10S 35W 09ABB 01
	10S 36W 16CCC 01
	10S 36W 36ACC 01
Trego	12S 23W 20CCC 01
	14S 25W 13BBA 01
Wabaunsee	10S 10E 15DCC 01
	10S 12E 29ADD 01
Wallace	11S 38W 35CCC 02
	11S 42W 08DDC 01
	11S 42W 10AAD 01
	13S 39W 33BBB 01
	13S 42W 10BAC 01
	13S 43W 36ABB 01
	14S 38W 21DCC 01
	14S 39W 28CAA 01
	14S 40W 23ADD 01
	14S 40W 29ABA 01
	14S 41W 18DCB 01
	14S 41W 22BBC 01
	14S 42W 10BAA 01
	14S 42W 30BCA 01
	14S 43W 14ABA 01
	15S 38W 05CCB 01
	15S 38W 14CCD 01
	15S 38W 21CCC 01
	15S 38W 36CBB 01
	15S 39W 02BCA 01
	15S 39W 06CBC 01
	15S 39W 08ACC 01
	15S 39W 26ACC 01
	15S 40W 03BAB 01
	15S 40W 09DCB 01
	15S 40W 26CAB 01
	15S 41W 02AAA 01
	15S 41W 05ACB 01
	15S 41W 27CBC 01
	15S 41W 36DDB 02
	15S 42W 02BBB 01
	15S 42W 32BDA 01
	15S 42W 36CDC 01
Washington	01S 05E 05ADA 01
	04S 02E 14CCC 01
	05S 01E 20ADA 01
	05S 01E 31DDD 01

Table 4. *Ground-water-level observation wells, 1991 water year*--Continued

County	Well number
Wichita	16S 35W 06AAB 01
	16S 35W 13CCC 01
	16S 35W 20CCC 01
	16S 36W 03DCC 01
	16S 36W 07BCB 01
	16S 36W 21CCC 01
	16S 36W 30CBC 01
	16S 36W 34CCC 02
	16S 36W 36CBC 01
	16S 37W 17BBB 01
	16S 37W 30BAB 01
	16S 38W 10ABB 01
	16S 38W 26BBB 01
	17S 35W 02BBB 01
	17S 35W 15CDC 01
	17S 35W 18ACB 01
	17S 35W 18DCC 01
	17S 35W 27CCC 01
	17S 35W 30CBB 01
	17S 36W 10CBB 01
	17S 36W 23BCC 01
	17S 36W 33BCB 01
	17S 37W 08BAA 01
	7S 37W 13CDD 01
	17S 37W 28CCC 01
	17S 38W 21BBB 01
	17S 38W 24ACC 01
	17S 38W 28CCC 01
	18S 35W 08BBC 02
	18S 35W 14DCD 01
	18S 35W 31DDD 01
Wichita (continued)	18S 36W 15DAD 01
	18S 37W 01BBB 01
	18S 37W 21BBB 01
	18S 37W 36ABC 01
	18S 38W 02BCC 01
	18S 38W 08BBD 01
	18S 38W 12BCC 01
	18S 38W 20ACC 02
	18S 38W 23BAB 01
	18S 38W 31DBC 01
	18S 38W 36DDD 01
	19S 35W 01AAA 01
	19S 35W 08BBB 01
	19S 36W 15BAA 01
	19S 37W 22AAB 01
	19S 37W 28ABB 01
	19S 38W 26CCB 01
	19S 38W 31CBC 01
	20S 35W 15BBB 01
	20S 36W 14DAD 01
	20S 36W 24ACC 01
	20S 37W 29DCC 01
	20S 38W 17CBD 01
	20S 38W 33BBA 01
Wyandotte	11S 24E 14BDA 01
	11S 24E 32ABA 02

Table 5. *Surface-water-quality stations, 1991 water year*

Ident. no. (fig. 10)	Station name	Sampling purpose	Coop. or support
		Missouri River basin	
06-			
8566	Republican R. at Clay Center	CHEM, BIOL, TOC, METAL, COLI, SED, FIELD	CBR
8725	N. Fk. Solomon R. at Portis	CHEM, FIELD	CBR
8740	S. Fk. Solomon R. at Osborne	CHEM, BIOL, TOC, METAL, COLI, SED, FIELD	CBR
8776	Smoky Hill R. at Enterprise	CHEM, BIOL, TOC, METAL, SED, BED, COLI, FIELD	CBR/KWO
87965	Kings Cr. nr Manhattan	CHEM, METAL, TOC, FIELD, SED	CBR
		Arkansas River basin	
07-			
1375	Arkansas R. nr Coolidge	CHEM, BIOL, TOC, METAL, COLI, FIELD, SED	CBR
1442	Little Ark. R. at Valley Ctr.	SED (not shown in fig. 10)	T-CE
1465	Arkansas R. at Arkansas City	SED (not shown in fig. 10)	T-CE
14707	Whitewater R. at Towanda	SED (not shown in fig. 10)	T-CE
1478	Walnut R. at Winfield	SED (not shown in fig. 10)	T-CE
1675	Otter Cr. at Climax	SED (not shown in fig. 10)	T-CE
1698	Elk R. at Elk Falls	SED (not shown in fig. 10)	T-CE
1707	Big Hill Cr. nr Cherryvale	SED (not shown in fig. 10)	T-CE
1795	Neosho R. at Council Grove	SED (not shown in fig. 10)	T-CE
17973	Neosho R. nr Americus	SED (not shown in fig. 10)	T-CE
179795	Cottonwood R. bl Marion Lake	SED (not shown in fig. 10)	T-CE
18225	Cottonwood R. nr Plymouth	SED (not shown in fig. 10)	T-CE
1835	Neosho R. nr Parsons	CHEM, BIOL, TOC, METAL, SED, COLI, FIELD	CBR

Table 6. *Ground-water-quality observation wells, 1989 water year*

County	Well number
Atchison	05S 20E 17ADA
	06S 18E 22BCD
Barber	31S 12W 24BDD
	32S 10W 21BBA
	33S 11W 33ABB
Barton	19S 11W 31AAB
	20S 14W 27BCA
Brown	01S 17E 07CBC
	02S 17E 31DDC
Butler	29S 03E 20BAB
	29S 07E 07DDA
Chase	19S 07E 27CBC
	19S 08E 20AAA
Cherokee	32S 23E 06AD
	33S 23E 13ABB
	33S 25E 18DAA
	34S 24E 17DCC
	34S 24E 35DAB
	34S 25E 23AAC
Clark	30S 25W 24BCC
	31S 23W 07BBA
	33S 23W 12BBD
	34S 25W 36DC
Clay	06S 01E 02BAC
	07S 02E 03CDC
	07S 04E 20ADC
	08S 02E 11ADB
	10S 01E 17DCC
Cloud	05S 01W 26ABD
	05S 03W 32ADA
	08S 01W 17CBD
	08S 05W 14ACD
Comanche	32S 18W 07DCC
	33S 20W 03BAB
Cowley	34S 03E 25BDA
	34S 04E 35CDC
Crawford	29S 23E 24ACD
	29S 25E 01ACB
	30S 25E 28DDA
Decatur	04S 27W 17DAC
Dickinson	12S 04E 30DDD
	13S 01E 18DCA
Doniphan	02S 19E 27CBC
	03S 21E 06BCC
Douglas	11S 18E 34BDA
	12S 20E 19AAA
	13S 21E 06AAB
	14S 19E 21BBB
	14S 20E 18ABB
Edwards	24S 18W 25BDC
	25S 19W 01AC
	25S 20W 07CAA
Ellis	14S 18W 03CCD
	14S 18W 25AAB
	15S 18W 28CAC
Ellsworth	15S 08W 19BCD
	17S 09W 16DAB
Finney	21S 32W 08ABD
	23S 31W 03DCC
	23S 33W 17BBB
	24S 33W 07ACA
Ford	26S 24W 20CCC
Geary	12S 05E 01BBA
Gove	11S 26W 30DDD
	14S 29W 20CBB

Table 6. *Ground-water-quality observation wells, 1989 water year*--Continued

County	Well number	County	Well number
Graham	07S 25W 27DCC	Leavenworth	08S 21E 19BAA
	08S 21W 17ACB		
		Lincoln	10S 07W 12ACA
Gray	24S 29W 19BBC		12S 06W 15DAA
	26S 27W 17CCA		12S 07W 06AAA
	29S 28W 28CDC		12S 10W 21DDD
Hamilton	23S 42W 19CBB	Logan	11S 32W 03ADB
	23S 42W 26CCB		11S 36W 06DBB
	24S 39W 30BBD		13S 35W 23ACD
	24S 40W 19BBC		13S 36W 20CBC
Harper	32S 07W 02CDA	McPherson	17S 05W 23DAB
	32S 08W 20BCB		19S 03W 29DBA
	33S 07W 28CCC		20S 01W 11CCB
			21S 03W 31CCB
Harvey	22S 01W 15AA		
	23S 01W 32BBC	Marion	19S 01E 04ACC
	23S 02W 29CDD		22S 03E 04AA
	23S 03W 29DBD		
	24S 03W 26ADA	Marshall	04S 06E 16DDD
			04S 09E 16AAB
Hodgeman	21S 22W 03BBC		
	23S 23W 06CAB	Meade	32S 28W 11BA
Jackson	05S 16E 10BBA	Mitchell	06S 09W 26CAD
Jefferson	07S 19E 29BBD	Morris	14S 06E 34AAC
	11S 16E 13CBD		14S 08E 07DAC
Jewell	02S 09W 23BAC	Morton	32S 42W 14CCC
			33S 43W 27CDC
Johnson	12S 22E 25BBC		
		Nemaha	02S 12E 26CDA
Kearny	21S 37W 02CDD		04S 13E 35BAA
	24S 35W 31DDB		05S 11E 10ADB
	24S 36W 16BAD		05S 14E 11ACC
	25S 36W 28BBD		
		Ness	19S 23W 05CCD
Kingman	27S 10W 32DCC		
	30S 05W 12DDC	Norton	02S 21W 08ADD
			05S 24W 14CCB
Lane	18S 29W 13DBA		

Table 6. *Ground-water-quality observation wells, 1989 water year*--Continued

County	Well number	County	Well number
Osborne	06S 11W 28ACD	Riley (continued)	10S 07E 32DBD
	06S12W 06DAA		11S 06E 12ADB
	07S 15W 02DBC		
	10S 15W 18AAA	Rooks	07S 18W 24BAD
			09S 18W 35CCCD
Ottawa	09S 04W 10BBC		09S 19W 34BBD
	12S 03W 01DBA		
	12S 05W 09DCA	Rush	16S 17W 16DCD
			18S 16W 23AAA
Phillips	01S 20W 25		18S 20W 20DCA
	04S 16W 27CAD		
	04S 20W 34BDB	Russell	14S 11W 07CAB
Pottawatomie	07S 07E 23BBA	Saline	14S 03W 25BAD
	10S 09E 09CDC		15S 02W 26DDD
	10S 10E 09ABC		
	10S 12E 09ADB	Scott	17S 32W 05ABB
			18S 33W 24ADC
Pratt	26S 11W 30ADD		
	26S 14W 18CCA	Sedgwick	25S 01W 07BAA
	27S 13W 08DDC		25S 01W 30ABB
	29S 14W 23BBA		25S 01W 36ACB
			25S 03W 14CCB
Reno	22S 07W 10CAA		26S 01E 17AAB
	23S 06W 13BBA		
	25S 04W 05DAD		27S 02W 36BBB
			29S 01E 05CAA
	25S 08W 10BAD		29S 01E 08CBB
	26S 10W 05DDD		29S 02W 23DDD
Republic	01S 02W 33DCD	Seward	31S 32W 03DAD
	01S 03W 02CCB		
	01S 04W 31BCC	Shawnee	11S 15E 13BBC
	03S 04W 17DAD		
	04S 01W 16ACC	Sheridan	08S 28W 15BBA
Rice	18S 06W 29CCD	Sherman	08S 39W 19DCA
	20S 08W 15DDD		08S 42W 20CAC
	20S 08W 23ABA		
	21S 08W 21BAC	Smith	03S 15W 20DCC
Riley	07S 06E 21CDD	Stafford	23S 13W 33BDB
	09S 05E 01BDB		24S 15W 22BBA

Table 6. *Ground-water-quality observation wells, 1989 water year*--Continued

County	Well number	County	Well number
Stanton	28S 41W 36DB	Thomas	07S 33W 31DBB
	30S 39W 23BBB		07S 36W 15DCC
Stevens	31S 35W 26DCC	Trego	12S 22W 08BAB
	33S 37W 16AC		
		Washington	02S 03E 32ABB
Sumner	30S 02E 06CAB		04S 05E 09CAA
	31S 01E 04BDC		05S 02E 12CBA
	31S 02E 02BBB		
	31S 03W 05ACA	Wichita	18S 37W 13CAC
	32S 02W 31DBD		
		Wyandotte	10S 25E 27DBD
	33S 02E 06BBA		11S 23E 28CBC
	34S 02W 21DAB		11S 25E 20ABA