WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1994, TO SEPTEMBER 30, 1995

Compiled by Ellen E. Hardy and Stefanie L. Dragos

U.S. GEOLOGICAL SURVEY
Open-File Report 96-577

Salt Lake City, Utah
1996

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Gordon P. Eaton, Director

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District Chief
U.S. Geological Survey
Room 1016 Administration Building
1745 West 1700 South
Salt Lake City, Utah 84104

Copies of this report can be purchased from:

U.S. Geological Survey
Branch of Information Services
Box 25286
Denver Federal Center
Denver, Colorado 80225

Message from the District Chief

The U.S. Geological Survey, Water Resources Division, is entering its 106th year of activities in Utah. As Utah's economy and population continue to expand, so has the demand for water and the need for quantitative, unbiased water-resources data and interpretive studies. The Utah District program is designed to provide this information and help the Water Resources Division fulfill its mission of assessing the quantity and quality of the Nation's water resources.

Utah, like other Western States, has experienced several rapid and extreme changes between wet and dry precipitation cycles in recent years. Following a dry 1994, most areas in Utah experienced greater-than-normal precipitation in 1995. The early snowfall season was wet and warm Statewide, with precipitation falling as rain and wet snow in the southern parts of the State. In mid-February and again in mid-March, the Santa Clara River near St. George experienced greater-than-normal flows, which resulted in some flooding and damage. The wet conditions also likely caused a major landslide in Zion National Park that temporarily blocked the North Fork Virgin River and destroyed the access road to part of the park. In May, wet and cool conditions resulted in continued accumulation of snow in the high mountains. This late snowpack caused greater-than-normal flows in northern and eastern Utah in June and July. As a sidenote, it also resulted in the longest ski season in Utah's history, with skiing as late as the Fourth of July at one area near Salt Lake City.

Monitoring stormflows and ground-water levels and estimating basin water budgets during alternating wet and dry cycles illustrates the need for long-term hydrologic records. The past is our only guide to the future; water managers and decision makers require both long-term averages as well as potential extremes if adequate water supplies are to be assured.

The future promises the continued challenge of helping local, State, and Federal agencies meet their water-resources information needs. I look forward to another active year in which the U.S. Geological Survey helps meet these needs.

Kimball E. Goddard
District Chief
U.S. Geological Survey, Water Resources Division
Salt Lake City, Utah 84104
kgoddard@usgs.gov

Utah District Web Page:
http://wwwdutslc.wr.usgs.gov

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INTRODUCTION

This report contains summaries of the progress of water-resources studies in Utah done by the U.S. Geological Survey, Water Resources Division, Utah District, from October 1, 1994, to September 30, 1995. The water-resources program in Utah during this period consisted of 23 projects; a discussion of each project is presented in the main body of this report.

The following sections outline the origin of the U.S. Geological Survey, the basic mission of the Water Resources Division, the organizational structure of the Utah District, office addresses of the Utah District, the distribution of program funding as source of funds and type of activity funded in Federal Fiscal Year (FY) 1995 (October 1, 1994, to September 30, 1995), and the agencies with which the District cooperates. The last part of the introduction is a list of reports produced by the District from October 1994 to September 1995.

Origin of the U.S. Geological Survey

The U.S. Geological Survey was established by an act of Congress on March 3, 1879, to provide a permanent Federal agency to conduct the systematic and scientific "classification of the public lands, and examination of the geologic structure, mineral resources, and products of national domain." An integral part of that original mission includes publishing and disseminating the earth-science information needed to understand, to plan the use of, and to manage the Nation's energy, land, mineral, and water resources.

Since 1879, the research and fact-finding role of the U.S. Geological Survey has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the U.S. Geological Survey has become the Federal Government's largest earth-science research agency, the Nation's largest civilian map-making agency, the primary source of data on the Nation's surface- and ground-water resources, and the employer of the largest number of professional earth scientists. Today's programs serve a diversity of needs and users. Programs include:

- Conducting detailed assessments of the energy and mineral potential of the Nation's land and offshore areas.
- Investigating and issuing warnings of earthquakes, volcanic eruptions, landslides, and other geologic and hydrologic hazards.
- Conducting research on the geologic structure of the Nation.
- Studying the geologic features, structure, processes, and history of the other planets of our solar system.
- Conducting topographic surveys of the Nation and preparing topographic and thematic maps and related cartographic products.
- Developing and producing digital cartographic data bases and products.
- Collecting data on a routine basis to determine the quantity, quality, and use of surface and ground water.
- Conducting water-resource appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting research in hydraulics and hydrology, and coordinating all Federal water-data acquisition.
- Using remotely sensed data to develop new cartographic, geologic, and hydrologic research techniques for natural-resources planning and management.

- Providing earth-science information through an extensive publication program and a network of public access points.

Along with its continuing commitment to meet the growing and changing earth-science needs of the Nation, the U.S. Geological Survey remains dedicated to its original mission to collect, analyze, interpret, publish, and disseminate information about the natural resources of the Nation—providing "Earth Science in the Public Service."

Mission of the U.S. Geological Survey, Water Resources Division

The mission of the Water Resources Division, which supports the overall mission of the U.S. Department of the Interior and the U.S. Geological Survey, is to provide the hydrologic information and understanding needed for the best use and management of the Nation's water resources for the benefit of the people of the United States.

To accomplish its mission, the Water Resources Division, in cooperation with State and local governments and other Federal agencies:

- Systematically collects data needed for the continuing determination and evaluation of the quantity, quality, and use of the Nation's water resources.
- Conducts analytical and interpretive water-resources appraisals to describe the occurrence, availability, and physical, chemical, and biological characteristics of surface and ground water and their interrelation.
- Conducts supportive basic and problem-oriented research in hydraulics, hydrology, and related fields of science and engineering to improve the basis for field investigations and measurement techniques and to understand hydrologic systems sufficiently well to predict quantitatively their response to stress, either natural or manmade.
- Disseminates water data and the results of investigations and research through reports, maps, computerized information services, and other forms of public releases.
- Coordinates the activities of all Federal agencies in the acquisition of certain water data.
- Provides scientific and technical assistance in hydrologic fields to State, local, and other Federal agencies, to licensees of the Federal Energy Regulatory Commission, and, on behalf of the U.S. Department of State, to international agencies.
- Acquires, develops, and disseminates information on water-related natural hazards such as droughts, floods, landslides, land subsidence, mudflows, and volcanoes.
- Administers the provisions of the Water Resources Research Act of 1984 that include the programs of the State Water Resources Research Institutes and the Research Grants and Contracts.
- Supports the provisions of the National Environmental Policy Act of 1969 and manages U.S. Geological Survey conduct of natural-resources surveys in response to the Comprehensive Environmental Response, Compensation, and Liability Act (Superfund Act) of 1980.

Authority for carrying out this mission is derived from legislation of 1879, which created the U.S. Geological Survey, and legislation of 1888 and 1894, which provided for gaging of streams and determining the Nation's water supply. Congressional appropriations have been made annually since 1894 for gaging streams and performing other functions relating to water resources. In 1964, the U.S. Geological Survey's mission was broadened to include the role of lead agency in the coordination of the activities of all Federal agencies in the acquisition of certain water data. This responsibility was assigned to the Department of the Interior by the Office of Management and Budget Circular A-67.

Organization of the Utah District

The Utah District consists of the District Office in Salt Lake City and Field Offices in Salt Lake City, Moab, and Cedar City. The locations of these offices and their areas of responsibility are shown in figure 1. The Utah District of the Water Resources Division is organized into three groups under the District Chief and management staff (fig. 2). Water-resources projects are done by the Hydrologic Investigations Section (primarily interpretive studies) and Hydrologic Surveillance Section (primarily collection of hydrologic data). Responsibility for each project is

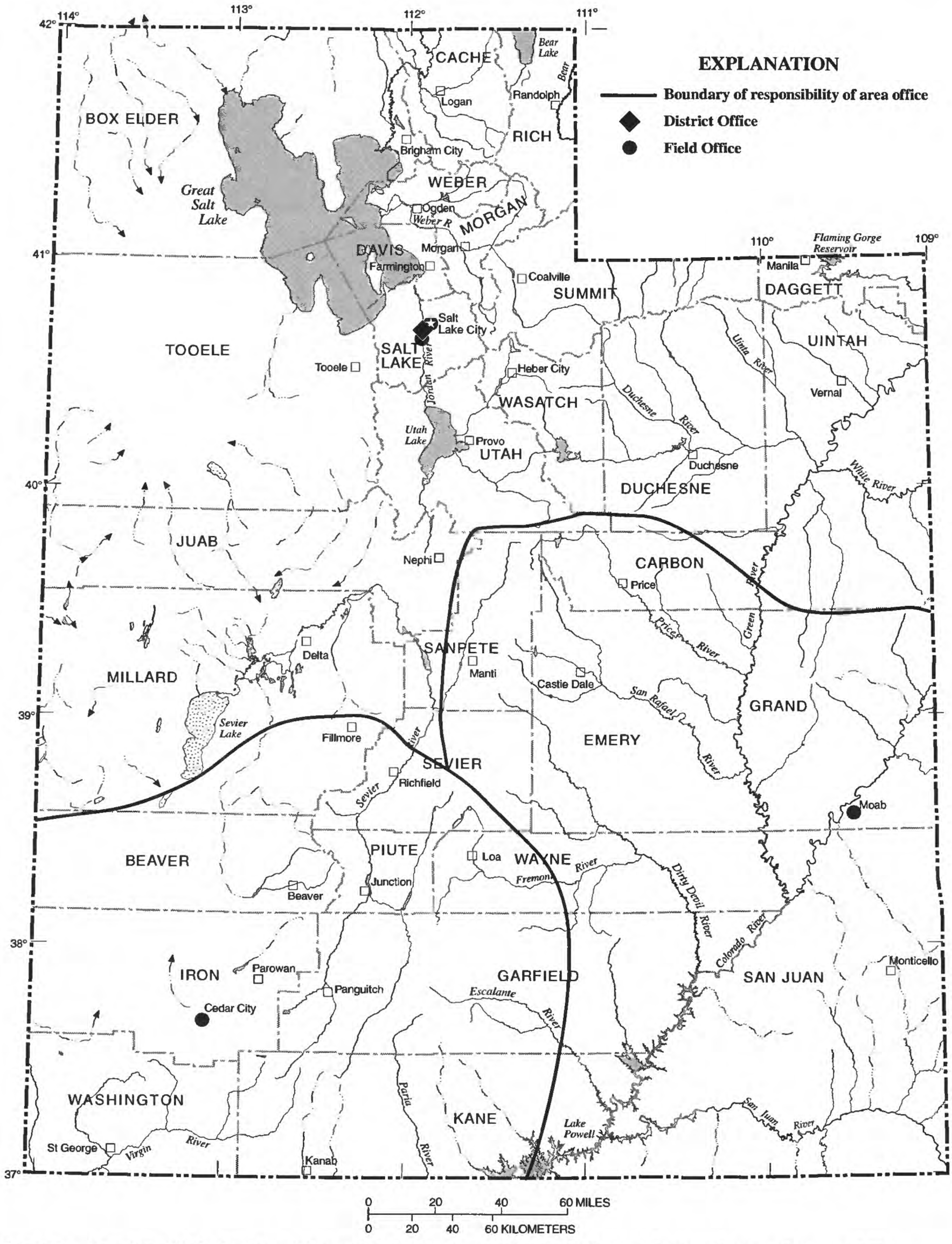


Figure 1. Location of U.S. Geological Survey, Water Resources Division, offices and general areas of responsibility.

District Chief and Management Staff

Support Units	Hydrologic Investigations	Hydrologic Surveillance
Salt Lake City District Office Administrative Section Publications Section Computer Section Data Base Unit Geographic Information Systems Unit	*Salt Lake City District Office* **Ground-Water Flow** Basin studies Recharge studies Fractured-rock studies Water-use studies Site-characterization studies Solute transport studies **Hydrochemical Processes** National Water Quality Assessment Ground-water quality mapping Great Salt Lake studies Contamination monitoring Salinity studies **Biological Processes** Great Salt Lake biota Selenium-irrigation drainage	*Salt Lake City Field Office* *Cedar City Field Office* *Moab Field Office* **Data-Collection Activities** Surface-water discharge data Ground-water levels Ground-water quality monitoring Stream gain-loss studies

Figure 2. Organization of the Utah District.

assigned to a project chief. Support for project work is supplied by District support groups: the Publications Section, the Computer Section, the Administrative Section, the Data Base Unit, and the Geographic Information Systems Unit.

Office Addresses of the Utah District

Inquiries regarding projects may be directed to the District Office or to the office in which the work originated.

District Office
and Salt Lake City
Field Office
(801) 975-3350

U.S. Geological Survey
Water Resources Division
Room 1016 Administration
Building
1745 West 1700 South
Salt Lake City, Utah 84104

Moab Field Office
(801) 259-5495

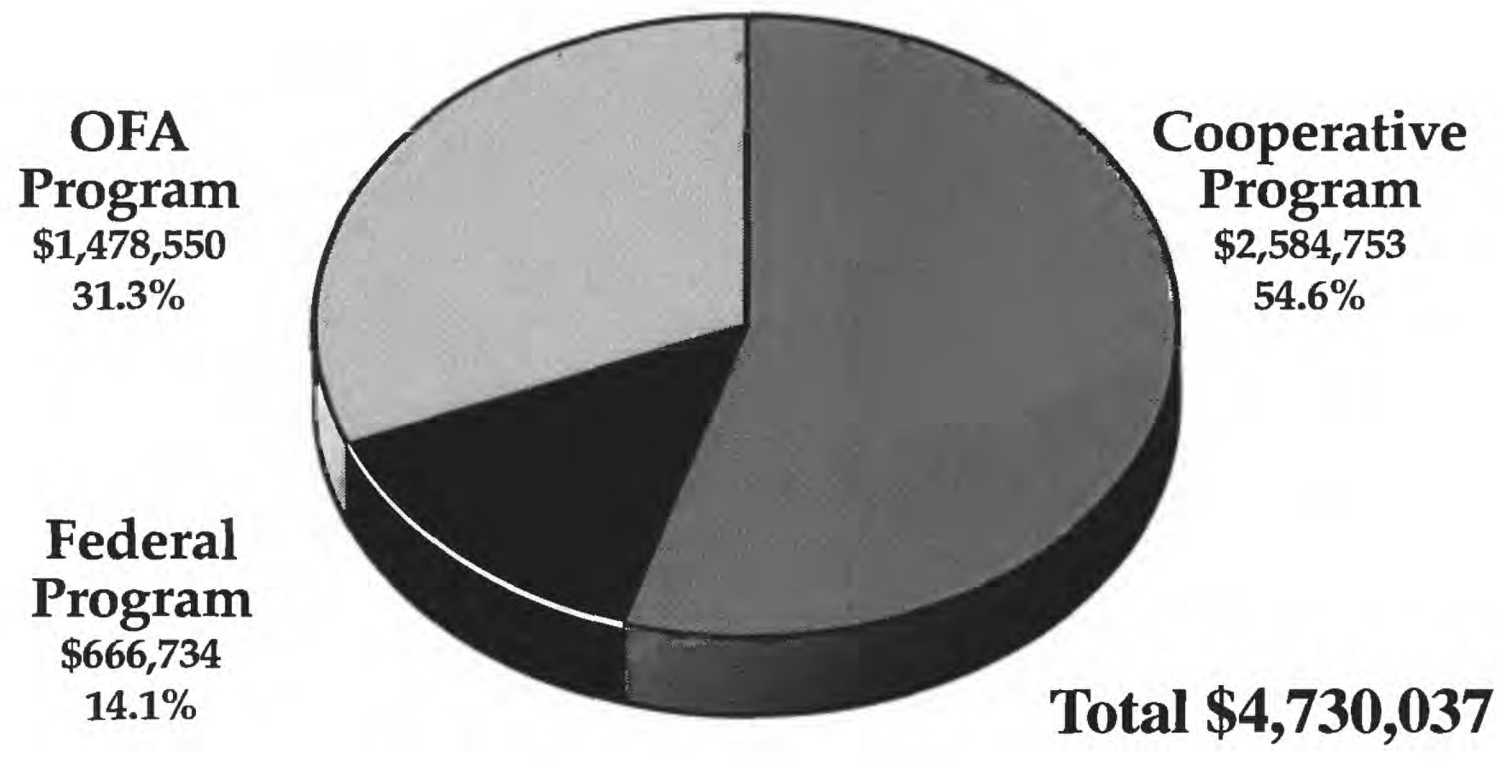
U.S. Geological Survey
Water Resources Division
121 West 200 South
P.O. Box 490
Moab, Utah 84532

Cedar City Field
Office
(801) 586-4543

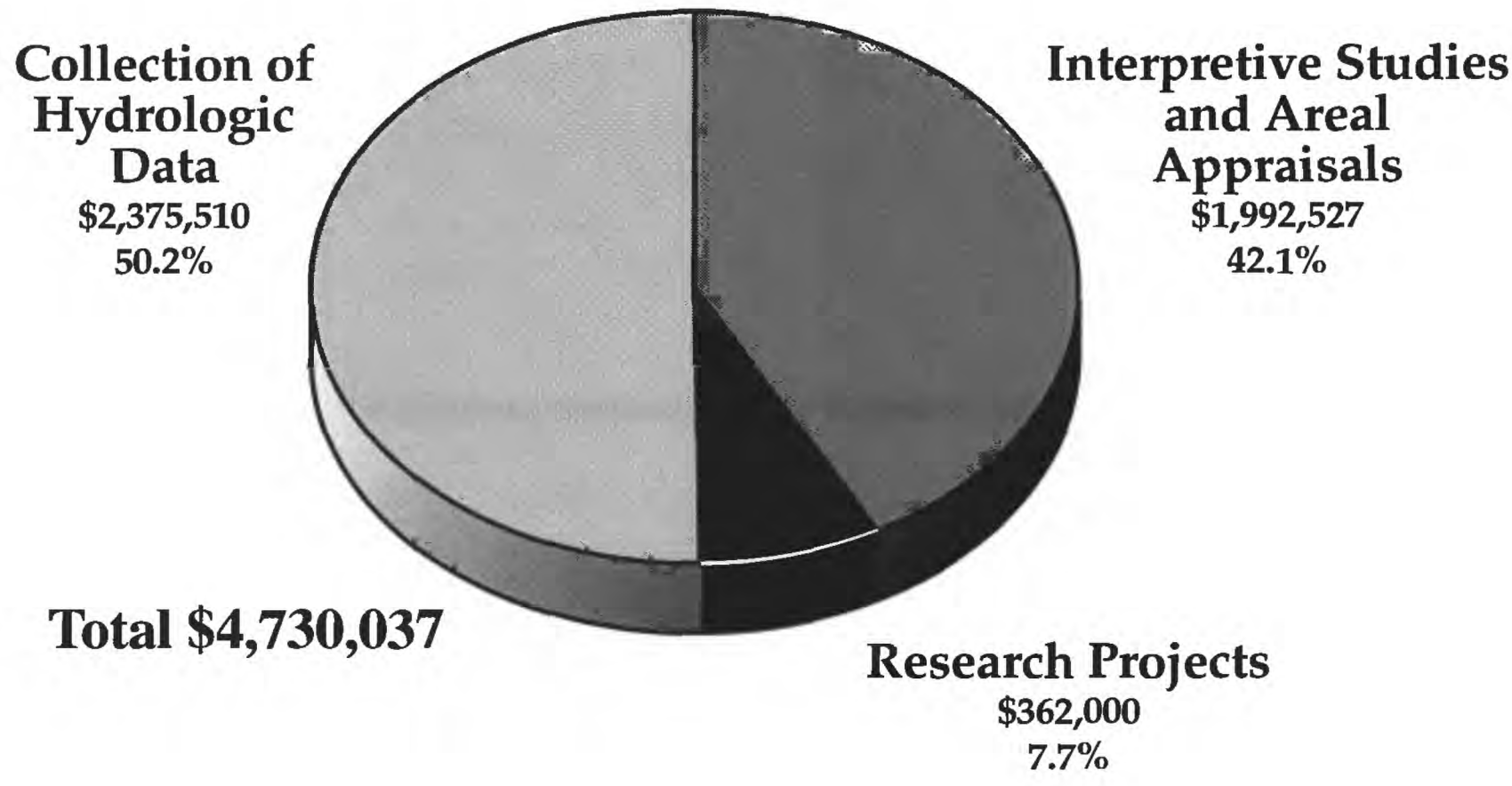
U.S. Geological Survey
Water Resources Division
2390 West Highway 56
Suite 8
Cedar City, Utah 84720

Program Funding and Cooperating Agencies

Funds to support water-resources work by the Utah District come from three sources. Cooperative-program funds and services are provided from State and local government agencies and generally are matched by Federal funds on a 50-50 basis. Funds transferred from other Federal agencies (OFA) are part of the OFA Program, and funds appropriated directly to the U.S. Geological Survey by Congress are part of the Federal Program. In FY 1995, total financial support from these programs for the Utah District was about $4.73 million. The amount of funding received from each of the three sources is:



In FY 1995, the Utah District pursued three broad categories of studies: (1) collection of hydrologic data, (2) interpretive studies and areal appraisals, and (3) research projects. About 50 percent of the program was for collection of hydrologic data, 42 percent was for interpretive studies and areal appraisals, and 8 percent was for research projects. These studies provide water managers and planners with information about the availability and quality of Utah's water resources. The distribution of funds among the three categories is:



From October 1, 1994, to September 30, 1995, the cooperating agencies for District projects were:

State Agencies

Arizona Department of Water Resources
Nevada Department of Conservation and Natural Resources
    Division of Water Resources
Utah Department of Environmental Quality
    Division of Water Quality
Utah Department of Natural Resources
    Division of Oil, Gas, and Mining
    Division of Water Resources
    Division of Water Rights
    Geological Survey
Utah Department of Wildlife Resources

Local Agencies

Bear River Commission
Central Utah Water Conservancy District
City of Grantsville
City of Moab
City of Tooele
East Juab County Water Conservancy District

Grand County
Navajo Environmental Protection Administration
Navajo Nation Department of Water Resources Management
Ogden River Water Users Association
Salt Lake County Division of Flood Control and Water Quality
Tooele County
Utah State University
Washington County Water Conservancy District
Weber Basin Water Conservancy District
Weber River Water Users Association

Federal Agencies

Bureau of Land Management
Bureau of Reclamation
National Park Service
U.S. Air Force
U.S. Bureau of Indian Affairs
U.S. Army
U.S. Department of Labor
U.S. Department of the Interior
    National Irrigation Water Quality Program
U.S. Environmental Protection Agency
U.S. Fish and Wildlife Service

Reports Released or Published

The following reports were released or published during October 1, 1994, to September 30, 1995:

Allen, D.V., Garrett, R.B., and others, Ground-water conditions in Utah, spring of 1995: Utah Department of Natural Resources Cooperative Investigations Report No. 35, 89 p.

Anderson, P.B., Susong, D.D., Wold, S.R., Heilweil, V.M., and Baskin, R.L., Hydrology of recharge areas and water quality of the principal aquifers along the Wasatch Front and adjacent areas, Utah: U.S. Geological Survey Water-Resources Investigations Report 93-4221, 80 p.

Avery, Charles, Ground-water hydrology of Ogden Valley and surrounding area, eastern Weber County, Utah, and simulation of ground-water flow in the valley-fill aquifer system: Utah Department of Natural Resources Technical Publication No. 99, 84 p.

Carlson, D.D., and Meyer, D.F., Flood on the Virgin River, January 1989, in Utah, Arizona, and Nevada: U.S. Geological Survey Water-Resources Investigations Report 94-4159, 21 p.

Hardy, E.E., and Dragos, S.L., Water-resources activities in Utah by the U.S. Geological Survey, October 1, 1992, to September 30, 1993: U.S. Geological Survey Open-File Report 95-138, 60 p.

Herbert, L.R., Seepage study of the Virgin River from Ash Creek to Harrisburg Dome, Washington County, Utah: Utah Department of Natural Resources Technical Publication No. 106, 8 p.

Lambert, P.M., Mason, J.L., and Puchta, R.W., Hydrology of the Sevier-Sigurd ground-water basin and other ground-water basins, central Sevier Valley, Utah: Utah Department of Natural Resources Technical Publication No. 103, 181 p.

Mason, J.L., Brothers, W.C., Gerner, L.J., and Muir, P.S., Selected hydrologic data for the Bonneville Salt Flats and Pilot Valley, western Utah, 1991-93, U.S. Geological Survey Open-File Report 95-104, 60 p.

Naftz, D.L., Spangler, L.E., and Peterman, Z.E., Using geochemical data to identify sources of salinity to the freshwater Navajo aquifer in southeastern Utah: U.S. Geological Survey Fact Sheet FS-095-95.

ReMillard, M.D., and others, Water resources data for Utah, water year 1994: U.S. Geological Survey Water-Data Report UT-94-1.

Sandberg, G.W., and Smith, C.J., Seepage study of the Sevier River basin above Sevier Bridge Reservoir, Utah, 1988: Utah Department of Natural Resources Technical Publication No. 112, 53 p.

Slaughter, C.B., Freethey, G.W., and Spangler, L.E., Hydrology of the North Fork of the Right Fork of Miller Creek, Carbon County, Utah, before, during, and after underground coal mining: U.S. Geological Survey Water-Resources Investigations Report 95-4025, 56 p.

Steiger, J.I., Selected hydrologic data for Juab Valley, Utah, 1935-94: U.S. Geological Survey Open-File Report 95-101, 91 p.

Susong, D.D., Water budget and simulation of one-dimensional unsaturated flow for a flood- and a sprinkler-irrigated field near Milford, Utah: U.S. Geological Survey Water-Resources Investigations Report 95-4072 and Utah Department of Natural Resources Technical Publication No. 109, 32 p.

Thiros, S.A., Chemical composition of ground water, hydrologic properties of basin-fill material, and ground-water movement in Salt Lake Valley, Utah: Utah Department of Natural Resources Technical Publication No. 110-A, 59 p.

Wilberg, D.E., Origin of water that discharges from Calf Creek Springs, Garfield County, Utah: U.S. Geological Survey Open-File Report 95-340, 10 p.

Reports prepared by or in cooperation with the Utah District can be obtained or inspected at the following locations:

Utah District Office **Room 1016 Administration Building** **1745 West 1700 South** **Salt Lake City, Utah 84104** **(801)975-3350**	U.S. Geological Survey Open-File Reports, Water-Resources Investigations Reports, Hydrologic-Data Reports, and Water-Data Reports; Utah Department of Natural Resources Technical Publications, and Cooperative Investigations Reports.
U.S. Geological Survey **Earth Science Information Center** **2222 West 2300 South, 2nd Floor** **Salt Lake City, Utah 84119** **(801)975-3742**	U.S. Geological Survey Water-Supply Papers, Professional Papers, Circulars, and Hydrologic Investigations Atlases.
Utah Department of Natural Resources **1594 West North Temple** **Salt Lake City, Utah 84116** **(801)538-7240**	Utah Department of Natural Resources Technical Publications and Cooperative Investigations Reports; and U.S. Geological Survey Water Circulars, Hydrologic-Data Reports, and Water-Use Reports.

CURRENT PROJECTS BY NUMBER AND TITLE

Collection of Hydrologic Data

Surface-Water Data

Number: UT-00-001

Cooperating Agencies: Bureau of Reclamation; National Park Service; Utah Division of Water Rights; Utah Division of Water Resources; Central Utah Water Conservancy District; Bear River Commission; Weber Basin Water Conservancy District; Salt Lake County Division of Flood Control and Water Quality; Weber River Water Users Association; Ogden River Water Users Association; and other local water agencies

Staff: L.R. Herbert, Hydrologic Technician, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Information on surface water is needed for management of the resource and for warning of related hazards. This information is used by water managers and planners in water supply, hydroelectric power generation, irrigation, flood control, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. To provide this information, an appropriate data base on discharge of streams and contents and stages of reservoirs and lakes is necessary.

Objectives: To obtain data on stream discharge and reservoir and lake contents and stages at selected sites throughout Utah.

Approach: Standard methods for the operation and maintenance of streamflow-gaging stations and for the computation, computer storage, and publication of the data are used.

Progress: Data collection and computation necessary for the publication of discharge records for 161 streamflow-gaging stations and contents and stage records for 10 reservoir- and 3 lake-stage stations continued during the year. In addition, streamflow data were collected at seven partial-record sites. The locations of the stations and station numbers are shown in figure 3. Data collected at these stations, as well as larger-scale maps showing station locations, are presented in the series of reports entitled "Water resources data for Utah," U.S. Geological Survey Water-Data Reports. The stations are classified as follows:

	Number of stations
Discharge	
Current use	129
Hydrologic data for planning and design	31
Benchmark for long-term trends	1
Contents of lakes and reservoirs	11
Stage of Great Salt Lake	2

Nine streamflow-gaging stations and five reservoir sites were discontinued as of September 30, 1995. These were:

09234400	Flaming Gorge Reservoir at Flaming Gorge Dam
09408500	Santa Clara-Pinto diversion near Pinto
10102250	Bear River at Smithfield
10139300	Wheeler Creek near Huntsville
10172870	Trout Creek near Callao
10180000	Sevier River near Circleville
10183900	East Fork Sevier River near Rubys Inn
10188000	Otter Creek Reservoir near Antimony
10191000	Piute Reservoir near Marysville

10194000	Sevier River above Clear Creek near Sevier
10206000	Salina Creek at Salina
10218500	Sevier Bridge Reservoir near Juab
10219200	Chicken Creek near Levan
10238500	Minersville Reservoir near Minersville

Plans for Next Year: Continue operation of network. Prepare 1996 water-year records for publication.

Report:

ReMillard, M.R., and others, 1995, Water resources data for Utah, water year 1994: U.S. Geological Survey Water–Data Report UT-94-1.

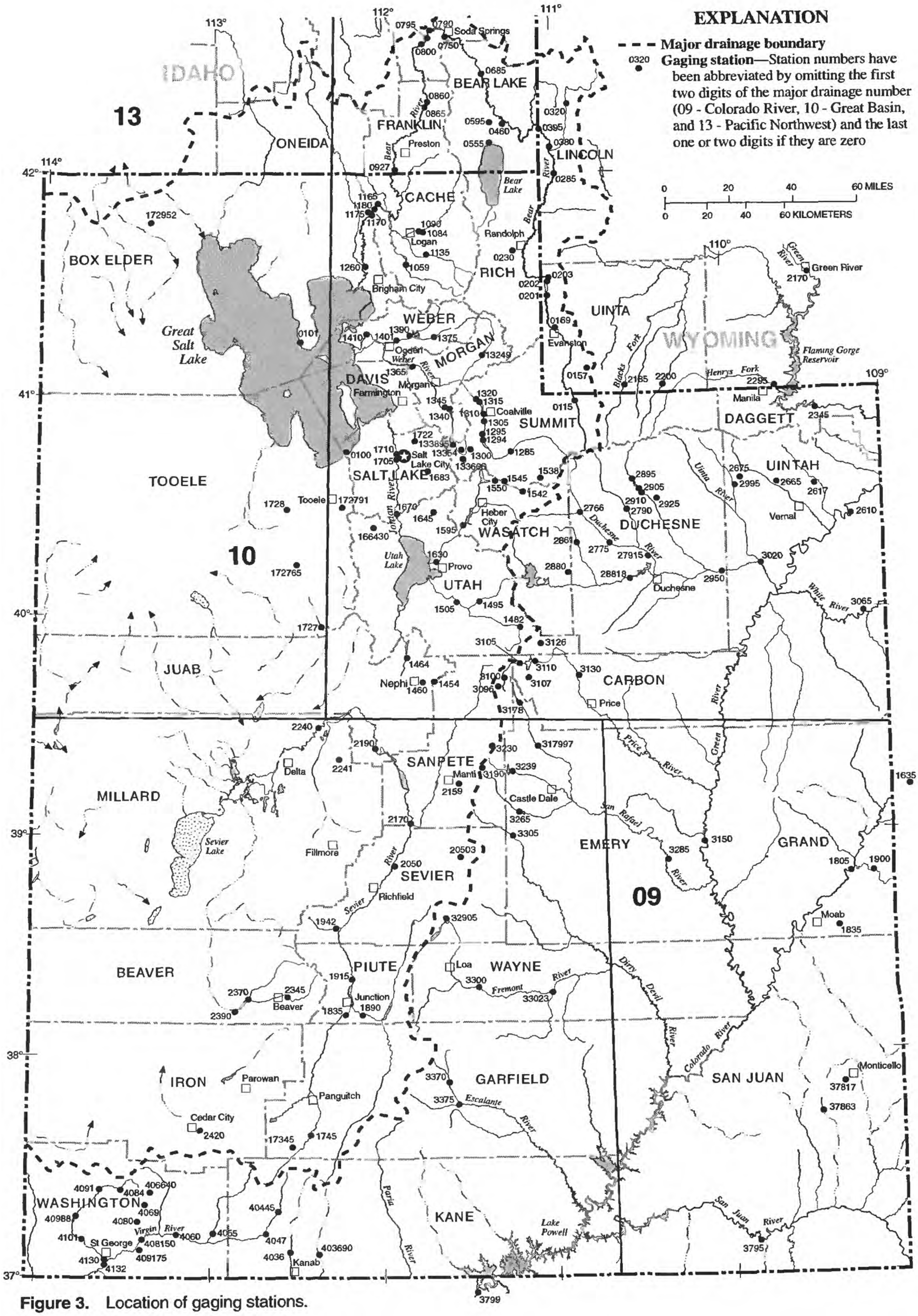


Figure 3. Location of gaging stations.

Ground-Water Data and Ground-Water Conditions in Utah

Number: UT-00-002

Cooperating Agencies: Utah Division of Water Rights; Utah Division of Water Resources; Central Utah Water Conservancy District

Staff: L.R. Herbert, Hydrologic Technician, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Long-term records of water levels and ground-water withdrawals are needed to evaluate the effects of climatic variations, to determine the effects of withdrawals from aquifers on water levels, to assist in the prediction of future conditions of aquifers, and to provide data for management of ground-water resources.

Objectives: (1) To obtain long-term records of ground-water levels for determination of water-level changes for yearly or other periods, (2) to determine withdrawals from aquifers in the State, and (3) to make an annual evaluation of ground-water conditions in Utah and publish the information in a report.

Approach: Measure water levels annually (normally during February and March) and operate continuous water-level recorders on selected observation wells (fig. 4). Measure discharge or obtain amounts of discharge from irrigation wells in 17 selected valleys; determine the ratio of water produced to energy consumed, and use the ratio along with energy-consumption data to help compute total annual withdrawal from irrigation wells. Measure discharge from selected flowing wells. Obtain estimates of ground water withdrawn from wells for public supply and industrial use from the Utah Division of Water Rights. Obtain additional estimates of ground water withdrawn from wells for industrial or public-supply use by interviewing users. Determine the number and diameter of new wells drilled annually from well drillers' reports filed with the Utah Division of Water Rights. Prepare an annual report on ground-water conditions in Utah that includes data, graphs, and maps showing water-level changes; withdrawals from wells; number of wells drilled in defined ground-water basins or areas; changes in ground-water quality; and a discussion of ground-water conditions in each basin or area with substantial withdrawals. Store water-level data in computer files and publish selected data in the annual USGS report, "Water resources data for Utah."

Progress: Water levels were measured in about 1,000 wells in February and March. In addition, water levels in 25 of these wells were measured monthly, and continuous water-level recorders were maintained on 27 of these wells. During the irrigation season, about 500 discharging irrigation wells were observed; discharge was measured at about one-half of the wells, and the ratio of water production to energy consumption was determined. Natural flow was measured at about 30 flowing wells during the irrigation season. Number and diameter of wells drilled during the past year were compiled. The thirty-second in the series of annual reports on ground-water conditions in Utah was completed. The continuous water-level records were published in the annual "Water Resources Data—Utah Water Year 1994" report.

Plans for Next Year: Continue collecting, recording, and publishing data on water levels, ground-water withdrawals, and wells drilled. The thirty-third in the series of annual ground-water reports will be compiled.

Reports:

Allen, D.V., Garrett, R.B., and others, 1995, Ground-water conditions in Utah, spring of 1995: Utah Division of Water Resources Cooperative Investigations Report 35.

ReMillard, M.D., and others, 1995, Water resources data for Utah, water year 1994: U.S. Geological Survey Water–Data Report UT-94-1.

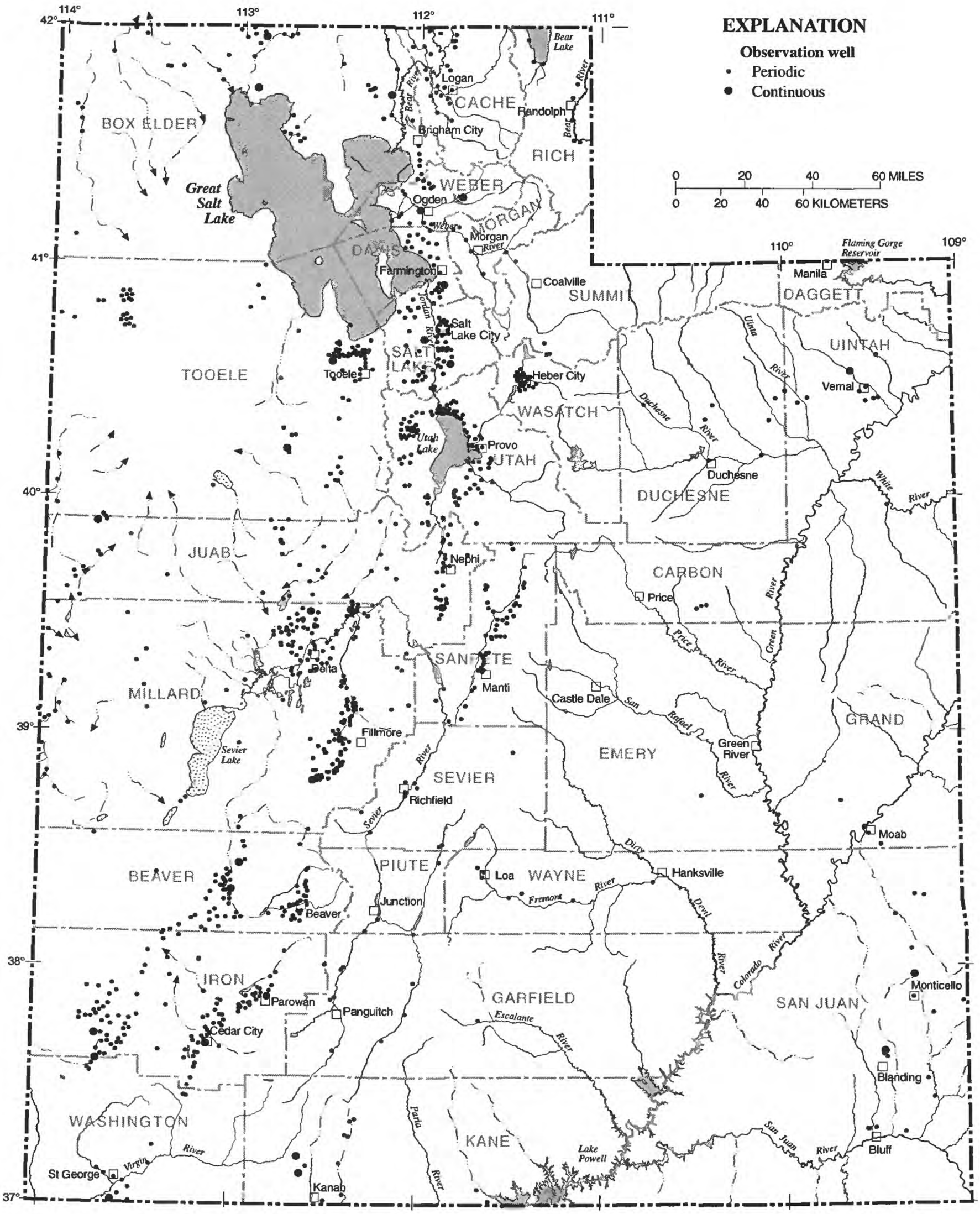


Figure 4. Location of observation wells in which water levels were measured.

Water-Quality, Fluvial-Sediment, and Precipitation Data

Numbers: UT–00–003; UT–00–004; UT-00-005

Cooperating Agencies: Utah Division of Water Resources; Utah Division of Water Rights; Utah Division of Oil, Gas, and Mining; Bureau of Reclamation

Staff: L.R. Herbert, Hydrologic Technician, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Data on the quality of surface and ground water and the amounts of sediment loads in selected rivers are needed for the management of water resources. Water-quality problems can affect industries, water-treatment facilities, irrigators, and individuals. Sediment reduces storage in reservoirs, contaminates water supplies, and harms fisheries. Sediment and precipitation data are needed for erosion studies, reservoir design, water-resources management, and evaluation of water quality. Data bases are needed to store and provide the appropriate water-quality, sediment, and precipitation information.

Objectives: To obtain records of quality of water from streams and wells, sediment, and precipitation at selected sites throughout Utah.

Approach: Use standard methods for the collection and analysis of precipitation data; chemical-quality, fluvial-sediment, and biological samples; and computer storage and publication of data.

Progress: Water samples for chemical analysis were obtained periodically at 12 stream sites (fig. 5) using the USGS parts per billion inorganic sampling protocol. In addition, continuous or daily temperature and/or specific-conductance data were obtained at eight of these stream sites. About 200 wells are in the ground-water-quality monitoring program (fig. 6), and complete chemical analysis was obtained for water from about 70 wells. Water from 10 additional wells was sampled in an area of oil-field brine injection in the Uinta Basin. All water-quality data for streams and wells are listed in the annual water-resources data reports. Sediment data were obtained continuously at two sites and periodically at an additional four sites.

Plans for Next Year: Continue collecting water-quality data from selected surface-water sites with the inorganic sampling protocol. Continue processing data and preparing records for publication. Continue collecting water-quality data from the State ground-water network and from selected wells in the brine-injection area of the Uinta Basin. Continue collecting and processing sediment data and preparing records for publication. Continue collecting precipitation data.

Report:

ReMillard, M.D., and others, 1995, Water resources data for Utah, water year 1994: U.S. Geological Survey Water-Data Report UT–94–1.

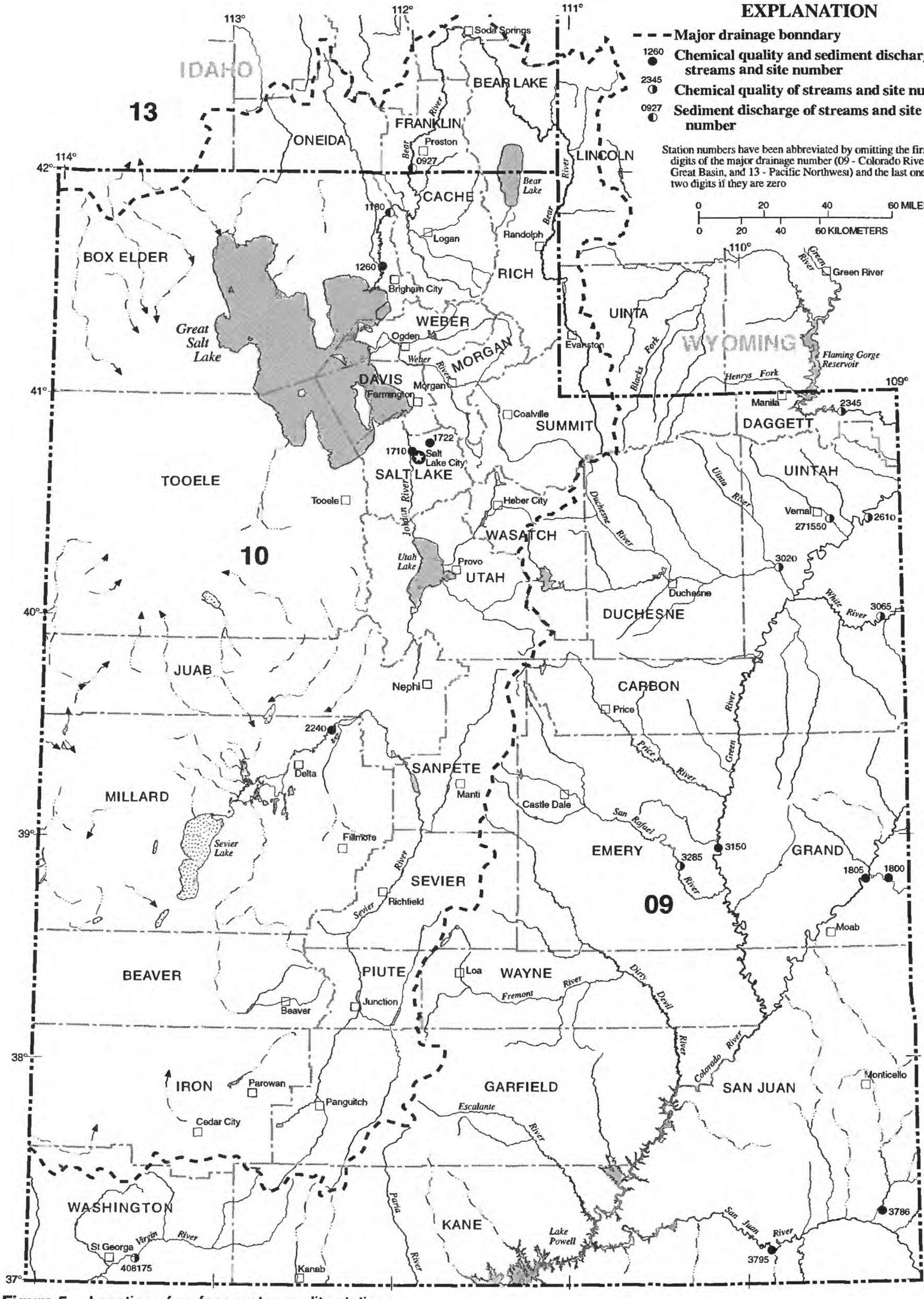


Figure 5. Location of surface-water-quality stations.

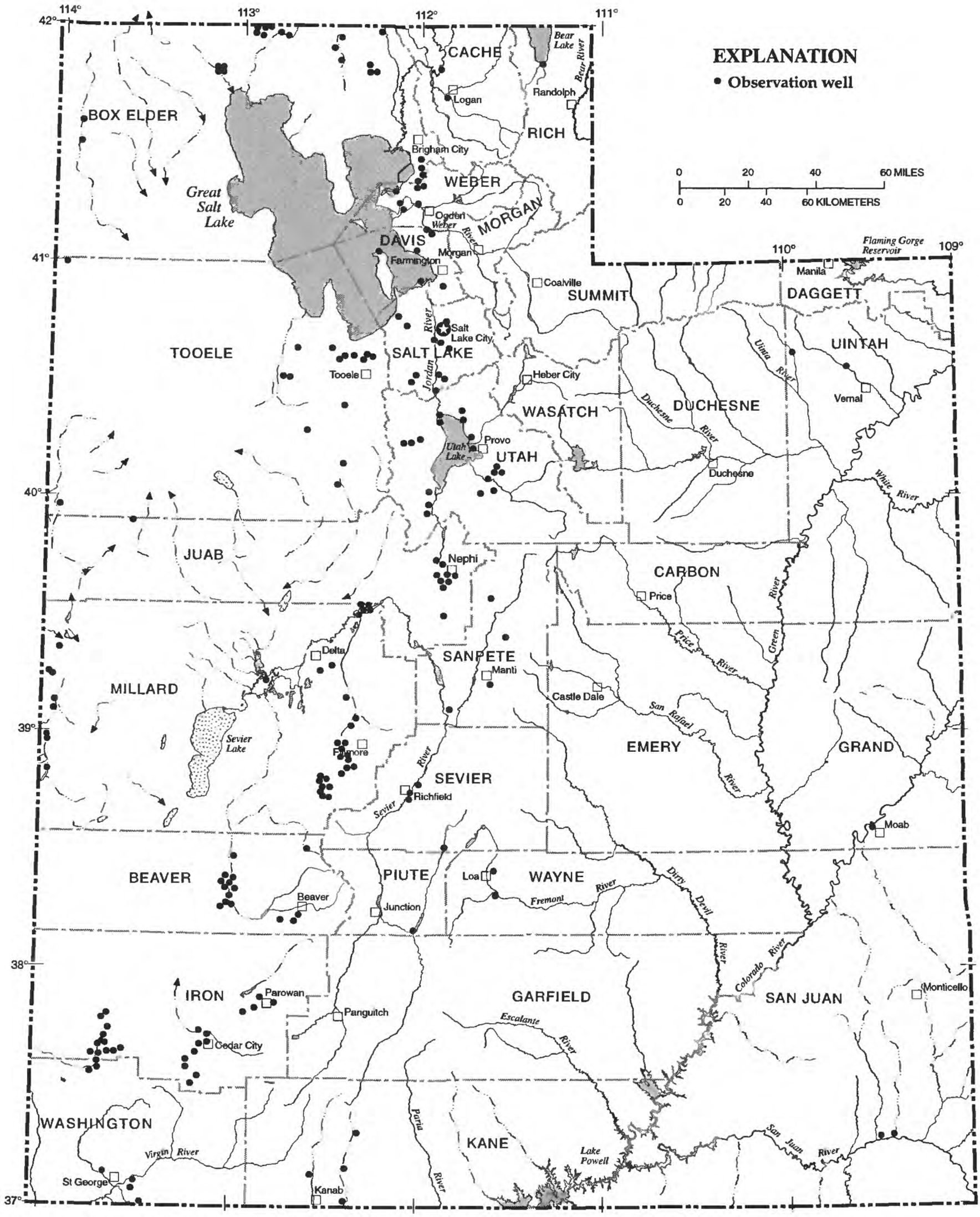


Figure 6. Location of observation wells from which water samples were collected for monitoring water quality.

Interpretive Studies

Locations of interpretive studies discussed in this section are shown in figure 7.

Statewide Water Use

Number: UT–00–007

Cooperating Agencies: Utah Division of Water Rights; Utah Division of Water Resources

Staff: H.K. Hadley, Hydrologist, Project Chief (part time)

Period of Project: Began July 1977, continuing

Problem: In 1977, the U.S. Congress recognized the need for consistent, current, and reliable information on water use for the entire United States and directed the U.S. Geological Survey to set up a program to collect, compile, and publish such data. These data are needed to document trends in total water use and in the different categories of use, and to aid in the management of the Nation's water resources.

Objective: To obtain information about withdrawals and return flows of water for different uses, and consumptive use of water in connection with each type of withdrawal.

Approach: Determine total water diversions and consumptive use by verification of user measurements and records and, where possible, by field inventory and measurement of surface-water diversions and selected types of ground-water diversions. Use acreage and crop surveys to aid in estimating consumptive use by irrigation. State personnel are collecting data on public-supply and industrial use; U.S. Geological Survey personnel are collecting data on irrigation use.

Progress: Mail surveys were done by the Utah Division of Water Rights to determine water use by about 390 public-water suppliers and about 120 major self-supplied and public-supply industries. Wastewater discharge measurements were made at six locations (commercial and domestic) for the St. George municipal consumptive-use study during the year. Three problems were encountered: (1) At two locations, outflows were larger than deliveries. (2) No velocity readings were recorded at several locations at different times because low discharge caused the velocity sensor on the flowmeter to remain above water. (3) Dams installed to increase water depth caused back eddies and resulted in negative velocity readings. Volumetric measurements could not be made because of the configuration of the sewer holes, and slope/area calculations did not produce reasonable discharge estimates. Reasonable depth data and velocity readings are being used to construct rating curves to estimate weekly discharge. The Great Salt Lake Basins study unit of the National Water Quality Assessment was a pilot area for a public-supplier survey to determine what type of water-quality testing is done on public-supply water sources and what data is submitted to the State.

Plans For Next Year: Water-use data will be collected and compiled for the Utah section of the "1995 Estimated Use of Water in the United States" report. The major water-use categories include public supply, domestic, commercial, industrial, mining, fossil fuel, and hydroelectric power, livestock, animal specialities, irrigation, wastewater, and reservoir evaporation.

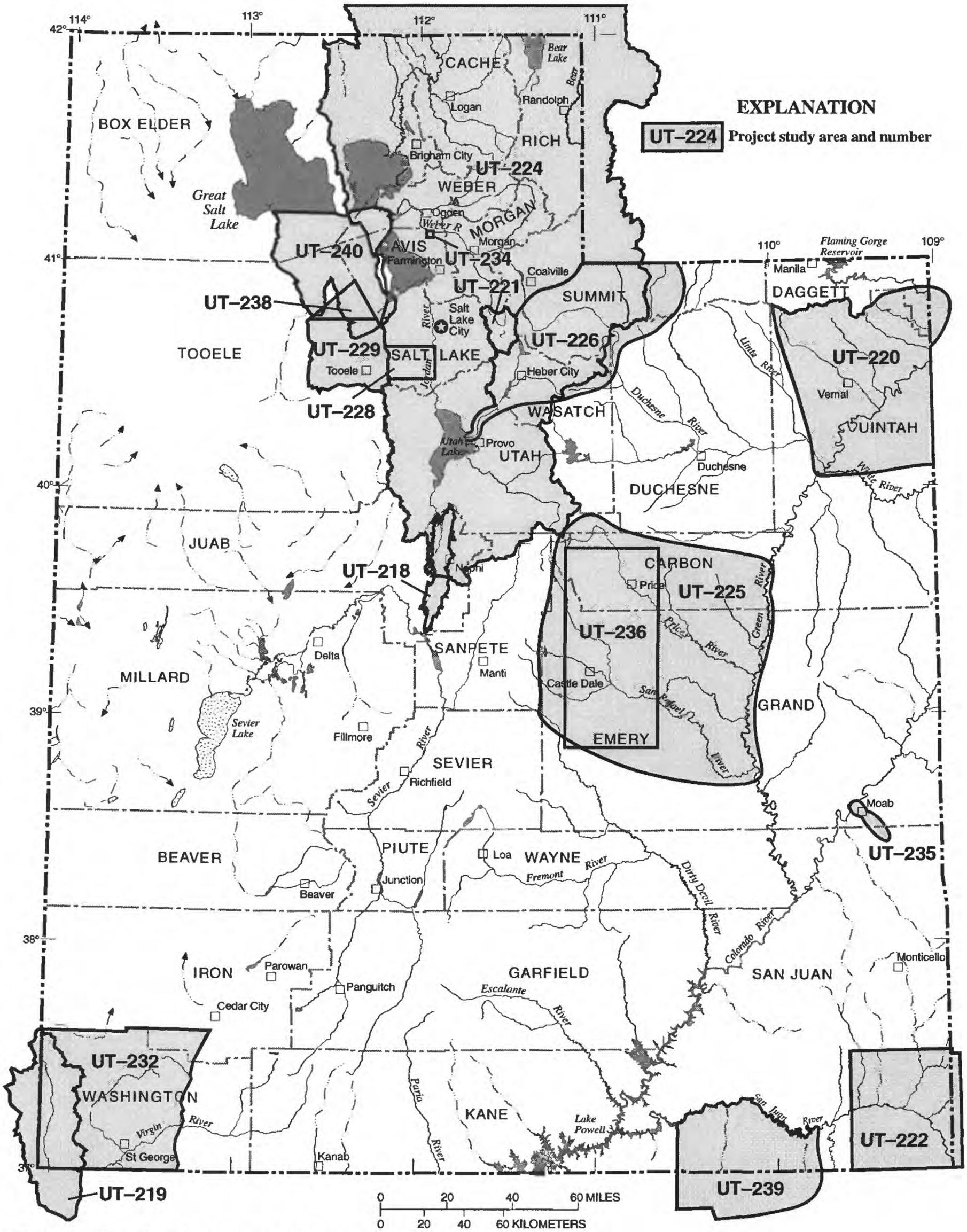


Figure 7. Location of interpretive studies.

Ground Water in Juab Valley, Juab County, Utah

Number: UT-92-218

Cooperating Agencies: Central Utah Water Conservancy District; East Juab County Water Conservancy District

Staff: S.A. Thiros, Project Chief (full time)
J.I. Steiger, Hydrologist (part time)
H.K. Hadley, Hydrologist (part time)
B.J. Stolp, Hydrologist (part time)

Period of Project: January 1992 to September 1995

Problem: Water will be imported into Juab Valley, mostly for irrigation, as part of the Central Utah Project. The Central Utah Water Conservancy District wants to optimize the size of the pipeline delivering water to Juab Valley and needs to know how much of local peak demand can be met by ground water. The East Juab County Water Conservancy District wants to optimize use of water in the valley, including local surface water, local ground water, and imported water, and needs information on ground water and the effects of its development to integrate ground-water use and development into the overall water-management plan for Juab Valley.

Objectives: (1) To assess current ground-water conditions and document changes since previous studies during 1962-66; (2) to define and quantify the ground-water system of the valley—hydrologic properties, estimated recharge, movement, estimated discharge, and water quality; (3) to evaluate current and potential sources of ground-water salinity in the southern end of the valley; and (4) to provide a tool to understand the valley's ground-water system and to estimate the effects of changes in ground-water withdrawals or recharge on water levels, natural discharge, and water quality.

Approach: (1) Compile all available data and inventory significant new wells and selected springs; (2) measure water levels in wells and prepare a potentiometric-surface map; (3) use drillers' logs to improve definition of basin-fill deposits; (4) conduct aquifer tests to improve definition of hydrologic properties; (5) estimate and measure the components of recharge and discharge; (6) analyze water samples to better define water-quality problems; and (7) construct and calibrate a three-dimensional model of ground-water flow.

Progress: Data collected during this study were published as U.S. Geological Survey Open-File Report No. 95-101. The numerical model of the ground-water flow system was completed and the interpretive report for the study is in review.

Plans for Next Year: Publish the interpretive report in the Utah Department of Natural Resources Technical Publications series.

Report:

Steiger, J.I., 1995, Selected hydrologic data for Juab Valley, Utah, 1935-94: U.S. Geological Survey Open-File Report No. 95-101.

Hydrologic Reconnaissance of the Beaver Dam Wash Area of the Virgin River Basin, Washington County, Utah, Mohave County, Arizona, and Lincoln County, Nevada

Number: UT-92-219

Cooperating Agencies: Utah Division of Water Resources; Nevada Department of Conservation and Natural Resources, Division of Water Resources; Arizona Department of Water Resources; and Bureau of Land Management

Staff: G.E. Pyper, Hydrologist, Project Chief (retired volunteer)
W.F. Holmes, Supervisory Hydrologist (part time)
M. Enright, Lead Hydrologic Technician (part time)

Period of Project: December 1992 to September 1995

Problem: The area of southwestern Utah, southeastern Nevada, and the northwestern corner of Arizona is one of the fastest-growing areas in the Western United States. The three States would like to know the extent of water resources in the Beaver Dam Wash drainage basin, an undeveloped basin that includes parts of all three States and in which little is known about surface- and ground-water resources. The States also would like to know the potential effects of developing water in the riparian areas of the basin.

Objectives: (1) Improve understanding of surface water and surface-water quality, including estimating average annual flow at selected locations and mapping perennial reaches; (2) improve understanding of ground water by defining aquifers; estimating recharge, discharge, direction of movement, aquifer properties, and storage; and defining water quality; (3) define the relation between surface and ground water; and (4) estimate a water budget for Beaver Dam Wash and determine annual surface- and ground-water flow from Beaver Dam Wash to the Virgin River.

Approach: (1) Compile available surface-water data, correlate data from streamflow-gaging stations in Beaver Dam Wash to estimate long-term flow, install a stream gage at the mouth of the wash, install a crest-stage gage at Lytle Ranch, use channel geometry to estimate average flow at selected locations on major tributaries, map perennial reaches of streams from the air, and sample surface water for chemical analysis; (2) compile available ground-water data; inventory and sample wells and springs; construct potentiometric-surface maps; conduct geophysical surveys to define basin-fill thickness and character; drill, log, and sample test holes at one or more sites and conduct simple aquifer tests; conduct an aquifer test in the lower part of the basin where producing wells exist; use collected data to estimate quantity of ground water in storage; and conduct a reconnaissance survey of the outcrops of Navajo Sandstone in the upper part of the wash to estimate ground-water conditions; (3) conduct seepage runs, at low flows, of major perennial reaches; and use available aerial reconnaissance, seepage, and ground-water data to classify reaches as seasonally or perennially gaining or losing; and (4) estimate surface-water outflow to the Virgin River; estimate ground-water outflow to the Virgin River valley; and estimate a water budget for Beaver Dam Wash.

Progress: An interpretive report and a basic-data report have been partially completed.

Plans for Next Year: Complete writing reports. Submit reports to cooperators for comment; address comments, and submit reports for approval.

Data Synthesis of Results of Investigations Conducted Under the Department of the Interior National Irrigation Water Quality Program

Project Number: UT-93-220

Cooperating Agency: U.S. Department of the Interior, National Irrigation Water Quality Program

Staff: D.L. Naftz, Project Chief

Period of Project: October 1992 through September 1996

Problem: Extensive geochemical and hydrologic data from 26 sites in the Western United States, including Utah, have been collected during geochemical studies conducted under the U.S. Department of the Interior National Irrigation Water Quality Program. The multivariate data set provides an opportunity to identify the geochemical and hydrologic characteristics of landscapes in which trace elements have been identified in irrigation runoff. Because of the large geographic coverage of this data base, these characteristics can be used to determine where irrigation-induced water-quality problems may occur in other parts of the United States and in other countries.

Objectives: The overall objective is to identify geochemical commonalities and differences that affect water quality in irrigated areas in the Western United States. Specific objectives of the project are to (1) use the constructed data base to identify how the hydrologic and geologic setting and geochemical, biological, and human-induced processes affect the magnitude, seasonality, and extent of trace-element contamination problems; (2) develop the capability to determine where irrigation drainage water-quality problems might occur so that problem areas can be identified; and (3) identify weaknesses in the data and offer suggestions to future investigators to improve data collection.

Approach: Normative salt assemblages, ionic ratios, and stable isotopes will be studied separately and together to evaluate commonalities and differences in trace-element source areas and geochemical weathering cycles among the 26 study sites. Although marine shales are common trace-element sources, little is known about trace-element source minerals or weathering processes that mobilize the trace elements. The geochemical computer program SNORM will be used to calculate salt norms from the chemical analyses of water samples. The results from the SNORM calculations will be coupled with pattern-recognition modeling techniques to identify important trace-element weathering reactions. Results of the pattern-recognition modeling will be used to construct a geochemically based classification model using soft independent modeling by class analogy algorithms. This classification model will then be used to evaluate the potential for trace-element production in other areas where corresponding trace-element water-quality data are not available.

Progress: Approval was obtained for publication of the pattern-recognition modeling results in the Journal of Chemometrics. The paper is being reviewed by journal referees. An abstract on research results was prepared and presented at the American Water Resources Association Summer Symposium in June 1995. Oral presentations on study results were prepared and presented to the National Academy of Sciences Oversight Committee and U.S. Geological Survey Senior Staff. An abstract on study results was approved and submitted to the American Institute of Hydrology for presentation at their September 1996 meeting. An annotated outline and preliminary interpretation of the geochemical processes controlling the concentration of uranium in irrigation drainwater were completed.

Plans for Next Year: Publish the pattern-recognition modeling paper. Obtain approval for and publish a U.S. Geological Survey Fact Sheet and a report describing the geochemical processes that control uranium in irrigation drainwater.

Water Resources of Snyderville Basin, Park City, and Surrounding Communities, Summit County, Utah

Number: UT-93-221

Cooperating Agency: Utah Division of Water Rights

Staff: L.E. Brooks, Hydrologist (part time)
Paul Downhour, Hydrologic Technician (part time)

Period of Project: July 1993 to September 1997

Problem: For this study, the Snyderville Basin and Park City area is defined as the southwestern corner of Summit County, including the valley generally south of and straddling Interstate 80 through which East Canyon Creek flows (Snyderville Basin); the area around Park City, including Prospector Square and Deer Valley; and the area from Richardson Flat to Tollgate Canyon. Population in this area has substantially increased from 1980 through 1993, and much of this increase has occurred since 1987.

Increasing demands on the ground- and surface-water resources in the area are caused by housing, industrial, and commercial development in the area, and plans by ski areas to increase snow-making operations. One of the major constraints on development of additional residential areas and commercial activities is water supply. Surface water in the area is part of the Weber River drainage basin and is considered to be fully appropriated. There are concerns about the effect of increased withdrawals of ground water on springs, surface-water flow, and water levels in existing wells.

The quality of water in the Park City area is suitable for domestic purposes but could deteriorate with industrial development or if centralized sewage treatment cannot accommodate the increase in housing developments. At least two public-water suppliers have indicated that sulfate concentrations are increasing. The cause of increased concentrations of certain dissolved constituents is not known but could be related to changes that have occurred in the hydrologic system as a result of development.

Objectives: The purpose of the study is to provide water-resources planners and managers with quantitative information on water resources in the Snyderville Basin and Park City area. Specific objectives of the study are to (1) define and describe the lateral and vertical extent of the principal aquifers in the area; (2) describe the hydrologic system, including hydrologic properties of the aquifer, surface-water discharge and variability, ground-water recharge, rate and direction of movement, discharge, and storage and water use; (3) improve estimates of existing water budgets of the area to give managers a more accurate tool to use for planning additional development; (4) define and describe the interaction of surface and ground water; (5) describe the chemical quality of the surface and ground water, and identify potential causes of increasing dissolved-solids concentrations; and (6) describe the hydrologic and hydrochemical effects that could be expected to occur as development creates a steadily increasing need for more water.

Approach: (1) Collect hydrologic and geologic data that can be used to define the geometry of the principal aquifers; (2) formulate a concept of the hydrologic system and recharge and discharge using aquifer tests, fracture analysis, precipitation records, water-level data, water-use data, spring and streamflow measurements, and water-quality data; (3) collect surface- and ground-water samples and analyze for potential causes of increasing dissolved-solids concentrations; (4) if possible, develop tools to examine the water-balance relations in the project area; (5) prepare a report describing the analysis of the data and results of the study; and (6) prepare a report documenting the data collected.

Progress: The collection of basic hydrologic data was completed. Water levels have been measured in 35 wells on a monthly basis and twice yearly in more than 50 wells. In October 1994, water temperature, specific conductance, and flow measurements were made at 50 springs and surface-water sites to define the relation between surface water and ground water in the study area. In the spring of 1995, water samples were collected from 32 sites for chemical analysis, of which 16 were analyzed for chlorofluorocarbons and 28 were analyzed for isotopes.

Plans for Next Year: Hydrologic data collected during the first 2 years of the study will be published. Data and interpretations contained in a report by the Utah Geological Survey that describes the geologic framework of the study area will be used to help define the flow paths through consolidated rock from sources of recharge to areas of discharge. Water level and chemical data will be used to substantiate probable flow paths. The study area will be divided on the basis of geologic framework and distribution of valley-fill deposits into five or six subareas for which water budgets will be estimated. A draft of the interpretive report will be completed.

Using Multivariate Statistics and Pattern-Recognition Techniques to Define Possible Migration Pathways of Saline Water into Fresh Ground Water, Aneth Area, Utah

Number: UT-93-222

Cooperating Agencies: Utah Division of Oil, Gas, and Mining; Bureau of Land Management; Bureau of Reclamation; U.S. Environmental Protection Agency; U.S. Bureau of Indian Affairs; Navajo Environmental Protection Administration; Navajo Nation Department of Water Resources Management

Staff: D.L. Naftz, Hydrologist, Project Chief
L.E. Spangler, Hydrologist (part time)

Period of Project: October 1991 to September 1995

Problem: Many wells that penetrate the Navajo aquifer in the area of the Greater Aneth Oil Field yield water that is slightly to very saline, which is uncharacteristic for this aquifer in southern and southeastern Utah. During the last 25 years, salinity levels have increased in several water wells completed in the Navajo aquifer. The most substantial increase has occurred near the town of Aneth. This increase in salinity may have resulted from the injection of oil-production water rather than upward migration of brines from underlying salts. Because neither the extent nor the severity of the problem is known, an understanding of the regional hydrology and geochemistry of the Navajo aquifer is necessary to better evaluate the source and extent of contamination and the remedial measures that may be required to minimize the problem.

Objectives: (1) To identify conservative and nonconservative inorganic, isotopic, and organic geochemical constituents that can be used to define the source(s) and path(s) of the saline water in the freshwater aquifers, and (2) to use the geochemical data in forward and inverse mixing models and in a geochemical pattern-recognition model to identify and quantify different saline source waters that may be increasing the dissolved-solids concentration in the Navajo aquifer.

Approach: The investigation will be completed in two distinct phases: (1) Collect and compile new and existing geologic, geochemical, and hydrologic information and define end-member waters from the data using bivariate techniques, and (2) identify saline sources and mixing ratios by using mixing models and multivariate statistical techniques.

Progress: A journal article indicating that the oil-field brines were not causing the observed salinity increases was published. A second report was published in February 1995 as a U.S. Geological Survey Fact Sheet titled "Using geochemical data to identify sources of salinity to the freshwater Navajo aquifer in southeastern Utah." Study results were presented at the May 1995 Colorado River Salinity Forum meeting in Jackson, Wyoming. Two abstracts that describe the study results were prepared and presented, one at the American Water Resources Association Spring Symposium and the second at the American Chemical Society Rocky Mountain Regional Meeting. An article interpreting the results of the strontium isotope data was prepared for the Journal of Chemical Geology and is currently in technical review. The final report, a U.S. Geological Survey Water-Resources Investigations Report, was completed and submitted for technical review in August 1995.

Plans for Next Year: Approve and publish the final report and the Journal of Chemical Geology paper.

National Water Quality Assessment (NAWQA) for Great Salt Lake River Basins, Utah, Idaho, and Wyoming

Number: UT-94-224

Cooperating Agency: None

Staff: K.M. Waddell, Supervisory Hydrologist, Project Chief
R.L. Baskin, Hydrologist

Period of Project: October 1993—Continuing

Problem: The status and trends of the Nation's water quality have not been evaluated on a consistent basis so that nationwide comparisons can be made.

Objectives: To describe the status and trends of water quality in a nationally consistent manner.

Approach: The Great Salt Lake River Basins study unit was initiated during Fiscal Year 1994 (October 1, 1993, to September 30, 1994) as one of 60 study units planned for the NAWQA. The quality of both ground and surface water will be studied by using a nationally consistent approach for design of data collection and methodology for collection and analysis of water samples.

Progress: The Great Salt Lake River Basins study unit was only partially funded because of budgetary limitations in Fiscal Year 1995. As a result, the study unit was in semidormant status and the planned scope of work was limited to the following planning activities and minimal technical interpretations: Attended water-quality meetings (Tri-State Water Quality Committee) and discussed NAWQA plans. Participated in non-point source conference and discussed NAWQA with participants. Presented posters at International Rangeland Conference (Salt Lake City, Utah) and Utah Non-Point Source Conference (Cedar City, Utah). Attended NAWQA National meeting (Denver, Colorado) and proposed work plans for abbreviated NAWQA effort for Fiscal Year 1995. Presented NAWQA plans to Central Utah Project Remediation Committee and discussed preliminary proposals for cooperative work with Nature Conservancy in wetland areas of Great Salt Lake, Utah. Continued efforts in hydrologic mapping of NAWQA study unit and began effort to evaluate Environmental Protection Agency RF-3 files and make corrections.

Plans for Next Year: If budget appropriations are approved at the requested funding level, we will complete staffing, prepare a new workplan, purchase necessary equipment, and begin full-scale evaluation of the NAWQA study unit.

Field Screening for Irrigation Contaminants in the Scofield and Emery Project Areas, Utah

Number: UT-94-225

Cooperating Agencies: U.S. Department of the Interior, National Irrigation Drainage Program (with U.S. Fish and Wildlife Service); and Bureau of Reclamation

Staff: D.W. Stephens, Project Chief

Period of Project: October 1994 through September 1995

Problem: Irrigation drainage from Bureau of Reclamation projects may be adversely affecting water quality in some wetlands and a State waterfowl management area.

Objectives: Determine if drainage of agricultural water has caused or is causing problems for human health or fish and wildlife in the two project areas.

Approach: Sample water, bottom sediment, and biological tissues from a representative number of sites to determine if wildlife is adversely affected. Determine tissue concentrations of trace elements to assess human risk. Sample upstream of Department of the Interior project diversions to determine background levels of contaminants in water and biota.

Progress: Water, bottom sediment, and biota were sampled at 27 sites in the project areas. Analyses were done for most trace elements in all media and for uranium in the water and sediment. All data for water analyses and screening results for bottom sediment have been received. Determination of selenium, arsenic, and mercury in bottom sediment has not been completed, and many bottom sediment samples were destroyed during lab preparation and could not be analyzed. Tissue analyses for the biota have not been completed by U.S. Fish and Wildlife Service laboratories.

Generally, concentrations of most trace elements in bottom sediments were not sufficiently high to adversely affect biota. Concentrations of selenium in water samples from two subsurface drains were greater than 10 µg/L, and water entering Desert Lake Waterfowl Management Area contained as much as 13 µg/L. Generally, water containing high concentrations of selenium also contained dissolved uranium in excess of 35 µg/L. Data from water testing indicate there are problems with selenium, uranium, and dissolved-solids concentrations in water supplies to Desert Lake. Most water from the Scofield Project was generally high in dissolved solids, but selenium concentrations exceeded the State standard of 5 µg/L for wildlife protection only in Coal Creek and Miller Creek.

Plans for Next Year: None.

Application of Topographically Distributed Energy-Balance Snowmelt-Runoff Model to a Mountain Basin with Cold, Low-Density Snowcover Under Varying Climate Conditions

Number: UT-94-226

Cooperating Agency: Utah Division of Water Rights

Staff: D. Marks, Hydrologist, Project Chief
D.D. Susong, Hydrologist (part time)

Period of Project: October 1994 to September 1997

Problem: Effective management and development of limited water resources in the intermountain Western United States are critical to the economic and ecologic well-being of the region. The Central Utah Project (CUP) develops water resources in the Colorado River Basin and Great Basin for delivery to water users along the Wasatch Range of central Utah. In the areas being developed, most of the precipitation falls as snow. The CUP is an elaborate reservoir and water-distribution system requiring increasingly accurate predictions of snowmelt runoff and stream discharge to optimize reservoir use, maximize water use and availability, and meet water-rights obligations. Current methods for predicting snowmelt and subsequent runoff and stream discharge do not accurately account for topographic controls on snowmelt processes and do not allow water-resource managers to estimate spatial patterns of snowmelt generation, runoff, and associated effects on water quality, soil moisture, and ground-water recharge. This makes it difficult to optimize reservoir capacities and optimally move water through a complex distribution system under potentially changing land use, land cover, and climate conditions.

Objectives: (1) Design and install a snow- and climatic-monitoring network to collect data that will be used to calibrate the distributed estimates of climate parameters required to drive an energy-balance snowmelt model; (2) develop an operational version of a topographically distributed energy-balance snowmelt and runoff-routing model that can be used by water-resource managers; (3) test and verify the model using the range of climatic and snowcover conditions that occur in continental mountainous drainages, such as the Wasatch Range of central Utah; (4) modify the energy-balance snowmelt model and its components for inclusion in the U.S. Geological Survey Modular Hydrologic Modeling System (MHMS); and (5) transfer the technology to water-resource management agencies.

Approach: Collect data for use in the energy-balance snowmelt and runoff-routing models that will be modified to be a module in MHMS. The modeling system will be tested and delivered to CUP water managers for operational testing and application. The models will be calibrated to continental snowpacks and will be transferable throughout the intermountain region.

Progress: Data collection has begun. A site in the Wasatch Range has been selected, and initial site surveys and monitoring are being done. Geographic-information-system coverages have been created for the Provo and Weber River basins. Climate- and snow-monitoring sites were established. Snow surveys were begun. Radiation experiments measuring solar and thermal irradiance were completed.

Plans for Next Year: Terminate project and present results and data. Complete proposals for further funding.

Kennecott Utah Copper Plume

Number: UT-94-228

Cooperating Agency: U.S. Environmental Protection Agency

Staff: S.R. Wold, Hydrologist, Project Chief

Period of Project: August 1994 to September 1996

Problem: During mining of a sulfide ore deposit to extract valuable minerals and metals, the principal aquifer of the ground-water system of southwestern Salt Lake County has been recharged with water of poor quality. Three sources of the poor-quality water are the Large Bingham Creek Reservoir, the South Jordan Evaporation Pond, and runoff from the abandoned mine tunnels and tailings in the Lark area. Low pH values and increased concentrations of sulfate, trace metals, and dissolved solids characterize the contaminated ground-water system. Kennecott Utah Copper (KUC) is the responsible party and principal investigator of this ground-water contamination study, which qualifies for the National Priority List but has not been listed.

Objectives: Recently, the U.S. Environmental Protection Agency (EPA) and KUC agreed to do a Remedial Investigation/Feasibility Study (RI/FS) to characterize site conditions and evaluate remedial alternatives. At the request of the EPA and with the consensus of members of a technical review committee, the U.S. Geological Survey agreed to serve as technical advisor to the EPA and oversee the RI/FS activities done by KUC in their efforts to characterize, delineate the extent of, and remediate the contaminated ground water.

Approach: As technical advisor, U.S. Geological Survey personnel with appropriate expertise will review and critique documents, workplans, and operating procedures when required. Consultation with appropriate personnel of the U.S. Geological Survey, both locally and nationally, will occur as the need arises.

KUC will drill holes in excess of 1,000 feet deep for installation of up to three monitoring wells per hole that will be completed at different depths in and below the intervals of poor-quality water. Information obtained by KUC and their contractors during the drilling and installation of monitoring wells and from analysis of water samples collected from the wells will allow characterization and delineation of the poor-quality ground water. The U.S. Geological Survey will periodically observe these activities to ensure adherence to KUC standard operating procedures and to collect duplicate water samples for analysis at the U.S. Geological Survey National Water Quality Laboratory or at other laboratories. Comparison of analytical results will provide a basis to either verify the KUC findings or, if the results are different, to determine the cause of the discrepancy and seek a solution. "Tiered" oversight by the U.S. Geological Survey will be contingent on the nature of a potential problem. For example, if a discrepancy between analyses is determined, then the number of duplicate samples will increase until the problem is resolved to the satisfaction of all entities involved. Conversely, if it is determined that no analysis problem exists, then the U.S. Geological Survey will collect duplicate samples from selected wells at a less frequent interval. Ground-water and transport-modeling activities by the U.S. Geological Survey might occur in the future.

Progress: The RI/FS workplan written by KUC consultants was reviewed and a meeting held to discuss the workplan. Split samples were collected at selected wells to do quality-control check on Kennecott Laboratory. An aquifer test at a Kennecott well was observed. A quarterly report was submitted to the EPA.

Plans for Next Year: Technical expertise will be provided during each phase of remediation. Implementation of the workplan will be monitored and the work guided through site visits. The modeling phase of the project will be planned, and technical review of the workplan will be offered to the EPA.

Recharge Areas and Ground-Water Quality in Tooele Valley, Utah

Number: UT-94-229

Cooperating Agencies: Tooele County; Utah Geological Survey; Utah Department of Environmental Quality; Utah Division of Water Rights

Staff: J.I. Steiger, Hydrologist, Project Chief
M. Lowe, Geologist, Utah Geological Survey

Period of Project: August 1994 to September 1995

Problem: Tooele County is experiencing rapid population growth in its rural areas. Much of the population growth is in areas where sewage-treatment facilities are not available and septic tanks are used. A potential problem associated with disposal of sewage in a large number of septic tanks is increased nitrate concentrations in ground water. To protect ground-water resources, Tooele County Commissioners would like to classify their ground-water system, establish ground-water protection levels, and identify and regulate existing and potential sources of nitrate contamination. This project is designed to provide some of the information needed by Tooele County for classifying the ground-water system in Tooele Valley.

One of the areas of new development in Tooele Valley is in the east Erda area. Water samples from several new domestic wells in the area had concentrations of nitrates exceeding State Drinking Water Standards. Tooele County needs to determine possible sources of the high nitrate concentrations and determine what effects they might have on water from public-supply wells and future well development in the east Erda area.

Objectives: The objectives of this study are to provide Tooele County with (1) a map showing primary and secondary ground-water recharge areas and the discharge area; (2) a map showing dissolved-solids concentrations in water from wells less than about 150 feet deep and in wells equal to or greater than about 150 feet deep; (3) a table showing water quality in selected wells and springs in Tooele Valley; and (4) additional hydrologic information related to the occurrence and movement of the nitrate contamination in the east Erda area.

Approach: The first phase of the project involves mapping primary and secondary recharge areas and discharge areas based on information contained in drillers' logs, water-level measurements, and on location of springs, flowing wells, and phreatophytes.

The second phase will document past and present water quality. Ground-water samples for chemical analysis from about 50 sites will be collected. The results of the analyses will be combined with existing data in a table showing water quality in water samples from wells and springs. This information will be used to identify areas where dissolved-solids concentrations are less than 500 milligrams per liter (mg/L), 500 to 3,000 mg/L, 3,000 to 10,000 mg/L, and greater than 10,000 mg/L. The third phase of the project will measure water levels and survey altitude for wells in the east Erda area and compile the data into a potentiometric surface map. The final phase of the project will incorporate the data and data analysis into a map report.

Progress: Project is complete except for preparation of the interpretive report.

Plans for Next Year: Complete and publish the interpretive report.

Central Virgin River Ground-Water Study, Southwestern Utah

Number: UT-95-232

Cooperating Agencies: Utah Division of Water Rights; Washington County Water Conservancy District

Staff: V.M. Heilweil, Hydrologist, Project Chief

Period of Project: April 1995 to September 1999

Problem: The central Virgin River basin and especially the communities of St. George, Washington, Hurricane, Santa Clara, and Ivins are experiencing tremendous growth. The 1990 census indicates the population of these communities has doubled since 1980. State and local agencies are concerned that the increase in population will cause water shortages unless prudent planning measures are implemented.

Objectives: Additional knowledge gained from studying the ground-water systems of the central Virgin River basin would aid State and local water-resource managers in planning for growth in ground-water use without jeopardizing the resource. Objectives of the study are (1) to quantify the ground-water resources in the Navajo aquifer and New Harmony/Kanarraville alluvial aquifer, and (2) to review the potential water-yielding capability of other significant aquifers within the study area.

Approach: Phase 1: Compilation, synthesis, and collection of appropriate surface-water, ground-water, and water-quality data. Phase 2: Compilation and field investigation of the lithologic character, structure, and stratigraphic relation of the formations that constitute the important aquifers of the area. Phase 3: Analysis and interpretation of the data and conceptualization and description of the hydrologic system. Phase 4: Ground-water flow model development and simulation of the movement of ground water into, within, and from the Navajo aquifer and the New Harmony/Kanarraville alluvial aquifer.

Progress: Completed work includes well inventory (about 90 wells); preliminary aquifer test at Gunlock well field; seepage studies along Navajo Sandstone outcrop areas of Cottonwood, Quail, Leeds, Wet Sandy, South Ash, and Ash Creeks; well-pumpage inventory of 18 wells (mostly along Hurricane Bench); and initial development of ground-water flow model of New Harmony/Kanarraville alluvial aquifer.

Plans for Next Year: Continue well inventory and pumpage inventory; seepage studies along Santa Clara River; aquifer tests at Gunlock, Mill Creek, Hurricane Bench, Anderson Junction, and New Harmony; inventory of spring discharge and field water quality; initial development of ground-water flow model of Navajo aquifer.

Hydrogeology of Hill Air Force Base and Adjacent Areas, Utah

Number: UT-95-234

Cooperating Agency: U.S. Air Force, managed by the Environmental Management Directorate (EMR), Hill Air Force Base

Staff: S.A. Thiros, Hydrologist, Project Chief

Period of Project: February 1995 to September 1999

Problem: A large quantity of data has been collected to better understand the extent of contamination to the ground-water system at Hill Air Force Base on a site-specific scale. Information on lithology, water level, water chemistry, well completion, and hydrologic properties is available from investigations of eight sites, much of which has been entered into a central data base. A better understanding of the ground-water system on a larger scale is necessary to conduct future environmental investigations.

Objectives: (1) To gain a better understanding of the subsurface using lithologic and geophysical information; (2) to better define the ground-water flow system of the area in and around Hill Air Force Base, primarily using existing data; (3) to provide a tool to better understand ground-water flow in the area; (4) to update the geographic-information-system (GIS) data base with data pertaining to environmental investigations; (5) to develop versatile tools that allow better visualization of the hydrologic data; and (6) to evaluate changes in the extent of contaminants in the subsurface with time.

Approach: (1) Construct generalized cross sections of the subsurface for areas with adequate data. (2) Study the ground-water flow system of the area in and around Hill Air Force Base. (3) Compile information from other sources relevant to environmental investigations at Hill Air Force Base into the EMR-GIS data base. (4) Work with the EMR computer section to develop programs that allow better visualization of hydrologic data using GIS. (5) Use GIS to map and contour subsurface concentrations of contaminants and show the contaminant plume shape.

Progress: Data sites added to the data base during 1995 were checked for duplication, location accuracy, and site type and were plotted on a map. Computer programs were developed to retrieve chemical data within a selected time period. A geologic cross section of the subsurface was constructed to show changes in lithology. U.S. Geological Survey digital line graphs and digital elevation models of the area were added to the EMR-GIS.

Plans for Next Year: Construct a ground-water surface map and contour maps of contamination in the ground water. Map the top of the first major confining layer encountered during drilling. Create computerized map files of the area and a data base that can be viewed and queried by project managers. Map areas of Hill Air Force Base for which hydrologic data are not available.

Baseline Ground-Water-Quality Mapping in the Spanish Valley Area, Grand and San Juan Counties, Utah

Number: UT-95-235

Cooperating Agencies: U.S. Environmental Protection Agency; Utah Department of Environmental Quality; Grand County; City of Moab

Staff: J.I. Steiger, Hydrologist, Project Chief
D.D. Susong, Hydrologist

Period of Project: August 1994 to September 1995

Problem: The Spanish Valley area is experiencing a rapid increase in development of residential and business property. Some of this development is taking place on the east side of Spanish Valley in the outcrop area of the Navajo Sandstone, which contains the principal drinking-water aquifer for the area. Additional development is occurring in the valley south of Moab where alluvium makes up a secondary aquifer. Sewage-treatment facilities are currently inadequate to meet the sustained level of growth. Grand County would like to classify the water in the two aquifers according to the State's Groundwater Classification System and develop a pollution prevention plan that would enable them to protect the ground-water resources of Grand and San Juan Counties.

Objectives: The objectives of this study are to provide Grand County with maps showing (1) recharge areas for the alluvial and Navajo aquifers and (2) dissolved-solids concentrations in water from wells in the valley and Navajo aquifer; and (3) a table showing water-quality data for water from selected wells and springs in Spanish Valley.

Approach: (1) Compile existing water-quality data. (2) Collect water samples from 20 wells completed in the alluvial aquifer and 10 springs or wells completed in the Navajo aquifer. The samples will be analyzed for common ions, inorganic constituents, metals, and nutrients. Twelve of these 30 sites also will be analyzed for organic constituents. (3) Interpret geologic maps and aerial photographs to delineate recharge areas for the alluvial and Navajo aquifers. (4) Prepare water-quality and recharge area maps for publication and write interpretive report.

Progress: Thirty sites were sampled for inorganic constituents and nutrients, and 12 sites were analyzed for organic constituents. Coverages for the base map were created and edited. Geologic and precipitation information was compiled. Sample sites were updated or added to the data base.

Plans for Next Year: Compile all water-quality, geologic, and precipitation data in a map report and submit for review and approval.

Determination of Background Methane Concentrations in Soil Gas and Shallow Ground Water near Price, Utah

Number: UT-95-236

Cooperating Agency: Utah Division of Oil, Gas, and Mining

Staff: D.L. Naftz, Hydrologist, Project Chief
H.K. Hadley, Hydrologist (part time)

Period of Project: July 1995 to September 1996

Problem: Ongoing and future development of coal-bed methane resources in the vicinity of Price, Utah, could cause migration of methane into near-surface environments. After dewatering, the methane can potentially migrate into the shallow subsurface (saturated and unsaturated zones) through abandoned wells, conventional gas wells, coal-bed gas wells, cathodic protection wells, and natural fractures. Pre- and early-development baseline methane concentrations in ground water and soil gas are needed to measure the effects of future coal-bed methane development in the vicinity of Price, Utah.

Objectives: The overall objective of the proposed study is to determine the pre- and early-development methane concentrations in ground water and soil gas in areas to be affected by development of coal-bed methane in the vicinity of Price, Utah. Specific objectives are to (1) determine methane concentrations in water samples from about 30 wells and springs in the study area; (2) determine soil-gas methane concentrations in close proximity to approximately 20 active and plugged gas wells in the study area; and (3) calculate a threshold value for methane in ground water using appropriate statistical techniques.

Approach: Water samples will be collected from 30 sites and soil-gas samples will be collected from 20 sites adjacent to active and plugged gas wells. Methane concentration will be determined onsite using a gas chromatograph with a flame ionization detector. The background water and soil-gas data will be compiled and statistically summarized.

Progress: Maps were prepared showing the location of active and abandoned oil and gas wells in the study area, and sampling sites were selected. About 50 soil-gas and 15 water samples were collected and analyzed for methane concentration.

Plans for Next Year: The data will be tabulated and statistically summarized. The location and concentration of methane at each sample site will be displayed in map form. An oral presentation of the study finding and suggestions for future study will be presented to the cooperator.

Conceptual and Computer Models of Ground-Water Flow In Tooele Valley, Utah

Number: UT-95-238

Cooperating Agencies: Tooele County; U.S. Army; Utah Division of Water Resources; City of Tooele; and City of Grantsville

Staff: W.F. Holmes, Hydrologist, Project Supervisor (part time)
P.M. Lambert, Hydrologist
M. Stanger, Geographer (University of Utah, part time)

Period of Project: August 1995 through July 1997

Problem: The increasing population of Tooele Valley requires additional water supplies for industrial, public supply, and domestic use. Ground water is the most important source of water in Tooele Valley, and increased withdrawals are expected to cause water levels to decline and may require well owners to lower pumps or deepen their wells. Lower water levels also could reduce the discharge from flowing wells, reduce the discharge to springs, and reduce the crop yield of subirrigated lands in the lower parts of the valley. Water managers need a tool that is capable of determining the effects of continued ground-water development on the ground-water system in Tooele Valley.

The availability of ground water for public supply is limited by quality. Areas of poor-quality ground water, unsuitable for public use, have been identified in Tooele Valley. High concentrations of sulfate measured in ground water in the Pine Canyon area and in the southern part of the valley are probably a result of recharge from tunnels containing mine-drainage waters. Water from wells in the northern part of the valley contains high concentrations of sodium chloride, which could be related to dissolution of evaporites deposited in ancient lakes. Industrial wastewater containing organic solvents has contaminated ground water at and near Tooele Army Depot. Some ground water near Bates Canyon has concentrations of nitrate that are greater than State drinking-water standards. Increased ground-water withdrawals and resultant water-level declines in Tooele Valley may induce the movement of poor-quality water into freshwater aquifers. The direction and rate of ground-water flow in Tooele Valley needs to be better understood.

Currently allocated water rights are thought to exceed the total annual inflow of good-quality ground water to basin-fill material in the valley. The State of Utah needs to know the effects of additional ground-water development on the hydrologic system and the source area for water withdrawn from proposed wells at several locations within the valley. A better understanding of the flow system would allow water managers and planners to anticipate and prevent migration of poor-quality water to points of withdrawal, and thus better manage development of the principal aquifer.

Objective: The principal objective is to improve the understanding of the ground-water system in Tooele Valley and to develop computer models that can be used to investigate ground-water flow.

Approach: The approach to achieving the objectives includes (1) compilation and interpretation of available hydrologic and geologic data to develop an improved conceptual model of the ground-water flow system in Tooele Valley, (2) development of a three-dimensional ground-water flow model of Tooele Valley, and (3) application of the ground-water flow model in conjunction with a solute-transport model to simulate the movement of contaminated ground water in the vicinity of Tooele Army Depot in the southern part of the valley.

Progress: During 1995, work focused mainly on project planning and on compiling available hydrologic, geologic, and geographic data for Tooele Valley and the surrounding area. A literature search was completed and the pertinent information gathered. Some of the reviewed data, including land-surface contours and aquifer-property data, were incorporated into a Geographic Information System (GIS) ARC/INFO data base, which will store much of the hydrologic and computed model data for the study. Data defining other components of the system, including recharge to and discharge from the ground-water reservoir, are being compiled and reviewed.

Work on computer-model development included the investigation of modeling approaches and techniques and the development of a preliminary one-layer flow model of the ground-water system. Estimates of aquifer properties and recharge to and discharge from the system made during previous studies were incorporated into the preliminary

model. Various approaches for estimating aquifer properties for use as initial model input are being examined, including the use of stochastic techniques recently developed by Utah State University.

Plans for Next Year: Work during 1996 will focus on developing an improved conceptual model of the ground-water system based on compiled available data and developing the three-dimensional ground-water flow model of that system. Work will begin on a report documenting the conceptual and computer models of the flow system. Data defining historic and present ground-water conditions at Tooele Army Depot will be compiled and analyzed in preparation for the development of the solute-transport model.

Ground Water in the Monument Valley Area of the Navajo Indian Reservation, Utah and Arizona

Number: UT-95-239

Cooperating Agency: Navajo Nation Department of Water Resources Management

Staff: L.E. Spangler, Hydrologist, Project Chief
G.W. Freethey, Supervisory Hydrologist (part time)

Period of Project: August 1994 to September 1995

Problem: The Navajo Indian Reservation (the Navajo Nation) in Utah lies within one of the driest parts of the Western United States. Normal annual precipitation is generally less than 8 inches. Water supplies for people living on northern reservation lands are generally from wells and springs, but in some areas these supplies are small or are slightly to moderately saline and not suitable for domestic purposes. One area where the supply of drinking water is especially scarce is Monument Valley, which is near the center of the Utah part of the Navajo Reservation and extends south into Arizona.

The main concern of the Navajo Department of Water Resources Management is maintaining an adequate water supply for the residents of the Monument Valley area. Additional water sources need to be identified to avoid the expense of piping water into the area from the San Juan River. In addition, supplemental water supplies need to be developed to meet the needs of an increasing number of tourists.

Objectives: The general objectives of the proposed investigation are to (1) determine the feasibility of developing additional water supplies in alluvial deposits along the Oljeto Wash drainage system and characterize the quality of the shallow ground water; (2) describe the stratigraphy, structural character, and water-bearing potential of consolidated rocks in the Monument Valley area and the chemical quality of the water contained in the rocks; and (3) analyze the potential for ground-water development from these consolidated rocks on the basis of hydrologic properties, proximity to possible recharge sources, and the feasibility of developing these aquifers by using conventional drilling techniques.

Approach: Specific work elements for objective 1 are to (1) inventory wells and springs and establish a discharge, water-level, and water-quality monitoring network; (2) install 10 to 20 monitoring wells in areas where data are needed; (3) determine the extent and thickness of the alluvial aquifer; (4) determine the water-transmitting properties of the alluvium; and (5) determine the quantity of ground water in storage and the amount of ground water that can be developed.

Work elements for objective 2 are to (1) inventory oil or gas test holes drilled into consolidated formations in the study area; (2) search geologic literature for additional information on structure and lithology; (3) identify wells and sample and analyze the water for dissolved-solids and major ion concentrations; and (4) construct maps and cross sections showing the geology of and the quality of water in the consolidated-rock aquifers.

Work elements for objective 3 are to (1) identify significant water-bearing formations and estimate the water storage and transmitting properties; (2) arrange, design, and conduct aquifer test(s); (3) estimate hydrologic properties from results of specific-capacity tests; (4) construct potentiometric contour maps; (5) estimate the effects of geologic structure and stratigraphy on the occurrence and movement of ground water in the consolidated rocks of the area; (6) identify areas of ground-water recharge and estimate the rate of recharge; (7) locate and identify areas of ground-water discharge and estimate the rate of discharge; (8) identify test-hole drill areas; and (9) propose a test-drilling program to explore ground-water sources below the Navajo Sandstone.

Progress: The project proposal was submitted to the Navajo Nation with a joint-funding agreement. Discussions were held regarding the drilling and installation of monitoring wells, plans for a pump test in the alluvial aquifer, and a resistivity survey of the alluvial aquifer. Wells and springs in the Oljeto Wash area of Monument Valley have been inventoried by the Navajo Department of Water Resources Management.

Plans for Next Year: Design a monitoring network and drill 10 to 15 monitoring wells in the alluvial aquifer; conduct a pump test of a supply well in the alluvial aquifer; inventory all wells and springs in the study area, enter the data into the U.S. Geological Survey data base; and sample selected wells and springs for analysis of major ions.

Assessment of Brine Shrimp Population and Nutrients in Great Salt Lake, Utah

Number: UT-95-240

Cooperating Agencies: Utah Department of Wildlife Resources; Utah State University

Staff: D.W. Stephens, Hydrologist, Project Chief
Kevin Johnson, Hydrologic Technician
Other District Personnel as required

Period of Project: July 1995 to July 1998

Problem: Great Salt Lake supports a $90 million per year brine-shrimp industry. More information is needed about the population, structure, food resource base, and variables that affect shrimp population dynamics.

Objectives: (1) Determine changes in sex and age-class structure of shrimp population throughout the year; (2) measure variations in nitrogen and phosphorus concentration at selected sites throughout the year; (3) measure quality and quantity of algal resources available to shrimp; and (4) measure standard limnological variables in the water column and correlate them with changes in the algal and shrimp communities.

Approach: Sample at randomly selected, fixed stations at variable times throughout the year. Use biological, chemical, and physical data as inputs to a population model being developed at Utah State University.

Progress: Established 15 randomly selected sites and sampled each site monthly. Established procedures with U.S. Geological Survey Central Laboratory for analysis of nutrients in brine.

Plans for Next Year: Begin annual sampling at regular intervals in March 1996. Complete analysis of samples and write data report.