WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1995, TO SEPTEMBER 30, 1996

Compiled by Ellen E. Hardy and Stefanie L. Dragos

U.S. GEOLOGICAL SURVEY

Open-File Report 97-578

Salt Lake City, Utah
1997

U.S. DEPARTMENT OF THE INTERIOR

BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY

Mark Schaefer, Acting Director

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For additional information write to:

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 107th year of activities in Utah. As Utah's economy and population continue to expand, so does 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.

The following report describes the many data-collection activities and interpretive investigations in which the Utah District is involved. The results of this work have traditionally been provided through various types of printed reports: Fact Sheets, Open-File Reports, Water-Data Reports, Water-Resources Investigations Reports, Water-Supply Papers, and Professional Papers, as well as through Utah Department of Natural Resources Technical Publications. Release of information through printed media will no doubt continue in the foreseeable future. However, it is clear that rapid development of electronic communication technology is having and will continue to have a profound effect on the way information is shared. The U.S. Geological Survey is at the leading edge of this new technology.

I encourage those agencies and individuals with access to the World Wide Web and the Internet to visit the Utah District Web Page (address listed below) and the many other sites within the Division. One important advantage of this technology is access to "real-time" streamflow information 24 hours a day. In Utah, 49 streamflow-gaging stations and 3 lake-elevation gaging stations on Great Salt Lake provide real-time data, and more stations are planned for the future. The information is used for everything from lifesaving evacuations during flood emergencies to whitewater boating and knowing if the fishing is good. Throughout the Nation, thousands of such sites can be accessed instantly from any computer with Internet access. The ramifications for information transfer are staggering.

It is clear that in the future the ways in which information is provided to the public will be quite different than they have been in the recent past. I expect to see a time when all basic data, map information, and interpretive reports are available over the World Wide Web. This is just one more way in which the U.S. Geological Survey helps provide the sound scientific information needed to manage our Nation's water resources.

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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WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1995, TO SEPTEMBER 30, 1996

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INTRODUCTION

This report contains summaries of the progress of water-resources activities of the U.S. Geological Survey (USGS), Water Resources Division, Utah District, from October 1, 1995, to September 30, 1996. The water-resources program in Utah during this period consisted of 22 projects; a discussion of each project is presented in the main body of this report.

The following sections outline the origin of the USGS, the 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 1996 (FY96) (October 1, 1995, to September 30, 1996), 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 1995 to September 1996.

Origin of the U.S. Geological Survey

The USGS 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 factfinding role of the USGS has grown and been modified to meet the changing needs of the Nation it serves. As part of that evolution, the USGS has become the Federal Government's largest earth-science research agency, the Nation's largest civilian mapmaking 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 USGS 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 USGS, 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 USGS 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 that created the USGS and legislation of 1888 and 1894 that provided for stream gaging and determining the Nation's water supply. Congressional appropriations have been made annually since 1894 for stream gaging and performing other functions related to water resources. In 1964, the USGS'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 in 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 District 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 the Hydrologic Surveillance Section (primarily collection of hydrologic data). Responsibility for each project is assigned to a project chief. Support for

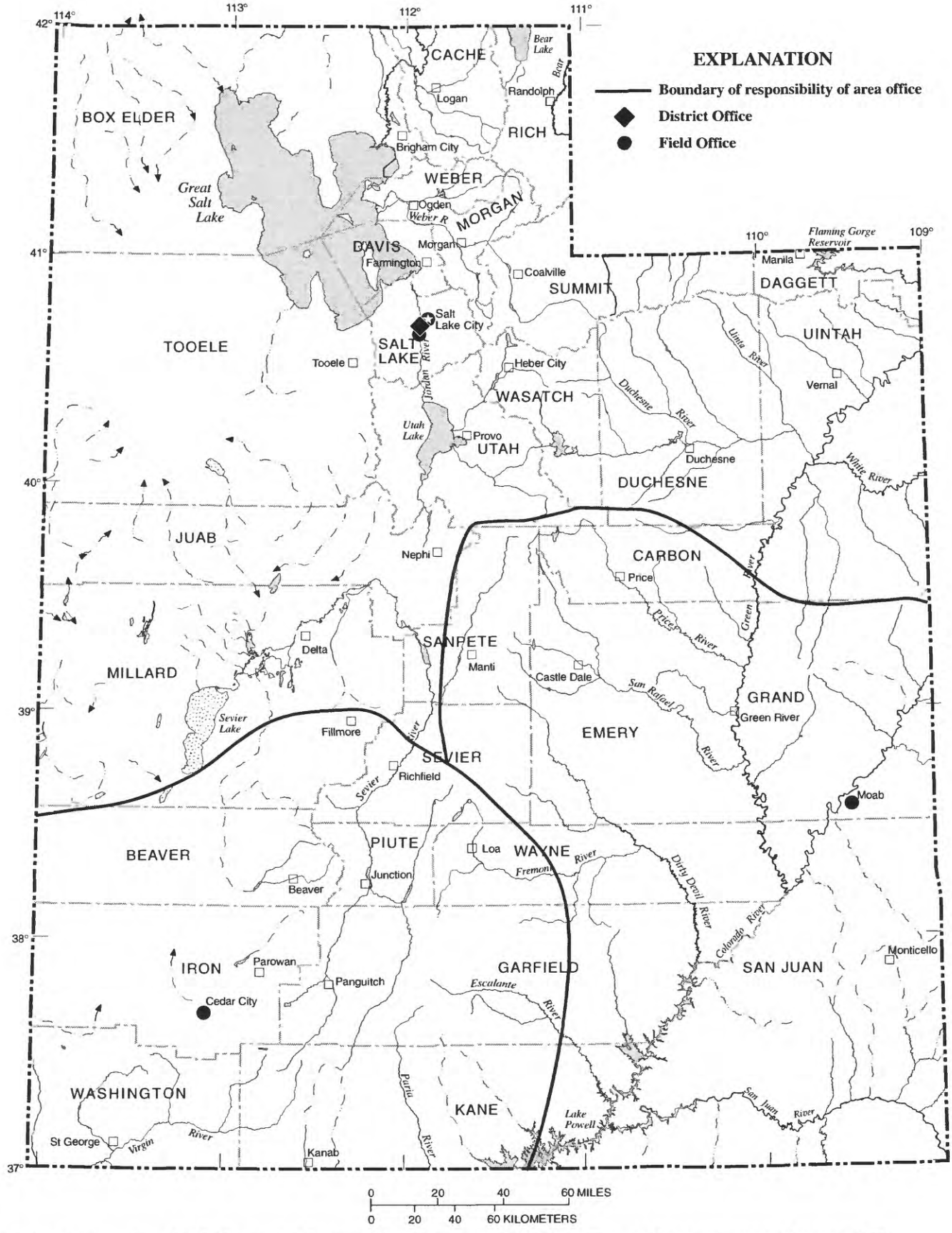


Figure 1. Location of U.S. Geological Survey, Water Resources Division, offices and general areas of responsibility.

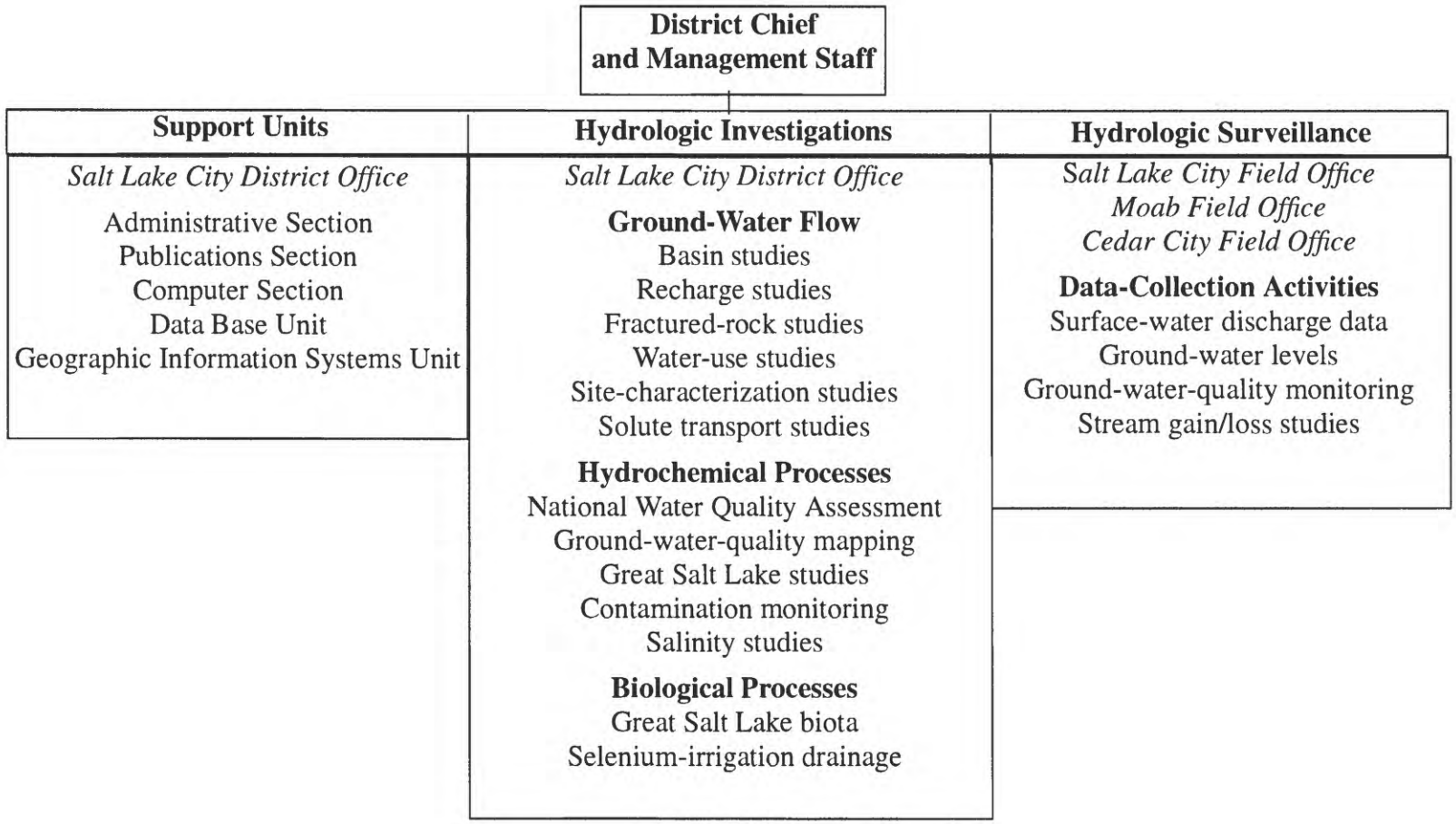


Figure 2. Organization of the Utah District.

project work is supplied by the Administrative Section, the Publications Section, the Computer 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

Cedar City Field Office
(801) 586-4543

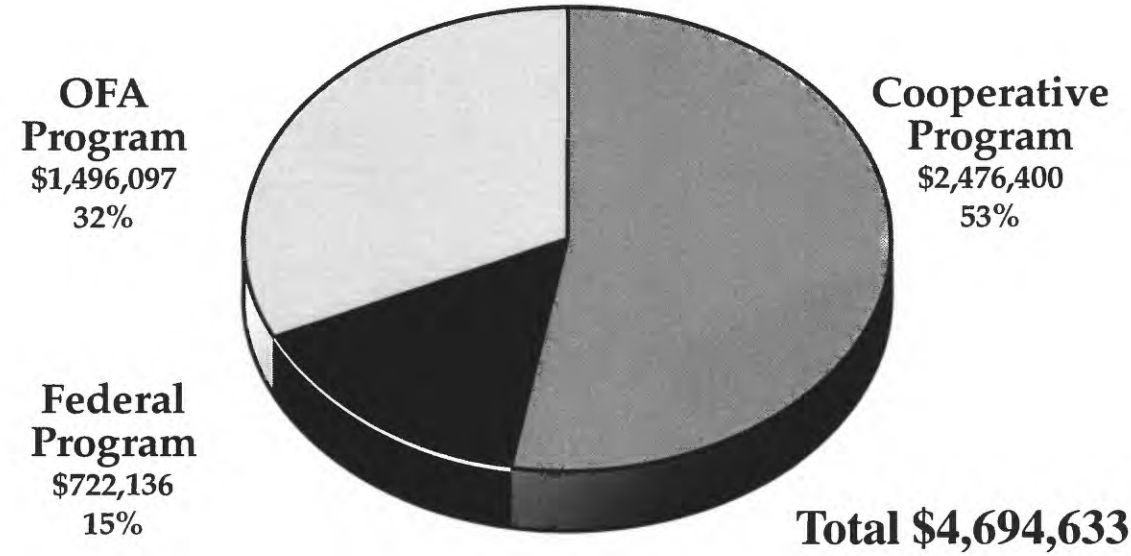
U.S. Geological Survey
Water Resources Division
2390 West Highway 56
Suite 8
Cedar City, Utah 84720

Moab Field Office
(801) 259-5495

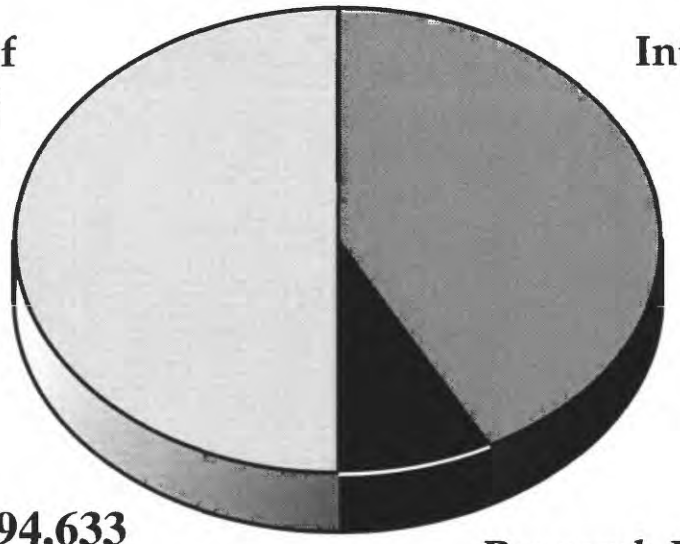
U.S. Geological Survey
Water Resources Division
121 West 200 South
P.O. Box 490
Moab, Utah 84532

Program Funding and Cooperating Agencies

Funds to support water-resources work done by the Utah District come from three sources. Cooperative-Program funds and services are provided by 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 USGS by Congress are part of the Federal Program. In FY96, total financial support from these programs for the Utah District was about $4.7 million. The amount of funding received from each of the three sources is:



In FY96, 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:



Collection of Hydrologic Data
$2,350,425
50%

Interpretive Studies and Areal Appraisals
$1,980,143
42%

Total $4,694,633

Research Projects
$364,065
8%

From October 1, 1995, to September 30, 1996, 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
    Utah Geological Survey
    Division of Wildlife Resources

Local Agencies

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

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

U.S. Department of the Interior
- Bureau of Land Management
- Bureau of Reclamation
- National Park Service

U.S. Department of Defense
- U.S. Air Force
- U.S. Army

U.S. Department of Energy
U.S. Environmental Protection Agency

Reports Released or Published

The following reports were released or published from October 1, 1995, to September 30, 1996:

Allen, D.V., Floods, runoff, and snowpack in Utah, 1995: U.S. Geological Survey Fact Sheet FS-106-96.

Allen, D.V., Steiger, J.I., and others, Ground-water conditions in Utah, Spring of 1995: Utah Department of Natural Resources Cooperative Investigations Report No. 35.

Brooks, L.E., and Stolp, B.J., Hydrology and simulation of ground-water flow in southern Utah and Goshen Valleys, Utah: Utah Department of Natural Resources Technical Publication No. 111, 96 p.

Hardy, E.E., and Dragos, S.L., Water-resources activities in Utah by the U.S. Geological Survey, October 1, 1993, to September 30, 1994: U.S. Geological Survey Open-File Report 96-102, 58 p.

Lambert, P.M., Numerical simulation of ground-water flow in basin-fill material in Salt Lake Valley, Utah: Utah Department of Natural Resources Technical Publication No. 110-B, 58 p.

Lambert, P.M., Particle-tracking analysis of time-related capture zones for selected public-supply wells in Salt Lake Valley, Utah: Utah Department of Natural Resources Technical Publication No. 110-C, 36 p.

Naftz, D.L., Using geochemical and statistical tools to identify irrigated areas that may contain high selenium concentrations in surface water: U.S. Geological Survey Fact Sheet FS-077-96.

ReMillard, M.D., and others, Water resources data for Utah, water year 1995: U.S. Geological Survey Water-Data Report UT-95-1, 312 p.

Stephens, D.W., Thompson, K.R., and Wangsgard, J.B., Potential effects of coal mining and road construction on the water quality of Scofield Reservoir and its drainage area, central Utah, October 1982 to October 1984: U.S. Geological Survey Water-Resources Investigations Report 96-4020, 77 p.

Susong, D.D., Map showing chemical quality of water in the basin-fill aquifer, Milford area, Utah, July and August 1994: U.S. Geological Survey Water-Resources Investigations Report 96-4057, 2 sheets.

Thiros, S.A., Stolp, B.J., Hadley, H.K., and Steiger, J.I., Hydrology and simulation of ground-water flow in Juab Valley, Juab County, Utah: Utah Department of Natural Resources Technical Publication No. 114, 100 p.

Wilberg, D.E., and Heilweil, V.M., Hydrology of Sanpete Valley, Sanpete and Juab Counties, Utah, and simulation of ground-water flow in the valley-fill aquifer: Utah Department of Natural Resources Technical Publication No. 113, 121 p.

Wold, S.R., Thomas, B.E., and Waddell, K.M., Water and salt balance of Great Salt Lake, Utah, and simulation of water and salt balance through the causeway: U.S. Geological Survey Open-File Report 95-428, 66 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: J.R. Kolva, Supervisory Hydrologist, 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.

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

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

Progress: Data collection and computation necessary for the publication of discharge records for 155 streamflow-gaging stations and contents and stage records for 13 reservoir- and 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," USGS Water-Data Reports. The stations are classified as follows:

	Number of stations
Discharge	
Current use	123
Hydrologic data for planning and design	31
Benchmark for long-term trends	1
Contents of reservoirs and lakes	11
Stage of Great Salt Lake	2

Seven streamflow-gaging stations were discontinued as of September 30, 1996. These were:

09271600	Stewart Lake Outflow near Jensen
10113500	Blacksmith Fork above UP&L Dam near Hyrum
10148200	Tie Fork near Soldier Summit
10153800	North Fork Provo River near Kamas
10133540	Kimball Creek above East Canyon Creek near Park City
10133600	McLeod Creek near Park City
10133895	East Canyon Creek above Big Bear Hollow near Park City

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

Report:

ReMillard, M.D., and others, 1996, Water resources data for Utah, water year 1995: U.S. Geological Survey Water–Data Report UT-95-1.

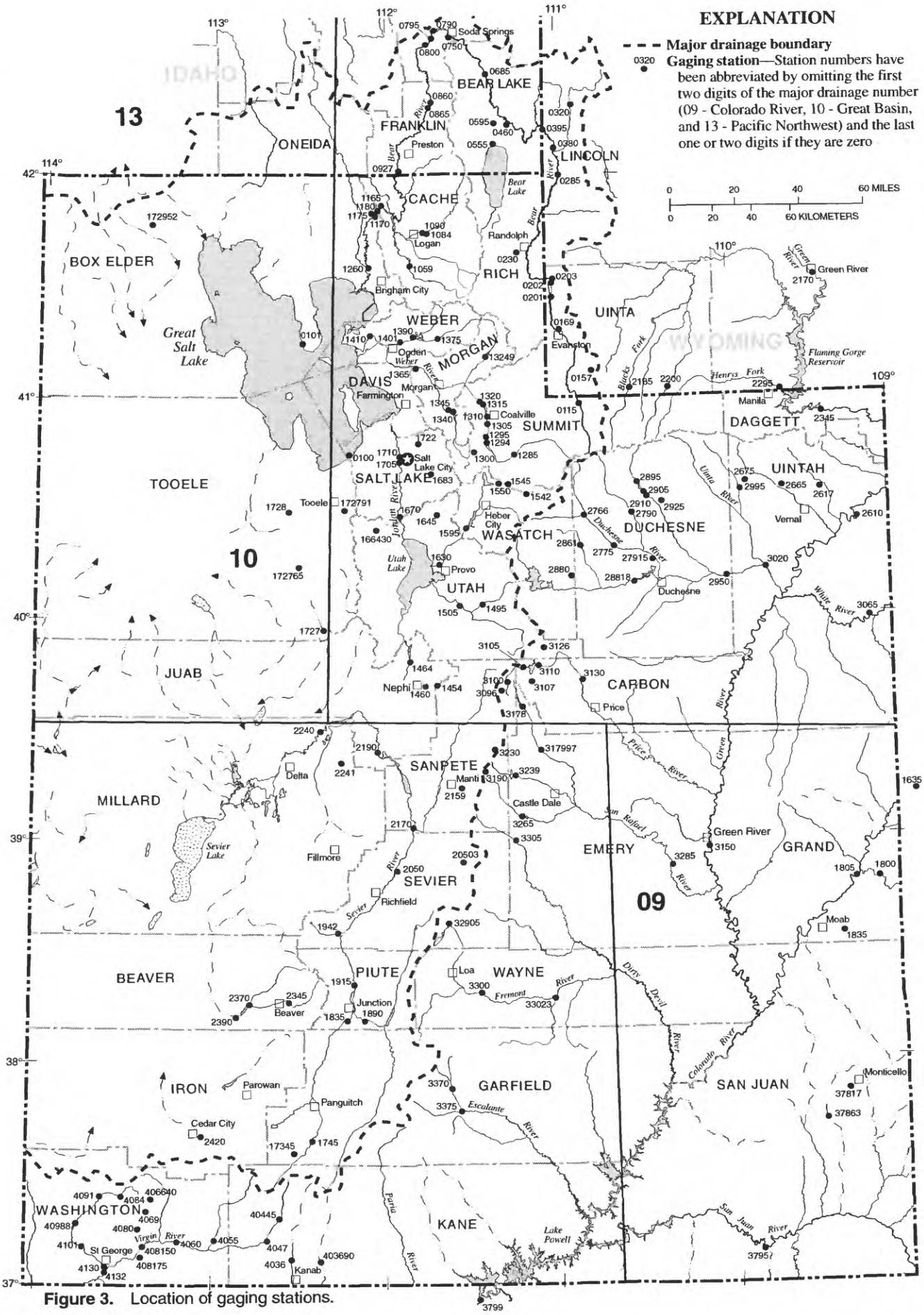


Figure 3. Location of gaging stations.

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: J.R. Kolva, Supervisory Hydrologist, Project Chief (part time)
Other District personnel as assigned

Period of Project: Continuing

Problem: Long-term records of water level and ground-water withdrawal are needed to evaluate the effects of climatic variations, to determine the effect of withdrawal from aquifers on water level, 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 level for determination of water-level changes for yearly or other periods, (2) to determine withdrawal 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 level 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 public-supply or industrial 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 that has substantial withdrawal. Store water-level data in computer files and publish selected data in the annual USGS report, "Water resources data for Utah."

Progress: The water level in about 1,000 wells was measured in February and March. In addition, the water level in 25 of these wells was 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. The number and diameter of wells drilled during the past year were compiled. The thirty-third in the series of annual reports on ground-water conditions in Utah was completed. The continuous water-level records were published in the annual USGS report, "Water resources data for Utah."

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

Reports:

Allen, D.V., Steiger, J.I., 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, 1996, Water resources data for Utah, water year 1995: U.S. Geological Survey Water–Data Report UT-95-1.

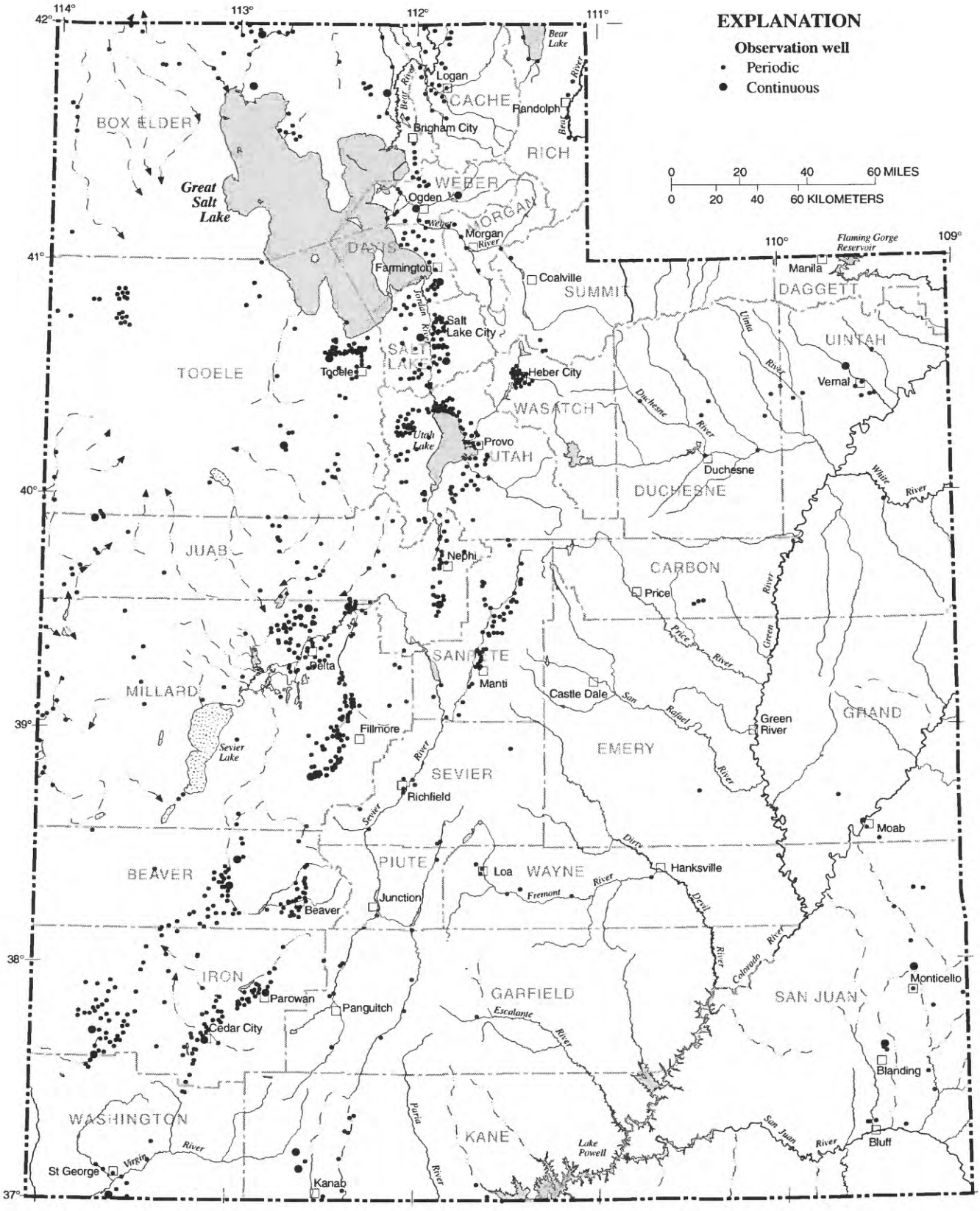


Figure 4. Location of observation wells in which water levels were measured.

Water-Quality, Fluvial-Sediment, and Precipitation Data

Number: 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: J.R. Kolva, Supervisory Hydrologist, 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 sediment load 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 water-quality evaluation. Data bases are needed to store and provide the appropriate water-quality, sediment, and precipitation information.

Objective: To obtain records of water quality, sediment, and precipitation at selected sites throughout Utah.

Approach: Standard methods will be used for the collection and analysis of chemical-quality samples, fluvial-sediment samples, biological samples, and precipitation data, and for the 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 by using 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 precipitation data.

Report:

ReMillard, M.D., and others, 1996, Water resources data for Utah, water year 1995: U.S. Geological Survey Water-Data Report UT–95–1.

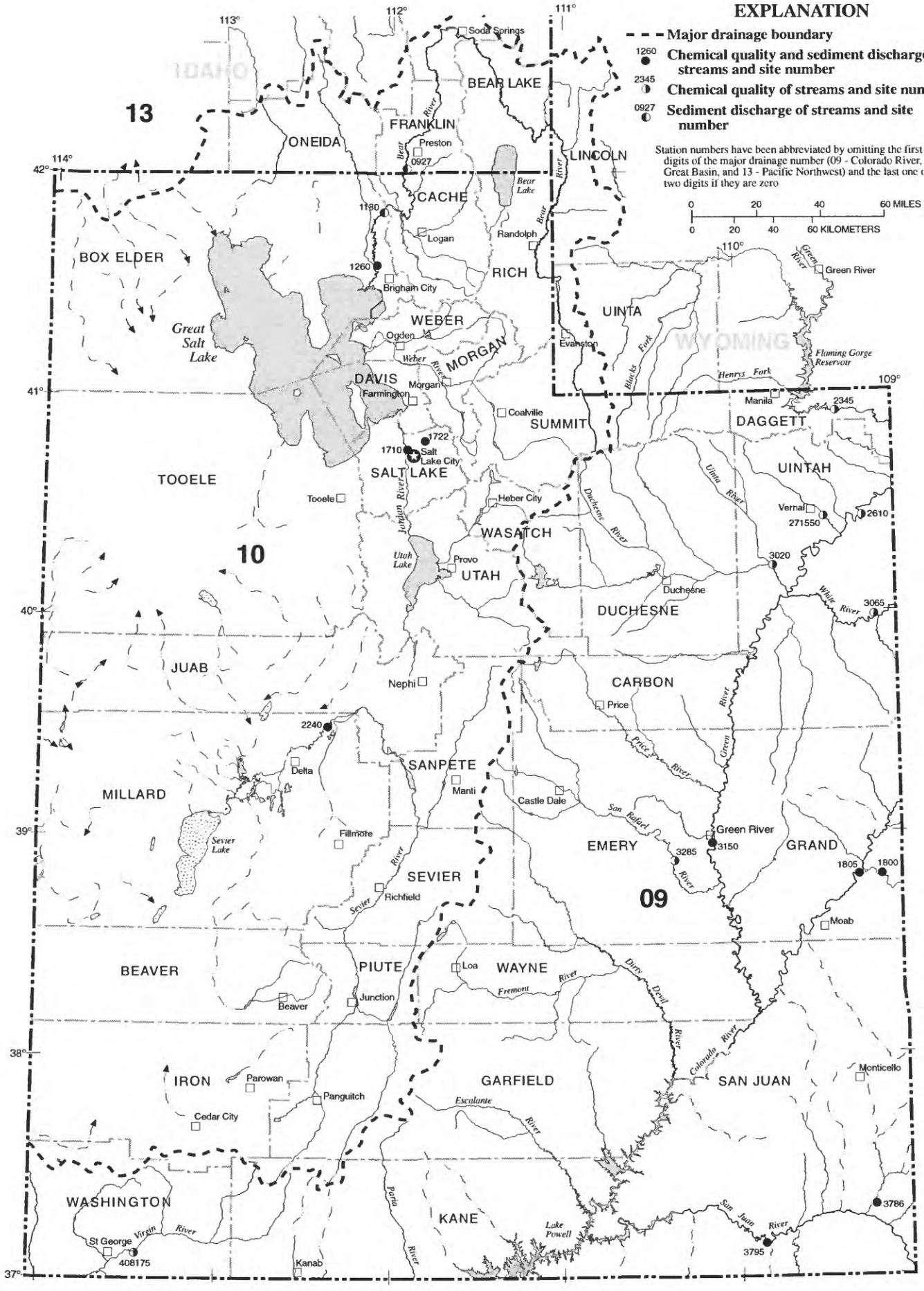


Figure 5. Location of surface-water-quality stations.

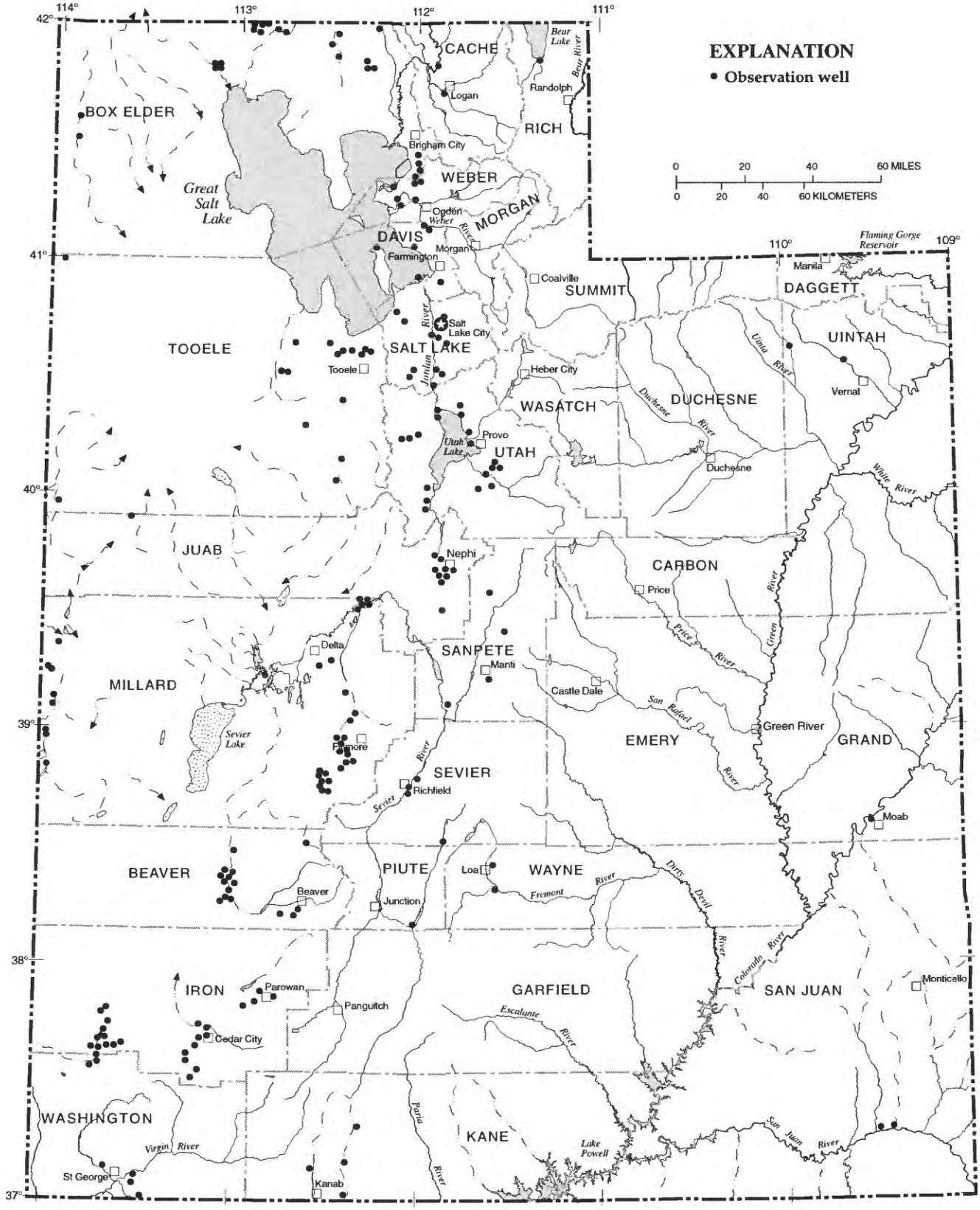


Figure 6. Location of observation wells from which water samples were collected for monitoring water quality.

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)
K.K. Wilson, Hydrologic Technician (part time)

Period of Project: 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 USGS 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 the withdrawal and return flow of water for different uses, and the consumptive use of water in connection with each type of withdrawal.

Approach: Determine total amount of water diversion 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 estimate consumptive use by irrigation. State personnel are collecting data on public-supply and industrial use; USGS 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. Water-use data are being 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.

Plans for Next Year: Work will continue on a Utah Water-Use report that illustrates and compares Utah water use during 1985, 1990, and 1995.

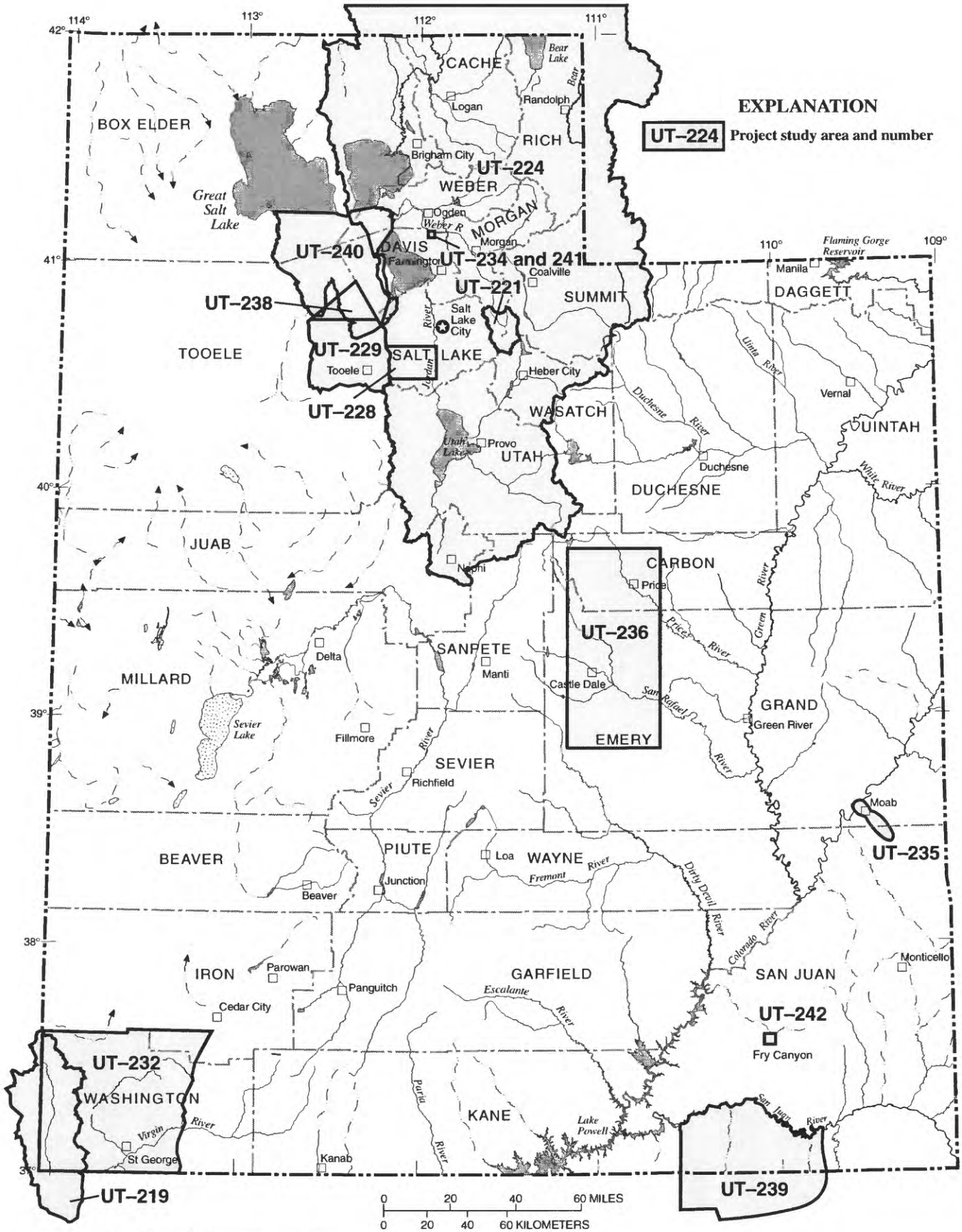


Figure 7. Location of interpretive studies.

Mechanisms of Stream Recovery from Metal Contamination

Number: UT-97-208

Cooperating Agencies: None

Staff: B.A. Kimball, Hydrologist, Project Chief
L.J. Gerner, Hydrologist (part time)

Period of Project: February 1986 to September 2001

Problem: Past mining of ore deposits in the Leadville, Colorado, area has yielded economic amounts of gold, silver, copper, lead, zinc, iron, and bismuth. Water flowing through abandoned tailings and from draining mine adits in the Leadville area contributes large amounts of cadmium, copper, iron, lead, manganese, nickel, and zinc to the Arkansas River. Reactive solute-transport processes occurring within the channel are not well quantified. An interdisciplinary study of controls on trace-element concentration in streams in the Leadville area will allow a better understanding of the transport and removal mechanisms that control trace-element concentration in streams in general.

Objectives: The objectives of this study are to (1) characterize the in-stream chemical processes that control the transport and distribution of trace elements in streams in the Leadville area; (2) characterize the chemistry of sediment and sediment coatings that are active in controlling the dissolved concentration of trace elements; (3) quantify the time and length scales for chemical and hydrologic processes that affect the metals, and determine the extent to which chemical equilibrium has been attained; and (4) quantify suspended-sediment concentration and particle-size distribution at various streamflow regimes.

Approach: Water and sediment samples will define the transition from natural conditions to areas of active chemical precipitation, and to areas dominated by natural weathering and sediment transport. Determination of concentration, mineralogy, and particle-size distribution will be made for the suspended and bed sediment. After size separation into clay, silt, and sand, organic and metallic coatings on the sediment will be analyzed by extraction procedures to determine chemistry. X-ray diffraction, scanning electron microscopy, and chemical analyses will be used to determine the mineral and organic phases that control heavy-metal concentrations. The results will be tested by an in-stream transport experiment. Stable-isotope distribution may also prove useful in evaluating diagenetic changes.

Progress: Progress on reactive solute-transport modeling was published in six journal publications. Development of the transport model and its application are presented in companion papers in Water Resources Research. The application of the model to a pH modification experiment was published in Environmental Science & Technology. Simulations of this data set provided important interpretations of the amount of pH control by atmospheric carbon dioxide, by precipitation of aluminum and iron hydroxides, and by exchange of hydrogen ions with the streambed iron. Response to this work has been substantial and is reflected by invitations for seven talks about the transport modeling and work on metals in colloids. Two of these talks were presented to the local group of stakeholders in Silverton, Colorado, to provide them with a better scientific understanding to help them make decisions about remediation of mine drainage. Several scales of interaction between the stream and the hyporheic zone were identified in another publication in Water Resources Research.

The tracer-injection methods mostly have been applied on a limited spatial scale in streams that have relatively small discharge. Field work during FY96 yielded results that allow application to larger spatial scales and discharges. In Chalk Creek, Colorado, intensive spatial sampling was needed to adequately describe mine-drainage inflow on a watershed scale. One of the most important questions for the regulatory agencies in Colorado was whether there were multiple sources of mine-drainage inflow to Chalk Creek. Analysis clearly pointed to two sources of mine-drainage inflow and also quantified the noncontaminated watershed input to the stream. In Cement Creek, Colorado, a rigorous spatial sampling was applied to a 10-kilometer reach of stream. Although the results are not available yet, they will be applied on larger scales to support the Abandoned Mine Land Initiative in FY97.

Plans for Next Year: Most of FY97 will be spent simulating past experiments in St. Kevin Gulch, preparing papers on those experiments, and analyzing work for the experiments of summer FY96 and FY97. There will be two tracer experiments during summer FY97, both as part of the Abandoned Mine Land Initiative. Tracer injections in the Animas River basin in Colorado and the Boulder River basin in Montana will support the work being done by the Colorado and Montana Districts on the new initiative.

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: K.M. Waddell, Supervisory Hydrologist, Acting Project Chief
G.E. Pyper, Hydrologist, Project Chief (retired volunteer)
J.S. Gates, Hydrologist (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 northwestern Arizona is one of the fastest growing in the Western United States. The three States need 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 for 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 the understanding of surface water and surface-water quality by estimating average annual flow at selected locations and mapping perennial reaches; (2) improve the 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: The data report has been completed and printed. An interpretive report has been completed and is currently in review.

Plans for Next Year: Complete review of interpretive report.

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: J.L. Mason, Hydrologist, Project Chief
L.E. Brooks, Hydrologist (part time)
Paul Downhour, Hydrologic Technician (part time)

Period of Project: July 1993 to September 1997

Problem: The Snyderville Basin and Park City study 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 increased substantially 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 being caused by housing, industrial, and commercial development and by ski areas planning to increase snow-making operations. Water supply is one of the major constraints on development of additional residential areas and commercial activities. 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 withdrawal of ground water on springs, surface-water flow, and ground-water levels.

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 concentration is increasing. The cause of increased concentration 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 concentration; 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 them for potential causes of increasing dissolved-solids concentration; (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 data report has been completed and approved. A report describing the geologic framework of the study area has been completed by the Utah Geological Survey, and pertinent data have been entered into a geographic-information-system (GIS) data base. These data, along with geochemical, water-level, and water-use data, are being used to define the ground-water flow paths through consolidated rock from areas of recharge to discharge. Data sets necessary for snowmelt/runoff computer simulations have been completed. Water-level and drain-tunnel discharge data can be used in conjunction with streamflow data to estimate the amount of water that recharges the consolidated rock and that becomes surface runoff. The study area has been divided into six subareas on the basis of

geologic framework, distribution of valley-fill deposits, and data-collection network. Water budgets that account for inflow and outflow for each subarea are being developed.

Plans for Next Year: Publish data report. Complete interpretation of probable ground-water flow paths and identification of source areas that contribute ground water to surface flow that leaves the study area. Complete snowmelt/runoff simulations. Finalize water budgets for each subarea. Complete interpretive report in 1997.

Simulating Climate-Biosphere Interactions Under Changing Climate Conditions

Number: UT-97-223

Cooperating Agency: U.S. Environmental Protection Agency

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

Period of Project: October 1993 to September 1997

Problem: Global climate changes affect the terrestrial biosphere through changes in the regional energy balance and associated changes in the regional water balance. Large shifts in vegetation patterns and conditions could occur as a result of climate change. Changes in the regional water balance influence interaction between vegetation and climate by altering the magnitude and timing of surface albedo and radiation balance, soil-moisture storage, and evapotranspiration. New hydrologic models must be developed to simulate the spatial magnitude and extent of hydrospheric processes and properties in response to changing climate conditions.

Objectives: (1) Develop a coupled energy and water balance (CEWB) model that realistically simulates vegetation-water balance interaction under any climate conditions in any region or river basin on the globe; (2) develop methodologies to extend sparse, irregularly distributed observations of climate parameters such as precipitation, temperature, humidity, and wind over complex topography to provide the spatially distributed inputs required for models; and (3) modify and implement an energy-balance snowmelt model to predict patterns of snowmelt and runoff at multiple scales over the simulated boreal-forest region in Canada.

Approach: The strategy is to bridge the gap between the detailed process simulation of the watershed-scale models and the simple land-surface hydrology of the coarse-resolution global climate models. Models will be developed to simulate hydrologic processes over large regions that include complex topography, soils, and vegetation. These models will be extensions of previously developed watershed-scale models and will include coupled vegetation-hydrologic processes. They will provide the foundation for future global-scale models that accurately represent vegetation-hydrologic interaction.

The regional-scale models will be used directly to: (1) improve the understanding of the response of critical hydrologic processes to climate variation over large heterogeneous regions; (2) determine the sensitivity of critical processes (precipitation, evapotranspiration, soil moisture, and runoff) to projected climate change; and (3) assess potential effects of climate change on specific regions of interest. The regional models also will be used to: (1) develop improved parameterization and representation of critical hydrologic processes in continental and global-scale models; (2) determine the minimum data, time-step, and spatial resolution required for global-scale simulations; and (3) calibrate continental and global-scale models under current and projected conditions.

Progress: The preliminary canopy-shading module has been developed for the snowmelt-runoff model. Snowmelt simulations have been completed for the boreal-forest region in Canada and for rain-on-snow storms in the Pacific Northwest, Boise River basin in Idaho, and Wasatch Range in Utah. New model codes were written for spatial topographic distribution of climate parameters and applied in the Boise River basin and Wasatch Range. The snowmelt-model preprocessor was extensively rewritten. Cooperative snowmelt-runoff modeling projects were started at sites in the Cascade and Coast Ranges of Oregon.

Plans for Next Year: Revise and complete canopy-shading module of the snowmelt model. Continue snowmelt-runoff simulations in the Cascade Range, Boise River basin, and Wasatch Range. Continue developing and improving spatial distribution codes.

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

Number: UT-94-224

Cooperating Agencies: 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.

Objective: 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 FY94 as 1 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 during FY96. 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. The staff attended water-quality meetings, presented NAWQA plans to "Friends of Great Salt Lake," attended Utah Water Users Conference, and discussed NAWQA plans. Work continued on digital coverages of NAWQA study area in cooperation with the Utah Department of Environmental Quality. The staff attended the Utah Department of Environmental Quality coordination meeting with other State agencies and participated in the planning meeting with U.S. Fish and Wildlife Service, Nature Conservancy, and Central Utah Project remediation board for coordination of Wetland Contaminant Assessment Study of selected shore areas of Great Salt Lake. A surface-water specialist, ground-water specialist, and biologist were selected for the NAWQA staff, who will begin part-time work in FY97.

Plans for Next Year: Budget appropriations were approved for the Great Salt Lake River Basins study unit. Because of the 2-year delay, the study unit was placed in a new-start status scheduled to begin with 16 other study units in FY97. A lead technician will be selected and will begin work during the early summer of 1998. A student will be employed part time to work on the data base. During FY97, the bibliographic summary will be completed, two liaison meetings are planned, personnel will attend the National NAWQA Conference and participate in on-the-job training activities of other study units, and a field reconnaissance will be conducted. Existing water-quality data will be compiled and evaluated, and an annotated draft of the report will be prepared.

Kennecott Utah Copper Plume

Number: UT-94-228

Cooperating Agency: U.S. Environmental Protection Agency

Staff: P.M. Lambert, Hydrologist, Project Chief
D.L. Naftz, Hydrologist (part time)
J.I. Steiger, Hydrologist (part time)

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.

Objective: 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 USGS 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: USGS personnel will review and critique documents, work plans, and operating procedures when required, observe KUC data-collection activities in the field, and review the results of analyses of these data by KUC.

KUC will conduct field activities during the RI/FS, including: (1) installing monitoring wells, (2) conducting aquifer tests, and (3) collecting and analyzing ground-water samples. The USGS will periodically observe these activities to ensure adherence to KUC standard operating procedures. Duplicate water samples will be collected for analysis at the USGS National Water Quality Laboratory or at other laboratories. KUC will incorporate the results of their analyses of field data into conceptual, and possibly computer, models of the contaminated area to organize the data and to develop tools to evaluate remedial alternatives. The USGS will oversee the development of these models and provide technical assistance as the need arises.

Progress: Installation of monitoring wells was observed in the field and aquifer tests were observed at two of these wells. Meetings were held with KUC personnel involved in the interpretation of geologic and geophysical logs and the development of geochemical and ground-water flow models to review progress and preliminary results of this work.

Plans for Next Year: The USGS will continue to provide technical advice on each phase of the RI/FS. Results and KUC analyses of aquifer tests will be reviewed. Geologic cross sections developed by KUC from data collected during the installation of monitoring wells will be reviewed. Results of geochemical experiments and geochemical and ground-water flow models will be reviewed.

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

Number: UT-94-229

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

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

Period of Project: October 1995 to September 1996

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. The nitrate concentration of water samples from several new domestic wells in the area exceeded State drinking-water standards. Tooele County needs to determine possible sources of the nitrate and determine what effects the concentrations 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 and discharge areas; (2) a map showing dissolved-solids concentration in water from wells penetrating deposits of saturated thickness less than or equal to 150 feet deep and in wells penetrating deposits of saturated thickness 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 from drillers' logs, water-level measurements, and location of springs, flowing wells, and phreatophytes.

The second phase will document past and present water quality. Ground-water samples for chemical analysis will be collected from about 50 sites. 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 the dissolved-solids concentration is 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 will involve water-level measurements and an altitude survey for wells in the east Erda area and compilation of 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: The interpretive report has been completed and is in review.

Plans for Next Year: Print and release 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
Dale Wilberg, Hydrologist (part time)
Chris Wilkowske, Hydrologic Technician (part time)
G.W. Freethey, Supervisory Hydrologist (part time)

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: Development of ground-water flow model and simulation of the movement of ground water into, within, and from the Navajo aquifer and the New Harmony/Kanarraville alluvial aquifer.

Progress: Water-level inventory (about 60 wells) has been completed; 5 aquifer tests (Hurricane Bench, Gunlock well field, Grapevine Pass, Anderson Junction, and New Harmony) were done; Navajo aquifer spring-discharge inventory has been completed; potentiometric maps for the Navajo aquifer were constructed; 35 ground-water samples were collected for laboratory analysis of general chemistry, stable isotopes, and chlorofluorocarbons; and a ground-water flow model of the New Harmony/Kanarraville alluvial aquifer was developed.

Plans for Next Year: Complete the New Harmony/Kanarraville ground-water flow model; develop a ground-water flow model to analyze the Gunlock well-field aquifer-test data; develop preliminary ground-water flow models for the Navajo aquifer; analyze and interpret water-chemistry data as related to ground-water flow paths; and compile 1996 water year ground-water budget data for the 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 Hill Air Force Base Environmental Management Restoration (EMR) Division

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, and much of the information 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 update the geographic-information-system (GIS) data base with data pertaining to environmental investigations; (4) to develop versatile tools that allow better visualization of the hydrologic data; and (5) to evaluate changes in the extent of contaminants in the subsurface with time.

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

Progress: Digital-elevation models were developed for areas of Hill Air Force Base. Hydrologic data-site symbols, aerial photographs, and selected line features such as the base boundary were draped over the elevation models to provide other viewing perspectives. A map of the ground-water surface for the base area was constructed, and areas where data were not available were targeted for probing by a cone penetrometer. Contour maps of contaminant concentration in ground water were made for selected areas. Aquifer tests were reanalyzed to account for delayed yield. Assistance was given in the planning of additional tests. Hydrographs showing water-level and contaminant-concentration changes for selected areas of the base were constructed.

Plans for Next Year: Continue to update maps and develop ways to show and interpret the data that have been collected. Apply innovative geophysical techniques to determine ground-water flow paths and flow velocities. Better define the ground-water budgets for selected areas in which contaminants have been found.

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 Division of Water Quality; Grand County; City of Moab

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

Period of Project: October 1995 to September 1996

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 the valley fill 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 valley-fill and Navajo aquifers; (2) dissolved-solids concentration in water from wells in the valley-fill and Navajo aquifers; 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 valley-fill aquifer and 10 springs or wells completed in the Navajo aquifer; analyze the samples for common ions, inorganic constituents, metals, and nutrients; and analyze samples from 12 of the 30 sites for organic constituents; (3) interpret geologic maps and aerial photographs to delineate recharge areas for the valley-fill and Navajo aquifers; and (4) prepare water-quality and recharge-area maps for publication and write the interpretive report.

Progress: The interpretive report has been completed and is in review.

Plans for Next Year: Print and release the interpretive report.

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 development of coal-bed methane resources 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 concentration in water samples from about 30 wells and springs in the study area, (2) determine soil-gas methane concentration 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: Soil-gas samples will be collected from about 30 sites adjacent to active and plugged gas wells. Methane concentration will be determined onsite using a gas chromatograph with a flame ionization detector.

Progress: Maps were prepared showing the location of active and abandoned oil and gas wells in the study area, and sampling sites were selected. During September 1996, 33 soil-gas samples were collected and analyzed for methane concentration. Data were tabulated and discussed with the State cooperator.

Plans for Next Year: There are currently no plans for next year; however, the cooperator has expressed an interest to continue monitoring if funds become available.

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; City of Grantsville

Staff: P.M. Lambert, Hydrologist, Project Chief
M. Stanger, Geographer, University of Utah (part time)

Period of Project: August 1995 to March 1998

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 withdrawal is expected to cause water levels to decline and may require well owners to lower pumps or deepen wells. Lower water levels also could reduce the discharge from flowing wells, the discharge to springs, and 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 sulfate concentrations 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 sodium chloride concentrations that could be related to dissolution of evaporites deposited in ancient lakes. Industrial wastewater containing organic solvents has contaminated ground water at Tooele Army Depot. Some ground water near Bates Canyon has a nitrate concentration that is greater than State drinking-water standards. Increased ground-water withdrawal and resultant water-level decline 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 better manage development of the principal aquifer.

Objectives: 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 numerical model of ground-water flow in Tooele Valley, and (3) application of the numerical 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: Work has focused on the development of a conceptual model and a computer model of regional ground-water flow in Tooele Valley. Data obtained during previous studies and new data collected during this study were analyzed and synthesized into a conceptual model that quantifies (1) the geometry and physical properties of the basin-fill aquifer system in the valley, and (2) recharge to and discharge from that system.

Initial estimates of computer-model parameters were specified based on ranges of probable values defined in the conceptual model and were incorporated into a 5-layer, finite-difference, numerical model of the ground-water system. Currently, the model is being calibrated to conditions observed during 1963-68 by comparing model-computed and measured water level, and model-computed and estimated flow, at selected recharge and discharge boundaries.

Data defining historic and current ground-water conditions at Tooele Army Depot have been compiled and formatted for use during development of the solute-transport model of the area.

Plans for Next Year: Work during 1997 will focus on completing the conceptual and computer models of the ground-water flow system in Tooele Valley. A report documenting the models will be completed and submitted for editorial and technical review. Work will begin on development of the solute-transport model of Tooele Army Depot. Methods will be developed to allow the solute-transport model to work in conjunction with the ground-water flow model of the valley.

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 1996

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 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 Nation 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 the increasing number of tourists.

Objectives: 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 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 concentration; and (4) construct maps and cross sections showing the geology of the consolidated rocks 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 DeChelly Sandstone.

Progress: A monitoring-well network was designed and 11 monitoring wells were drilled into the alluvial aquifer; water levels in monitoring wells and other selected wells were measured; all wells and springs in the study area were inventoried and the data were entered into the USGS data base, and selected wells were sampled for major-ion analysis.

Plans for Next Year: Conduct an aquifer test at a previously drilled monitoring well and measure drawdown in adjacent observation wells; conduct geophysical resistivity surveys across parts of the Oljeto Wash aquifer using previously drilled monitoring wells as control points; and collect additional water samples for major-ion analysis. Water levels also will be determined at least monthly in wells in the study area. Upon completion of the aquifer test and geophysical surveys, interpretive reports will be written and submitted to region for approval.

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 the shrimp population throughout the year, (2) measure variations in nitrogen and phosphorus concentrations at selected sites throughout the year, (3) measure the 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 input to a population model being developed at Utah State University.

Progress: Established 15 randomly selected sites and sampled each site monthly. Established procedures with USGS Central Laboratory for analysis of nutrients in brine. Completed design of data-base management system and entered all shrimp data and nutrient and phytoplankton data for 1995-96. It was determined that the usual chlorophyte phytoplankton community was replaced by a diatom community. Associated with the diatom dominance were 2 years of record shrimp cyst production.

Plans for Next Year: Complete analysis of samples and write data report.

Hill Air Force Base Natural Resources Data Base Design

Number: UT-95-241

Cooperating Agency: U.S. Air Force, Hill Air Force Base Environmental Management Directorate Natural Resources Group

Staff: R.L. Baskin, Hydrologist, Project Chief

Period of Project: June 1995 to September 1997

Problem: New emphasis has been placed on the value of digital information within the Federal Government and on digital spatial data in particular. A need exists in the Hill Air Force Base Environmental Management Directorate Natural Resources Group to develop an on-line system to manage digital spatial data, associated computer programs, standardized procedures and data-set naming conventions, and related documentation to support a variety of natural resource and data-base applications. The Directorate would like to have a data-base management system that is compatible with the systems currently in use at the Water Resources Division of the USGS, the State of Utah Automated Geographic Reference Center (AGRC), and the Natural Resources Department at Utah State University (USU). Currently, no such system exists at the Directorate.

Objective: Design and install a spatial data-base management system on the computer system of the Hill Air Force Base Environmental Management Directorate Natural Resources Group that is compatible with the geographic information system of the Water Resources Division of the USGS, the State of Utah AGRC, and the Natural Resources Department at USU.

Approach: (1) Review AGRC and USU data-base structures, (2) outline data-base structure and data requirements, (3) design data-base templates, (4) review digital data-base design with Directorate and make necessary changes, (5) install data-base structure on Directorate computer, and (6) provide administrative report detailing the data-base concepts and structure.

Progress: The data base has been designed, tested, and installed on the computer system of the Hill Air Force Base Environmental Management Directorate Natural Resources Group. A student was hired by the Directorate to prepare spatial data for inclusion in the spatial data-base management system. An administrative report has been prepared and printed.

Plans for Next Year: Provide support for operation and maintenance of the spatial data-base management system as needed.

Field Demonstration of In-Situ Chemical Barriers to Control Uranium Contamination in Ground Water, Fry Canyon, Utah

Number: UT-96-242

Cooperating Agencies: U.S. Environmental Protection Agency; Bureau of Land Management; U.S. Department of Energy; Utah Department of Environmental Quality

Staff: D.L. Naftz, Hydrologist, Project Chief
G.W. Freethey, Supervisory Hydrologist (part time)
Ryan Rowland, Hydrologic Technician (student)

Period of Project: October 1995 to September 1999

Problem: Potable ground-water supplies worldwide are contaminated or threatened by advancing plumes containing radionuclides and metals. Passive in-situ chemical barriers may offer a cost-effective alternative or supplement to pump-and-treat technologies for controlling ground-water contamination. An in-situ chemical barrier is a permeable zone of reactive materials that are placed in the subsurface to remove ground-water contaminants and results in clean ground water exiting from the treatment zone. Laboratory experiments have indicated the usefulness of chemical barriers; however, field demonstrations of these technologies are needed to test their usefulness for ground-water clean up. Abandoned and unreclaimed tailings from uranium-upgrading and copper-leaching operations adjacent to Fry Creek provide a site for the field demonstration of chemical-barrier technology to remove uranium from ground water. The Fry Canyon site is located on Bureau of Land Management property.

Objectives: (1) Characterize the pre-demonstration hydrologic and geochemcial conditions in the shallow groundwater system at the Fry Canyon site; (2) assess developed technologies for application to the site, including laboratory experiments to obtain site-specific operating parameters; (3) design the field demonstration and obtain necessary permits; (4) perform the field demonstration; and (5) evaluate the performance of the field system and determine cost effectiveness of the process.

Approach: The investigation will be completed in five phases: (1) Characterize the pre-demonstration hydrology and geochemistry of the shallow ground-water system(s) using standard techniques, (2) use tailings and ground water collected from the site in laboratory experiments to obtain operating parameters for the field demonstration, (3) use laboratory and field data to design the field demonstration, (4) install the chemical barrier and conduct and monitor the field demonstration, and (5) use data collected from the field demonstration to determine method effectiveness and develop cost estimates for commercialization of the technique.

Progress: A multi-agency and multi-discipline study team was assembled, and initial organizational meetings were conducted. A project work plan was completed and approved by the study team. Regulatory approval was obtained for objective 1 field activities. An alternative site list of other abandoned uranium mines was prepared in the event that the Fry Canyon site was found to be unsuitable. Eight monitoring wells were installed. Chemical and physical characterization of the sediment samples collected during drilling was initiated. Water samples were collected and analyzed for selected field parameters and major- and trace-element concentrations. Slug tests were conducted in selected monitoring wells. Water levels were measured in the monitoring wells. A pressure transducer was installed in well FC2 to determine and monitor stream/aquifer interaction at the site. An abstract describing the initial study results was submitted and accepted for an upcoming scientific meeting.

Plans for Next Year: Complete objective 1, hydrologic characterization activities at Fry Canyon site, including (1) chemical and physical characterization of the solid-phase material, (2) field and lab column tests using possible barrier materials, (3) determination of aquifer properties (potentiometric surface, gradient, and hydraulic conductivity), (4) baseline geochemistry of the ground water, and (5) meeting with Fry Canyon study team to determine site suitability. Publish the results of the objective 1 hydrologic characterization activities at Fry Canyon. Attend a scientific meeting on chemical barriers. Address hydrologic, regulatory, and design requirements prior to installing the chemical barrier(s) at the Fry Canyon site. Install the barrier(s) and begin field-monitoring activities to assess the barrier(s) performance.