WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN UTAH, OCTOBER 1, 1997, TO SEPTEMBER 30, 1998

Compiled by Ellen E. Hardy and Stefanie L. Dragos

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, 1997, to September 30, 1998. The water-resources program in Utah during this period consisted of 25 projects, and a discussion of each project is presented.

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 1998 (FY98) (October 1, 1997, to September 30, 1998), 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 1997 to September 1998.

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 "Science for a changing world."

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 project work is supplied by the Administrative Section and the Scientific Information Management Section (SIM). The SIM section consists of four units—Publications, Computer, Data Management, and Geographic Information Systems.

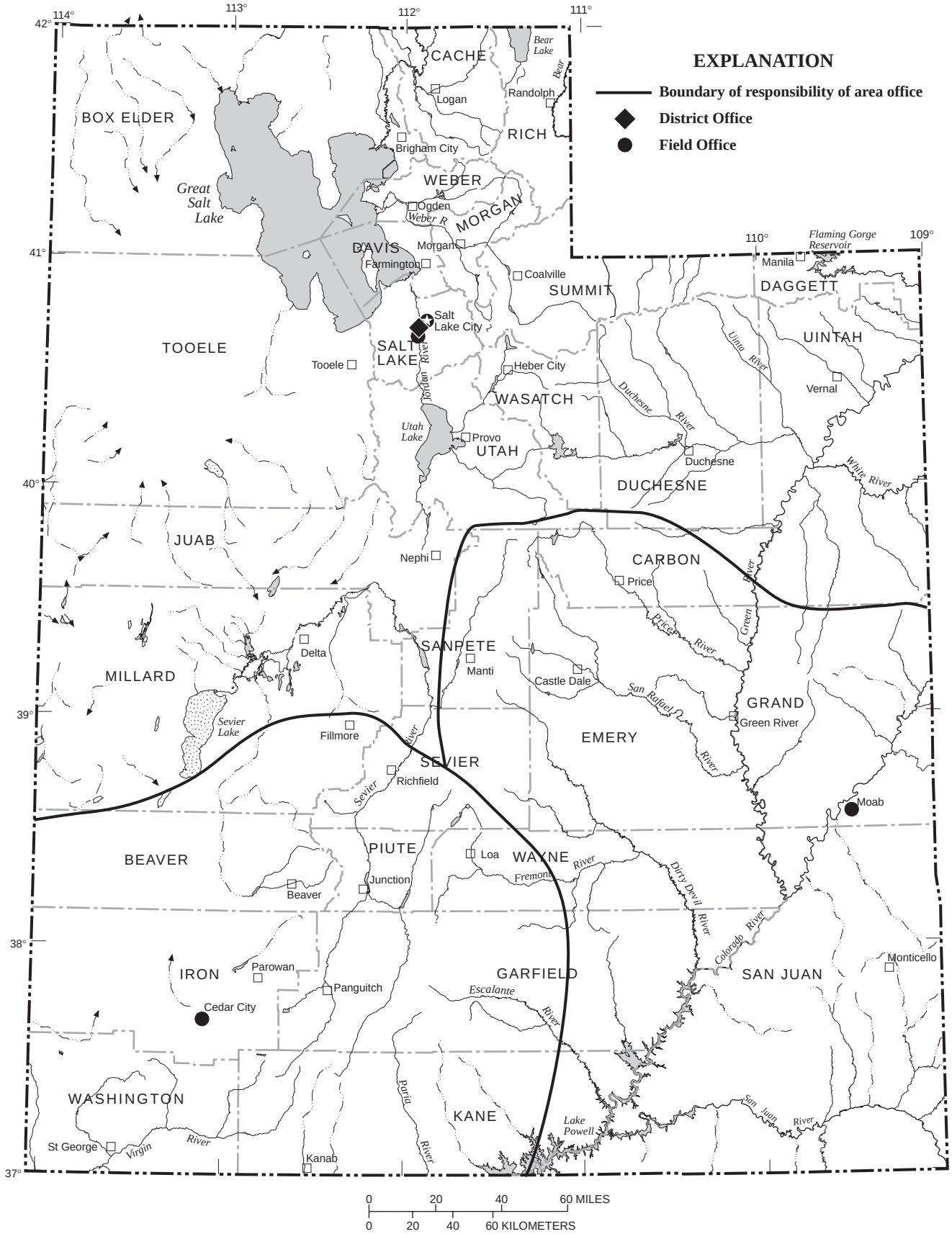

Figure 1. Location of U.S. Geological Survey, Water Resources Division, offices and general areas of responsibility.

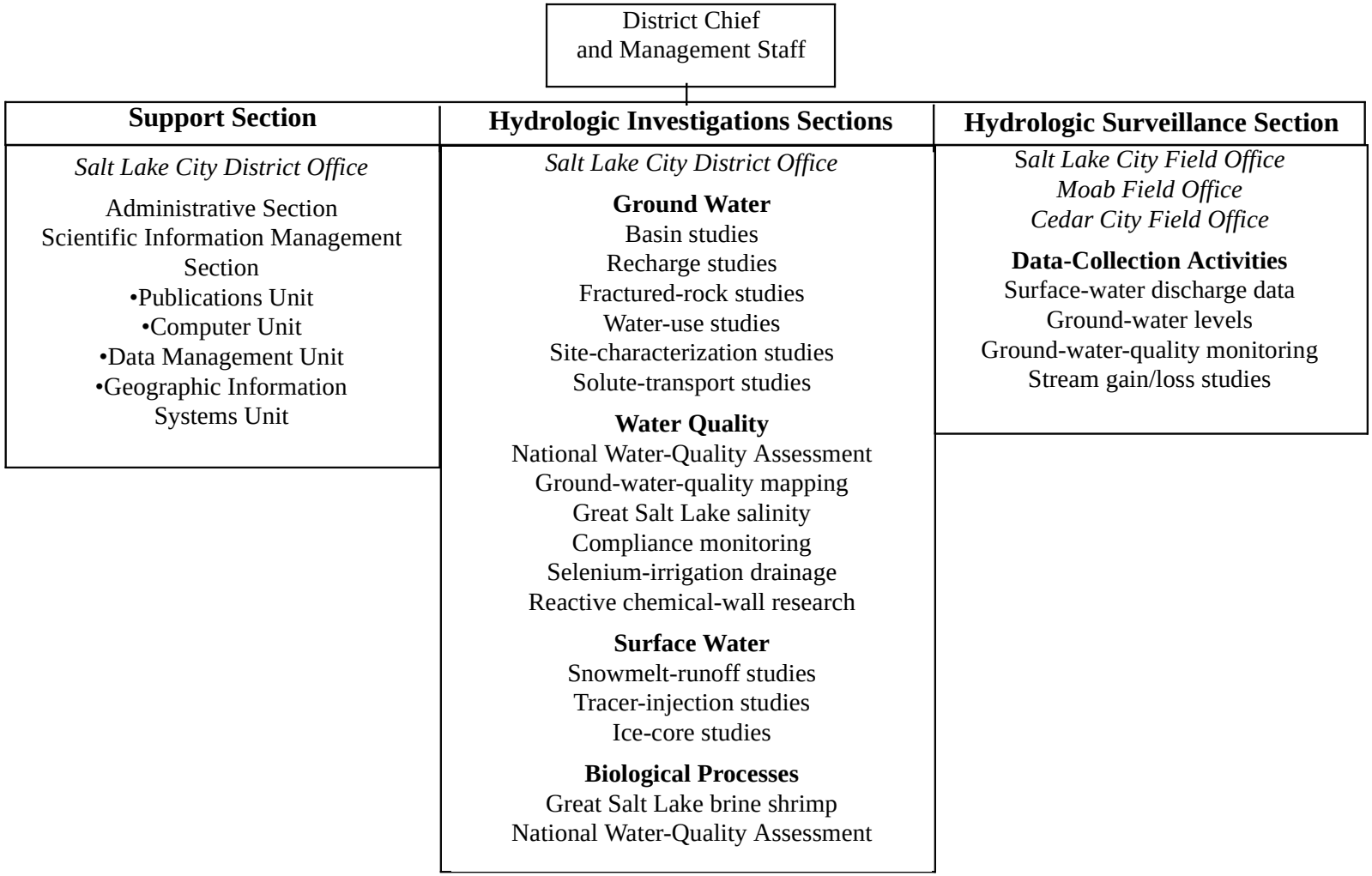

Figure 2. Organization of the Utah District.

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
(435) 259-5495

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

Cedar City Field Office
(435) 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 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 FY97, total financial support from these programs for the Utah District was about $5.4 million. The amount of funding received from each of the three sources is:

FY 98		
OFA	1,181,554	22%
Federal	1,597,520	29%
Cooperative	2,637,050	49%
Total	5,416,124	100%

In FY98, 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, 39 percent was for interpretive studies and areal appraisals, and 11 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 represented as:

	FY 98 information	
Collection of data	2,685,281	50%
Interpretive Studies	2,120,625	39%
Research Projects	610,218	11%
Total	5,416,124	100%

Reports Released or Published

The following reports were released or published from October 1, 1997, to September 30, 1998:

Brooks, L.E., Mason, J.L., and Susong, D.D., Hydrology and snowmelt simulation of Snydervile Basin, Park City, and adjacent areas, Summit County, Utah, Utah Department of Natural Resources Technical Publication No. 115, 84 p.

Gerner, S.J., and Steiger, J.I., Ground-water conditions in Utah, spring of 1997, Utah Department of Natural Resources Cooperative Investigations Report No. 38, 121 p.

Hardy, E.E., and Dragos, S.L., Water-resources activities of the U.S. Geological Survey in Utah, October 1, 1995, to September 30, 1996, U.S. Geological Survey Open-File Report 97-578, 36 p.

Hardy, Ellen E., and Dragos, S.L., Water-resources activities of the U.S. Geological Survey in Utah, October 1, 1996, to September 30, 1997, U.S. Geological Survey Open-File Report 98-277, 38 p.

Herbert, L.R., and others, Water resources data for Utah, water year 1997: U.S. Geological Survey Water-Data Report UT-97-1, 288 p.

Holmes, W.F., Pyper, G.E., Gates, J.G., Schaefer, D.H., and Waddell, K.M., Hydrology and water quality of the Beaver Dam Wash area, Washington County, Utah, Lincoln County, Nevada, and Mohave County, Arizona, U.S. Geological Survey Water-Resources Investigations Report 97-4193, 71 p.

Mason, J.L., and Kipp Jr., K.L., Investigation of Salt Loss from the Bonneville Salt Flats, northwestern Utah, U.S. Geological Survey Fact Sheet 135-97, 4 p.

Mason, J.L., and Kipp Jr., K.L, Hydrology of the Bonneville Salt Flats, northwestern Utah, and simulation of ground-water flow and solute transport in the shallow-brine aquifer, U.S. Geological Survey Professional Paper 1585, 108 p.

Mason, J.L., Ground-water hydrology and simulated effects of development in the Milford Area, an arid basin in southwestern Utah, U.S. Geological Survey Professional Paper 1409-G, 69 p.

Naftz, D.L., Hadley, H.K., and Hunt, G.L., Determination of methane concentrations in shallow ground water and soil gas near Price, Utah, U.S. Geological Survey Fact Sheet FS 191-97, 4 p.

Steiger, J.I., and Susong, D.D., Recharge areas and quality of ground water from the Glen Canyon and valley-fill aquifers, Spanish Valley area, Grand and San Juan Counties, Utah, U.S. Geological Survey Water-Resources Investigations Map Report 97-4206, 4 sheets.

Susong, D.D., Chemical quality of water in consolidated rock and the basin-fill aquifer, west side of the Oquirrh Mountains, Tooele County, U.S. Geological Survey Water-Resources Investigations Report 97-4247, 2 sheets.

Susong, D.D., Burden, C.B., and others, Ground-water conditions in Utah, Spring of 1998, Utah Department of Natural Resources Cooperative Investigations Report No. 39, 120 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 movement through the causeway. U.S. Geological Survey, Water-Supply Paper 2450, 64 p.

Wilkowske, C.D., Heilweil, V.M., and Wilberg, D.E., Selected hydrologic data for the central Virgin River basin area, Washington and Iron Counties, Utah, 1915-97, U.S. Geological Survey Open-File Report 98-389, 53 p.

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

U.S. Geological Survey **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 **Salt Lake Information Office** **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.

Collection of Hydrologic Data

Surface-Water Data

Number: UT-00-001

Cooperating Agencies: Bureau of Reclamation; 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 to better manage and plan for 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 153 streamflow-gaging stations and contents and stage records for 14 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	122
Hydrologic data	30
Benchmark	1
Contents of reservoirs and lakes	11
Stage of Great Salt Lake	3

Three streamflow-gaging stations were discontinued as of September 30, 1998. They were:

09286100	Red Creek above Reservoir, near Fruitland
09329050	Seven Mile Creek near Fish Lake
10172791	Settlement Creek above Reservoir, near Tooele

Plans for Next Year: Continue operation of network. Prepare 1998 water-year records for publication.

Report:

Herbert, L.R., and others, 1998, Water resources data for Utah, water year 1997: U.S. Geological Survey Water–Data Report UT-97-1.

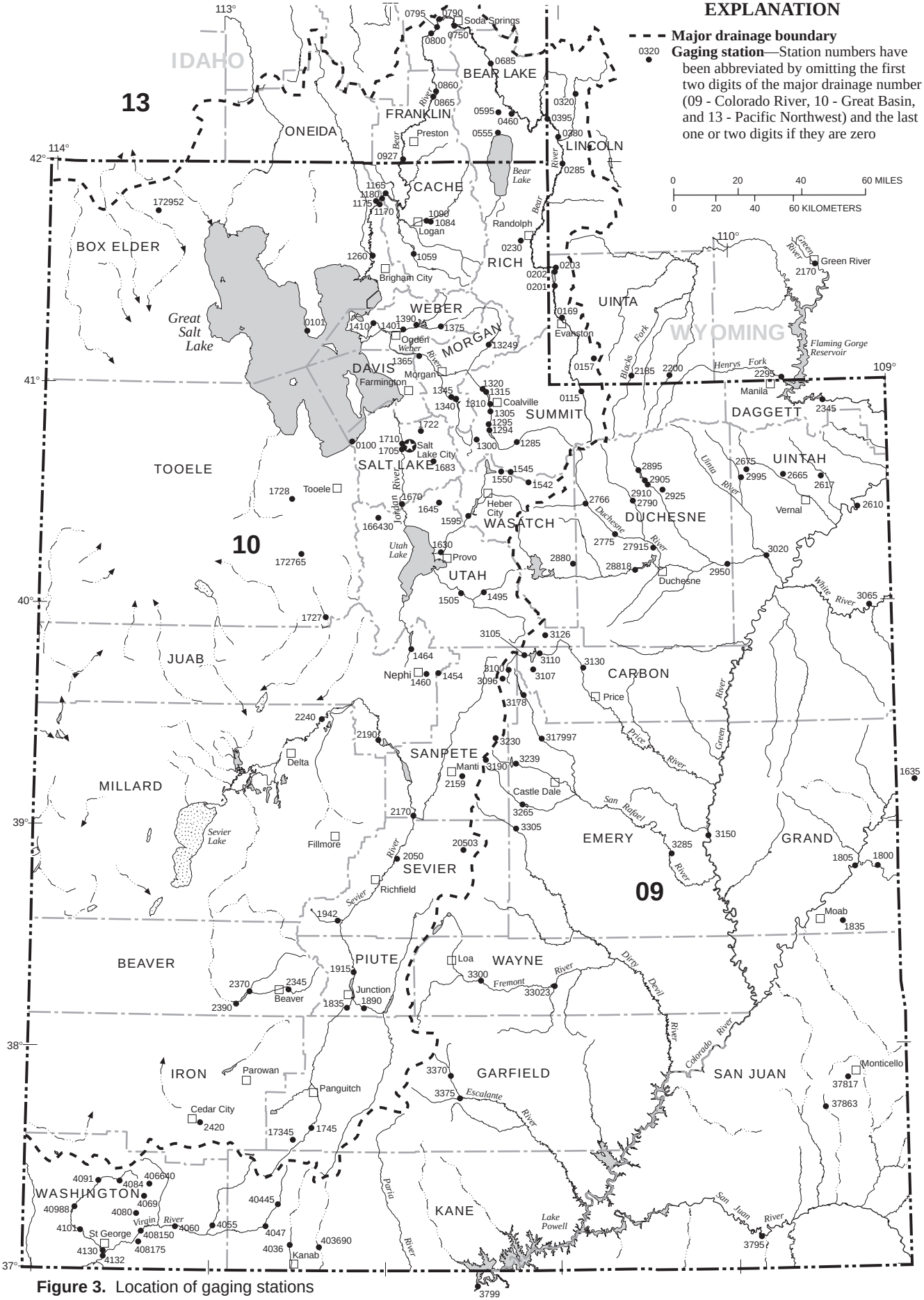

Figure 3. Location of gaging stations

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: Water levels were measured in about 1,000 wells in February and March. In addition, the water level in 25 of these wells was measured monthly, and continuous water-level records 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 35th 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 36th in the series of annual reports on ground-water conditions will be compiled.

Reports:

Susong, D.D., Burden, C.B., and others, 1998, Ground-water conditions in Utah, spring of 1998: Utah Department of Natural Resources Cooperative Investigations Report No. 39, 120 p.

Herbert, L.R., and others, 1998, Water resources data for Utah, water year 1997: U.S. Geological Survey Water–Data Report UT-97-1.

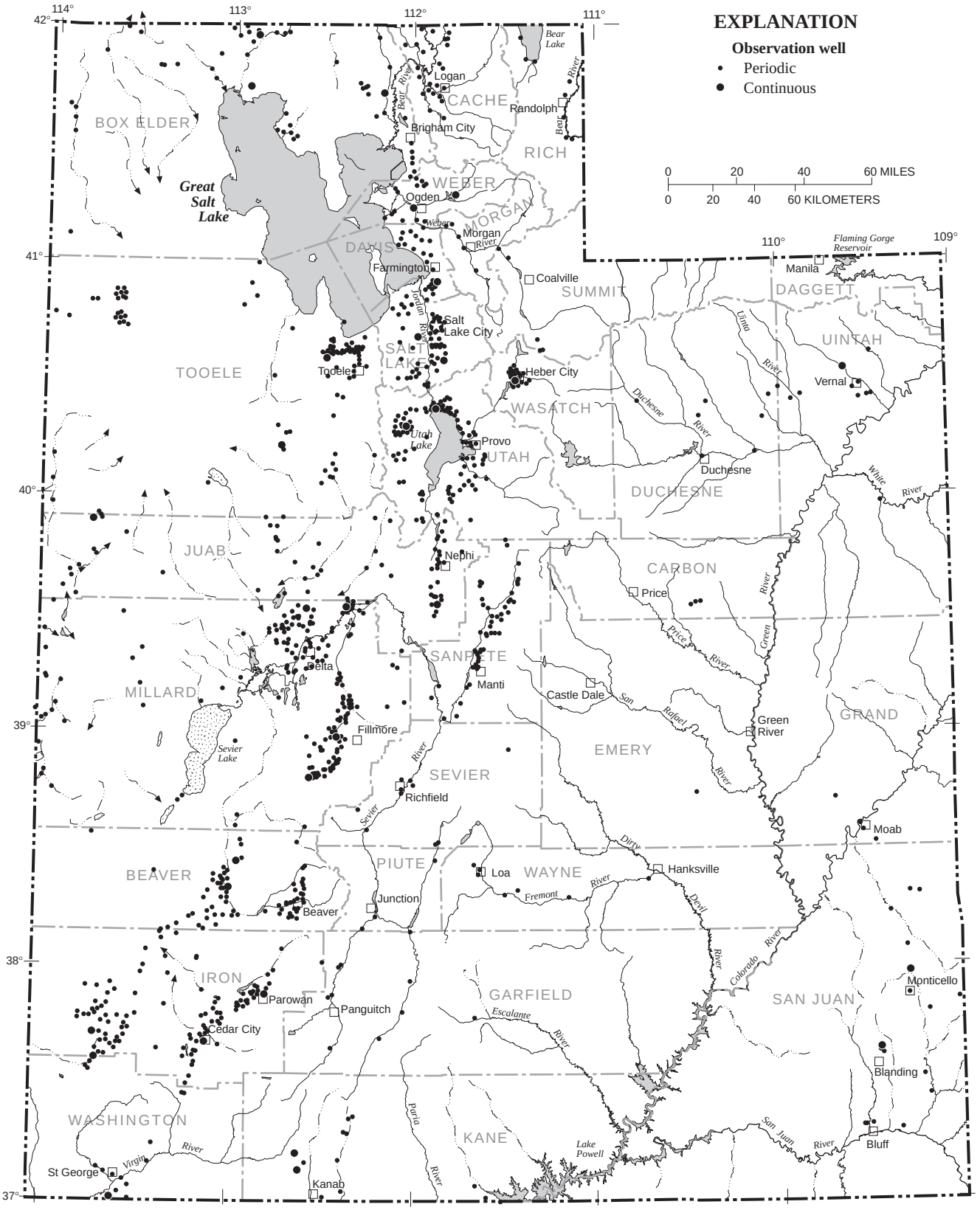

Figure 4. Location of observation wells in which water levels were measured.

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 water-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), of which complete chemical analyses were obtained from about 70 wells. Water from about 20 surface-water sites in Utah, Uintah, and Duchesne Counties was sampled using the USGS parts per billion inorganic sampling protocol. All water-quality data for streams and wells are listed in the annual water-resources data reports. Sediment data were obtained during controlled releases at six sites and periodically at three additional sites. Supervision of the acid-rain network site near Green River continued.

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. Continue supervision of acid-rain network site near Green River.

Report:

Herbert, L.R., and others, 1998, Water resources data for Utah, water year 1997: U.S. Geological Survey Water-Data Report UT–97–1.

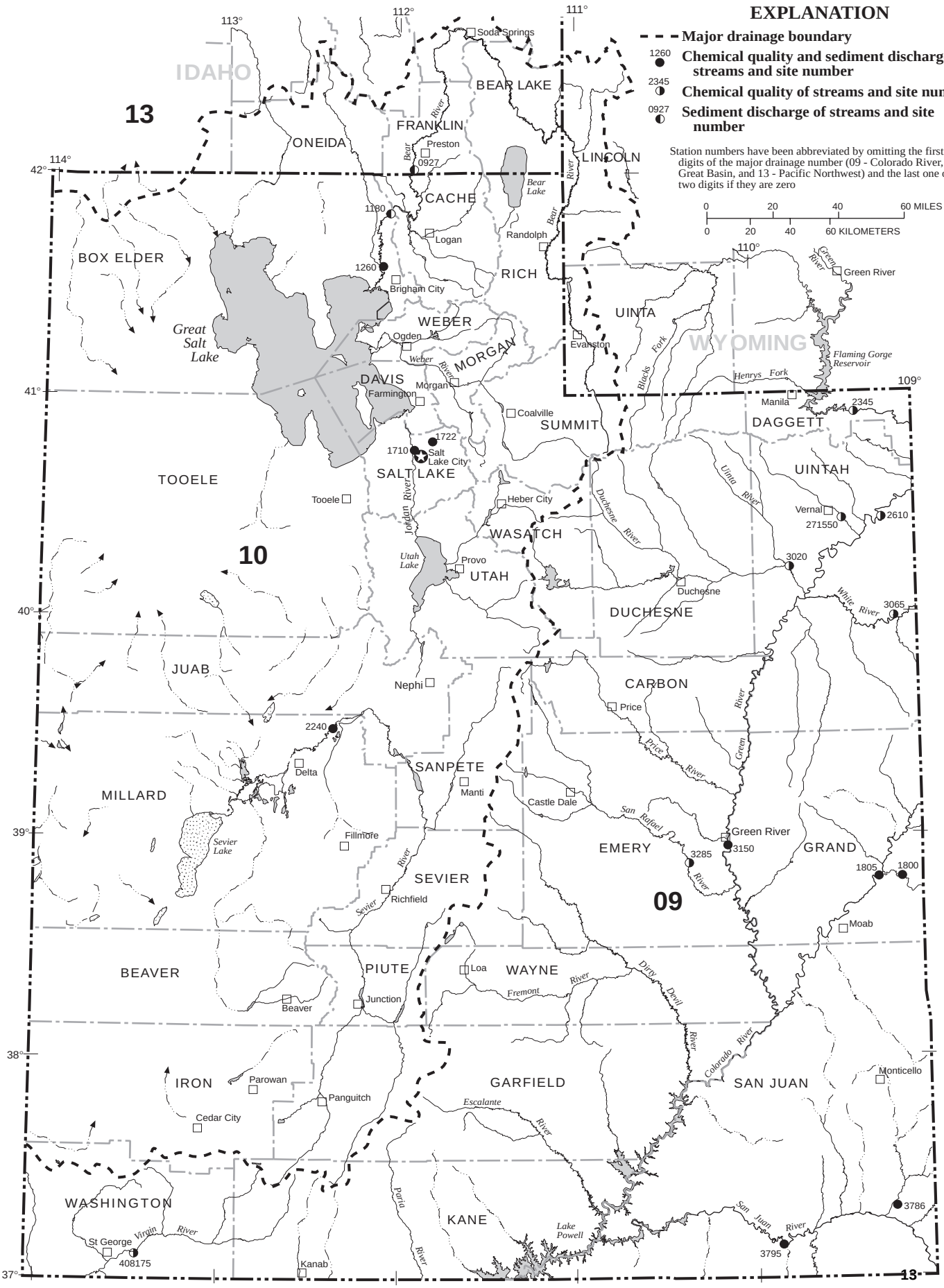

Figure 5. Location of surface-water-quality stations.

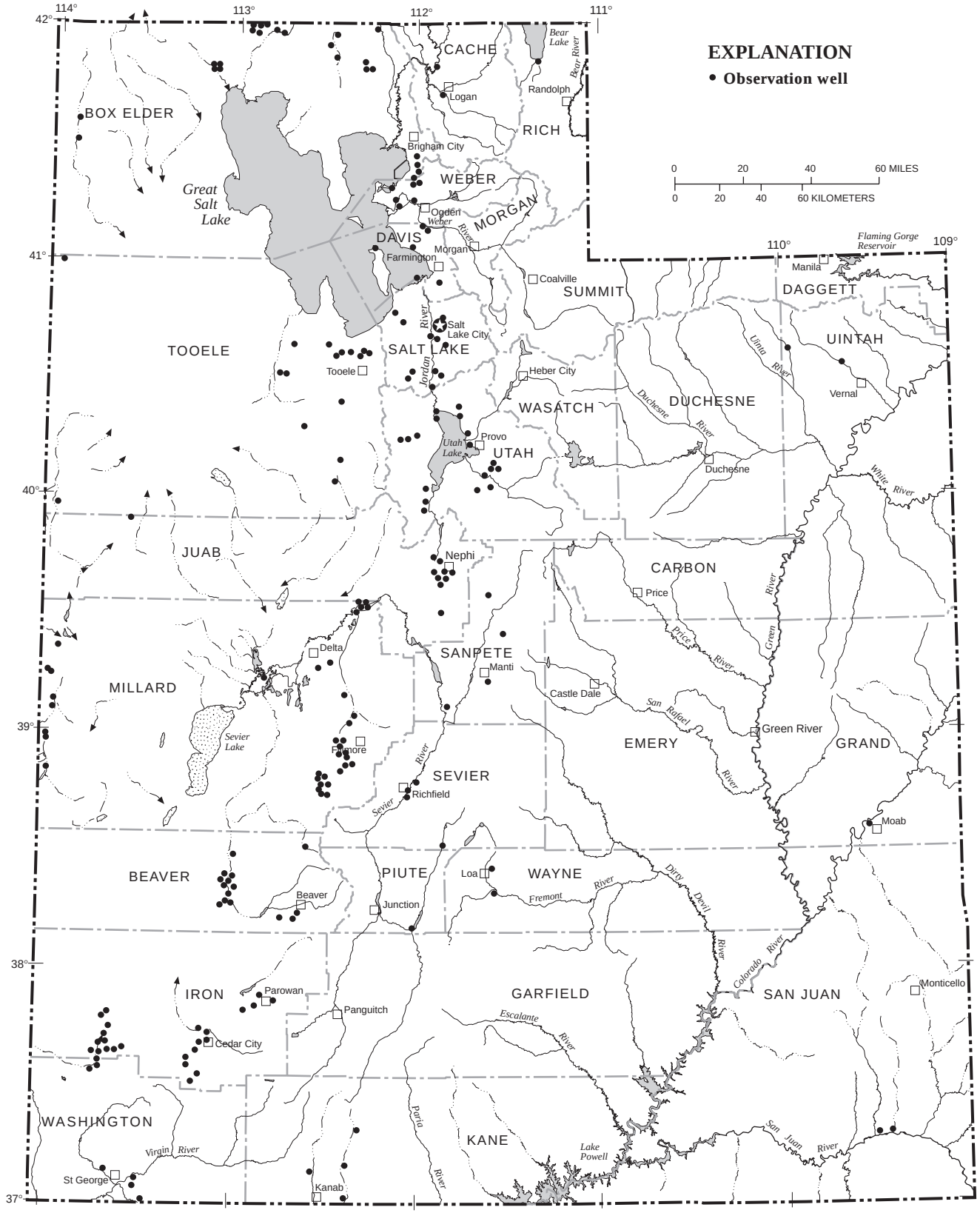

Figure 6. Location of observation wells from which water samples were collected for monitoring water quality.

Interpretive Studies

The location of each interpretive study discussed in this section is 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: July 1977—Continuing

Problem: In 1977, the U.S. Congress recognized the need for consistent, current, and reliable water-use information on water for the entire United States and directed the USGS to establish 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 for each use category.

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. During a noncompilation year, focus was placed on outreach activities. For the Utah State Fair, a water use poster was created which illustrated total withdrawals; ground-water and surface-water components of those total withdrawals; public supply and agricultural withdrawals; and ground-water and surface-water components of those withdrawals for 1985, 1990, and 1995.

Plans for Next Year: A fact sheet will be created for comparison of 1985, 1990, and 1995 water-use data in Utah.

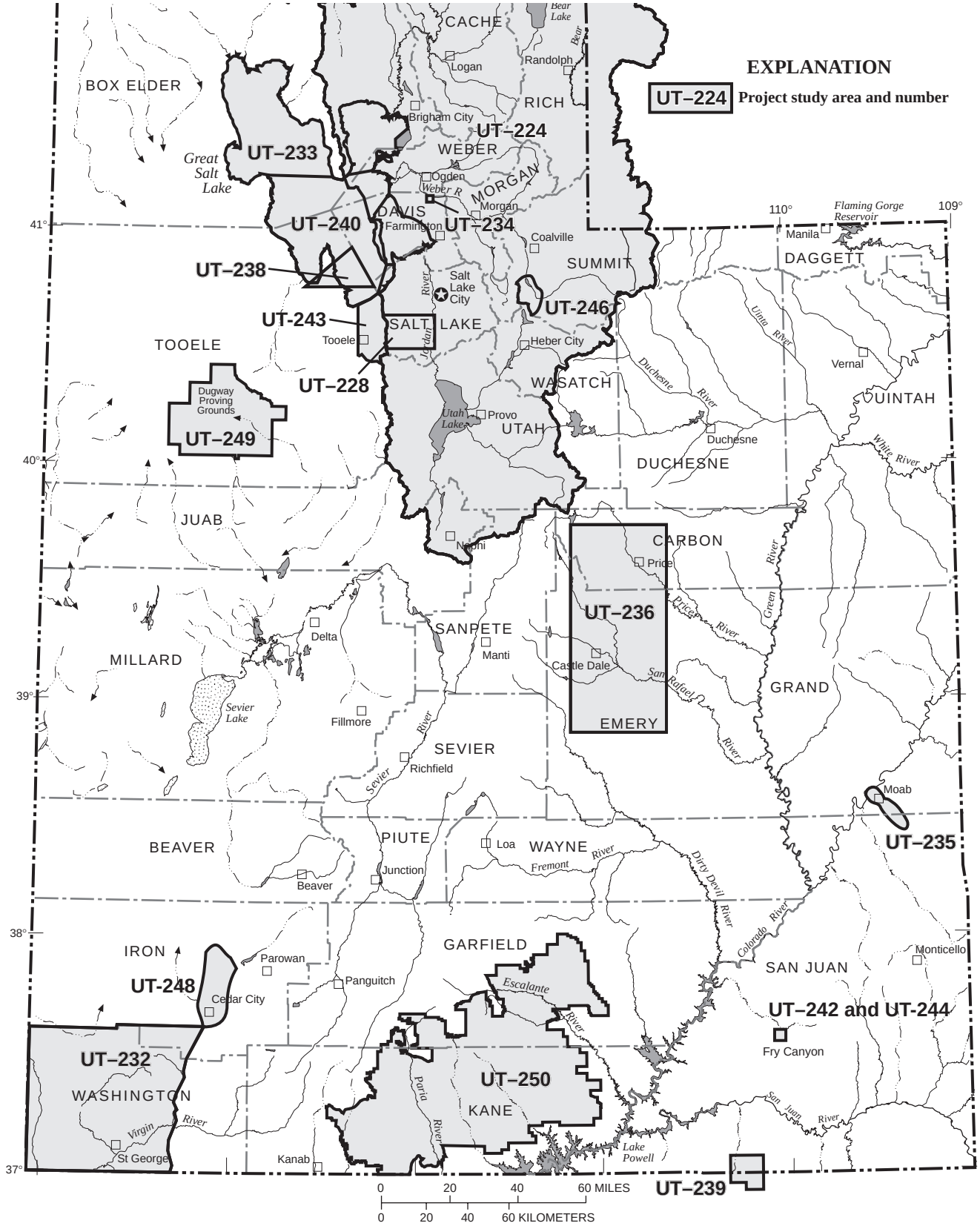

Figure 7. Location of interpretive studies done in the State of utah

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 Western United States has yielded metals with significant economic value. Water flowing through abandoned tailings and from draining mine adits contributes cadmium, copper, iron, lead, manganese, nickel, and zinc to hundreds of streams. Reactive solute-transport processes affecting these metals are not well quantified. An interdisciplinary study of controls on trace-element concentration in streams throughout the West will allow a better understanding of the transport and removal mechanisms involved.

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; (2) characterize the chemistry of sediment and sediment coatings that are active in controlling the dissolved concentration of trace elements; and (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.

Approach: Spatial profiles of pH, metal concentrations, and major solutes in streams affected by acid mine drainage are the result of the interaction of hydrologic and geochemical processes. One of the most useful ways to study these processes and to gain understanding of the many contributions to metal loading in streams is with tracer-injection studies. Tracers are used to calculate discharge throughout a stream reach. Samples of water and colloids are collected to study geochemical processes in the context of hydrologic transport. This also results in characterization of a watershed with a detailed profile of metal loading to the stream so that all the sources can be considered.

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
S.A. Thiros, Hydrologist
H.K. Hadley, Hydrologist
D.W. Stephens, Biologist
E.M. Giddings, Biologist
S.J. Gerner, Lead Hydrologic Technician
Jay Cederberg, Technician

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 as 1 of 60 nationwide 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: A mobile laboratory has been procured and equipped. A subunit survey for ground water was completed and the second one was initiated. Bed-sediment and tissue sampling was completed during late summer of FY98. Streamflow gages and other water-quality monitoring equipment were installed as needed. Existing water-quality data were compiled and evaluated and a draft report was prepared. A biologist, technician, and two students were added to fully staff the NAWQA project. Other district personnel were trained for operating the sampling sites.

Plans for Next Year: Complete retrospective reports for ground water, surface water, biology, and environmental setting. Complete second subunit survey for ground water and fist land-use ground-water survey for an urban area. Do surface-water synoptic survey for an urban area, ecological surveys, and bed sediment and tissue sampling at selected stream sites, collect monthly water-quality data at 10 surface-water sites. Attend National NAWQA training session.

Kennecott Utah Copper Plume

Number: UT-94-228

Cooperating Agency: U.S. Environmental Protection Agency

Staff: B.J. Stolp, Hydrologist, Project Chief
J.L. Mason, Hydrologist (part time)
W.F. Holmes, Supervisory Hydrologist (part time)
H.K. Hadley, Hydrologist (part time)

Period of Project: August 1994 to September 1999

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 Valley 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. Copper, selenium, and other metals also have been introduced to surface and ground water at the northern end of the Oquirrh Mountains. Kennecott Utah Copper, Inc. (KUC) is the responsible party and principal investigator of this contamination study, which qualifies for the National Priority List but has not been listed.

Objective: The U.S. Environmental Protection Agency (EPA), KUC, and the Utah Department of Environmental Quality (UDEQ) 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: As part of the RI/FS process, KUC will (1) install monitoring wells, (2) conduct aquifer tests, and (3) collect and analyze ground-water samples. The USGS will periodically observe these activities to ensure adherence to KUC standard operating procedures. KUC will incorporate the results of their analyses of field data into conceptual and computer models of the contaminated areas and will evaluate remedial alternatives. USGS personnel will critique documents, oversee the development of computer models, and provide technical assistance as the need arises. To ensure appropriate expertise, USGS personnel, both locally and nationally, will be consulted.

Progress: USGS personnel provided technical reviews of geochemical studies and ground-water flow modeling. The reviewed work is part of the appendices and body of the RI/FS for southwestern Salt Lake Valley and the RI for the North Zone. USGS personnel attended all Technical Review Committee meetings held in FY98.

Plans for Next Year: The USGS will continue to provide, as needed, technical review and advice on each phase of the RI/FS for both the North Zone and southwestern Salt Lake Valley sites. Results of geochemical, ground-water flow, and solute transport models will be reviewed.

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
C.D. Wilkowske, Hydrologic Technician (part time)
G.W. Freethey, Supervisory Hydrologist (part time)
B.J. Stolp, Hydrologist (part time)
D.E. Wilberg, 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 that 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 help State and local water-resource managers plan for growth in ground-water use without jeopardizing the resource. Objectives are to (1) quantify the ground-water resources in the Navajo Sandstone aquifer and New Harmony/Kanarraville alluvial aquifer, and (2) review the potential water-yielding capability of other significant aquifers within the study area.

Approach: Phase 1: Compile, synthesize, and collect appropriate surface-water, ground-water, and water-quality data. Phase 2: Investigate the lithologic character, structure, and stratigraphic relation of the formations that make up the important aquifers of the area. Phase 3: Analyze and interpret the data and conceptualize and describe the hydrologic system. Phase 4: Develop ground-water flow models and simulate movement of ground water into, within, and from the Navajo Sandstone aquifer and the New Harmony aquifer system.

Progress: Data-base entry for the water-level inventory (about 60 wells) was completed; the 5 aquifer tests (Hurricane Bench, Gunlock well field, Grapevine Pass, Anderson Junction, and New Harmony) were analyzed; and Regional approval of the results was obtained. The ground-water flow models of the New Harmony basin aquifer system and the central part of the Navajo Sandstone aquifer have been completed. Sources of recharge to the Navajo aquifer have been more clearly identified from geochemical data. The data report containing water-level, water-chemistry, and discharge data has been printed.

Plans for Next Year: Develop a ground-water flow model for the Gunlock part of the Navajo aquifer, refine the central part of the Navajo aquifer and New Harmony basin aquifer system ground-water flow models, and prepare an interpretive report on the central Virgin River basin ground-water study, including documentation of the three ground-water flow models.

Modification and Verification of Model for Predicting the Water and Salt Balance of Great Salt Lake, Utah

Number: UT-98-233

Cooperating Agencies: Utah Division of Water Resources; Utah Division of Natural Resources; Tooele County

Staff: S.R. Wold, Hydrologist, Project Chief
K.M. Waddell, Hydrologist (part time)

Period of Project: October 1998 to September 1999

Problem: Great Salt Lake is a highly complex and dynamic hydrologic system for which a numerical model is used to provide insight into the dynamic response of the water and the salt balance for variable climatic conditions. The original model of Waddell and Bolke (1973) was used to determine the effects of different widths of causeway culverts on the elevation difference between the north and south parts of the lake and to help design a breach that was constructed in 1984 to alleviate flooding along the shores of the south part of the lake. The model was revised in 1996 so that it would be valid for higher lake levels and modified conveyance properties by Wold, Thomas and Waddell (1997). The model currently requires verification because the hydraulic properties of the causeway fill have changed with the addition of more fill material to raise and maintain the causeway and also because of compaction with time.

Objectives: To verify, and if necessary, further calibrate the model of Wold, Thomas, and Waddell (1996) using data collected during 1987-97.

Approach: The basic capabilities of the model by Wold, Thomas, and Waddell (1997) will not be revised, but the model will be verified with existing data. (1) Monthly inflow and evaporation will be computed for 1987-97. (2) All culvert and or breach measurements and associated data will be compiled for 1987-97. (3) The dissolved loads of salts for all sampling during 1987-97 will be computed. (4) The seepage through the causeway fill will be revised indirectly, if necessary, by calibration of the overall model after the other components of model have been verified.

Progress: The 1987-97 water balance for Great Salt Lake has been calibrated.

Plans for Next Year: Compile the salt balance, and calibrate the model for 1987-97 breach and culvert discharge. Calibrate the overall model and permeability of the causeway fill material for 1987-97.

References:

Waddell, K.M., and bolke, E.L., 1973, The effects of restricted circulation on the salt balance of Great Salt Lake, Utah: Utah Geological Survey Water-Resources Bulletin 18, 54 p.

Wold, S.R., Thomas, B.E., and Waddell, K.M., 1997, Water and salt balance of Great Salt Lake, Utah, and simulation of water and salt movement through the causeway: U.S. Geological Survey Water-Supply Paper 2450, 64 p.

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 (part time)
M.M. Jarman, Physical Scientist

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: Continued to integrate lease data base into EMR-GIS. Helped EMR-GIS administrator develop maps and tools for use on network intranet. Continued updates to design files to support publication on network intranet. Supported project managers and others with GIS tools and relational data base retrievals.

Plans for Next Year: Continue to support GIS requests. Continue work within EMR-GIS data base in preparation for network intranet publications. Support implementation of pump-and-treat system in Landfill OU5 south gage area. Aid in preparation of maps, posters, and presentations for UGIC meeting in November. Training in GIS, hydrology, geomorphology, and hazmat, as 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 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 help 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 was published and distributed.

Plans for Next Year: None.

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 1998

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 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 about 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: A poster describing the results of the project was prepared and presented at a local government meeting in March 1998. An oral presentation discussing the results of the project was presented to the Utah Geological Association in June 1998. Forty sites were sampled for methane concentration in soil gas during September 1998. The results were tabulated and prepared for transmittal to the cooperator. A fact sheet discussing data collected over the last 2 1/2 years was published and distributed.

Plans For Next Year: Results of the 1998 sampling and analysis will be transmitted 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; City of Grantsville

Staff: B.J. Stolp, Hydrologist, Project Chief

Period of Project: August 1995 to April 1999

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. A better understanding of the direction and rate of ground-water flow in Tooele Valley is needed.

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 computer model of ground-water flow in Tooele Valley, and (3) application of the numerical model in conjunction with a regridded, embedded flow model to investigate flow paths and advection processes in the vicinity of Tooele Army Depot.

Progress: During 1998, the conceptual and numerical models of regional ground-water flow system of Tooele Valley were completed. Calibration of the numerical model was accomplished by simulating steady-state conditions in 1968 and transient-state conditions for 1969-94. The report that describes these models has been written and reviewed by colleagues within the USGS and at the regional level. Response to these comments were completed. A subregional ground-water flow model of Tooele Army Depot has been constructed and linked to the regional ground-water flow model of Tooele Valley.

Plans for Next Year: During early 1999, a report describing the conceptual and numerical models of the ground-water flow system of Tooele Valley will be submitted for final approval. Following approval, the report will be published. Additional work will focus on quantifying the effects of regional processes on the subregional ground-water flow system at Tooele Army Depot. Flow paths and advection processes will be quantified by using particle tracking techniques within the subregional model area, and the sensitivity of flow paths to simulated changes in the regional ground-water system will be analyzed. A report documenting this work will be completed and submitted for review and approval. Publication of this report is planned for 1999.

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

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

Period of Project: October 1997 to September 1998

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 principal concern of the Navajo Nation Department of Water Resources 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 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 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 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; and (8) identify test-hole drill areas to explore ground-water sources below the DeChelly Sandstone.

Progress: In FY98, results of a multiple-well aquifer test were approved and a copy of the report was forwarded to the Navajo Nation. The map report for the alluvial aquifer study was completed and reviewed by colleagues. Sampling of wells and springs in consolidated-rock aquifers continued, and water levels were measured where possible. Water samples were collected from 21 wells and springs for analysis of major-ion chemistry. Several wells were selected and used for single-well tests to determine the hydraulic characteristics of the DeChelly Sandstone. A new well was drilled in the alluvial aquifer, a detailed stratigraphic log was made, and a single-well aquifer test was completed. Selected results of the alluvial aquifer study were presented in a poster at the Arizona Hydrological Society's Annual Symposium in Tucson, Arizona, at the end of September.

Plans for Next Year: The map report for the alluvial aquifer study will be finished and published. Other single-well aquifer tests will be analyzed and submitted to region for approval. Collection of water samples from several bedrock aquifers and any additional aquifer tests will be completed. The final interpretive report for the project will be written. A meeting during the first quarter is planned with the cooperator to formulate plans and budgeting for the remainder of the study and to discuss potential future work in the Navajo Mountain area.

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
Nate Grossman, Hydrologic Technician
Adrian Schaefermeyer, Hydrologic Technician
Other District personnel as required

Period of Project: July 1995 to July 1999

Problem: Great Salt Lake supports a $90-million per year brine-shrimp industry and feeds hundreds of thousands of migratory birds. 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 brine shrimp, nutrients, and physical conditions 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: Seventeen randomly selected sites were established and sampled about monthly. The historically predominant chlorophyte phytoplankton community was determined to have been replaced by a diatom community. Associated with the initiation of diatom dominance were 2 years of record shrimp cyst production. Because most of the diatoms present in 1997 were larger than the oral cavity of the shrimp nauplii, development from nauplius to juvenile stage was severely limited and the shrimp crop declined dramatically. Harvest of the shrimp cysts was stopped after only 3 weeks because the crop was so poor. In 1998, a cooler and wetter spring delayed development of the shrimp population. Though sufficient food resources were present early in the year, nuisance species of alga appeared in the summer that were poor food resources. Few shrimp cysts were produced and the shrimp harvest was again stopped after 3 weeks.

Plans for Next Year: Complete analysis of samples and write two journal articles.

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)
R.C. 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 predemonstration hydrologic and geochemical conditions in the shallow ground-water 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 predemonstration 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: The three permeable reactive barriers have functioned successfully for 12 months. The majority of the contaminant of concern (uranium) in the ground water was removed after the contaminated ground water flowed through the barriers. A full year of monitoring data was collected during the first year of the demonstration period. Parameters monitored during the first year included (1) hourly pH, specific conductance, temperature, dissolved oxygen, and oxidation reduction potential in each of the three barriers; (2) hourly water levels in 12 wells within and adjacent to the three barriers; (3) concentrations of selected chemical constituents (including uranium) in more than 60 monitoring points during eight different time periods; and (4) ground-water flow velocity and direction determinations at selected wells within and adjacent to the barriers. Fourteen additional monitoring wells were installed at the site in August 1998. Six separate tracer tests were done in September 1998. The existing ground-water flow model was updated. Specific capacity tests were done on selected wells. Preliminary results from the project were presented at five scientific/technical meetings. Three abstracts and a poster describing the initial study results were prepared and published. A draft manuscript of initial study results was prepared for publication in the journal Environment International.

Plans for Next Year: Monitoring of the three permeable reactive barriers and monthly maintenance of data loggers, transducers, and minimonitors will continue. Cores from the barriers will be collected and analyzed. Additional tracer and specific capacity tests will be done. The project data base will be brought up to date. A summary report and fact sheet describing the initial study results will be written and published.

Determination of Nitrate Loading to the Basin-Fill Aquifer, Tooele Valley, Tooele County, Utah

Number: UT-97-243

Cooperating Agency: Tooele County

Staff: D.D. Susong, Hydrologist, Project Chief
K.M. Hanson, Physical Scientist (part time)

Period of Project: January 1997 to December 1997

Problem: Historical land use in the Tooele Valley area was primarily agricultural with some mining and smelting. Substantial parts of the valley are still farmed today, but agriculture is slowly yielding to development of residential subdivisions. Many of these subdivisions do not have public water-supply systems or community sewage-treatment facilities and rely on individual wells and septic systems. The nitrate concentration of water from some individual wells in the eastern part of Tooele County exceeds the State standard of 10 mg/L. The amount of nitrate entering the ground-water system from septic systems and the effect on drinking-water supplies need to be determined. To continue residential development with individual wells and septic systems, Tooele County planners need to determine which areas are susceptible to nitrate loading from individual septic systems and (or) other sources of nitrogen, and how nitrogen is cycled through the unsaturated zone.

Objectives: Objectives of the proposed study are to (1) assess nitrate loading to the principal aquifer in Tooele Valley and the effects of septic systems on water quality, (2) determine sources of nitrate contamination, and (3) delineate areas that are susceptible to nitrate contamination from septic systems.

Approach: The study will be conducted in two phases. In the first phase, the sources of existing nitrate contamination on the east side of Tooele Valley will be determined. In the second phase, a map will be prepared to show areas susceptible to nitrate contamination on the basis of soil and aquifer characteristics, land use, nitrate sources, unsaturated zone characteristics, ground-water recharge and discharge, and flow velocities.

Progress: The previously surveyed network of water-level measuring points in the Erda area was expanded. Water levels were measured, and an updated potentiometric-surface map was produced. Additional wells for sampling were selected and samples were collected from 10 wells. Samples were collected from two wells while they were being drilled to determine vertical nitrate gradients. Geographic-information-system coverages were compiled for land use, soils, and vegetation.

Plans for Next Year: Collect additional samples from new wells as they are drilled. Delineate nitrate plume and propose monitoring well locations. Redirect project to nitrate plume in place of nonpoint source contamination. Drill multiple completion monitoring wells and collect water samples for analysis.

Development and Technology Transfer of the Iron Hydroxide/Phosphate Sandwich: A Reactive Chemical Barrier to Remediate Ground Water with Metal Contaminants

Number: UT-97-244

Cooperating Agencies: None

Staff: D.L. Naftz, Hydrologist, Project Chief

Period of Project: February 1997 to February 2000

Problem: Plumes of contaminated ground water are often managed by operating above-ground pump-and-treat systems. These systems require continuous site management and maintenance, which are generally expensive and not cost effective in removing contaminants that are strongly sorbed to porous media. An alternative technology that is receiving considerable attention is the use of in-situ reactive walls or barriers. In this technology, a ground-water plume flows through a permeable reaction zone within the aquifer where physical, chemical, or biological processes remove contaminants from the ground water. Clean ground water exits from the downgradient side of the reaction zone.

Objectives: The objective of the study is to develop the iron hydroxide/phosphate barrier sandwich and demonstrate its ability to clean up contaminated ground water so that a patentable product from the research can be obtained.

Approach: A combination of laboratory and field demonstrations will be used to produce a patentable product at the end of the project. This product will be used to remediate contaminated ground water in deep aquifers that cannot be treated using classic reactive-wall emplacement techniques.

Progress: Laboratory work on the different barrier materials was continued. Two different prototypes of the barrier deployment packages were constructed. Six of the first prototype packages were deployed at the COGEMA in-situ uranium mine in Wyoming. The six packages were retrieved in June 1998 and analyzed for uranium and associated trace-element uptake. Trace-element removal efficiencies were determined. Three large-diameter wells were drilled during August 1998 at the Fry Canyon site in southeastern Utah. The second barrier prototype was built and prepared for deployment in the Fry Canyon site. A ground-water flow model for the Area 1 site at Fry Canyon was constructed to simulate the efficiency of barrier package deployment in arrays of large-diameter, non-pumping wells. Permission was obtained to deploy the new prototype barrier packages at Fry Canyon. A mid-year progress report was prepared for the funding agency. A new iron source with higher iron concentrations and permeability than the previous iron source was developed for use in the new barrier packages.

Plans for Next Year: Three barrier packages will be deployed in large-diameter wells at Area 1, Fry Canyon, Utah. The uranium concentration in water flowing through the barrier packages will be monitored quarterly. Additional demonstration of barrier packages during mining operations at the COGEMA uranium mine in Wyoming will occur. The packages will be removed after the field demonstration at both sites, and the removal efficiency of uranium, selenium, arsenic, and vanadium on the material contained within the barrier packages will be determined. Multiple patents on barrier deployment packages and barrier material will be applied for.

Hydrology of Kamas Valley and Adjacent Areas, Summit County, Utah

Number: UT-97-246

Cooperating Agencies: Utah Division of Water Rights; Summit County; Weber Basin Water Conservancy District

Staff: J.L. Mason, Hydrologist, Project Chief
L.E. Brooks, Hydrologist
J.I. Steiger, Hydrologist

Period of Project: July 1997 to September 2002

Problem: Kamas Valley is experiencing increasing residential development. The water needed to support this new development will come from ground-water sources. The Utah Division of Water Rights needs to determine how additional ground-water development will affect existing surface- and ground-water appropriations. Existing data and results of past studies are not adequate to allow a thorough understanding of the hydrologic system. Specific needs include a better understanding of direction and rate of ground-water flow, the amount of recharge into, storage within, and discharge from aquifers, the hydrologic connection between surface and ground water, the quality of ground water prior to additional residential development, and the change in chemical composition of ground water as it moves through the ground-water system.

Objectives: Specific Objectives are to (1) describe the geohydrologic framework of the area (2) construct a steady-state ground-water flow model to help determine data needs and to test conceptual ideas; (3) determine or estimate the hydrologic properties of the unconsolidated valley fill and the consolidated rocks at selected locations; (4) determine the direction of ground-water flow in the unconsolidated valley fill in Kamas Valley; (5) refine previous estimates of ground-water recharge and discharge, where feasible; (6) describe ground-water and surface-water interactions in Kamas Valley; and (7) describe the chemical quality of surface water and ground water, including historical trends, extent and movement of nitrate, relation to land use if possible, and potential sources of degradation.

Approach: New and existing geohydrologic data will be collected, compiled, and interpreted to help define the hydrologic system and its interactions. Cross sections across the valley and across the fault on the east side of the valley will be constructed. A preliminary ground-water flow model will be used to determine additional data needs, and the ground-water flow model will be refined as additional data are collected. Because of limited data and the lack of stress on the ground-water system, the model will not be calibrated to transient-state conditions. The steady-state ground-water flow model will be used to assess the general effects of additional ground-water development by comparing water-budget components before and after projected development. Aquifer properties will be determined by estimating transmissivity from specific-capacity values reported on drillers' logs and by completing single- and multiwell aquifer tests. The chemical quality of surface and ground water will be described, including historical trends, maps of water quality, and relation to land use, if possible. Potential sources of present or potential degradation of the water supply will be described.

Progress: Project planning document has been completed. Well inventory has been completed. Emphasis was placed on location of suitable wells in the Francis area for determining location of the ground-water divide. Water levels are measured monthly in 30 wells. Instantaneous discharge measurements also are made monthly at 2 springs and at 2 surface-water sites. A streamflow-gaging station was established for Indian Hollow. Two snowmelt/climate stations have been installed in the study area, one in the mountains east of Kamas Valley and one on the valley floor along the west side. A preliminary ground-water flow model has been developed is in the calibration stage.

Plans for Next Year: Continue ground-water model development. Continue monthly measurements. Continue operation of two snowmelt/climate stations. Complete seepage measurements along parts of the Weber River and Beaver Creek. Continue to complete aquifer tests when feasible. Begin surface- and ground-water sampling to determine baseline water quality. If funding is available, drill monitoring wells that can be used for long-term water-level measurements and water-quality sampling.

Movement and Chemical Composition of Ground Water in the Basin-Fill Aquifer, Cedar Valley, Utah

Number: UT-97-248

Cooperating Agency: Central Iron County Water Conservancy District

Staff: J.L. Mason, Hydrologist, Project Chief
D.E. Wilberg, Hydrologist

Period of Project: July 1997 to September 2003

Problem: Cedar City and the surrounding areas of Cedar Valley in southwestern Utah are experiencing rapid population growth typical of the Western United States. Ground water and surface water historically used for agriculture are being used increasingly for culinary and industrial supplies. Ground-water quality in the basin-fill aquifer is variable, and water suppliers need to know how much water can be pumped in different locations of the valley without causing poor-quality water to influence the public-supply wells.

Objectives: The general objective of the study is to define the hydrologic and hydrochemical systems in the basin-fill aquifer of Cedar Valley. Specific objectives are to (1) define the hydrologic properties of the basin-fill aquifer, (2) determine the direction and rate of ground-water movement, (3) define areal and temporal variations in the chemical composition of the ground water, (4) determine the processes responsible for variations in the chemical quality of the ground water, and (5) ascertain the effects of current and future ground-water withdrawals on the chemical quality.

Approach: The objectives are to (1) study and map the surface and subsurface geology; (2) inventory wells and collect samples of ground water, surface water, and aquifer material to characterize the isotopic signature of end members; (3) using end-member mixing models to determine the source of nitrate in certain wells; (4) sampling and analyzing for inorganic constituents in ground water and using the results to determine reactions occurring along ground-water flow paths; (5) conducting aquifer tests and seepage investigations, studying climatic records, drillers' logs, water-level changes, water-level configurations, pumping variability, land-use patterns, and geologic framework of the aquifer to allow development of ground-water budgets; (6) constructing a qualitative ground-water flow model of the basin-fill aquifer in Cedar Valley to test current conceptual models and guide data collection; (7) constructing a quantitative steady-state model by matching the results from the model to measured hydrologic values; and (8) using the quantitative model to project likely flow paths to wells and likely sources of water to wells under various withdrawal alternatives determined by local water users.

Progress: Well inventory has been completed. More than 160 irrigation, public-supply, and stock wells were inventoried. Existing dissolved-solids and nitrate data were plotted and maps showing approximate distributions were completed. A potentiometric-surface map was completed using water-level measurements made during October and November, 1997. A preliminary ground-water flow model was developed to test the conceptual understanding of the ground-water system in the unconsolidated basin fill.

Plans for Next Year: Continue ground-water model development. Make mass water-level measurements in wells throughout the valley in November and March. Collect ground-water samples for chemical analysis to determine any temporal changes in water quality and to identify possible nitrate source(s). Conduct seepage studies on major streams and canals to determine rates for gains and losses.

Quality and movement of ground water near Dugway Proving Ground, Tooele County, Utah

Number: UT-98-249

Cooperating Agency: U.S. Army

Staff: Judy I. Steiger, Hydrologist, Project Chief
Michael Enright, Hydrologic Technician

Period of Project: January 1998 to December 30, 1999

Problem: U.S. Army Dugway Proving Ground is a chemical and biological testing facility in northwestern Utah. Environmental managers at the facility need to gain a better understanding of the ground-water system within and surrounding the military installation to better manage and protect the water resources of the area. Information about the existing and historic ground-water quality, the location of recharge areas, and the direction and rate of ground-water flow in the basin-fill and consolidated-rock aquifer is needed.

Objectives: (1) To determine the existing chemical character of ground water in the basin-fill and consolidated-rock aquifers; (2) to determine the changes, if any, in the quality of the ground water that have occurred in the last 20 to 30 years; (3) to delineate the main areas where the basin-fill and consolidated-rock aquifers are being recharged; (4) to delineate the paths along which ground water moves between recharge and discharge areas; and (5) to determine the rate of horizontal and vertical ground-water movement in the basin-fill material.

Approach: (1) Develop a detailed project workplan; (2) inventory wells and springs in the area and measure water levels where possible; (3) compile existing hydrologic and geologic references, data, and maps of the area and determine if addition geologic mapping is required; (4) determine constituents to sample and identify 15 wells and springs to sample; (5) use driller's logs, geologic maps, and hydrologic interpretive studies to delineate recharge areas; and (6) prepare a map report and create GIS coverages for the area of all the data collected and interpretation of the data.

Progress: Completed a search of USGS ground-water site inventory for well and spring locations. Completed search of USGS publications, and water-quality data base for historical water-quality data. Collected water samples for analysis at six sites, including two springs and four wells. Samples were analyzed for inorganics, organics, nutrients, pesticides, metals, explosives, and common ions. Completed a search for geologic maps and other information related to the geology of the area.

Plans for Next Year: Identify suitable sites for water-quality sampling and collect water samples at eight sites. Update and enter historical water-quality data in the USGS data base. Compile GIS coverages of geology and precipitation. Delineate recharge areas. Measure water levels is as many suitable sites as possible during March 1999. Compile water-level elevations and create a water-level contour map. Complete detailed project workplan and begin writing project report.

Hydrologic and water-quality data compilation and interpretation in the Grand Staircase-Escalante National Monument

Number: UT-98-250

Cooperating Agency: Bureau of Land Management, National Park Service

Staff: Karen Hanson, Physical Scientist, Project Chief
Geoff Freethey, Supervisory Hydrologist (part time)
Bert Stolp, Hydrologist (part time)

Period of Project: March 1998 to September 1998

Problem: The Bureau of Land Management (BLM) is responsible for managing the Grand Staircase-Escalante National Monument (GSENM). Part of designing a solid management plan includes compiling existing data and other information about the natural resources in the Monument. One of the more significant natural resources in the Monument is water.

to effectively plan for protecting the Monument's ecological systems, a good understanding of the amount and quality of surface and ground water is required.

Objectives: The principal objective of this study is to compile existing ground-water, surface-water, and water-quality data pertaining to Grand Staircase Escalante National Monument from available sources. These sources include the files and data bases of the Bureau of Land Management, the Divisions of the State Department of Natural Resources, the State Department of Environmental Quality, the U.S. Geological Survey, energy-development companies, and other government and local agencies. The second objective is to use those data to make basic interpretations about the ground-water resources, the quality of water within and adjacent to the Monument, and the annual and longer-term variation in stream characteristics.

Approach: The approach is to first compile existing data of the USGS and determine pertinent hydrologic data sites within the boundaries of the Monument. The initial data retrieval from the ground-water, surface-water, and water quality data bases will be transformed into an ARC/INFO data base retaining hydrologic, chemical, and physical data items as attributes for the point coverages created. Then other Federal, State, and local sources of similar data will be searched and added to the initial coverages. The information in the data base will be used to produce maps that will assist Monument managers to plan for the future of the area. Maps might include but not be limited to (1) ground-water level or change maps, (2) ground- and surface-water quality maps, (3) runoff maps, and (4) water-resource location maps (springs, riparian area, perennial stream segments).

Progress: (1) NWISARC problems were resolved and the 38 requested parameters were retrieved from the USGS water-quality data base. A point coverage of 2,895 records was generated. Documentation and explanation of attributes were completed. (2) An Arc/Info export coverage containing 10,726 records, with documentation and explanation of attributes was provided from data obtained from the Division of Water Rights for retrieval by BLM. An Arc/Info coverage of 48 surface-water gaging stations with 13 attributes, including drainage area, precipitation received, discharge, etc. was generated.

Plans for Next Year: Supply additional data if available. Support data already distributed to BLM with requested additional information. Plan a monitoring network. Begin data collection.

Field Demonstration of surface complexation models of sorption at a U.S. Remediation Site

Number: UT-98-252

Cooperating Agency: Nuclear Regulatory Commission

Staff: D.D. Naftz, Project Chief

Period of Project: July 1998 to September 2002

Problem: Numerous sites throughout the United States contain shallow ground water that is contaminated by uranium byproducts that result from mining, milling, and other industrial processes. The Nuclear Regulatory Commission (NRC) is currently responsible for licensing site remediation and clean up of uranium-contaminated sites. Distribution coefficients (Kd) have typically been used by the NRC in performance assessment (PA) transport modeling to determine contaminant retardation and address site release issues. The use of Kd values for PA transport modeling may be oversimplistic. Surface complexation modeling (SCM) could be of significant value to PA modeling if the SCM was used to determine the range of Kd values that need to be considered and provide a sound scientific basis for the range of values chosen.

Objectives: (1) Site selection/characterization, (2) preparation and assistance with field experiments, and (3) assistance in preparation of final reports,

Approach: A series of batch and column studies will be conducted to investigate uranium adsorption and transport using sediments obtained from the field demonstration site located near Naturita, Colorado. Field experiments will be conducted to investigate uranium transport in small-scale tracer tests at the field site. Multispecies reactive solute transport modeling will be conducted to simulate the existing uranium contamination using site specific data. These simulations will be used to develop PA model calculations.

Progress: Sediment samples from the colluvial aquifer were collected for use in laboratory investigations. The project work plan was completed and submitted to the Nuclear Regulatory Commission. The health and safety plan for the project area was written and approved by the Department of Energy and State regulatory agencies. Drilling permits and right-of-way agreements were obtained for the initial FY 99 drilling program.

Plans for Next Year: Installation of 30 wells with a total of 100 monitoring sites will be completed. Initial tracer injection tests will be completed. Wells will be surveyed. Six stream stage benchmarks will be installed and surveyed. River stage will be measured quarterly. Quarterly monitoring will be conducted at the site to document existing water quality and geochemistry. Two pressure transducers and two water-quality minimonitors will be installed at the site and serviced on a monthly basis. Pump tests will be conducted to determine the hydraulic conductivity of the alluvial aquifer. A potentiometric surface map of the shallow alluvial aquifer will be constructed. A ground-water flow model will be constructed for the site. Water-quality maps showing the distribution of selected chemical constituents in the ground water will be constructed.