Water-Related Scientific Activities of the U.S. Geological Survey in Nevada, Fiscal Years 1995 and 1996

Compiled by M. Teresa Foglesong

U.S. GEOLOGICAL SURVEY

Open-File Report 97-195

Carson City, Nevada
1997

U.S. DEPARTMENT OF THE INTERIOR
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MESSAGE FROM THE NEVADA DISTRICT CHIEF

The U.S. Geological Survey began to document the water resources of Nevada in the 1880's. Now, as then, the mission of the Survey's Water Resources Division is to provide the technical and scientific information and understanding needed for the best use and management of the Nation's water resources to benefit the people of the United States. To this end, the Nevada District's employees in Carson City, Elko, and Las Vegas work with more than 40 cooperating Federal, State, and local agencies, and Indian Tribes to collect basic data and make interpretive investigations as to the source, distribution, quality, and uses of Nevada's water.

Water-resources planning and management are exceptional challenges in Nevada, the nation's most arid, yet fastest growing State. The public availability of consistent and objective, high-quality data provides the essential foundation for research and assessment by all entities working on Nevada water-resources problems and issues, including scientists in the universities of Nevada and adjacent states; technical staff of cooperating Federal, State, and local agencies, and Native American tribes; and national and international consulting firms. To this end, the Nevada District's cadre of technicians, scientists, and support staff is dedicated to the highest professional standards for collection and dissemination of unbiased water- and earth-resources data, resource-assessment studies, and related research.

Since 1985, we have been summarizing our activities in Nevada in this series of periodic "activities reports." With the increasing popularity of the interactive World-Wide Web for public access to data and information, we are providing current information on Nevada's water resources at our web site: **http://wwwnv.wr.usgs.gov**

We welcome comments and suggestions for improving the quality of our service to Nevada and the Nation. For further inquiries on any of the programs and projects listed in this report, please contact us by mail, phone, fax, or email:

Jon O. Nowlin, District Chief,
U.S. Geological Survey
333 W. Nye Lane, Room 203
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Multiply	By	To Obtain
acre	4,047	square meter
acre-foot (acre-ft)	1,233	cubic meter
acre-foot per year (acre-ft/yr)	0.001233	cubic hectometer per year
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
foot (ft)	0.3048	meter
gallon per minute (gal/min)	0.06309	liter per second
inch (in.)	25.40	millimeter
mile (mi)	1.609	kilometer
square foot (ft^2)	0.0929	square meter
square mile (mi^2)	2.590	square kilometer

Fiscal Year and Water Year: Both constitute a 12-month period from October 1 through September 30, and are designated by the year in which the period ends (for example, fiscal year 1995 began October 1, 1994, and ended September 30, 1995).

Abbreviated Water-Quality Unit Used in This Report
mg/L, milligrams per liter

Water-Related Scientific Activities of the U.S. Geological Survey in Nevada, Fiscal Years 1995 and 1996

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INTRODUCTION

The U.S. Geological Survey has been collecting water-resources data in Nevada since the 1880's. This report contains an overview of the progress of water-related scientific activities in Nevada by the Water Resources Division of the U.S. Geological Survey, from October 1, 1994, to September 30, 1996. The organizational structure, funding, and technical resources of the Nevada District, as well as water conditions throughout the State and some major water issues in the State during the past 2 fiscal years, are described herein.

The Nevada District program consisted of 32 projects during the past 2 fiscal years. A description of each project is given in the main body of the report. A list of publications produced by the Nevada District staff and a list of sources of information to aid the reader in locating other Geological Survey products are included at the end of the report.

ORIGIN OF THE U.S. GEOLOGICAL SURVEY

The U.S. Geological Survey (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 geological structure, mineral resources, and products of national domain." An integral part of that original mission is to publish and distribute the earth-science information needed to understand, plan the use of, and manage the Nation's energy, land, mineral, and water resources.

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

BASIC MISSION AND PROGRAM OF THE WATER RESOURCES DIVISION

The mission of the Water Resources Division (WRD) of the USGS is to provide the hydrologic information and understanding needed to manage the Nation's water resources to benefit the people of the United States. To accomplish this mission, WRD, in cooperation with Federal, State, and local agencies, uses a variety of investigative and interpretive techniques to collect and transfer hydrologic information to the water-resources community and the public. WRD undertakes this mission by applying objective scientific methods and maintaining an unbiased stance in the midst of often highly controversial political issues.

Programs sponsored by WRD in Nevada include:

- Data collection to aid in evaluating the quantity, quality, distribution, and use of water resources in Nevada;
- Analytical and interpretive water-resources appraisals to describe the occurrence, quality, and availability of surface and ground water in Nevada;
- Basic and problem-oriented research in hydraulics, hydrology, and related fields of science and engineering;
- Scientific and technical assistance in hydrology to other Federal, State, and local agencies; and

- Public distribution of water-resources data and results of water-resources investigations through reports, maps, computerized information services, and other forms of release.

NEVADA DISTRICT, WATER RESOURCES DIVISION

History

In 1889, U.S. Geological Survey personnel began measuring the flow of Nevada streams, starting with the Truckee River Basin. In 1913, the USGS and the Nevada State Engineer initiated a cooperative program to support the stream-gaging activities; more than eight decades later, that program is still in place. A groundwater program, also in cooperation with the State Engineer, began more than 50 years ago in 1945; it, too, is still in place. This information and additional historical perspective regarding the USGS presence in Nevada are provided by Shamberger (1991, p. 59-74).[1] Table 1, an update of the USGS chronology presented by Shamberger (1991, p. 93), lists the Geological Survey officials who have been in charge of water-resources investigations and data collection in the State since 1913.

Organization

The Nevada District currently is responsible for water-related U.S. Geological Survey activities in Nevada. The Nevada District has about 130 employees, most of whom are in the Carson City District Office; 27 are in the Las Vegas Office; and 3 are in the Elko Field Office. Organization of the Nevada District is shown in figure 1. Basic data on water resources in Nevada are collected throughout the State by personnel from the three offices. The area of responsibility for each office is shown in figure 2.

[1]Hugh A. Shamberger was Nevada State Engineer from 1951 to 1957, Director of the newly created Nevada Department of Conservation and Natural Resources from 1957 to 1965, and a senior hydrologist with the USGS from 1968 to 1984.

Addresses and phone numbers of the three District offices in Nevada are listed below; inquiries regarding projects described in this report should be directed to the Public Information Assistant in the Nevada District Office in Carson City.

Nevada District Office
333 W. Nye Lane, Rm 203
Carson City, Nevada 89706-0866
(702) 887-7600

Las Vegas Office
6770 S. Paradise Rd.
Las Vegas, Nevada 89119-3721
(702) 897-4000

Elko Field Office
P.O. Box 1044
Elko, Nevada 89803-1044
(702) 738-5322

Funding and Cooperating Agencies

Programs of the Water Resources Division in Nevada are funded as follows:

1. Federal Program—funding is appropriated directly to USGS by the U.S. Congress for projects of national interest;

2. Cooperative Program—funding is shared by USGS and interested State or local agencies; and

3. Other Federal Agencies (OFA) Program—funding is supplied by Federal agencies requesting technical assistance from USGS.

Total funds and sources of those funds for fiscal years 1995 and 1996 are listed in table 2 and shown in figure 3. Total funds decreased from $10.32 million in fiscal year 1995 to $9.01 million in fiscal year 1996. Cooperating agencies active during 1995 and 1996 are listed in tables 3 and 4.

Technical Resources

District Staff

The most important factor for continuing growth in the Nevada District of high-quality data networks, hydrologic appraisals, and related research has been the dedication and technical excellence of the District staff. In figure 3A, the number of full-time equivalent positions for a given year equals the total number of hours worked during that year by all Nevada District

Table 1. U.S. Geological Survey officials in charge of Water Resources Division activities in Nevada, 1913-96 (modified from Shamberger, 1991, p. 93)

SURFACE WATER BRANCH PERSONNEL, 1913-62				
District office	**District Engineer**	**Period**	**Engineer in charge**	**Remarks**
Salt Lake City, Utah, for Utah and Nevada	E.A. Porter	1913-16		
	C.C. Jacob	1916-17		
	A.B. Purton	1917-42		
	M.J. Wilson	1942-47		
		1947-51	L.R. Sawyer	During 1947, a Surface Water Branch field office was established in Carson City to operate the cooperative streamgaging program in Nevada.
		1951-59	C.H. Carstens	
		1960-61	L.J. Snell	
Carson City, Nev.	E.E. Harris	1961-62		

GROUND WATER BRANCH DISTRICT OFFICE, 1945-62			
District office	**District Engineer**	**Period**	**Remarks**
Carson City, Nev.	T.W. Robinson	1945-50	A cooperative ground-water study involving Las Vegas and Pahrump Valleys was started July 1, 1944, with G.B. Maxey, Associate Geologist, in charge under general supervision of P.E. Dennis, District Geologist, Salt Lake City, Utah. On July 1, 1945, a statewide Ground Water District Office was established in Carson City.
	O.J. Loeltz	1950-62	

WATER RESOURCES DIVISION DISTRICT OFFICE, 1962-present (1996)				
District office	**District Chief**	**Period**	**Office Chief**	**Remarks**
Carson City, Nev.	G.F.Worts, Jr.	1962-74		In 1962, the USGS began consolidating field activities of the Water Resources Division surface-water, ground-water, and water-quality branches into single multidisciplinary offices. The first consolidated District office in the Nation was established in Carson City on July 1, with all Division programs under general supervision of Nevada District Chief.
	J.P. Monis	1974-77		
	F.T. Hidaka	1977-79		
	T.J. Durbin	1979-81		
	Terry Katzer	1981-82		
Boise, Idaho	E.F. Hubbard, Jr.	1982-85	Terry Katzer	Idaho and Nevada District Offices merged into one District in August 1982, with District Chief and Idaho Office Chief in Boise, and Nevada Office Chief in Carson City.
		1985-86	Otto Moosburner	Acting Nevada Office Chief.
		1986-87	W.J. Carswell, Jr.	
Carson City, Nev.	W.J. Carswell, Jr.	1987-91		Idaho-Nevada District demerged into separate districts in October 1987, with Nevada District Chief in Carson City.
	J.O. Nowlin	1991-present		

NEVADA DISTRICT ORGANIZATIONAL STRUCTURE

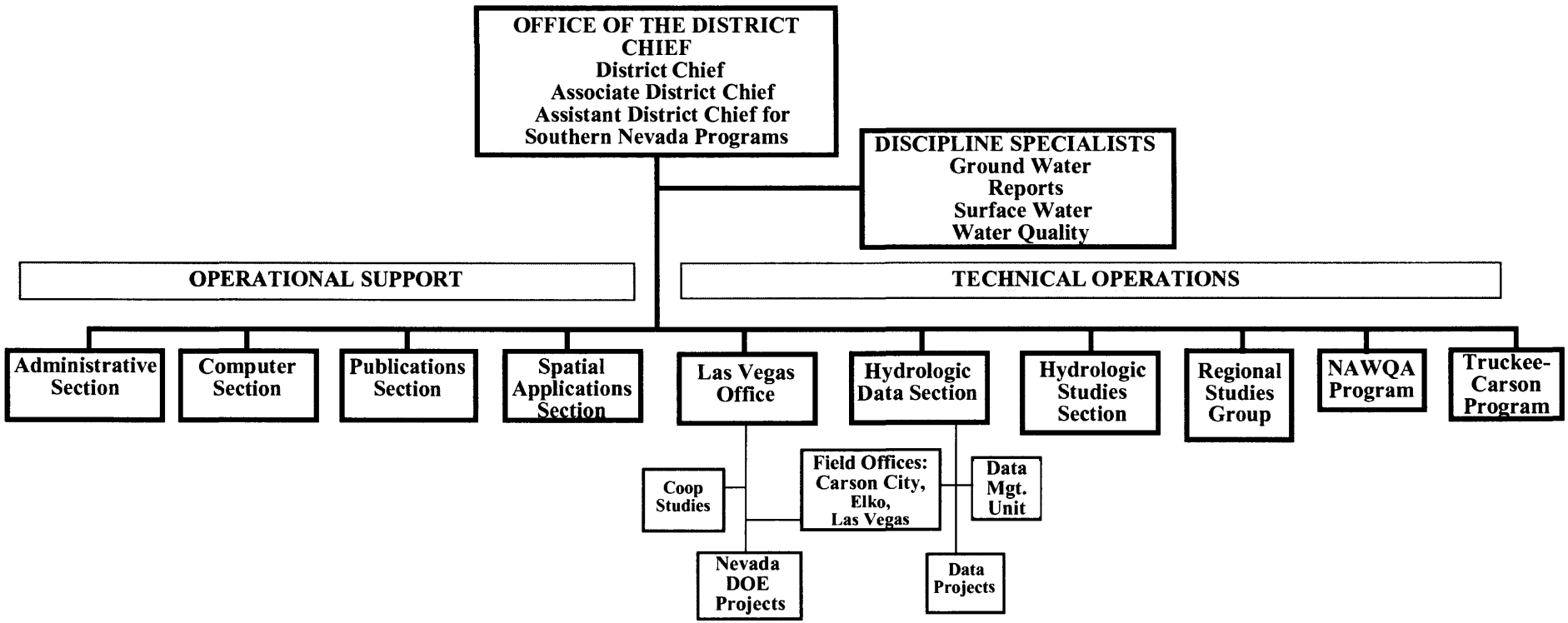


Figure 1. Nevada District organizational structure as of February 1996.

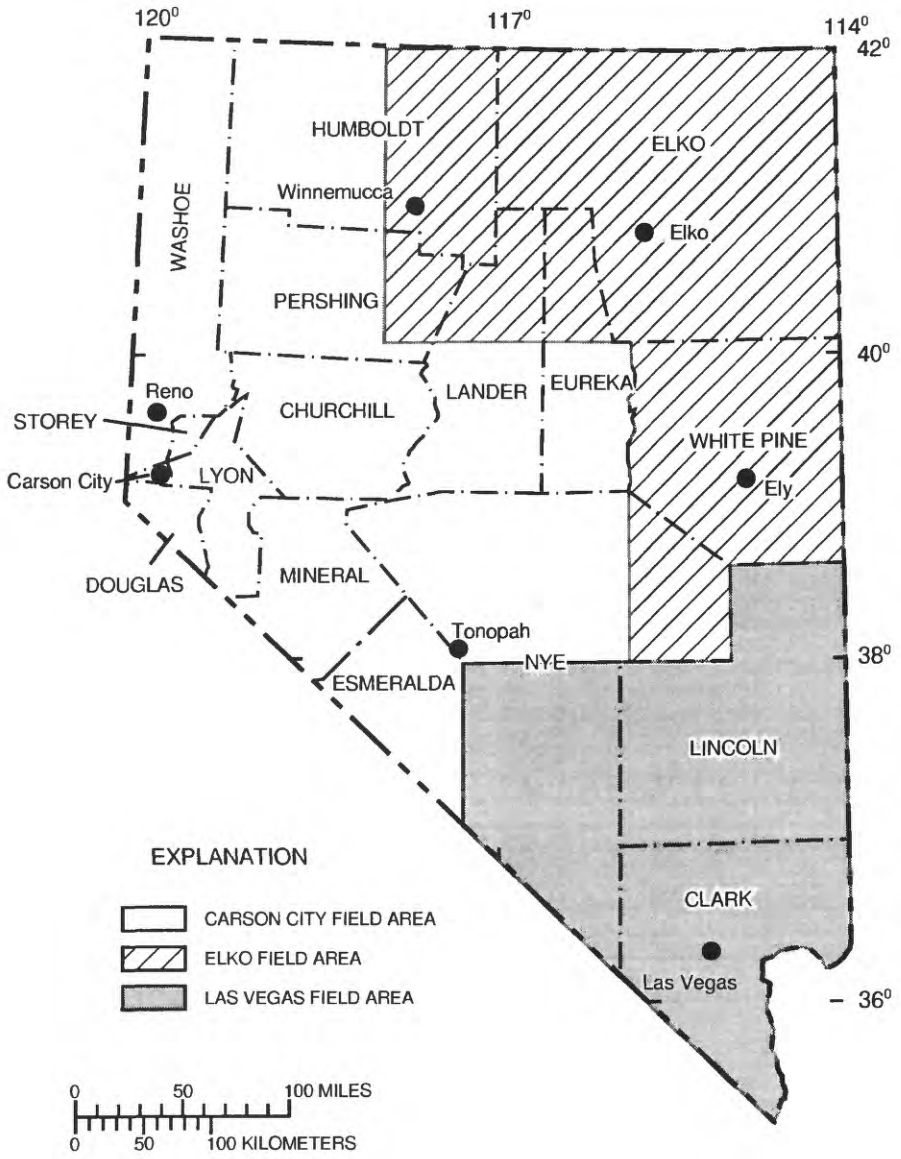


Figure 2. Geographic areas of responsibility for basic-data collection by Nevada District field offices.

staff members, both full-time and part-time, divided by 2,080 hours (the total number of full-time working hours per year).

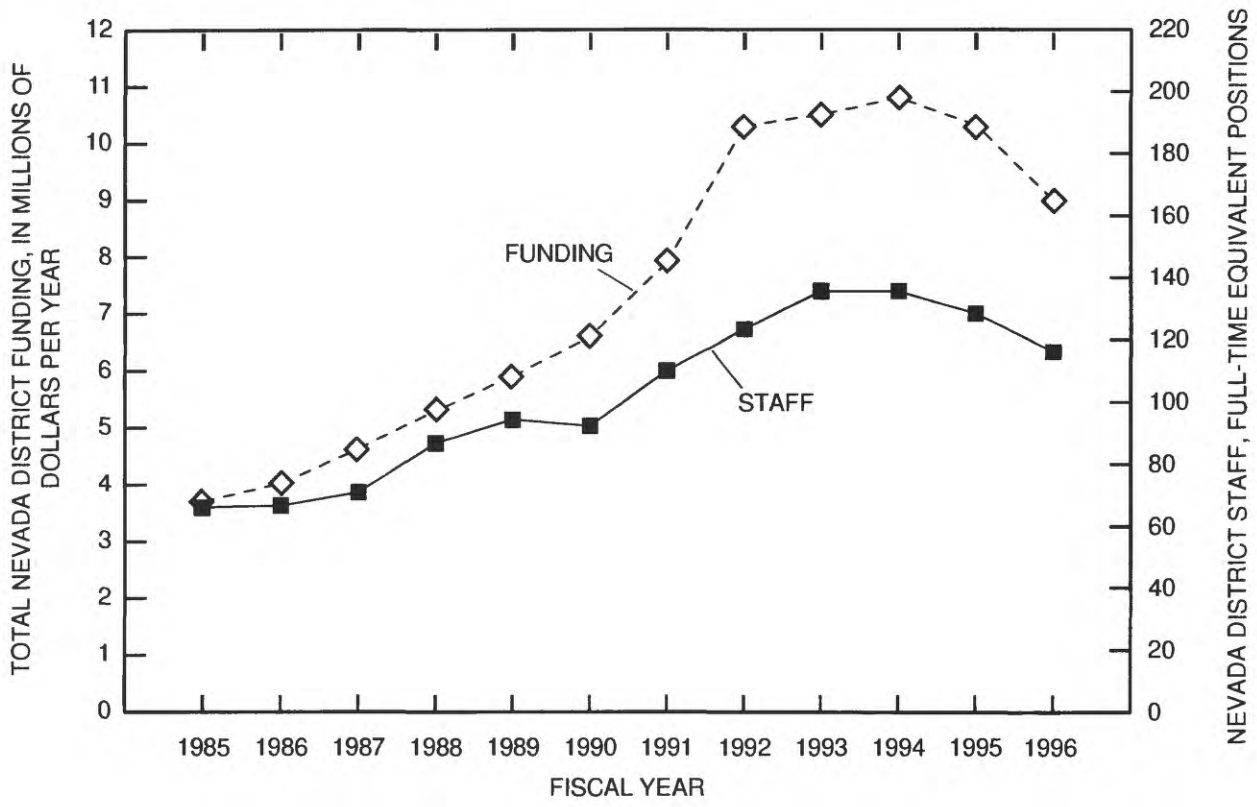
The staff is well educated. In fiscal year 1996, about 75 percent of the total staff had college degrees, including five doctorates. About 59 percent of the support staff (administration, computer, and publications sections) had college degrees. Technical skills of the District staff reflect the broad interdisciplinary nature of the Nevada program.

Table 2. Nevada District budget, fiscal years 1995 and 1996

[In thousands of dollars; OFA, other Federal agencies]

	Fiscal year	
	1995	**1996**
Federal Program	3,325	2,518
OFA Program	2,765	2,201
Cooperative Program		
Federal share	1,846	1,846
State and local share	2,374	2,448
TOTAL FUNDING	10,320	9,013

A. Trend in total funds and staff, fiscal years 1985-96



B. Funding from major types of programs, fiscal years 1995 and 1996

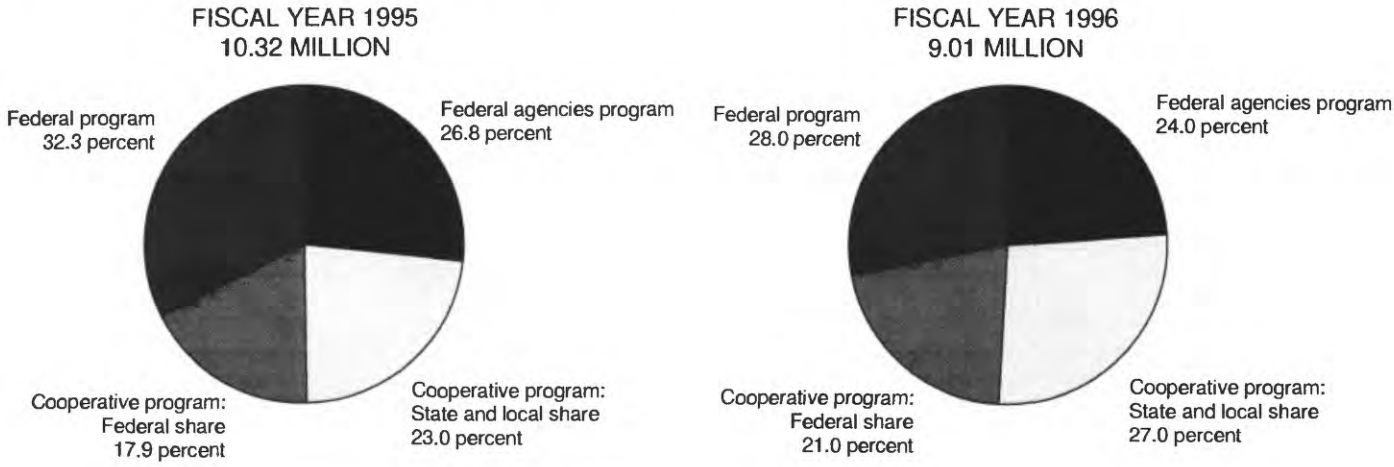


Figure 3. Nevada District program and staff, and distribution of funding.

Table 3. Cooperating State and local agencies

State agencies
Nevada Bureau of Mines and Geology
Nevada Department of Conservation and Natural Resources
Division of Environmental Protection
Division of Water Resources
Division of Wildlife
Nevada Department of Transportation
Local agencies
Carson City
Public Works Department
Carson-Truckee Water Conservancy District
Carson Water Subconservancy District
Churchill County
City of Henderson
City of Las Vegas
City of Reno
City of Sparks
Clark County Regional Flood Control District
Clark County Sanitation District
Douglas County
Duck Valley Reservation Shoshone-Paiute Tribes
Las Vegas Valley Water District
Pyramid Lake Paiute Tribe
Southern Nevada Water Authority
Summit Lake Paiute Tribe
Tahoe Regional Planning Agency
Truckee-Carson Irrigation District
Walker River Irrigation District
Walker River Paiute Tribe
Washoe County
Department of Comprehensive Planning
Department of Public Works
Washoe Indian Tribe

Table 4. Contributing Federal agencies

Army Corps of Engineers
Board of Water Commissioners
Department of Defense
Department of Energy
Department of the Interior
Bureau of Indian Affairs
Bureau of Land Management
Bureau of Reclamation
Fish and Wildlife Service
National Park Service
Office of the Secretary
Environmental Protection Agency
Federal Emergency Management Agency
Federal Water Master
Nuclear Regulatory Commission

Computer Facilities

The USGS has rapidly expanding requirements for computing, including data-base management, scientific interpretation and simulation, electronic report processing, administrative processing, and geographic information systems. To meet these needs, the Nevada District operates in a distributed computer environment, which is called the Distributed Information System (DIS-II). DIS-II consists of a network of advanced Unix workstations, appropriate software, local-area networks (LAN) for intra-office telecommunications, and wide-area networks (WAN) to link the three Nevada offices. Each workstation is a fast and powerful desktop computer with a high-resolution graphic monitor and enough software, hardware, and peripheral devices to allow a worker to perform most advanced tasks at the individual station. The LAN is an office-based telecommunications network that connects many computers and other devices to each other. Shared devices such as file servers and printers, are accessed through the LAN also.

The USGS utilizes a WAN known as the Department of the Interior Network (DOINET). The Nevada District LANs are hubs in the DOINET, which links the USGS headquarters in Reston, Va., with WRD offices across the nation (figure 4*A*). The Nevada District offices in Carson City and Las Vegas are connected through DOINET to each other, the Nevada Division of Water Resources (NDWR), Elko Field Office, and Nevada Test Site in Mercury, Nev. (figure 4*B*). The DOINET connection also provides access to the Internet, a collection of networks that are connected together to form one large virtual network containing a wealth of diverse information.

By the end of 1995, the Nevada District had implemented six main hubs of a distributed computer environment, driving workgroup clusters of MS/DOS and Macintosh computers running X-windows, emulation software, X-terminals, and associated peripheral equipment (figure 4*C*). Peripherals include cd-rom technology, floppy disk technology, tape drives, scanners, laser printers, and color plotters. Currently (1996), the Carson City Office has one Data General AViiON 9500 fileserver, one Data General AViiON 6220 fileserver, four Data General AViiON 532 workstations, and fourteen Data General AViiON 300 workstations as the main hub. The Las Vegas Office has one Data General AViiON 9500 fileserver, three Data General AViiON 532 workstations, and one Data General AViiON 300 workstations as the main hub. Located in

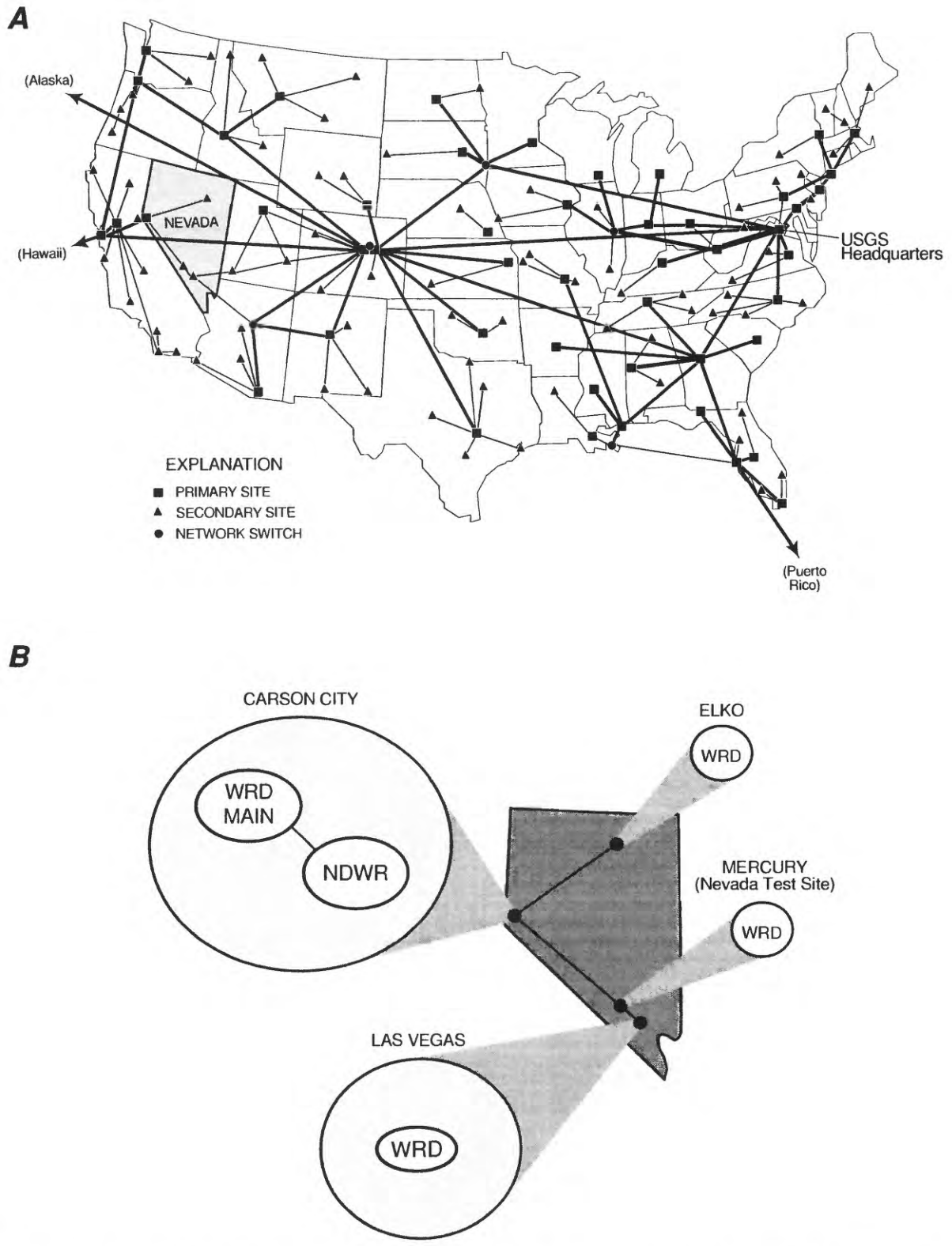


Figure 4. Distributed-Information-System networks in 1996: *(A)* Department of the Interior network (DOINET), *(B)* wide-area network (WAN) of the Nevada District, and *(C)* local-area network (LAN) of the Nevada District. Abbreviations: NDWR, Nevada Division of Water Resources; WRD, Water Resources Division.

C

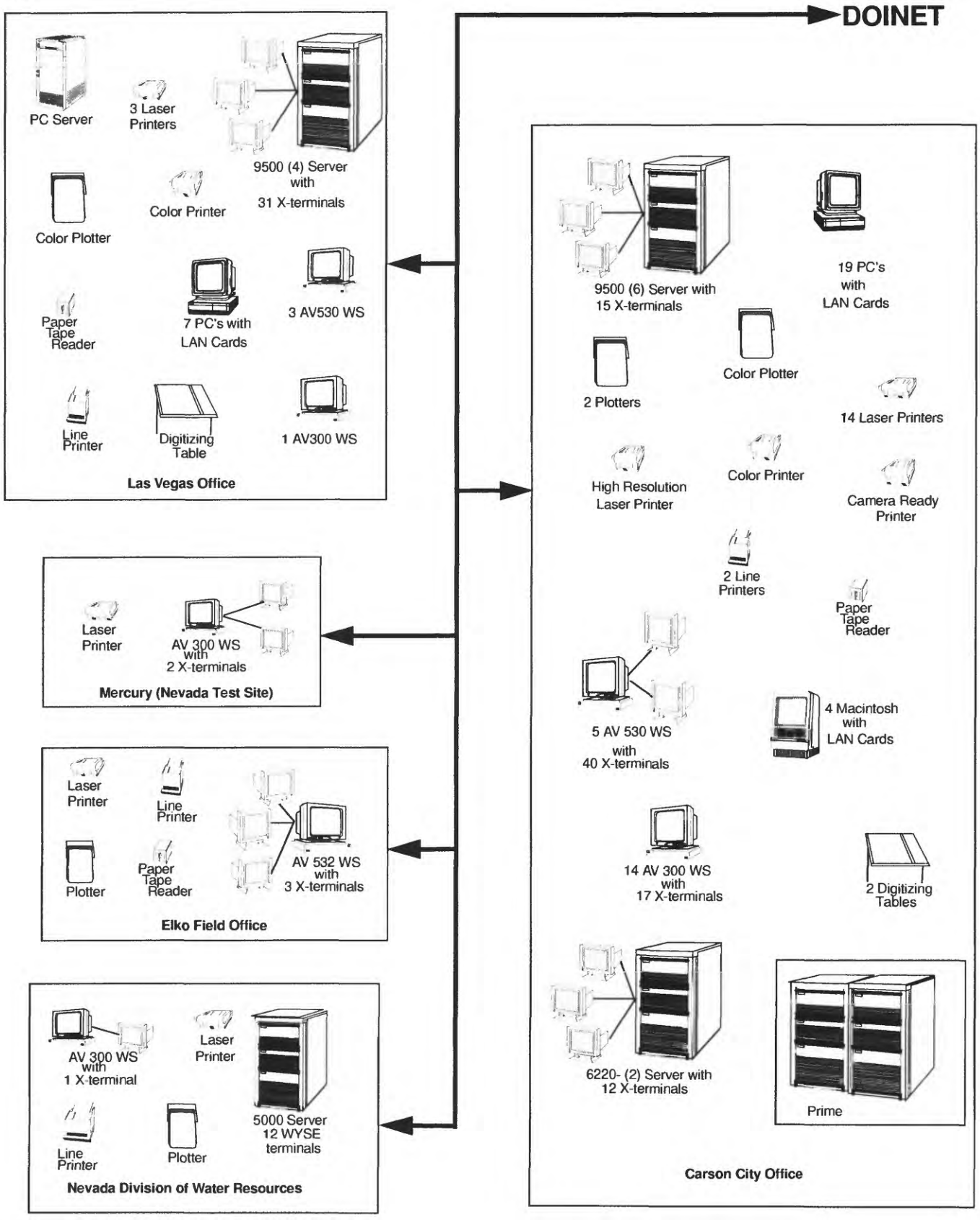


Figure 4. Continued.

the NDWR is another main hub, which consists of one Data General AViiON 5000 fileserver and one Data General AViiON 300 workstation. Both Carson City and Elko Field Offices have Data General AViiON 532 workstations as their main hubs. The field office at the Nevada Test Site has a Data General AViiON 300 workstation as the main hub.

During fiscal years 1995 and 1996, the Las Vegas office benchmarked a PC Windows NT application server accessible to all workstations and X-terminals on the local area network, and tested office productivity software on this platform. This concept has been fully implemented in the Las Vegas Office and is planned to be implemented in the Carson City Office by the end of calendar year 1996.

During fiscal year 1996, the Nevada District implemented a World Wide Web (www) server, making it possible for the public to access up-to-date water-resources information such as streamflow and bibliographic data. The Nevada District public homepage is accessible at **http://wwwnv.wr.usgs.gov**

The USGS also maintains a web page for the public with information on biology, geology, mapping, and water for the United States. Interactive information on earth science is available through "Ask a Geologist." One also can access a variety of information on ordering USGS products, such as data and interpretive publications; the Learning Web; Internet resources; and a search capability for questions on earth science topics. The address is **http://www.usgs.gov**

Data Base Management

The primary hydrologic data-storage mechanisms for the Nevada District computer system are the National Water-Information System (NWIS) data bases. NWIS currently is composed of several subsidiary data bases: Automated Data Processing System (ADAPS), supporting continuous (hourly or more frequent) surface-water, ground-water, and water-quality data; Ground-Water Site Inventory (GWSI), supporting water-level, well construction, and location data; Water-Quality Data (QWDATA), supporting physical, chemical, biological, and sediment data; and Water Use (WUSE), supporting site-specific and aggregated water-use data.

The stress of exponential urban growth in Nevada on current and potential water supplies and resultant effects on hydrologic environments has generated an unprecedented need for, and resultant volume of, water-resources data and information. In cooperation with the Nevada Division of Environmental Protection (NDEP), Nevada Consumer Health Protection Service, and the U.S. Environmental Protection Agency (USEPA), the Nevada District continued the lead role in development of automated systems for capturing ground-water data from laboratories of several State and local agencies. The Nevada Water Permit File, developed by the Nevada District for the Nevada Division of Water Resources, was expanded to include Geographic Information System (GIS)-automated spatial data for drillers' logs, water permits, and water use.

Geophysical Data Collection

The Nevada District uses surface- and borehole-geophysical methods to investigate hydrologic problems. Several surface-geophysical instruments, computer software to process the data, and geophysical data bases, are maintained within the District. Instrumentation includes two seismographs, two gravimeters, a magnetometer, and an electrical-resistivity array. In addition, many types of geophysical methods and instrumentation are available elsewhere within USGS for District use: surface methods (electromagnetotellurics, VLF (very-low frequency), resistivity, ground-penetrating radar, and marine seismic); airborne methods (radiometrics, magnetics, and side-looking radar); and borehole methods (short- and long-normal resistivity, acoustic velocity, neutron, gamma density, natural gamma, temperature, flowmeter, televiewer, radar, and gravity).

Water-Quality Analysis

Water-quality investigations are another important part of Nevada District operations. The District maintains mobile field laboratories with instrumentation for onsite measurement of pH, alkalinity, specific conductance, temperature, and dissolved oxygen, and onsite processing of water samples for analysis in the laboratory. Mobile and inhouse laboratory facilities are maintained for sample preparation and storage, reagent preparation, and instrument calibration and repair. The USGS National Water-Quality Laboratory in Arvada, Colo., which does production analyses and research, is used for detailed chemical analyses of water, sediment, and tissue of aquatic biota. Additional analytical support is provided by cooperators and contract laboratories for some specific projects.

Electronic Data Collection

Many studies undertaken by the Nevada District now involve some form of direct electronic data acquisition. Electronic field monitors and data loggers are used for continuous, fixed-interval, and event monitoring or sampling in areas where frequent site visits are not practical. Electronic recording of water-quality data, water levels in wells and streams, and climatologic data related to evapotranspiration are the most common applications.

Field monitors are used to record water-quality characteristics—pH, specific conductance, temperature, and dissolved oxygen—in studies such as those at the Stillwater National Refuge and Carson Lake. Hourly water levels are monitored electronically in some wells in the eastern part of the State and at the Nevada Test Site to determine aquifer response to earth-tide fluctuations. Two systems are used for remote transmission of data. Data-collection platforms send data to geosynchronous satellites that relay the data through the DIS computer network to the District data bases. Direct line-of-sight radio telemetry also is in use, such as in the Clark County Flood-Alert System, which provides real-time monitoring of precipitation and streamflow at 26 sites. Additionally, the District uses electronic instrumentation and other techniques for direct determination of bare-soil evaporation and plant transpiration.

Other District Activities

As part of its responsibility to provide water-resources information to the public, the Nevada District staff participates in several activities in addition to data collection and hydrologic investigations.

Committee Involvement.—Members of the Nevada District staff serve on a variety of local and National committees and advisory boards. Recent examples include:

Carson River Mercury Superfund Site Technical Advisory Committee,
Clark County Comprehensive Planning Committee,
Desert Research Institute Advisory Council on Water Resources Research,
Feather River Junior College Advisory Committee,
Governor's Drought Review and Reporting Committee,
Governor's Technical Advisory Committee for the Carson River,
Lake Tahoe Basin Erosion Control Technical Advisory Committee,
Lake Tahoe Interagency Monitoring Program Technical Advisory Committee,
Mackay School of Mines Advisory Board,
Mojave Ecosystem Science Advisory Group,
Nevada Nonpoint-Source Pollution Task Force,
New Mexico Water Resources Research Institute Research Program,
Nevada Division of Environmental Protection Ground-Water Technical Task Force,
Nevada State GIS Advisory Board,
Nevada State Mapping Advisory Committee,
Nevada Water Resources Association Planning Committee,
Soil Science Society of America Technical Assistance to Eduadorian Scientists on Unsaturated Zone Methods,
Southern Nevada Federal Executive Association,
Truckee River Operating Agreement Committee,
Truckee River Water-Quality Monitoring Technical Advisory Committee,
Truckee River Water-Quality Strategy Committee,
University of Nevada-Reno Hydrology Program Advisory Committee,
Upper Carson Watershed Management Plan Committee,
Upper Truckee River Focused Watershed Group,
Vadose Zone Technical Liaison with State of California, and
Virgin River Interior Coordinating Committee

National involvement includes:

Committees for preparing NWIS-II functional specifications,
assistance to planning NAWQA outreach,
workgroups for administrative and water-quality data systems,
Subsidence Special Interest Group,
Radiochemical Advisory Committee,
Department of the Interior (DOI) Bureaus Technical Representative,
DOI Devils Hole Work Group,
Director's Benchmark Committee on Outreach,
U.S. Fish and Wildlife Service Water Rights Acquisition Program,
Instrumentation Technical Advisory Subcommittee,
USDOE Strategic Planning Team for Environmental Water-Quality Monitoring,
U.S. Department of Agriculture (USDA) Erosion Control Group,
USDA Small Business Innovation Research Program of National Research Initiative Competitive Grants Office,
USGS Western Region Overhead Policy Advisory Committee,
USGS Western Region Office of Ground Water Borehole Geophysics Advisory Group,
Sedimentation Subcommittee of the Interagency Committee on Water Data,
USDOE Environmental Restoration Program Executive Advisory Group,
USDOE Hydrologic Resources Management Program,

USDOE Nevada Operations Office Environmental Action Committee,
USGS PC Windows Integration Special Interest Group,
USGS telecommunications Advisory Commission, USGS Unsaturated Zone Interest Group,
USGS Liaison for Nuclear Regulatory Commission and Pacific Northwest Laboratory Working Group on Unsaturated Bore Processes, and
USGS Western Region Technicians Advisory Committee.

In addition, Nevada District staff teach and coordinate National USGS training courses, review water-quality reports for the Office of Water Quality, and serve as Ad Hoc technical reviewers for journals such as the Geological Society of America, American Society of Agronomy, Soil Science Society of America, Water Resources Association, Water Resources Bulletin of America, and Water Resources Research.

Environmental Impact Statements.—With increasing frequency, Federal, State, and local cooperators are requesting District staff reviews of environmental impact statements to verify the interpretation of hydrologic data presented in the statements.

Education.—The Nevada District actively participates in the educational community. Presentations on basic hydrology and general earth-science issues are given at local elementary and high schools; formal classes on hydrologic techniques and geographic information systems are prepared for local universities; and students from universities, junior colleges, and high schools are employed in work-study programs in the Survey. Members of the Nevada District staff also participate in career and job fairs sponsored by high schools and universities.

Public Information and Outreach.—The Nevada District is a focal point for the public regarding map and earth-science questions. Staff members answer questions on regional hydrology and geology, basic scientific ideas, USGS publications, and related items. Each year, the Nevada District is represented at the Nevada Water Conference, which is sponsored by the Nevada Water Resources Association. The Public Information Assistant (PIA) compiles information in response to public requests for data and published information. The PIA may be contacted at (702) 887-7649 or email **usgsinfo_nv@usgs.gov**

During fiscal years 1995 and 1996, two Fact Sheets were published about the USGS in Nevada, which included activities by the Geologic Division, National Mapping Division, and Water Resources Division. During fiscal year 1996 the Nevada District created a home page on the World Wide Web (www) for the public to access information such as streamflow data, bibliographic data, and previous activities reports. The Nevada District home page is accessible at **http://wwwnv.wr.usgs.gov**

Western Region Research Drilling Program—The Western Region office operates and maintains a Research Drilling Program for the express purpose of developing new techniques in exploratory drilling. The primary product of the drilling program is the installation of monitoring wells for Bureau programs. Drilling services are provided on a reimbursement primarily for, but not limited to Western Region WRD Districts. The drill rig is located in Mound House, Nev., about 5 miles east of Carson City on a 1-acre parcel of land with a 5,000-square-foot building and warehouse facility. The office contact and address for correspondence is:

Donald H. Schaefer
U.S. Geological Survey, WRD
32 Affonso Drive
Mound House, NV 89706

Telephone: (702) 246-3462

WATER CONDITIONS IN NEVADA

Surface Water

Surface-water resources are sparse in Nevada because of the semiarid to arid climate. Typically, as much as 75 percent of Nevada's precipitation falls during the winter months. Only the highest mountains produce, on the average, more than 10 inches of annual runoff (Moosburner, 1986, p. 323). The three principal mountain sources of runoff are the Sierra Nevada, near the western boundary of the State, and the Ruby and Jarbidge Mountains, in the northeast.

Nevada has no large rivers. The largest streams in the State are the Humboldt River, which drains the Ruby and Jarbidge Mountains; the Truckee, Carson, and Walker Rivers, which drain parts of the Sierra Nevada in California and Nevada; and the Muddy and Virgin Rivers, which flow into the Colorado River in the southeastern part of the State (figure 5). Many of these rivers are controlled by dams, reservoirs, and diversions. Of the mentioned rivers, only the Humboldt and Muddy begin and end within Nevada.

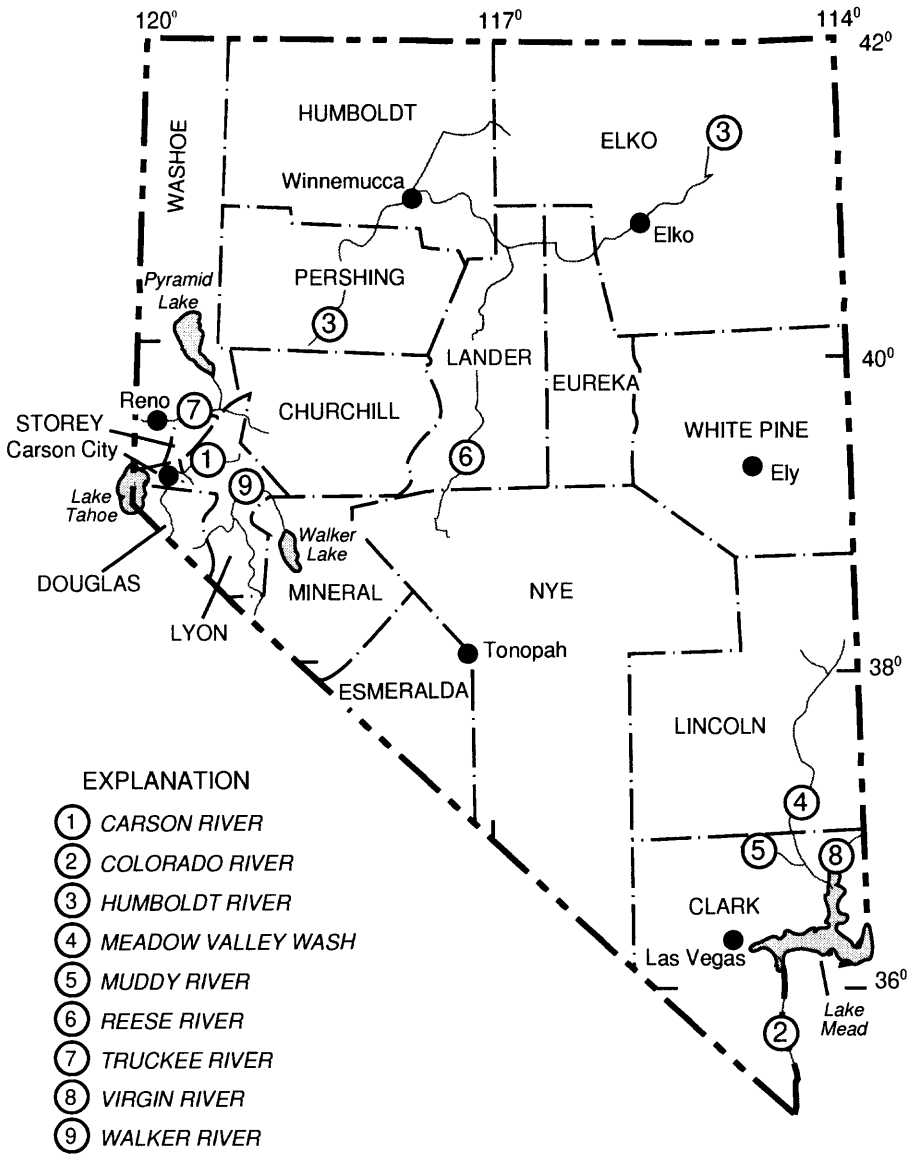


Figure 5. Principal streams and lakes in Nevada.

In water year 1995, above-average precipitation and runoff provided significant relief from the previous 8 years of drought in northern Nevada and parts of the Great Basin including the lower Colorado River Basin. Flow in the major streams generally ranged from 75 to 220 percent of long-term average. Flows in the major streams ranged from 120 to 220 percent of average (years) in those draining parts of the Sierra Nevada and from 150 to 160 percent of average (years) for sites along the Humboldt River (figure 6). Flow at the Colorado River below Hoover Dam was at 87 percent of its long-term average (1935-95). The above average precipitation and runoff continued in northern Nevada in water year 1996, while parts of southern Nevada returned to drought conditions.

Surface-Water Quality

The quality of surface water in Nevada differs from place to place and season to season. Concentrations of dissolved solids are commonly higher in the southern part of the State than in the northern part, and are dependent to a large extent on streamflow rates. Concentrations usually are greatest during low

streamflow, due to the dominance of ground-water contributions, and are lowest during high streamflow, due to dilution by precipitation or snowmelt.

During water years 1995 and 1996, the Carson River near Carson City streamflow-gaging station had mean dissolved-solids concentrations of 121 and 106 percent (respectively) of the long-term mean (1966-96). Streamflow at this station was 221 percent of the long-term mean (1940-95) for water year 1995, and an estimated 156 percent of the long-term mean (1940-96) for water year 1996. During water years 1995 and 1996, a southern Nevada streamflow-gaging station (Virgin River at Littlefield) had mean dissolved-solids concentrations of 85 and 104 percent (respectively) of the mean for the period of record (1949-96). Streamflow at this station was 202 percent of the long-term mean (1930-95) for water year 1995, and an estimated 67 percent of the long-term mean (1930-96) for water year 1996.

During water years 1995 and 1996, the Colorado River below Hoover Dam streamflow-gaging station had mean dissolved-solids concentrations that were equal to and 96 percent (respectively) of the mean for the period of record (1946-96). Annual streamflow was 87 percent of the long-term mean (1935-95) for water year 1995, and estimated to be equal to the long-term mean (1935-96) for water year 1996.

Ground Water

Ground water continues to be an important source for drinking-water supply and for irrigation in Nevada. Most ground water is withdrawn from unconsolidated deposits of sand and gravel. In a few places, ground water is withdrawn from volcanic rocks such as the basalt aquifer that supplies water for the City of Fallon and the Naval Air Station, and from sedimentary rocks such as the carbonate (limestone and dolomite) rock aquifers in southern Nevada. In addition to withdrawals for drinking-water supply and irrigation, substantial quantities of ground water continue to be withdrawn for mining operations including the dewatering of mined areas. These withdrawals are mostly from consolidated volcanic and sedimentary rocks. In 1995, ground-water withdrawals exceeded 220,000 acre-feet. Dewatering of mined areas accounted for more than 80 percent of the withdrawals (George Jackson, Nevada State Engineers Office, Carson City, Nev., written commun., 1996).

Sand and gravel aquifers most often are used for drinking-water supply and irrigation because the deposits underlie large areas of the numerous valleys that characterize much of the Nevada landscape and because well yields are more predictable than yields from other types of deposits (silts and clays) and rocks (volcanic, metamorphic, igneous, and sedimentary).

Many new wells were drilled during 1995 and 1996. A total of 3,160 wells were drilled in 1995, which supersedes the total of 3,033 wells drilled in 1994. The number of wells has continually increased since 1982 when only 750 wells were drilled in Nevada. Most wells are drilled for domestic water supply. Domestic water-supply wells typically are completed between 125 and 250 feet below land surface. Wells used for public and industrial supplies, and for irrigation generally are drilled deeper; to depths between 250 and 1,000 feet.

Generally, ground water is at greater depth beneath the alluvial fans that border the mountains than beneath the valley floors or near streams and rivers. Ground-water levels do not remain constant but fluctuate in response to changes in climate, and to changes in the quantity and location of recharge and discharge.

Ground-water levels typically rise from late winter to spring in response to increased recharge from rain, snowmelt and runoff, and decreased discharge from evapotranspiration and pumping. During this period, more water usually is recharged to aquifers in the State than is discharged. In contrast, water levels typically decline from the summer to early winter when recharge from rain and runoff is less and discharge from evapotranspiration and pumping is more. During this period, more water usually is discharged from aquifers in the State than is recharged.

Long-term climatic changes and pumping can affect water-level trends over many year periods. Ground-water levels in widely scattered wells in eastern Nevada that are not affected by pumping have risen since the early 1960's. These water-level rises are the result of a wetter-than-normal period that followed a drier-than-normal period between 1930 and 1960 (Michael D. Dettinger and Donald H. Schaefer, U.S. Geological Survey, written commun., 1995). The most recent drought from 1987 to 1994 resulted in a decline of ground-water levels throughout much of Nevada. However, during 1995 and 1996, ground-water levels rose in response to greater-than-normal precipitation.

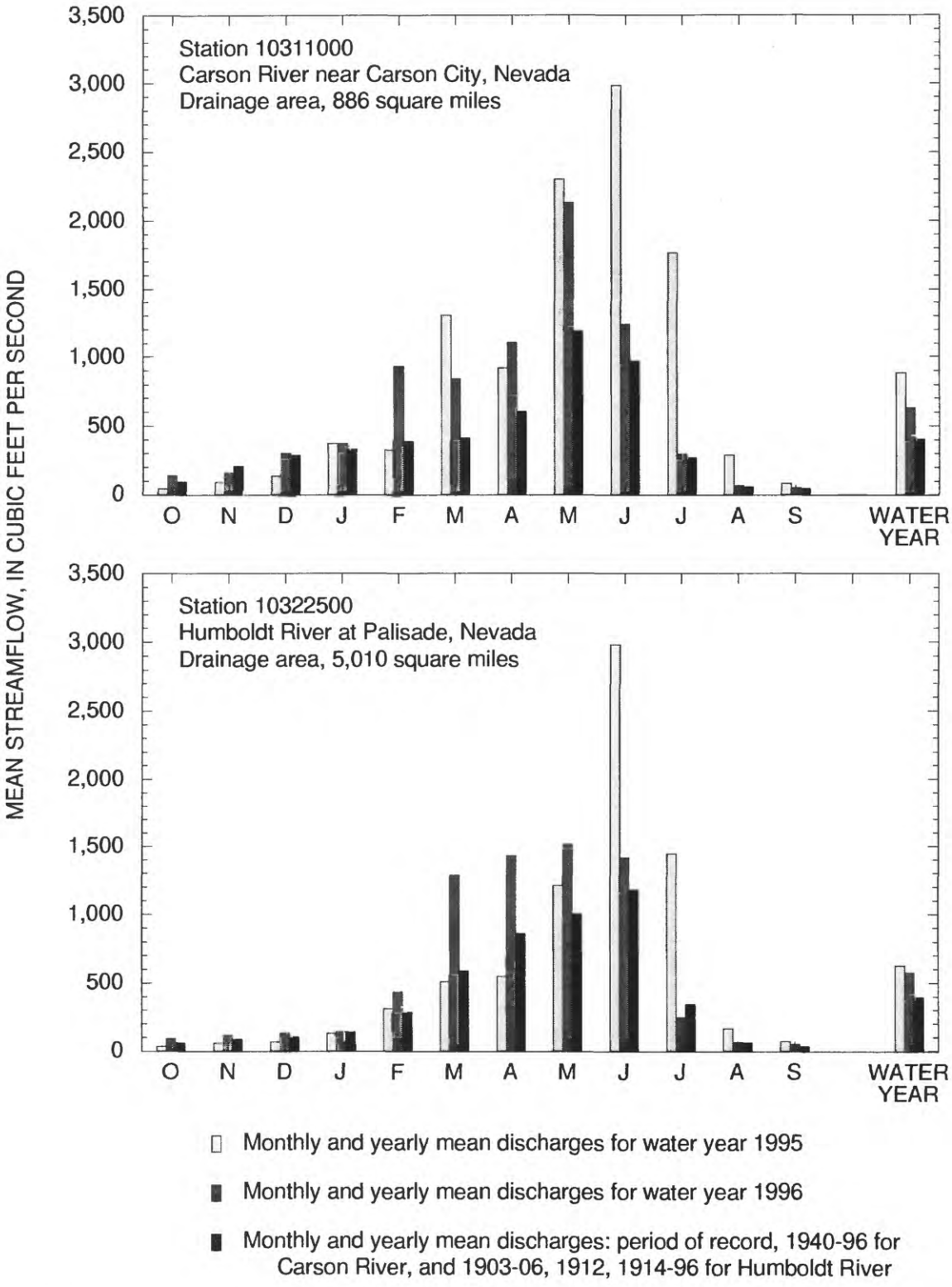


Figure 6. Discharges during water years 1995 and 1996, and long-term mean discharge at two representative gaging stations.

During this period, ground-water levels rose 35 to 50 feet in Kings Canyon near the base of the Carson Range west of Carson City (figure 7).

Whenever ground water is pumped from an aquifer, it is a new discharge from the aquifer and ground-water levels will decline in the aquifer. Water levels will continue to decline unless the water that is pumped is balanced by an increase in recharge or by a decrease in natural discharge. Ground water is pumped in many valleys in Nevada and water levels have declined in some valleys for more than 40 years. In Las Vegas Valley, pumping for public-water supply has caused ground-water levels to decline more than 100 feet in some areas of the valley since the 1940's. In Diamond Valley (north-central Nevada), pumping for irrigation has caused ground-water levels to decline more than 70 feet at the south end of the valley since the early 1960's. Ground-water level declines caused by pumping in several valleys increased during the drought years from 1987 to 1995. Since 1995, however, ground-water levels have risen in many places in response to recharge from greater-than-normal precipitation, a reduction in pumping, or both.

Drought

Water year 1995 marked the end of 8 years of drought (1987-95) in northern Nevada. Snowpack ranged from 90 percent to more than 130 percent of average annual snowpack in the principal river basins of northern Nevada as of April 1995.

Lake Tahoe, which drains to the Truckee River, rose above its natural rim on March 15, 1995, and rose 3.4 feet above that rim by September 30, 1995. With the above-average 1995-96 snowpack, the level of Lake Tahoe was close to the maximum elevation of 6.1 feet above the rim at the start of summer of 1996.

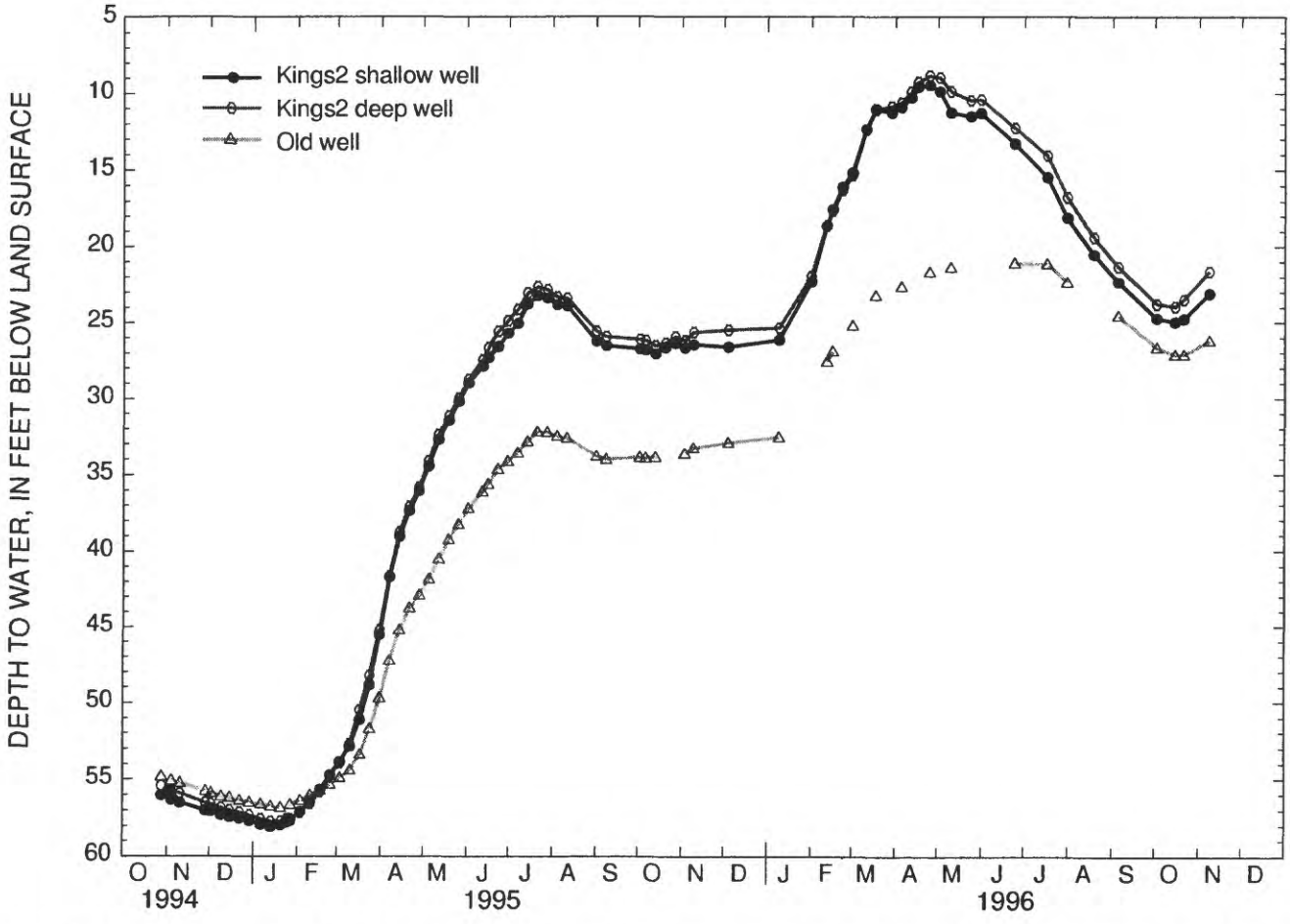


Figure 7. Ground-water level rise in three wells in Kings Canyon, west of Carson City, Nev., for water years 1995 and 1996.

Runoff from the above-average 1992-93 snowpack enabled the cui-ui, an endangered sucker-like fish found in Pyramid Lake, to swim up the Truckee River to spawn for the first time since 1986. Flow from released storage water in the upper Truckee River allowed another spawning run in 1994; however, reservoir supplies were severely depleted. Runoff from the above-average 1995-96 snowpack allowed the cui-ui to spawn for the fourth consecutive year in 1996. Since 1909, the water level in Pyramid Lake has declined 73 feet (figure 8), which is equivalent to a 30 percent reduction in lake volume. During the above-average runoff of the 1995 water year, the lake level rose 2.1 feet by September 30, 1995, an increase of 230,000 acre-feet. During water year 1996, the lake level rose 4.1 feet, an increase of 460,000 acre-feet.

Fish in Walker Lake, the terminus of the Walker River, may die in less than 5 years (when the water-surface altitude reaches 3,940 feet) unless the lake receives large amounts of freshwater inflow to reduce salinity (Mike Sevon, Nevada Department of Wildlife, written commun., 1994). Since 1908, the water level in Walker Lake has declined 132 feet (figure 8), which is equivalent to a 75-percent reduction in volume. The lake-surface altitude has dropped about 30 feet since the onset of the drought (1984) in northern Nevada. Irrigation diversions and infiltration deplete virtually all the flows upstream from Walker Lake. The 1995 water year runoff provided some relief in the long-term decline as Walker Lake levels rose 3.4 feet, an additional 93,000 acre-feet of storage. During water year 1996, the lake level rose 1.3 feet, an increase of 57,000 acre-feet.

MAJOR WATER ISSUES IN NEVADA

Urban Water Use

Nevada leads the Nation in rate of population growth. The population in Nevada increased by more than 63 percent in the 1970's, and by 55 percent in the 1980's (figure 9). The population of Nevada in 1996 was about 1.64 million (figure 9), according to the Nevada State Demographer (written commun., 1996). Estimates by the State Demographer indicate the population will more than double to 3.47 million by 2016. The major growth centers in Nevada are Las Vegas Valley and vicinity in the south; Reno, Sparks, Carson City, and vicinity in the northwest; and Elko and vicinity in the northeast. Many people think of Nevada as a rural state because it has an average population density of only 12 people per square mile. However, more than 85 percent of the population lives in communities of 2,500 people or more. Population growth around these urban centers makes Nevada the fourth most urban State in the Nation (Robert Speaker, U.S. Department of Commerce, written commun., 1991).

Nevada also is the most arid state in the Nation. The arid Nevada valleys, still home to the West's largest wild horse populations, are increasingly targeted as sources of water for the rapidly expanding urban Reno-Sparks area in northwestern Nevada and Las Vegas in southern Nevada. Concurrent with the continuing strong growth of the gaming/tourism industry in the urban areas, the rapidly expanding large-scale open-pit gold mines of northern and northeastern Nevada were the largest producers of gold and silver in North America in 1994 (Skorupa, 1995).

A trend is emerging in the development boom in southern Nevada as new mega-hotels/casinos now emphasize family tourism as much as, or more than, gaming. One of the fastest growing areas in the United States continued to be in Las Vegas Valley. Between 1990 and 1994, Henderson, Nev., was the fastest growing city (with a population over 100,000) and Las Vegas was the fourth fastest growing city (with a population over 100,000). Several major new resort projects have been constructed or are being constructed that will match or exceed the 1993 boom that opened 12,000 new hotel rooms in 1 year. Traffic through McCarran International Airport makes it the 8th busiest airport in the United States and the 12th busiest airport in the world. Applications for diversion of water of up to 190,000 acre-feet per year from the Lower Virgin River by the Las Vegas Valley Water District were approved by the Nevada State Engineer.

The effects of Nevada's rapid growth in population are concentrated in relatively small areas in southern Nevada (including Las Vegas Valley), the western parts of the Truckee and Carson River Basins in northwestern Nevada, and, to a lesser extent, the Elko area in the northeastern part of the State. In northern Nevada, water for this new growth is being developed from the conversion of agricultural water rights and water supplies. Rapid urbanization has the potential to affect the quality, as well as the quantity, of available water in areas that include the Lake Tahoe Basin, the Truckee, Carson, and Humboldt River Basins, and Las Vegas Valley. Currently, increasing nitrate concentrations in ground water are an important issue

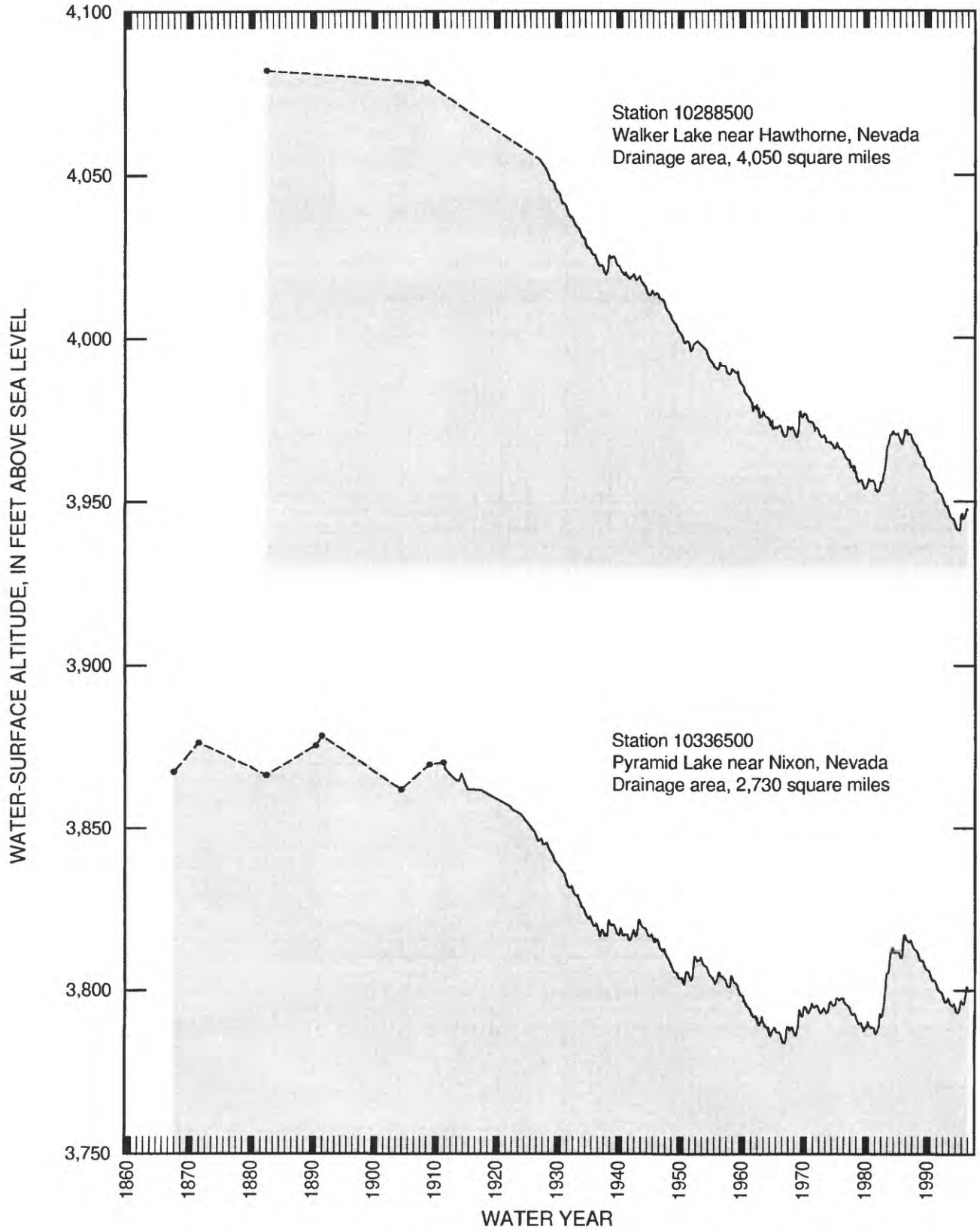


Figure 8. Water-surface altitude at Walker and Pyramid Lakes.

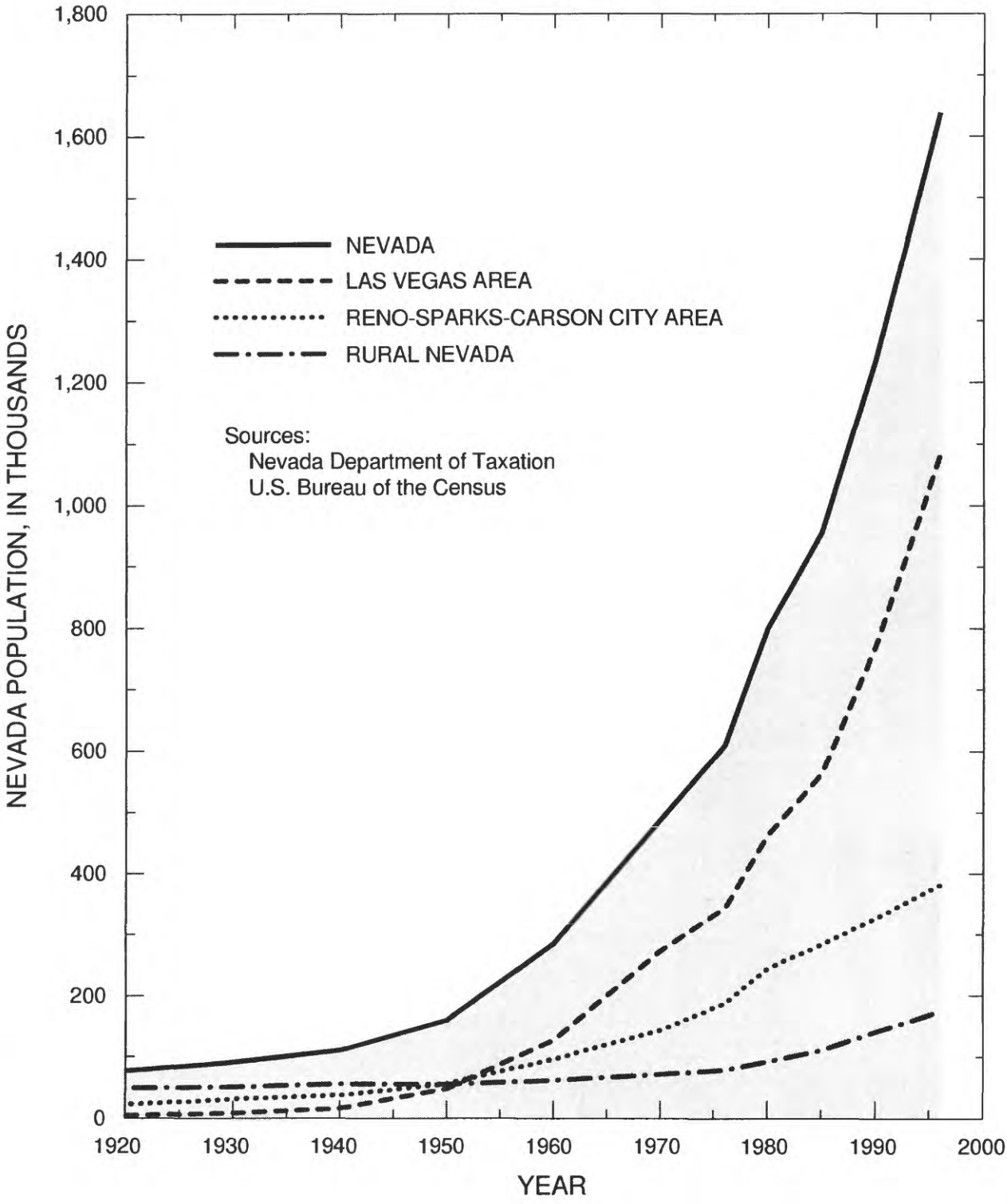


Figure 9. Nevada population trends, 1920-96.

in urban areas of northern and southern Nevada. In some areas, the use of individual septic tanks for sewage disposal has been prohibited because nitrate concentrations in ground water approach or exceed State and Federal standards (Moore, 1989). Other issues of concern to urbanizing areas include the presence of synthetic organic compounds in shallow ground water and potential trends in increasing dissolved-solids concentrations due to surficial recharge from agricultural, landscape, and recreational (golf course) irrigation. The lowering of water levels in the Las Vegas area has caused the ground to subside (Burbey, 1995).

The reuse of treated wastewater is increasing due to more stringent requirements on the quality of effluent and the lack of available water. In 1996, about 18,000 acre-feet of wastewater was reused, about 9 percent of the total treated wastewater in Nevada. Douglas County (at about 100 percent) and Carson City (at about 65 percent) are the leading counties in the State reusing treated wastewater. Current uses for treated wastewater are agricultural irrigation, golf-course irrigation, power plant cooling water, artificial wetlands, and dust control (Naomi Duerr, Nevada Division of Water Planning, oral commun., 1996).

Agricultural Water Use

Irrigation is the largest use of water in Nevada. In 1990, this use accounted for about 84 percent of all offstream withdrawals. In Nevada, irrigated crops include alfalfa seed, alfalfa, and other hay; winter and spring wheat; and potatoes and other vegetables. Of these, hay is the leading crop grown in Nevada. In 1995-96, farmers received all their permitted water because streamflows were above normal. In northern Nevada, a wet spring in 1995 allowed farmers to irrigate less in the early part of the growing season (Namiotka, 1995).

When growing Nevada communities withdraw the maximum amount of water available through their current water rights, the largest alternative supply is from the purchase or lease of agricultural rights. The result is increased pressure on agricultural water-right holders to sell their rights to other users. However, agricultural users are reluctant to support long-term leasing of their water rights for urban use, for fear of losing their agrarian lifestyle.

Water Allocation in Truckee River and Carson River Basins

Agencies have been in litigation since the late 1800's over allocation of surface water in the Truckee River and Carson River Basins of Nevada and California. Basic issues involve division of the resources between the States, and competing demands in Nevada among (1) urban use in the growing Reno-Sparks area (mid-Truckee River); (2) Indian and endangered-species fishery requirements at Pyramid Lake (terminus of Truckee River); and (3) irrigation, fish, and waterfowl needs in Fallon and the Stillwater Wildlife Management Area (lower Carson River). Public Law 101-618, containing the Fallon Paiute-Shoshone Tribal Settlement Act and the Truckee-Carson-Pyramid Lake Water Rights Settlement Act (Jones and others, 1991, p. 99-117), was signed into law in November 1990. Section 205 of the Truckee-Carson-Pyramid Lake Act requires negotiation and implementation of an interagency operating agreement and operating plan for the Truckee River. The Act specifies that final ratification of the Truckee River Operating Agreement (TROA) and plan be in place by November 1997.

U.S. Geological Survey assistance to other Department of the Interior agencies in implementation of Public Law 101-618 continued during 1995-96. The Nevada District Truckee-Carson Program initiated upgrades of data networks to support the development of river-flow and water-quality models, and real-time data networks for river operations. Initial activities in development of the Truckee-Carson River-systems model include preliminary calibration of flow-routing models for the Carson and Truckee Rivers, and implementation of a graphical user interface for generating and displaying the results of simulations of alternative scenarios for river operations. Models currently under development include stream-temperature and total dissolved-solids models of the Truckee River, precipitation-runoff models of the Lake Tahoe and Truckee River Basins, and a model to simulate pre-TROA operations and allocations in both the Truckee and Carson River Basins. Other Nevada District projects have published ground-water assessments of the Newlands Irrigation Project and Stillwater Wildlife Management Area to meet Bureau of Reclamation and U.S. Fish and Wildlife Service obligations under Public Law 101-618 for preliminary reports to Congress.

National Water-Quality Assessment Program

Due to the lack of long-term, consistent information that could be used to assess the quality of water resources of the Nation, the USGS implemented a pilot National Water-Quality Assessment (NAWQA) program in 1986 to develop, test, and refine assessment methods. The Carson River Basin was selected as a pilot study area. An interim review of the pilot program by the National Academy of Sciences in 1989 determined that implementation of a full-scale NAWQA program is in the best interest of the Nation, and that USGS is well qualified to establish and implement such a program. In 1991, USGS began a full-scale NAWQA program to describe the status of and trends in the quality of the Nation's surface- and ground-water resources, and to provide a scientific understanding of the primary natural and human factors that affect water quality. The Nevada Basin and Range study unit, which includes the Carson and Truckee River Basins and Las Vegas Valley, is 1 of 60 proposed NAWQA units that will be investigated throughout the Nation. The Nevada Basin and Range study is focusing on comparing and contrasting the effects of urban and agricultural land and water use on water quality.

Hydrology at Nevada Test Site

The Nevada District provides support to the U.S. Department of Energy (USDOE) by studying the hydrologic effects of weapons testing at the Nevada Test Site (NTS). Nuclear weapons have been tested at NTS since the early 1950's. The site was chosen because of its remote location, government ownership, and interior drainage system (Great Basin). Long-term studies of basin-and-range hydrology have identified regional aquifers that may allow radionuclides introduced into the subsurface environment to migrate beyond the NTS boundary. Studies are continuing that will determine the potential for radionuclides to be transported within these aquifers and that will assist USDOE in minimizing the effects of testing on the subsurface environment.

Other hydrologic research activities at NTS include investigations using geophysics and radioactive isotopes. Downhole radar shows promise to determine the location and magnitude of formation fractures controlling ground-water movement; flow velocity also may be determined using this geophysical technique. In other areas in and around NTS, a determination of the direction and rate of ground-water flow may be addressed using isotopes of strontium and uranium.

The Hydrologic Resources Management Program is applying state-of-the-art electronic pressure transducers to record minute (0.002-foot) changes in water level in deep (more than 2,000-foot) wells at NTS. Sophisticated programs for reduction of time-series data have been applied to filter out barometric and earth-tide effects on subtle water-level fluctuations. This has allowed the processing of complex data-logger information to provide hydrographs that are being used to develop quantitative estimates of aquifer characteristics.

Potential Nuclear-Waste Repository at Yucca Mountain

In December 1987, the U.S. Congress identified Yucca Mountain, near the Nevada Test Site, as a potential location for the Nation's first high-level nuclear-waste repository. The potential repository is to be completed by 2010 and would be expected to contain nuclear waste for at least 10,000 years.

The Nevada District assists the USGS Yucca Mountain Project Branch by operating monitoring networks in support of individual studies of unsaturated and saturated ground-water flow as part of the Yucca Mountain project.

Mining and Water in the Humboldt River Basin

The advent of leaching processes that use cyanide (toxic in sufficient concentrations) for recovery of gold from low-grade ore has resulted in a mining boom, particularly in the Humboldt River Basin. Several large open-pit mines are currently being dewatered at rates up to 70,000 gallons per minute. A small part of this water is used for operations and reinjection, irrigation of agricultural lands, or surface discharge into the Humboldt River or its tributary channels. The localized and cumulative effects are not well understood, especially in combination with effects of long-standing irrigation practices and increasing municipal growth.

Salinity and Water Budget of Walker Lake

Walker Lake, a desert lake near Hawthorne, Nev., has gone dry several times during the last 10,000 years in response to changes in climatic and hydrologic

conditions. The lake-surface altitude has decreased by 135 feet since 1882, when agricultural irrigation began in the basin. During the same period, dissolved-solids concentrations increased from about 2,500 to 13,300 milligrams per liter (July 1994). This increase of dissolved solids threatens the Walker Lake ecosystem and the fish that depend on this ecosystem. The loss of the lake's trout fishery would affect the economy of the local communities. Upstream users, who are economically dependent upon availability of water-rights appropriations, also would be affected.

In cooperation with the Walker River Paiute Tribe, Nevada District hydrologists have estimated changes in Walker Lake salinity in response to lake-level changes and salt inputs. The water budget shows that, assuming hydrologic conditions remain the same as from 1939 to 1993, about 33,000 acre-feet per year of water in excess of the long-term average is needed to maintain the 1994 lake-surface altitude. The lake-surface altitude would need to rise approximately 20 feet, which is equivalent to about 70,000 acre-feet of water, to reduce the 1994 dissolved-solids concentration to 10,000 milligrams per liter and maintain a viable fishery. An additional 47,000 acre-feet per year would be needed to maintain the higher lake level. In 1995, the water level of Walker Lake rose approximately 5 feet in response to a 200 percent of normal snowpack in the Sierra Nevada headwaters.

Issue-Related Research

The existing water resources cannot easily accommodate urban and economic development in Nevada, and that inability focuses most Nevada District customer interest on issues such as data networks, resource assessment, delineation of water yields, documentation of water use, and information-management systems. However, many aspects of meeting urgent public need for hydrologic information also provide opportunities for applied research on fundamental processes.

"Simple" water budgets for arid ground-water basins require measurements and estimations of hydrologic processes that are far from well understood. A research project in the Nevada District is refining instruments and models for estimation of ground-water evapotranspiration by phreatophytes, the major source of water discharge in many undeveloped valleys.

The need to refine techniques for estimating ground-water recharge led to funding of another research project that will focus on the effect of temperature on infiltration through the unsaturated zone beneath small streams and ditches on alluvial fans. Increased requirements to assess and manage complex hydrologic basins has placed new emphasis on more complex models to simulate interactions between streams and aquifers.

Two studies, one in Douglas County and one in Washoe County, are being made to identify the source or sources of nitrate in ground water. Nitrate concentrations in ground water that exceed the drinking water standard of 10 milligrams per liter are not unique to these counties in northern Nevada; nitrate also occurs in other Western States. Research to develop methods to identify and quantify sources of nitrates in these counties could have wide application throughout Nevada and many areas in the United States.

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PROJECTS FUNDED IN FISCAL YEARS 1995 and 1996

Surface-Water Data Network *(Project 001)*

Location: Statewide and eastern California.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1894.

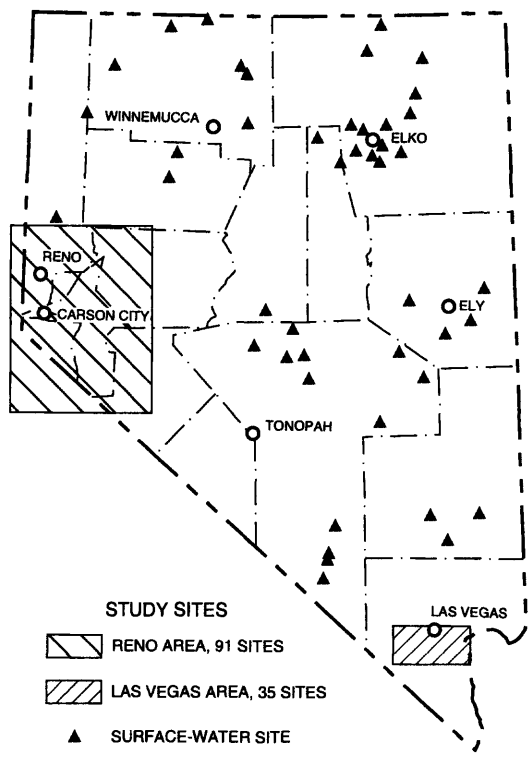
Cooperating and Supporting Federal Agencies: Bureau of Land Management, Bureau of Reclamation, Carson City Public Works Department, Carson-Truckee Water Conservancy District, Carson Water Subconservancy District, City of Henderson, City of Las Vegas, City of Reno, City of Sparks, Clark County Regional Flood Control District, Clark County Sanitation District, Douglas County, Duck Valley Reservation Shoshone-Paiute Tribes, Federal Water Master, National Park Service, Nevada Department of Conservation and Natural Resources, Nevada Division of Water Resources, Nevada Division of Wildlife, Pyramid Lake Paiute Tribe, Southern Nevada Water Authority, Summit Lake Paiute Tribe, Truckee-Carson Irrigation District, U.S. Army Corps of Engineers, U.S. Board of Water Commissioners, U.S. Fish and Wildlife Service, Walker River Irrigation District, Walker River Paiute Tribe, Washoe County Department of Comprehensive Planning, Washoe County Department of Public Works, and Washoe Indian Tribe.

Problem: Surface-water runoff is highly variable, both areally and seasonally, throughout the State. Information is needed for surveillance, planning, design, hazard warning, and management. These data are particularly relevant to water-related fields such as water supply, hydroelectric power, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water-resources development. An appropriate data base is necessary to support such ongoing needs.

Objectives: Data will be collected for (1) assessment of water resources, (2) operation of reservoirs and industries, (3) waste disposal and pollution control operations, (4) water-quality estimations, (5) compact and legal requirements, (6) analysis of short-term variability and long-term trends for forecasting, and (7) research.

Approach: The stage (water level) and discharge of lakes and streams are measured at a network of surface-water stations and sites using standard USGS methods. Data-collection intervals are determined according to the principal purpose of each site.

Progress and Significant Results, Fiscal Years 1995 and 1996: Streamflow monitoring at year-round and irrigation-season stations continued. The number of year-round sites



and irrigation-season sites slightly increased during both fiscal years. In addition, stage measurements were made at several lakes and reservoirs. All data were processed and stored in the National Water-Information System computer data base. The annual data reports were published. Real-time and historical data retrieval-application programs were placed on the Nevada District Internet home page.

Plans for Fiscal Year 1997: Statewide surface-water-data collection, computation, and compilation will continue. Field surveys and computations for indirect measurements of flow will be made as needed. The annual data report will be compiled and published. Real-time and historical data will be updated on the Nevada District Internet home page.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.

Ground-Water Data Network *(Project 002)*

Location: Statewide.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1945.

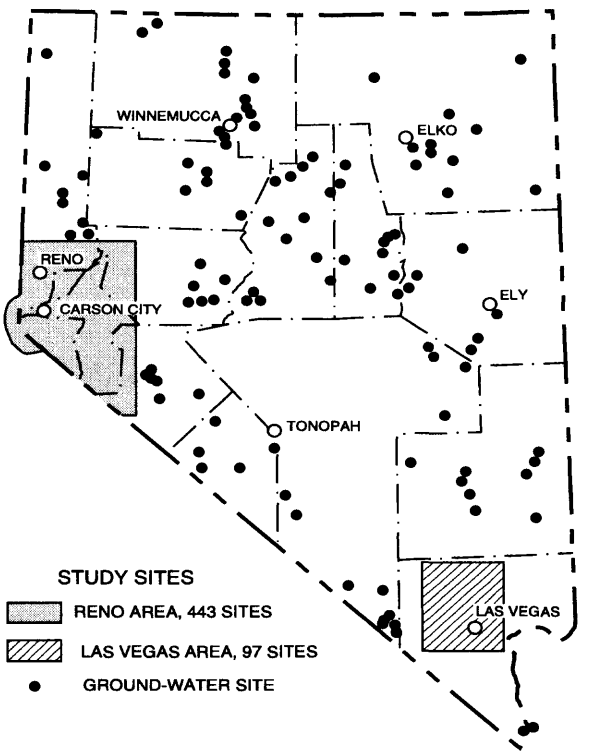
Cooperating Agencies: Carson City Public Works Department, Churchill County, Douglas County, Las Vegas Valley Water District, and Nevada Division of Water Resources.

Problem: The long-term response of regional aquifers throughout the State to natural climatic variations and induced stresses is largely unknown. Proper planning and management of State water resources require long-term information so that trends can be defined, problems discovered, and corrective actions taken. Measurements of recharge to and discharge from ground-water systems provide a data base from which to evaluate the effects of management and development, and assist in determining future supplies.

Objectives: Long-term records will provide information to identify trends in ground-water levels in response to natural climatic variations and induced stresses within the State. The data are used by Federal, State, and local planners to (1) assess the ground-water resource, (2) estimate future conditions, (3) detect and define pollution and supply problems, and (4) provide information for management of the resource.

Approach: A regionally representative network of wells is maintained to allow measurement of water levels in most aquifers within the State. The ground-water well networks are designed to meet the needs of the customers. Measurements are made at approximately the same times each year to reduce seasonal effects. New wells are added to the network as old wells are destroyed, local land use changes, and other needs arise.

Progress and Significant Results, Fiscal Years 1995 and 1996: Ground-water-data collection, computation, and compilation continued. Basic records were verified for depth-to-water in wells and discharge from springs at sites included on the routine statewide network. All data were processed and stored in the National Water-Information System computer data base. The present network continued to expand. Two reference manuals were published in cooperation with the Nevada Division of Water Resources. A report on water levels in Las Vegas was published. The annual data reports were published.



Plans for Fiscal Year 1997: Ground-water data collection, computation, and compilation will continue. The annual data report will be compiled and published.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

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Cartier, K.D., Bauer, E.M., and Farnham, J.L., 1995, Reference manual for data base on Nevada water-rights permits: U.S. Geological Survey Open-File Report 95-452, 30 p.

Clary, S.L., McClary D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.

Water-Quality Data Network *(Project 003)*

Location: Statewide and eastern California.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1939.

Cooperating and Supporting Federal Agencies: Bureau of Land Management, Carson City Public Works Department, Douglas County, Nevada Bureau of Mines and Geology, Nevada Division of Environmental Protection, Nevada Division of Water Resources, Nevada Division of Wildlife, Southern Nevada Water Authority, and U.S. Fish and Wildlife Service.

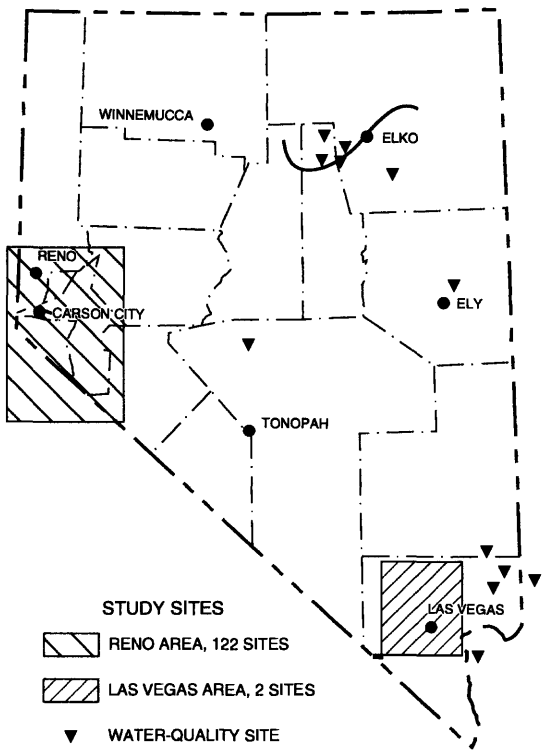
Problem: The physical, chemical, and biological quality of surface water and ground water is highly variable and must be monitored to identify local influences, seasonal trends, and long-term trends. Long-term records of standardized water-quality data provide information for management and planning.

Objectives: Analysis of the data will allow identification of short- and long-term trends, provide early warning of developing water-quality problems, and provide information for Federal management of interstate waters.

Approach: A network of water-quality sites for surface water and ground water has been established to provide information about physical, chemical, and biological characteristics. Standard USGS methods of water-sample collection, preservation, and analysis are used.

Progress and Significant Results, Fiscal Years 1995 and 1996: Approximately 81 water-quality sites existed in water year 1996. Data collection and analysis continued using improved statistical techniques. All data were processed and stored in the National Water-Information System computer data base. Station descriptions were updated as needed. The annual data reports were published. Reports on dissolved-solids contribution to the Colorado River and Douglas County water-quality data were published.

Plans for Fiscal Year 1997: Data collection and analysis will continue. The annual data report will be compiled and published.



Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.

Mello, K.A., 1996, Hydrologic data for Carson and Antelope Valleys, Douglas County, Nevada, and Alpine and Mono Counties, California, 1981-94: U.S. Geological Survey Open-File Report 96-464, 54 p., 2 diskettes.

Westenburg, C.L., 1995, Dissolved-solids contribution to the Colorado River from public lands in southeastern Nevada, through September 1993: U.S. Geological Survey Water-Resources Investigations Report 94-4210, 25 p.

National Trends Network for Monitoring Atmospheric Deposition *(Project 005)*

Location: Smith Valley and Saval Ranch, Nev.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1985.

Supporting USGS Program: National Atmospheric Deposition Program.

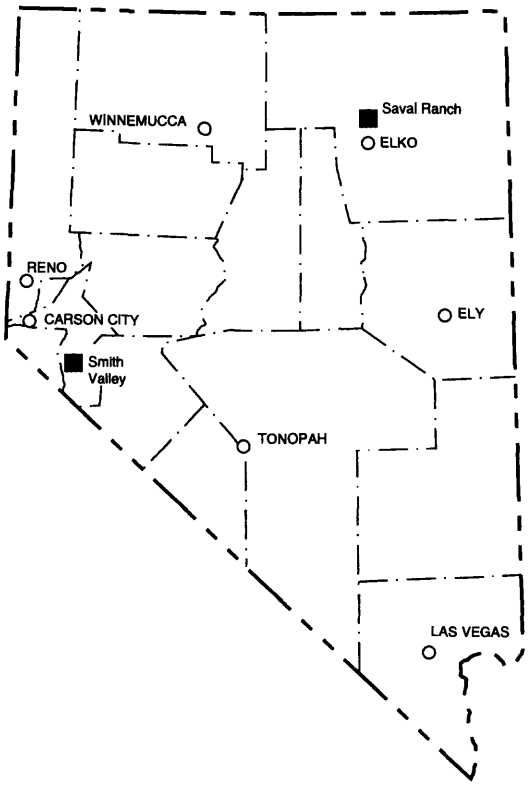
Problem: Acid precipitation has caused adverse ecological and economic consequences in the Eastern United States. In the Western United States, the chemical composition and variability of wet atmospheric deposition is largely unknown due to a lack of quantitative data. However, industrial and vehicular emissions, which are known to cause acid precipitation in the east, are found also in the west.

Objectives: Precipitation data will be characterized to determine variations and trends as part of a Nationwide program to quantify the chemical properties of wet atmospheric deposition.

Approach: Two atmospheric-deposition samplers are being operated, one in Smith Valley, Nev., and one at Saval Ranch, Nev. The samplers are checked weekly, and samples are collected and analyzed for pH and specific conductance when sufficient precipitation occurs.

Progress and Significant Results, Fiscal Years 1995 and 1996: Twenty-four samples contained adequate quantities of precipitation for field determination of pH and specific conductance in 1995 and 1996. An interstate comparison study was made by the National Atmospheric Deposition Program and the National Trends Network. The data were published in the annual data summaries of the National Atmospheric Deposition Program. The Smith Valley site was relocated because of vandalism.

Plans for Fiscal Year 1997: Sample collection and compilation of data from the Smith Valley and the Saval Ranch sites will continue.



Flood-Insurance Studies *(Project 006)*

Location: Northern Nevada.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1985.

Supporting Federal Agency: Federal Emergency Management Agency.

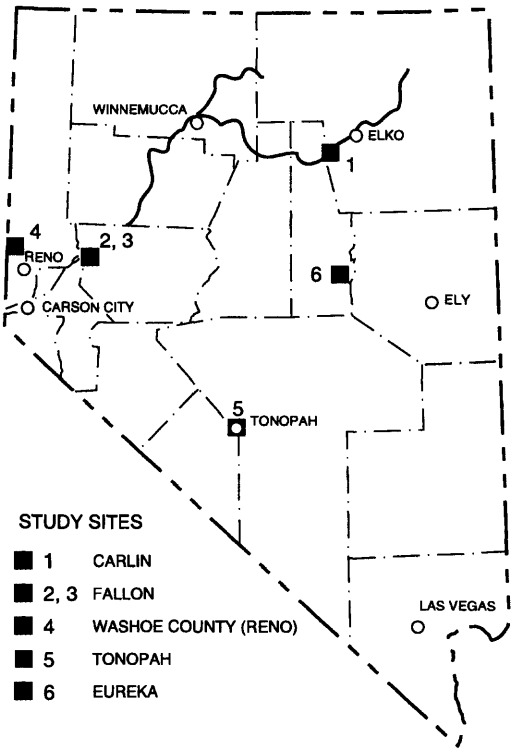
Problem: Flooding in arid regions can be devastating because most rain occurs in the spring, when rain on snow is likely, and sparse vegetation and compacted desert soils allow little infiltration of rainfall and snowmelt. Excessive overland flow is also a consequence of locally intense thunderstorms. The National Flood Insurance Act of 1968 provides that the Federal Emergency Management Agency (FEMA) operates a flood-insurance program through the Federal Flood Insurance Administration. FEMA needs information from flood studies in selected areas to determine appropriate flood-insurance premiums.

Objectives: Efficient procedures will be developed to obtain information at the accuracy required by FEMA on flood frequency and inundated areas, and to determine 100-year-flood-plain boundaries.

Approach: Precipitation, river-stage, and discharge measurements collected as part of the surface-water data network are used. Flood frequencies are determined from long-term measurements of discharge or regional flood-frequency analyses. River slopes, channel and flood-plain dimensions, drainage areas, and other characteristics of drainage basins are estimated from maps, where possible, or measured directly. Areas of potential inundation are estimated using ground surveys, photogrammetry, and other available data in conjunction with flood-frequency estimates, hydraulic analysis, and, as appropriate, drainage-basin models.

Progress and Significant Results, Fiscal Years 1995 and 1996: Data collection and analysis was completed for the Washoe, Fallon, and Eureka Counties study sites. Flood-data analysis for all studies was submitted to FEMA for review and publication. Flood-data analyses for the Fallon area were completed and submitted to FEMA for publication.

Plans for Fiscal Year 1997: Analysis of the flood data for Fernley and Hawthorne studies will be completed and results submitted for publication by FEMA. A new study in Douglas County is expected to begin in early 1997.



Water Use in Nevada *(Project 007)*

Location: Statewide.

Project Chief: E. James Crompton.

Period of Project: Intermittent since 1978.

Cooperating Agency: Nevada Division of Water Resources.

Problem: Nevada is the driest State in the Nation, and it also has the fastest growing population. Water-use data are critically needed for the planning and management of the State's water resources. In addition to obtaining water-use data, methods need to be developed for improving data collection. More efficient ways of storing and retrieving data, to be compatible with other computer data bases, also need to be developed.

Objectives: Water-use information will be made available for the best utilization and management of the resource. The data will be collected, stored, and distributed to complement the available water-quantity and water-quality information. The data-storage system is designed to handle site-specific and aggregate water-use data to meet the needs of local users, State agencies, USGS, and other Federal agencies.

Approach: Information is to be compiled based on the smallest unit feasible, usually individual points of diversion or withdrawal. Three major advantages of using this approach are that (1) more sources of reliable information are available at smaller scales, (2) compilations detailed enough to provide specific information about small areas are in demand at a local level, and (3) larger scale requirements may be satisfied by summing the small-scale information.

Progress and Significant Results, Fiscal Years 1995 and 1996: Collection and compilation of water-use data in Nevada continued in accordance with national guidelines. Enhancements were made to the computerized data base of water-rights permits developed to allow USGS and the Nevada Division of Water Resources to share data bases on a wide-area network. The data base has capabilities for quality control and quality assurance that ensure accuracy of the data. Conversion of the well drillers' log file to a data base compatible with the permit file was completed and is being used. A method is being developed to make the water-use data base compatible with the permit file. An associated project created and tested a data base for the storage of spatial water-rights data. Water-use information was published in the annual data reports.

Plans for Fiscal Year 1997: Water-use information will be compiled and published in the annual data report. The water use report for 1985 will be published. A presentation on ARCView and water rights will be given. The collection and compilation of water-use data in Nevada during 1995 will be completed and submitted for Regional and National compilations. Enhancements will be made to the data base to store quarterly water-use reports.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.

Flood Investigations of Nevada Streams
(Project 036)

Location: Statewide.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1961.

Cooperating and Supporting Federal Agencies: Nevada Department of Transportation and U.S. Army Corps of Engineers.

Problem: The design of hydraulic structures within stream channels depends on accurate estimations of flood frequency and related debris-flow magnitude. Flood-recurrence intervals generally cannot be estimated on the basis of channel characteristics alone; long-term records of peak-flow measurements also are necessary. The Nevada Department of Transportation needs flood data to assist in the design of hydraulic structures for highways.

Objectives: The frequency and magnitude of floods of Nevada streams are appraised and data are provided for use in the design of highways and hydraulic structures.

Approach: Crest-stage gages to measure peak-streamflow stages have been installed, and are being maintained and operated. Sites are visited periodically to obtain flood records, maintain equipment, and make indirect measurements. Each crest-stage site is monitored for at least 10-15 years to provide data defining flood frequency and magnitude.

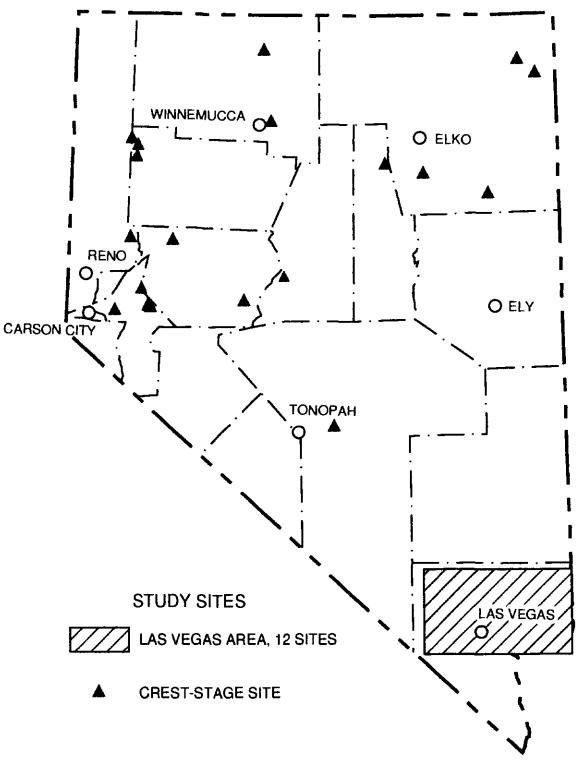
Progress and Significant Results, Fiscal Years 1995 and 1996: Peak-streamflow data were collected at 26 sites. Peak-flow data for the 1994 and 1995 water years were published in the annual data reports. Data collection and investigations of mud- and debris-flow areas continued. A compilation of Nevada streamflow statistics was initiated.

Plans for Fiscal Year 1997: Compilation of streamflow statistics will continue.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.



Beatty Disposal-Site Investigation
(Project 072)

Location: Amargosa Desert near Beatty, Nev.

Project Chief: Brian J. Andraski.

Period of Project: Continuous since 1976.

Supporting Federal Agency and USGS program: Nuclear Regulatory Commission and Low-Level Nuclear Waste Hydrology Program.

Problem: Low-level radioactive waste has been buried at a site near Beatty, Nev., since 1962. Processes affecting movement of water in dry sediments are not understood. Therefore, rates of potential migration of radioactive solutes cannot be estimated for present climatic conditions.

Objectives: Mechanisms and soil properties will be defined for controlling rates and directions of moisture movement (as liquid and vapor) through unsaturated soil under disturbed and undisturbed conditions. Methods for measuring properties of and water movement in dry alluvial soils will be developed. Rates of trench subsidence and erosion over time will be determined. Results of these studies will be used to (1) evaluate the geohydrologic suitability of existing site for waste containment and (2) contribute information for development of guidelines and criteria for selection and establishment of future burial sites for low-level radioactive waste.

Approach: Soil moisture and temperature are measured at an undisturbed site and at a disturbed test-trench site. Meteorological conditions are being monitored. Physical properties, such as permeability and grain-size distribution, of the undisturbed-soil profile and test-trench backfill are characterized through laboratory analysis. Vertical variability of these properties is evaluated by statistical analysis. Erosion and subsidence of test trenches are being monitored.

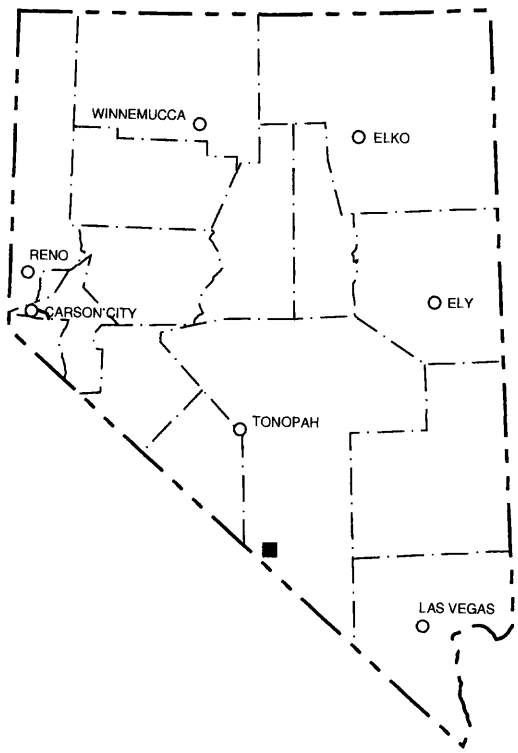
Progress and Significant Results, Fiscal Years 1995 and 1996: Long-term monitoring of soil moisture, erosion, and subsidence continued. Final compilation and analysis of long-term field and laboratory data were completed. Reports were published and presentations on study results were made at several meetings.

Plans for Fiscal Year 1997: Collection and evaluation of weather, soil moisture, erosion, and subsidence data will continue. Results will be used to improve understanding of processes affecting waste isolation at the Beatty site. Reports will be submitted for approval and publication.

Publications, Fiscal Years 1995 and 1996:

Andraski, B.J., 1996, Disturbance effects on soil properties and water balance at a low-level radioactive waste site, Amargosa Desert, Nevada [abs.]: 86th Annual Meeting, American Society of Agronomy, Seattle, November 1994, Agronomy Abstracts, v. 86, p. 227.

———1996, Properties and variability of soil and trench fill at an arid waste-burial site: Soil Science Society of America Journal, v. 60, p. 54-66.



———1996, Simulated trench studies near Beatty, Nevada—Initial results and implications, *in* Conference on Disposal of Low-Level Radioactive Waste, Reston, Va., May 1993: U.S. Geological Survey Water-Resources Investigations Report 95-4015, p. 111-118.

———1996, Waste burial in arid environments—Application of information from a field laboratory in the Mojave Desert [abs.]: RCRA Corrective Action Conference, U.S. Environmental Protection Agency, San Francisco, March 1996, p. 10-11.

Andraski, B.J., and Prudic, D.E., 1996, Soil, plant and structural considerations for surface barriers in arid environments—Application of results from studies in the Mojave Desert near Beatty, Nevada: Barriers for long-term isolation, Denver, August 1995, Proceedings, 1 diskette.

Andraski, B.J., Prudic, D.E., and Nichols, W.D., 1995, Waste burial in arid environments—Application of information from a field laboratory in the Mojave Desert, southern Nevada: U.S. Geological Survey Fact Sheet FS-179-95, 4 p.

Wood, J.L., 1996, Selected meteorological and micrometeorological data for an arid site near Beatty, Nye County, Nevada, calendar year 1992: U.S. Geological Survey Open-File Report 96-434, 33 p.

Wood, J.L., and Andraski, B.J., 1995, Selected meteorological data for an arid site near Beatty, Nye County, Nevada, calendar years 1990 and 1991: U.S. Geological Survey Open-File Report 94-489, 49 p.

Nevada Carbonate-Rock Aquifers
(Project 128)

Location: Eastern and southern Nevada.

Project Chief: Donald H. Schaefer, 1985-94; James M. Thomas, 1995-96.

Period of Project: Continuous since 1984.

Cooperating Agency: Las Vegas Valley Water District.

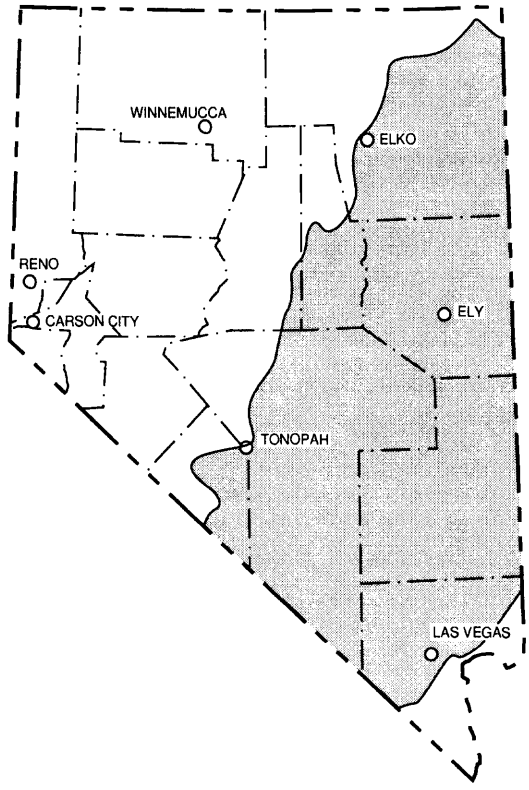
Problem: Demand for water in Las Vegas and smaller towns in eastern and southern Nevada is growing and additional supplies may be needed from ground-water sources outside the local basins. Previous assessments of the water resources of eastern Nevada indicate that the carbonate-rock aquifers are a potential ground-water source, but insufficient data are available upon which to base a decision for the location of major supply wells. The location of wells needs to be based on adequate data and sound hydrologic reasoning because of the high cost of developing wells in the carbonate-rock aquifers. Testing and monitoring of selected wells are needed to ensure continued availability of water supplies.

Objectives: The carbonate aquifers of eastern Nevada are being studied to determine the location of units with high transmissivity, high storage capacity, and good water quality, and, where possible, the cause of the high transmissivities. Areas with potential for siting of high-production wells may be selected for test drilling and evaluation.

Approach: Initial studies focused on the southern part of the carbonate-rock province; later phases were aimed at the central and northern parts of the carbonate-rock province. Detailed hydrological, chemical, and geological analyses of springs and wells already available were used to gain understanding of the carbonate-rock hydrology and to site other test wells. Test wells drilled by USGS and Bureau of Reclamation were used to determine aquifer properties. Areal studies, including remote-sensing, geological, geophysical, geochemical, and meteorological surveys were used with the well-test data to define areas in which high-production wells may be sited.

Progress and Significant Results, Fiscal Years 1995 and 1996: Routine data collection and ground-water monitoring continued. Several wells were replaced and additional recorders were installed in the wells.

Plans for Fiscal Year 1997: Routine data collection and ground-water monitoring will continue. A hydrologic atlas and data report will be published.



Publications, Fiscal Years 1995 and 1996:

Burbey, T.J., in press, Hydrogeology and potential for development of carbonate-rock aquifers in southern Nevada and southeastern California: U.S. Geological Survey Water-Resources Investigations Report 95-4168, 72 p.

Dettinger, M.D., and Schaefer, D.H., 1995, Decade-scale hydroclimatic forcing of ground-water levels in the central Great Basin, eastern Nevada: Summer Symposium, American Water Resources Association, Honolulu, June 1995, p. 195-204.

———in press, Hydrogeology of structurally extended terrain in the eastern Great Basin of Nevada, Utah, and adjacent states, from geologic and geophysical models: U.S. Geological Survey Hydrologic Investigations Atlas 694-D, 1 sheet.

Thomas, J.M., in press, Carbon-14 dating of ground water in southern Nevada—Three decades of surprises: Geological Society of America, October 1996, Denver, Colo., Abstracts with Programs.

Tumbusch, M.L., and Schaefer, D.H., in press, Selected hydrologic data for and location of MX wells in east-central and southern Nevada, January 1980 through May 1996: U.S. Geological Survey Open-File Report 96-469.

Nevada Test Site Hydrology *(Project 130)*

Location: Southern Nye County, Nev.

Project Chief: Gary M. Russell, 1993-94; David A. Beck, 1995-present.

Period of Project: Continuous since 1985.

Supporting Federal Agency: U.S. Department of Energy.

Problem: Underground nuclear-weapons testing at the Nevada Test Site (NTS) creates the potential for long-term contamination of ground-water supplies by radionuclides. Also, the location and design of test holes require hydrologic information.

Objectives: The regional ground-water flow system underlying NTS will be characterized. The potential for radionuclide migration related to underground nuclear-weapons testing will be investigated and other hydrologic expertise will be provided in support of the U.S. Department of Energy, Hydrologic Resources Management Program.

Approach: Several studies will be proposed, designed, and developed to obtain data necessary to meet the objectives. A network of test holes and wells was established to collect hydrogeologic data at NTS and vicinity. Geologic and hydrologic information is being processed in a geographic information system. Data are stored in computerized USGS data bases.

Progress and Significant Results, Fiscal Years 1995 and 1996: Hydrologic expertise and technical support were provided to the Hydrologic Resources Management Program at NTS. Routine data collection, computation, and compilations continued. Major supply wells for NTS were instrumented with flow meters and data loggers to document the variability of discharge rates and to provide a more accurate reporting of water withdrawals. Reports containing ground-water data collected for water years 1990-93 were published. The Yucca Flat and Pahute Mesa water-table contour maps were approved and published. A report on the summary of activities at well PM-2 was prepared for approval and publication. Presentations were given at several meetings.

Plans for Fiscal Year 1997: Data-collection activities will continue. Calibrations will be made for the flow meters on the major supply wells for NTS. Reports will be approved and published.

Publications, Fiscal Years 1995 and 1996:

Carman, R.L., 1994, Meteorological data for four sites at surface-disruption features in Yucca Flat, Nevada Test Site, Nye County, Nevada, 1985-86: U.S. Geological Survey Open-File Report 94-491, 43 p.

Hale, G.S., Trudeau, D.A., and Savard, C.S., 1995, Water-level data from wells and test holes through 1991 and potentiometric contours as of 1991 for Yucca Flat, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 95-4177, scale 1:48,000.

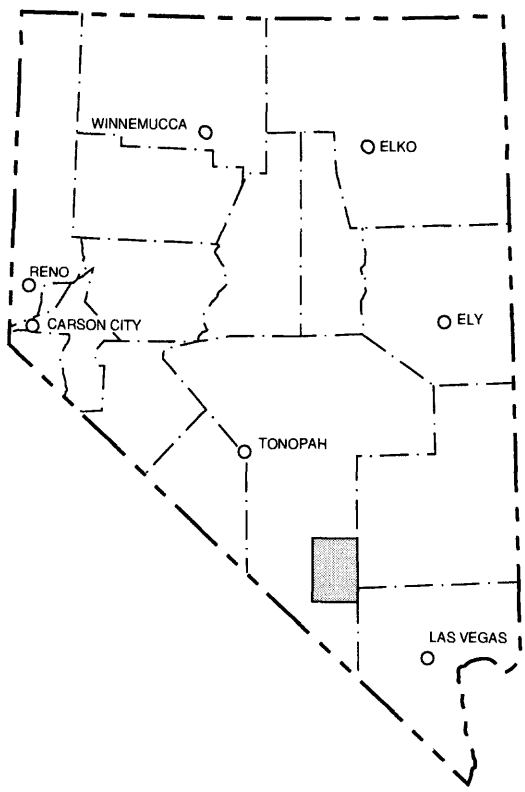
Kilroy, K.C., and Savard, C.S., in press, Geohydrology of Pahute Mesa-3 test well, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 95-4239.

Reiner, S.R., Locke, G.L., and Robie, L.S., 1995, Ground-water data for the Nevada Test Site, and selected other areas in south-central Nevada, 1992-93: U.S. Geological Survey Open-File Report 95-160, 38 p.

Robie, L.S., Reiner, S.R., and Locke, G.L., 1995, Ground-water data for the Nevada Test Site, 1992, and for selected other areas in south-central Nevada, 1952-92: U.S. Geological Survey Open-File Report 95-284, 48 p.

Unger, R.W., 1995, Evaluation of digital pressure sensors used to measure water levels at the Nevada Test Site, Nye County, Nevada, 1990-93 [abs.], *in* Hollett, K.J., Wilbourn, S.L., and Latkovich, V.J., comps., Proceedings of a U.S. Geological Survey workshop on the application and needs of submersible pressure sensors, Denver, Colo., June 7-10, 1994: U.S. Geological Survey Open-File Report 94-531, p. 41.

Wood, D.B., and Reiner, S.R., in press, Ground-water data for 1990-91 and ground-water withdrawals for 1951-91, Nevada Test Site and vicinity, Nye County, Nevada: U.S. Geological Survey Open-File Report 96-475.



Stream Monitoring in Lake Tahoe Basin
(Project 147)

Location: Lake Tahoe Basin, Nevada and California.

Project Chief: Timothy G. Rowe.

Period of Project: Continuous since 1987.

Cooperating Agency: Tahoe Regional Planning Agency.

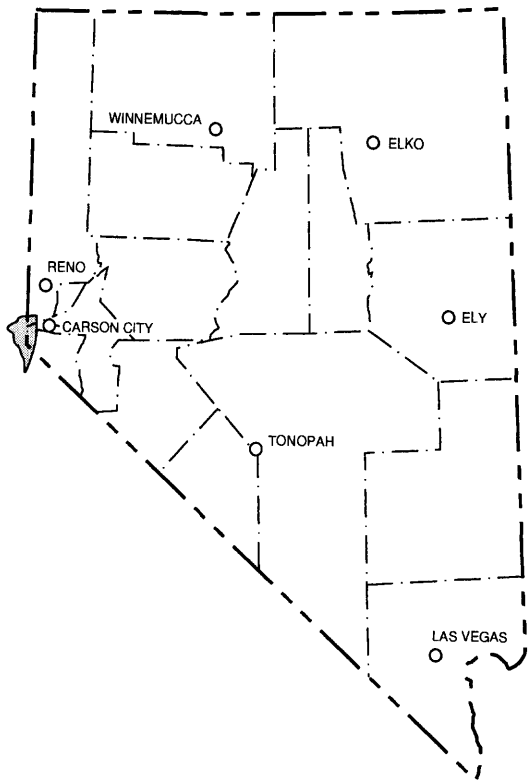
Problem: Deteriorating water quality and clarity in Lake Tahoe prompted the initiation of environmental programs in the basin. Water-quality data, especially nutrient data, for streams and ground-water aquifers that discharge to Lake Tahoe are needed to document the local and regional effectiveness of environmental programs and to assure compliance with the State water-quality management plan.

Objectives: This study will (1) provide a long-term data base for estimation of streamflow and of sediment and nutrient loadings from major streams tributary to Lake Tahoe, (2) provide a long-term data base for assessment of ground-water levels and nutrient quality in Lake Tahoe Basin, (3) support assessment of the effects of land use and development in the Lake Tahoe Basin on nutrient and sediment loads, and (4) provide water-quality data in support of basic research on the processes controlling algal enrichment in Lake Tahoe.

Approach: The existing network of 32 sites will be maintained to better define the nutrient and sediment input to Lake Tahoe from tributary streams. The sites are part of the Lake Tahoe Interagency Monitoring Program (LTIMP) network. Water-quality analyses are done by the Tahoe Research Group, University of California at Davis.

Progress and Significant Results, Fiscal Years 1995 and 1996: The stream-monitoring network continued to provide data needed to develop estimates of annual streamflow and loads of sediment and nutrients contributed to Lake Tahoe by Nevada tributaries. Twenty continuous-record streamflow-gaging stations were operated and maintained; water samples were collected and analyzed for concentrations of suspended sediment, iron, and nitrogen and phosphorous species. The 32-well monitoring network operated during 1990-92 was re-established and incorporated into this project in 1995. Data were collected, compiled, and computed for publication in the annual data reports. Technical assistance was provided to LTIMP groups and committees. Outreach activities were provided to Lake Tahoe Basin schools in 1995. Presentations were made at the Nevada Water Resources Association annual conference in March 1995 and at the USGS Nitrogen Cycling Workshop in November 1995.

Plans for Fiscal Year 1997: Stream and ground-water network operations will continue and reports will be submitted for review. Data will be published in the annual data report.



Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water Resources data, Nevada, water year 1994: U.S. Geological Survey water data report NV-94-1, 768 p.

Rowe, T.G., 1995, Seasonal variation of nutrient and sediment loadings of streamflow into Lake Tahoe from Incline Creek Basin, Nevada, water year 1993 [abs.]: Nevada Water Conference, Nevada Water Resources Association, Reno, March 1995, Abstracts of Technical Papers and Posters, p. 18.

Rowe, T.G., 1996, Nitrogen and sediment loadings and streamflow variations due to thunderstorm runoff into Lake Tahoe from Incline Creek Basin in Nevada, September 1994 [abs.]: U.S. Geological Survey Nitrogen-Cycling Workshop, Golden, Colo., October-November 1995.

Irrigation Drainage in and near Stillwater Wildlife Management Area *(Project 148)*

Location: Churchill and Pershing Counties, Nev.

Project Chief: Ray J. Hoffman.

Period of Project: Continuous since 1986.

Supporting USGS Program: Department of the Interior National Irrigation Water-Quality Program and National Water-Quality Assessment Program.

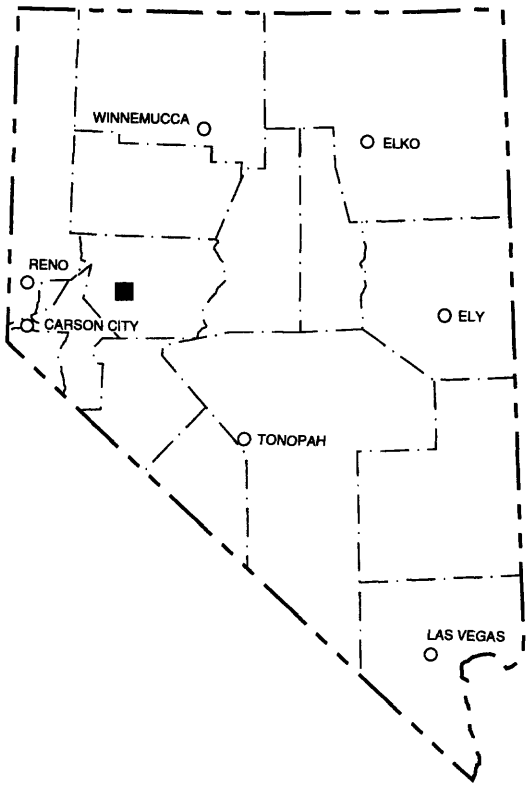
Problem: The Stillwater National Wildlife Refuge (SNWR) and nearby Carson Lake contain the largest marsh in Nevada, and are important sanctuaries for migratory and other waterfowl. The marsh is maintained mostly by irrigation-return flow drained from agricultural fields in the Fallon area. Elevated concentrations of potentially toxic trace elements have been found in the drain water, bottom sediment, and biota and this is a major concern for the Department of the Interior. The geochemical processes controlling the mobilization, transport, and fate of these trace elements and their effects on migratory waterfowl were studied in Phase 3 of the project. The USGS has been asked to continue to provide technical support and assistance to the Department of the Interior as part of Phase 4 of the project. Phase 4 involves the planning for remediation.

Objectives: The objectives are to monitor and collect surface-water data in the SNWR and Carson Lake for mitigation and possible clean-up purposes. Technical expertise and support will be provided to the Bureau of Reclamation.

Approach: Year-round measurements of drainflow, specific conductance, and water temperature will be made in several drain inputs to the SNWR and Carson Lake. Monthly samples for the analyses of major ions and selected trace elements will be collected during the irrigation season. These data will be collected in conjunction with the collateral U.S. Fish and Wildlife Service biomonitoring program.

Progress and Significant Results, Fiscal Years 1995 and 1996: Report writing and data-collection activities continued. Technical assistance and support materials were provided at meetings. A report on Walker Lake screening was submitted for approval. In cooperation with the Nevada Basin and Range NAWQA Program (Project 167), three synoptic studies were done throughout the Fallon agricultural area and vicinity before and during the irrigation season to provide data to identify lands that produce the greatest load of contaminants in irrigation return flows.

Plans for Fiscal Year 1997: Routine data-collection activities and monitoring will continue. Technical assistance and support materials will be provided at meetings. Report writing will continue.



Surface-Water Runoff Monitoring, Yucca Mountain Area *(Project 161)*

Location: Southern Nye County, Nev.

Project Chief: David A. Beck.

Period of Project: Continuous since 1989.

Supporting Federal Agency: U.S. Department of Energy.

Problem: Yucca Mountain is being studied as a potential repository for high-level radioactive waste. Streamflow data are needed to help determine the relation between precipitation and runoff and between runoff and infiltration in the area.

Objectives: The study (1) uses streamflow data to describe the runoff characteristics of the area and assess the response of runoff to precipitation and (2) provides basic data and interpretation of surface-water runoff data to other investigations. The data are used in those studies to evaluate infiltration to the unsaturated zone and ground-water recharge at Yucca Mountain and surrounding areas.

Approach: Streamflow data from a dense network of recording and nonrecording gages on Yucca Mountain washes and a regional network peripheral to Yucca Mountain are collected and analyzed.

Progress and Significant Results, Fiscal Years 1995 and 1996: Three additional continuous-recording streamflow gages and 13 new crest-stage gages were installed. A fact sheet was published. As a result of reduced funding in 1996, routine data-collection activities and monitoring continued only at three continuous-recording streamflow gages. Streamflow and precipitation data were published in the annual data reports.

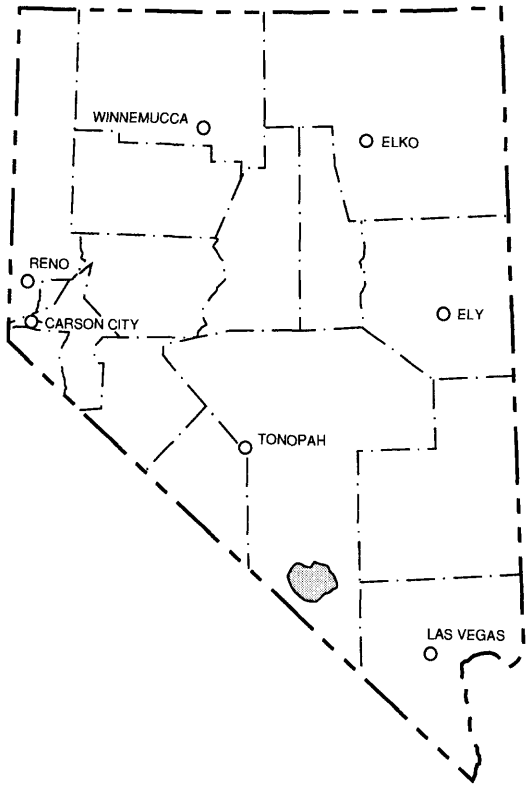
Plans for Fiscal Year 1997: Routine data-collection activities and monitoring will continue. Streamflow and precipitation data will be published in the annual data report.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Beck, D.A., and Glancy, P.A., 1995, Overview of runoff of March 11, 1995, in Fortymile Wash and Amargosa River, southern Nevada: U.S. Geological Survey Fact Sheet FS-210-95, 4 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water Data Report NV-94-1, 768 p.



Ground-Water Monitoring Program, Yucca Mountain Area *(Project 163)*

Location: Southern Nye County, Nev., and eastern California.

Project Chief: Richard J. La Camera.

Period of Project: Continuous since 1989.

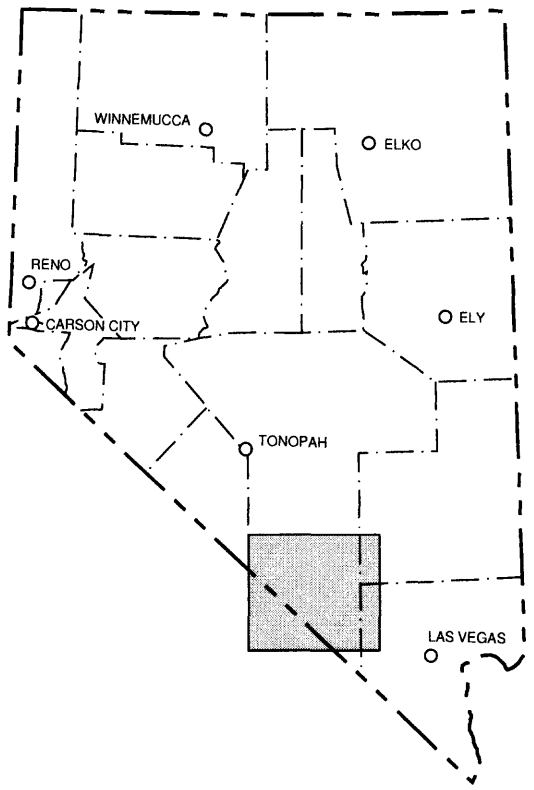
Supporting Federal Agency: U.S. Department of Energy (USDOE).

Problem: Yucca Mountain is being considered as a potential repository of high-level radioactive waste. Hydrologic, geologic, geochemical, and other investigations are needed to determine the suitability of the site for storage of waste. Possible adverse effects on ground-water quantity due to studies, construction, or operation of a potential repository must be identified. In order to identify adverse effects, the quantity and use of ground-water resources in the area require systematic monitoring. Available data and previous data-collection activities are inadequate to satisfactorily provide early detection of adverse effects on ground-water resources.

Objectives: The study monitors and characterizes the quantity and use of ground-water resources at and near Yucca Mountain to (1) document ground-water conditions; (2) detect changes in those conditions due to ongoing site investigations, other activities in the region, or natural variability; and (3) provide a basis for further hydrologic analyses to determine changes due to waste storage and related activities.

Approach: Data will be collected and compiled to characterize ground-water quantity and withdrawals. Water levels will be measured monthly at about 35 sites and springflows will be measured quarterly at about 6 sites to indicate changes in ground-water quantity in the region. Selected ground-water level and springflow data collected as part of other data-collection activities also will be compiled and evaluated to supplement data collection. Ground-water withdrawals from wells will be compiled on the basis of records maintained by other agencies, organizations, and programs to estimate annual ground-water withdrawals in the region. Data collection and compilation will continue until site investigations are complete. A data base will be created that will be used to document baseline and changing conditions and to evaluate potential effects of site investigations.

Progress and Significant Results, Fiscal Years 1995 and 1996: Routine data-collection activities and monitoring continued. Altitudes of reference points were verified by making land surveys. Electric tapes and pressure-sensor systems were calibrated. USDOE was provided with quarterly



reports of data collected and compiled at monitoring sites. Concurrence was given by USDOE on the format and content of annual monitoring reports. Report writing continued.

Plans for Fiscal Year 1997: Data-collection compilation activities will continue. USDOE will be provided with quarterly updates of data collected and compiled at monitoring sites. Work on summary monitoring reports will continue. Advise and assist USDOE on water-quality data-collection programs and implementation.

Publications, Fiscal Years 1995 and 1996:

Hale, G.S., and Westenburg, C.L., 1995, Selected ground-water data for Yucca Mountain Region, southern Nevada and eastern California, calendar year 1993: U.S. Geological Open-File Report 95-158, 67 p.

Plume, R.W., and La Camera, R.J., 1996, Hydrogeology of rocks penetrated by test well JF-3, Jackass Flats, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 95-4245, 21 p.

Westenburg, C.L, and La Camera, R.J., 1996, Selected ground-water data for Yucca Mountain region, southern Nevada and eastern California, through December 1994: U.S. Geological Survey Open-File Report 96-205, 73 p.

Nevada Basin and Range National Water-Quality Assessment *(Project 167)*

Location: Carson and Truckee River Basins, Nevada and California, and Las Vegas Valley, Nev.

Project Chief: Hugh E. Bevans.

Period of Project: Continuous since 1990.

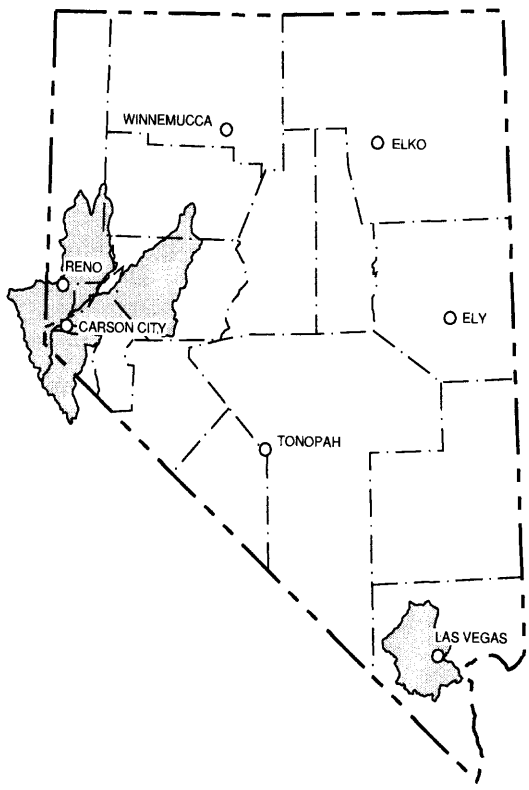
Cooperating Agencies and Supporting USGS Program: Department of the Interior National Irrigation Water-Quality Program, National Park Service, National Biological Service, National Water-Quality Assessment Program, U.S. Environmental Protection Agency, and U.S. Fish and Wildlife Service.

Problem: Information about the quality of ground- and surface-water resources is needed on a consistent and continuing basis so that water-resource managers and the public will have a scientifically sound basis for evaluating resources, planning effective water-quality management programs, and predicting effects of land- and water-management practices.

Objectives: The Nevada Basin and Range is 1 of 60 proposed NAWQA study units distributed throughout the Nation that will be investigated to (1) provide a Nationally consistent description of current water-quality conditions; (2) define long-term trends in water quality; and (3) identify, describe, and explain, as possible, the major factors that affect observed water-quality conditions and trends.

Approach: The investigation will be made in 10-year cycles that include retrospective analysis of available water-quality data and ancillary information, intensive periods of data collection and analysis, and trend monitoring. During the retrospective phase, available water-quality and ancillary (land use, water use, and geologic) data from several sources will be compiled. Reports will be written that summarize and interpret available information on pesticides, nutrients, and suspended sediment. An intensive data-collection and analysis phase will be undertaken during the 3rd through 6th years of the study to develop a nationally consistent water-quality data base. During the 7th through 10th years of the study, report writing and low-level monitoring activities will continue. The 10-year project cycle is scheduled to begin again in the 11th year with a new retrospective phase.

Progress and Significant Results, Fiscal Years 1995 and 1996: Intensive data-collection activities were completed at the 10 basic fixed surface-water sites, and at the Las Vegas Wash intensive fixed urban surface-water sites; 2 years of major-ion, nutrient, and suspended-sediment data were collected at the basic and intensive sites, and 2 years of pesticide data were collected at the intensive site. Principal aquifers were sampled for various constituents in the Las Vegas area, Reno-Sparks area, and the Carson Valley. A surface-water synoptic study of irrigation drainage to wetlands in the



Carson Desert, in cooperation with the Department of the Interior National Irrigation Water-Quality Program, was completed. Water samples were analyzed and toxicity tests were made using drain water and water fleas. Wells were installed and sampled to provide information about the transport and movement of radionuclides in ground water near Lake Tahoe. Investigations to evaluate endocrine disruption in fish were made in the Truckee River, Las Vegas Wash, and Lake Mead. The Las Vegas Wash and Lake Mead study is being made in cooperation with the National Biological Service, National Parks Service, U.S. Fish and Wildlife Service, and U.S. Environmental Protection Agency. Data on organic compounds in water, bottom-sediments, and fish tissue were collected as part of this study. Surface- and ground-water quality data were published in annual data reports.

Plans for Fiscal Year 1997: Low-level surface- and ground-water and aquatic ecology monitoring networks will be designed and implemented. Investigation activities will continue. Reports will be submitted for approval and publication.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water-Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Covay, K.J., Banks, J.M., Bevans, H.E., and Watkins, S.A., 1996, Environmental and hydrologic settings of the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California: U.S. Geological Survey Water-Resources Investigations Report 96-4087, 72 p.

Lawrence, S.J., 1995, Trace elements in bed sediments and aquatic invertebrates from three streams in Nevada [abs.]: Second SETAC World Congress 16th annual meeting, Vancouver, British Columbia, November 5-9, 1995, p. 312.

Lawrence, S.J., in press, Nitrate and ammonia in shallow ground water, Carson City urban area, Nevada 1989: U.S. Geological Survey Water-Resources Investigations Report 96-4224, 53 p.

Lawrence, S.J., and Bevans, H.E., 1994, Mercury in bottom sediment and aquatic invertebrates, Carson and Truckee River Basins, Nevada and California [abs.]: 15th Annual Meeting, Society of Environmental Toxicology and Chemistry, Denver, October 1994, Abstract Book, p. 19.

Lico, M.S., and Seiler, R.L., 1994, Ground-water quality and geochemistry, Carson Desert, western Nevada: U.S. Geological Survey Open-File Report 94-31, 91 p.

Thomas, J.M., and Lawrence, S.J., 1994, Ground-water quality and geochemistry in Dayton, Stagecoach, and Churchill Valleys, western Nevada: U.S. Geological Survey Open-File Report 93-356, 68 p.

Welch, A.H., 1994, Ground-water quality and geochemistry in Carson and Eagle Valleys, western Nevada and eastern California: U.S. Geological Survey Open-File Report 93-33, 99 p.

Welch, A.H., Lawrence, S.J., Lico, M.S., Thomas, J.M., and Schaefer, D.H., in press, Ground-water quality assessment of the Carson River Basin, Nevada and California—Results of investigations, 1987-91: U.S. Geological Survey Water-Supply Paper 2356A.

Granular Velocity Subsidence Model
(Project 169)

Location: Southeastern Nevada.

Project Chief: Thomas J. Burbey, 1990-96; Michael T. Pavelko, 1996-present.

Period of Project: 1990-97.

Cooperating Agencies: Las Vegas Valley Water District and Nevada Division of Water Resources.

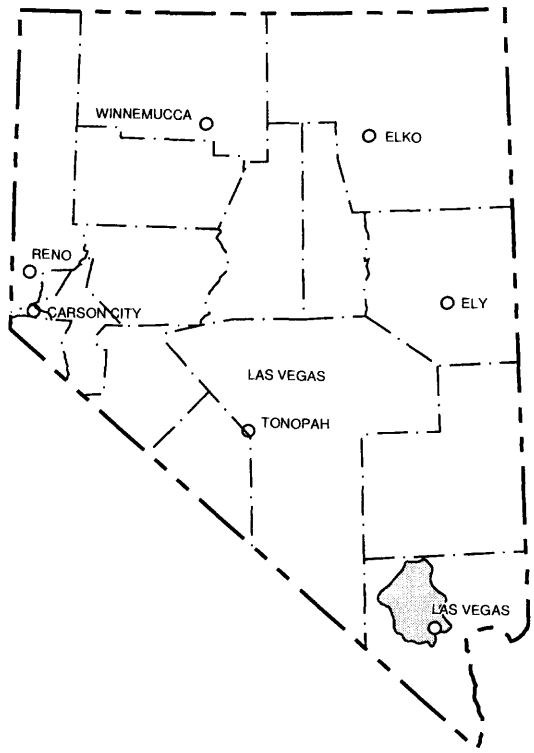
Problem: Land subsidence due to ground-water withdrawal is an ongoing problem in many urban and agricultural areas around the world. Current models that link ground-water flow and skeletal deformation of aquifers have limited use because the directional components of skeletal movement are intractable without extensive and debilitating assumptions.

Objectives: Loss of aquifer storage from compaction of sediments will be determined or methods will be evaluated for estimating loss of aquifer storage from compaction.

Approach: A previously developed finite-difference ground-water flow model will be converted to the USGS modular model using currently available subsidence modules. An extensometer has been installed and a horizontal-translation network established to obtain data necessary for the calibration of the model. Synthetic Aperature Radar imagery will be evaluated to determine if the imagery can detect and measure land surface deformation.

Progress and Significant Results, Fiscal Years 1995 and 1996: Data collection activities continued. Existing extensometer and nested piezometers continue to be a good source of information for subsidence, for making estimates on vertical leakage from vertical head-gradient information, and for obtaining measurements of horizontal movement using an inclinometer probe. IBS1 and IBS3 vertical subsidence packages were incorporated into the current ground-water flow model established by the Las Vegas Valley Water District for the Las Vegas Hydrographic Area. Subsidence routines were installed to simulate vertical compaction due to pumping. IBS1 is the standard subsidence code and IBS3 incorporates effects of change in total load at land surface.

Plans For Fiscal Year 1997: Measurements of subsidence and horizontal movement at the existing monitoring site will continue including periodic logs of horizontal displacement using a downhole tilt meter; hourly vertical displacements with the extensometer; and hourly water level measurements from pressure transducers in three nested piezometers. Synthetic Aperature Radar imagery will be evaluated to determine if imagery can detect and measure land-surface deformation. Work will be done in cooperation with the USGS National Research Program, NASA's Jet Propulsion Laboratory, and the Nevada Bureau of Mines and Geology. Elastic and inelastic storage properties at the principal



aquifer will be estimated from compaction and ground-level data collected at the existing monitoring site. The vertical subsidence package that was incorporated into the ground-water model of Las Vegas Valley in 1996 will be evaluated to determine if it can be used for estimating loss of aquifer storage from compaction on a valley-wide basis.

Publications, Fiscal Years 1995 and 1996:

Burbey, T.J., 1995, Comparison of simulation result from one- and three-dimensional models of aquifer-system deformation: 38th Annual Meeting, Association of Engineering Geologists, Sacramento, Calif., October 1995, Proceedings, p. 38.

———1995, Simulation of three-dimensional granular displacement in unconsolidated aquifers, *in* Prince, K.R., Galloway, D.L., and Leake, S.A., eds., U.S. Geological Survey Subsidence Interest Group Conference, Edwards Air Force Base, Antelope Valley, California, November 18-19, 1992—Abstracts and summary: U.S. Geological Survey Open-File Report 94-532, p. 71-73.

———1996, Comparison of simulation results from one-and three-dimensional aquifer-system deformation models: Joseph P. Poland Symposium on Land Subsidence, Sacramento, Calif., October 4, 1995, Proceedings

Helm, D.C., 1995, Hydraulic forces that play a role in generating fissures at depth, *in* Prince, K.R., Galloway, D.L., and Leake, S.A., eds., U.S. Geological Survey Subsidence Interest Group Conference, Edwards Air Force Base, Antelope Valley, California, November 18-19, 1992—Abstracts and summary: U.S. Geological Survey Open-File Report 94-532, p. 71-73.

Environmental Restoration, Nevada Test Site
(Project 170)

Location: Southern Nye County, Nev.

Project Chief: Randell J. Laczniak.

Period of Project: Continuous since 1991.

Supporting Federal Agency: U.S. Department of Energy (USDOE).

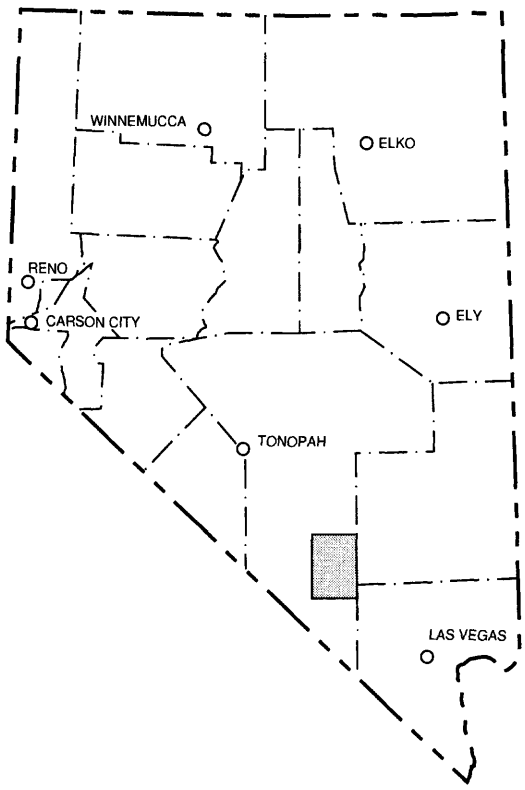
Problem: Underground testing of nuclear weapons at the Nevada Test Site (NTS) has created potential environmental hazards. USDOE is concerned about these hazards and is committed to comply with existing environmental laws and regulations. USDOE has begun an Environmental Restoration Program (ERP) to acquire information and provide the resources necessary to address environmental concerns at NTS. USDOE has requested USGS participation in this program.

Objectives: USGS provides hydrologic expertise and technical guidance to USDOE in support of ERP, primarily on activities related to characterization of the ground-water flow system. USGS develops and participates in special studies to address unresolved hydrologic issues at NTS, and provides regional synthesis and analysis of hydrologic information gathered through ERP activities. The USGS will provide the lead scientific role in activities to refine estimates of ground-water discharge from subbasins downgradient of NTS.

Approach: The USGS participates in program efforts to acquire hydrologic information at NTS and vicinity. Primary activities include the siting of drill holes, reviewing program control documents, developing and reviewing hydrologic testing and sampling plans, and collecting water-level and water-chemistry data from on- and off-site monitoring locations. Studies to refine ground-water discharge estimates from the major subbasins beneath NTS are being initiated. Participation on other hydrologic studies will be provided in response to USDOE requests.

Progress and Significant Results, Fiscal Years 1995 and 1996: Hydrologic expertise and technical support were provided to USDOE. Water-level networks were maintained on- and off-site. Hydrologic data collected through program activities were provided monthly and published in the annual data reports. The discharge studies at Ash Meadows and Oasis Valley continued. Report writing continued.

Plans for Fiscal Year 1997: Hydrologic support will continue to be provided to USDOE. On- and off-site water-level networks will be maintained. The discharge studies at Ash Meadows and Oasis Valley will continue. Data reports will be published. Data will be published in the annual data report.



Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water-Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water Resources data, Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Laczniak, R.J., Cole, C.C., Sawyer, D.A., and Trudeau, D.A., 1996, Summary of hydrogeologic controls on ground-water flow at the Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Water-Resources Investigations Report 96-4109, 59 p.

Nichols, W.D., and Rapp, T.R., 1996, Micrometeorological data for energy-budget studies near Rogers Spring, Ash Meadows National Wildlife Refuge, Nye County, Nevada, 1994: U.S. Geological Survey Open-File Report 96-170, 49 p.

Truckee-Carson Program, River Basin Modeling and Monitoring *(Project 171)*

Location: Truckee River and Carson River Basins, Nevada and California.

Project Chief: Larry R. Bohman.

Period of Project: Continuous since 1991.

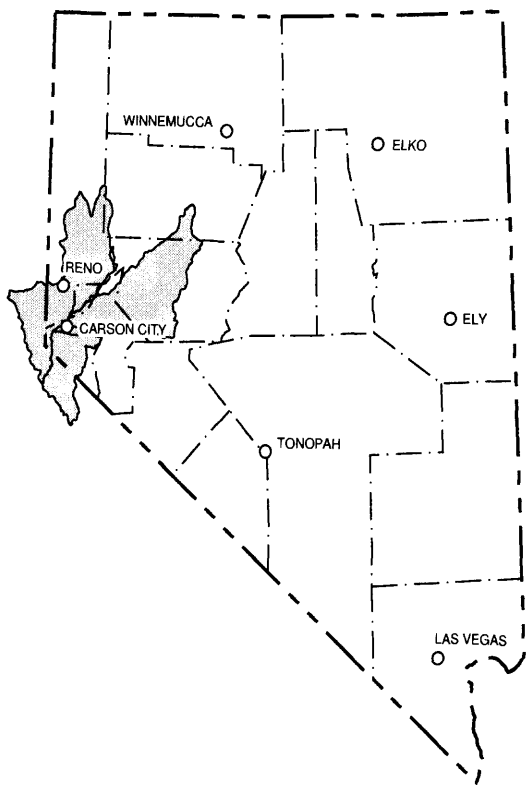
Supporting USGS Program: Truckee-Carson Program.

Problem: Title II of Public Law 101-618, the Truckee-Carson-Pyramid Lake Water Rights Settlement Act of 1990, contains many explicit and implicit action requirements for Department of the Interior agencies, principally the Bureau of Reclamation, U.S. Fish and Wildlife Service, and Bureau of Indian Affairs. The U.S. Geological Survey has been asked to provide detailed water-resources data and analysis for the Truckee River and Carson River Basins of California and Nevada, including the Lake Tahoe Basin. Environmental assessments required by the Act not only will need collation and synthesis of existing data, but also models to assess causes and effects of alternative management and operational scenarios connected with river operations, water-rights transfers, and changes in irrigation practices.

Objectives: A Federal river-monitoring network will be designed and implemented to provide consistent, long-term data for water-resources management and planning. River-basin simulation models will be developed, tested, and applied as tools for water-resources management and planning. Technical support will be provided to the Department of the Interior as required under legislative mandates.

Approach: Existing networks and data of the Department of the Interior were reviewed. A data-base management system and a baseline Federal gaging-station network were designed and implemented to monitor streamflow, storage, and water quality. Appropriate modeling tools are being adapted or developed and calibrated to the Truckee River and Carson River Basins for use by several agencies. The resultant models will be used to review and revise the data networks. Technical support to the Department of the Interior for implementation of Public Law 101-618 is being provided. Staff will participate in technical workgroups and committees. In fiscal year 1995, studies on ground-water yield in California and parts of the Truckee River Basin will begin, if required.

Progress and Significant Results, Fiscal Years 1995 and 1996: Data-collection activities continued. Technical and hydrologic support to the Department of the Interior was provided. Development of hydraulic and water-quality models continued. Work began to translate and code operation/allocation rules into the modeling framework so that a fully functional policy-analysis tool for basin managers could be developed. Precipitation-runoff models were



calibrated for several basins surrounding Lake Tahoe and along the Truckee River between Tahoe City, Calif., and Reno, Nev. Fact sheets were published and presentations were given at the American Water Resources Association and Nevada Water Resources Association annual conferences. Data were published in the annual data reports. Development of a project geographic informations systems data base continued.

Plans for Fiscal Year 1997: Data-collection activities will continue. Data will be published in the annual data report. Report writing will continue. Technical and hydrologic support to the Department of the Interior will be provided. The Truckee-Carson Program modeling system development will continue with the completion of the precipitation-runoff models of the Lake Tahoe and Truckee River Basin upstream of the California-Nevada State line. Operational rules representing conditions specified in the new Truckee River Operating Agreement will be translated into the USGS operations/allocations model code. Improvements to the user interface will be made to facilitate the use of the modeling system by Federal, State, and local-water management officials.

Publications, Fiscal Year 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water-Data Report NV-95-1, 734 p.

Berris, S.N., in press, Daily flow-routing and simulations for the Truckee River, California and Nevada: U.S. Geological Survey Water-Resources Investigations Report 96-4097.

Berris, S.N., and Hess, G.W., 1996, Simulation and analysis of Truckee and Carson River streamflow and operations [abs.]: Annual Conference, Nevada Water Resources Association, Las Vegas, February, Abstracts of Technical Papers and Posters, p. 19.

Berris, S.N., Hess, G.W., and Cartier, K.D., 1996, Simulation of selected reservoir operations in the upper Truckee River Basin, California: U.S. Geological Survey Fact Sheet FS-982-96, 4 p.

Bohman, L.R., Berris, S.N., and Hess, G.W., 1995, Interactive computer program to simulate and analyze streamflow, Truckee and Carson River Basins, Nevada and California: U.S. Geological Survey Fact Sheet FS-165-95, 4 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Hess, G.W., 1996, Progress report on daily flow-routing simulation for the Carson River, California and Nevada: U.S. Geological Survey Open-File Report 96-211, 41 p.

Beatty Deep Unsaturated Zone *(Project 172)*

Location: Amargosa Desert near Beatty, Nev.

Project Chief: David E. Prudic.

Period of Project: 1992-97.

Supporting Federal Agency and USGS Program: Low-Level Nuclear Waste Hydrology Program and U.S. Nuclear Regulatory Commission.

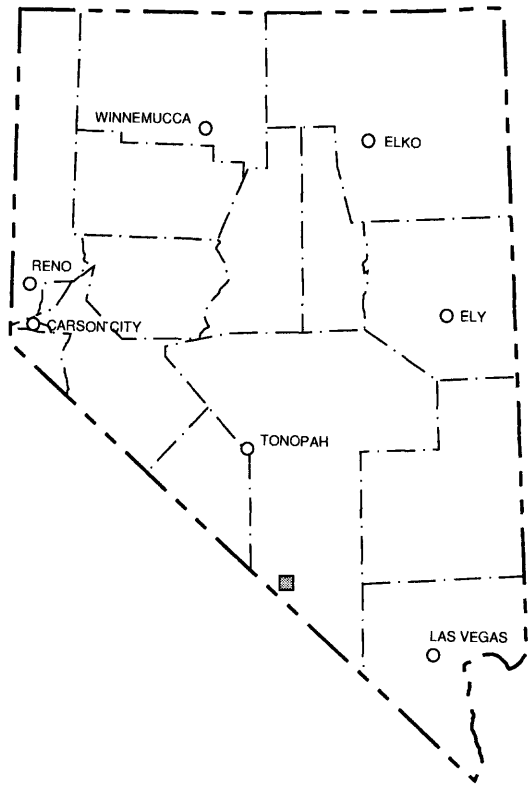
Problem: Burial of low-level radioactive waste in thick, unsaturated zones in desert environments has been an accepted practice for many years. However, understanding and monitoring the movement of water and contaminants in such environments has proved difficult. Methods to measure water content and soil-water pressure have improved recently. Data collected indicate that water movement involves liquid and vapor flow. To better understand the potential for movement of contaminants at such sites, there is a need to understand the processes involved in multiphase fluid flow.

Objectives: The effects of normal seasonal heating of the upper several feet of soils on water movement during the summer months, followed by cooling in the winter months, will be studied. The effects of atmospheric changes on the movement of vapor flow will be evaluated. The direction of water flow below the zone of seasonal fluctuations in temperatures and soil-water pressure will be determined. The hypothesis of upward vapor flow from a deep water table (300-370 feet below land surface) will be tested.

Approach: Soil-gas pressure changes caused by atmospheric pressure changes will be monitored to determine air permeability in unsaturated sediments and to determine the depth of atmospheric air circulation in the unsaturated zone. Soil-gas samples will be collected to determine the depth of atmospheric air circulation. Test holes will be drilled to determine moisture contents, soil-water pressure, and temperatures in the deep unsaturated zone.

Progress and Significant Results, Fiscal Years 1995 and 1996: Soil gas for 10 air piezometers installed in a test hole (UZB-2) about 500 feet south of the nearest burial trench have concentrations of tritium and carbon-14 much greater than background concentrations in the atmosphere. Additional soil-gas samples were collected at shallow depth (about 5 feet) along the fence enclosing the waste-burial area. These samples have much greater concentrations of tritium and carbon-14, about the same or less than background concentrations in the atmosphere. The most likely source of the tritium and carbon-14 found at test hole UZB-2 is lateral migration from the waste-burial area through unsaturated sediments.

Plans for Fiscal Year 1997: Providing funds are available, plans are to investigate the extent of tritium and carbon-14 migration through the unsaturated zone and determine the mechanisms for the migration.



Publications, Fiscal Year 1995 and 1996:

Prudic, D.E., 1996, Water-vapor movement through unsaturated alluvium in Amargosa Desert near Beatty, Nevada—Current understanding and continuing studies, *in* Stevens, P.R., and Nicholson, T.J., eds., Joint U.S. Geological Survey, U.S. Nuclear Regulatory Commission Workshop on research related to low-level radioactive waste display, May 4-6, 1993, Nation Center, Reston, Virginia, Proceedings: U.S. Geological Survey Water-Resources Investigations Report 95-4015, p. 157-166.

Prudic, D.E., and Striegl, R.G., 1995, Tritium and radioactive carbon (^{14}C) analyses of gas collected from unsaturated sediments next to a low-level radioactive-waste burial site south of Beatty, Nevada, April 1994 and July 1995: U.S. Geological Survey Open-File Report 95-741, 7 p.

Striegl, R.G., Prudic, D.E., Duval, J.S., Healy, R.W., Landa, E.R., Pollock, D.W., Thorstenson, D.C., and Weeks, E.P., 1996, Factors affecting tritium and ^{14}carbon distributions in the unsaturated zone near the low-level radioactive-waste burial site south of Beatty, Nevada: U.S. Geological Survey Open-File Report 96-110, 16 p.

Data Synthesis of Irrigation Drainage Areas
(Project 176)

Location: Western United States.

Project Chief: Ralph L. Seiler.

Period of Project: 1992-95.

Supporting USGS Program: Department of Interior National Irrigation Water Quality Program.

Problem: Concern has increased during the last several years about the quality of irrigation drainage and its potential harmful effects on human health, fish, and wildlife. As a result, the National Irrigation Water Quality Program was begun in October 1985 to identify the extent of irrigation-induced water-quality problems in the Western United States. Twenty-six areas in 14 states were investigated by interbureau (USGS, U.S. Fish and Wildlife Service (USFWS), and Bureau of Reclamation) study teams to determine whether irrigation drainage has caused harmful effects on human health, fish and wildlife, or other beneficial uses of water. Reports on the results of these investigations have been published and several are in review. A comprehensive evaluation of the data is needed to determine how climate, hydrology, geology, and other factors affect the extent and magnitude of irrigation water-quality problems.

Objectives: Most of the data collected for the investigations has been compiled into one data base. Multivariate statistics and pattern-recognition techniques are being used to identify how the hydrologic and geologic setting and geochemical and biological processes link with human activities to determine the magnitude and extent of contamination problems. As much as possible, capabilities will be developed to predict where irrigation drainage may result in water-quality problems.

Approach: A data base was created that combined water-quality data from USGS, Water Resources Division; sediment data from USGS, Geologic Division; and biologic data from USFWS. A study team including three scientists from USGS and one scientist from USFWS was formed. One USGS member was the team leader who coordinated the overall project and built the data base. The team members will work independently in their areas of expertise and will collaborate for the summary report.

Progress and Significant Results, Fiscal Years 1995 and 1996: The water and sediment parts of the data base were completed. Two papers were published and presentations were given at the American Institute of Hydrology and American Water Resources Association conferences. Two other papers are in review. A presentation on the investigation was given to USGS headquarters staff in Reston, Va.

Plans for Fiscal Year 1997: Data analysis will be completed and draft reports will be written and submitted for approval. The biological part of the data base will be completed by USFWS.

Publications, Fiscal Years 1995 and 1996:

Seiler, R.L., 1995, Prediction of areas where irrigation drainage may induce selenium contamination of water: Journal of Environmental Quality, v. 24, p. 973-979.

———in press, Synthesis of data from studies of the National Irrigation Water-Quality Program: Water Resources Bulletin.

Seiler, R.L., and Skorupa, J.P., 1995, Identification of areas at risk for selenium contamination in the Western United States: Annual Meeting, American Institute of Hydrology, Denver, May 1995, Proceedings, p. LL85-LL94.

Skorupa, J.P., and Seiler, R.L., 1995, Implications of biological sensitivity to selenium for managing irrigation projects: Summer Symposium, American Water Resources Association, Honolulu, June 1995, Proceedings, unpaginated.

Water Resources Evaluation of Spanish Springs Valley *(Project 180)*

Location: North of Reno-Sparks, Nev.

Project Chief: David L. Berger.

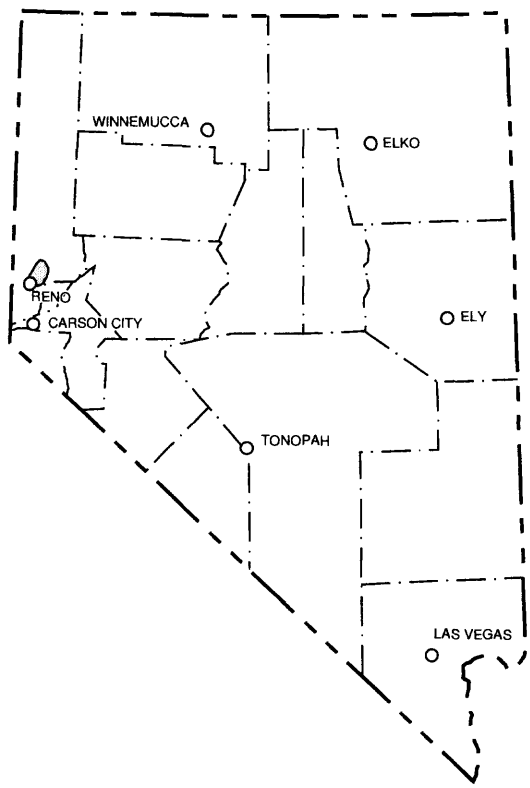
Period of Project: 1993-96.

Cooperating Agency: Nevada Division of Water Resources.

Problem: Spanish Springs Valley, in northwest Nevada, is experiencing rapid population growth, and planners anticipate land-use changes from rural and agricultural to suburban designations. By 2007, residential development in Spanish Springs Valley is expected to increase substantially. For over a century, flow from the Truckee River has been diverted to Spanish Springs Valley by the Orr Ditch for agricultural use. More than 50 percent of the total annual ground-water recharge to the basin occurs as seepage losses from the Orr Ditch and associated irrigated lands. The effects on the sustained yield of the basin from the decrease or removal of irrigation seepage is unknown, but must be addressed to assist in proper planning and future management decisions.

Objectives: The project will evaluate and refine estimates of the water budget and sustained yield of the aquifer system in Spanish Springs Valley. A determination of the effects of changes in surface-water importation on the sustained yield of the basin also will be made.

Approach: Discharge measurements of all imported surface water and all return flow to the Truckee Meadows will be made. Precipitation gages will be established at several altitudes in the basin and measurements used to update the existing precipitation map. These data will be correlated with long-term precipitation data from nearby stations. Geophysical data will be collected and geophysical modeling programs will be used to define basin-fill thickness. A deep-percolation model and chloride-balance technique will be used to estimate ground-water recharge from precipitation within the basin. Water-level, geochemical, and isotopic data will be used to determine ground-water flow paths, sources, and mixing. Satellite imaging, aerial photography, and field mapping will be used to estimate areas of specific phreatophyte types and densities. A three-dimensional mathematical flow model of the aquifer system will be developed and used to evaluate the ground-water budget. The model will incorporate a stream-routing package for simulating interactions between surface and ground water and balances of inflow and outflow. Simulations will be made to evaluate the effects of decreased flows in Orr Ditch.



Progress and Significant Results, Fiscal Years 1995 and 1996: Data-collection activities continued at a reduced frequency. Installation of nested piezometer sites for sampling chlorofluorocarbons was completed. Analysis of the results from the ground-water-flow model was made for transient conditions and several hypothetical development scenarios. Data were published in the annual data reports. The final report was submitted for approval.

Plans for Fiscal Year 1997: The final report will be published.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Estimating Regional Ground-Water Discharge by Evapotranspiration
(Project 184)

Location: Central Nevada.

Project Chief: William D. Nichols.

Period of Project: 1993-97.

Cooperating Agency: Nevada Division of Water Resources.

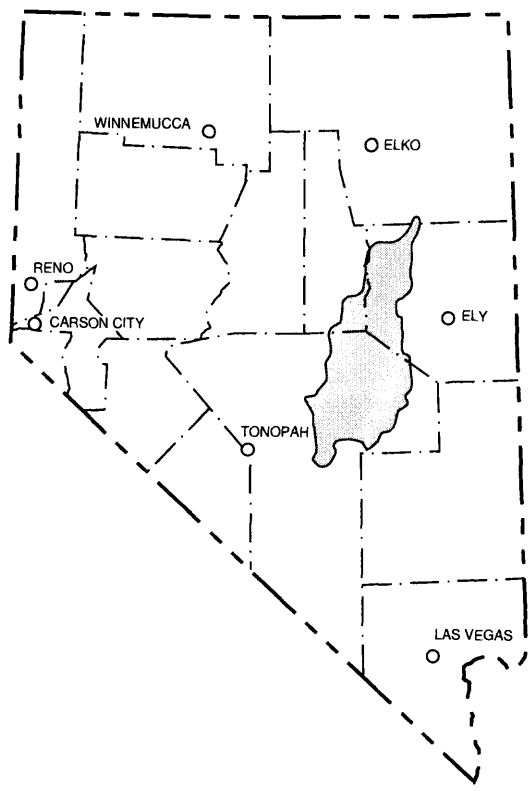
Problem: Understanding the water balance is fundamental to evaluating water resources. Among the terms of the water balance, evapotranspiration (ET) is the least known and least understood. In many arid and semiarid areas such as Nevada, ET includes large quantities of ground water, but few methods have been developed to measure or estimate this quantity. Developing and improving methods for estimating ground-water discharge by ET on a regional scale will improve the reliability of estimated ground-water discharge and provide a framework for evaluating current empirical methods for estimating ground-water recharge. This, in turn, will lead to improved methods for estimating the total water balance on a regional scale.

Objectives: The investigation will develop a generally applicable model for estimating ground-water discharge by ET in the central Great Basin. Regional-scale ground-water discharge by ET will be estimated for the Eastern Great Basin.

Approach: Field investigations were begun at selected locations in the study area to measure energy budget and depth-to-water data. Plant-type and plant-density data will be collected also. These data will be used in conjunction with Landsat satellite imagery to develop equations describing ground-water discharge by ET.

Progress and Significant Results, Fiscal Years 1995 and 1996: ET measurements were made in the central Great Basin study area. Plant type and density were determined for calibration of land-cover classification using Landsat satellite imagery in the central Great Basin. More data for the study area were collected and compiled. Preparation of regional maps of the percent land cover began. The ground-water ET in relation to plant cover was estimated for Little Fish Lake Valley, Hot Creek, Little Smoky, and Railroad Valleys. A report and a journal article were published.

Plans for Fiscal Year 1997: Data compilation and analysis will be completed. Work will continue on the model and reports will be published.



Publications, Fiscal Years 1995 and 1996:

Nichols, W.D., 1994, Ground-water discharge by phreatophyte shrubs in the Great Basin as related to depth to groundwater: Water Resources Research, v. 30, no. 12, p. 3265-3274.

Nichols, W.D., and Rapp, T.R., 1996, Micrometeorological data for energy-budget studies near Rogers Spring, Ash Meadows National Wildlife Refuge, Nye County, Nevada, 1994: U.S. Geological Survey Open-File Report 96-170, 49 p.

Intermittent Recharge in Eagle Valley
(Project 185)

Location: Eagle Valley, Nev.

Project Chief: David E. Prudic.

Period of Project: 1994-99.

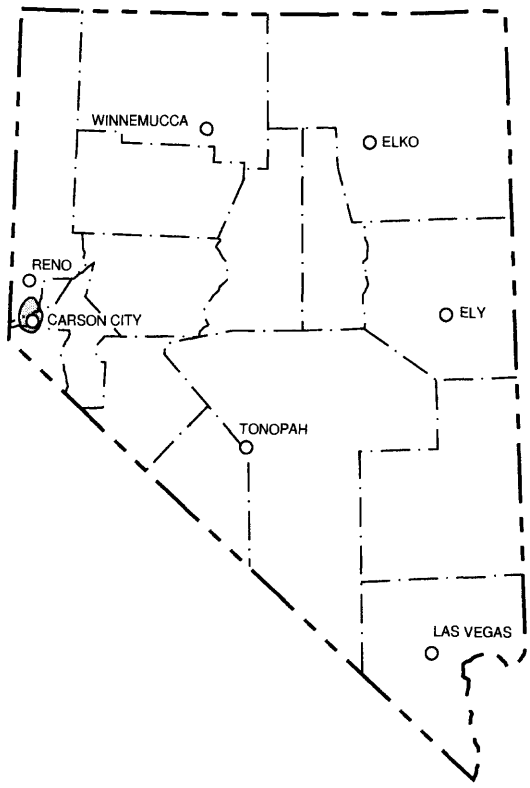
Cooperating Agency: Carson City Utilities Department and Washoe Tribe of California and Nevada.

Problem: Many basins in the Western United States receive a large part of their ground-water recharge from intermittent surface-water flow. This recharge is typically from natural ephemeral streams, unlined irrigation ditches, and augmentation projects. Currently, ground-water flow models by the U.S. Geological Survey assume instantaneous recharge between surface water and ground water, and do not include any of the processes of flow through an unsaturated zone that may delay or affect the quantity of recharge. Better numerical methods are needed to more accurately simulate flow between land surface and aquifers separated by an unsaturated zone, because of increased concerns about pollution affecting ground water and because increased demands for ground water require more accurate estimates of recharge.

Objective: This project will develop new methods for estimating ground-water recharge from streams and from underflow beneath adjacent mountains. A better method will be developed for simulating percolation from a stream to the underlying ground-water table by way of an unsaturated zone.

Approach: Recharge from intermittent streamflow in Vicee Canyon will be determined from transient temperature-depth profiles. The effect of temperature on stream infiltration will be measured and simulated with a variably saturated flow model modified to account for heat transport. Underflow beneath the major drainages entering the basin-fill aquifer will be determined by estimating thickness of fill beneath Vicee, Ash, and Kings Canyons using geophysical methods and by drilling three test holes in each canyon to determine aquifer properties and hydraulic gradients.

Progress and Significant Results, Fiscal Years 1995 and 1996: Two experiments (October 1994 and June 1995) were completed in Vicee Canyon. The experiments were designed to measure daily changes in stream infiltration and temperature, and soil temperatures beneath the stream. Results from the experiment indicate that infiltration into the sediments changes in relation to daily heating increases and cooling decreases of the stream water. The pattern of changing infiltration rates was simulated using a computer model that accounts for water and heat flow through variably saturated sediments. Subsurface flow beneath Ash, Kings, and Vicee Canyons was calculated using Darcy's Law. Test holes were drilled near the mouths of each canyon to determine the distribution of permeable sediments and rocks, and the hydraulic gradient. Estimates of hydraulic conductivity were



determined from slug tests of wells. These estimates were correlated to borehole resistivity measurements, which were then used to estimate the distribution of hydraulic conductivity beneath each canyon. Greatest subsurface flow was estimated beneath Kings Canyon. Kings Canyon is underlain by fractured metamorphic rocks that are highly permeable. This suggests that the metamorphic rocks can be highly permeable, and where permeable, the rocks may act as conduits for subsurface flow to the basin-fill aquifers.

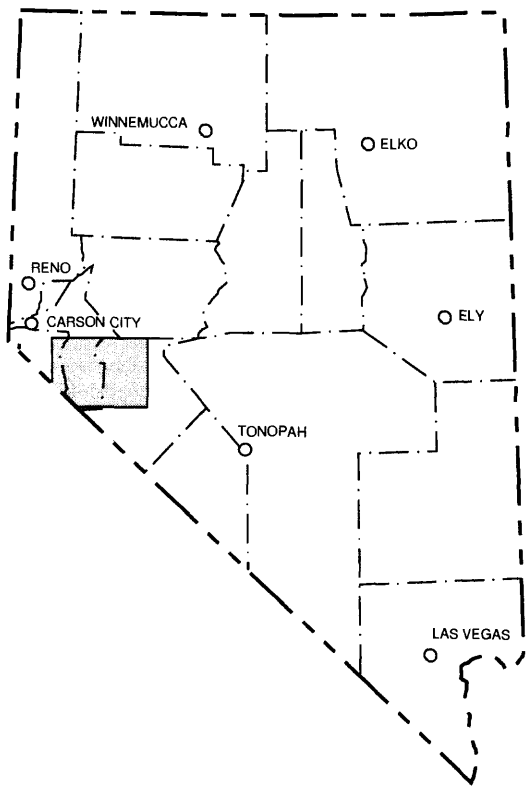
Plans for Fiscal Year 1997: Subsurface flow beneath all drainages that enter Eagle Valley will be estimated. Recharge from streams that cross the valley floor from direct precipitation on the valley floor and from irrigated fields and lawns will be estimated. A precipitation network will continue through 1997, as will seepage measurements along Clear Creek.

Publications, Fiscal Years 1995 and 1996:

Maurer, D.K., Berger, D.L., and Prudic, D.E., in press, Subsurface flow to Eagle Valley from Vicee, Ash, and Kings Canyons, Carson City, Nevada, estimated from Darcy's Law and the chloride-balance method: U.S. Geological Survey Water-Resources Investigations Report 96-4088, 74 p.

Prudic, D.E., Maurer, D.K., Wood, J.L., and Constantz, James, 1995, Diurnal temperature fluctuations as a tracer to water movement beneath an ephemeral mountain stream, Vicee Canyon, Carson City, Nevada [abs.]: Eos, American Geophysical Union Transactions, v. 76, p. 239.

Walker River Assessment *(Project 186)*



Location: Walker River and Walker Lake area, Nevada and California.

Project Chief: James M. Thomas, 1994-96; Stephen E. Hammond, 1996.

Period of Project: 1994-96.

Cooperating Agency: Walker River Paiute Tribe.

Problem: The lake-surface altitude of Walker Lake, a terminal desert lake near Hawthorne, Nev., has declined by 135 feet since 1882 when agricultural irrigation began in the basin. During the same period, the salinity has increased from approximately 2,500 to 13,300 milligrams per liter, disrupting the ecosystem because species vital to the food chain can no longer survive. The lake is an important migratory resting and feeding site for waterfowl, such as pelicans and loons, that depend on a reliable source of food during their stopover. The loss of the lake's trout fishery would affect the economy of the local communities. The upstream users are economically dependent upon availability of water-rights appropriations. The present rate of salt migration into Walker Lake from bottom sediments is unknown. An investigation is needed to estimate changes in Walker Lake salinity in response to evaporation and salt inputs from surface water, ground water, and lake-bottom sediments.

Objective: Changes in Walker Lake salinity will be estimated in response to evaporative water loss and the combined salt contribution from surface water, ground water, and lake-bottom sediments by estimating changes in lake salinity for different scenarios of river inflow and salt loading. The contributions of dissolved salts to Walker Lake from ground water and from lake-bottom sediments will not be monitored and therefore will be estimated.

Progress and Significant Results, Fiscal Years 1995 and 1996: Routine data collection continued. Data were published in the annual data reports. A fact sheet was published. Report writing continued.

Plans for Fiscal Year 1997: Reports will be published.

Publications, Fiscal Years 1995 and 1996:

Bauer, D.J., Foster, B.J., Joyner, J.D., and Swanson, R.A., 1996, Water resources data, Nevada, water year 1995: U.S. Geological Survey Water Data Report NV-95-1, 734 p.

Clary, S.L., McClary, D.R., Whitney, Rita, and Reeves, D.D., 1995, Water resources data, Nevada, water year 1994: U.S. Geological Survey Water-Data Report NV-94-1, 768 p.

Thomas, J.M., 1995, Water budget and salinity of Walker Lake, western Nevada: U.S. Geological Survey Fact Sheet FS-115-95, 4 p.

Bridge Scour *(Project 187)*

Location: Western and southern Nevada.

Project Chief: Rhea P. Williams.

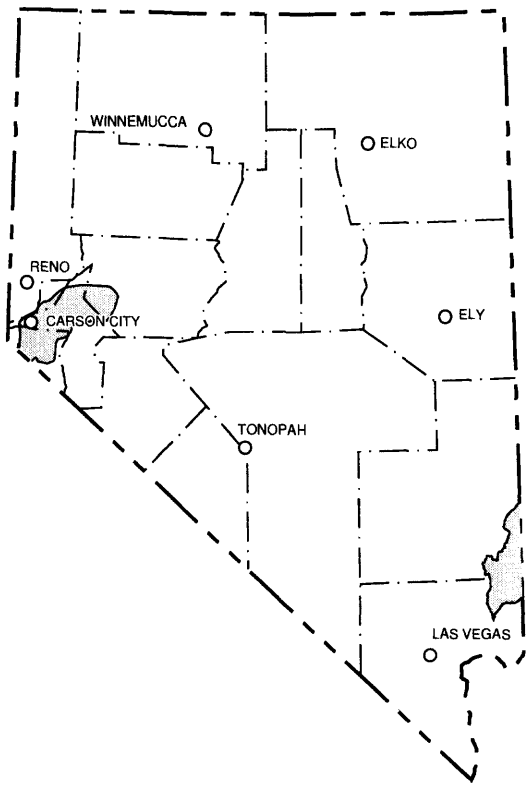
Period of Project: 1994-97.

Cooperating Agency: Nevada Department of Transportation.

Problem: The most common cause of bridge failures is the scouring of bridge foundations during floods. Scour is a lowering of the streambed below a surveyed or an assumed datum. Scour depth is the depth of bed material eroded by discharge. In 1988, the Federal Highway Administration (FHWA) requested that all State highway agencies evaluate the bridges on the Federal Aid System for susceptibility to scour-related failure. A schedule has been proposed to have all over-water bridges evaluated for scour susceptibility within the next few years. The FHWA published Hydraulic Engineering Circulars HEC-18 and HEC-20 to provide guidance in evaluating scour potential. Through an initial screening process, the Nevada Department of Transportation (NDOT) has looked at more than 200 bridges; some, which appear susceptible to scour, need further evaluation. The USGS proposed a three-level program to assist NDOT in evaluating the potential for scour-related failure of bridges in Nevada on the basis of procedures in the FHWA circulars.

Objective: Assistance will be provided to NDOT for assessment and evaluation of scour depth at selected bridge sites using the guidelines in the Hydraulic Engineering circulars.

Approach: Field data will be collected to obtain cross sections, bridge geometry, and bed-material particle-size distribution for "scour-susceptible" bridges identified by NDOT (Level 1). The data will be compiled in a geographic information system for future channel comparisons. A hydrologic assessment of the 100- and 500-year flood discharges for a bridge site will be made on the basis of existing flood-frequency reports. The "extreme" event under consideration for these analyses is a flood with a 500-year recurrence interval. Scour calculations will be made using site-collected data as required (Level 2). A hydraulic sediment-transport model may be needed. For critical scour sites and anticipated long-term geomorphic changes, work includes sediment-transport modeling for general and local scour predictions (Level 3). Site reports and conclusions of the analysis for each bridge site will be prepared.



Progress and Significant Results, Fiscal Years 1995 and 1996: Level 1 and Level 2 data were collected and analyzed for selected bridges on the Carson River. A Level 3 analysis using a sediment-transport model was completed for two bridges on the Virgin River. Additionally, geomorphic data from historical aerial photography and channel geometry surveys were analyzed for the Virgin River. Report writing began to document Level 1 and 2 data for the Carson River and separately, to describe the Level 3 and geomorphic analysis for the Virgin River.

Plans for Fiscal Year 1997: The reports will be submitted for approval and publication.

Ground-Water Budget Dayton Valley
(Project 188)

Location: West-central Nevada.

Project Chief: Douglas K. Maurer.

Period of Project: 1996-97.

Cooperating Agency: Carson Water Subconservancy District.

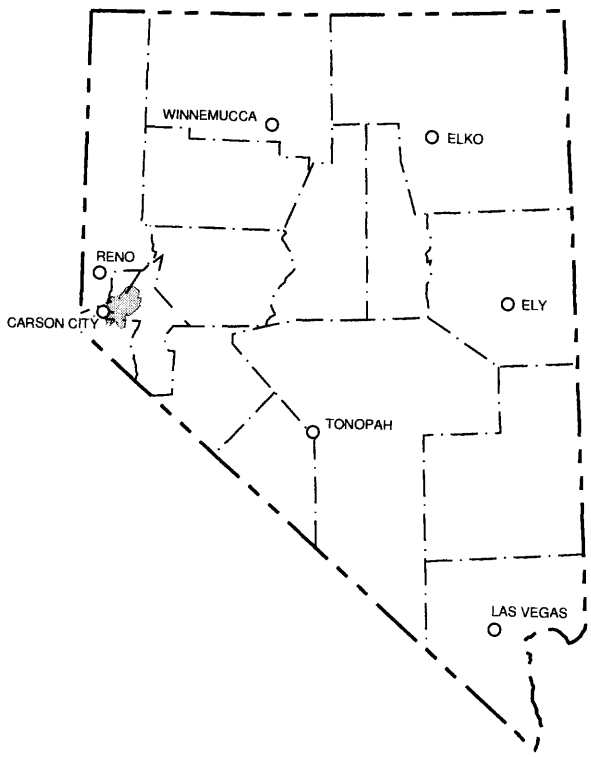
Problem: Population in the Dayton Valley Hydrographic Area in eastern Carson City and western Lyon Counties is increasing rapidly. Ground-water withdrawals to provide water for the growing population also have increased rapidly in recent years. Water in the Carson River, which flows through the area, is fully allocated. An increasing demand for water in downstream areas has caused concern for downstream users as development in Dayton Valley could affect the volume of streamflow in the river. A better understanding of hydrologic processes in the area would facilitate the management of the water resources.

Objective: A preliminary water budget for the Dayton Valley Hydrographic Area will be developed. The hydrologic data base will be updated.

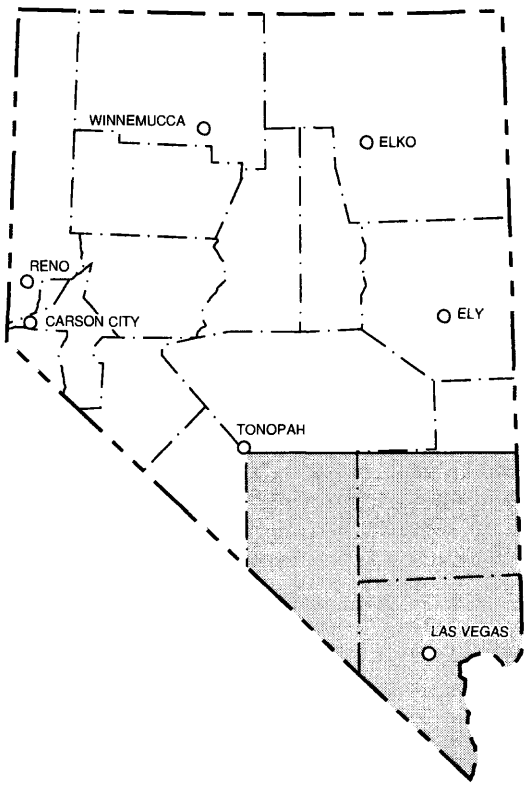
Approach: Flow records for Carson River, Eagle Valley Creek, and Mexican Ditch, and miscellaneous flow measurements and flow data for land application of treated sewage effluent will be evaluated. Ground-water levels near the boundary between Carson and Eagle Valleys will be measured. Pumping records for municipal wells will be obtained and evaluated. Records for domestic wells obtained from the Nevada State Engineer will be inventoried.

Progress and Significant Results, Fiscal Year 1996: A long-term water-level measurement network was established and monthly water-level measurements were made. Preliminary results from the reassessment of the water budget of the area indicate that precipitation within the Dayton Valley Hydrographic Area could be greater than that estimated previously, especially at higher altitudes.

Plans for Fiscal Year 1997: High altitude precipitation gages were installed, data collection will continue and deep well drilling will begin.



Age Dating Using Dissolved Organic Carbon
(Project 189)



Location: Southern Nevada.

Project Chief: James M. Thomas.

Period of Project: 1994-96.

Cooperating Agency: Las Vegas Valley Water District

Problem: The determination of ground-water age, which can be used to calculate travel times of ground water in aquifers of southern Nevada by using carbon isotopes of dissolved inorganic carbon is vague. Ground-water age, or the time of travel along a flow path, is extremely important for determining the contribution of ground water to streams and recharge to aquifers in the carbonate-rock area of southern Nevada. Previous studies indicate that about one-third of the flow in the Virgin River is from carbonate springs. Rates of ground-water flow and times of travel from recharge area to streams and carbonate-rock aquifers in underlying Las Vegas Valley and adjacent basins are needed to effectively manage southern Nevada's water resources.

Objective: The study will determine ground-water age using carbon-14 of dissolved organic carbon.

Approach: Sufficient dissolved organic carbon will be collected from springs in southern Nevada using reverse osmosis to determine the percent of modern carbon of the dissolved organic carbon. Ultrafiltration will be used to separate the dissolved organic carbon-reverse osmosis retentate into high, middle, and low molecular weight components. The data will be analyzed using accelerator mass spectrometry to determine carbon-13 and carbon-14 of dissolved organic carbon for age dating the water.

Progress and Significant Results, Fiscal Years 1995 and 1996:

Dissolved organic carbon was collected using reverse osmosis and separated into high, middle, and low molecular weight fractions using ultrafiltration techniques. Dissolved organic carbon analyses by accelerator mass spectrometry were completed. Dissolved organic carbon-14 ages indicated some ground water in the Mesquite area that discharges to the Virgin River is thousands of years old. Accelerator mass spectrometry analyses were made and report writing began.

Plans for Fiscal Year 1997: The report will be published.

Publications, Fiscal Years 1995 and 1996:

Burr, G.S., Thomas, J.M., and Courtney, C., 1996, Radiocarbon dating of dissolved organic and inorganic compounds in groundwater [abs.]: Radiocarbon, v. 38, no. 1, p. 12.

Humboldt Assessment - Phase I *(Project 190)*

Location: North-central Nevada.

Project Chief: William D. Nichols.

Period of Project: 1996-99.

Cooperating Agency: Bureau of Land Management

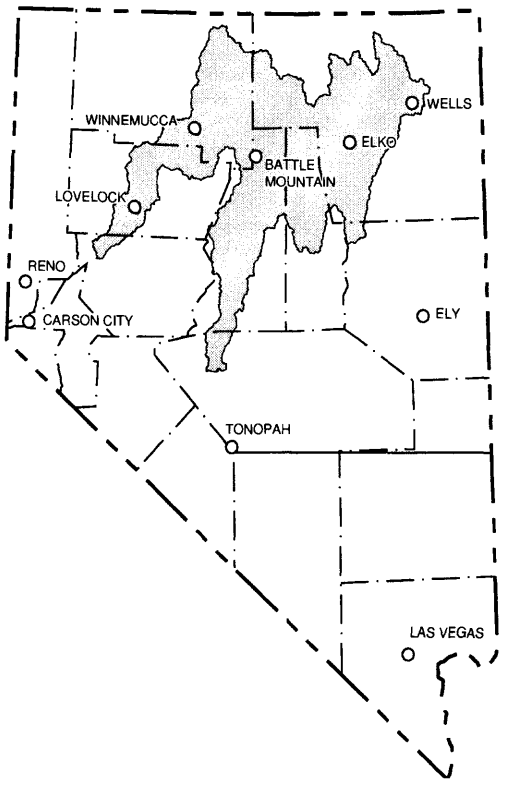
Problem: Nevada is experiencing a gold mining boom, with most of the activity occurring within the Humboldt River Basin. Nevada currently accounts for about 60 percent of United States gold production and about 9 percent of the world's production; continued significant increases in production are likely. Currently, 14 large scale open-pit gold mines and many smaller ones are active in the basin. Little is known about the cumulative effects of massive withdrawals on the regional aquifer systems, or on the flow regimen of the Humboldt River. Storage and disposal of these large quantities of water have proven to be significant challenges. A study to assess hydrologic conditions and potential effects of mining is needed to provide information for management of resources in the basin.

Objective: A scientific appraisal of the ground- and surface-water resources of hydrographic areas within the Humboldt River Basin and their contribution to the quantity and timing of flows in the mainstem Humboldt River will be made. The program will include both monitoring and studies to support analyses of the likely cumulative effects of all major water uses in the basin, including mining-related activities on water quantity, water quality, and beneficial uses (including aquatic habitat for fish and wildlife). Data collection and evaluation will include an analysis of existing monitoring programs in the basin, and design and implementation of revised or supplemental hydrologic monitoring networks and activities. Other studies, such as development of ground- and/or surface-water flow models, will support the scientific appraisal.

Approach: An information system to effectively manage water-resources data of the Humboldt River Basin will be compiled and maintained, and will be accessible by the public. Regional-scale, long-term monitoring needed to supplement and provide objective data on long-term effects in the basin will be initiated. The long-term assessment studies required to scientifically assess and objectively document regional, long-term, cumulative effects of mining and other large-scale water uses on the Humboldt River Basin will be designed.

Progress and Significant Results, Fiscal Year 1996: Data collection activities began.

Plans for Fiscal Year 1997: Data analyses of ground-water measurements will be done and report writing will begin.



Las Vegas Trihalomethanes *(Project 191)*

Location: Southern Nevada.

Project Chief: James M. Thomas.

Period of Project: 1995-97.

Cooperating Agency: Las Vegas Valley Water District.

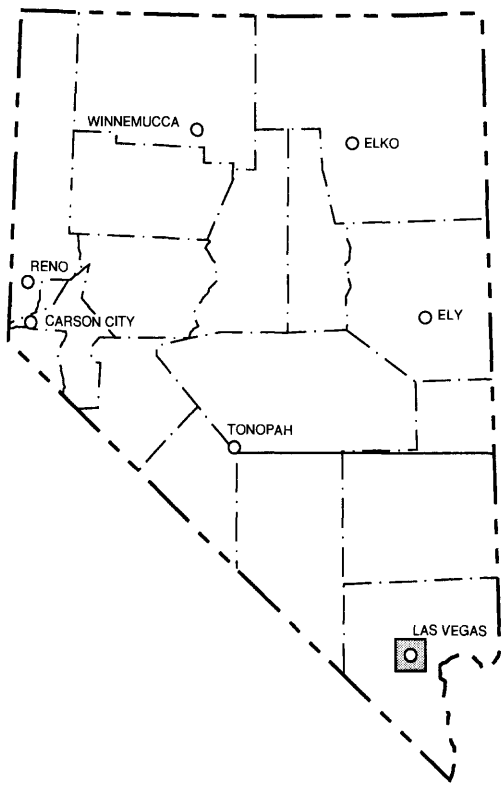
Problem: Chlorination disinfection by-products in artificial storage and recovery (ASR) projects are a problem throughout the United States. An ASR program is currently being used by the Las Vegas Valley Water District to supplement municipal water supplies for Las Vegas Valley. Lake Mead water that has been filtered and chlorinated is artificially recharged in basin-fill sediments in Las Vegas Valley through production wells during the winter months and recovered in the summer months during periods of high water use. Chlorination of Lake Mead water results in water with about 50 milligrams per liter of trihalomethanes (THMs) and 15 milligrams per liter of haloacetic acids (HAAs). The artificial recharge water has about 1 milligram per liter free chlorine residual and 2.7 milligrams per liter total organic carbon resulting in the continued formation of THMs and HAAs in the aquifer after injection. Thus, initial recovered water has concentrations of THMs and HAAs of about 85 and 20 milligrams per liter, respectively. THMs and HAAs are potentially carconogenic and mutagenic.

Objective: A determination will be made to find if the reduction in THMs and HAAs during recovery of artificially recharged water in Las Vegas Valley is from biodegradation with the aquifer, dilution with ground water, or a combination of the two processes. A determination also will be made to see if THMs and HAAs can be biodegraded by with the natural microbial community within the ASR aquifer under certain conditions, and if they are biodegradable, determine the rates at which they degrade.

Approach: Data will be collected and analyzed for several experiments on THMs and HAAs.

Progress and Significant Results, Fiscal Years 1995 and 1996: Data collection activities began.

Plans for Fiscal Year 1997: Data interpretation and report writing will begin.



Lemmon Valley Nitrates *(Project 192)*

Location: Northern Nevada.

Project Chief: Ralph L. Seiler.

Period of Project: 1996-97.

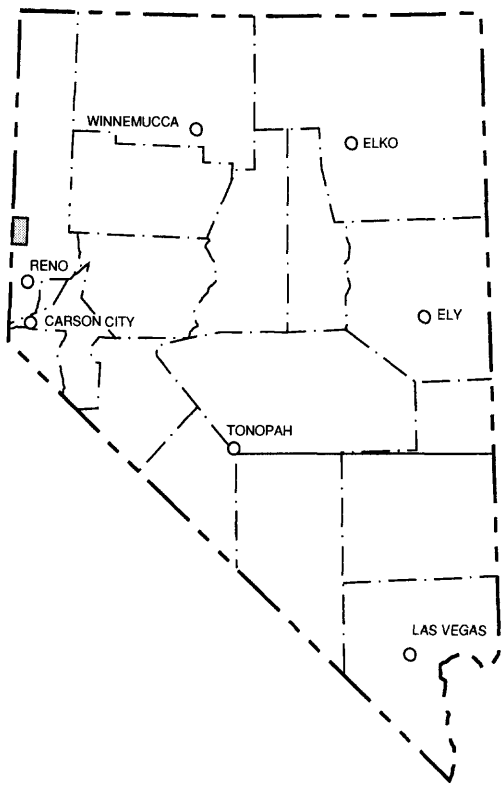
Cooperating Agency: Washoe County.

Problem: Drinking water supplies in Nevada, both public and domestic, are derived primarily from ground-water resources. Historically, water users in rural and suburban areas of Nevada have relied on individual wells for water supply and septic systems for disposal of domestic sewage. Additionally, horse and cattle ranching are a principal economic activity in many rural areas of Nevada. As populations in rural and suburban communities near Reno have increased rapidly in recent years, high and increasing concentrations of nitrate are being detected in ground-water resources. Ground water in parts of the Lemmon and Cold Spring Valleys northwest of Reno has nitrate concentrations that exceed the drinking water standard. Data are not available on other species of nitrogen such as nitrite, ammonia, or organic nitrogen. The source(s) of high nitrate concentrations have not been identified. In areas where several potential sources of nitrate are present, a scientific method is needed to determine the major source for quantifying the contribution of each source.

Objective: A compilation of water-quality measurements and constituents that may identify sources of nitrogen species in ground water will be developed. The potential of using the analytic compilation to make quantitative estimates of nitrogen species contributed to ground water by different sources will be evaluated.

Approach: The investigation will be done in two phases. The first phase will develop a compilation of water-quality measurements and constituents for identifying sources of nitrogen contamination in ground water, and evaluating the compilation to develop quantitative estimates of source contributions. If funded, phase 2 of the study will determine the areal distribution of nitrogen species and related constituents in ground-water resources of the study area.

Progress and Significant Results, Fiscal Year 1996: A comprehensive suite of water-quality measurements and constituents was developed through an intensive literature search. The literature search was published as an Open-File Report. Water samples from several different sources were used to test whether sources of nitrogen contamination in ground water can be identified. Potential sources in residential areas are septic fields, fertilizer application, and livestock. Monitoring wells were selected in areas affected by one or two selected potential nitrogen sources and sampled for the comprehensive list of water-quality measurements and constituents.

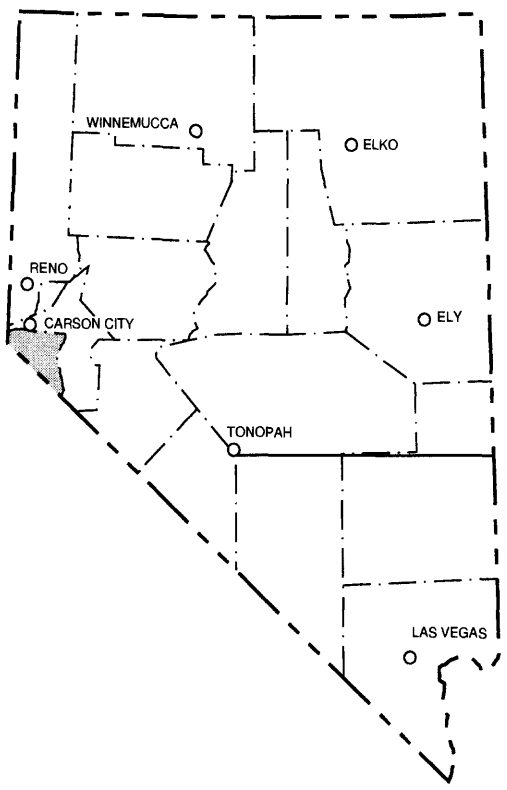


Plans for Fiscal Year 1997: If the project continues into phase 2, the analytic results will be evaluated and a preliminary compilation of measurements and constituents selected to identify and quantify sources of nitrogen contamination will be made. The preliminary compilation of analyses will be applied in selected areas that have mixed sources of nitrogen contamination. Thirty monitoring, domestic, or stock wells will be sampled. Results will be evaluated to refine and develop the analytic compilation for identifying and quantifying sources.

Publications, Fiscal Years 1995 and 1996:

Seiler, R.L., 1996, Methods for identifying sources of nitrogen contamination of ground water in valleys in Washoe County, Nevada: U.S. Geological Survey Open-File Report 96-461, 20 p.

Douglas County Nitrates *(Project 193)*



Location: Douglas County, Nevada.

Project Chief: James M. Thomas.

Period of Project: 1996-98.

Cooperating Agency: Douglas County.

Problem: Water from a supply well in the Indian Hills area of Carson Valley in Douglas County contains dissolved nitrate at a concentration that exceeds the drinking water standard. Douglas County, the supplier of water to homes in the area, is concerned about the source(s) of the high nitrate concentration. The production well is in an area where homes are on septic systems. Although homes with septic systems are a possible source of nitrate, fertilizer used on lawns, livestock present in the area, and naturally occurring soil-zone nitrate also are possible sources. An option being considered for control of the nitrate problem is adding a system to sewer the area around public supply wells. Before the expense of this system to sewer the Indian Hills area, the source(s) of nitrate in ground water in water supply wells need to be identified.

Objective: The main objective is to identify the principal sources of nitrate in ground water in the Indian Hills area of Douglas County. The secondary objectives are to determine the areal distribution of nitrate concentration in ground water in the Indian Hills area, quantify the amount of nitrate contributed to ground water from different sources, determine the contribution of nitrate from different aquifer zones in the production well, and to estimate a rate of nitrate reduction for nitrate dissolved in the ground water.

Approach: Sources of nitrate in ground water in the Indian Hills area will be identified using several methods. A gas-chromatograph scan will be made on ground-water samples collected in the area to attempt to identify septic effluent. Sulfonated compounds (associated with laundry detergents) will be analyzed to try to identify septic effluent. Nitrogen and oxygen isotopic compositions of the dissolved nitrate will be determined. Chlorofluorocarbons will be analyzed for identification of septic effluent input to ground water. Major ions will be analyzed.

Progress and Significant Results, Fiscal Year 1996: Data-collection activities began.

Plans for fiscal year 1997: Data-collection activities will continue and data will be published in the annual data report.

Evaporation Rates for Lake Mead *(Project 195)*

Location: Southern Nevada.

Project Chief: Craig L. Westenburg.

Period of Project: 1996-2000.

Cooperating Agency: Bureau of Reclamation.

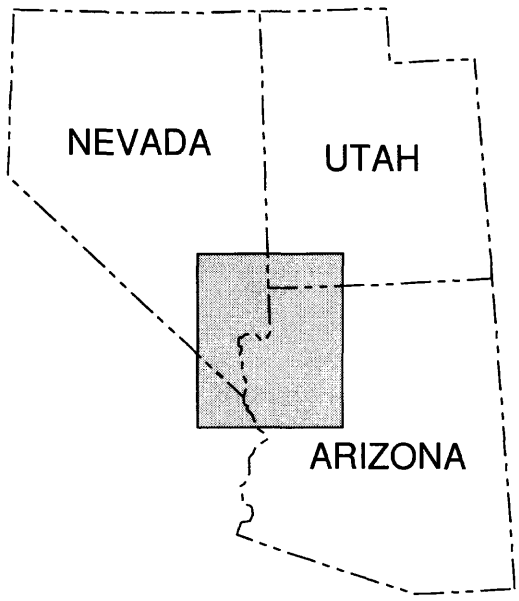
Problem: Evaporation from Lake Mead in Arizona and Nevada represents approximately 10 percent of the consumptive water use from the Lower Colorado River Basin. Because evaporation makes up a significant part of water lost from the river system each year, accurate estimates of evaporation from Lake Mead are needed to account for and manage the water resources of the Lower Colorado River Basin. In addition, plans to use Lake Mead as a storage reservoir for banked water requires careful accounting of water lost by evaporation due to the increase in lake surface area resulting from the addition of banked water.

At present, water-surface evaporation at Lake Mead is computed by the U.S. Geological Survey using a mass-transfer equation, developed in the 1950's and data collected by the National Weather Service and the Bureau of Reclamation from Las Vegas McCarran Airport. When the equation was developed in the 1950's, air temperature and relative humidity at Las Vegas were considered representative of conditions upwind of Lake Mead. Since the 1950's, the population of the Las Vegas area has grown from about 50,000 to over 1 million. Local climatic changes associated with rapid urbanization may affect the conditions that previously allowed Las Vegas McCarran Airport to represent conditions upwind of Lake Mead.

Objective: Estimates of evaporation from Lake Mead will be re-evaluated. The differences between meteorologic parameters collected at McCarran Airport and those collected at Lake Mead will be investigated to determine the effect these differences may have on calculated evaporation rates. A determination will be made as to whether meteorologic parameters and the resulting calculated evaporation rates vary among stations at different locations on and around the lake. A new equation to estimate evaporation at Lake Mead, if the current equation is found to be inadequate for use with current conditions, will be developed.

Approach: Meteorological data will be collected and calculated, respectively, at several sites on Lake Mead. The data will be compared with existing data on Lake Mead using the current equation. Evaporation will be calculated using an energy-budget method.

Progress and Significant Results, Fiscal Year 1996: A preliminary analysis of characteristics that might affect evaporation was started. Data collection and analysis will begin.



Plans for Fiscal Year 1997: Data-collection activities and analysis will begin. Data will be published in the annual data report.

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National Water Data Exchange
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Reston, VA 22092
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telephone (702) 887-7600

U.S. Geological Survey
Water Resources Division
6770 S. Paradise Road
Las Vegas, NV 89119-3721
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U.S. Geological Survey
Water Resources Division
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Additional information about the Nevada District activities may be obtained from:

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