U.S. Department of the Interior
U.S. Geological Survey

Water-Related Scientific Activities of the U.S. Geological Survey in Nevada, Fiscal Years 1997 and 1998

Open-File Report 99-206

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Compiled by M. Teresa Foglesong

U.S. GEOLOGICAL SURVEY

Open-File Report 99-206

Carson City, Nevada
1999

U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
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Copies of this report can be purchased from:

U.S. Geological Survey
Information Services
Box 25286
Denver, CO 80225-0286

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CONVERSION FACTORS, DEFINITIONS, AND ABBREVIATED WATER-QUALITY UNIT

Multiply	By	To Obtain
acre-foot (acre-ft)	1,233	cubic meter
foot (ft)	0.3048	meter
mile (mi)	1.609	kilometer
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).

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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 water-related scientific activities in Nevada by the Water Resources Division of the U.S. Geological Survey, from October 1, 1996, to September 30, 1998. 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 37 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, biologic, 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 the Nation's largest earth, water, biological science, and civilian mapping agency, the USGS works in cooperation with more than 2,000 organizations across the country to provide scientific information to resource managers, planners, and other customers. This information is gathered in every state by USGS to minimize the loss of life and property from natural disasters, to contribute to the conservation and the sound economic and physical development of the Nation's natural resources, and to enhance the quality of life by monitoring water, biological, energy, and mineral resources.

MISSION AND PROGRAM OF THE WATER RESOURCES DIVISION

The mission of the Water Resources Division (WRD) of the USGS is to provide reliable, impartial, and timely information that is needed to understand the Nation's water resources. The use of this information by decision makers helps to minimize the loss of life and property from water-related hazards, such as floods, droughts, and land movement; effectively manage ground-water and surface-water resources for domestic, agricultural, commercial, industrial, recreational, and ecological uses; protect and enhance water resources for human health, aquatic health, and environmental quality; and contribute to wise physical and economic development of the Nation's resources for the benefit of present and future generations.

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.

WATER RESOURCES DIVISION, NEVADA

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 in 1945; it, too, is still in place.

Organization

The Nevada District is responsible for USGS water-related activities in Nevada. The Nevada District has about 130 employees, most of whom are in the Carson City District Office; 38 are in the Las Vegas Office; and 2 are in the Elko Field Office. 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 1.

Addresses and phone numbers of the three Nevada District offices 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.

U.S. Geological Survey, WRD
Nevada District Office
333 W. Nye Lane, Rm 203
Carson City, NV 89706-0866
(775) 887-7600

U.S. Geological Survey, WRD
Southern Nevada Operations
6770 S. Paradise Rd.
Las Vegas, NV 89119-3721
(702) 897-4000

U.S. Geological Survey, WRD
Elko Field Office
P.O. Box 1044
Elko, NV 89803-1044
(775) 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 1997 and 1998 are in shown in figure 2. Total funds increased from $10.9 million in fiscal year 1997 to $11.0 million in fiscal year 1998.

Technical Resources

District Staff

The most important factor for maintaining high-quality data networks, hydrologic appraisals, and related research in the Nevada District has been the dedication and technical excellence of the District staff. The staff is well educated. In fiscal year 1997, about 52 percent of the total staff had college degrees, including five doctorates. About 44 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.

Computer Environment

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. These needs are met using a distributed computer environment which consists of a network of advanced Unix and Microsoft Windows workstations, appropriate software, and local area networks (LAN) for office telecommunications.

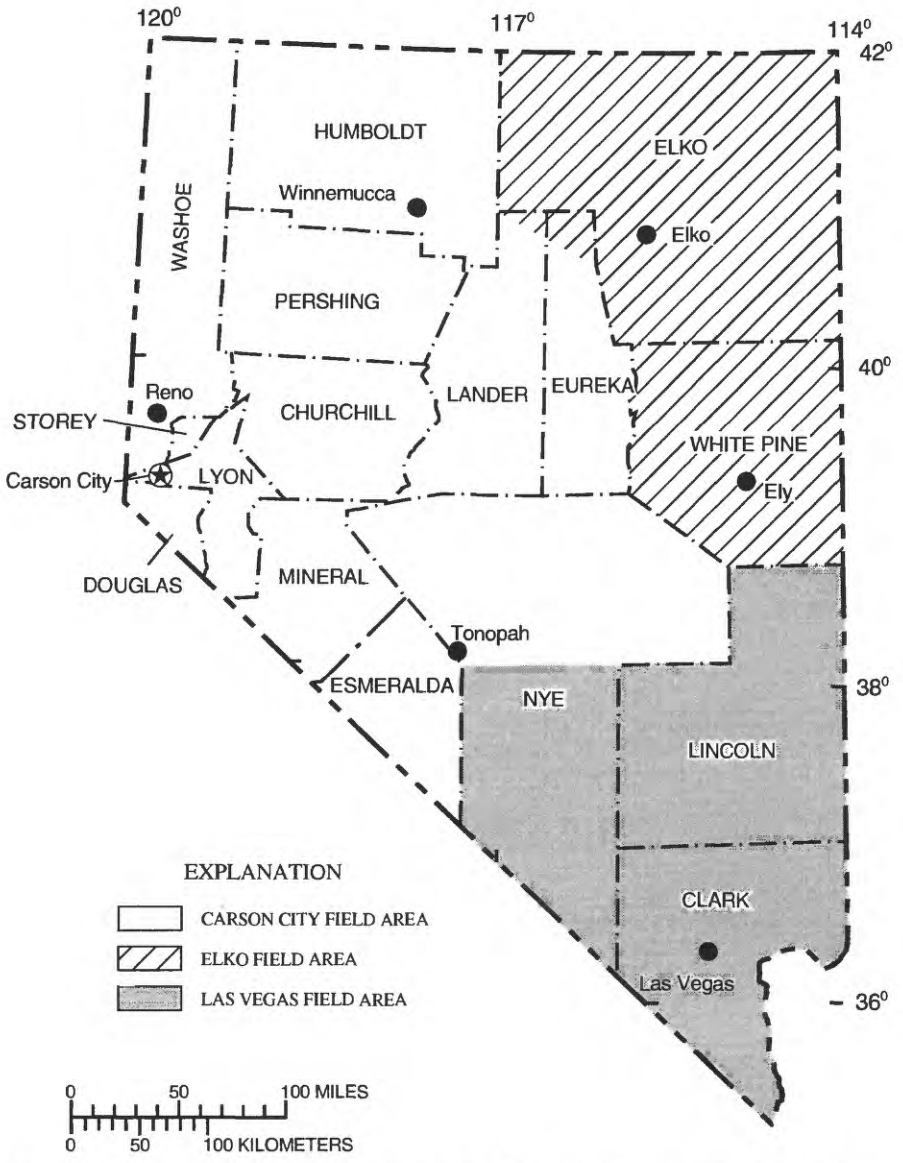
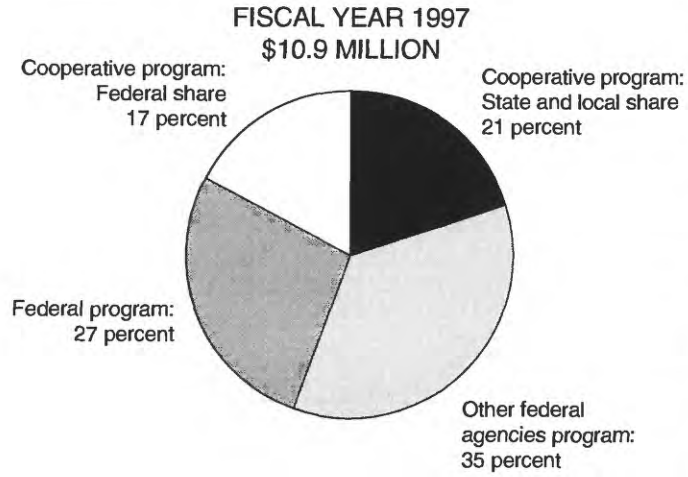


Figure 1. Geographic areas of responsibility for basic-data collection by Nevada District field offices.

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.

The USGS manages a wide area network (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. The Nevada District offices in Carson City and Las Vegas are connected to each other through DOINET. The Nevada Division of Water Resources (NDWR), Elko Field Office, and Nevada Weapons Test Site in Mercury, Nev., also are connected through DOINET. The DOINET connection provides access to the Internet, a collection of networks that are accessible to form one large virtual network containing a wealth of diverse information.

During fiscal years 1997-98 the Nevada District operated a computer environment that was characterized by the continued use of Data General Unix workstations and by an increasing emphasis on Microsoft Windows/Intel applications, particularly through the use of Windows NT and Windows NT/WinCenter Servers. Other Unix platforms, such as those from



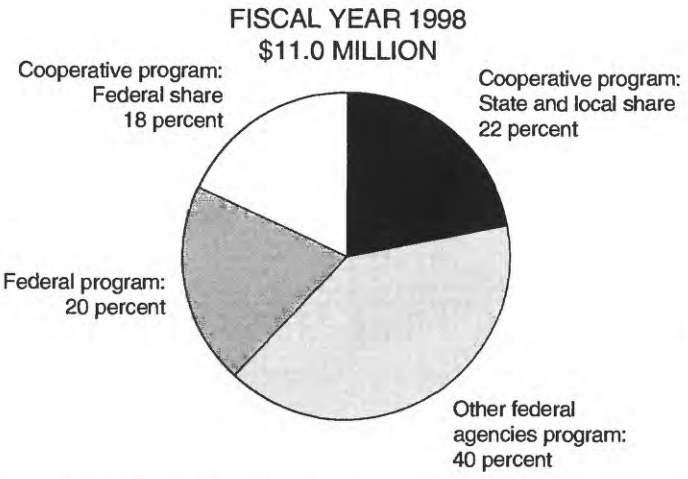


Figure 2. Nevada District program and distribution of funding.

Sun and Silicon Graphics, were used as data base and application servers. The District has implemented six main hubs of a distributed computer environment driving workgroup clusters of Microsoft Windows and Macintosh computers, Unix workstations, and associated peripheral equipment. Peripherals include X-terminals, cd-rom technology, floppy-disk technology, tape drives, scanners, laser printers, and color plotters.

Our cooperators and the public have become increasingly aware of the Nevada District World Wide Web (www) home page, which serves water-resources information such as streamflow and bibliographic data. The District continues the development of applications to serve this information. In 1997, the data for published reports were available for public access on the Nevada District www server for the first time. The Nevada District public home page is accessible at **<http://nevada.usgs.gov >**.

The USGS also maintains a national web page for public use 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.

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 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. Principal streams and lakes in Nevada where data are available are shown in figure 3.

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.

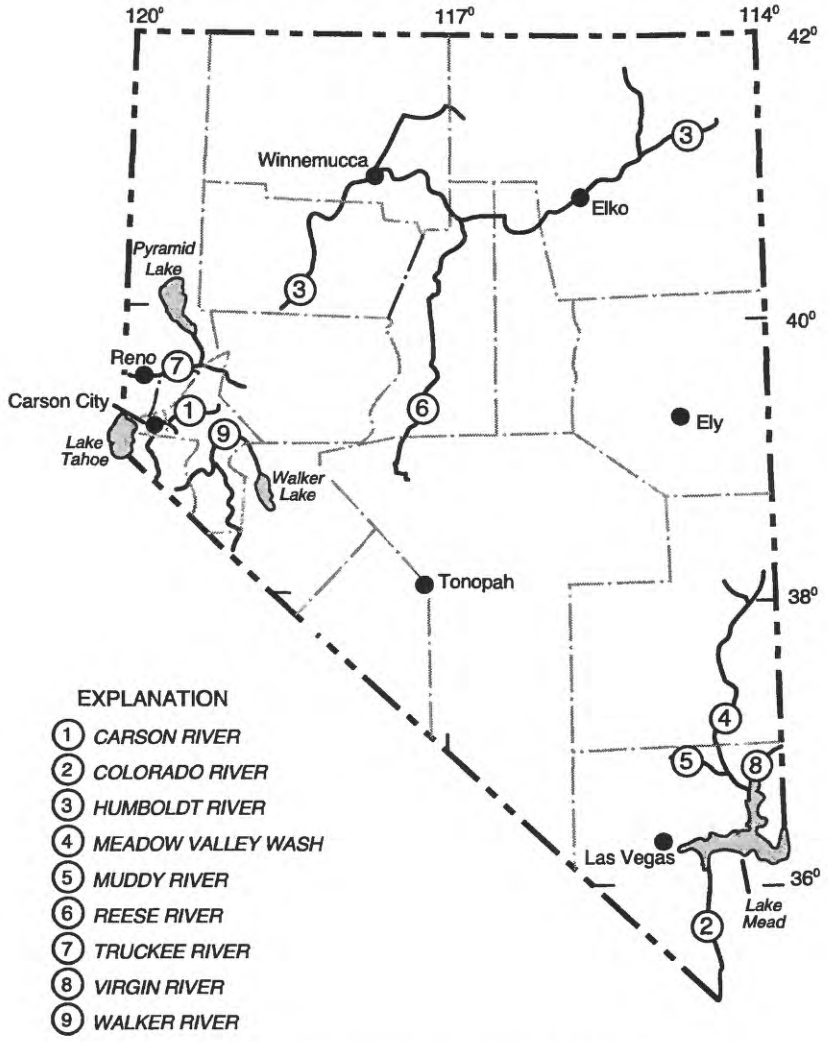


Figure 3. Principle streams and lakes in Nevada.

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 14 sites. Additionally, the District uses electronic instrumentation and other techniques for direct determination of bare-soil evaporation and plant transpiration.

Other District Activities

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

Committee Involvement.—Members of the Nevada District staff serve on a variety of National and local committees and advisory boards. In addition, the 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 societies such as the American Geophysical Union, American Society of Agronomy, Geological Society of America, Soil Science Society of America, American Chemical Society, and Water Resources Association.

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, community 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 (775) 887-7649 or email <**usgsinfo_nv@usgs.gov**>.

The Nevada District created a home page on the www for the public to access information such as streamflow data, bibliographic data, project information, and some online reports. The Nevada District home page is accessible at <**http://nevada.usgs.gov**>.

Western Region Research Drilling Program.—The Western Region office operates and maintains a Research Drilling Program to develop new techniques in exploratory drilling. The primary product of the drilling program is the installation of monitoring wells for Bureau programs. Drilling services are available for, but not limited to, Western Region WRD Districts. The Western Region Drill Rig operations are located in Mound House, Nev., about 5 miles east of Carson City.

The office address for correspondence is:

U.S. Geological Survey, WRD
Western Region Drill Rig
32 Affonso Drive
Mound House, NV 89706
Telephone: (775) 246-3462

MAJOR WATER ISSUES IN NEVADA

Flooding in Nevada

Five of the last 6 years (1993-98) had excessive runoff conditions due to heavy snowpack. These conditions are rare in the high desert climate of northern Nevada. As the 1997 water year began, above average precipitation created this heavy snowpack through the end of December 1996.

Beginning on New Year's Day 1997, unseasonably warm rains from the Pacific Ocean melted a part of the snowpack, causing flooding in the Carson, Truckee, and Walker River Basins, and Lake Tahoe Basin.

Damage costs were estimated at about $1 billion (Reno Gazette-Journal, 1997) for urban and agricultural areas. The towns of Reno, Sparks, Carson City, and Yerington suffered extensive damages. The resulting floods destroyed 10 streamflow gages and damaged another 26, and 12 cableways needed significant repair. More than 50 indirect peak-flow measurements were used to determine the magnitude and extent of the flooding. The Nevada District received funding from Congress to replace destroyed gages and repair gages and cableways damaged during the '1997 New Year's Flood.'

Since the flooding, the public has been more interested in the estimates of flood recurrence intervals. The USGS responded by publishing several fact sheets describing aspects of the January 1997 flooding (Garcia, 1997; Hess and Williams, 1997; Thomas and Hess, 1997; and Thomas and Williams, 1997). Included are flood peaks and estimates of recurrence intervals for the Carson, Truckee, and Walker River Basins, and the Lake Tahoe Basin. Another fact sheet describes flood-recurrence intervals and the 100-year flood designation.

The Truckee-Carson River Systems Model (Project 171) was used to compare the actual flood hydrographs for the Truckee River in the urban areas of Reno with a simulation of the flood peaks that would have occurred without the reservoirs. Using data from collaborative work with U.S. Environmental Protection Agency on the Carson River Superfund project, a fact sheet was published describing the mercury and suspended-sediment loads during the flood year 1997 into and out from Lahontan Reservoir in the Carson River Basin (Hoffman and Taylor, 1998). Finally, a fact sheet describing the January flood in Nevada and California was jointly published as a cooperative effort of the two USGS districts (Hammond and Harmon, 1998).

Urban Water Use

Nevada continues to lead the Nation in rate of population growth (figure 4). The population in Nevada increased by more than 54 percent in the past 8 years and doubled in the past 15 years. Projections indicate that the State's population will double again in the next 20 years (Nevada State Demographer, 1998). The population of southeastern Nevada (Las Vegas/Clark County) doubled in the past 10 years. The major growth centers in Nevada are Las Vegas Valley and vicinity in the southeast; Reno, Sparks, Carson City, and vicinity in the northwest; and Elko and vicinity in the northeast.

Nevada appears to be a rural state because it has an average population density of only 16 people per square mile. However, in the 1990 census, Nevada was ranked as the fourth most urbanized state, with more than 88 percent of the population living in communities of 2,500 people or more (U.S. Bureau of the Census, 1991).

The arid, sparsely populated interior valleys in Nevada, still home to the West's largest wild-horse populations, are increasingly targeted as sources of water for the rapidly expanding Reno-Sparks metropolitan area in northwestern Nevada and Las Vegas metropolitan area in southern Nevada.

Concurrent with the continuing strong growth of the gaming and tourism industry in the urban areas, the large-scale, open-pit gold mines of northern and northeastern Nevada were ranked in 1997 as the second largest producers of gold and silver in the world.

A trend has emerged in the development boom in southern Nevada as new mega-hotels and casinos emphasize family tourism as much as, or more than, gaming. The fastest growing area in the United States continues to be the Las Vegas Valley metropolitan area. Between 1990 and 1997, Henderson was the fastest growing city in the country (with a population over 148,000, an average annual growth rate of 16.2 percent, and a doubling rate of about 6 years) and Las Vegas was the sixth fastest growing city (with a 1997 population over 425,000, an average annual growth rate of 8.3 percent, and a doubling rate of about 11 years). Between 1990 and 1996, the Reno-Sparks metropolitan area was the 21st fastest growing area.

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 southern Nevada, water for this new growth is being developed from water conservation, and obtaining water rights and water supplies from outside Las Vegas Valley. 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 Truckee, Carson, and Humboldt River Basins, Lake Tahoe Basin, and

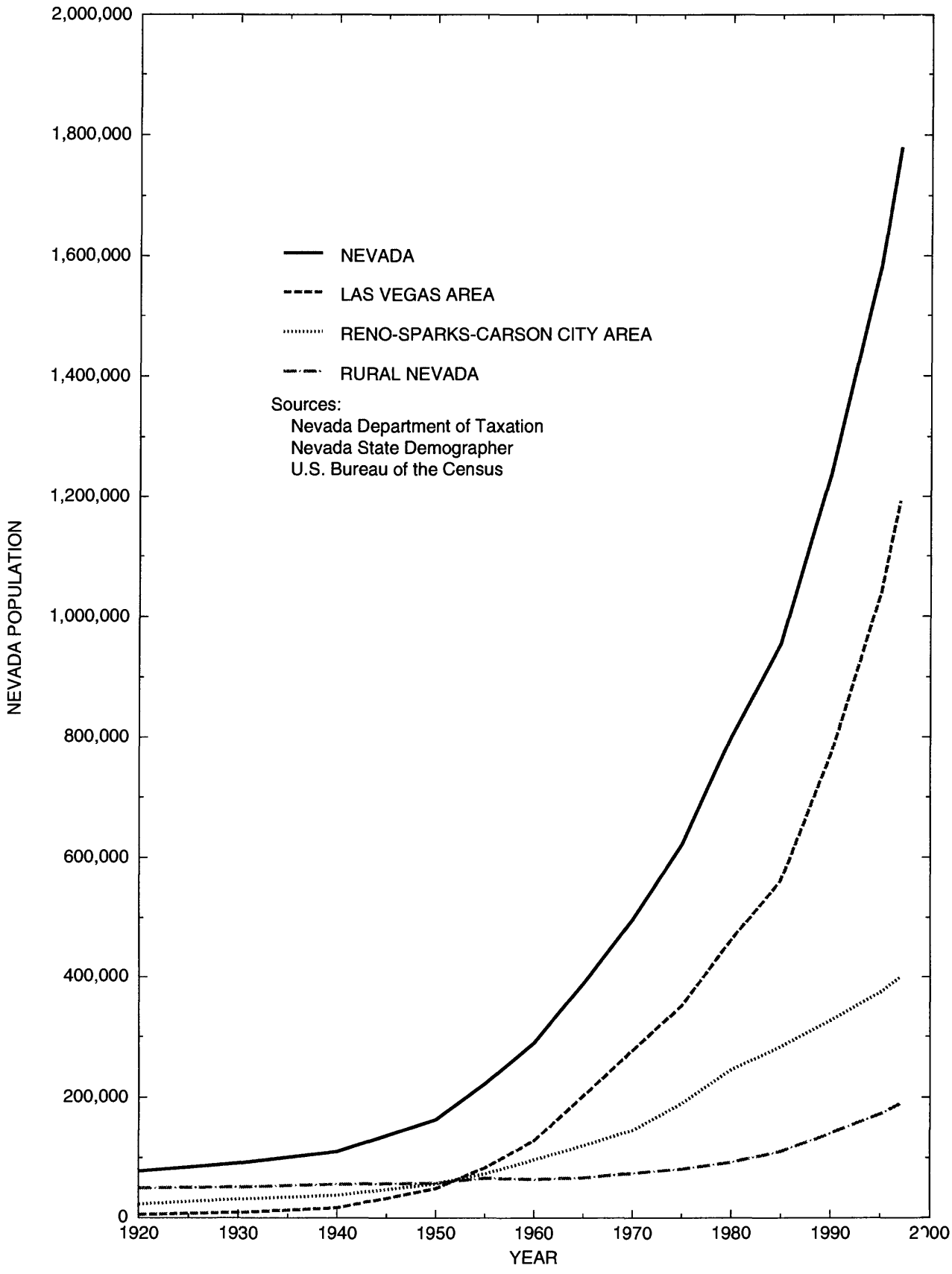


Figure 4. Nevada population trends, 1920-97.

Las Vegas Valley. Currently (1998), the increase of nitrate concentrations in ground water is an important issue. In some areas, the use of individual septic tanks for sewage disposal has been prohibited due to nitrate concentrations in ground water that are approaching or exceeding State standards. This prohibition initiated projects to construct sewage service to already developed urban and suburban areas. 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 property damage from ground subsidence.

The reuse of treated wastewater is increasing because of more stringent requirements on the quality of effluent and the lack of available water. In 1997, about 26,300 acre-feet of wastewater was reused, about 12 percent of the total treated wastewater in Nevada. Douglas County (about 53 percent) and Carson City (about 50 percent) are the statewide leaders in reusing treated wastewater (Randy Pahl, Nevada Division of Water Planning, oral commun., 1998). Current uses for treated wastewater are agricultural irrigation, golf course and park irrigation, powerplant cooling water, wetlands, and dust control.

Agricultural Water Use

Irrigation is the largest use of water in Nevada. Irrigated crops include alfalfa seed, alfalfa, and hay; winter and spring wheat; and potatoes and other vegetables. Of these, hay is the leading crop. In this decade, irrigators have been at the mercy of Nevada's climatic variability. The 7-year extended drought of 1987-94 was followed by above average precipitation in 1995-98, culminating in the severe record-setting floods of New Year's Day 1997 in northwestern Nevada. Effects of these swings in precipitation range from little or no water for irrigation in the mid-90's to wholesale damage of the irrigation infrastructure in the winter of 1997.

When Nevada communities withdraw the maximum amount of water available through their current water rights, the largest alternative supply of water 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 and destroying the economic base of the rural farming communities.

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 California and Nevada. 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. A very strong incentive to meet this deadline was the placing in abeyance, until December 1997, of several major cases of water-rights litigation. In 1998, negotiations are still continuing on details of the TROA and the specter of renewed litigation is of concern to all involved parties.

U.S. Geological Survey assistance to other U.S. Department of the Interior agencies in implementation of Public Law 101-618 continued during 1997-98. The Nevada District Truckee-Carson Program initiated upgrades of data networks to support the development of river-flow and water-quality models, and of real-time data networks for river operations. Flow-routing modules for models of the Truckee River and Carson River systems have been tested and documented. Stream-temperature and dissolved-solids models of the Truckee River have been developed by Taylor (1998) and currently under development are precipitation-runoff models of the Lake Tahoe and Truckee River Basins. Models simulating river/reservoir operations and allocations in the Truckee River and Carson River Basins also are being developed. Ongoing improvements are being made to a graphical user interface that

not only assists the user in generating alternative scenarios for river operations, but also facilitates the interpretation of modeling results through a variety of standard statistical and graphical techniques, including animation.

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 (NVBR) study unit, which includes the Truckee River and Carson River Basins and Las Vegas Valley, is 1 of 60 proposed NAWQA units that were 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. By the end of fiscal year 1998, the NVBR has published 12 reports and is designing and implementing the low-level operational phase of the 10-year NAWQA cycle.

Hydrology at Nevada Test Site

The Nevada District provides support to the U.S. Department of Energy (USDOE) by studying the hydrologic effects of past weapons testing at the Nevada Test Site (NTS). Nuclear weapons were tested at NTS from the early 1950's until the moratorium in 1992. 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, as part of the Environmental Restoration Program (ERP), that will determine the potential for radionuclides to be transported within these aquifers and that will assist USDOE in mitigations of the effects of past testing on the subsurface environment.

Other hydrologic research activities in and around NTS include an estimation of evapotranspiration (ET) for quantifying annual rates of ground-water discharge and a determination of the age, flow direction, and rate of ground water using geochemical techniques.

The Hydrologic Resources Management Program (HRMP) supports regional modeling efforts that will play an integral part in evaluating water resources at NTS for future defense and economic development activities. The USGS operates 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 or subtle water-level fluctuations. These programs have allowed the processing of complex data-logger information to provide hydrographs that are used to develop quantitative estimates of aquifer characteristics. Other HRMP activities include the collection and compilation of water-use data from the major NTS production wells instrumented with digital flowmeters and data loggers, and the development and operation of a records and archiving program at the USGS Core Library at NTS.

Potential Nuclear-Waste Repository at Yucca Mountain

In December 1987, the U.S. Congress identified Yucca Mountain, within and immediately west of the NTS, 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 studying the paleohydrology and flooding possibilities in the Yucca Mountain area. The District also operates monitoring networks to collect data in support of individual studies of unsaturated and saturated ground-water flow as part of the Yucca Mountain project.

Death Valley Regional Ground-Water Flow Model

Many Federal, State, and local agencies have an interest in understanding the ground-water flow system in the Death Valley region, which includes NTS. Driven by the needs of DOE Nevada Test Site and Yucca Mountain Programs, a cooperative program was developed with U.S. Fish and Wildlife Service, National Park Service, and USGS to enhance existing ground-water models and develop new tools for scientific investigations. This program will be a truly distributed, multidisciplinary, and multiorganizational project involving WRD, Geologic Division (GD), and Biological Resources Division of USGS, DOE's National Laboratories, and university researchers. Project management will be transferred in fiscal years 1998-99 from the USGS Yucca Mountain Program to the Nevada District, but USGS scientists contributing to the project will be dispersed among the four divisions of USGS and among five or more states.

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, while most is used for irrigation of agricultural lands or is discharged 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, climate fluctuations, and increasing municipal growth. The need to better understand the long-term effects of these major changes in the regional-flow systems has led WRD and GD to launch multiyear, multiorganizational Humboldt River mineral- and water-resources assessments. Work in fiscal year 1998 by WRD was being expanded to include collaboration with the U.S. Fish and Wildlife Service on analysis of the effects of changes in river-flow regimes and water-quality loadings on aquatic habitats in the basin.

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 or fundamental processes.

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

The need to refine techniques for estimating ground-water recharge led to funding of another research project that will determine the effect of temperature on infiltration through the unsaturated zone beneath small streams and ditches that cross 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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Thomas, K.A., and Williams, R.P., 1997, Flood of January 1997 in the Carson River Basin, California and Nevada: U.S. Geological Survey Fact Sheet FS-183-97, 2 p.

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PROJECTS FUNDED IN FISCAL YEARS 1997 AND 1998

Surface-Water Data Network *(Project 001)*

Location: Statewide and eastern California.

Project Chief: Stephen E. Hammond.

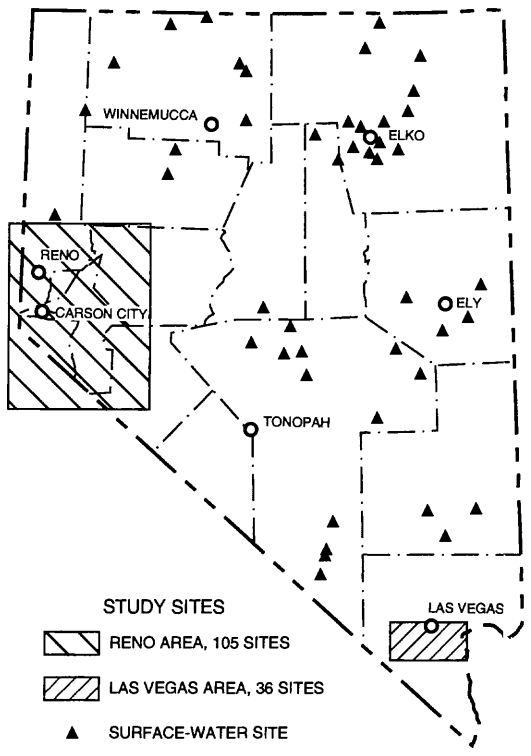
Period of Project: Continuous since 1894.

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, U.S. Forest 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 1997 and 1998: Statewide surface-water-data collection, computation, and compilation continued. Field surveys and computations for indirect measurements of flow during the January 1997 flood were made. The annual data reports were published. Several fact sheets regarding the January 1997 flooding in California and Nevada were published. Real-time and historical data were updated on the Nevada District Internet home page at <**http://nevada.usgs.gov**>.

Plans for Fiscal Year 1999: 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 published. Real-time and historical data will be updated on the Nevada District Internet home page.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

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Hammond, S.E., and Harmon, J.E., 1998, Publications document floods of January 1997 in California and Nevada: U.S. Geological Survey Fact Sheet FS-093-98, 4 p.

Hess, G.W., and Williams, R.P., 1997, Flood of January 1997 in the Truckee River Basin, western Nevada: U.S. Geological Survey Fact Sheet FS-123-97, 2 p.

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Thomas, K.A., and Williams, R.P., 1997, Flood of January 1997 in the Carson River Basin, California and Nevada: U.S. Geological Survey Fact Sheet FS-183-97, 2 p.

Ground-Water Data Network *(Project 002)*

Location: Statewide.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1945.

Cooperating and Supporting Federal Agencies: U.S. Army Corps of Engineers, Carson City Public Works Department, Churchill County, Douglas County, Las Vegas Valley Water District, and Nevada Division of Water Resources.

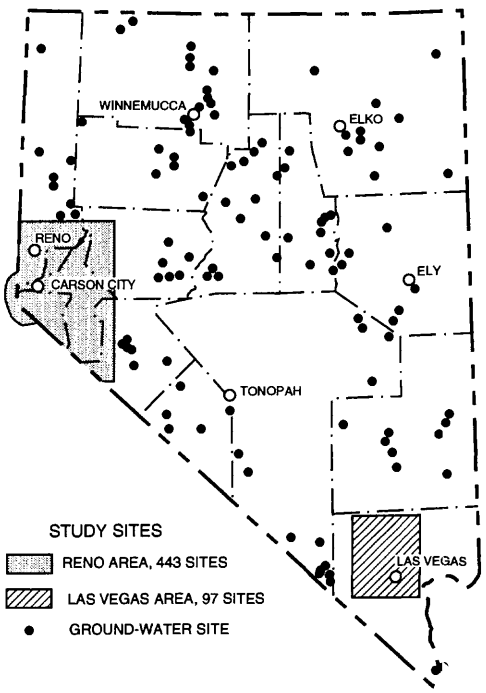
Problem: The long-term response of regional aquifers throughout the State to natural climatic variations and induced stresses is largely unknown. Proper planning and management of State water resources require long-term information so that trends can be defined, problems discovered, and corrective actions 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 1997 and 1998: Ground-water-data collection, computation, and compilation continued. The annual data reports were published.

Plans for Fiscal Year 1999: Ground-water-data collection, computation, and compilation will continue. The annual data report will be published.



Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

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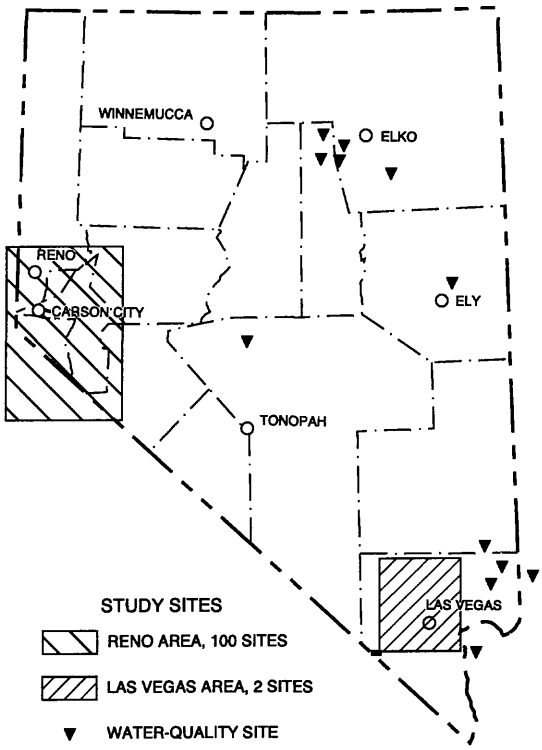
Water-Quality Data Network *(Project 003)*



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, Clark County Regional Flood Control District, Douglas County, Nevada Bureau of Mines and Geology, Nevada Department of Business and Industry, Nevada Division of Environmental Protection, Nevada Division of Water Resources, Southern Nevada Water Authority, U.S. Department of Energy, 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 1997 and 1998: Data collection and analysis continued. The annual data reports were published. A fact sheet on pesticides in ground water was published.

Plans for Fiscal Year 1999: Data collection and analysis will continue. The annual data report will be compiled and published.

Publications, Fiscal Years 1997 and 1998:

Adams, P.A., Moses, C.W., and Bevans, H.E., 1997, Monitoring for pesticides in ground water in Nevada: U.S. Geological Survey Fact Sheet FS-139-97, 2 p.

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

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

Location: Smith Valley, Nev.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1985.

Supporting USGS Program: National Atmospheric Deposition Program.

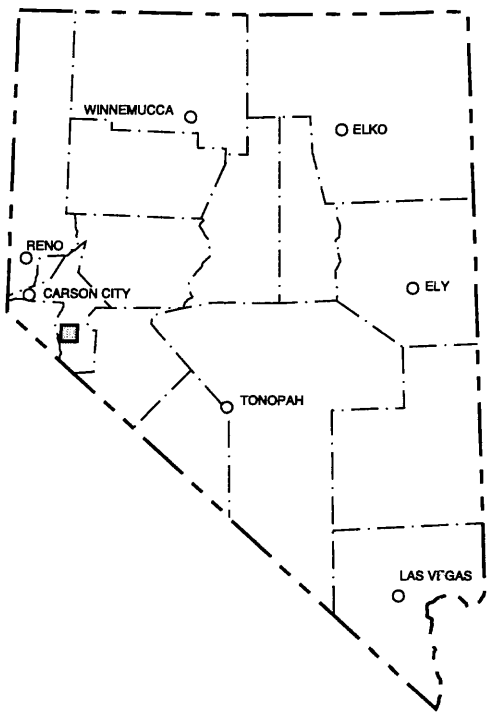
Problem: Acid precipitation has caused adverse ecological and economic consequences in the Eastern United States. In the Western United States, the chemical composition and variability of wet atmospheric deposition is largely unknown due to a lack of quantitative data. However, industrial and vehicular 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: An atmospheric-deposition sampler in Smith Valley in Lyon County near Smith, Nev., is operated. Samples are collected weekly for analysis of pH and specific conductance when sufficient precipitation occurs.

Progress and Significant Results, Fiscal Years 1997 and 1998: After some storms, the sampler contained adequate quantities of precipitation for field determination of pH and specific conductance in 1997 and 1998 water years. 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.

Plans for Fiscal Year 1999: Sample collection and compilation of data from the Smith Valley site will continue.



Flood-Insurance Studies *(Project 006)*

Location: Douglas County, Nev.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1985.

Supporting Federal Agency: Federal Emergency Management Agency.

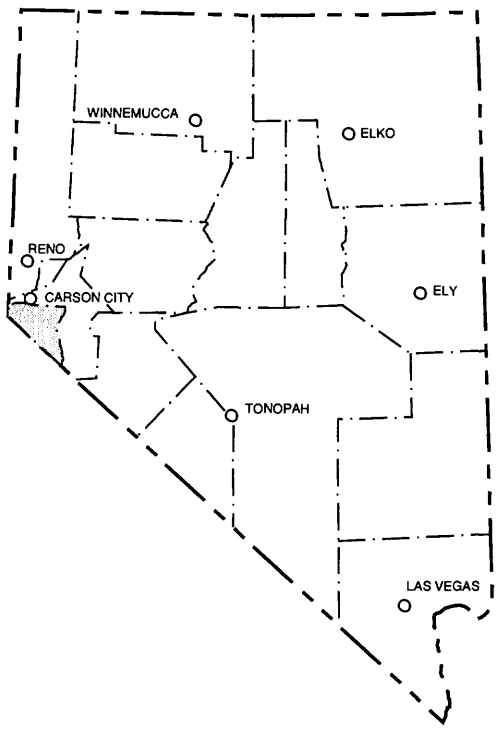
Problem: Flooding in arid regions can be devastating because most rain occurs in the spring, when rain on snow is likely, and sparse vegetation and compacted desert soils allow little infiltration of rainfall and snowmelt. Excessive overland flow is also a consequence of locally intense thunderstorms. 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 1997 and 1998: Analysis of the flood data for the Fernley and Hawthorne studies was completed and results were submitted to FEMA for publication.

Plans for Fiscal Year 1999: Analysis of the flood data for the Douglas County study will be completed and results will be submitted for publication by FEMA.



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 1997 and 1998: Water-use information was published in the annual data reports. The collection and compilation of water-use data in Nevada during 1995 was completed and submitted for regional and National compilations. Enhancements were made to the data base to store quarterly water-use reports.

Plans for Fiscal Year 1999: Water-use information will be compiled and published in the annual data report. The data base will be updated with quarterly water-use reports.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Flood Investigations of Nevada Streams
(Project 036)

Location: Statewide.

Project Chief: Stephen E. Hammond.

Period of Project: Continuous since 1961.

Cooperating Agency: Nevada Department of Transportation

Problem: The design of highways and 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.

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 1997 and 1998: Peak-streamflow data were collected at three sites. A network analysis was made and as a result several existing sites will be replaced with data-collection sites where peak-flow data are needed. Peak-flow data were published in the annual data reports. Data collection and investigations of mud- and debris-flow areas continued.

Plans for Fiscal Year 1999: Peak-flow data for the 1997 and 1998 water years will be published in the annual data report. Compilation of streamflow statistics will continue.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

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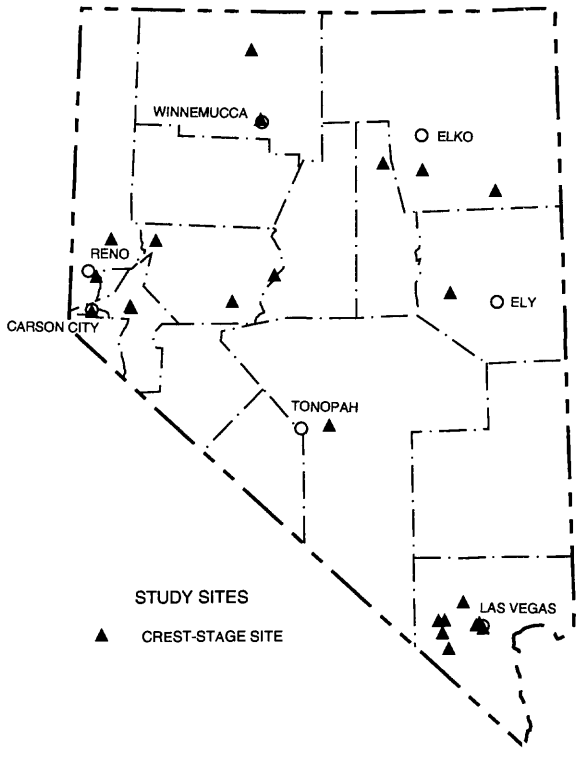


Nevada Carbonate-Rock Aquifers *(Project 128)*

Location: Eastern and southern Nevada.

Project Chief: Richard L. Kane, 1996-present.

Period of Project: Continuous since 1984.

Cooperating Agency: Las Vegas Valley Water District.

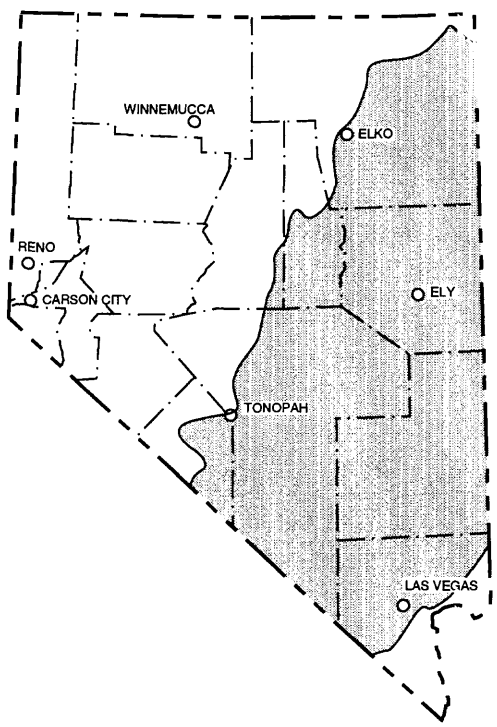
Problem: Demand for water in Las Vegas and smaller towns in eastern and southern Nevada is growing and additional supplies may be needed from ground-water sources outside the local basins. Previous assessments of the water resources of eastern Nevada indicate that the carbonate-rock aquifers are a potential ground-water source, but insufficient data are available to determine 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 1997 and 1998: Routine data collection and ground-water monitoring continued. A hydrologic atlas and data report were published. Data from 14 continuous-record sites were published for the period of record in the annual data reports.

Plans for Fiscal Year 1999: Routine data collection and ground-water monitoring will continue and the data will be published in the annual data report.



Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

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Nevada Test Site Hydrology *(Project 130)*

Location: Southern Nye County, Nev.

Project Chief: Daniel J. Bright, 1997-present.

Period of Project: Continuous since 1985.

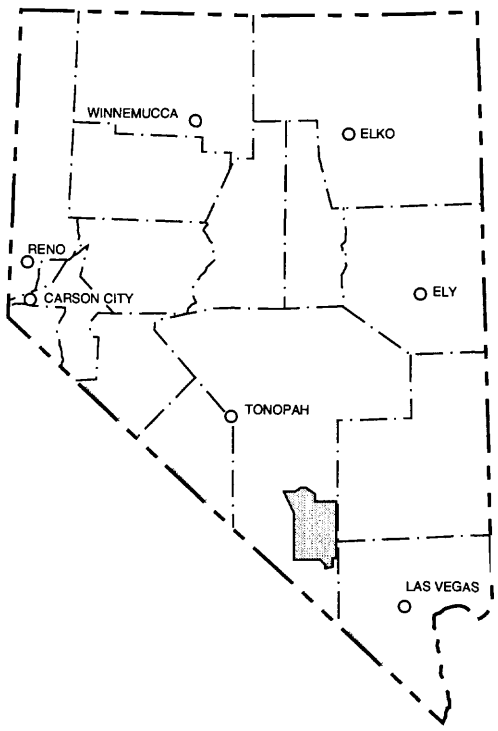
Supporting Federal Agency: U.S. Department of Energy.

Problem: Underground nuclear weapons testing at the Nevada Test Site has created the potential for long-term contamination of ground-water supplies by radionuclides. The U.S. Department of Energy (USDOE) requires information on ground-water levels and supplies to assist in monitoring the potential migration of radionuclides and in planning new uses for the Nevada Test Site (NTS) since the 1992 moratorium on underground nuclear-weapons testing.

Objectives: Selected ground-water flow systems underlying NTS will be characterized. Water-level and water-use data will be collected and compiled to assist in USDOE monitoring and planning activities at the NTS. Existing geohydrologic data will continue to be organized and archived at the USGS core library. Other hydrologic expertise will be provided in support of the USDOE, Hydrologic Resources Management Program.

Approach: Specially designed studies will be developed and documented to characterize selected ground-water flow systems. A network of selected test holes and wells will be established to collect water-level and water-use data. Water-level data are stored in the USGS National Water Information System (NWIS). Water-use data are published in the annual USGS water-data report.

Progress and Significant Results, Fiscal Years 1997 and 1998: A study was initiated to evaluate the potential impacts of water withdrawals on water levels within the Frenchman Flat and Mercury Valley areas. A report on well PM-2 data was published. Routine data collection, computation, and compilations continued and the data were published in the annual data reports. Alternate types of continuous water-level monitoring instrumentation for potential application in deep wells at the NTS were tested. Plans were initiated to develop a prototype system for calibrating flowmeters on the major supply wells for the NTS. Information on USGS/DOE collaborative studies in Nevada can be viewed on a newly developed home page <**http://nevada.usgs.gov/doe_nv/**>. A records and archiving program at the USGS Core Library at the NTS was established. A home page was developed to document hydrogeological data available at the USGS Core Library/Data Center <**http://nevada.usgs.gov/mercury/**>.



Hydrologic expertise and technical support were provided to the Hydrologic Resources Management Program at NTS.

Plans for Fiscal Year 1999: A report on Frenchman Flat and Mercury Valley will be approved and published. Water-level and water-use data for 1998 will be published in the annual data report. Archiving of geohydrologic data for the NTS will continue.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Russell, G.M., and Locke, G.L., 1997, Summary of data concerning radiological contamination at well PM-2, Nevada Test Site, Nye County, Nevada: U.S. Geological Survey Open-File Report 96-599, 84 p.

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.

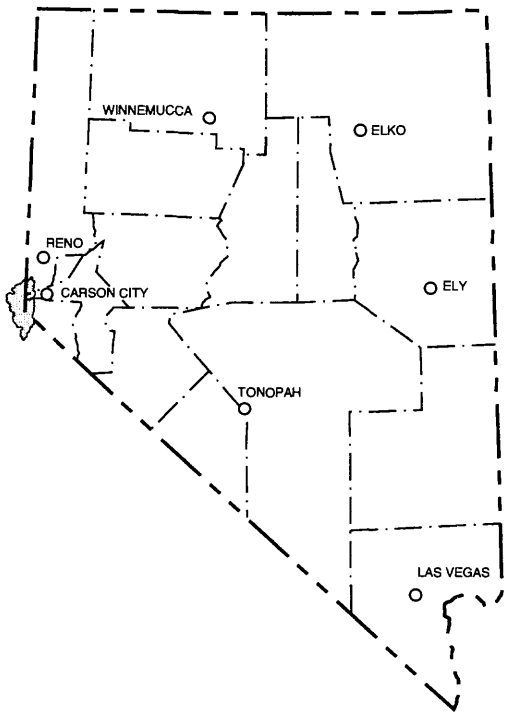
Cooperating Agency: Tahoe Regional Planning Agency.

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

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 surface-water 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. Nutrient analyses are done by the Tahoe Research Group, University of California at Davis, and suspended-sediment analyses are done by USGS.

Progress and Significant Results, Fiscal Years 1997 and 1998: 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 California and 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. Data were published in the annual data reports. Technical assistance was provided to Lake Tahoe Interagency Monitoring Program, Upper Truckee River-Trout Creek Focused Watershed Group, and other committees. Outreach activities were provided to Lake Tahoe Basin schools. Oral presentations were made at the USGS Tahoe Basin Workshop at Granlibakken, Calif.; and at the Lake Tahoe Presidential Summit Forest Health Workshop at Incline Village, Nev. A USGS Fact Sheet and an Open-File Map Report were published for the Lake Tahoe Presidential Summit. Information about ongoing activities at Lake Tahoe can be accessed at <**http://water.wr.usgs.gov/tahoe**>.



The ground-water/ surface-water study continued in the Upper Truckee River/Trout Creek Basins. A water-temperature network including 12 sites was added in the Upper Truckee River/Trout Creek Basin.

Plans for Fiscal Year 1999: 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 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Boughton, C.J., and Lico, M.S., 1998, Volatile organic compounds in Lake Tahoe, Nevada and California, July-September 1997: U.S. Geological Survey Fact Sheet FS-055-98, 2 p.

Boughton, C.J., Rowe, T.G., Allander, K.K., and Robledo, A.R., 1997, Stream and ground-water monitoring program, Lake Tahoe Basin, Nevada and California: U.S. Geological Survey Fact Sheet FS-100-97, 6 p.

Rowe, T.G., 1996, Nitrogen and sediment loadings and streamflow variation due to thunderstorm runoff into Lake Tahoe from Incline Creek Basin in Nevada, September 1994 [abs.], *in* Puckett, L.J., and Triska, F.J., eds., U.S. Geological Survey Nitrogen-Cycling

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———1998, Loads and yields of suspended sediment and nutrients for selected watersheds in the Lake Tahoe Basin, California and Nevada: National Water Quality Monitoring Council Conference, Reno, Nevada, July 1998, Proceedings, p. 111-525—111-535.

Rowe, T.G., Rockwell, G.L, and Hess, G.W., 1998, Flood of January 1997 in the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Fact Sheet FS-005-98, 2 p.

Rowe, T.G., and Stone, J.C., 1997, Selected hydrologic features of the Lake Tahoe Basin, California and Nevada: U.S. Geological Survey Open-File Report 97-384, 1 sheet.

Thodal, C.E., 1997, Hydrogeology of Lake Tahoe Basin, California and Nevada, and results of a ground-water quality monitoring network, water years 1990-92: U.S. Geological Survey Water-Resources Investigations Report 97-4072, 54 p.

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

Location: Churchill County, Nev.

Project Chief: Ray J. Hoffman.

Period of Project: Continuous since 1986.

Supporting Federal Agencies: Bureau of Reclamation, U.S. Department of the Interior National Irrigation Water-Quality Program and National Water-Quality Assessment Program.

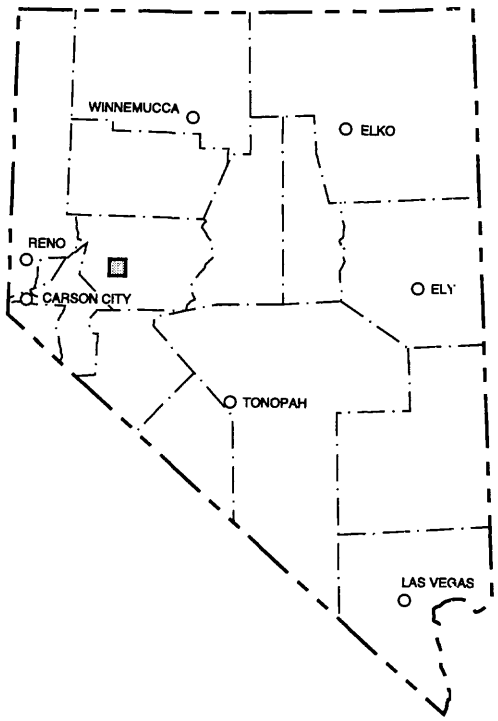
Problem: The Stillwater National Wildlife Refuge (SNWR) and nearby Carson Lake contain the largest marsh in Nevada, and are important sanctuaries for migratory and other waterfowl. The marsh is maintained mostly by irrigation-return flow drained from agricultural fields in the Fallon area. Elevated concentrations of potentially toxic trace elements have been found in the drain water, bottom sediment, and biota. 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 U.S. Department of the Interior as part of Phase 4 of the project. Phase 4 involves the planning for remediation.

Objectives: Technical expertise and support will be provided to the Bureau of Reclamation for possible remediation activity.

Approach: Year-round measurements of drainflow, specific conductance, and water temperature will be made at 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 1997 and 1998: Routine data-collection activities and monitoring were discontinued. Technical assistance and support materials were provided at meetings. Reports were prepared and published.

Plans for Fiscal Year 1999: Technical assistance and support materials will be provided at meetings. Report writing will continue.



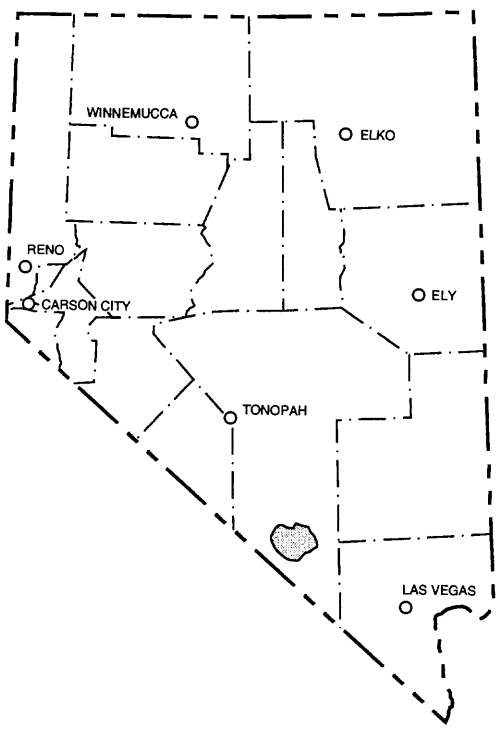
Publications, Fiscal Years 1997 and 1998:

Hoffman, R.J., and Taylor, R.L., 1998, Mercury and suspended sediment, Carson River Basin, Nevada--Loads to and from Lahontan Reservoir in flood year 1997 and deposition in reservoir prior to 1983: U.S. Geological Survey Fact Sheet FS-001-98, 6 p.

Seiler, R.L., and Tuttle, P.L., 1997, Field verification study of water quality, bottom sediment, and biota associated with irrigation drainage in and near Humboldt Wildlife Management Area, Churchill and Pershing Counties, Nevada, 1996: U.S. Geological Survey Open-File Report 97-586, 38 p.

Tuttle, P.L., and Thodal, C.E., 1998, Field screening of water quality, bottom sediment, and biota associated with irrigation in and near the Indian Lakes area, Stillwater Wildlife Management Area, Churchill County, west-central Nevada, 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4250, 57 p.

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



Location: Southern Nye County, Nev.

Project Chief: Daron J.Tanko, 1997-present.

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 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 1997 and 1998: A reduction in 1997 funds curtailed the network to two gages. With the high probability of El Nino, 1998 funds were increased to add four gages to the network for a total of six sites. Equipment at all sites was upgraded and three washes were added to the automated satellite network. Deactivated gages were removed from the field. Flooding during February 23-24, 1998, is being documented in a fact sheet. Streamflow data were published in the annual data reports. Information on USGS involvement at Yucca Mountain was developed for the internet at <**http://nevada.usgs.gov/doe_nv/ympexpl.htm**>.

Plans for Fiscal Year 1999: Routine data-collection activities and monitoring will continue. Streamflow and precipitation data will be published in the annual data report.

Publications, Fiscal Years 1997 and 1999:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

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

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

Project Chief: Richard J. La Camera.

Period of Project: Continuous since 1989.

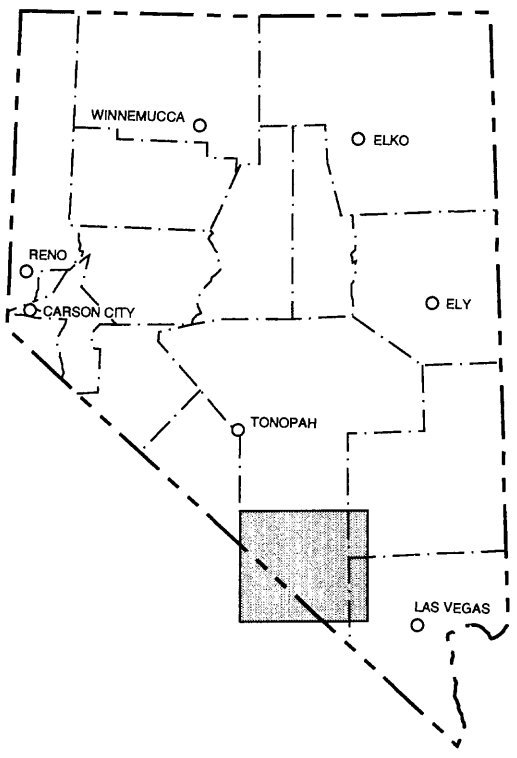
Supporting Federal Agency: U.S. Department of Energy.

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. Systematic monitoring of quantity and use of ground-water resources in the area would facilitate the identification of adverse effects. Available data are inadequate to satisfactorily provide early detection of adverse effects on ground-water resources and evaluate potential impacts.

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. Information on USGS involvement at Yucca Mountain was developed for the internet at **<http://nevada.usgs.gov/doe_nv/ympexpl.htm>**.

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 document changes in ground-water quantity in the region. Selected ground-water level and springflow data 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 from records maintained by other agencies, organizations, and programs to estimate annual withdrawals in the region. A data base will be created to document baseline and changing conditions and to evaluate potential effects of site investigations.

Progress and Significant Results, Fiscal Years 1997 and 1998: Routine data-collection activities and monitoring continued. Data were published in annual data reports. Electric tapes and pressure-sensor systems were calibrated. U.S. Department of Energy (USDOE) was provided with quarterly reports of data collected and compiled at monitoring sites. Monitoring data were evaluated and alternate monitoring scenarios were proposed to USDOE for water-appropriation applications and hearings. Project staff participated in workshops related to water resources in the Yucca Mountain Region and Death Valley National Park. Report writing continued.



Plans for Fiscal Year 1999: Data-collection and 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. Project staff will advise and assist USDOE on water-quality, data-collection programs and implementation. Monitoring data will continue to be evaluated and alternate monitoring scenarios will be proposed to USDOE for water-appropriation applications and hearings.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

La Camera, R.J., and Locke, G.L., 1998, Selected ground-water data for Yucca Mountain region, southern Nevada and eastern California, through December 1996: U.S. Geological Survey Open-File Report 97-821, 79 p.

La Camera, R.J., Westenburg, C.L., and Locke, G.L., 1996, Selected ground-water data for Yucca Mountain region, southern Nevada and eastern California, through December 1995: U.S. Geological Survey Open-File Report 96-553, 75 p.

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

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

Project Chief: Hugh E. Bevans.

Period of Project: Continuous since 1990.

Cooperating Agencies and Supporting USGS Program: U.S. Department of the Interior National Irrigation Water-Quality Program, National Park Service, and National Water-Quality Assessment Program

Problem: Consistent and continuing information about the quality of ground- and surface-water resources will give water-resource managers and the public 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 about 60 NAWQA study units distributed throughout the Nation that are being 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 is 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 are compiled. Reports are planned that summarize and interpret available information on pesticides, nutrients, and suspended sediment. An intensive data-collection and analysis phase has been 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, activities include report writing and low-level monitoring. 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 1997 and 1998: Low-level, surface-water and aquatic-ecology monitoring networks were designed and implemented. Data were published in the annual data report. Numerous reports were submitted for approval and publication. Presentations were given at meetings and conferences. Information on the NAWQA program was developed for the internet at <**http://nevada.usgs.gov/nawqa/**>.

Plans for Fiscal Year 1999: Continue low-level, surface-water and aquatic-ecology monitoring network. Remaining reports will be submitted for approval and publication. Supplemental data will be documented and archived. New related cooperative investigations will be developed.

Publications, Fiscal Years 1997 and 1998:

Adams, P.A., Moses, C.W., and Bevans, H.E., 1997, Monitoring for pesticides in ground water in Nevada: U.S. Geological Survey Fact Sheet FS-139-97, 2 p.

Bevans, H.E., Goodbred, S.L., and Miesner, J.F., 1997, Synthetic organic compounds and endocrine disruption in Lake Mead: 214th American Chemical Society National Meeting, Las Vegas, Nevada, September 7-11, 1997, Book of Abstracts, pt. 1, ENVR 088.

Bevans, H.E., Goodbred, S.L., and Miesner, J.F., 1997, Synthetic organic compounds and carp endocrinology and histology, Las Vegas Wash and Las Vegas and Callville Bays of Lake Mead, Nevada, 1992 and 1995: Proceedings, Fifth National Watershed Conference, May 18-21, 1997, Reno, Nevada, p. 573-579.

Bevans, H.E., Lico, M.S., and Lawrence, S.J., 1998, Water quality in the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California, 1992-96: U.S. Geological Survey Circular 1170, 47 p.

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Covay, K.J., and Bevans, H.E., 1997, Data on ground-water quality, Reno-Sparks area, Nevada, 1994 and 1995: U.S. Geological Survey Open-File Report 97-222, 1 sheet.

Kilroy, K.C., Lawrence, S.J., Lico, M.S., Bevans, H.E., and Watkins, S.A., 1997, Water-quality assessment of the Las Vegas Valley area and the Carson and Truckee River Basins, Nevada and California—Nutrients, pesticides, and suspended sediment, October 1969-April 1990: U.S. Geological Survey Water-Resources Investigations Report 97-4106, 144 p.

Kilroy, K.C., and Watkins, S.A., 1997, Pesticides in surface water, bottom sediment, crayfish, and shallow ground water in Las Vegas Valley area, Carson River Basin and Truckee River Basin, Nevada and California, 1992-95: U.S. Geological Survey Fact Sheet FS-075-97, 6 p.

Lawrence, S.J., 1998, Trace-element enrichment in streambed sediment and crayfish, Carson and Truckee Rivers, Nevada and California, September 1992: U.S. Geological Survey Water-Resources Investigations Report 97-4258, 16 p.

———1998, Trace elements in bed sediment and crayfish tissue in the Truckee River and Carson River Basins, and Las Vegas Valley area, Nevada, September, 1992: Fifth National Watershed Conference, May 18-21, 1997, Reno, Nevada, Proceedings, p. 565-572.

Lawrence, S.J., and Pennington, R.N., 1998, Physical and geomorphological measurements at selected segments in the Carson and Truckee River Basins, Nevada and California, 1993-96: U.S. Geological Survey Open-File Report 97-764, 135 p.

Leiker, T.J., Bevans, H.E., and Goodbred, S.L., 1997, Halogenated organic compounds in endocrine-disrupted male carp from tributaries of Lake Mead, Nevada [abs.]: 18th Annual Meeting, Society of Environmental Toxicology and Chemistry, San Francisco, November 1997, Abstract Book, p. 266.

Lico, M.S., 1998, Quality of ground water beneath urban and agricultural lands in Las Vegas Valley and the Carson and Truckee River Basins—Implications for water supply: U.S. Geological Survey Water-Resources Investigations Report 97-4259, 24 p.

Lico, M.S., and Pennington, R.N., 1997, Concentrations, loads, and yields of potentially toxic constituents in irrigation-drain systems, Newlands Project Area, Carson Desert, Nevada, for November 1994-October 1995: U.S. Geological Survey Water-Resources Investigations Report 97-4034, 58 p.

Welch, A.H., Lawrence, S.J., Lico, M.S., Thomas, J.M., and Schaefer, D.H., 1997, Ground-water quality assessment of the Carson River Basin, Nevada and California—Results of investigations,1987-91: U.S. Geological Survey Water-Supply Paper 2356-A, 93 p.

Welch, A.H., and Lico, M.S., 1997, Factors controlling arsenic and uranium in shallow ground water, southern Carson Desert, Nevada [abs.]: Seventh Annual V.M. Goldschmidt Conference, Tucson, Arizona, Lunar and Planetary Institute, Contribution 921, p. 216-217.

———1998, Factors controlling arsenic and uranium in shallow ground water, southern Carson Desert, Nevada: Applied Geochemistry, v. 13, no. 4, p. 521-539.

Subsidence Modeling in Las Vegas Valley
(Project 169)

Location: Las Vegas Valley, Nev.

Project Chief: Michael T. Pavelko, 1996-present.

Period of Project: 1990-99.

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

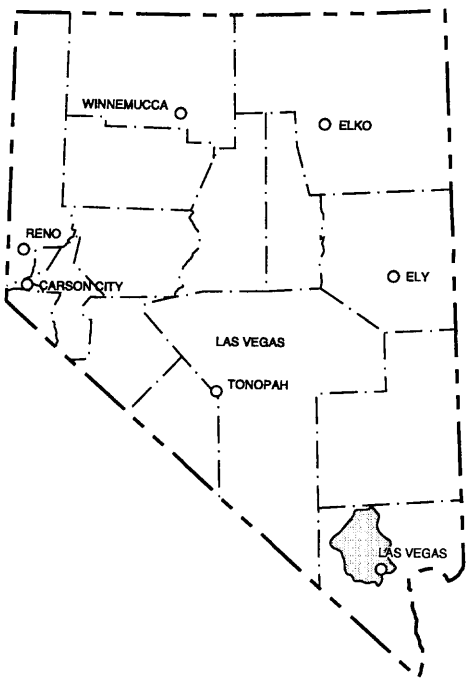
Problem: Land subsidence due to ground-water withdrawal is an ongoing problem in many urban and agricultural areas. Land subsidence and associated earth fissures can result in millions of dollars of damage to engineered structures. Studies have shown that a significant part of the volume of water pumped from many aquifer systems originates from the compaction of fine-grained sediments. Mechanical and hydraulic properties associated with the sediments are difficult to measure.

Objectives: Develop a one-dimensional compaction model of an existing extensometer site in Las Vegas Valley. The model will be used to better develop a better understanding of aquifer-system mechanics with regard to land subsidence, particularly the difficult-to-measure properties of fine-grained units. Produce high resolution, time-series maps of valley-wide land subsidence.

Approach: Collect and analyze land subsidence and sediment compaction data, including extensometer and water-level data. Data analyses will provide good first estimates of aquifer-system properties to be used as input parameters for the one-dimensional compaction model. The model will be calibrated and parameters refined using trial and error and inverse modeling techniques.

Progress and Significant Results, Fiscal Years 1997 and 1998: Data collection continued. Work began on the one-dimensional compaction model. SAR data were obtained and surface displacement maps were produced.

Plans For Fiscal Year 1999: Efforts to calibrate the one-dimensional compaction model will continue. SAR data will continue to be obtained, processed, and analyzed.



Environmental Restoration at Nevada Test Site *(Project 170)*

Location: Southern Nye County, Nev.

Project Chief: Randell J. Laczniak.

Period of Project: Continuous since 1991.

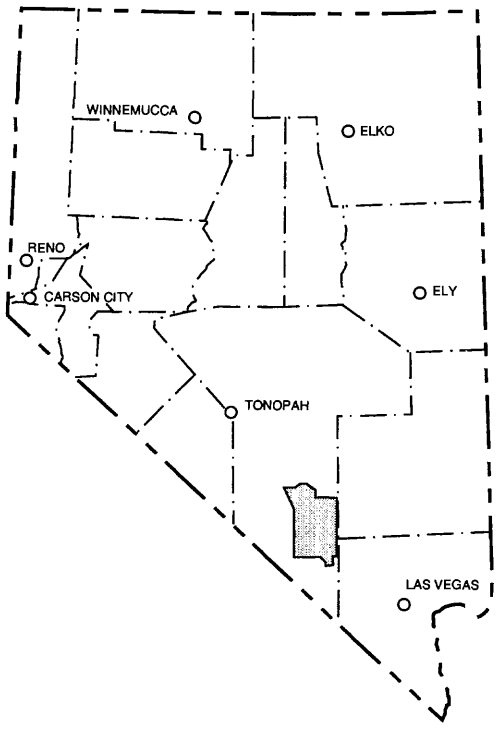
Supporting Federal Agency: U.S. Department of Energy.

Problem: Underground testing of nuclear weapons at the Nevada Test Site (NTS) has created potential environmental hazards. U.S. Department of Energy (USDOE) is concerned about these hazards and is committed to comply with existing environmental laws and regulations. USDOE manages 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 from 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 onsite and offsite monitoring locations. Studies to refine ground-water discharge estimates from the major subbasins beneath NTS have been initiated. Participation on other hydrologic studies will be provided in response to USDOE requests.

Progress and Significant Results, Fiscal Years 1997 and 1998: Hydrologic expertise and technical support were provided to USDOE. Water-level networks were maintained onsite and offsite. Hydrologic data collected through program activities were provided quarterly and published in the annual data reports. The discharge study at Ash Meadows was phased down to one evapotranspiration site, and the study in Oasis Valley (including geochemistry and drilling) was initiated. Hydrologic data were provided through quarterly letters and the internet at <**http://nevada.usgs.gov/doe_nv/erp.htm**>. Report writing continued. Equipment to fractionate dissolved organic carbon from ground water was constructed and tested. Thirteen monitoring holes were drilled to characterize the geohydrology of the Oasis Valley area. Studies analyzing the changes in water levels in the Frenchman Flat and Pahute Mesa areas were initiated.



Plans for Fiscal Year 1999: Hydrologic support will continue to be provided to USDOE. Onsite and offsite water-level networks will be maintained. Reports will be published. Hydrologic data will be provided through the internet and published in the annual data report. Studies analyzing the changes in water levels in the Frenchman Flat and Pahute Mesa areas will continue. The discharge study and geochemical investigation of Oasis Valley will continue.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Nichols, W.D., Laczniak, R.J., De Meo, G.A., and Rapp, T.R., 1997, Estimated ground-water discharge by evapotranspiration, Ash Meadows National Wildlife Refuge, Nye County, Nevada, 1994: U.S. Geological Survey Water-Resources Investigations Report 97-4025, 13 p.

Trudeau, D.A., and Rowley, P.D., 1998, Hydrogeologic investigations to characterize ground-water flow paths locally contaminated by underground nuclear tests, Nevada Test Site [abs.]: Joint Conference, International Association of Hydrogeologists and American Institute of Hydrogeologists and American Institute of Hydrology, Las Vegas, September-October 1998, Proceedings, p. 61.

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

Location: Truckee River and Carson River Basins, Nev. and Calif.

Project Chief: Larry R. Bohman.

Period of Project: Continuous since 1991.

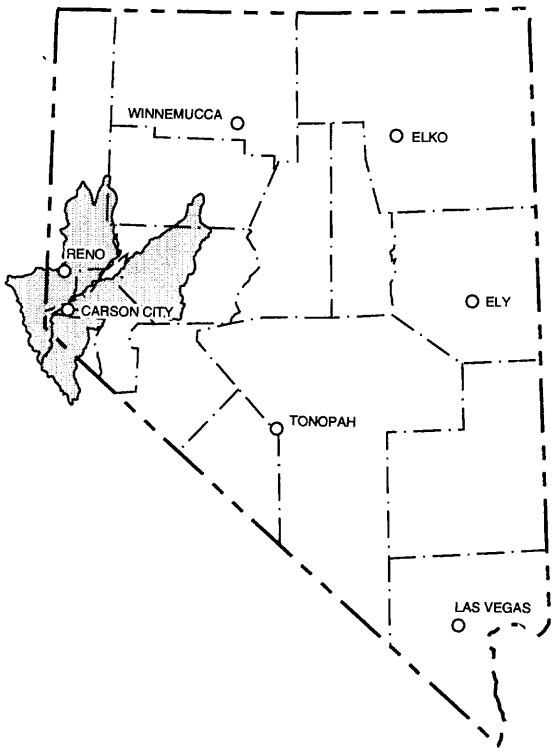
Supporting USGS Program: Truckee-Carson Program.

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 U.S. 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 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 U.S. Department of the Interior as required under legislative mandates.

Approach: Existing networks and data of the U.S. 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 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 U.S. Department of the Interior for implementation of Public Law 101-618 is being provided. Staff will participate in technical workgroups and committees.

Progress and Significant Results, Fiscal Years 1997 and 1998: Data-collection activities for streamflow, stream temperature, and conductivity continued. Data for water years 1996 and 1997 were published in the annual data report. Documentation for models simulating hourly stream temperature and dissolved solids was published. Two fact sheets were published on Carson River diversion operations and the January 1997 flood. Precipitation-runoff models for gaged basins in the Lake Tahoe and Truckee River Basins were calibrated and verified. Similar models simulating runoff in the



remaining ungaged parts of both basins were constructed by transferring the runoff-producing parameters using geographic-information-systems techniques. A synthetic-historical data set (1930-96) was built that contains the meteorological data needed for input into the precipitation-runoff models. A report describing models simulating river diversion operations in the Carson River Basin was begun. Models simulating existing river/reservoir operations and operations proposed under the new Truckee River Operating Agreement were coded using information or agreements available in about June 1997. Two special requests by the U.S. Department of the Interior to simulate alternatives to the existing regulations governing diversions to the Truckee Canal were accommodated successfully. Other technical and hydrologic support to the U.S. Department of the Interior was provided. Information on the Truckee-Carson program was developed for the internet at **<http://nevada.usgs.gov/tcp/>**.

Plans for Fiscal Year 1999: Data-collection activities will be discontinued. Data from 1998 will be published in the annual data report. Technical and hydrologic support to the U.S. Department of the Interior will be provided. Documentation of the components for the Truckee-Carson Program modeling system will continue with the publication of precipitation-runoff models of the Lake Tahoe and Truckee River Basin upstream from the California-Nevada State line. Documentation of the Carson River operations model will be published. Continual updates to the operations model for the Truckee River Basin will be necessary as new agreements

are reached for the proposed operating agreement. Quality assurance and testing of all operations models will continue. Impromptu model runs will be made as specified by the U.S. Department of the Interior to informally simulate policies under assessment or negotiation. A draft of the operations model for the Truckee River will be written. Improvements to the user interface will be made to facilitate the use of the modeling system by Federal, State, and local water managers.

Publications, Fiscal Years 1997 and 1998:

Berris, S.N., Hess, G.W., Taylor, R.L., and Bohman, L.R., 1997, Flood-control effects of Truckee River Basin reservoirs, December 31, 1996, through January 4, 1997, California and Nevada: U.S. Geological Survey Fact Sheet FS-037-97, 4 p.

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Hess, G.W., 1997, Simulation of selected river diversion operations in the upper Carson River Basin, California and Nevada: U.S. Geological Survey Fact Sheet FS-240-96, 4 p.

———1997, Simulation of selected river diversion operation in the upper Carson River Basin, California and Nevada [abs.]: Annual Conference, Nevada Water Resources Association, Elko, Abstracts of Technical Papers and Posters, p. 24.

Taylor, R.L., 1998, Simulation of hourly stream temperature and daily dissolved solids for the Truckee River, California and Nevada: U.S. Geological Survey Water-Resources Investigations Report 98-4064, 76 p.

Data Synthesis of Irrigation Drainage Program
(Project 176)

Location: Western United States.

Project Chief: Ralph L. Seiler.

Period of Project: 1992-99.

Supporting USGS Program: U.S. Department of the 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. 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. 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 and sediment data from USGS and biologic data from USFWS. A study team including three scientists from USGS and one scientist from USFWS was formed. The team members work independently in their areas of expertise and will collaborate for the summary report.

Progress and Significant Results, Fiscal Years 1997 and 1998: Data analysis was completed and reports were submitted for review and approval. The biological part of the data base was completed by U.S. Fish and Wildlife Service. Presentations were given at the Society of Environmental Toxicology and Chemistry meeting in San Francisco, Calif., and the Nevada State GIS Conference in Reno, Nev.

Plans for Fiscal Year 1999: Reports will be completed and published.

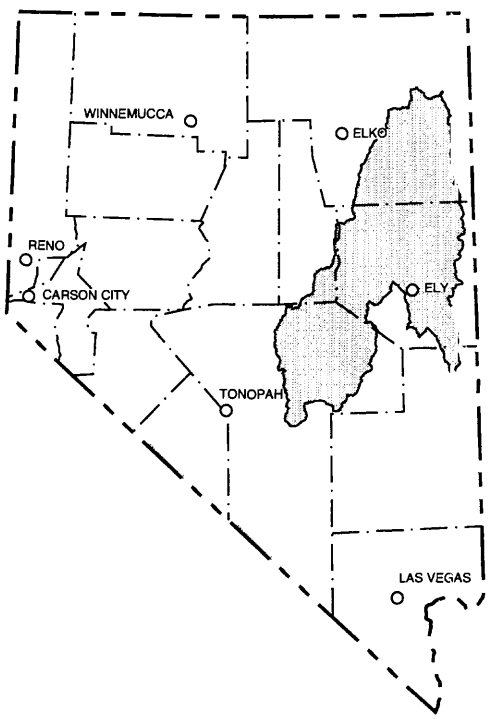
Publications, Fiscal Years 1997 and 1998:

Seiler, R.L., 1997, Geology, climate, and hydrology as predictors of ecotoxicological effects from selenium in irrigation drainage [abs.]: 18th Annual Meeting, Society of Environmental Toxicology and Chemistry, San Francisco, Calif., November 1997, Abstract book, p. 15.

———1997, Methods to identify areas susceptible to irrigation-induced selenium contamination in the western United States: U.S. Geological Survey Fact Sheet 97-038-97, 4 p.

Seiler, R.L., and Peltz-Lewis, L.A., 1997, Use of GIS to identify areas susceptible to irrigation-induced selenium contamination [abs.]: Seventh Annual Nevada State GIS Conference, Reno, January 1997, Final Program, p. 42.

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



Location: Central Nevada.

Project Chief: William D. Nichols.

Period of Project: 1993-99.

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 1997 and 1998: Data compilation and analysis were completed. Reports were reviewed.

Plans for Fiscal Year 1999: The reports will be completed and published.

Publications, Fiscal Years 1997 and 1998:

Nichols, W.D., Laczniak, R.J., De Meo, G.A., and Rapp, T.R., 1997, Estimated ground-water discharge by evapotranspiration, Ash Meadows National Wildlife Refuge, Nye County, Nevada, 1994: U.S. Geological Survey Water-Resources Investigations Report 97-4025, 13 p.

Intermittent Recharge in Eagle Valley
(Project 185)

Location: Eagle Valley, Nev.

Project Chief: Douglas K. Maurer, 1996-present.

Period of Project: 1994-99.

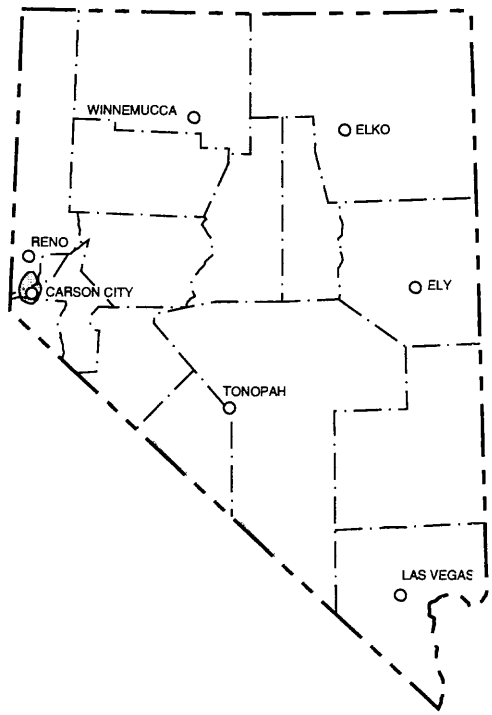
Cooperating Agency: Carson City Utilities Department and Washoe Tribe of California and Nevada.

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. Underflow from all watersheds tributary to Eagle Valley and recharge from streamflow, precipitation, and irrigation on the valley floor, will be estimated in a second phase of study.

Progress and Significant Results, Fiscal Years 1997 and 1998: Subsurface flow beneath all watersheds tributary to Eagle Valley were estimated and summarized in a report. Recharge from streams that cross the valley floor, from direct precipitation on the valley floor, and from irrigated fields and lawns was estimated. A precipitation network continued through 1998, as well as seepage measurements along Clear, Kings Canyon, and Ash Canyon Creeks, and soil moisture measurements at several points on the valley floor.



Recharge from stream losses and direct precipitation on the valley floor are significant. A report was published and report writing continued.

Plans for Fiscal Year 1999: The final report will be published.

Publications, Fiscal Years 1997 and 1998:

Maurer, D.K., and Berger, D.L., 1997, Subsurface flow and water yield from watersheds tributary to Eagle Valley Hydrographic Area, west-central Nevada: U.S. Geological Survey Water-Resources Investigations Report 97-4191, 56 p.

Ronan, A.D., Prudic, D.E., Thodal, C.E., and Constantz, Jim, 1998, Field study and simulation of diurnal temperature effects on infiltration and variably saturated flow beneath an ephemeral stream: Water Resources Research, v. 34, no. 9, p. 2137-2153.

Ground-Water Budget for Dayton Valley
(Project 188)

Location: West-central Nevada.

Project Chief: Douglas K. Maurer.

Period of Project: Continuous since 1994.

Cooperating Agency: Carson Water Subconservancy District.

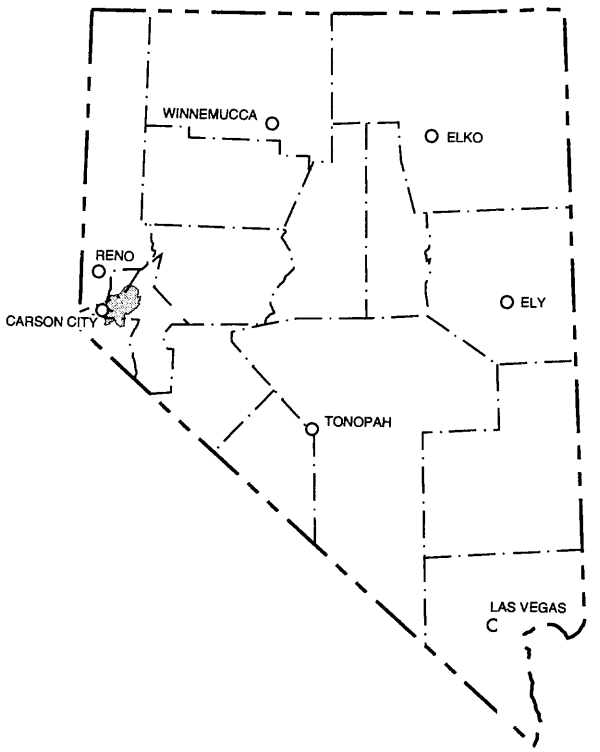
Problem: Population in the Dayton Valley Hydrographic Area in eastern Carson City and western Lyon Counties is increasing rapidly. Ground-water withdrawals to provide water for the growing population also have increased rapidly in recent years. Water in the Carson River, which flows through the area, is fully allocated. An increasing demand for water in downstream areas has caused concern for downstream users because development in Dayton Valley could affect the volume of streamflow in the river. Estimates of agricultural pumpage in the initial phase of this study were based on estimates compiled by the Nevada Division of Water Resources. The estimates used water-righted acreage in the valley, multiplied by an assumed water-use rate, and divided based on the assumption that pumps were used, on the average, for half of the irrigation season during average to dry years. A more detailed investigation of agricultural pumpage would allow refinement of the estimate for this water-budget component. A better estimate would improve the understanding of hydrologic processes in the area and facilitate the management of the water resources.

Objective: A preliminary water budget for the Dayton Valley Hydrographic Area will be developed. Estimates of agricultural pumpage in the Carson Plains subbasin will be refined. 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. A complete inventory of agricultural wells will be made and pump efficiency tests will be made to determine pumpage from historical kilowatt-hour data.

Progress and Significant Results, Fiscal Years 1997 and 1998: The initial report was published and data-collection activities continued. High-altitude precipitation gages were installed and a water-level measurement network was developed and is being measured quarterly.

Plans for Fiscal Year 1999: Data-collection activities will continue.



Publications, Fiscal Years 1997 and 1998:

Maurer, D.K., 1997, Hydrology and ground-water budgets of the Dayton Valley Hydrographic Area, west-central Nevada: U.S. Geological Survey Water-Resources Investigations Report 97-4123, 89 p.

Assessment of Middle Humboldt River Basin
(Project 190)

Location: North-central Nevada.

Project Chief: William D. Nichols, 1996-1997; Hugh E. Bevans, 1997-present.

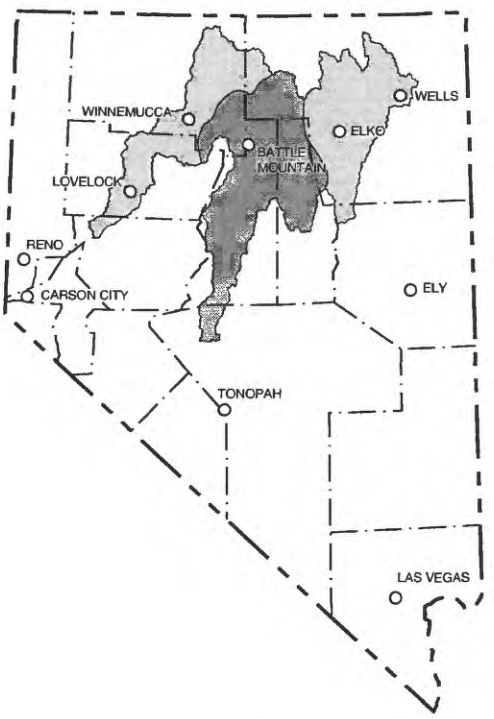
Period of Project: 1996-2002.

Cooperating and Supporting Federal Agencies: Bureau of Land Management and Nevada Department of Conservation and Natural Resources.

Problem: Nevada is experiencing a gold-mining boom, with most of the activity 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 Middle Humboldt River Basin and their contribution to the quantity and timing of flows in the mainstem Humboldt River will be made. This effort will include both monitoring and studies to support analyses of the likely cumulative effects of all major water uses in the basin. 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, including the development of a linked ground-water/streamflow mode, will be made to support the scientific appraisal.

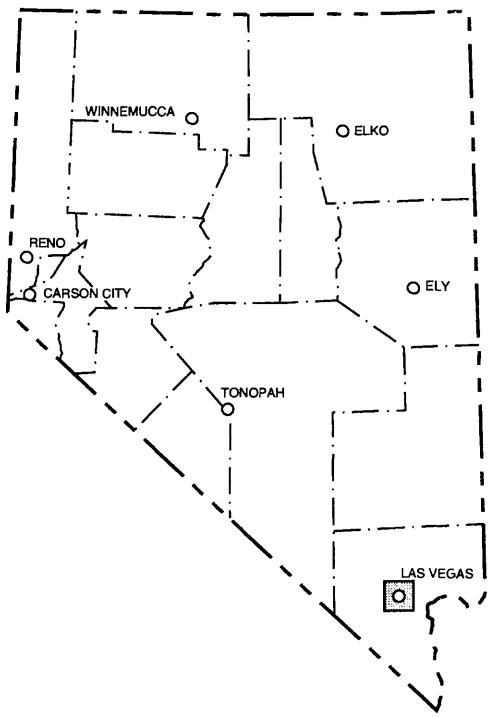
Approach: An information system to effectively manage water-resources data of the Middle Humboldt River Basin will be compiled and maintained, and will be accessible by the public. Steady-state water budgets will be developed for each hydrographic subbasin of the Middle Humboldt River Basin. The geohydrologic framework of the area will be defined using available and new data. Ground-water withdrawals will be quantified. All of these data and information will be used to develop a linked ground-water/streamflow model for predicting effects of water use and natural factors on ground water and streamflow.



Progress and Significant Results, Fiscal Years 1997 and 1998: Reports on the hydrogeologic framework and improved methods for estimating water budgets were prepared for review. A project to quantify agricultural water use was started. An internet web site was created to facilitate access to hydrologic data and other information, at **<http://nevada.usgs.gov/humb/>**.

Plans for Fiscal Year 1999: Reports on the hydrogeologic framework and estimating water budgets will be submitted for approval. Two reports on water use will be written and submitted for approval. Work on the linked ground-water/streamflow model will begin. Technical assistance and support materials will be provided at meetings.

Las Vegas Trihalomethanes and Haloacetic Acids *(Project 191)*



Location: Southern Nevada.

Project Chief: James M. Thomas.

Period of Project: 1995-98.

Cooperating Agency: Southern Nevada Water Authority.

Problem: Chlorination disinfection by-products in aquifer 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 micrograms per liter of trihalomethanes (THM's) and 15 micrograms per liter of haloacetic acids (HAA's). The artificial recharge water also has about 1 milligram per liter of free chlorine residual and 2.7 milligrams per liter of total organic carbon. Initial recovered water has concentrations of THM's and HAA's of about 85 and 20 micrograms per liter, respectively. With further pumping, the concentrations decrease to values that are lower than those of the artificial recharge. Because THM's and HAA's are potentially carconogenic and mutagenic, the change in concentrations of THM's and HAA's during storage and recovery deserves evaluation.

Objective: The reduction in THM and HAA concentrations during recovery of artificially recharged water in Las Vegas Valley will be studied to determine whether it is because of biodegradation within the aquifer, or dilution with ground water, or a combination of the two processes. If THM's and HAA's are shown to be biodegraded by the natural microbial community within the ASR aquifer under certain conditions, the rates at which they degrade will be determined.

Approach: Data will be collected and analyzed for several experiments on THM's and HAA's.

Progress and Significant Results, Fiscal Years 1997 and 1998: Drilling, coring, laboratory studies of biodegradation of THM's and HAA's, geochemical modeling, and model-predicted THM'S and HAA's as compared to measured values during several ASR seasons have all been completed. Two journal articles are being prepared for approval and publication.

Plans for Fiscal Year 1999: The two articles will be completed and submitted to journal editors.

Northern Valley Nitrates *(Project 192)*

Location: Northern Nevada.

Project Chief: Ralph L. Seiler.

Period of Project: 1996-99.

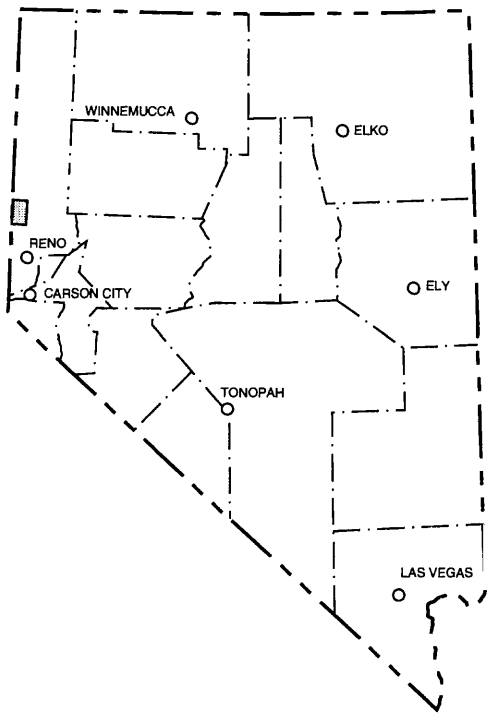
Cooperating Agencies: Washoe County and University of Nevada, Reno, Agricultural Experiment Station.

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, Golden, and Spanish Spring Valleys northwest of Reno have nitrate concentrations that exceed the drinking-water standard. The source(s) of high nitrate concentrations need to be identified. In areas where several potential sources of nitrate are present, a scientific method is needed to identify the major source and 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 has been developed. The potential of using the analytic compilation to make a chemical fingerprint for nitrate contributed to ground water by septic systems is being evaluated.

Approach: The investigation is being done in three phases. The first phase involved developing a compilation of water-quality properties and constituents that could serve to identify sources of nitrogen contamination in ground water. The second phase involved evaluating the compilation by collecting samples from areas where septic systems are known contaminant sources and identifying a unique chemical fingerprint for the nitrate source. The third phase involves testing the fingerprint by collecting samples from nitrogen-contaminated wells in Spanish Springs Valley.

Progress and Significant Results, Fiscal Year 1997 and 1998: Ground-water samples were collected from monitoring, domestic, and municipal wells in Lemmon, Golden, and Spanish Springs Valleys. Samples also were collected from monitoring wells in fields at the University of Nevada, Reno, Agricultural Experiment Station, where treated effluent is used to irrigate alfalfa. Samples of water-reclamation-plant effluent were analyzed and the results compared with ground water from the alfalfa fields and from contaminated areas in Lemmon and Golden Valleys.



Plans for Fiscal Year 1999: The data will be interpreted and a report will be published.

Publications, Fiscal Years 1997 and 1998:

Seiler, R.L., Zaugg, S.D., Thomas, J.M., and Howcroft, D.L., in press, Caffeine and pharmaceuticals as indicators of waste water contamination in wells: Ground Water, v. 37, no 3, p. 405-410.

Douglas County Nitrates *(Project 193)*

Location: Douglas County, Nev.

Project Chief: James M. Thomas.

Period of Project: 1996-98.

Cooperating Agency: Douglas County.

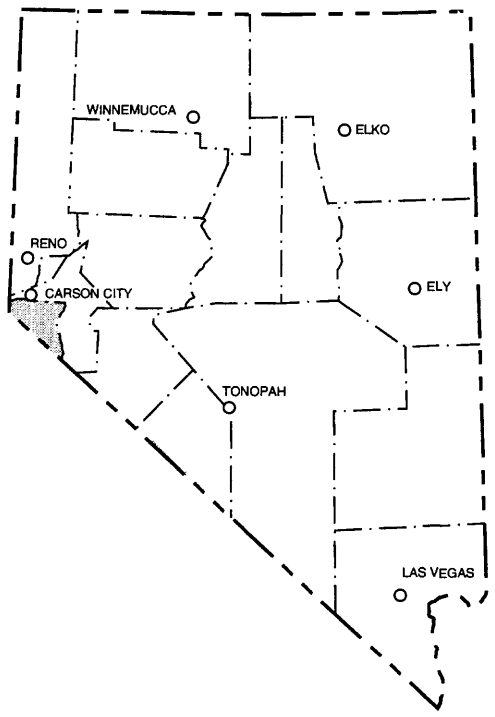
Problem: Water from a supply well in the Indian Hills area of Carson Valley in Douglas County contains dissolved nitrate at a concentration that exceeds the drinking-water standard. Douglas County, the supplier of water to homes in the area, is concerned about the source(s) of the high nitrate concentration. 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 sewering the Indian Hills area is undertaken, the source(s) of nitrate in ground water in 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, and to identify nitrate contributed to ground water from different sources.

Approach: Sources of nitrate in ground water in the Indian Hills area will be identified using several methods. These methods include the use of major ions, trace elements, nutrients, anthropogenic (synthetic) compounds, and stable isotopes of nitrate and water to identify nitrate sources. Major-ion, trace-element, and nutrient concentrations have traditionally been used to identify nitrate sources in ground water. The presence of anthropogenic compounds, such as methyl-blue active substances (MBAS) and caffeine, in ground water provides a positive indication that sewage effluent is the source of at least some of the nitrate. Additionally, high concentrations of anthropogenic chlorofluorocarbons (CFC's) are associated with sewage effluent. Nitrogen-15 and oxygen-18 isotopes of nitrate have been used to distinguish sources of nitrate dissolved in ground water. Deuterium and oxygen-18 concentrations in sewage effluent also can be different from that of the local ground, sometimes providing another indicator of sewage effluent in ground water.

Progress and Significant Results, Fiscal Years 1997 and 1998: Data was analyzed and published in the annual water-data reports. A report was written.

Plans for Fiscal Year 1999: The report will be published.



Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Bostic, R.E., Kane, R.L., Kipfer, K.M., and Johnson, A.W., 1997, Water resources data, Nevada, water year 1996: U.S. Geological Survey Water-Data Report NV-96-1, 611 p.

Fallon Basalt *(Project 194)*

Location: Churchill County, Nev.

Project Chief: Douglas K. Maurer.

Period of Project: Continuous since 1996.

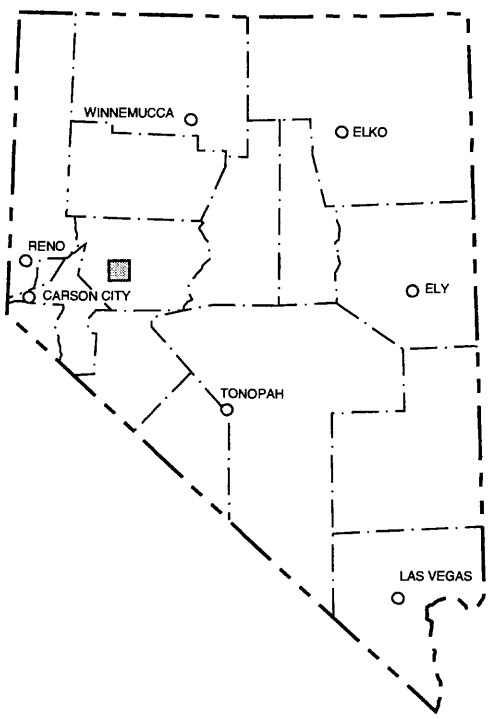
Cooperating and Supporting Federal Agencies: Bureau of Reclamation and Nevada Division of Water Resources.

Problem: The basalt aquifer beneath Fallon, Nev., is the principal source of water for the Fallon Naval Air Station, the City of Fallon, the Fallon Paiute-Shoshone Tribe, and Kennemetals, Inc. Concerns have been raised about the relation between increased pumping from the basalt aquifer and water-level declines and the increasing concentrations of chloride and other solutes. Possible effects of lowered water levels in the overlying shallow aquifers also have raised concerns. These concerns are for the future quality and quantity of water pumped from the basalt aquifer. Also, possible changing patterns of nearby irrigation could adversely affect the quantity and quality of water in the aquifer. A study would determine where water enters the aquifer, to assess the viability of the aquifer as a long-term water supply, and would identify the potential for deterioration of water quality in the aquifer.

Objective: The quantity and locations of water recharging the basalt aquifer will be evaluated. The quality of water within the basalt aquifer in basin-fill aquifers surrounding the basalt, and of water entering the basalt aquifer, will be assessed. The long-term rate of ground-water withdrawal from the basalt aquifer that would maintain the present water quality, and acceptable pumping levels at wells under current hydrologic conditions, will be quantified. Additionally, the effect of increased pumping and reduced water deliveries in the vicinity of the basalt aquifer will be estimated. The feasibility of injecting surface water in the basalt to reduce the rate of water-level decline and water-quality degradation will be determined.

Approach: The work will be divided into two phases: Phase I will consist of a study to compile existing data, make preliminary surface geophysical measurements, collect water-quality samples, install shallow and deep monitoring wells, and monitor surface- and ground-water levels and surface-water flow. Phase II will consist of detailed surface-geophysical data collection and interpretation, installation of additional deep monitoring wells, water-quality sampling, and development of numerical ground-water flow and geochemical models.

Progress and Significant Results, Fiscal Years 1997 and 1998: Marine seismic-reflection geophysical measurements were made along S-Line Canal to determine lithology near basalt outcropping at Rattlesnake Hill. The soft bottom of the shallow canal did not allow adequate data to be collected.



Five monitoring wells were installed near Rattlesnake Hill adjacent to surface-water bodies that could supply recharge to the basalt. Water-quality samples were taken and results are being analyzed. Five monitoring wells of intermediate depth (400 to 640 feet) were installed to determine water quality in sedimentary aquifers near the deeper parts of the basalt aquifer. A water-level measurement network was established and measured bi-weekly to determine water-level fluctuations in and near the basalt. Measurements confirm water-level declines of 7-10 feet throughout the basalt aquifer since the mid-1970's.

Plans for Fiscal Year 1999: A deep monitoring well will be installed to a depth of greater than 1,000 feet in the basalt aquifer and water samples will be obtained from greater depths in the basalt than any previously obtained. All existing data will be analyzed and a report summarizing hydrogeology and geochemistry in and near the basalt aquifer will be written.

Evaporation Rates for Lake Mead *(Project 195)*

Location: Southern Nevada and northwestern Arizona.

Project Chief: Craig L. Westenburg.

Period of Project: 1996-2000.

Supporting Federal Agencies: Bureau of Reclamation and U.S. Department of the Interior.

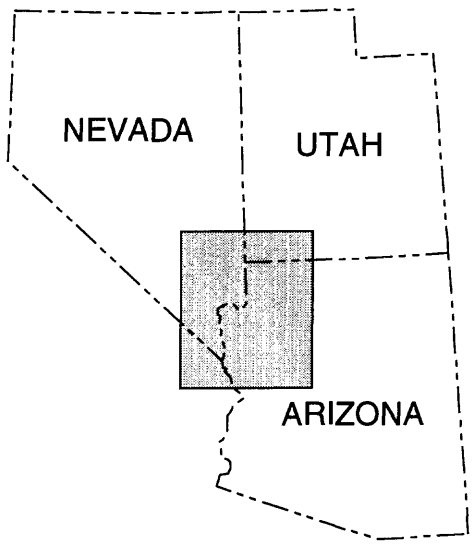
Problem: Evaporation from Lake Mead in Nevada and Arizona represents approximately 10 percent of the consumptive water use from the Lower Colorado River Basin. Because evaporation makes up a significant part of water lost from the river system each year, accurate estimates of evaporation from Lake Mead 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 at McCarran International Airport in Las Vegas. When the equation was developed in the 1950's, air temperature and relative humidity at Las Vegas were considered representative of conditions upwind from Lake Mead. Since the 1950's, the population of the Las Vegas area has grown from about 50,000 to more than 1 million. Local climatic changes associated with rapid urbanization may affect the conditions that previously allowed 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 the 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 differ among stations at different locations on and around the lake. If the 1950's equation is found to be inadequate for use with current conditions, a new one will be developed.

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

Progress and Significant Results, Fiscal Years 1997 and 1998: Data were analyzed and published in the 1997 annual data report.



Plans for Fiscal Year 1999: Data for 1998-99 will be analyzed and published in the annual data reports. Work will begin on a final data report and an interpretive report.

Publications, Fiscal Years 1997 and 1998:

Bonner, L.J., Elliott, P.E., Etcheinendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Newlands Aquifers *(Project 196)*

Location: Southern Carson Desert, Nev.

Project Chief: Ralph L. Seiler.

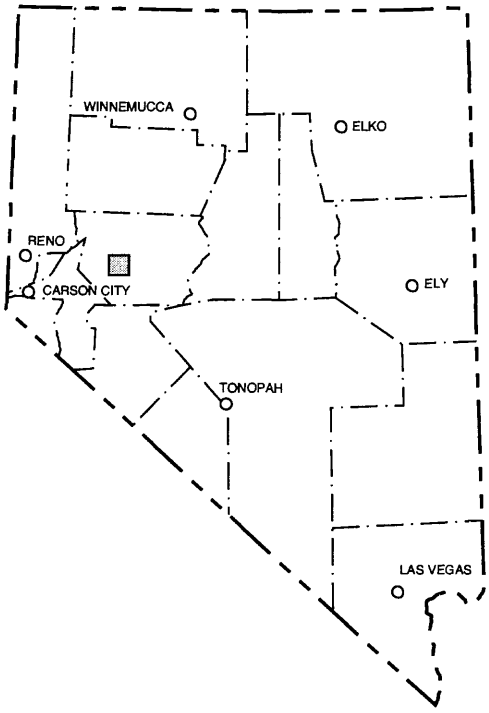
Period of Project: 1997-99.

Supporting Federal Agency: Bureau of Reclamation.

Problem: Irrigation water supplied by the Bureau of Reclamation to farmers in the southern Carson Desert is the primary source of recharge to the shallow aquifer in the area. The Newlands Project was constructed between 1903 and 1915 and was the first reclamation project in the United States. The Carson Desert occupies much of the floor of ancient Lake Lahontan and is the natural terminus of the Carson River. As part of the Newlands Project, some water in the Truckee River is diverted through the Truckee Canal to Lahontan Reservoir. Since the mid-1960's, about 40 percent of the flow in the Truckee River has been diverted to the Carson Desert. The U.S. Department of the Interior is implementing a water-rights acquisition program that will result in significant changes in the location of water delivery and may reduce future quantities of water delivered to the Newlands Project. The possibility of reduced application of water to currently irrigated lands has raised concerns about effects on water levels and water quality in the underlying aquifers, in particular the shallow aquifer, which is used as a water supply for 3,000 to 4,000 domestic wells in the rural areas around Fallon. Because the hydrology of the shallow aquifer varies across the southern Carson Desert, responses resulting from a decrease in application of surface water on irrigated lands may be more pronounced in some areas than in others. An understanding of the relative changes in ground-water levels in the shallow aquifer in different areas of southern Carson Desert can assist in evaluating the effect of changing the location or reducing the quantity of water applied to land in the Newlands Project.

Objectives: The Bureau of Reclamation will be provided an assessment of the potential effects caused by changing the quantity and location of surface water applied to irrigated lands in the Newlands Project and the potential effects on ground-water levels and quality in the shallow aquifer beneath selected areas of the southern Carson Desert.

Approach: Conceptual models based on understanding of the hydrology and geochemistry of the shallow aquifer are used to analyze the relative effects of changing irrigation practices. The modular finite-difference, ground-water flow model of the U.S. Geological Survey is used to construct a numerical model for two areas: (1) where the shallow aquifer is recharged by surface-water aquifers and (2) where ground water in the shallow aquifer discharges to land surface. The models are specifically designed and discussed in terms of relative effects caused by decreasing the area of irrigation and the quantity of water used for irrigation in the two areas.



Progress and Significant Results, Fiscal Years 1997 and 1998: The model calibration was completed and the report was submitted for review.

Plans for Fiscal Year 1999: Report will be written, reviewed, and published. Findings will be presented at meetings.

Arsenic in Ground Water *(Project 201)*

Location: Nationwide.

Project Chief: Alan H. Welch.

Period of Project: 1998-2000

USGS Program: National Water-Quality Assessment Program.

Problem: Ground water is an important source of supply for municipal and rural water users. Wise use and protection of this resource requires an understanding of its quality. One water-quality issue of particular importance is the occurrence of arsenic in ground water throughout the Nation. This issue is important because of ongoing efforts to evaluate (1) the exposure from drinking ground water containing arsenic and (2) the potential costs for treatment. Evaluation of exposure, which is based on occurrence, is part of an ongoing effort to revise the current drinking-water standard for arsenic. The potential for a revised standard has led to the recognition, by both regulators and the water suppliers, that a better understanding of arsenic occurrence is needed. A better understanding of arsenic in ground water would form the basis for evaluating health risks and water-treatment needs for public and domestic supplies.

Objectives: The occurrence of arsenic in the Nation's ground water will be described on the basis of evaluations of data and literature detailing the occurrence and controls on arsenic in ground water. The occurrence will be described in a regional context. Geologic, geochemical, and hydrologic characteristics are expected to be related to regional differences in the occurrence of arsenic in ground water. An indication of the frequency with which arsenic concentrations exceed both the current and revised, lower drinking-water standards in different regions will be included in the description.

Approach: Data bases containing arsenic analyses of ground water for large parts of the Nation will be assembled and incorporated into a central ground-water data base. The data will be evaluated. An understanding of potential geologic and geochemical controls on arsenic will be developed from a literature review. Literature discussing the occurrence of arsenic in ground water in the United States will be assembled and reviewed concurrently with the data-base assembly. A journal article will be written and will contain the main findings of the study. A fact sheet or other briefing document will be written that will be useful for water users and for meetings.

Progress and Significant Results, Fiscal Years 1997 and 1998: Assembly of the data base and evaluation of the data began. A literature review was started and report writing began.

Plans for Fiscal Year 1999: Reports will be written, reviewed, and published. Findings will be presented at meetings.

Amargosa Desert Research Site (*Project 202*)

Location: Amargosa Desert near Beatty, Nev.

Project Chief: Brian J. Andraski.

Period of Project: Continuous since 1997.

USGS Program: Toxic Substances Hydrology Program.

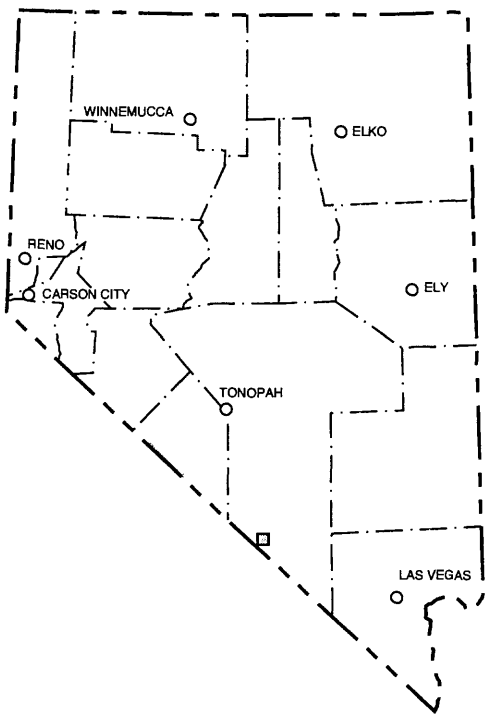
Problem: Complex unsaturated-zone processes cause great uncertainty in the prediction of water and chemical movements in arid regions. Research is needed to develop fundamental understanding of these processes to assist in the formulation of national environmental policy and regulation.

Objectives: Improve the understanding of, and methods for, characterizing the mechanisms that control subsurface migration and fate of contaminants in arid environments.

Approach: Research at the Amargosa Desert Research Site (ADRS) is a multidisciplinary, collaborative effort among scientists from the U.S. Geological Survey (USGS), universities, research institutes, and national laboratories. The research team will integrate existing and new information to test and refine theories and models; will fill gaps in present knowledge of the unsaturated zone-plant-atmosphere continuum through further data collection and analyses of spatial and temporal heterogeneities; and will test and develop methods that are needed to characterize processes occurring in the field.

Progress and Significant Results, Fiscal Years 1997 and 1998: The ADRS was incorporated into the USGS Toxic Substances Hydrology Program in 1997. Analysis of multiple-year soil-moisture data showed that the natural soil-plant system provides effective controls on the annual near-surface water balance that limit the potential for deep percolation of precipitation. Episodic, deep drying during periods of below-average precipitation further limited the potential for deep percolation under natural, vegetated conditions. In contrast, under non-vegetated waste-site conditions, continued accumulation and shallow (3-6 feet) penetration of infiltrated water was observed. Data collected throughout the thick (360 feet) unsaturated zone beneath an undisturbed, vegetated area (water potential, temperature, deuterium, and oxygen-18) were found to be consistent with the hypothesis of upward movement and evaporative discharge of ground water at land surface. Analysis of tritium data collected in this area showed temporal changes (1992-97) and a bimodal distribution that indicate lateral migration of tritiated water vapor away from the waste facility that is adjacent to the ADRS. Information about ADRS is available at the newly created internet web site **<http://nevada.usgs.gov/adrs>**.

Plans for Fiscal Year 1999: Testing of a new non-contaminating transfer system for analysis of field samples with high levels of carbon-14 will be completed. Testing and



refinement of models to evaluate unsaturated flow and transport will continue. Gaps in present knowledge will be filled through further data collection and analyses of spatial and temporal heterogeneities using geologic mapping, sample collection, measurement of evapotranspiration and soil-carbon dioxide flux, and measurement of weather and soil-moisture conditions. Development of a workplan for the design and installation of additional deep boreholes to support process-oriented study of flow and transport through the thick unsaturated zone will be completed. Construction and testing of a new non-contaminating transfer system for analysis of field samples with high levels of carbon-14 will be completed.

Publications, Fiscal Years 1997 and 1998:

Andraski, B.J., 1997, Overview of U.S. Geological Survey unsaturated-zone research at a site in the Amargosa Desert, southern Nevada—1976-96 [abs.]: 17th Annual Hydrology Days, American Geophysical Union, Ft. Collins, Colo., April 1997, Proceedings.

———1997, Soil-water movement under natural-site and waste-site conditions—A multiple-year field study in the Mojave Desert, Nevada: Water Resources Research, v. 33, no. 9, p. 1901-1916.

———1997, Test-trench studies in the Amargosa Desert, southern Nevada—Results and application of information to landfill covers in arid environments, *in* Feynolds, T.D., and Morris, R.C., eds., Landfill capping in the semi-arid west—Problems, perspectives, and solutions, May 21-22, 1997, Jackson Lake Lodge, Wyo.,

Conference Proceedings: Idaho Falls, Idaho, Environmental Science and Research Foundation Report, ESRF-019, p. 165-179.

Andraski, B.J., and Prudic, D.E., 1997, Soil, plant, and structural considerations for surface barriers in arid environments—Application of results from studies in the Mojave Desert near Beatty, Nevada, *in* Barrier technologies for environmental management, summary of a workshop: Washington, D.C., National Academy Press, p. D50-D60.

Prudic, D.E., Stonestrom, D.A., and Striegl, R.G., 1997, Tritium, deuterium, and oxygen-18 in water collected from unsaturated sediments near a low-level radioactive-waste burial site south of Beatty, Nevada: U.S. Geological Survey Water-Resources Investigations Report 97-4062, 23 p.

Stonestrom, D.A., Prudic, D.E., and Striegl, R.G., 1997, Deuterium and oxygen-18 in water from a deep unsaturated zone in the Amargosa Desert, Nye County, Nevada [abs.]: Eos, American Geophysical Transactions, v. 78, no. 46, p. 302-303.

Striegl, R.G., Healy, R.W., Michel, R.L., and Prudic, D.E., 1998, Tritium in unsaturated zone gases and air at the Amargosa Desert Research Site, and in spring and river water, near Beatty, Nevada, May 1997: U.S. Geological Survey Open-File Report 97-778, 13 p.

Evaporation Rates at Death Valley *(Project 203)*

Location: Death Valley, Calif. and Nev.

Project Chief: Guy A. DeMeo.

Supporting Federal Agency: National Park Service.

Period of Project: 1998-2002.

Problem: Quantitative analysis of the ground-water resources of an area requires knowledge of the ground-water budget. In most regions, particularly arid regions, the individual components of the ground-water budget are poorly known at best. Ground-water recharge occurs intermittently over large ill-defined areas and cannot be directly measured. Ground-water discharge may occur as spring discharge, which may leave the area as surface discharge; as underflow, which may be impossible to measure; and as evapotranspiration (ET) from phreatophytes and, where ground water is shallow, from bare soil. Of all these components of the ground-water budget, only spring discharge and ET can be measured with any confidence. Death Valley is the definitive closed hydrologic basin. Ground- and surface-water inflow leave the basin only by ET. Even spring discharge ultimately is lost by this process. Field techniques and computational procedures for measuring and calculating site-specific ET are now sufficiently developed to extend these methods to areas where climatic conditions are more extreme.

Objectives: Estimates of ET from representative areas of phreatophytes, open water, and shallow ground water will be determined.

Approach: Field measurements at selected sites in the Death Valley saltpan, area which extends from about Cottonball Basin to about Mormon Point, will be used to develop representative rates of ET. These rates, together with estimated areas for which each rate applies, can be used to develop an estimate of ground-water evaporation from the Death Valley saltpan area. Areas for which each rate applies can be estimated from Landsat imagery. Field-study sites representative of major areas of ground-water ET, such as phreatophytes, shallow ground water, saturated soil, and open water will be selected. Evapotranspiration will be measured at these sites using energy-budget Bowen ratio, energy-combination, and eddy-correlation methods. Data will be collected at three to six sites a year during the first 2 years of the study. These data will be used to calculate ET rates and to develop relations between mean daily ET of ground water and other variables such as phreatophyte type, depth to ground water, windspeed, and total energy available. Remotely sensed satellite data can be used to classify the land-surface cover of Death Valley corresponding to the areas of ground-water discharge. The vegetation map of Hunt (1966) provides data for preliminary calibration of satellite imagery. Additionally,

surface-temperature data that is satellite derived may be used with currently developing models to estimate instantaneous mid-day ET rates for comparison.

Progress and Significant Results, Fiscal Year 1997: An ET site was installed on the west side of the Death Valley in a sparsely vegetated location. The main plant is pickleweed (a phreatophyte). The site also includes a well. Another ET site was installed on the salt playa with no vegetation. Preliminary GIS work was done to delineate the ET units. This work also included a field reconnaissance to verify the satellite data.

Plans for Fiscal Year 1999: New sites will be established. The study will be expanded to include regions north and south of the saltpan. Evaporation estimates of spring discharge will be made. Salts will be analyzed.

Mercury in the Carson River, Carson City to Below Lahontan Reservoir *(Project 204)*

Location: Eagle Valley, Dayton Valley, Stagecoach Valley, Churchill Valley, Lahontan Reservoir, and Carson Desert, Nev.

Project Chief: Stephen J. Lawrence.

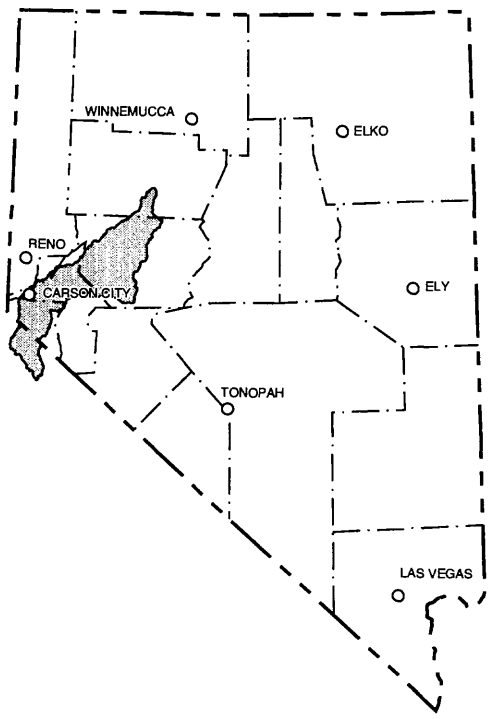
Period of Project: 1997-99.

Supporting Federal Agency: U.S. Environmental Protection Agency, Region IX.

Problem: In August 1990, the U.S. Environmental Protection Agency (USEPA), listed the Carson River in west-central Nevada, as a site for possible remediation of mercury contamination under the auspices of the Comprehensive Environmental Response, Contamination, and Liability Act of 1980, also known as CERCLA, or Superfund. Subsequently, USEPA coined the term Carson River Mercury Site (CRMS) to identify the site of investigation which is about a 100-mile reach of the river from Carson City in Eagle Valley to Stillwater National Wildlife Refuge in the Carson Desert. As part of the initial CRMS investigation, USEPA is required to do a Remedial Investigation and Feasibility Study (RI/FS) to characterize the scope of contamination of mercury, which poses a potential risk to human health and to the environment of the affected area. The results of the RI/FS will assist resource managers to develop sound plans for remediating the potential risks. Recognizing the importance of fluvial transport of mercury-contaminated sediments to Lahontan Reservoir, EPA-Region IX requested in March 1997 that the U.S. Geological Survey (USGS) Nevada District, collect mercury and mercury-related data on the Carson River during 1997 and 1998.

Objective: Data on concentrations of total and dissolved mercury, total and dissolved methyl-mercury, and suspended sediment will be collected at the USGS gaging station, Carson River near Fort Churchill, Nev. (10312000). These data subsequently can be used to determine seasonal loads of total mercury and methyl-mercury to Lahontan Reservoir.

Approach: Field measurements of streamflow, water temperature, specific conductance, dissolved oxygen (DO), and pH will be recorded each time that water samples are collected. Streamflow measurements will be made. Water samples will be collected along the cross section of the river using depth-integrating techniques. Data collection will occur weekly during the rising stage of the spring 1997 snowmelt hydrograph, then every other week during the falling stage of the snowmelt hydrograph, and monthly thereafter from July 1997 through March 1998, during low-low conditions. The data collection program described herein also incorporates two "event measurements," runoff from thunderstorms, one each in 1997 and 1998, assuming



that these storm runoffs occur. These event data will document the movement of mercury into Lahontan Reservoir during non-snowmelt runoff periods.

Progress and Significant Results, Fiscal Years 1997 and 1998: Samples during snowmelt runoff and during low flow were taken. Data were combined with those for samples from the 1997 flood and were used to estimate suspended sediment and total mercury which passed the Fort Churchill gaging station from January through September 1997. In the second quarter of 1998, samples were collected at six additional sites on the Carson River using the protocols developed for the Forth Churchill site. Data was published in the annual data report.

Plans, Fiscal Year 1999: Samples will be collected at seven sites. All hydrologic data will stored in the USGS National Water Information System and USEPA STORET data bases, and will be published in the USGS annual data book for Nevada.

Publications, Fiscal Year 1998:

Bonner, L.J., Elliott, P.E., Etchemendy, L.P., and Swartwood, J.R., 1998, Water resources data, Nevada, water year 1997: U.S. Geological Survey Water-Data Report NV-97-1, 636 p.

Hoffman, R.J., and Taylor, R.L., 1998, Mercury and suspended sediment, Carson River Basin, Nevada—Loads to and from Lahontan Reservoir in flood year 1997 and deposition in reservoir prior to 1983: U.S. Geological Survey Fact Sheet FS-001-98, 6 p.

Synthetic Organic Compounds in Las Vegas Valley *(Project 205)*

Location: Las Vegas Valley, Nev.

Project Chief: Kenneth J. Covay.

Period of Project: 1997-98.

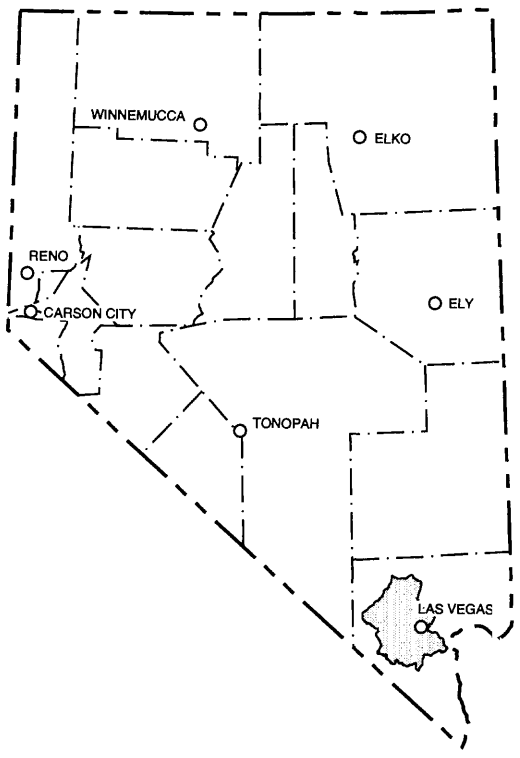
Cooperating Agency: Clark County Regional Flood Control District.

Problem: Urban runoff, shallow ground water from urban landscape watering, treated sewage effluent, and industrial drainage from urban areas in Las Vegas Valley are transported by Las Vegas Wash and its tributaries to Las Vegas Bay of Lake Mead. Lake Mead is a National Recreation Area administered by the National Park Service (NPS) and is used for public water supplies and recreation (fishing, swimming, and boating). Lake Mead also is habitat for the endangered Razorback sucker. Water-quality contaminants transported by the Las Vegas Wash drainage system to Las Vegas Bay could impair its suitability for all these uses.

Objectives: Investigating the distribution of hydrophobic, synthetic organic compounds will provide additional information that can be combined with data from previous U.S. Geological Survey (USGS) studies to identify source areas of these contaminants in the Las Vegas Wash drainage system upstream from Las Vegas Bay of Lake Mead. Hydrophobic, synthetic organic compounds in the water column of perennial discharges will be identified; such discharge sites include water-reclamation effluent to Las Vegas Wash (City of Las Vegas, Clark County, and City of Henderson), selected sites on Las Vegas Wash upstream and downstream from industrial areas, and known areas of contamination. Hydrophobic, synthetic organic compounds in bottom sediments of tributary washes upstream from and within the urban drainage system of Las Vegas Wash also will be identified.

Approach: Data will be collected and entered into the USGS National Water Information System data base. The data will be documented and a USGS open-file report will be written.

Progress and Significant Results, Fiscal Year 1998: Semipermeable membrane devices (SPMD) were installed for 5 weeks at several sites. Bottom-sediment samples were collected from selected sites on tributary washes and analyzed for hydrophobic, synthetic organic compounds. Detention basins upstream from the Las Vegas urban area were sampled for background information and contributions from rural areas at several sites. Tributary sites were sampled within the urban area. Bottom-sediment samples were analyzed and the data was reviewed, processed, and entered into the computerized USGS National Water Information System database. Samples were analyzed and downloaded into the USEPA STORET data base. SPMD data were reviewed, processed, and entered into a local USGS data base.



Plans for Fiscal Year 1999: All bottom-sediment and SPMD data will be published in a USGS open-file report.

Lake Tahoe Organics Survey *(Project 206)*

Location: Lake Tahoe, Nev.

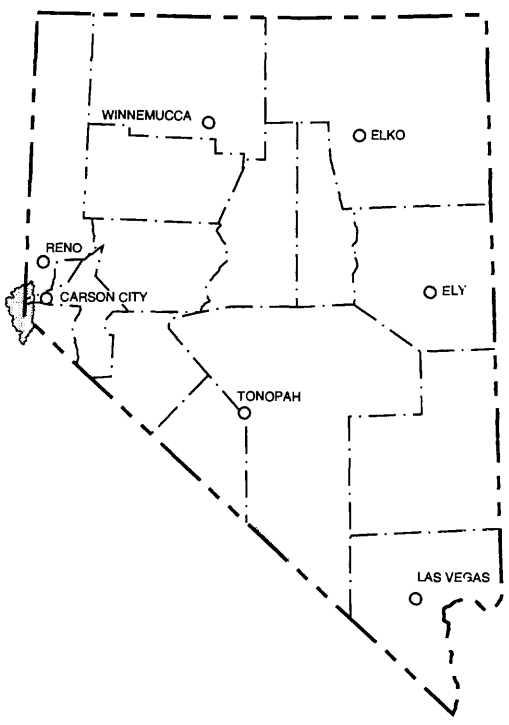
Project Chief: Michael S. Lico.

Period of Project: 1998-99.

Cooperating Agency: Tahoe Regional Planning Agency.

Problem: The increased production and use of synthetic-organic compounds in the United States during the past 60 years, coupled with their ease of transport to streams and lakes, makes knowledge of their environmental source and fate essential for water-resource management. Many of these compounds persist in the environment and are known to be toxic to plants, animals, and humans. For example, residues of persistent organochlorine compounds have been detected in remote areas of the earth, including Antarctic snow and from fish collected at depths of 8,000 feet in the Atlantic Ocean. Ironically, some pesticide degradation products are more toxic than the parent compound. Synthetic-organic compounds enter streams and lakes from atmospheric deposition, point-source outflows, non-point surface runoff, ground-water discharges, and gasoline-powered water craft. Noteworthy for Lake Tahoe is the recent concern by residents, and non-residents alike, of gasoline emissions to the lake from two-cycle engines. Synthetic-organic compounds of interest include methyl *tert*-butyl ether (MTBE), gasoline compounds and their byproducts, and polycyclic aromatic hydrocarbons (PAH's). [Note: Some PAH's are found naturally in the environment.] Although considerable research has been done concerning the quality of Lake Tahoe during the past 40 years, little is known of the occurrence, concentration, and distribution of soluble pesticides, organochlorine compounds (pesticides and industrial compounds), semivolatile-industrial compounds, and synthetic hydrocarbons, in this dilute, subalpine lake. Because of increasing development of the watershed and increased recreational use of Lake Tahoe and surrounding lands, background information on the occurrence of synthetic-organic compounds of its waters is needed by local water-resource managers to ascertain whether or not such compounds are present. The presence and concentrations of these compounds may be used to set water-quality standards for Lake Tahoe. This survey also will prove useful to the USGS national drinking water initiative by providing hydrologic data on synthetic-organic compounds in dilute, high-altitude lakes. Lake Tahoe is a source of drinking water for some municipalities in the basin.

Objectives: The presence or absence of organochlorine, semivolatile industrial, and synthetic hydrocarbon compounds (for example MTBE, gasoline, and PAH's), and soluble pesticides in selected areas of Lake Tahoe will be determined. These areas are near the mouths of principal tributaries to the lake and in those principal tributaries. Also, water samples will be collected at two offshore (deep water)



locations. These data will provide contemporary background information on the occurrence of synthetic organic compounds in Lake Tahoe by which future comparisons can be made. In addition, similar data will be collected from a subalpine lake in Desolation Wilderness whose watershed has received minimal impact by human activities. Data from this reference site will be compared and contrasted with the data collected from Lake Tahoe.

Approach: Sampling sites in Lake Tahoe and tributaries will be selected to represent areas that reflect various land use and recreational water use within the Lake Tahoe Basin. Samples of dissolved-organochlorine and semivolatile industrial compounds will be collected using submerged semipermeable-membrane devices (SPMD's). Water samples for soluble pesticides and volatile hydrocarbons will be collected proximate to deployed SPMD's and near the lake surface. Water samples for nitrogen and phosphorus concentrations will be collected at the lake sites. Bottom-sediment samples will be collected at seven lake sites and six tributary sites. These samples will be analyzed for the same compounds as those analyzed for the SPMD's. Ancillary data, such as Hydrolab profiles of depth, temperature, specific conductance, pH, and dissolved oxygen, will be collected at most lake sites. Similar suites of data will be collected at the reference site. Organic-chemical analysis of SPMD's, water, and bottom sediment will be done. Field-blank, trip-blank, and replicate samples will be collected and processed for quality-control purposes. Data collection will occur during two seasons in calendar year 1998 and one season in calendar year 1999. Following an initial reconnaissance to

select sampling sites in late winter or early spring 1998, data collection for tributary inflows will begin in spring 1998 during the snowmelt runoff period. Data collection for the lake sites will be in the summer of 1998 during peak recreational use, and a second round of tributary measurements will be made in the winter of 1998-99 during base- runoff conditions. Because of expected relatively cool water temperatures during the summer, the SPMD's probably will remain submerged for about 2 months.

Progress and Significant Results, Fiscal Year 1998: A field reconnaissance of select sampling sites was completed. Data collection for tributary inflows began. Data-collection activities at lakes were delayed because of wet weather.

Plans for Fiscal Year 1999: Data-collection activities will continue dependent on weather. A summary report will be prepared and published.

Historical Trends in Deposition of Sediment, Synthetic-Organic Compounds, and Trace Elements at Lake Mead *(Project 214)*

Location: Lake Mead, Nev., and Ariz.

Project Chief: Kenneth J. Covay.

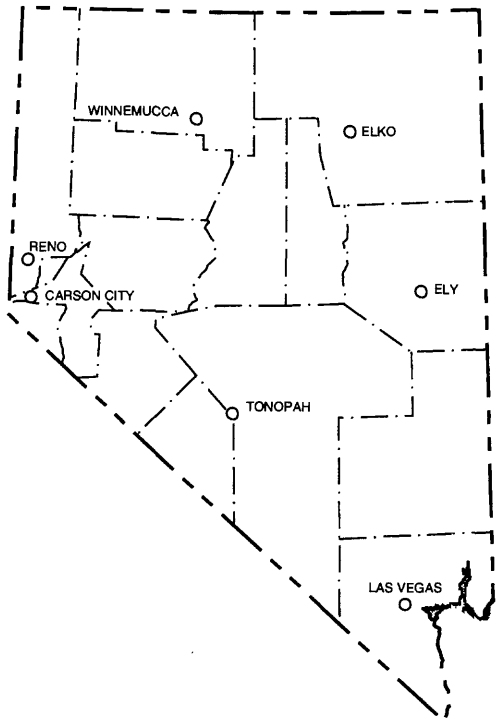
Period of Project: 1998-99.

Cooperating Agency: University of Nevada, Las Vegas.

Problem: Sources and factors affecting the deposition of sediments and associated synthetic-organic compounds, and trace elements in Lake Mead generally are not well understood. El Nino weather patterns have been responsible historically for causing unusually wet conditions in the arid southwestern United States. These wet conditions, which are characterized by increased surface runoff and streamflow, probably are major periods of sediment erosion and transport. Re-creation of historical rates of sediment deposition and their evaluation with respect to El Nino occurrences would provide important information on the role of these unusually wet weather patterns on the erosion and transport of sediment in the arid southwestern United States. Lake Mead on the Colorado River is a major depositional area for fluvial sediment in the southwestern United States and provides an excellent opportunity for evaluating effects of El Nino on historical rates of sediment erosion, transport, and deposition. Previous investigations by the U.S. Geological Survey (USGS) have shown that Las Vegas Wash, which transports urban drainage and treated sewage to Las Vegas Bay of Lake Mead, is the probable source of metals, organochlorine pesticides, and industrial compounds detected in Las Vegas Bay. Information on sources and trends of these metals, pesticides, and compounds is needed to evaluate their current and future significance.

Objectives: This investigation will provide data and interpretations needed to determine historical trends of the deposition of sediment and associated hydrophobic-synthetic-organic compounds, and trace elements in selected areas of Lake Mead. Information on trends in historical deposition will be evaluated for (1) determining historical rates of sediment deposition; (2) identifying source areas of sediment and chemical constituents; (3) identifying factors affecting the deposition of sediment and chemical constituents, such as climate and land use; and (4) determining which chemical constituents are increasing and decreasing. Concentrations of some constituents may have peaked years ago and are decreasing at rates, indicating they soon will be of little concern. Historical concentrations and temporal trends in the deposition of sediment and associated chemical constituents will be reconstructed by analyzing age-dated sediment cores.

Approach: This investigation will be done in conjunction with a study by the Health Physics Department at the University of Nevada, Las Vegas (UNLV), to describe the occurrence and distribution of radionuclides from above-ground nuclear weapons testing at the Nevada Test Site in the late



1950's and early 1960's. Bottom-sediment cores will be collected from selected sites in Lake Mead. UNLV scientists will analyze cores for radionuclides and age date the cores at selected depth intervals. Subsamples of age-dated, bottom-sediment cores will be used for analyses of sediment deposition, synthetic organic compounds, and trace elements. Preliminary coring and geophysical mapping of bottom sediments will be done by UNLV and USGS scientists to determine sediment thicknesses in selected areas of Lake Mead. Sediment cores for analysis of chemical constituents will be collected in May 1998. Results of chemical analyses will be evaluated to see if "fingerprints" of these constituents can be used to identify source areas, represented by the Colorado River Arm, the Overton Arm below the confluence of the Virgin and Muddy Rivers, and Las Vegas Bay. The National Water-Quality Assessment Program (NAWQA) will coordinate with this investigation by collecting some of the cores and analyzing subsamples. Historic trends in sediment and constituent deposition will be evaluated at all sites.

Progress and Significant Results, Fiscal Year 1998: Preliminary coring and cross sections of sediment thickness, determined by acoustic chirping, were used to select sites for sediment coring. Sediment cores for age dating and analyses of radionuclides, synthetic organic compounds, and trace elements were collected and subsamples were sent to laboratories.

Plans for Fiscal Year 1999: The data will be interpreted and results will be published.

Southern Nevada Evapotranspiration
(Project 215)

Location: Southern Nye County, Nev., and adjacent parts of Inyo County, Calif.

Project Chief: Randell J. Laczniak.

Period of Project: 1998-99.

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

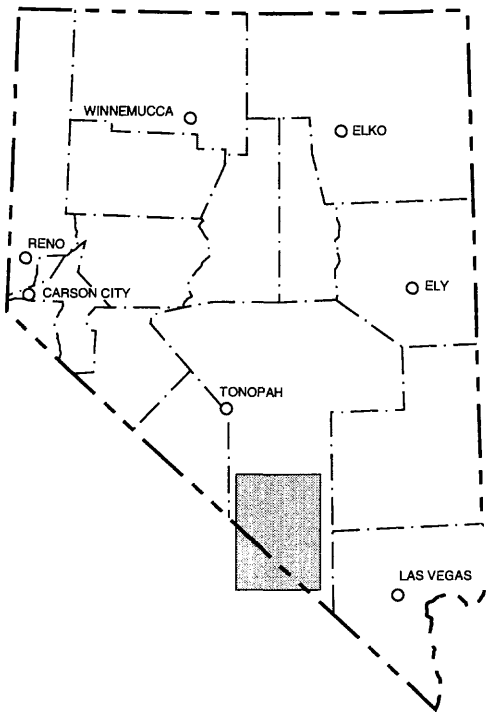
Problem: The risk associated with underground nuclear-weapons testing of the late 1950's and early 1960's and a proposed high-level nuclear waste repository at the Nevada Test Site (NTS) are currently being evaluated using ground-water flow and transport models. Ground-water discharge is uncertain, but must be known to accurately assess the risk associated with the transport of any contaminants introduced into the subsurface environment. Estimates of evapotranspiration (ET) are essential for quantifying annual rates of ground-water discharge.

Objectives: Estimates of ET will be developed from major areas of ground-water discharge downgradient from the NTS. A regional map showing the spatial distribution of ET units throughout southern Nevada will be prepared.

Approach: Annual ET will be estimated by delineating general areas of ET from remotely sensed Landsat Thematic Mapper data acquired in June 1992. ET areas will be further refined by classifying units defined by similarities in vegetation and soil conditions. ET rates will be assigned to each unit on the basis of estimates determined from field measurements made during prior and ongoing studies. Annual ET for each major discharge area will be determined by summing estimates of ET calculated for each of the individual ET units.

Progress and Significant Results, Fiscal Year 1998: A preliminary classification for the entire area of interest has been completed. ET rates throughout the general area, determined by energy-budget methods, have been compiled and are being evaluated in terms of the preliminary unit classifications. A final classification of ET units and associated estimates of ET rates will be completed by the end of fiscal year 1998.

Plans for Fiscal Year 1999: Annual ET will be computed for each of the major discharge areas and a report documenting the results will be published.



Quality of Surface Water and Bottom Sediment in Lower Humboldt River Basin *(Project 216)*

Location: Pershing County, Nev.

Project Chief: Carl E. Thodal.

Period of Project: 1998-2000.

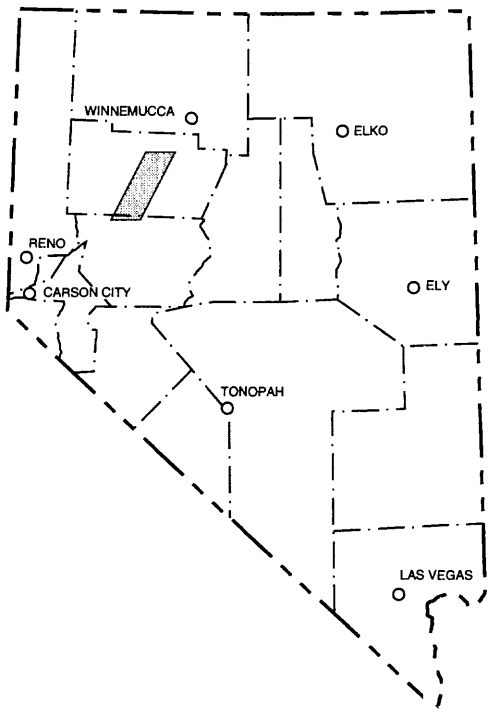
Supporting Federal Agency: U.S. Fish and Wildlife Service.

Problem: Beginning in 1997, large amounts of water are being discharged to the Humboldt River from large-scale dewatering of aquifers in tributary drainage basins upstream from Golconda. Operators of open-pit gold mines pump water from the aquifer to lower the water table near the mines to facilitate mining. The cumulative effect of discharges from these dewatering operations is to more than double the baseflow of the Humboldt River. In addition to changes in streamflow, the U.S. Fish and Wildlife Service (USFWS) is concerned that the chemical quality of the Humboldt River will change as a result of these ground-water discharges to the river, and that these water-quality changes will adversely affect fish and wildlife in the Humboldt Wildlife Management Area (WMA). During periods of high flow, water discharges from the Humboldt Basin to the Carson Desert. The potential exists for degradation of water quality in the Stillwater Wildlife Management area, which lies in the Carson Desert.

Data are needed to characterize the quality of inflows to the Humboldt WMA and assess effects resulting from changes in river discharge and land use. Analysis of the data can provide information about the importance of mining, agriculture, and treated effluent as contributors to dissolved solids and trace elements entering and leaving the Humboldt WMA relative to natural loadings indicated by historical data.

Objectives: A monitoring program will be initiated to provide data that characterize streamflow, water quality, and their variability among the major inflows to and outflows from Humboldt WMA. Data resulting from 15 months of monitoring will be evaluated in terms of Nevada water-quality criteria, variability of concentrations due to rates of streamflow and temporal changes in land use, and dominant source of inflow. To the extent possible, the major sources and proportions of dissolved solids and trace elements entering Humboldt WMA that originate from the several major sources will be determined.

Approach: The project will be done in conjunction with USFWS biological monitoring of sites along the Humboldt River, agricultural drains, and in lakes within the Humboldt WMA. Data will be collected at three sites on the Humboldt River, at two sites on the principal drains feeding lakes in the Humboldt WMA, and at one site each at Humboldt Lake and on Lower Humboldt Drain. The USGS will install gaging



stations at three sites and collect data from currently gaged sites that are part of existing programs. Continuous monitors for specific conductance will be installed at all five gages. Water-quality samples will be collected and analyzed at regular intervals; the schedule may be adjusted to include samples representative of the range of streamflow and several sources of inflow. Bottom-sediment samples will be collected at each of the seven sites in March before snowmelt runoff, and analyzed for concentrations of trace elements. The USGS hydrologist will work with USFWS biologists to examine relations between discharge, surface-water quality, aquatic community structure, and trace-element concentrations in biological tissues.

Progress and Significant Results, Fiscal Year 1998: Streamflow gages and specific-conductance monitors have been installed. Streamflow and specific conductance is being monitored. Surface-water data are being collected at gaged sites. Humboldt Lake water and bottom sediments have been sampled.

Plans for Fiscal Year 1999: Data collection, monitoring, sampling will continue. The data will be analyzed, evaluated, and the results will be provided to the U.S. Fish and Wildlife Service.

WATER-RELATED PUBLICATIONS, NEVADA DISTRICT, FISCAL YEARS 1997 AND 1998

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