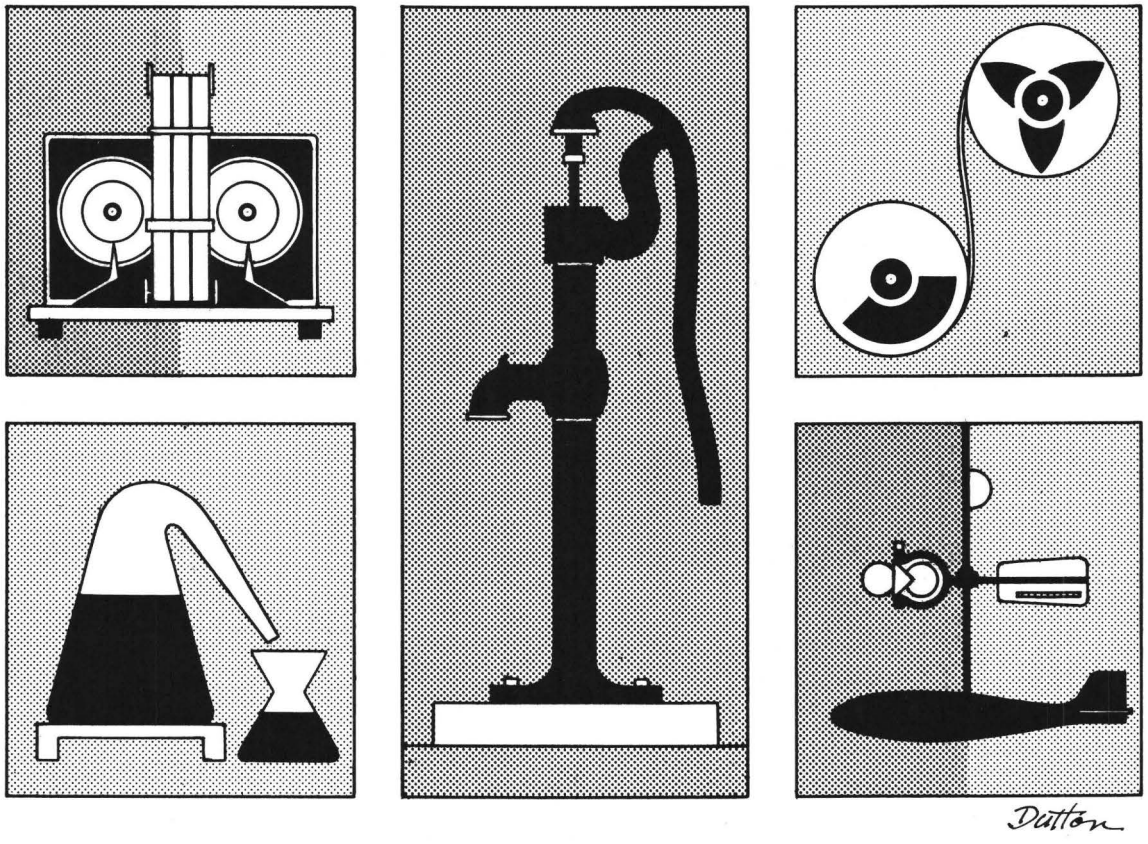
SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN COLORADO -- FISCAL YEAR 1984



U.S. Geological Survey

SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN COLORADO--FISCAL YEAR 1984

Lakewood, Colorado
1984

UNITED STATES DEPARTMENT OF THE INTERIOR

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GEOLOGICAL SURVEY

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SUMMARY OF WATER-RESOURCES ACTIVITIES OF THE U.S. GEOLOGICAL SURVEY IN COLORADO--FISCAL YEAR 1984

INTRODUCTION

Water-resources investigations of the U.S. Geological Survey in Colorado consist of collecting water-resources data and conducting interpretive hydrologic investigations. The water-resources data and the results of the investigations are published or released by either the U.S. Geological Survey or by cooperating agencies. This report describes the water-resources investigations in Colorado for the 1984 fiscal year (October 1, 1983, to September 30, 1984).

The U.S. Geological Survey's investigations of the water resources of Colorado are under the direction of James F. Blakey, District Chief. The Colorado District office is in Building 53, Denver Federal Center, Lakewood, Colorado. The Colorado District has four subdistrict offices in Grand Junction, Lakewood, Meeker, and Pueblo. Requests for information should be addressed as follows:

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COOPERATING AGENCIES

In Colorado, some of the water-resources data-collection activities and interpretive hydrologic investigations are conducted in cooperation with Federal, State, and local agencies. Those agencies cooperating with the U.S. Geological Survey during fiscal year 1984 are:

Arkansas River Compact Administration
Central Yuma Ground-Water Management District
Cherokee Water and Sanitation District
City and County of Denver, Board of Water Commissioners
City of Aspen
City of Aurora
City of Arvada
City of Colorado Springs, Department of Public Utilities
City of Colorado Springs, Office of the City Manager
City of Englewood, Bi-City Wastewater-Treatment Plant
City of Fruita
City of Glenwood Springs
City of Steamboat Springs
Colorado Department of Health, Radiation Control Division
Colorado Department of Highways
Colorado Department of Natural Resources,
  Division of Water Resources, Office of the State Engineer
Colorado River Water Conservation District
Crowley County
Custer County Commissioners
Delta County Board of County Commissioners
Denver Regional Council of Governments
Eagle County Board of Commissioners
El Paso County Water Users Association
Frenchman Ground-Water Management District
Garfield County
Grand County Board of Commissioners
Larimer-Weld Regional Council of Governments
Marks Butte Ground Water Management District
Metropolitan Denver Sewage Disposal District No. 1
North Kiowa Bijou Ground Water Management District
Northern Colorado Water Conservancy District
Northwest Colorado Council of Governments
Pitkin County Board of County Commissioners
Pinebrook Water District
Pueblo Civil Defense Agency
Purgatoire River Water Conservancy District
Rio Blanco County
Rio Grande Water Conservation District
Round Mountain Water and Sanitation District
Sand Hills Ground-Water Management District
Southeastern Colorado Water Conservancy District
Southern High Plains Ground-Water Management District
Southwestern Water Conservation District
Town of Breckenridge
Trinchera Conservancy District

Uncompahgre Valley Water Users Association
Upper Arkansas River Water Conservancy District
Upper Black Squirrel Creek, Ground-Water Management District
Upper Yampa Water Conservancy District
Urban Drainage and Flood Control District
W-Y Ground-Water Management District
Water Users No. 1
Yellow Jacket Water Conservancy District
U.S. Air Force Academy
U.S. Department of Agriculture, San Juan National Forest
U.S. Deparment of Agriculture, Soil Conservation Service
U.S. Department of the Army
    Corps of Engineers
    Fort Carson
U.S. Department of Energy
U.S. Department of the Interior
    Bureau of Land Management
    Bureau of Reclamation
    Office of Surface Mining
    Park Service
U.S. Environmental Protection Agency
U.S. Federal Highway Administration

COLLECTION OF WATER-RESOURCES DATA

Hydrologic-data stations are maintained at selected locations throughout Colorado and constitute a water-resources-data network for obtaining records on stream discharge and stage, reservoir and lake storage, ground-water levels, well and spring discharge, and the quality of surface and ground water. Every year some stations are added and others are terminated; thus, the U.S. Geological Survey has both a current and a historical file of hydrologic data. Most water-resources data are stored in the U.S. Geological Survey's WATSTORE (National Water Data Storage and Retrieval System) and are available on request to water planners and others involved in making decisions affecting Colorado's water resources. These data can be retrieved in machine-readable form or in the form of computer-printed tables, statistical summaries, and digital plots. Local assistance in the acquisition of services or products from WATSTORE can be obtained by contacting the District Chief, Lakewood, Colo.

Surface-Water Data

Surface-water discharge (streamflow), stage (water level), and water-quality data are collected for general hydrologic purposes, such as assessment of water resources, areal analysis, determination of long-term trends, research and special studies, or for management and operational purposes. Data-collection platforms (DCP's), used for the transmission of real-time river-stage information, have been installed at many sites. Real-time acquisition of the information is essential to many agencies for operating reservoirs, predicting river stage and flood conditions, and optimizing the use of water resources. DCP information is transmitted to the

GOES (Geostationary Operational Environmental Satellite) and received at the U.S. Geological Survey ground station located in Denver where it is processed and made available to other agencies. Discharge and stage data currently are being obtained at the number of stations given below.

Station Classification	Number of Stations	
Stream stations	350	
Continuous record		331
Partial record		19
DCP real-time record		25
Lake and reservoir stations	27	
Total	377	

The number and type of stations located in each county are shown on plate 1 and table 1 (p. 5).

Water-quality data (common ions, nutrients, and/or trace metals) are obtained at 111 of the surface-water stations listed in table 1 and also at 7 other miscellaneous-record sites where flow measurements are obtained only when the stream is sampled. Eight of the forementioned stations are part of a U.S. Geological Survey nationwide network known as NASQAN (National Stream Quality Accounting Network), which provides data used in the nationwide evaluation of trends in stream quality.

Water-quality data of various types currently are being collected at the number of stations shown below.

Station Classification	Number of Stations
Physical water-quality data (includes temperature, specific conductance, pH, and/or dissolved oxygen)	303
Chemical data (common ions, nutrients and/or trace metals)	118
Radiochemical data	24
Bacteriological data	40
Pesticides data	22
Suspended-sediment data	50

Information from these stations is used to monitor the quality of surface water in Colorado. The frequency of sample collection can vary from daily for some of the physical data to annual for pesticide or radiochemical data. In addition to the water-quality data collected at the forementioned stations, a variety of information is collected at miscellaneous sites as a part of interpretive hydrologic studies. This information is also available from U.S. Geological Survey files.

Table 1.--*Water-resources data-collection stations in operation during fiscal year 1984, by county*

County	Surface-water stations				Ground-water stations
	Continuous record	Partial record	Lake and reservoir	Water quality	Wells
Adams	2	0	0	0	47
Alamosa	0	0	0	0	47
Arapahoe	3	0	1	1	16
Archuleta	9	0	0	1	0
Baca	0	0	0	0	31
Bent	4	0	1	0	51
Boulder	5	2	0	0	3
Chaffee	3	1	0	0	19
Cheyenne	0	0	0	0	4
Clear Creek	1	0	0	0	0
Conejos	7	0	2	0	16
Costilla	0	0	0	0	33
Crowley	0	0	0	0	11
Custer	1	0	0	0	0
Delta	12	0	0	0	0
Denver	2	1	0	0	6
Dolores	2	0	0	0	0
Douglas	2	0	2	0	23
Eagle	24	2	1	3	0
Elbert	0	0	0	0	2
El Paso	18	0	0	10	125
Fremont	6	0	0	3	16
Garfield	8	1	0	5	0
Gilpin	0	0	0	0	0
Grand	24	0	4	4	1
Gunnison	8	0	1	0	0
Hinsdale	4	0	0	0	0
Huerfano	0	0	0	0	5
Jackson	2	0	0	1	0
Jefferson	7	7	0	6	0

Table 1.--*Water-resources data-collection stations in operation during fiscal year 1984, by county*--Continued

County	Surface-water stations				Ground-water stations
	Continuous record	Partial record	Lake and reservoir	Water quality	Wells
Kiowa	0	0	0	0	3
Kit Carson	0	0	0	0	9
Lake	4	0	1	3	8
La Plata	8	1	1	2	2
Larimer	11	2	2	12	16
Las Animas	15	0	1	13	0
Lincoln	0	0	0	0	2
Logan	0	0	0	0	33
Mesa	12	0	1	4	2
Mineral	1	0	0	0	0
Moffat	8	0	0	3	1
Montezuma	7	0	0	2	1
Montrose	4	1	0	2	0
Morgan	2	0	0	1	57
Otero	5	0	0	0	45
Ouray	3	0	0	0	0
Park	10	0	1	0	0
Phillips	0	0	0	0	59
Pitkin	12	0	0	0	0
Prowers	2	0	0	0	75
Pueblo	8	1	2	2	57
Rio Blanco	28	0	0	23	0
Rio Grande	3	0	0	0	24
Routt	9	0	0	5	0
Saguache	3	0	3	2	34
San Juan	0	0	0	0	0
San Miguel	1	0	0	1	0
Sedgwick	1	0	0	0	22
Summit	14	0	2	0	0
Teller	0	0	0	0	0
Washington	0	0	0	0	22
Weld	5	0	0	2	104
Yuma	1	0	1	0	158
Totals	331	19	27	111	1,190

Ground-Water Data

Water levels in wells are a key parameter for monitoring ground-water trends; however, they must be integrated with other observations and ground-water investigations in order to have the fullest meaning and usefulness. A network of 57 observation wells (pl. 1) is maintained in Colorado by the U.S. Geological Survey. In addition, a network of about 880 observation wells is maintained in Colorado, in cooperation with various east-slope water-conservancy districts and water-management districts for monitoring fluctuations in water levels. Only 40 wells are being measured on the western slope during 1984. Other wells known as "project wells" are used for specific (generally short-term) investigations and, although they are not part of the observation-well networks, data obtained from them also are available. The numbers of wells currently being measured are given below.

Frequency of measurement	Number of wells
Continuous	72
Monthly	0
Bimonthly	50
Semiannually	40
Annually	1,028
Total	1,190

The number of wells located in each county is shown in table 1 (p. 5).

Water-quality data are not collected routinely from wells in the statewide networks. However, a variety of water-quality data are collected at numerous wells during the course of many interpretive hydrologic investigations, which may include water-quality data from some statewide observation wells. These data are available from the files of the U.S. Geological Survey.

INTERPRETIVE HYDROLOGIC INVESTIGATIONS

Fifty-one interpretive hydrologic investigations are being conducted during fiscal year 1984 in cooperation with 65 Federal, State, and local agencies. Hydrologic investigations are being conducted which will provide information needed to answer hydrologic questions specific to the State's four major river basins (Missouri, Arkansas, Rio Grande, and Colorado), as well as those which address statewide, multistate, and nationwide hydrologic problems. A summary of each investigation including problem, objectives, approach, progress, and plans follows. The summaries are presented in a chronological order, except projects CO-83-005, CO-84-006, and CO-78-007, based on the investigation's beginning date.

PROJECT TITLE: National Trends Network for Monitoring Atmospheric Deposition

PROJECT NUMBER: CO-83-005

STUDY LOCATION: Bent County, Colorado

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Ronnie D. Steger, Subdistrict Office, Pueblo

PROJECT DURATION: October 1983 to September 1986

PROBLEM: Great variability exists nationwide in precipitation quality and quantity and their potential environmental impacts.

OBJECTIVES: Develop a nationwide information base of precipitation quantity and quality data. Evaluate regional variations in precipitation quantity and quality related to regional land use, as well as the way in which these precipitation quantity and quality variations influence stream discharge and chemistry.

APPROACH: Operate one precipitation station at the Las Animas fish hatchery near Las Animas, Colorado, as part of the National Atmospheric Deposition Network. Obtain information on precipitation quantity, quality, pH, and specific conductance for storm events. Collect samples for chemical analyses and send to the Illinois State Water Survey Laboratory. Coordinate computations of chemical loading and evaluation of areal and temporal variations in precipitation quantity and quality.

PROGRESS: The site for the precipitation station was selected and equipment installed in fiscal year 1983. Operation of the site began October 4, 1983.

PLANS FOR FY 1984: Continue operation and maintenance of the precipitation monitoring station in accordance with nationally consistent guidelines established for the network.

PROJECT TITLE: Flood Investigations

PROJECT NUMBER: CO-84-006

STUDY LOCATION: Statewide

COOPERATING AGENCY: Federal Emergency Management Agency

PROJECT CHIEF AND OFFICE: Harold E. Petsch, Jr., District Office, Lakewood

PROJECT DURATION: April 1984 to September 1986

PROBLEM: The National Flood Insurance Act of 1968 and the Flood Disaster Protection Act of 1973 provides for the operation of a flood-insurance program. The Federal Emergency Management Agency (FEMA) needs flood studies in selected areas to determine applicable flood-insurance premium rates.

OBJECTIVES: Conduct the necessary hydrologic and hydraulic evaluations and studies of areas assigned by FEMA, and present these results in an appropriate format.

APPROACH: Conduct the necessary evaluations or conduct surveys by ground or photogrammetric methods. Determine flood-discharge frequency relationships using local historical information, gaging-station records, or other applicable information. Determine water-surface profiles using step-backwater models or other acceptable methods, and furnish results in reports prepared to FEMA specifications.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Evaluate 20 cities and unincorporated areas of 4 counties for use of less-detailed flood-insurance study methods. Select most appropriate methods for each area; submit an estimated cost for such studies.

PROJECT TITLE: Statewide Water-Use Inventory

PROJECT NUMBER: CO-78-007

STUDY LOCATION: Statewide

COOPERATING AGENCY: Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer

PROJECT CHIEF AND OFFICE: Thomas J. Major, District Office, Lakewood

PROJECT DURATION: October 1977 to September 1984

PROBLEM: Water-use data in Colorado are not complete and detailed enough for planning purposes and implementation of a State Water Plan. Sources of water supplies, water use, and the volume of water consumed or available for multiple-use requires documentation, so that State and local managers and planners may be better informed to make decisions regarding development of the State's water resources.

OBJECTIVES: Develop an inventory procedure to obtain both current and future water-use data. Develop a computerized data base that can be accessed by a variety of users.

APPROACH: Obtain water-use data by contacting users (either in person or by mail) and soliciting their cooperation in determining what data they are collecting. If they are already collecting water-use data, ask them to complete a questionnaire in which water-use data are tabulated, if they are not collecting water-use data, devise techniques for converting available data into water-equivalent water-use data, or suggest techniques for collecting water-use data.

PROGRESS: A State data base has been created for storage and retrieval of water-use data. Data accumulated include: Water-rights tabulation; surface-water distribution maps; irrigated-acreage tabulation; and total yields of wells by county, township, irrigation district, and State water division. All major municipalities in the State have agreed to provide water-use and Standard Industrial Classification data. Thirty-one utility companies with irrigation accounts have agreed to provide energy-consumption data for use in estimating ground-water withdrawals. These data have been aggregated according to irrigation method and township. Data have been collected on the quantity of energy consumed to produce water from several hundred wells. These data will be used to determine, based on energy consumption, the amount of ground water pumped. During fiscal year 1983, limited funds were used to collate 1980 water-use data and to begin coding these data for entry into the Geological Survey's National Water-Use Data System (NWUDS).

PLANS FOR FY 84: Complete entry of 1980 water-use data into NWUDS. Assemble and review, prior to computer storage, data available for 1981-83. Obtain final reviews and approval for the report that estimates the volume of ground-water withdrawals, based on energy-consumption data.

PROJECT TITLE: Hydrology of Parachute Creek and Roan Creek Basins, Northwestern Colorado

PROJECT NUMBER: CO-75-066

STUDY LOCATION: Garfield County

COOPERATING AGENCY: U.S. Bureau of Land Management and U.S. Geological Survey

PROJECT CHIEF AND OFFICE: James M. Norris, District Office, Lakewood

PROJECT DURATION: July 1974 to September 1984

PROBLEM: Imminent development of synfuels has placed an increased amount of responsibility on the Federal Government to determine the hydrologic effects of oil-shale development. Problems affecting the water resources include water rights, water quality, and water quantity of the Colorado River Basin. To address the problems, streamflow, water-quality, and climatic data that can be incorporated into model analyses to predict runoff characteristics, ground-water and surface-water interactions, variations in water-quality conditions, and optimal water use are necessary.

OBJECTIVES: Provide data from selected sites in the Parachute Creek and Roan Creek basins to characterize high- and low-flow conditions, variation in water-quality, and ground-water and surface-water interactions including estimates of recharge to the Green River Formation aquifers prior to extensive oil-shale development.

APPROACH: Install hydrologic monitoring stations to collect stream-discharge and sediment-yield data. Collect water-quality data from the streams. Locate springs and collect discharge and water-quality data. Contact land owners to obtain permission to establish an observation-well network using their existing wells. Coordinate project activities with the activities of project CO-77-100 that is to develop a computer model of the ground-water system in the Piceance Creek, Parachute Creek, and Roan Creek drainage basins.

PROGRESS: Four continuous-record streamflow stations were operated through 1981; two were equipped with automatic suspended-sediment samplers and two were equipped with two-parameter water-quality monitors. Two stations were operated through 1982 and all monitoring activities were terminated for 1983. Discharge data and samples for water-quality analysis have been collected at 271 springs. An observation-well network has been established; 41 wells have been inventoried. Samples for water-quality analysis have been collected for wells and streams. Two production wells and 10 observation wells have been drilled for use in determining the hydraulic characteristics of the alluvial aquifer along Roan Creek; an aquifer test was completed. Channel geometry was determined at 10 sites; gain-and-loss studies were made. All data collected under this project are being compiled into a data report as well as entered into computer storage to facilitate additional analyses. During FY 83, the calibration phase of the precipitation-runoff modeling phase of the project was nearly completed.

PLANS FOR FY 84: Final model calibration and verification. Complete final report describing model calibration and potential for transferability of model parameters.

PROJECT TITLE: Ground-Water Resources of the Denver Basin

PROJECT NUMBER: CO-76-080

STUDY LOCATION: Weld, Morgan, Boulder, Jefferson, Adams, Arapahoe, Denver, Douglas, Elbert, Lincoln, and El Paso Counties

COOPERATING AGENCY: Adams County Board of Commissioners; Arapahoe County; City and County of Denver, Board of Water Commissioners; Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer; Elbert County Planning Department; El Paso County Board of Commissioners; and Douglas County Planning and Zoning Department

PROJECT CHIEF AND OFFICE: Stanley G. Robson, District Office, Lakewood

PROJECT DURATION: July 1975 to September 1984

PROBLEM: The Denver basin is underlain by four major bedrock aquifers. Increased pumpage from these aquifers, especially in localized areas in and near the major population centers along the Front Range, has resulted in a rapid decline of the aquifers' potentiometric surfaces because water is being withdrawn from the aquifers faster than it is being recharged. The geohydrology of the basin is complex and few data are available to determine water movement within and between aquifers, major areas of recharge to and discharge from the aquifers, chemical quality of water in the aquifers, and development potential of the multiple-aquifer system. A knowledge of the geohydrologic system of the basin is needed by State and local officials to more effectively manage the resource.

OBJECTIVES: Collect and interpret geohydrologic data needed to develop a computer model of the ground-water-flow system. Collect and interpret ground-water-quality data to better evaluate the water-supply potential of the bedrock aquifers. Develop a computer model of the ground-water-flow system that can be used to evaluate long-term effects of various water-management alternatives.

APPROACH: Collect and interpret geohydrologic data from wells completed in each aquifer. Establish an observation-well network to monitor water levels in each aquifer. Collect and interpret water-quality data from each aquifer. Determine coefficients of storage and hydraulic conductivity for each aquifer. Prepare maps summarizing all data collected. Develop a computer model of the ground-water-flow system.

PROGRESS: Geohydrologic data have been obtained from about 700 wells. Selected water-quality data have been obtained from about 500 wells; comprehensive water-quality data have been obtained from about 100 wells. Aquifer tests have been run on 80 bedrock wells, and data have been compiled for an additional 150 aquifer tests. Five hydrologic atlases showing the extent, thickness, structure, sand content, and water quality of the four bedrock aquifers have been prepared or are in the process of publication. A quasi-3-dimensional flow model of the four principal bedrock aquifers in the Denver basin has been constructed and calibrated. The model was used to define the steady-state water budget and to investigate the water-level response of the aquifers to various rates of pumping and artificial recharge. Results indicate that as much as 1,800 feet of water-level decline could occur in the confined parts of the deeper aquifers, if large rates of future pumpage occur.

PLANS FOR FY 84: Complete the final report.

PROJECT TITLE: Effects of Narrows Reservoir on Gain-and-Loss, Water-Quality, and Sediment Load Characteristics of the South Platte River

PROJECT NUMBER: CO-76-083

STUDY LOCATION: Morgan and Weld Counties

COOPERATING AGENCY: U.S. Bureau of Reclamation

PROJECT CHIEF AND OFFICE: Barbara C. Ruddy, Subdistrict Office, Lakewood

PROJECT DURATION: October 1976 to September 1984 with suspension during Fiscal Years 1980 and 1981

PROBLEM: Construction of the Narrows Reservoir will affect the gain-and-loss, water quality, and sediment-transport characteristics of the South Platte River. A knowledge of existing gain-and-loss, water-quality, and sediment-transport characteristics is needed so that the effects of the reservoir on these characteristics can be determined both during and after construction.

OBJECTIVE: Document existing gain-and-loss, water quality, and sediment-transport characteristics of the South Platte River by collecting base-line data.

APPROACH: Conduct gain-and-loss investigations throughout the irrigation season on a 25-square-mile study reach. Collect sediment-load data at a dam-site streamflow-gaging station in conjunction with sediment sampling at downstream irrigation ditch sites. Collect water-quality data at a streamflow-gaging station upstream from the proposed reservoir.

PROGRESS: Monthly gain-and-loss investigations, discharge and sediment measurements, and water-quality measurements have been made as scheduled. Daily sediment measurements were made at 12 canal sites and at the proposed dam site on the South Platte River. These measurements were supplemented by twice-monthly discharge and sediment measurements at these same sites. A sediment record is being compiled for the South Platte River at the proposed dam site. Data obtained through 1979 are published in a report entitled "Characteristics of the South Platte River in the vicinity of the proposed Narrows Reservoir near Fort Morgan, Colorado," Water-Resources Investigations Report 82-4071.

PLANS FOR FY 84: Complete final report, summarizing flow and sediment data for the project.

PROJECT TITLE: Water Resources Monitoring, Region Seven--West Central Colorado

PROJECT NUMBER: CO-77-096

STUDY LOCATION: Gunnison, Montrose, and Delta Counties

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: James M. Norris, District Office, Lakewood

PROJECT DURATION: February 1977 to September 1984

PROBLEM: Coal mining and associated developments of the scale and duration anticipated in major coal producing regions of the west may have adverse effects on the water resources of these regions. Mine dewatering, changes in land-use patterns, disposal of wastes, stream-channel realinement, and withdrawals of water for industrial and domestic use may significantly alter existing regional surface- and ground-water systems, limit available supplies, interfere with traditional water uses, and cause deterioration of the remaining water resources.

OBJECTIVES: Determine characteristics of the regional water-resources system, and provide an information base for use in detecting and documenting changes in the system or in its components that may be associated with land-use changes.

APPROACH: Evaluate the existing water-resources monitoring network in the North Fork Gunnison River basin for its regional surveillance value. Add additional monitoring stations or upgrade existing sites to provide information for specific land-use and geological areas within the basin. Based on graphical and statistical techniques, evaluate data that describe ground-water levels and quality and streamflows and their quality so that changes may be detected and documented.

PROGRESS: Streamflow was measured and water-quality samples were analyzed at 20 sites on the North Fork Gunnison River and tributaries. Of the more than 140 samples collected, approximately 30 percent were analyzed for metals, and the remainder for major dissolved chemical constituents. Average pH at the sites ranged from 7.6 to 8.3 (individual values ranged from 7.1 to 8.6), and average specific conductance ranged from 61 to 244 microsiemens per centimeter. The water in the basin predominantly is a calcium bicarbonate type. Preliminary data analysis indicates that the sources of water-quality constituents in the main stem and solubility controls are associated with the various geologic formations and mining activities adjacent to the North Fork Gunnison River main stem.

PLANS FOR FY 84: Compile and analyze all data for the 20 study sites and prepare final report.

PROJECT TITLE: Effects of Sludge Disposal on Ground-Water Quality

PROJECT NUMBER: CO-77-097

STUDY LOCATION: Arapahoe County

COOPERATING AGENCY: Metropolitan Denver Sewage Disposal District No. 1

PROJECT CHIEF AND OFFICE: Neville G. Gaggiani, Subdistrict Office, Lakewood

PROJECT DURATION: May 1977 to September 1988

PROBLEM: In 1983 nitrate-nitrogen concentrations in the hundreds of milligrams per liter were found in the alluvial aquifer within the sewage-sludge land-disposal site, located in Arapahoe County, Colorado. The Metropolitan Denver Sewage Disposal District No. 1 has been operating the site for more than 10 years. Although the high concentrations seem to be confined to the site, there is concern that the contamination could spread and affect ground-water quality adjacent to the site.

OBJECTIVES: Determine the location of, depth to, and areal extent of alluvial and bedrock aquifers beneath the sludge disposal site and adjacent area. Determine the direction of ground-water flow and the present quality of ground water.

APPROACH: Expand the present ground-water monitoring network within an approximate 28-square-mile area around the sludge disposal site. Using network wells, obtain water-level measurements and samples for water-quality analysis. Construct potentiometric-surface maps of the alluvial and bedrock aquifers to aid in determining ground-water flow paths. Solute transport potential will be evaluated based on estimates of aquifer hydraulic properties.

PROGRESS: Three samplings were made from the 15 observation wells near the sludge disposal areas. Results showed a high concentration of nitrate-nitrogen in 7 of the observation wells. Plans were made to expand the project to determine the location of, depth to, and areal extent of alluvial and bedrock aquifers beneath the sludge disposal site and adjacent area.

PLANS FOR FY 84: Increase ground-water quality sampling to quarterly. Wells drilled in November 1983 will be incorporated into the network for water-level measurements and water-quality sampling.

PROJECT TITLE: Ground-Water Model of the Piceance Structural Basin

PROJECT NUMBER: CO-77-100

STUDY LOCATION: Rio Blanco and Garfield Counties

COOPERATING AGENCY: Rio Blanco County

PROJECT CHIEF AND OFFICE: R. Theodore Hurr, District Office, Lakewood

PROJECT DURATION: August 1977 to December 1984, except for FY 81

PROBLEM: Rich oil-shale deposits in the Piceance basin eventually will be developed by industry. However, the draining of these deposits prior to development could cause widespread changes in the hydrologic regimen of the area. Extensive dewatering of the aquifers may reduce the flow of springs and streams. A hydrologic model has been developed to simulate the effects of mine dewatering on the regional ground-water system. However, a better understanding of the interconnections between aquifers themselves as well as with the surface-water system is necessary to provide a more reliable prediction of the consequences of oil-shale development.

OBJECTIVE: Improve the understanding of the ground-water flow system by determining the degree of hydraulic connection between the bedrock aquifers, the alluvial aquifer, and the streams, and by improving the model framework so that mine drainage impacts can be simulated realistically.

APPROACH: Improve the understanding of the ground-water flow system by obtaining additional well-log and testing data from oil-shale companies. Prepare improved potentiometric maps for the bedrock aquifers. In addition, appraise the vertical distribution of horizontal hydraulic conductivity using the relation between well yield and well depth. Sample bedrock aquifers at various sites for radionuclides to permit calculation of (1) residence times, and (2) regional-aquifer characteristics. Appraise stream-aquifer relations using gain-and-loss studies along Piceance and Yellow Creeks and stream discharge and water-quality measurements in Roan and Parachute Creeks. Improve model by the addition of the valley-fill alluvial aquifer as another model layer, and conversion of constant-head nodes to head-dependent discharge sites.

PROGRESS: The results of the preliminary modeling effort have been published in U.S. Geological Survey Water-Resources Investigations Open-File Report 82-637. The three-dimensional, five-layer digital model has provided the opportunity to obtain initial estimates of the aquifer system's hydraulic parameters. However, model results for parts of the Piceance basin appear to be somewhat anomalous. In an effort to obtain hydrologic information that would provide better understanding and knowledge of the surface- and ground-water systems, the following work elements were undertaken in FY 83. Nine samples of ground water from bedrock wells and springs were collected and analyzed for carbon-age dating of the water. Seepage gain-and-loss studies and collection of surface water samples were done on Piceance Creek and Yellow Creek as part of the effort to establish the degree of hydraulic connection between the bedrock aquifers and the shallow alluvial system. Aquifer tests were run to determine interconnection between the alluvial and bedrock aquifer systems. Drilling was done to improve knowledge of the extent of the alluvial aquifer in the Piceance basin.

PLANS FOR FY 84: Initiate a program of drilling and testing in the alluvial aquifer to better establish the degree of hydraulic connection between the bedrock aquifers and the alluvium. Include water-level measurements, slug and aquifer testing, and water-quality sampling. Interpret water age from carbon-age dating analyses. Complete surface-water sampling and flow measurements on Roan and Parachute Creeks. Modify the 3-D ground-water model to include the shallow alluvial system. Prepare a draft report presenting recent data, analyses, and interpretations.

PROJECT TITLE: Flood Hydrology of Foothill Streams in Colorado

PROJECT NUMBER: CO-78-106

STUDY LOCATION: Foothill locations above approximately 6,000 feet in central and western Colorado

COOPERATING AGENCY: Colorado Department of Natural Resources, Colorado Water Conservation Board; Urban Drainage and Flood Control District; U.S. Army Corps of Engineers; and the U.S. Bureau of Reclamation

PROJECT CHIEF AND OFFICE: Robert D. Jarrett, District Office, Lakewood

PROJECT DURATION: October 1977 to September 1986

PROBLEM: More than three-fourths of the people in Colorado live along or near the base of high mountains. Streams along the foothills are subject to flooding from both snowmelt and rainfall, but by far the most destructive type of flood results from "cloudburst-type" rainfall associated with severe thunderstorms during summer months. Because data on these floods belong to mixed statistical populations, standard techniques of flood-frequency analysis are inadequate. In addition, the data available are insufficient for detailed analyses.

OBJECTIVES: Develop methods for determining flood frequencies from records of mixed-population floods and for estimating flood characteristics at ungaged sites on streams where mixed-population floods occur.

APPROACH: Tabulate and evaluate existing flood and precipitation data. Develop methods for identifying and analyzing mixed-population floods using historical flood records. Develop techniques for estimating flood characteristics at ungaged sites using physical and climatical characteristics of foothill basins. Design and test hydrologic models for application in foothill basins. Determine what additional hydrologic data are needed and develop a network to collect these data.

PROGRESS: A literature search and review has been completed. Studies using geomorphic and botanic data and channel-geometry data to develop techniques for estimating flood characteristics at ungaged sites have been completed. Seventeen crest-stage gages have been installed and data are being collected. Methods are being developed for identifying and analyzing mixed-population floods. Records from an additional 69 gaging stations were used to separate snowmelt from rainfall floods. Statistical analysis of mixed-population flood records indicates that rainfall-produced floods are less prevalent at higher elevations than expected. A paper on debris flows has been published by the Association of Engineering Geologists in their bulletin, and a paper entitled "A multidisciplinary approach to the flood hydrology of foothills streams in Colorado" has been approved for journal publication. The project draft report entitled "Flood hydrology of foothills streams in Colorado," which provides analyses of mixed-population floods, is nearly complete. Peak-flow data collection at 16 crest-stage gages was continued.

PLANS FOR FY 84: Complete the final report for which a draft was started in FY 83.

PROJECT TITLE: Hydrology of Proposed Coal-Mining Areas, Moffat, Rio Blanco, and Routt Counties

PROJECT NUMBER: CO-79-113

STUDY LOCATION: Northwestern Colorado--Moffat, Routt, and Rio Blanco Counties

COOPERATING AGENCY: U.S Bureau of Land Management

PROJECT CHIEF AND OFFICE: Randolph S. Parker, District Office, Lakewood

PROJECT DURATION: October 1978 to September 1985

PROBLEM: To evaluate the impact of coal mining in the Yampa River basin, the hydrologic system of proposed coal-mining areas needs to be defined prior to the start of mining. Because it will not be possible to directly determine the hydrologic system of every proposed coal-mining area, a method of evaluation needs to be developed that can be easily adapted to areas for which detailed studies of the hydrologic system are not planned.

OBJECTIVES: Determine the existing quantity and quality of surface- and ground-water resources and predict the effects of coal mining on the hydrologic system. Develop a computer model that can be used to predict the effects of coal mining on the hydrology of areas in which intensive studies are not planned.

APPROACH: Obtain data requisite to development of a streamflow-oriented computer model by instrumenting watersheds to obtain climatic, land-use, soil-moisture, stream-discharge, and water-quality information for nine basins. Collect flow-oriented suspended-sediment samples at three sites as well as periodic water-quality data at gaged and miscellaneous sites in the Yampa River basin. Operate two climate stations.

PROGRESS: Calibration of the streamflow model using data from nine watersheds is complete. Two reports, one describing the calibration procedure and the other describing predictive capabilities of the model in the gaged watersheds and the potential for model transferability to ungaged basins, are being prepared. The watersheds used in model calibration represent the types of hydrologic environments encountered in the southern half of the Yampa basin where active coal mining occurs. Snowmelt is the major source of water in all these basins. Preliminary sensitivity analysis of model parameters shows that in a snow accumulation and melt situation, the parameter that indexes SMAX (maximum available water-holding capacity of the soil) is extremely important. A calibration procedure was developed that optimized SMAX for each hydrologic response unit within the basins. This calibration procedure uses vegetation type and elevation as independent variables to predict values for the parameter SMAX. Although the model generally is adequate, improvement in results could be gained by being able to model frozen soils and a shallow ground-water system that retains water for several years.

The water-quality data from both gaged and miscellaneous sites are being analyzed. Independent variables reflecting geology, climate, and land use are used to predict the major dissolved water-quality constituents for streams draining the north valley area of the Yampa basin.

PLANS FOR FY 84: Complete the final report documenting modeling activities. Continue water-quality data-collection activities on the north valley wall of the Yampa River basin. Plan final report on the synoptic water-quality program for FY 85 completion.

PROJECT TITLE: Hydrology and Reclamation Potential of Coal-Spoil Piles

PROJECT NUMBER: CO-79-114

STUDY LOCATION: Routt County

COOPERATING AGENCY: U.S. Bureau of Land Management, U.S. Geological Survey, and Colorado Water Conservation Board

PROJECT CHIEF AND OFFICE: Robert S. Williams, Jr., District Office, Lakewood

PROJECT DURATION: October 1978 to September 1984

PROBLEM: Coal mining will create large areas of spoil piles. The hydrology and reclamation potential of the piles need to be known so that their effects on the hydrologic system beneath and adjacent to the piles can be determined. Because it will not be possible to directly determine the hydrology and reclamation potential of all spoil piles, it is necessary to define the characteristics of a representative spoil pile that can be used in making inferences regarding impacts on hydrologic system of other spoil piles.

OBJECTIVES: Determine the hydrologic characteristics of coal-spoil piles. Determine changes in chemical quality as water moves through the piles. Determine the effects of various reclamation procedures on the hydrology of the piles. Determine the effects of the piles on the hydrologic system beneath and adjacent to the piles. Collect data that can be used easily in existing hydrologic models to predict the hydrology and reclamation potential of the piles, and the effects of the piles on the hydrologic system beneath and adjacent to the piles in areas in which intensive studies are not planned.

APPROACH: Install five drainage type lysimeters in a reclaimed spoil pile and four sets of six porous cup lysimeters in an undisturbed soil. Measure the quantity and quality of water percolating through the drainage-type lysimeters. Install soil water access tubes near the lysimeters to measure soil water content. Apply top soil to two of the drainage type lysimeters to determine the hydrologic effect of top soil and the spoil pile. Drill six wells in the spoil pile and four wells in nearby unmined areas. Measure water levels in all the wells and collect water samples for chemical analysis. Correlate water-quality analyses from the lysimeters, observation wells, and laboratory columns.

PROGRESS: All lysimeters have been installed and all wells have been drilled including four wells in the alluvium at the mine site. Soil-water measurements have been continued at all established sites. Three soil-water access tubes have been installed to the bottom of the spoil pile. A well has been drilled to the bottom of the spoil pile near each access tube. Water levels and water quantity and quality are being monitored at each site.

Preliminary results in a report currently being prepared indicate that soil-water content in the spoil pile differs from soil-water content in an undisturbed soil in the manner of deep percolation and time of peak water content. The spoil pile does not inhibit downward movement of water, as do the lower horizons in undisturbed soil profile. Consequently, a wetting front moves deeper in a spoil pile than it would in an undisturbed soil. The spoil pile reaches its peak soil-water content 30 to 45 days before a similar condition is reached in the undisturbed area.

The spoil-pile leachate had a dissolved-solids concentration of 3,600 milligrams per liter. Calcium, magnesium, and sulfate were the dominant ions in the leachate with sodium and bicarbonate present in lesser concentration. This high dissolved-solids content decreased from 1978 to 1979, but increased slightly from 1979 to 1980.

PLANS FOR FY 84: Complete and publish final project report.

PROJECT TITLE: Regional Monitoring of the Hydrologic System of Raton Mesa, Colorado

PROJECT NUMBER: CO-79-115

STUDY LOCATION: Las Animas County

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Peyton O. Abbott, Subdistrict Office, Pueblo

PROJECT DURATION: October 1978 to September 1984

PROBLEM: Proposed expansion of coal mining in the Raton Mesa coal fields may have adverse effects on the hydrologic system of the area. A knowledge of the existing hydrologic system is needed prior to the expansion of coal mining so that the effects of mining can be determined.

OBJECTIVE: Describe the hydrologic system of the area; determine the relations between climatic conditions, land-use, and geology and surface- and ground-water quantity and quality.

APPROACH: Locate five surface-water stations on the Purgatoire River, its major tributaries, and the Apishapa River. Collect discharge, water-quality, and suspended-sediment data at all stations. Provide a general index of the hydrology of the area by the distribution of gages, and monitor areas with proposed mining, as well as areas with little mining potential (base-line stations).

PROGRESS: Surface-water stations have been installed, and sediment, streamflow, and water-quality data have been collected. Both direct and automatic sediment-sampling techniques were used. Two high flows provided valuable data on sediment yield and water quality. A seepage investigation was conducted on the Purgatoire River to define gain-and-loss characteristics. All data have been evaluated and stored in the computer. A final report to summarize and evaluate data is being prepared.

PLANS FOR FY 84: Complete and publish the final report.

PROJECT TITLE: Montoring of the Hydrologic System in North Park, Jackson County, Colorado

PROJECT NUMBER: CO-79-117

STUDY LOCATION: Jackson County

COOPERATING AGENCY: U.S. Bureau of Land Management, Jackson County, and U.S. Geological Survey

PROJECT CHIEF AND OFFICE: Gerhard Kuhn, Subdistrict Office, Lakewood

PROJECT DURATION: October 1978 to September 1984

PROBLEM: The development of coal in Jackson County may have adverse effects on the hydrologic system in the county. A knowledge of the existing hydrologic system is needed prior to the beginning of coal mining so that the effects of mining can be determined.

OBJECTIVES: Define the hydrologic system of the area, interrelating surface flow and ground-water movement with climatic controls. Define the availability and quality of surface water in the study area.

APPROACH: Locate two complete surface-water monitoring stations in the Canadian River drainage, Colorado, to supplement existing data-gathering activities in the North Platte drainage basin. Determine sediment discharge, and analyze periodic water-quality samples at each site.

PROGRESS: Two continuous-record streamflow stations equipped with automatic sediment samplers and water-quality monitors, two partial-record rainfall-runoff stations, and five additional precipitation gages have provided data for the study area. A climatological station provided records of air temperature, wind, and solar radiation. All data collection was discontinued September 30, 1983. Data from the stations have been compiled and are available. Data from the study area have been utilized in the following two reports. Water-quality statistics for streams in Jackson County are published in a data report (U.S. Geological Survey Open-File Report 82-121). Some interpretation of the hydrologic system in North Park and adjacent areas in Wyoming is presented in a STOP-format report entitled "Hydrology of Area 54, Northern Great Plains and Rocky Mountain Coal Provinces, Colorado and Wyoming." This report has been approved for publication as Open-File Report (WRI) 83-146.

PLANS FOR FY 84: Climatological and streamflow data will be used in a preliminary attempt to calibrate a precipitation-runoff model for Williams Draw, an ephemeral stream in the North Park coal region.

PROJECT TITLE: Ground Water Studies in Coal-Mining Areas in Colorado

PROJECT NUMBER: CO-79-118

STUDY LOCATION: Statewide

COOPERATING AGENCY: U.S. Bureau of Land Management

PROJECT CHIEF AND OFFICE: Robert S. Williams, District Office, Lakewood

PROJECT DURATION: October 1978 to September 1984

PROBLEM: Coal mining may have adverse effects on ground-water resources in the vicinity of and downgradient from mine areas. Mine dewatering, changes in land use, disposal of wastes, and withdrawal of water for industrial and related uses may alter existing ground-water systems, limit available supplies, and cause deterioration of water quality. Few data are available for the ground-water systems containing coal beds.

OBJECTIVES: Determine the potentiometric surface and subsequent changes in the surface for each ground-water system containing coal beds. Determine the spatial distribution of the geohydrologic characteristics of the aquifers.

APPROACH: Establish an observation-well network to determine the potentiometric surfaces and to monitor water-level changes. Install continuous water-level recorders on some wells. Conduct aquifer tests and use geophysical logs to determine the geohydrologic characteristics. Collect water samples for chemical analysis.

PROGRESS: The data-collection phase of all project elements is complete. A final report for the North Fork Gunnison River study area was published during 1983.

PLANS FOR FY 84: Complete and publish two final reports: One on the Williams Fork Mountains and the other on seismic reflection and geophysical techniques.

PROJECT TITLE: Hydrology of the Southwest Alluvial Valleys Regional Aquifer System--Upper Rio Grande Basin

PROJECT NUMBER: CO-79-127

STUDY LOCATION: Rio Grande basin in south-central Colorado

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Glenn A. Hearne, District Office, Lakewood

PROJECT DURATION: October 1978 to September 1984

PROBLEM: Rapid population increases and consequent greater use of water resources is occurring in the "sunbelt" States of the southwest. To augment surface-water supplies, ground water from alluvial fill in desert basins is being developed. This development has resulted in continued water-level declines, land subsidence, depletion of streamflow, and water-quality changes.

OBJECTIVES: Define the hydrology of the alluvial-aquifer systems in the Upper Rio Grande basin as part of the analysis of the regional aquifer system. Determine the extent, hydraulic properties, water quality, and recharge to and discharge from the aquifers. Determine the relations between the ground water and surface water. Describe the flow system in the area and the response of the system to ground-water development.

APPROACH: Develop a water balance of the entire Upper Rio Grande basin using appropriate models for recharge and discharge. Develop a digital model for simulation of transient response to development in San Luis Valley north of San Luis Hills.

PROGRESS: A generalized geologic map has been prepared. Water-level changes from 1970 to 1980 were mapped for the unconfined aquifer. Data were inadequate to map water levels in the confined aquifer. A 2-D model of a section across San Luis Valley was developed and used to simulate pre-stress (1890) and 1950 conditions. The general response was similar to that reported for the valley and indicated that the 1950 condition was approximately stable. A 7-layer model was defined to simulate the transient response for 1950-79. Modifying the assumed areal distribution of withdrawals simulated water-level changes similar to those observed for the shallow aquifer north of San Luis Hills.

PLANS FOR FY 84: After final data review and further modification of the assumed areal distribution of withdrawals, the 7-layer model will be used to test selected hypotheses regarding data requirements and management alternatives. The summary report will be reviewed and submitted to the Region for approval.

PROJECT TITLE: Regional Streamflow and Water-Quality Monitoring in Larimer and Weld Counties, Colorado

PROJECT NUMBER: CO-79-130

STUDY LOCATION: Larimer and Weld Counties, Colorado

COOPERATING AGENCY: Larimer-Weld Regional Council of Governments

PROJECT CHIEF AND OFFICE: Steven R. Blakely, Subdistrict Office, Lakewood

PROJECT DURATION: June 1979 to September 1984

PROBLEM: Streamflow and water-quality data are needed to define present conditions and the impacts of urban runoff, nonpoint agricultural pollution, and sewage return flow. A complete and valid data base will be necessary for future planning, analysis, and modeling of water quality, low-flow stream characteristics, ground-water modeling, and demonstration of compliance to Federal and State water-quality standards.

OBJECTIVE: Define the quantity and quality of streamflow and the quality of selected lakes and impoundments in Larimer and Weld Counties. Investigate the principal drainages: Big Thompson River, Cache La Poudre River, and South Platte River.

APPROACH: Establish and operate streamflow stations; collect and chemically analyze water samples from rivers, lakes, and impoundments.

PROGRESS: Data collection includes records of continuous streamflow at two sites on the Cache La Poudre River, one each on the Big Thompson and Michigan Rivers, and two on Joe Wright Creek, as well as "contents" and monthly streamflow measurements made at five sites on the Cache La Poudre River and three sites on the Big Thompson River. Monthly streamflow measurements were also made at two sites on Joe Wright Creek and one site on Michigan River near Cameron Pass. Water-quality samples were collected at three locations and at three different depths on Horsetooth Reservoir in May, July, and September.

Initial data evaluation indicates that regression relationships of adequate reliability (an average coefficient of determination of 98 percent) exists between specific conductance and ionic concentrations such that the frequency of selected constituent determinations can be reduced.

PLANS FOR FY 84: Continue current data-collection schedule at all sites. Complete and publish a regional water-quality and streamflow basic-data report for Larimer and Weld Counties.

PROJECT TITLE: Effects of Energy Production Emissions on Colorado Lakes

PROJECT NUMBER: CO-80-131

STUDY LOCATION: Rio Blanco, Garfield, Mesa, and Delta Counties in northwestern Colorado

COOPERATING AGENCY: Bureau of Land Management, Environmental Protection Agency, Mesa County, and Delta County

PROJECT CHIEF AND OFFICE: John T. Turk, District Office, Lakewood

PROJECT DURATION: November 1979 to September 1984

PROBLEM: Current and proposed production of energy in Colorado and surrounding States will release acidic gases and other constituents that can affect the chemistry of precipitation and of poorly buffered lakes and streams. The water resources of the Flat Tops Wilderness Area in western Colorado are located downwind from areas of oil-shale development and coal-burning powerplants. The unreactive bedrock of the area, combined with the orogenic effect on precipitation, may cause the area to be particularly susceptible to adverse effects of energy production. Data on precipitation and lake quality do not exist to define predevelopment conditions or relative sensitivity of waters to input of additional chemical constituents.

OBJECTIVES: Delineate the areas in Colorado most susceptible to the influence of acid rain. Determine within susceptible areas the lakes with the least buffering capacity and smallest nutrient loading rate. Select lakes representative of other lakes within the susceptible areas for more detailed study. Determine baseline chemical quality of precipitation.

APPROACH: Select areas most susceptible to acidification based on: Downwind location from acidic-gas sources, unreactive bedrock geology, and large snowpack accumulation. Measure relative buffering capacity of the lakes by alkalinity-titration curves, and approximate nutrient loading by hypolimnetic-nutrient concentrations, snowpack amount and nutrient concentrations, and stream discharge rates and nutrient concentrations. Install and operate precipitation gages and weather station to collect samples for analysis of wet- and dry-deposition quality and data on wind direction and speed.

PROGRESS: Precipitation quantity and quality has been monitored at four sites in the study area. A reconnaissance of the Flat Tops Wilderness Area has been completed and a journal article was written describing the results. Results of this recent work on lakes in northwestern Colorado indicate that their sensitivity to the effects of acid rain can be predicted from a few readily determined characteristics, such as bedrock type and altitude. Statistical methods applied to information from a detailed study of lakes in the Flat Tops Wilderness Area, a basalt mesa, were successfully used to predict the sensitivity of lakes on Grand Mesa, a geologically similar area, almost 100 kilometers to the southwest. Alkalinity, a measure of the ability of a lake to neutralize added acids, was found to be highly correlated with altitude in the Flat Tops study. The slope of the alkalinity-on-altitude regression equation of the Grand Mesa lakes was equal to the equation initially developed for Flat Tops lakes. This would suggest that similar geochemical and hydrologic controls are important in the two areas. Further, the assessment of lake sensitivity in remote areas of the Western United States, where little historical information is available, can be made more cost-effective by employing such an approach in other geologically homogeneous areas. Instrumentation to provide detailed hydrologic information has been installed and operated at an index site in the Flat Tops Wilderness Area.

PLANS FOR FY 84: Continue operation of the index site in the Flat Top Wilderness Area to provide hydrologic information including precipitation quantity and quality, streamflow quantity and quality, lake quality, and biological characteristics. Additionally, perform a detailed limnological characterization of Mount Zirkel lakes.

PROJECT TITLE: Upper Black Squirrel Creek Basin Digital Model

PROJECT NUMBER: CO-81-143

STUDY LOCATION: Black Squirrel Creek basin, El Paso County, Colorado

COOPERATING AGENCY: Cherokee Water and Sanitation District

PROJECT CHIEF AND OFFICE: Douglas L. Cain, Subdistrict Office, Pueblo

PROJECT DURATION: Present through March 1986

PROBLEM: The Upper Black Squirrel basin is a State of Colorado designated ground-water basin and a major source of water for future supply. Large water-level declines have occurred in the basin since 1964. Recently, additional water-supply requirements have been created by the new Space Consolidation Center. The existing and anticipated water-supply demands make it necessary that hydrologic data be collected and evaluated to monitor ground-water changes and use the information to develop a two-dimensional digital model to be used in evaluating long-term water-use practices.

OBJECTIVES: Establish current water-level and water-quality conditions in the alluvial aquifer. Evaluate potential impacts of various options for development and use of alluvial ground water.

APPROACH: Inventory wells in the basin; select several wells for recorder installation. Make bi-monthly water-level measurements at remaining network wells. Measure specific conductance; sample wells selectively to obtain water for chemical analyses. Perform aquifer tests at selected wells to define variation in hydraulic properties. Use two-dimensional digital model to simulate long-term pumpage scenarios.

PROGRESS: Continuous ground-water-level recorders were installed on five wells in the basin. Available ground-water-level information was compiled and entered into the Statistical Analysis System (SAS) for plotting, checking, editing, and subsequent entry into the U.S. Geological Survey Ground Water Site Inventory (GWSI) data base.

PLANS FOR FY 84: Continue operation of recording wells, and perform aquifer tests as needed. Compile, collate, and enter into the computer available data necessary for development of ground-water model. Sample about 40 wells for selected chemical constituents.

PROJECT TITLE: Hydrology of the Closed Basin Project Area, San Luis Valley, Colorado

PROJECT NUMBER: CO-81-146

STUDY LOCATION: The study area is located in the Upper San Luis Valley in Saguache, Rio Grande, and Alamosa Counties

COOPERATING AGENCY: U.S. Bureau of Reclamation

PROJECT CHIEF AND OFFICE: Guy J. Leonard, Subdistrict Office, Pueblo

PROJECT DURATION: October 1980 to September 1984

PROBLEM: The Closed Basin project area is an internally drained part of the Closed Basin which is separated from the Rio Grande drainage in the Upper San Luis Valley. Significant quantities of water, which could be salvaged and put to beneficial use in agriculture and(or) used to partially fulfill Colorado's obligations to the interstate Rio Grande Compact, are lost to evapotranspiration.

OBJECTIVES: Describe thoroughly and evaluate quantitatively the hydrology of the project area. Construct and interrogate digital models necessary to evaluate the effect of well-field alternatives and pumping patterns on ground-water declines in the unconfined aquifer and confined zone.

APPROACH: Compile and evaluate existing data on wells, pumpage, vegetation, and ground-water and surface-water inflow to quantify hydrologic budget. Drill test holes to define hydraulic gradients, geology, hydrogeology, and chemistry. Build and interrogate a two-dimensional digital, difference model for well spacing and pumping patterns that would keep drawdown in the unconfined aquifer to 2 feet at the project area boundary.

PROGRESS: The two-dimensional ground-water model has been constructed and used to test well-field alternatives. Water levels have been recorded continuously in 215 wells. In 50 wells, gamma, gamma-gamma, and neutron logs have been completed. Temperature profiles have been measured in 25 wells and have been analyzed for vertical leakage. Water levels have been and are monitored continuously in 37 wells. Participated in onsite and computational aspects of six aquifer tests.

PLANS FOR FY 84: Continue to monitor water levels in 37 wells. Install recorders on 10 additional wells. Update the data base used for the ground-water model, and write report.

PROJECT TITLE: Central Midwest Regional Aquifer Study, Colorado

PROJECT NUMBER: CO-81-150

STUDY LOCATION: The Colorado part of this study is approximately the eastern one-half of Colorado east of the Front Range.

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Stanley G. Robson, District Office, Lakewood

PROJECT DURATION: October 1980 to September 1985

PROBLEM: Large volumes of ground water are contained in underutilized bedrock aquifers of Mesozoic and Paleozoic ages extending from eastern Colorado to Missouri. Development of these sources of water is hindered by lack of knowledge of the depth, permeability, and water quality found in the aquifers.

OBJECTIVES: Learn more about the geologic structure and hydrologic characteristics of the most promising bedrock aquifers in the Colorado part of the study. Study eight aquifers extending from the Front Range of the Rockies into Kansas, Nebraska, and Oklahoma.

APPROACH: Compile and analyze existing geologic and geophysical data to define the geologic structure of the aquifers. Use structure data to select wells that penetrate each aquifer. Use data from these wells to define the hydrologic characteristics of each aquifer. Use a regional model of the Dakota Sandstone to check the validity of the interpretive results.

PROGRESS: Structural mapping of bedrock aquifer units of Paleozoic and Mesozoic age in eastern Colorado has been completed. Other maps showing potentiometric surface, porosity, hydraulic conductivity, and aggregate sand, carbonate and evaporite thickness, have been compiled for the water-bearing units. Preparation of text and illustrations for final publication has begun.

PLANS FOR FY 84: Complete the final report to conclude the study.

PROJECT TITLE: Stream Water Resource Impacts of Energy Development within the White River Basin, Colorado and Utah

PROJECT NUMBER: CO-81-152

STUDY LOCATION: The study area includes the White River basin in northwestern Colorado and Utah

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Sherman R. Ellis, District Office, Lakewood

PROJECT DURATION: December 1980 to September 1984

PROBLEM: Various energy developments are now taking place or being planned across the States of Colorado and Utah. Decisions affecting the policy of the energy development need to consider all environmental impact aspects. The White River basin, located in northwestern Colorado and eastern Utah, has several forms of planned energy development including oil shale, coal, and natural gas. With this large anticipated energy development in the basin and associated population increases, there is a need to study current streamflow-quantity and -quality conditions and assess probable impacts of future changes.

OBJECTIVES: Describe hydrology of the study area in terms of water-resources availability and quality, prior to substantial energy development. Evaluate potential environmental and selected socioeconomic impacts of the energy-resource development plans.

APPROACH: Describe the current stream-water quality, aquatic biology, stream reaeration, traveltime, stream mean velocity, and existing alluvial ground-water conditions, including aquifer extent and hydraulic properties in the White River basin. Model the potential impacts of oil-shale development on salt loads in Piceance and Yellow Creeks and the White River. Evaluate the potential changes in streamflow regime that would result from construction of water-use projects, including effects from proposed reservoirs, canals, tunnels, and pumping plants.

PROGRESS: A journal article by Hackbart and Bauer describing the potential impacts of oil-shale development on salt loads in the White River was published in the journal of the American Society of Civil Engineers. Reaeration and time-of-travel studies were completed for the White River basin. Aquifer tests were made to determine the aquifer properties of the alluvial system from Powell Park, near Meeker, to Rangley.

PLANS FOR FY 84: Complete final report to include results of a reservoir-release and streamflow-routing model that can be used to assess effects of proposed reservoirs on streamflow in the White River.

PROJECT TITLE: Hydraulic and Water Quality Investigations of Springs in Roan Creek and Parachute Creek Basins

PROJECT NUMBER: CO-81-155

STUDY LOCATION: Roan Creek and Parachute Creek drainages in Garfield County

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: David L. Butler, Subdistrict Office, Grand Junction

PROJECT DURATION: October 1980 to September 1984

PROBLEM: Extensive oil-shale development is planned and preliminary work is in progress in the Roan Creek and Parachute Creek basins. Predevelopment information is needed to define the existing hydrologic system so potential adverse effects on the system due to oil-shale mining can be identified. Chemical and discharge information on the spring system in the basins would help define the ground-water system. Determination of ground-water/surface-water interaction is needed on the lower Green River and Wasatch Formations to refine a three-dimensional ground-water model for the Piceance structural basin currently under development in the Colorado District.

OBJECTIVES: Determine recharge-discharge relations of springs to the hydrologic system. Locate, if possible, springs discharging from lower Green River and Wasatch Formations. Determine the chemical quality of springs and relate that information to source formations. Determine concentration and variability of chemical constituents and select constituents which could be used as indicators of mining effects on water quality.

APPROACH: Assemble existing information on springs in the Uinta and upper Green River Formations. Prepare a geologic map of the study area and compile mineralogical information on formations. Previous studies have identified springs in the Uinta and upper Green River Formations; examine these springs for inclusion in a monitoring network. Conduct a field reconnaissance to identify springs discharging from the lower Green River and Wasatch Formations; if such springs are found, select candidate springs for monitoring. Then, establish a spring monitoring network, and, on a monthly basis, measure discharge and field parameters, and collect samples for analysis of common ions, organic carbon, phenols, cyanides, and dissolved-trace metals.

PROGRESS: Data collection for the fall sampling run in the upland plateau and ridges was completed in October. Thirteen upland springs and 14 lowland (canyon) springs were sampled. Of particular interest was a nitrate value of 11 milligrams per liter from one spring located in Roan Creek drainage. Additionally, 18 upland springs were visited by helicopter in February to collect mid-winter samples for chemical analyses. Results indicate little change in chemistry during winter. In November and December, gain-and-loss measurements were made along two selected reaches of Carr and West Fork Parachute Creeks. Water-quality samples were collected at each measurement site. Ion mass-balance calculations indicate that 7 to 8 percent of the ground-water inflow to Carr Creek may be from the lower Green River Formation. Changes in water chemistry in the West Fork basin were not sufficiently variable to determine possible source areas. The February sampling concluded data collection for the project.

PLANS FOR FY 84: Complete final report for the study.

PROJECT TITLE: Surface-Water Quality of Monument and Fountain Creeks and Nitrogen Concentration in the Widefield Aquifer

PROJECT NUMBER: CO-81-156

STUDY LOCATION: Monument Creek and Fountain Creek basins in El Paso and Pueblo Counties

COOPERATING AGENCY: El Paso County Water Association, City of Colorado Springs, Chapel Hills Water District, and Pueblo Area Council of Governments

PROJECT CHIEF AND OFFICE: Patrick F. Edelmann, Subdistrict Office, Pueblo

PROJECT DURATION: January 1981 to December 1984

PROBLEM: Rapid urban growth in the Colorado Springs area, anticipated changes in operation of wastewater-treatment plants, new State water-quality regulations, and elevated levels of nitrate (near 10 milligrams per liter as N) in a major aquifer used for municipal supply have led to a need for additional water-quality information from Monument and Fountain Creeks and the Widefield aquifer.

OBJECTIVES: Document variations in water quality in Monument and Fountain Creeks as it relates to municipal and industrial wastewater treatment and agricultural nonpoint sources. Define areal and seasonal variations in nutrient species in the Widefield aquifer.

APPROACH: Collect and evaluate monthly water-quality data from a network of 11 sites on Monument and Fountain Creeks. Evaluate water-quality data using histograms, regression analysis, and mass-balance approaches. Collect monthly samples from 5 wells and one-time samples from about 40 additional wells in the Widefield aquifer. Evaluate the data to show areal and seasonal variation of nitrogen species in the Widefield aquifer.

PROGRESS: Water-quality samples were collected monthly from 11 surface-water sites and 6 wells. Preliminary analysis of water-quality data indicated that Fountain Creek, most tributary streams, and the hydraulically connected ground-water system contain significant concentrations of various nitrogen forms. Plots of ground-water data illustrate large areal variations for nitrogen and dissolved solids. A preliminary nitrogen budget for the Widefield aquifer indicates Fountain Creek to be the primary contributor of nitrogen to the Widefield aquifer.

PLANS FOR FY 84: Continue collecting monthly water-quality data at 11 stream sites and bimonthly water-quality data at 6 municipal wells. Modify the data-collection program based on evaluation of data. Complete report describing water-quality variations in the Widefield aquifer.

PROJECT TITLE: Coal Region Data and Information Reports in Colorado

PROJECT NUMBER: CO-81-157

STUDY LOCATION: Coal regions in Colorado

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: David J. Lystrom, District Office, Lakewood

PROJECT DURATION: April 1981 to June 1985

PROBLEM: Development of coal resources are now taking place or being planned throughout the State of Colorado. The planning process requires current information concerning the hydrology, physiography, geology, and climate of coal resource regions. This information is at present dispersed in a variety of reports and unpublished data files of WRD (Water Resources Division) or other government agencies. Because this information is diversely located and may not be understandable to planners and managers, there is a need to compile available information in a form that will provide a basic description of hydrologic conditions for each coal resource region in Colorado.

OBJECTIVES: Compile information and publish a report describing basic hydrologic conditions for each major coal region in Colorado. These reports are intended for audiences ranging from the lay reader to the more technically-oriented planners and managers; with this audience in mind, the reports are not to be highly technical or interpretive. Present basic information to provide a background-information base describing hydrologic conditions prior to mining. Where information related to hydrologic impacts of mining is available, include a section describing these impacts. For the most part, only existing data will be used.

APPROACH: Use the STOP report format consistently for each coal region, according to guidelines provided by WRD's coal-program coordinator. This report format consists of a narrative page headed by a short subject title and a brief abstract. The narrative is supported by complementary illustrations on the adjacent page. A list of subjects, maps, graphs, and photographs will be selected based on a preliminary assessment of available data for each coal region report. Because only existing data will be used, flexibility will be given to authors to encourage innovation of subjects and illustrations.

PROGRESS: Coal area reports have been approved for North Park (Area 54), Raton Mesa (Area 61), and Yampa-White (Area 53) coal regions. The report for the Denver basin (Area 59) coal region has been submitted for U.S. Geological Survey Headquarters approval.

PLANS FOR FY 84: Publish reports for coal areas 54, 61, 53, and 59. Complete draft for coal area 58 (Gunnison River basin).

PROJECT TITLE: Regional Aquifer System Analysis of the Upper Colorado River Basin in Colorado

PROJECT NUMBER: CO-81-158

STUDY LOCATION: The Upper Colorado River Basin in western Colorado

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: O. James Taylor, District Office, Lakewood

PROJECT DURATION: July 1981 to September 1985

PROBLEM: Water demands are increasing in the Upper Colorado River Basin. Ground-water reservoirs may contain large supplies, but they have not been investigated. Effective water management cannot proceed until quantity and quality of available water supplies have been appraised.

OBJECTIVES: Locate major aquifer systems, estimate the volume of ground water in storage, determine the quality of available ground water, and estimate the hydrologic impacts of major withdrawals and injection.

APPROACH: Compile hydrologic and geochemical data from existing well logs and field inventory of wells and springs. Prepare and use simulation models to estimate the effects of withdrawals from and injection into various aquifer systems.

PROGRESS: A plan of study, U.S. Geological Survey Water-Resources Investigations Report 83-4184, has been published for the Upper Colorado River Basin RASA (Regional Aquifer System Analysis). The report describing the plan of study is being used to guide and distribute the workload among project personnel in the Colorado, Utah, and Wyoming Districts of the project area. Stratigraphic columns, geologic history, and hydrologic characteristics were reviewed for the project region. The stratigraphic columns were subdivided into 11 hydrogeologic units, based on depositional environment and lithology. A hydrologic atlas publication is in review and three others are in preparation. A basic-data report is nearly complete.

PLANS FOR FY 84: Submit three hydrologic atlases and one basic-data report for approval. Analyze aquifer characteristics and geochemical reactions for major aquifers. Begin simulation analysis of flow systems and preparation of three professional papers.

PROJECT TITLE: Comprehensive Hydrologic Quantity and Quality Model of the Arkansas River Basin, Colorado

PROJECT NUMBER: CO-82-159

STUDY LOCATION: The Arkansas River basin of southeastern Colorado

COOPERATING AGENCY: Southeastern Colorado Water Conservancy District and the U.S. Bureau of Land Management

PROJECT CHIEF AND OFFICE: Alan Burns, District Office, Lakewood

PROJECT DURATION: October 1981 to September 1985

PROBLEM: Major changes in water use and resultant water quality in the Arkansas River basin are having impacts on all water users. The current overappropriation of surface-water supplies has led to a complex water supply system of transmountain diversions, reservoir storage, and development of the hydraulically connected alluvial aquifer. There is currently no consistent, comprehensive means to assess the possible water quantity and quality effects of the many possible changes in the competing water uses.

OBJECTIVES: Construct and document a model capable of assessing the basinwide quantity and quality impacts resulting from changes in water use. This model would be an interactive, planning-type, stream-network model to simulate the impact of the adjacent alluvial aquifer, simulate a water-quality mix, and include the legal-priority system of Colorado Water law.

APPROACH: Develop the model from existing stream-network and stream-aquifer models. Develop stream-aquifer response functions, precipitation-runoff relationships, water-quality discharge relationships, and irrigation application/recharge factors for entry into the model. Calibrate and demonstrate examples of the model's predictive capabilities in workshops and describe them in a report.

PROGRESS: Computations to estimate monthly runoff in the Upper Basin, using snowpack, precipitation, temperature, and elevation indices as regression parameters, have been completed. Relationships between discharge and specific conductance and between specific conductance and other constituents for sites throughout the basin have been developed. All field work and interviews necessary to describe the operations of the river basin have been completed. A second version of the river-basin model that can route flows and loads through a basin has been set up on the computer. All accompanying interactive colorgraphics were developed and model calibration was initiated.

PLANS FOR FY 84: Complete runoff relationships for the rest of the basin. Develop and calibrate additional versions of the river-basin model; simulate additional components of the hydrologic system. Add additional interactive capabilities.

PROJECT TITLE: Impacts of Potential Reservoir Construction on Geomorphic and Hydraulic Conditions in the Lower Yampa River, Colorado

PROJECT NUMBER: CO-82-163

STUDY LOCATION: The study includes the main stem of the lower Yampa and Little Snake Rivers in Moffat County, Colorado

COOPERATING AGENCY: National Park Service

PROJECT CHIEF AND OFFICE: John G. Elliott, District Office, Lakewood

PROJECT DURATION: October 1981 to September 1984

PROBLEM: Proposed river storage and diversion projects for the Yampa River basin, northwestern Colorado, may reduce the magnitude and alter the sediment and water discharge through Dinosaur National Monument. Any changes in discharge may affect channel geometry, river pattern, sediment size, riparian conditions, and fish habitats. To determine minimum reservoir releases that would maintain natural conditions, existing discharge and sediment supply first must be quantified.

OBJECTIVES: Describe existing channel geometry, sites of sediment storage, and sediment size distribution. Establish a sediment transport relation. Identify the streamflow critical to existing channel geometry. Attempt to predict the nature of change in sediment transport, geomorphology, and sediment size given reduced streamflow from reservoir construction.

APPROACH: Use existing sediment transport and hydraulic-geometry relations to predict general fluvial changes resulting from the construction of water-impoundment structures. Supplement discharge and suspended-sediment data from two gaged sites in the study area with discharge, suspended- and bedload-sediment measurements at two sites in the Monument during the spring and summer of 1982.

PROGRESS: A total of 35 measurements of discharge and sediment loads have been completed in the 1982 and 1983 field seasons at streamflow-gaging station 09260050, Yampa River at Deerlodge Park. Additional measurements were made at 09260000, Little Snake River near Lily, and at the entrance to the Yampa Canyon of Dinosaur National Park. Data collection at 09260150, Yampa River below Box Elder Park, was suspended. Flow duration analysis has been completed and mean annual sediment loads through Deerlodge Park have been computed. Hydraulic-geometry relations have been derived from discharge data and channel cross sections.

PLANS FOR FY 84: Complete analysis of data and interpretation of data. Assess the effects of reduced streamflow and(or) sediment supplied to the Deerlodge Park reach. Present a report to the National Park Service, including the aforementioned analysis, as well as guidelines for further interpretive work.

PROJECT TITLE: Effects of Projected Urbanization on Inflows to Cherry Creek Reservoir

PROJECT NUMBER: CO-82-164

STUDY LOCATION: The study area includes the Cherry Creek drainage above Cherry Creek Reservoir, Arapahoe and Douglas Counties, Colorado

COOPERATING AGENCY: Denver Regional Council of Governments

PROJECT CHIEF AND OFFICE: Martha H. Mustard, Subdistrict Office, Lakewood

PROJECT DURATION: April 1984 to September 1988

PROBLEM: Cherry Creek Reservoir is a U.S. Army Corps of Engineers reservoir used extensively for fishing, swimming, and boating, located on the current edge of the Denver metropolitan-urban area. Urbanization upstream of the reservoir will affect the quantity and quality of urban runoff entering the reservoir. Changes in chemical composition of runoff as a result of watershed development could cause violation of water-quality standards set by the Colorado Water Quality Control Commission and affect the suitability of the reservoir for recreational activities.

OBJECTIVES: Monitor streamflow and collect samples under ambient and storm-runoff conditions for a 5-year period. Define ground-water levels and water quality in the alluvium upgradient of Cherry Creek Reservoir. Develop statistical relationships between water-quality loadings and precipitation and basin characteristics.

APPROACH: Monitor the quantity and quality of surface-water inflow; Cherry Creek and several principal tributaries will be monitored to provide data on seasonal and storm-event flow and water-quality conditions. Precipitation data will be provided by rain gages located in the basin. Variation in water-quality conditions will be defined by a sampling program that includes quarterly ambient and storm-event samples. Monitor the shallow ground-water system; water-level measurements and water samples will be collected at approximately 10 wells to define seasonal variations in the alluvial ground-water system near the reservoirs. Use multiple-regression techniques in the analysis of runoff and water-quality characteristics to determine how these variables relate to rainfall and basin characteristics.

PROGRESS: Preliminary results of a 1-year monitoring program show that most Cherry Creek Reservoir surface-water inflows are dry, except during very intense convective storms and after frontal storms of long duration. The major surface-water inflow to Cherry Creek Reservoir is Cherry Creek Tributary No. 1, which drains about 610 acres of urban area. The channel was reportedly dry during ambient conditions until development occurred in the basin; it now has base flow. Cherry Creek has a sand bed and flows intermittently. A basic-data report (U.S. Geological Survey Open-File Report 83-857) has been published.

PLANS FOR FY 84: Begin data collection in April 1984. Enter data generated during the year into WATSTORE. Deliver a data summary to the cooperator at the end of the water year, and each year thereafter. Complete and publish an interpretive report in 1988.

PROJECT TITLE: Evaluation of Water Resources in Cottonwood Creek, Ute Mountain Reservation, Colorado

PROJECT NUMBER: CO-82-168

STUDY LOCATION: Cottonwood Wash is located in the southwestern corner of Colorado near the town of Towoac on the Ute Mountain Indian Reservation

COOPERATING AGENCY: Ute Mountain Ute Tribe

PROJECT CHIEF AND OFFICE: Arthur L. Geldon, District Office, Lakewood

PROJECT DURATION: August 1982 to September 1984

PROBLEM: Water in the Ute Mountain area is in short supply because of the region's arid climate. Present data are inadequate to assess water resources. Cottonwood Wash, an intermittent to ephemeral stream, has a 16-square-mile watershed that is relatively undisturbed by human activity. A study of ground water, springs, and surface water in Cottonwood Wash will provide a basis for evaluating the availability of water in similar small watersheds regionally.

OBJECTIVES: Develop a water budget. Determine seasonal variations in spring discharge, stream discharge, ground-water storage, underflow from the drainage, and water quality. Determine transmissivity of the alluvial aquifer. Estimate impacts on the hydrologic system of using spring flow, surface flow, or alluvial ground water for domestic supply.

APPROACH: Inventory all springs and wells in the study area and enter all data in U.S. Geological Survey GWSI (Ground Water Site Inventory) computer files. Conduct seepage runs quarterly and collect semiannual water samples for major ions, selenium, barium, and bacteria from springs and streams as well as miscellaneous samples from wells. Drill and test three wells in alluvium to determine transmissivity. Integrate soils and vegetation data (collected and observed), climatic, and other physiographic data into PRMS (Precipitation-Runoff Modeling System) model to estimate water budget. Conceptualize hydrologic system, and assess impacts with two-dimensional ground-water model.

PROGRESS: A draft report has been written and is receiving technical review. The study revealed that most of the precipitation in the watershed is consumed by evapotranspiration; springflow is seasonal, but some springs flow year round. Water quality of springs and ground water deteriorates from good to poor from the upper to the lower part of the watershed. Finally, very little of the available water from surficial deposits currently is used.

PLANS FOR FY 84: Make final revisions to report based on review comments; publish report.

PROJECT TITLE: South Platte River Waste Assimilation

PROJECT NUMBER: CO-82-170

STUDY LOCATION: The South Platte River main stem extending from 50th Avenue in Denver upstream to Chatfield Reservoir

COOPERATING AGENCY: Cities of Littleton and Englewood, Colorado

PROJECT CHIEF AND OFFICE: Norman E. Spahr, District Office, Lakewood

PROJECT DURATION: June 1982 to September 1984

PROBLEM: The South Platte River in Denver is affected by point industrial and municipal discharges as well as several tributaries carrying urban runoff to the river. Little currently is known about the effects of treated waste-water effluent discharged during low-flow conditions on water-quality conditions of the South Platte River. Also, there is a lack of information on hydraulic properties which influence reaeration rates and time-of-travel of the South Platte River in this area.

OBJECTIVES: Determine time-of-travel of the South Platte in the study reach. Determine the extent of the mixing zone below the Bi-City WWTP (waste-water treatment plant) and measure residual chlorine, total ammonia, and field parameters in this zone. Determine diurnal variations during conditions of low-flow and warm and cold weather in carbonaceous biochemical oxygen demand, dissolved oxygen, stream temperature, pH, specific conductance, alkalinity, and selected nitrogen species in the South Platte and selected tributaries. Calculate un-ionized ammonia concentrations in the study reach. Calibrate and verify a one-dimensional steady-state water-quality model of the South Platte study reach for subsequent nitrogen concentration simulations.

APPROACH: Conduct three intensive 24-hour data-collection efforts during conditions of steady-state low-flow on the South Platte River (regulated at Chatfield Reservoir). Take water-quality samples and discharge measurements at selected instream sites and tributaries and municipal and industrial discharge sites. Conduct two time-of-travel runs and one reaeration data-collection run on the river. Collect data on benthic oxygen demand in the river; conduct two data-collection efforts to determine the extent of the mixing zone below the Bi-City WWTP and selected chemical constituent concentrations in that zone. Use the U.S. Geological Survey's one-dimensional, steady-state water-quality model (as documented by Bauer and others [Water-Resources Investigations Report 79-45, 1979)] to simulate selected constituent-species concentrations, based on hypothetical values of constituent-species concentrations in the effluent and levels of effluent discharge.

PROGRESS: The second of three regulated-flow data-collection efforts was completed during September 1983. Reaeration data were collected on selected reaches of the South Platte River. Water-quality samples were collected at 41 sites in the study area. These data will be used in conjunction with information from two additional sampling runs to calibrate the U.S. Geological Survey one-dimensional steady-state water-quality model.

PLANS FOR FY 84: Complete a third flow-regulated data-collection period in December of 1983. Calibrate a one-dimensional steady-state water-quality model for the study reach. Use model simulations to estimate the effects of hypothetical sewage effluent discharges. Complete a final report describing the procedures used for data collection, data interpretation, and results of the model.

PROJECT TITLE: Streamflow and Sediment Network Evaluation, Western Colorado

PROJECT NUMBER: CO-83-171

STUDY LOCATION: The mountainous regions of western Colorado

COOPERATING AGENCY: U.S. Bureau of Land Management and U.S. Geological Survey

PROJECT CHIEF AND OFFICE: James E. Kircher, District Office, Lakewood

PROJECT DURATION: October 1982 to September 1984

PROBLEM: Coal and oil-shale development in western Colorado is increasing the demand on the area's available water resources and, consequently, the need for quick, reliable methods of predicting streamflow conditions in ungaged basins. Therefore, there is a need to update the high-flow predictive equations available as well as develop predictive equations for low- and mean-flow characteristics, and sediment-discharge characteristics where sufficient data exist. The streamflow and sediment data-collection program of the U.S. Geological Survey in Colorado has evolved from a need for specific data rather than from a planned information collection system. Recent increases in costs of operations, constraints of funds and manpower, and public need for additional kinds of information have made necessary the evaluation of the existing gaging-station network.

OBJECTIVES: Develop regional relations for the prediction of streamflow and sediment characteristics in western Colorado. Use regional regression techniques to relate high, mean, and low-flow characteristics and sediment characteristics to channel and basin characteristics, where sufficient information is available for this analysis. Evaluate the existing network and look at reasons for operation of the gaging stations for future planning and adjustment of the streamflow data network.

APPROACH: Determine basin and climatic characteristics for the gaged basins from the latest maps available. Develop flow and sediment characteristics from observed streamflow development in the gaged basins to determine if any changes have occurred following development. Use state-of-the-art regression techniques to relate streamflow and sediment characteristics to basin, climatic, and channel characteristics. Establish a network-evaluation matrix to categorize and prioritize each data-collection site in accordance with set of network objectives.

PROGRESS: All basin, climatic, and hydrologic characteristics have been determined for all stations in the study area. An open-file report is being prepared summarizing this information for each site.

PLANS FOR FY 84: Complete statistical analyses that will define the regions and relationships for the determination of peak, high, low, and mean flows. Complete a report presenting these findings.

PROJECT TITLE: Assessment of Water Resources and Related Impacts Resulting from Military Training in the Pinon Canyon Area, Colorado

PROJECT NUMBER: CO-83-172

STUDY LOCATION: The study area is in southeastern Colorado, including tributaries of the Purgatoire and Apishapa Rivers in Las Animas County

COOPERATING AGENCY: Department of the Army, Fort Carson

PROJECT CHIEF AND OFFICE: Guy J. Leonard, Subdistrict Office, Pueblo

PROJECT DURATION: October 1982 to September 1988

PROBLEM: A 400-square-mile area will be acquired in the Pinon Canyon area by the U.S. Army and used for military training beginning in 1985. Conversion of land use from grazing may alter streamflow and water quality. These changes could not be quantified in the environmental impact statement for the acquisition, but are a concern to downstream water users in Colorado and Kansas. The Authorizing Act for the acquisition directs the Army to establish a system of hydrologic monitoring to collect baseline data and record changes in the quantity and quality of water flowing from the land acquired.

OBJECTIVES: Assess the quantity and quality of both surface- and ground-water resources in the area. Determine the impact of military training on the water resources of the area.

APPROACH: Monitor surface-water flow at 10 stations; two stations exist and eight stations were installed in FY 83. Monitor specific conductance continuously at all stations. Collect sediment samples by automatic samplers at seven stations. Collect water-quality samples of baseflow and storm runoff. Determine historic sediment yield by surveying sediment accumulation in 40 to 50 small reservoirs; these reservoirs will be resurveyed to determine sediment yield following military training. Inventory existing wells; sample 50 wells. Measure water levels monthly in 10 wells.

PROGRESS: Installed eight new streamflow-gaging stations and additional instrumentation at two existing streamflow-gaging stations. Installed 14 precipitation gages. Located and surveyed 30 small reservoirs. Hydrologic-data collection began.

PLANS FOR FY 84: Continue hydrologic-data collection. Locate and survey approximately 20 additional small reservoirs. Install stage recorders on five of the small reservoirs surveyed. Compile available data for existing wells in the area. Sample selected wells; choose a network of 10 wells for monthly water-surface elevation observation.

PROJECT TITLE: Modeled Impacts of Surface Coal Mining on Dissolved Solids in the Yampa River Basin, Northwestern Colorado

PROJECT NUMBER: CO-83-173

STUDY LOCATION: The study includes the Yampa River main stem and tributaries draining the valley south of the Yampa main stem. This area is in Routt and Moffat Counties, Colorado

COOPERATING AGENCY: U.S. Bureau of Land Management, Colorado Division of Mined Lands Reclamation

PROJECT CHIEF AND OFFICE: Randolph S. Parker, District Office, Lakewood

PROJECT DURATION: November 1982 to October 1984

PROBLEM: The Yampa River basin is an active area of coal mining. Many new mines and expansion of coal mines are proposed. These proposals must be considered with respect to the cumulative impacts on the hydrology downstream. Existing water-quality data indicate that substantial increases in dissolved solids have occurred downstream from existing mining activities.

APPROACH: Collect dissolved water-quality data on the major and minor tributaries of the Yampa River basin. Analyze water-quality data. Modify the Tongue River Dissolved Solids Model (Woods, 1981, U.S. Geological Survey Water-Resources Investigations Report 81-64) for major tributaries to the Yampa River and the Yampa River main stem by using these data and analyses.

PROGRESS: A model was developed to identify the cumulative effects of mining on dissolved solids downstream for the Trout Creek drainage and a reach of the Yampa River in northwest Colorado. Water quantity and quality is routed downstream through a series of nodes. The greatest increase in dissolved solids was noted in the small imbalances of Trout Creek and to Trout Creek itself. Little increase was noted in the Yampa River because of the large dilution effect.

PLANS FOR FY 84: Expand the model to include the total drainage of the Yampa River downstream to Maybell, Colorado; write a final report.

PROJECT TITLE: Hydrologic Reconnaissance of the San Juan River Region, Durango Coal Field in Southwest Colorado

PROJECT NUMBER: CO-83-174

STUDY LOCATION: The study area is the KCRLA (Known Coal Resources Leasing Area) including the Durango coal field of the San Juan River Region in parts of Archuleta, La Plata, and Montezuma Counties, Colorado

PROJECT CHIEF AND OFFICE: Tom D. Brooks, Subdistrict Office, Grand Junction

PROJECT DURATION: November 1982 to September 1984

PROBLEM: Active and potential surface and underground coal mines may be located above sandstone aquifers. Potentiometric surfaces for the sandstone aquifers may be above the coal seams and also may be used in a water supply. As coal mining in the area increases, a greater potential for aquifer disturbance will exist which may affect other local water users, the mining operation, and water quality.

OBJECTIVE: Define existing ground- and surface-water conditions in the study area.

APPROACH: Examine data records. Measure water levels. Conduct gain-and-loss measurements for selected streams. Map water-table or potentiometric contours. Analyze records of previous floods to determine the 100-year flood plain. Examine existing subsidence in mined areas within the study area. Determine the suitability of existing and collected information to assess mining impacts.

PROGRESS: Field work for the project has been completed. The data collected include an inventory of 39 wells with 25 sampled, an inventory of 4 springs with 2 sampled, and measurements at 14 stream sites with 4 sampled. Field work also included a survey of subsidence features at local mines, three sets of gain-and-loss measurements in the study area, development of rating curves for streamflow stations, a survey of the 100-year flood level in a stream valley, and a review of literature in the study area. The primary aquifer in the study area is the lower Menefee Formation and the upper Point Lookout Sandstone; both are primarily developed west of Durango.

PLANS FOR FY 84: Write the final project report.

PROJECT TITLE: Urban Studies Data Compilation and Analysis

PROJECT NUMBER: CO-83-176

STUDY LOCATION: Urban study areas nationwide

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Nancy E. Driver, District Office, Lakewood

PROJECT DURATION: January 1983 to December 1984

PROBLEM: Many Districts have conducted urban studies in which storm-event discharge, water-quality, and rainfall data have been collected. In most cases the data are not easily obtainable by interested users outside individual project offices. In addition, these data have not been compiled and interpreted on a regional basis.

OBJECTIVES: Compile the data into one urban-studies data base; conduct regional analyses to determine the significant climatic and basin characteristics that account for the variations in quality of runoff from urban watersheds.

APPROACH: Locate potential data sets from Districts that have conducted urban studies. Select only data sets that have documented runoff events. Check all data for quality assurance and load the data onto an urban-studies data-base magnetic tape. Compute annual and(or) storm loads for appropriate water-quality constituents. Determine which climatic and basin characteristics have significant impact on water quality, using statistical techniques such as multiple regression, cluster analysis, and regional regression.

PROGRESS: Districts were canvassed for candidate stations; a preliminary list of qualified stations has been developed. Data were transferred from WATSTORE to the Urban Hydrology Data Management System. Quality assurance checks on the stations currently are being made.

PLANS FOR FY 84: Complete the data compilation and prepare a data report. Initiate the regional-analysis phase of the study.

PROJECT TITLE: Water-Quality Reconnaissance of Blunn Reservoir

PROJECT NUMBER: CO-83-177

STUDY LOCATION: Jefferson County, Colorado

COOPERATING AGENCY: City of Arvada

PROJECT CHIEF AND OFFICE: Linda J. Britton, District Office, Lakewood

PROJECT DURATION: June 1983 to September 1985

PROBLEM: Blunn Reservoir presently is being filled, but faces potential problems associated with a rural-urban environment. Specifically, the irrigation canal that will be the major source of water to the reservoir may contain excessive nutrient concentrations that could provide conditions for rapid algal growth. Because the reservoir is in the filling stage, an opportunity exists to monitor the present water quality prior to its use as a drinking-water supply. In addition, a lack of data exists to describe the quality of inflows to the reservoir and to assess potential impacts on water stored in the reservoir.

OBJECTIVES: Provide an assessment of the chemical and biological quality of the reservoir. Provide an estimate of the water balance and loading of nutrients to the reservoir. Estimate the amount of algal growth that the reservoir is capable of supporting, as well as the substances that limit or stimulate growth. Evaluate the impact of various source waters to the reservoir. Estimate the primary productivity and trophic status of the reservoir.

APPROACH: Make thermal- and chemical-profile measurements biweekly; complete chemical and biological analyses of the water in spring, summer, and fall at several sites on the lake. Calculate water-balance to include inflow and outflow information, and nutrient loading from nutrient concentrations and estimates of storm loading. Complete algal growth-potential tests on source and reservoir waters. Use chemical and biological results to evaluate impacts on reservoir. Complete an estimate of primary productivity from oxygen-light-dark bottle sampling and trophic status from known indices.

PROGRESS: Vertical-profile measurements were conducted at three sites on the lake on a biweekly basis; water samples were collected monthly (during the summer) for chemical and biological analysis. The inflow of Ralston Creek was sampled on the same schedule. The lake thermally stratified and became anaerobic below the thermoline. Phytoplankton reduced the lake transparency to less than 1 meter at times.

PLANS FOR FY 84: Continue vertical-profile measurements and sampling in the spring and summer of 1984. Sample a new water source for the lake (Croke Canal) to determine its effect on lake water quality. Analyze the data for trophic status, algal control, and other limnological properties for a final report.

PROJECT TITLE: Analysis of Trends in Concentration and Load of Inorganic Solutes for the Colorado, Gunnison, and Dolores Rivers, Colorado and Utah

PROJECT NUMBER: CO-83-178

STUDY LOCATION: Colorado River Basin, Colorado and Utah

COOPERATING AGENCY: U.S. Bureau of Reclamation

PROJECT CHIEF AND OFFICE: Robert F. Middelburg, District Office, Lakewood

PROJECT DURATION: August 1983 to December 1984

PROBLEM: Salt load in the Colorado River causes millions of dollars damage annually to agricultural, industrial, and municipal users. There can be a number of reasons for trends in salinity loads at a particular site: (a) Natural changes in salinity input above the site, (b) climatic trends affecting streamflow, (c) man-induced changes in salinity input due to changes in agricultural or industrial activities, and (d) changes in streamflow patterns due to increased water use or the construction of reservoirs above the site. Determination of a downward or upward trend in salt load at monitoring locations and causes is required. Determination of the uncertainty at each monitoring site in terms of standard error of the salinity load as a function of the frequency of data collection also is needed. This would assist managers and planners in determining the data-collection frequency and associated costs needed to adequately define the salinity load in the study area.

OBJECTIVES: Review U.S. Bureau of Reclamation's method of computing monthly load values at four streamflow-gaging stations, using the U.S. Bureau of Reclamation's data base. Review the U.S. Bureau of Reclamation's methods and results for estimating concentration-streamflow relationships by comparing the U.S. Geological Survey results with those obtained by the U.S. Bureau of Reclamation. Analyze the salinity trends by using nonparametric techniques and compare results to the U.S. Bureau of Reclamation's regression approach. Evaluate the frequency of data collection by the use of an uncertainty curve; develop this method of analysis by evaluating one site.

APPROACH: Use state-of-the-art chemical-quality analyses and statistical techniques to evaluate the U.S. Bureau of Reclamation's method of computing monthly mean load values. Determine the best concentration-streamflow relations using state-of-the-art techniques; compare to results obtained by U.S. Bureau of Reclamation's regression-analysis approach. Determine method for determining uncertainty curves at salinity sites; test the method at one of the study sites; this would provide uncertainty relations that could be used by planners and managers to decide where additional data are needed, and to determine the optimal frequency of data collection.

PROGRESS: A final report titled "Trend analyses of salt load and evaluation of the frequency of water-quality measurements for the Gunnison, Colorado, and Dolores Rivers in Colorado and Utah" (U.S. Geological Survey Water-Resources Investigations Report 84-4048) has been published. Based on methods used in the preceding report, a followup effort in which the Geological Survey and Bureau of Reclamation are working jointly to develop a salinity-load data base for use in a planned Bureau report has been initiated.

PLANS FOR FY 84: Prepare a salinity-load data base for the period 1941-83 at 20 selected stations in the Colorado River Basin, to be available by June 1984. Prepare draft report documenting statistical procedures by October 1984. Finalize this report early in FY 85.

PROJECT TITLE: Analysis of the Sediment Data Network in Colorado

PROJECT NUMBER: CO-84-179

STUDY LOCATION: Statewide

COOPERATING AGENCIES: Colorado River Water Conservation District, U.S. Bureau of Reclamation, and U.S. Geological Survey.

PROJECT CHIEF AND OFFICE: John G. Elliott, District Office, Lakewood

PROJECT DURATION: October 1983 to September 1986

PROBLEM: Sediment data have been collected at surface-water sites for many years throughout Colorado by many different agencies. Most of these data have been published either in interpretive or in hydrologic-data reports. To date, however, there has been no coordinated effort to compile and analyze all sediment data available for Colorado streams. With the increased potential for coal and oil-shale mining and associated development as well as the future need for reservoirs and diversion structures, there is need to compile and interpret available sediment data so that it will be more usable to State and Federal water planning and management agencies. This need can be met by compiling data into a single data base and by preparing a statewide sediment yield map.

OBJECTIVES: Collate available sediment data; document location, source of data, and other pertinent technical information regarding the accuracy and usability of the data. Analyze available sediment data and prepare a statewide sediment yield map. Evaluate areas impacted by land-use changes, such as mining or agricultural development, where sediment data are available. Determine if sediment yield can be related to land use, basin, and climatic characteristics.

APPROACH: Tabulate and illustrate all data (including U.S. Geological Survey data) for presentation in a report. Compute annual sediment loads from daily-sediment stations. Make record extensions where they can be proven to be statistically sound. Regress mean annual sediment loads against land-use factors and basin and climatic characteristics to determine if variation in sediment loads can be explained by natural characteristics and man-induced development; the extent of this analysis will depend on the adequacy of the sediment data base.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Accumulate data from all agencies that have collected suspended sediment data in Colorado. Review data for accuracy and adequacy for use in yield computations. Determine yields at all locations where adequate information is available to define sediment-concentration/stream-discharge relationships.

PROJECT TITLE: Sources and Movement of Hazardous Wastes in a Heavily Used Stream-Aquifer System

PROJECT NUMBER: CO-84-180

STUDY LOCATION: El Paso County, Colorado

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Douglas L. Cain, Subdistrict Office, Pueblo

PROJECT DURATION: April 1984 to September 1987

PROBLEM: Stream-aquifer systems are among the most important sources of ground-water supply for municipal and agricultural uses in the semiarid west. Concurrently, the streams which are part of these systems often are used heavily for disposal of municipal, industrial, and agricultural waste water, resulting in a high potential for ground-water contamination. Currently, little is known about the concentrations, distribution, sources, and movement of hazardous substances in stream-aquifer systems.

OBJECTIVES: Determine the occurrence and distribution of organic substances and trace metals in the Fountain Creek stream-aquifer system. Determine if the occurrence or concentrations are related to land use or quality of recharge water. Evaluate the concentrations, sources, and movement of specific organic chemicals or metals in a small area of the stream-aquifer system; assess the applicability of the study results to other locations.

APPROACH: Assemble and evaluate existing data on water quality, well location and construction, land use, and waste discharge. Review literature on sampling methods for organics. Collect reconnaissance water-quality data from about 15 wells under each land use. Evaluate reconnaissance data for relationships. Select constituents for intensive study in a small area. Sample in small area, based on ground-water flow and recharge pattern, to determine temporal and spatial distribution, and source and movement of select constituents.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Assemble and evaluate existing geologic, hydrologic, water-quality and land-use data. Review literature, especially on sampling and occurrence of organic substances in ground water. Review records from existing wells to determine suitability for sampling. Prepare maps of existing and past land-use and point and nonpoint contaminant sources. Begin draft of preliminary report.

PROJECT TITLE: Dissolved Solids in the Colorado River Basin

PROJECT NUMBER: CO-84-181

STUDY LOCATION: Colorado River Basin

COOPERATING AGENCY: U.S. Bureau of Reclamation and U.S. Geological Survey

PROJECT CHIEF AND AGENCY: James E. Kircher, District Office, Lakewood

PROJECT DURATION: March 1984 to September 1986

PROBLEM: The salt load in the Colorado River causes millions of dollars in damage annually to agricultural, industrial, and municipal users. The U.S. Bureau of Reclamation is in progress of implementing various salinity control programs in the Upper Colorado River Basin to reduce salt loads to the river. There are indications of a decrease in salt load from some upper basin areas, but definitive causes for the decreases are not readily apparent. Hence, there is a need to determine if there is a trend in the salinity at the monitoring stations, and if so, the source of the trend.

OBJECTIVES: Determine for the Upper Colorado River Basin: (1) General source areas of dissolved solids and water discharge; (2) concentration variation at each station; (3) time series of annual dissolved-solids load at each site; (4) long-term trends in dissolved solids at each of the stations; (5) influence of man's activities on the salt load; and (6) develop a method to determine the natural salt load in the Upper Colorado River Basin.

APPROACH: Determine general source areas of dissolved solids by percentage of dissolved-solids load at the mouth of the Upper Colorado River Basin. Based on historical record, identify the range of concentrations of dissolved solids for each station. Determine and present the time series of annual dissolved-solids load, using state-of-the-art techniques. Using state-of-the-art statistical techniques, identify any long-term trends in dissolved solids that may exist. Using information on the development in the basin, project the historical salt load at each site in the Upper Colorado River Basin.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Determine percentage of dissolved solids contributed by each of the major tributaries in the Upper Colorado River Basin; determine time series of annual dissolved-solids load at four or five key stations. Additionally, determine if any trend exists in the annual time series of dissolved-solids load at four or five key stations in the Upper Colorado River Basin.

PROJECT TITLE: Intersubregional Transfer of Water--Central and Western United States

PROJECT NUMBER: CO-84-182

STUDY LOCATION: Continental United States west of the Mississippi River

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Harold Petsch, District Office, Lakewood

PROJECT DURATION: April 1984 to September 1984

PROBLEM: The Water Resources Division is proposing to develop a water budget for Water Resources Council Subregions of the United States for publication under the National Water Summary Program. Key components of the water budget are the transbasin and interbasin diversions resulting from man's development of water resources. Information to develop this data base must be requested from each U.S. Geological Survey, Water Resources Division District, in a manner consistent with national objectives.

OBJECTIVES: Develop a data base of net water imported and exported from each Water Resources Council subregion within the U.S. Geological Survey Water Resources Division, Central and Western regions, for the period October 1972 to September 1982.

APPROACH: Request each Water Resources Division District within the central and western Water Resources Division regions to provide annual amounts of water transferred between assigned Water Resources Council subregions by individual conveyances. Organize data provided and create data base.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Request Water Resources Division districts within the Central and Western Water Resources Divison regions to provide annual amounts of water transferred between assigned Water Resources Council subregions by individual conveyances. Organize provided data and create data base.

PROJECT TITLE: Preliminary Assessment of Methods for Determination of Evaporation Components by Water Resources Council (WRC) Subregions

PROJECT NUMBER: CO-84-183

STUDY LOCATION: Nationwide

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Norman E. Spahr, District Office, Lakewood

PROJECT DURATION: April 1984 to September 1985

PROBLEM: To estimate renewable water supply on a subregion basis for the National Water Summary, consumptive use must be known. Consumptive use includes industrial and agricultural consumption and net reservoir evaporation. Net reservoir evaporation is the water surface evaporation excluding the natural evapotranspiration that would occur had the reservoir not been constructed. Therefore, for the National Water Summary, estimates of natural evapotranspiration and gross evaporation will be needed on a Water Resources Division subregion unit basis.

OBJECTIVES: Determine deviations between values from the National Weather Service national evaporation map and values from site specific studies. Using test basins, determine order and magnitude and feasibility of computing natural basin evapotranspiration losses as compared to gross-reservoir evaporation. Create a data-base system of reservoirs having storage capacity greater than 5,000 acre-feet. Using created data base, develop history of reservoir development by hydrologic unit. Develop regional relationships to estimate surface area from storage capacity as current data do not include surface area.

APPROACH: Tabulate published and unpublished evaporation rates from energy-budget studies and compare to values from National Weather Service map. Evaluate techniques to determine water-budget components (evaporation, evapotranspiration) on a national basis, using selected test basins; test basins will be selected, based on criteria to simplify water-budget assumptions, i.e., best possible cases. If method will not work for best possible conditions, it will not work on a national basis. Using the U.S. Army Corps of Engineers' master inventory of dams, a file of reservoirs with storage capacity greater than 5,000 acre-feet has been generated; this file will be used as a reservoir-data base.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Tabulate published and unpublished rates that were determined using energy-budget techniques. Using the National Weather Service free-water surface evaporation map, determine evaporation rates for the same sites as were used in the energy-budget studies. Deviations between the Weather Service map and the energy-budget studies will yield information about the magnitude of errors that can be expected to be generated when using the Weather Service map to determine gross reservoir evaporation.

Choose test basins to use in the analysis of basin-evapotranspiration losses; include such selection criteria as size and location, amount of reservoir-surface area, period of streamflow and precipitation record, amount of agricultural activity, and other factors that may affect a water-budget analysis. Using the selected basins, evaluate how renewable water supply can be determined, using techniques that will be applicable on a national basis. Estimate errors associated with each term used to calculate renewable supply.

Generate a computer tape of reservoirs with storage capacity greater than 5,000 acre-feet from the U.S. Army Corps of Engineers' master inventory of dams. Using this data file as a data base, write software to generate summaries of reservoir-development history by hydrologic unit. Since surface area of the reservoirs in the data base is not available, develop statistical relationships between storage area and surface area by geographic regions. Adjust full-pool surface area to average-operational surface area by using equations found in the literature. The data base of reservoirs will have the capability to retrieve attributes of reservoirs by State and hydrologic unit.

PROJECT TITLE: An Update of Fluvial-Sediment Discharge to the Oceans from the United States

PROJECT NUMBER: CO-84-184

STUDY LOCATION: Nationwide

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Randolph S. Parker, District Office, Lakewood

PROJECT DURATION: April 1984 to September 1986

PROBLEM: Knowledge of the amount of sediment transported by the various rivers of the United States is important in designing reservoirs in order to allow sufficient space to store sediment expected to accumulate in them; in predicting the fate of contaminants such as pesticides, radionuclides, and toxic metals which can be absorbed to the sediment particles; and in indicating regional and continental rates of erosion. A summary of transported sediment will be important to the hydrologic community.

OBJECTIVES: Calculate sediment outflow to the oceans from the major sediment-producing rivers of the United States. In addition, give examples of changes in sediment yields from man's activities upstream, and examples of extreme events and their impact on sediment production.

APPROACH: Calculate sediment yields of major river basins in the United States from data contained in WATSTORE. Take examples of the impacts of man's modifications and extreme events from the literature.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Compile sediment yields for various rivers in the United States. Identify examples of the historical effects of reservoirs on sediment from the literature. These examples and calculations will be used as a chapter in the 1984 National Water Summary to be written by the U.S. Geological Survey.

PROJECT TITLE: Significant Accomplishments in Coal Hydrology, 1974-1984

PROJECT NUMBER: CO-84-185

STUDY LOCATION: Nationwide

COOPERATING AGENCY: U.S. Bureau of Land Management and U.S. Geological Survey

PROJECT CHIEF AND OFFICE: Linda J. Britton, District Office, Lakewood

PROJECT DURATION: March 1984 to October 1985

PROBLEM: During the past 10 years, the U.S. Geological Survey has conducted more than 250 hydrologic studies nationwide to assess the hydrologic effects of coal mining. This information needs to be summarized and the major study findings and accomplishments disseminated for informational and program-development purposes.

OBJECTIVES: Provide a general source of information on the accomplishments of the coal-hydrology program to Federal and State agencies that are concerned with planning, regulating, and enforcing land use and that are making water-resources and development decisions. The report also will contain a section on hydrologic information and research that still is needed.

APPROACH: Compile the accomplishments and findings of the coal-hydrology program, as related to issues and problems, through a coordinated effort by personnel of the U.S. Geological Survey and other Federal agencies. Discuss history, objectives, program design, application of results, and study needs from a national perspective in this report.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Begin organizing duties for personnel contributing to summarization of accomplishments in the coal-hydrology program. Compile information on history, objectives, and design of program; organize topics and results for final report.

PROJECT TITLE: Water Quality of Taylor Draw Reservoir

PROJECT NUMBER: CO-84-186

STUDY LOCATION: Rio Blanco County, Colorado

COOPERATING AGENCY: Colorado River Water Conservation District

PROJECT CHIEF AND OFFICE: Robert L. Tobin, Subdistrict Office, Meeker

PROJECT DURATION: April 1984 to December 1987

PROBLEM: Taylor Draw reservoir is a small-capacity reservoir (13,000 acre-feet) scheduled for completion on the White River in summer of 1984. The reservoir will have a short hydraulic residence time, except during late summer and fall and in low-flow years. During these periods, the reservoir may develop thermal stratification with associated changes in dissolved oxygen, biology, and chemical constituents. To evaluate these changes and the impacts of sediment loading to the reservoir, data must be collected at several depths throughout the year. This information, combined with sediment inflow-outflow data, will provide a 3-dimensional definition of the physical state of the reservoir including the rate of sediment deposition.

OBJECTIVES: Collect sufficient data to describe chemical and biological conditions, and the dynamics that occur within the reservoir during the first 2 years after filling. Make estimates of sediment retention and reservoir trap efficiency. Summarize all data in an interpretive report.

APPROACH: Determine water-quality characteristics with depth seasonally at two or three sites, from profile measurements of temperature, specific conductance, pH, and dissolved oxygen. Determine major ions, nutrients, trace metals, phytoplankton identification, chlorophyll a and b, and bacteria from samples taken at specific depths. Determine sediment loading to the reservoir from bedload and suspended-sediment collections at stream-gaging stations above and below the reservoir. Review data annually for their applicability to meeting study objectives and make necessary program changes.

PROGRESS: New project in FY 84.

PLANS FOR FY 84:

Develop sampling strategy, obtain necessary equipment, and instruct personnel on sampling techniques. Begin sediment data collection in April 1984; initiate reservoir sampling as the reservoir fills. Construct a stream-gaging station downstream from the dam following completion of the reservoir.

PROJECT TITLE: Total Sediment Transport at Colorado Reservoir Sites--Una Site, Colorado River near De Beque, Colorado

PROJECT NUMBER: CO-84-187

STUDY LOCATION: Mesa County, Colorado

COOPERATING AGENCY: Colorado River Water Conservation District

PROJECT CHIEF AND OFFICE: David L. Butler, Subdistrict Office, Grand Junction

PROJECT DURATION: April 1984 to September 1985

PROBLEM: Sediments transported by rivers flowing into reservoirs are deposited throughout the length of the impoundment. Deposits may occur in the upper reaches of the reservoir and are controlled by hydraulics as water depths increase and flow velocity decreases. With decrease in velocity, bedload or coarser material is dropped first; subsequently, sand-sized material is deposited. Ultimately, finer silt and clay fractions in suspension are deposited, usually farther within the reservoir.

Sediment deposition in reservoirs influences dam design in several ways. Deposition near the dam affects the location of inlet and outlet works. Delta buildup near the extreme upper end of reservoirs can increase water-surface elevations and result in an increase in inundated lands. To estimate total load and sedimentation rate, the following information is required: (1) Water discharge, (2) suspended-sediment concentration and size distribution, and (3) bedload-transport rate and size distribution.

OBJECTIVES: Measure the total inflow of suspended-sediment and bedload into reservoirs or through reaches of potential reservoir construction. Estimate the effect of sediment deposition on the operational policy of the reservoir, given the design characteristics of the dam.

APPROACH: (1) Using standard techniques, collect suspended-sediment, bed material, and bedload data; (2) develop suspended-sediment, bedload, and total sediment-discharge relations, based on the collected data and on estimates from empirical techniques such as the Colby and modified Einstein equations; (3) compute annual sediment discharges at potential reservoir locations, using the sediment ratings and streamflow data; and (4) estimate the trap efficiency of the reservoir, the specific weight of the deposited sediment, and distribution of the sediment within the reservoir to assist in the design of reservoir structure and operating pilings.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Obtain onsite data to define suspended and bedload transport for a range in discharge at the Una reservoir site during the 1984 snowmelt period. Create necessary data bases for final analyses to be completed in FY 85.

PROJECT TITLE: Bedrock and Alluvial Aquifer Hydrology of the Denver Basin

PROJECT NUMBER: CO-84-189

STUDY LOCATION: Denver metropolitan area and surrounding counties

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Stan G. Robson, District Office, Lakewood

PROJECT DURATION: May 1984 to September 1985

PROBLEM: Continued population growth in the Denver metropolitan area has increased the demand for supplies of potable water in an already water-short semiarid area. Ground water in alluvial and bedrock aquifers is being relied on more heavily to meet some of this demand. However, additional pumpage can infringe on existing water rights in the aquifers or on diversion rights to streams. Geohydrology of the bedrock-alluvial aquifer system is complex and poorly understood by the average water user. A nontechnical description of these ground-water supplies is needed to provide the layman with an understanding of the supply potential of the aquifers.

OBJECTIVES: Bring together existing data on the geohydrology of the alluvial and bedrock aquifer system, and with limited additional hydrologic study, present the information in a nontechnical publication suitable for use by the general public. Provide through this publication a layman discussion of the various aspects of the hydrologic system in the Denver basin, through use of simply written text, illustrations, and tables.

APPROACH: Compile, evaluate, and restate the geologic and hydrologic principles affecting the operation of the linked bedrock-alluvial aquifer system. Most of the geohydrologic information needed to prepare the text currently is available in the large resource of technical literature. However, some additional hydrologic analyses likely will be required to assure compatibility of results and avoid gaps in interpretation.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Collect and compile basic data and published reports, and reduce the large amount of available information to a usable form. Provide a complete understanding of the geohydrology of the alluvial-bedrock aquifer system by hydrologic evaluation.

PROJECT TITLE: Pilot Study of Scour Around Bridge Piers

PROJECT NUMBER: CO-84-190

STUDY LOCATION: Statewide

COOPERATING AGENCY: Federal Highway Administration

PROJECT CHIEF AND OFFICE: Robert D. Jarrett, District Office, Lakewood

PROJECT DURATION: May 1984 to September 1985

PROBLEM: Scour data at bridges are needed to evaluate scour formulas used by bridge engineers. A pilot study is needed to better define the approach and to assess the potential for success in obtaining necessary information prior to setting an agreement between the U.S. Geological Survey and the Federal Highway Administration to collect scour data at sites nationwide.

OBJECTIVES: Obtain hydraulic and scour data at bridge sites and develop sample work plans that describe methods of collecting scour data.

APPROACH: Select three to five bridge sites on sandbed streams by contacting Colorado Department of Highways and U.S. Geological Survey personnel. Collect discharge, scour depths at piers, cross sections, and slope of the water surface for three flow conditions at the bridge sites. Photograph the flow conditions. Compare measurements of scour to estimates of scour from scour formulas. Prepare sample work plans for further data collection.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Select three to five bridge sites where scour might occur in sandbed channels. Collect hydraulic and scour data at three flow conditions at the selected sites. Begin a data report.

PROJECT TITLE: Hydrologic Impacts of Ground-Water Development in the Wet Mountain Valley, Colorado

PROJECT NUMBER: CO-84-191

STUDY LOCATION: Custer and Huerfano Counties, south-central Colorado

COOPERATING AGENCY: Round Mountain Water and Sanitation District

PROJECT CHIEF AND OFFICE: Russell K. Livingston, Subdistrict Office, Pueblo

PROJECT DURATION: July 1984 to September 1985

PROBLEM: Extensive development of water supplies from the deep part of the aquifer in the Wet Mountain Valley could cause large water-level declines in this interval. Vertical connection in the aquifer also may allow head declines in the shallow part of the aquifer that would affect existing rights to surface water and ground water in the area. Such changes in the direction of ground-water movement could cause poor-quality water to move from areas of shallow water table to depth in the aquifer.

OBJECTIVES: Provide a better understanding of the hydrologic system in the Wet Mountain Valley, Colorado, and determine the extent to which the quantity and quality of surface and ground water in the valley might be affected by proposed development of ground-water resources.

APPROACH: Prepare a work plan to indicate the nature and extent of data-collection needs. Estimate evapotranspiration and aquifer characteristics and use, with other data, to construct a multilayer flow model of the valley-fill aquifer. Model simulation will indicate the effects of pumping on water levels at various depths in the aquifer.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Begin writing of work plan to be completed in FY 85. Describe in the work plan additional hydrologic-data needs and analytical (modeling) techniques to be used in the study.

PROJECT TITLE: Study of Colorado Water-Quality Monitoring Activities

PROJECT NUMBER: CO-84-192

STUDY LOCATION: Statewide

COOPERATING AGENCY: None--U.S. Geological Survey funds only

PROJECT CHIEF AND OFFICE: Tom Chaney, District Office, Lakewood

PROJECT DURATION: September 1984 to April 1985

PROBLEM: Water-quality information is collected by universities, private companies, and local agencies. At present (1984), no systematic information base is available that records which organizations collect water-quality data, what type of data are collected, where data are collected, availability and accuracy of the data, and the costs of collecting the data. Without knowledge of the type and quantity of data available, agencies may be duplicating efforts, or agencies may not be aware of existing data that would meet their needs. Federal, State, and local agencies, by coordinating their sampling activities, may increase the efficiency of their data-collection operations.

OBJECTIVES: Determine the number of Federal, State, and local agencies, as well as universities and private laboratories, conducting water-quality sampling program and analyses. Determine the type and quantity of data collected by these organizations. Determine the purpose of the data collection. Determine annual expenditures and their source.

APPROACH: (1) Interview key officials from agencies such as the Environmental Protection Agency, Colorado Department of Health, Colorado State University, and the Water Resources Institute to present standard questionnaire; obtain background information on sampling strategies and identify contacts at local government level for operation of water-supply systems and sewage-treatment plants; and identify major ongoing projects; (2) interview representatives of Federal, State, and local agencies and universities and private laboratories; (3) mail questionnaire to Federal, State, or local agencies and universities and private laboratories as appropriate; provide followup letter or telephone call as appropriate; (4) compile data into standard tabular format by level of government and by type of sampling activity; (5) tabulate financial data by funding source; (6) provide summaries of tabular data; (7) summarize Federal, State, and local legal requirements for Colorado; and (8) provide overview of data results, an evaluation of the degree of overlap, and discussion of the possibilities for coordination.

PROGRESS: New project in FY 84.

PLANS FOR FY 84: Make initial contacts with public agencies that conduct water-quality programs in Colorado. Complete a draft report by April 1985 that describes various agencies' programs and their purposes.

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U.S. GEOLOGICAL SURVEY: WATER-RESOURCES DATA REPORTS for Colorado and for the 1982-1984 water years--are available only from:

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Water-Resources Data Reports

[Reports are available from Open-File Services Section, Western Distribution Branch, U.S. Geological Survey, Box 25425, Denver Federal Center, Lakewood, CO 80225, except as indicated]

1. Adams, D. B., Goddard, K. E., Patt, R. O., and Galyean, K. C., 1983, Hydrologic data from Roan and Parachute Creek basins in northwestern Colorado: U.S. Geological Survey Open-File Report 83-859 (in press).
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4. Britton, L. J., 1983, Data compilation of benthic invertebrates from tributary streams of the Yampa and North Platte River basins, northwestern Colorado: U.S. Geological Survey Open-File Report 83-140, 99 p.
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15. _____1983, Water resources data for Colorado--Water year 1982, Volume 3, Dolores River basin, Green River basin, and San Juan River basin: U.S. Geological Survey Water-Data Report CO 82-3, 366 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161.

Water-Resources Interpretive Reports

[*, Contact District Chief for availability of report]

1. *Abbott, P. O., 1983, Hydrology of Area 61, Northern Great Plains and Rocky Mountain Coal Provinces, Colorado and New Mexico: U.S. Geological Survey Water-Resources Investigations Report 83-132 (in press).
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12. Britton, L. J., 1984, Reconnaissance of benthic invertebrates from tributary streams of the Yampa and North Platte River basins, northwestern Colorado: U.S. Geological Survey Water-Resources Investigations 83-4191, 73 p.
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46. Schneider, P. A., Jr., and Turk, J. T., 1983, A reconnaissance of groundwater contamination at selected landfills in Colorado: U.S. Geological Survey Water-Resources Investigations Report 83-4021, 33 p.
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51. Teller, R. W., and Chafin, D. T., 1984, Selected drill-stem test data for the Upper Colorado River Basin: U.S. Geological Survey Water-Resources Investigations Report 84-4146 (in press).

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PROJECTS COMPLETED EXCEPT FOR REPORTS DURING FISCAL YEARS 1983 AND 1984

Project number	*Project title*	*Project Chief*
CO-066	Hydrology of Parachute Creek and Roan Creek Basins, Northwestern Colorado	James M. Norris
CO-080	Ground-Water Resources of the Denver Basin	Stanley G. Robson
CO-096	Water Resources Monitoring, Region Seven--West Central Colorado	James M. Norris
CO-106	Flood Hydrology of Foothill Streams in Colorado	Robert D. Jarrett
CO-113	Hydrology of Proposed Coal-Mining Areas, Moffat, Rio Blanco, and Routt Counties	Randolph S. Parker
CO-114	Hydrology and Reclamation Potential of Coal-Spoil Piles	Robert S. Williams
CO-115	Regional Monitoring of the Hydrologic System of Raton Mesa, Colorado	Peyton O. Abbott
CO-117	Monitoring of the Hydrologic System in North Park, Jackson County, Colorado	Gerhard Kuhn
CO-129	Sediment Chemistry at Prospective Surface Mining Sites	John T. Turk
CO-155	Hydraulic and Water Quality Investigations of Springs in Roan Creek and Parachute Creek Basins	David L. Butler
CO-156	Surface-Water Quality of Monument and Fountain Creeks and Nitrogen Concentration in the Widefield Aquifer	Patrick F. Edelmann
CO-157	Coal Region Data and Information Reports in Colorado	David J. Lystrom
CO-170	South Platte River Waste Assimilation	Norman E. Spahr
CO-173	Modeled Impacts of Surface Coal Mining on Dissolved Solids in the Yampa River Basin, Northwestern Colorado	Randolph S. Parker

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