WATER-RESOURCES INVESTIGATIONS
OF THE U.S. GEOLOGICAL SURVEY
IN COLORADO--Fiscal Year 1983

Compiled by R. O. Hawkinson and D. J. Lystrom

U.S. GEOLOGICAL SURVEY

Open-File Report 83-138

Lakewood, Colorado

1983

UNITED STATES DEPARTMENT OF THE INTERIOR

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CONTENTS

CONTENTS--Continued

ILLUSTRATIONS

TABLE

METRIC CONVERSION FACTORS

Multiply	By	To obtain
foot	0.3048	meter
mile	1.609	kilometer
acre	0.4047	hectare
square mile	2.590	square kilometer
gallon per minute	0.06309	liter per second
acre-foot	0.001233	cubic hectometer
ton	0.9072	metric ton

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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 1983 fiscal year (October 1, 1982, to September 30, 1983).

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, Colo. 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 1983 are:

Adams County Board of Commissioners
Arapahoe County
Arkansas River Compact Administration
Central Yuma Groundwater Management District
Chapel Hills Water and Sanitation District
Cherokee Water and Sanitation District
City of Aspen
City of Aurora
City of Colorado Springs, Department of Public Utilities
City of Colorado Springs, Office of the City Manager
City and County of Denver, Board of Water Commissioners
City of Englewood, Bi-City Waste Water Treatment Plant
City of Glenwood Springs
Colorado Department of Natural Resources
  Colorado Water Conservation Board
  Division of Mined Lands Reclamation
  Division of Water Resources, Office of the State Engineer
Colorado River Water Conservation District
Copper Mountain Water and Sanitation District
Delta County Board of County Commissioners
Denver Regional Council of Governments
Eagle County Board of Commissioners
El Paso County Water Users Association
Frenchman Groundwater Management District
Garfield County
Grand County Board of Commissioners
Larimer-Weld Regional Council of Governments
Marks Butte Groundwater Management District
Mesa County
Metropolitan Denver Sewage Disposal District No. 1
Northern Colorado Water Conservancy District
Pitkin County Board of County Commissioners
Pleasant View Water and Sanitation District
Pueblo Board of Water Works
Pueblo Civil Defense Agency

Purgatoire River Water Conservancy District
Rio Blanco County
Rio Grande Water Conservation District
Sand Hills Groundwater Management District
Southeastern Colorado Water Conservancy District
Southwestern Water Conservation District
Trinchera Conservancy District
Uncompaghre Valley Water Users Association
Upper Arkansas River Water Conservancy District
Upper Yampa Water Conservancy District
Urban Drainage and Flood Control District
Ute Mountain Ute Tribe
Water Users No. 1
Yellow Jacket Water Conservancy District
U.S. Air Force Academy
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

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 WATSTØRE (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 analyses, and digital plots. Local assistance in the acquisition of services or products from WATSTØRE 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. Discharge and stage data currently are being obtained at the number of stations given below.

Station Classification	Number of stations	
Stream stations	393	
Continuous record		357
Partial record		36
Lake and reservoir stations	27	
Total	420	

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 81 of the surface-water stations listed in table 1 and also at 16 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.

Table 1.--Water-resources data-collection stations in operation during fiscal year 1983, by county

County	Surface-water stations				Ground-water stations
	Continuous record	Partial record	Lake and reservoir	Water quality	Wells
Adams	2	0	0	0	51
Alamosa	0	0	0	0	68
Arapahoe	4	4	0	1	19
Archuleta	9	0	0	0	23
Baca	0	2	0	0	41
Bent	4	0	1	0	48
Boulder	3	2	0	0	27
Chaffee	3	1	0	0	16
Cheyenne	0	0	0	0	41
Clear Creek	2	0	0	0	0
Conejos	5	0	4	1	53
Costilla	1	0	0	0	34
Crowley	0	0	0	0	9
Custer	0	0	0	0	8
Delta	12	0	0	0	20
Denver	2	1	0	0	7
Dolores	2	0	0	0	3
Douglas	2	0	2	0	27
Eagle	26	2	1	3	9
Elbert	0	0	0	0	24
El Paso	17	0	0	7	167
Fremont	5	0	0	3	42
Garfield	14	1	0	9	12
Gilpin	1	0	0	0	0
Grand	27	0	4	4	15
Gunnison	9	0	1	1	16
Hinsdale	4	0	0	0	3
Huerfano	0	0	0	0	8
Jackson	6	0	0	4	12
Jefferson	4	7	0	2	11
Kiowa	0	0	0	0	18
Kit Carson	0	1	0	0	195

Table 1.--Water-resources data-collection stations in operation during fiscal year 1983, by county--Continued

County	Surface-water stations				Ground-water stations
	Continuous record	Partial record	Lake and reservoir	Water quality	Wells
Lake	5	0	1	4	6
La Plata	10	1	0	2	25
Larimer	11	2	2	10	16
Las Animas	4	0	1	1	6
Lincoln	0	2	0	0	22
Logan	0	3	0	0	26
Mesa	18	0	1	6	12
Mineral	1	0	0	0	0
Moffat	7	0	0	2	23
Montezuma	10	0	0	2	10
Montrose	4	1	0	2	6
Morgan	2	0	0	1	59
Otero	5	0	0	0	40
Ouray	3	0	0	0	1
Park	9	0	1	1	14
Phillips	0	0	0	0	48
Pitkin	27	0	0	0	7
Prowers	2	0	0	0	85
Pueblo	8	1	2	0	73
Rio Blanco	29	1	0	21	52
Rio Grande	3	0	0	1	36
Routt	11	2	0	5	33
Saguache	3	0	3	2	80
San Juan	0	0	0	0	0
San Miguel	1	0	0	0	2
Sedgwick	1	1	0	0	24
Summit	14	0	2	0	5
Teller	0	0	0	0	0
Washington	0	1	0	0	106
Weld	5	0	0	2	169
Yuma	1	0	1	0	213
Totals	357	36	27	97	2,226

Station Classification	Number of Stations
Physical water-quality data (includes temperature, specific conductance, pH, and/or dissolved oxygen)	357
Chemical data (common ions, nutrients and/or trace metals)	97
Radiochemical data	17
Bacteriological data	29
Pesticides data	15
Suspended-sediment data	37

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 radio-chemical 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.

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 55 observation wells (pl. 1) is maintained in Colorado by the U.S. Geological Survey. In addition, a network of about 867 observation wells is maintained in Colorado in cooperation with the Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer, for monitoring fluctuations in water levels. 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	60
Monthly	49
Bimonthly	50
Semiannually	100
Annually	1,967
Total	2,226

The number of wells located in each county are 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

Forty-eight interpretive hydrologic investigations are being conducted during fiscal year 1983 in cooperation with fifty-four Federal, State, and local agencies. Hydrologic investigations are being conducted which will provide information needed to answer hydrologic questions specific to the States' four major river basins (Missouri, Arkansas, Rio Grande, and Colorado), as well as those which address statewide and multistate hydrologic problems. A summary of each investigation including problem, objectives, approach, progress, and plans follows. The summaries are presented in a chronological order, except for the statewide water use inventory (CO-78-007), based on the investigation's beginning date.

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: R. Theodore Hurr, 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. The sources of water supplies, water use, and the volume of water being consumed or available for multiple use needs to be documented so that State and local managers and planners may be better able 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, soliciting their cooperation, and 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 having 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. The data will be used to determine the amount of ground water pumped based on energy consumption.

PLANS FOR FY 83: Collection of municipal-water use, surface-water diversions, and ground-water pumpage data will continue. Development and application of methods to convert energy data for irrigation into equivalent water-use data also will continue. A report is planned to present estimates of the volume of ground-water withdrawals using energy-consumption data.

PROJECT TITLE: Water Management Study of the High Plains of Colorado

PROJECT NUMBER: CO-69-032

STUDY LOCATION: Northeast and eastern Colorado including all or parts of Logan, Sedgwick, Phillips, Washington, Yuma, Elbert, Lincoln, Kit Carson, Cheyenne, Kiowa, and, Prowers Counties.

COOPERATING AGENCY: Colorado Department of Natural Resources, Division of Water Resources, Office of the State Engineer, and the Central Yuma, Frenchman, Marks Butte, and Sand Hills Ground-Water Management Districts

PROJECT CHIEF AND OFFICE: Joe L. Blattner, Subdistrict Office, Lakewood

PROJECT DURATION: July 1968 to September 1984

PROBLEM: State and local water-management agencies are managing the ground-water supply in the northern High Plains where increased pumpage for irrigation is depleting the supply. The agencies need a basis for predicting and then evaluating the effects of proposed changes in ground-water use.

OBJECTIVES: Document the depletion of the ground-water supply. Collect data defining the hydrologic characteristics of the Ogallala aquifer. Monitor long-term water-level trends.

APPROACH: Locate and obtain hydrologic data from all wells that pump more than 100 gallons per minute. Using these wells, develop a monitoring network that will reflect water-level changes in the entire area. Collect and compile data to determine aquifer properties, recharge, return flow, consumptive use, and water quality.

PROGRESS: Data have been collected from about 3,800 wells. Data from about 1,000 wells have been coded for entry into the computer, and about 200 computer records were updated. About 110 well-discharge measurements have been made on 65 wells. A monitoring network of about 650 wells has been established and water levels are being measured yearly prior to the start of the irrigation season. Areas of water-level declines have been identified and are being monitored. The hydrologic characteristics of the Ogallala aquifer have been defined for much of the study area. Computer models have been developed, calibrated, and tested for five areas within the northern High Plains. Water-table maps have been prepared to show predevelopment conditions in the northern High Plains of Colorado in 1960, 1965, 1970, 1975, and 1980. A data report (Open-File Report 82-573) entitled "Water-level records for the northern High Plains of Colorado, 1978-82" was published.

PLANS FOR FY 83: Continue the annual water-level measurements at about 650 wells, enter data into USGS computer files, and prepare a publication listing the annual measurement results.

PROJECT TITLE: Determination of Evaporation and Thermal Regime of Selected Reservoirs

PROJECT NUMBER: CO-72-041

STUDY LOCATION: Central Colorado including Grand, Boulder, Summit, Jefferson, Douglas, and Park Counties.

COOPERATING AGENCY: City and County of Denver, Board of Water Commissioners

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

PROJECT DURATION: May 1972 to September 1983

PROBLEM: The Denver Board of Water Commissioners operates one of the world's most complex water collection and distribution systems. It stores large volumes of water in seven reservoirs located on both sides of the Continental Divide. These reservoirs are an extremely valuable resource--both in terms of water storage and recreational and esthetic values. The importance of the stored water is magnified in semi-arid areas such as eastern Colorado. As part of its water right, the Denver Board of Water Commis sioners is required to account for loss of water from its reservoirs by evaporation, and would like to minimize these losses. Therefore, a good measurement of evaporation and an understanding of factors affecting evaporation are very important.

OBJECTIVE: Review, evaluate, and publish previous data on evaporation from the reservoirs operated by the Denver Board of Water Commissioners. Determine the present rates of evaporation from these reservoirs and show annual and seasonal variations, and also determine the effects of factors such as altitude, wind shelter, and reserve operation on evaporation. Study methods for improving the relationship between pan and reservoir evaporation.

APPROACH: Install and operate mass-transfer and pan-evaporation equipment at Ralston, Dillon, Elevenmile Canyon, Cheesman, Williams Fork, and Gross Reservoirs. Conduct energy budget studies of reservoirs to include the compilation of evaporation.

PROGRESS: Evaporation losses from seven reservoirs operated by the Denver Water Department in central Colorado were determined during various periods from 1974-80. The reservoirs studied were Ralston, Cheesman, Antero, Williams Fork, Elevenmile Canyon, Dillon, and Gross. Energy-budget and mass-transfer methods were used to determine evaporation. Class-A pan data also were collected at each reservoir.

The energy-budget method was used to calibrate the mass-transfer coefficients for Ralston, Cheesman, Antero, and Williams Fork Reservoirs. Coefficients for Elevenmile Canyon, Dillon, and Gross Reservoirs are presented by Ficke and others (USGS, WRI 76-114, 1977). Energy-budget evaporation rates ranged from 0.05 to 0.74 cm/d (centimeters per day) based on 7 to 14-day periods. Mass-transfer evaporation rates ranged from 0.05 to 0.90 cm/d based on 7 to 14-day periods. Annual evaporation values were not determined because the instrumentation was not operated during the entire open-water period.

Class-A pan data were used to determine pan coefficients for each season at each reservoir. The coefficients varied from season to season and between reservoirs, and the seasonal values ranged from 0.29 to 1.05.

PLANS FOR FY 83: Complete the report presenting data from 1974 to 1980.

PROJECT TITLE: Effects of Wastes from a Cattle Feedlot on the Chemical Quality of Water in an Alluvial Aquifer

PROJECT NUMBER: CO-74-056

STUDY LOCATION: Weld County

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

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

PROJECT DURATION: July 1973 to September 1983

PROBLEM: Because large cattle feedlots produce wastes on a daily basis comparable in volume to daily wastes produced by a medium-size city, there is a great potential for ground-water contamination due to infiltration of the wastes into aquifers beneath and adjacent to the feedlot. Greater-than-normal concentrations of nitrate and other dissolved ions have been reported in ground water beneath and adjacent to large feedlots. These constituents are a contamination hazard to nearby wells and streams.

OBJECTIVE: Monitor and describe any changes that occur in the chemical quality of ground water resulting from the operation of a large cattle feedlot.

APPROACH: Establish an observation-well network on and adjacent to the area where a large cattle feedlot is to be constructed. Determine the chemical quality of ground water in both areas prior to construction of the feedlot. After construction, collect samples of ground water for chemical analysis from both the feedlot and the control areas. Determine changes in chemical quality resulting from operation of the feedlot.

PROGRESS: Observation wells and lysimeters have been installed near sumps which collect feedlot runoff. Comparison of iron and manganese concentrations from 1974 and 1977 samplings indicated an increase in concentration of these cations adjacent to the feedlot; 80 to 240 mg/L (milligrams per liter) and 20 to 3,300 mg/L, respectively. Nutrient concentrations as defined by nitrite and nitrate analyses did not show an increase close to the feedlot as did iron and manganese Study results will be presented in a hydrologic atlas and journal article, both in preparation.

PLANS FOR FY 83: Complete reports currently underway and develop a study plan to investigate the control mechanism on solubility of metals and developing anaerobic conditions and gas formations.

PROJECT TITLE: Hydraulic Research of Springs, Piceance Creek and Yellow Creek Drainage Basins

PROJECT NUMBER: CO-75-060

STUDY LOCATION: Northwest Colorado--Rio Blanco County

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

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

PROJECT DURATION: July 1974 to September 1983

PROBLEM: Aquifer dewatering resulting from oil-shale mining may affect groundwater discharge to streams and springs. Many springs in the Piceance basin are used as water supplies for livestock, irrigation, and domestic use. Knowledge of spring source and general water-quality characteristics are necessary to evaluate effects of aquifer dewatering associated with oil-shale development. The monitoring of selected index springs is essential during and following mining operations to evaluate long-term mining impacts.

OBJECTIVES: To determine the sources and hydrological characteristics of springs in Piceance basin. Review and maintain records of spring discharge and water quality so that changes resulting from development can be determined. To provide data that can be used in studies of hydrologic connections between bedrock aquifers and alluvial systems, and in the calibration of existing models which attempt to predict hydrologic behavior in the basin.

APPROACH: Using existing data from 80 to 90 springs in Piceance basin, select 20 springs to be monitored for flow, and physical and chemical variations. Discharge and field water-quality measurements will be made monthly; chemical analyses will be determined for high and low flows. All data will be stored in the USGS WATSTORE computer system and will be available to other ongoing hydrological studies in the basin.

PROGRESS: A review of data collected since the late 1960's indicates that the factors influencing spring flow and water chemistry in the Piceance basin are complex. Sources of spring water are the upper and lower bedrock aquifers and from valley-fill alluvium. Hydrographs of springs within the basin show changes in discharge with season, irrigation activities, and underground nuclear detonations. A report describing the hydraulics of springs based on data through 1977 has been published by the Colorado Department of Natural Resources, Division of Water, Office of the State Engineer. Chemical analyses of water samples show significant differences in water type and several trace elements, depending on aquifer source. An interpretive report summarizing data and findings to date will be completed this year.

PLANS FOR FY 83: Continue flow measurements and water-quality analyses at 20 index streams to provide a data base with continuity to use in assessing land-use change impacts.

PROJECT TITLE: Observation-Well Drilling and Potentiometric-Surface Mapping Piceance Creek and Yellow Creek Drainage Basins

PROJECT NUMBER: CO-75-061

STUDY LOCATION: Northwest Colorado -- Rio Blanco County

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

PROJECT CHIEF AND OFFICE: William P. Van Liew, Subdistrict Office, Meeker

PROJECT DURATION: July 1974 to September 1983

PROBLEM: Oil-shale development and associated mine dewatering will alter the existing steady-state geohydrologic conditions in the Piceance basin. The existing conditions must be documented prior to large-scale development so that any impacts on the ground-water system can be evaluated.

OBJECTIVES: Determine the predevelopment potentiometric surfaces of and monitor changes in water levels for the two primary bedrock aquifers as a result of oil-shale development. Use the data to improve the predictive capability of the existing ground-water system digital model.

APPROACH: Drill approximately 20 observation wells and convert existing core holes to observation wells to supplement the existing observation-well network. The wells will be completed so that the two principal aquifers can be monitored in each well. Geophysical characteristics will be determined for each well. Periodic water-level measurements and selective use of recorders will be used to obtain data requisite to construction of a potentiometric-surface map of each aquifer.

PROGRESS: Twenty-four wells totaling 30,300 feet have been drilled. Water-temperature and specific-conductance data, water samples for chemical analyses, and discharge-rate measurements have been collected. Water levels have been measured twice a year in 70 wells. More frequent measurements (monthly or recorder data) have been obtained near the C-a and C-b lease tracts. A report currently in preparation will present information collected to date and a steady-state potentiometric-surface map of upper and lower bedrock aquifers will be prepared.

PLANS FOR FY 83: Complete the report which is in progress. Maintain a network of 20 wells measured monthly to provide a data base that can be used in the evaluation of the effects of oil-shale mine dewatering on the upper and lower aquifers.

PROJECT TITLE: Aquifer Testing, Piceance Creek and Yellow Creek Drainage Basins

PRPJECT NUMBER: CO-75-062

STUDY LOCATION: Northwest Colorado -- Rio Blanco County

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

PROJECT CHIEF AND OFFICE: Frank A. Welder, Subdistrict Office, Meeker

PROJECT DURATION: July 1974 to September 1983

PROBLEM: The effects of aquifer dewatering resulting from oil-shale mining can be predicted using a computer model. However, the accuracy of the model depends on the definition of the transmissive and storage properties of the two aquifers and of the vertical-hydraulic conductivity of the confining layer that separates the aquifers. Existing data have provided a basis for preliminary modeling efforts, but additional information is necessary to better define regional and local variations in aquifer properties, the vertical permeability of major confining layers, and the hydraulic connection between bedrock aquifers and valley-fill alluvium.

OBJECTIVES: Determine the regional variations in aquifer properties and the vertical hydraulic conductivity of the confining layer. Use the data to improve the predictive capability of the existing computer model.

APPROACH: The following components are involved in the study approach:

(1) Collate and review available water-level data from bedrock and alluvial wells--compare these data with spring and surface-flow hydrographs.
(2) Determine potentiometric surfaces within the various aquifers.
(3) Identify test holes drilled for exploratory purposes--complete selected production and observation wells for aquifer testing to improve knowledge of upper and lower aquifers and the degree of interconnection.
(4) Drill test holes at selected locations, near springs and along stream channels where significant gain or loss of flow is identified, for use in aquifer testing to determine connection between the stream and the alluvium and between the alluvium and upper bedrock system.
(5) Collect water-quality information that can be used to identify water source.
(6) Prepare a final report.

PROGRESS: Nine aquifer tests have been conducted and data are being analyzed for inclusion in the potentiometric-surface map report described for Project CO-75-061.

PLANS FOR FY 83: The report will be completed during 1983 and additional aquifer tests of the upper and lower system conducted as opportunities are available. Additionally, a production well and observation wells will be drilled into the alluvium and upper aquifer and tested to provide increased information about aquifer and surface-water interactions.

PROJECT TITLE: Geochemical Investigation, Piceance Creek and Yellow Creek Basins

PROJECT NUMBER: CO-75-064

STUDY LOCATION: Northwest Colorado -- Rio Blanco County

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

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

PROJECT DURATION: August 1974 to September 1983

PROBLEM: Aquifer dewatering resulting from oil-shale mining may alter existing recharge conditions to the two bedrock aquifers and change existing flow patterns within the aquifers. The existing chemical equilibrium may be altered, resulting in the solution of minerals and increased dissolved-solids concentrations. Presently, the dissolved-solids concentrations range from a few hundred to more than 60,000 mg/L (milligrams per liter). The discharge of the very saline water into springs and streams could result in a serious pollution problem. The existing chemical equilibrium needs to be known prior to the beginning of oil-shale mining, so that the effects of aquifer dewatering on the chemical equilibrium can be determined.

OBJECTIVES: Define the variation of water chemistry in the aquifers of the Piceance basin and its relationship to the soluble minerals of the Green River Formation. Develop a model of the chemical relationships and its use to predict the effects of oil-shale-mine dewatering on water chemistry.

APPROACH: Collect samples for chemical analysis from wells and springs. Develop a model that can be used to predict water-quality changes both within and between the aquifers. Use the water-quality data collected from wells and springs to calibrate the model.

PROGRESS: Analyses of data show that significant differences in water quality exist between and within the major aquifer systems in the Piceance basin. Most of the water in aquifers of the Green River Formation is of a sodium bicarbonate type and has high concentrations of fluoride; water in the alluvium and the Uinta Formation of Eocene age are generally a mixed-cation bicarbonate or bicarbonate-sulfate type and have concentrations of fluoride less than 1.0 mg/L. Concentrations of dissolved solids range from 400 to greater than 10,000 mg/L and generally increase with depth and with distance from the major recharge areas. Concentrations of dissolved solids are greatest in the north-central part of the basin where ground water is in contact with extensive deposits of nahcolite and related salts within the lower aquifers. An interpretive report presenting study results is in preparation.

PLANS FOR FY 83: Complete the report currently in progress.

PROJECT TITLE: Sediment Yield of Streams Draining the Piceance Basin, Northwestern Colorado

PROJECT NUMBER: CO-74-065

STUDY LOCATION: Rio Blanco County

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: July 1974 to September 1983

PROBLEM: Mining and associated activities have been shown to have a dramatic impact on the sediment yield of streams draining mined areas. In other areas, mining has been shown to increase sediment yield, alter channel geometry and channel morphology, and reduce the conveyance of streams. Prototype oil-shale development in the Piceance basin will involve the mining, processing, and disposal of over 150,000 tons of oil shale per day. Handling and disposal of such large quantities of spent shale may greatly increase the sediment load in streams.

OBJECTIVES: Define the sediment yield of streams draining the Piceance basin and the lands that are scheduled to be mined. These data will be used to determine the "natural" sediment yield of streams in the basin. After oil-shale mining begins, continue to collect data and define the sediment yield of streams from mined areas to evaluate the impact of oil-shale mining on sediment yield.

APPROACH: Install automatic suspended-sediment samplers at key stations throughout the basin to define the sediment yield of the basin and streams draining the leased tracts that are scheduled for oil-shale mining. In addition, monitor channel cross sections and profiles on hillslope erosion transects established during the previous water-resources investigation of the Piceance basin. Data from these stations will be used to define the "natural" sediment yield and monitor changes resulting from development.

PROGRESS: Statistical relations have been developed between suspended-sediment discharge in the Piceance basin and several regional factors such as climate, physiography, and land use. The sediment-collection network has been evaluated to detect changes in suspended-sediment discharge due to development in the basin and also to detect differences between the seasons. It was found that sediment discharge varied before and after mining and from season to season; however, due to the high variability and short period of record, the cause of these differences could not be determined. Part of the high variability in sediment discharge was caused by the variability in water discharge. Therefore, to improve the network, emphasis should be placed on the improvement of the water-discharge records and better determinations of the relations between suspended sediment and water discharge.

PLANS FOR FY 83: Publish the interpretive report. Maintain a skeletonized network of four stations, two on the Piceance Creek mainstem and two on tributaries, to provide a continuum of baseline information that will be useful in assessing long-term variations and trends in suspended sediment yield.

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 1983

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 right, 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: To provide data from selected sites in the Parachute Creek and Roan Creek basins that can be used 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-77-093 that is to determine the hydrologic conditions on the U.S. Naval Oil Shale Reserve No. 1, which is located in the Parachute Creek drainage basin, and with project CO-77-100 that is to develop a computer model of the ground-water system in the 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 from 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-loss studies were made. All data collected under this project are being compiled into a data report.

PLANS FOR FY 83: Complete and publish the data report. Incorporate the data base into other ongoing District surface-water and ground-water modeling projects.

PROJECT TITLE: Evaluation of Aquifers, Western Colorado

PROJECT NUMBER: CO-75-071

STUDY LOCATION: Western Colorado including Mesa, Delta, Gunnison, Montrose, and San Miguel Counties

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

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

PROJECT DURATION: October 1974 to July 1983

PROBLEM: The use of ground water to meet residential, commercial, industrial, recreational, and agricultural needs in western Colorado is increasing because most existing surface-water supplies have been appropriated. To manage the development of the ground-water resources and to assist in ground-water appropriation, State and local officials need to know the location and areal extent of the aquifers and the quantity and quality of water found in the aquifers.

OBJECTIVES: Locate and determine the areal extent of aquifers. Determine the quantity and quality of water found in the aquifers.

APPROACH: (1) Compile existing geologic and hydrologic information, including geologic maps, driller's records of wells, chemical quality of water data to determine areas where field work is required to establish the hydrologic characteristics of the various aquifers; (2) inventory wells and obtain water samples from these wells in areas of sparse data; (3) prepare a report that presents and discusses the information that has been collected.

PROGRESS: The ground-water data collection for the North Fork Gunnison, San Miguel, and Lower Gunnison Rivers is complete and draft reports are being reviewed. Data collection, reconnaissance, and well inventory are ongoing in the Uncompahgre River basin.

PLANS FOR FY 83: The three reports currently in review will be completed. Continued work in the Uncompahgre River basin beyond July 1983 is contingent upon continued funding.

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. Collection of pumpage data and analysis of well data have begun. 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 three-dimensional ground-water flow model has been constructed for use in evaluating effects of transient pumpage on water levels.

PLANS FOR FY 83: Complete calibration of the transient-state model and make required simulation runs. Complete first draft of 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: Donald R. Minges, Subdistrict Office, Lakewood

PROJECT DURATION: October 1976 to September 1983 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: Continuation of the study will document existing gain-and-loss, water-quality, and sediment-transport characteristics of the South Platte River by collecting base-line data.

APPROACH: Gain-and-loss investigations will be conducted throughout the irrigation season on a 25-square-mile study reach. Sediment-load data will be collected at a dam-site streamflow-gaging station in conjunction with sediment sampling at downstream irrigation ditch sites. Water-quality data will be collected at a streamflow-gaging station upstream from the projected reservior.

PROGRESS: Monthly gain-and-loss investigations, discharge and sediment measurements, and water-quality measurements have been made as scheduled. A report entitled "Characteristics of the South Platte River in the vicinity of the proposed Narrows Reservoir near Fort Morgan, Colorado" contains data through 1979 and has been approved for publication as Water-Resources Investigations Report 82-4071.

PLANS FOR FY 83: Conduct additional field surveys in the vicinity of the reservoir site. Prepare a summary of 1982 irrigation season gain-and-loss investigations for the U.S. Bureau of Reclamation.

PROJECT TITLE: Hydrologic Reconnaissance of the U.S. Naval Oil Shale Reserve No. 1, Parachute Creek Drainage Basin

PROJECT NUMBER: CO-77-093

STUDY LOCATION: Northwest Colorado -- Garfield County

COOPERATING AGENCY: U.S. Department of Energy

PROJECT CHIEF AND OFFICE: D. L. Collins, Subdistrict Office, Grand Junction

PROJECT DURATION: October 1976 to September 1983

PROBLEM: The U.S. Naval Oil Shale Reserve No. 1 is a site of potential oil-shale development. Previous investigations of the hydrology of the Piceance structural basin have not included an intensive hydrologic appraisal of the reserve. Streams draining the reserve are tributary to the Colorado River, whose water-quality characteristics are of national and international interest. The present hydrologic conditions of the reserve need to be known prior to the beginning of oil-shale mining so that the effects of the mining on the water quality of the Colorado River can be determined.

OBJECTIVES: Inventory the water resources and describe the hydrologic systems on and adjacent to the U.S. Naval Oil Shale Reserve No. 1.

APPROACH: Install hydrologic monitoring stations to collect precipitation, stream-discharge (on East Fork and East Middle Fork Parachute Creek and three major tributaries), and sediment-yield data. Collect water-quality data from the streams. Locate springs and collect discharge and water-quality data. Drill a minimum of 10 test holes. Collect geologic, discharge, and water-quality data during the drilling of the test holes. After drilling is completed, collect geophysical data from each test hole and conduct one to three aquifer tests in each test hole. Locate existing wells and collect water-level and water-quality data. Coordinate project activities with project CO-77-100 which has as an objective the development of a computer model of the ground-water system including the Parachute Creek and Roan Creek drainage basins.

PROGRESS: Surface-water quantity and quality data, suspended sediment data, precipitation and climatic data have been collected. Open-file basic-data Report 82-696 summarizing project data for water years 1976-79 has been approved for publication. A supplementary data report for water years 1980-81 is being prepared.

PLANS FOR FY 83: Continue operation of five surface-water quantity and quality stations including two daily suspended-sediment stations, two 2-parameter monitor stations, three precipitation stations, and one weather station. Complete the 1980-81 supplementary data report.

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 tradional water uses, and cause deterioration of the remaining water resources.

OBJECTIVES: The objectives of the program are to determine the characteristics of the regional water-resources system and to 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 µS/cm (microsiemens per centimeter at 25°C) (individual values ranged from 51 to 462 µS/cm). The water in the basin predominately 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 mainstem.

PLANS FOR FY 83: Obtain additional flow measurements and water-quality samples during high- and low-flow conditions at 20 locations within the basin. Slight modifications will be made to the previous network to reflect geologic and land-use variations. Compile and analyze all data and prepare draft of final report.

PROJECT TITLE: Effects of Sludge-Drying Basins on Ground-Water Quality

PROJECT NUMBER: CO-77-097

STUDY LOCATION: Adams County

COOPERATING AGENCY: Metropolitan Denver Sewage Disposal District No. 1

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

PROJECT DURATION: May 1977 to September 1983

PROBLEM: The MDSDD (Metropolitan Denver Sewage Disposal District) No. 1 plans to replace the current sewage-sludge land-disposal facility in Arapahoe County with sludge-drying basins to facilitate sludge disposal and to permit use of dried sludge as a fertilizer. The new facility will be in Adams County about 25 miles northeast of Denver. The MDSDD, the U.S. Environmental Protection Agency and local residents are concerned about the effects of the facility on the local ground-water quality.

OBJECTIVES: Determine the location of, depth to, and areal extent of alluvial and bedrock aquifers beneath the proposed sludge-drying site and adjacent area. Determine the direction of ground-water flow and the present quality of ground water. Determine the quality of the leachate, the rate of movement of the leachate into the aquifers, and the dispersion of the leachate once it enters the aquifers.

APPROACH: Establish a ground-water quality monitoring network within a 28-square-mile area around the sludge-drying site. Locate existing wells in the study area; measure depth to water, and obtain samples for water-quality analysis. Construct potentiometric-surface maps of the alluvial and bedrock aquifers to aid in determining where to drill new observation wells. Drill 40 observation wells, 34 in the alluvium and 6 in the bedrock. Measure the depth to water and obtain samples for water-quality analysis. Install six pan-type lysimeters under selected drying basins to determine infiltration rates of the leachate and to provide receptacles for the collection of water-quality samples. Collect samples of the leachate for analysis.

PROGRESS: Water levels and water quality are being monitored in 15 existing wells near the sludge disposal areas. Results of semi-annual monitoring indicate that a small zone of polluted ground water has continued to deteriorate in quality, indicating leakage from one disposal site.

PLANS FOR FY 83: Continue water-quality sampling and water-level monitoring in the aquifers underlying the sludge disposal sites.

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: Project objectives are to improve the understanding of the ground-water flow system, to determine the degree of hydraulic connection between the bedrock aquifers, the alluvial aquifer, and the streams, and to improve the model framework so that mine drainage impacts can be simulated realistically.

APPROACH: The understanding of the ground-water flow system will be improved by obtaining additional well-log and testing data from oil-shale companies. These data will be used to prepare improved potentiometric maps for the bedrock aquifers. In addition, the vertical distribution of horizontal hydraulic conductivity will be appraised, using the relation between well yield and well depth. Sampling of bedrock aquifers at various sites for radionuclides will permit calculation of (1) residence times and (2) regional aquifer characteristics. Stream-aquifer relations will be appraised using gain-and-loss studies along Piceance and Yellow Creeks and stream discharge and water-quality measurements in Roan and Parachute Creeks. Model improvement will consist of 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 WRI 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. Lack of data has hindered the evaluation of model results and refinement. To provide additional knowledge of the hydrologic system, gain and loss investigations have been made along Piceance Creek mainstem and ground-water samples have been collected for laboratory analyses to improve knowledge of variations in chemical quality between aquifers.

PLANS FOR FY 83: Obtain and collate water-level, geophysical, and aquifer test data from all available sources to improve knowledge of the distribution of hydraulic parameters and boundary conditions. Devise techniques that can be used to evaluate the hydrologic connection between the bedrock aquifer and the shallow system. Obtain water samples for radiochemical analyses and age dating to attempt to improve knowledge of residence time and aquifer interconnection.

PROJECT TITLE: Water-Resources Appraisal of the Fort Carson Military Reservation

PROJECT NUMBER: CO-78-105

STUDY LOCATION: El Paso, Fremont, and Pueblo Counties

COOPERATING AGENCY: U.S. Department of the Army, Fort Carson

PROJECT CHIEF AND OFFICE: Jerry L. Hughes, Subdistrict Office, Pueblo

PROJECT DURATION: October 1977 to September 1984

PROBLEM: Knowledge of the water resources on the Fort Carson Military Reservation is limited. Without knowledge of the quantity and quality of the area's water resources, the Reservation's existing water resources cannot be properly developed or managed.

OBJECTIVE: Assess the present surface- and ground-water resources of the Reservation in terms of quantity and quality.

APPROACH: Use water-rights records to determine the existing water rights of the reservation and their effect on water use in the reservation. Collect surface-water data to determine annual streamflow into and out of the reservation, seasonal variations in the quantity and water quality of streamflow, and seasonal variations in storage and water quality of existing reservoirs. Collect ground-water data from existing wells to determine the extent of alluvial and bedrock aquifers, areas of recharge to and discharge from the aquifers, yield characteristics, and seasonal variations in water quality. Use the data to determine areas of potential water resources development. Continued surface- and ground-water monitoring following land- and water-use changes on the reservation will provide data necessary to assess the effects of the changes.

PROGRESS: Water rights have been tabulated. Twenty-two streamflow-gaging stations have been installed and are operating. Sediment data have been collected by automatic samplers at two reservoir-inflow sites. Samples for water-quality analysis are routinely being collected at nine stations. About 105 wells have been inventoried; water levels are being measured in 40 wells. Continuous water-level recorders have been installed and are operating on three wells. Water samples for laboratory analysis have been collected from the wells. All data have been evaluated and entered into computer storage. Drafts of two reports--one, an assessment of water resources of the Fort Carson Military Reservation, the other an evaluation of potential ground-water contamination resulting from land application of sewage effluent on the golf course are complete and both reports are being reviewed.

PLANS FOR FY 83: Complete and publish the two reports currently in review. Continue collection of surface- and ground-water data. Drill approximately 10 additional alluvial wells to more fully define ground-water conditions and aquifer properties.

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 1983

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 model 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.

PLANS FOR FY 83: Complete the report "Flood hydrology of foothills streams in Colorado" which provides an analyses of mixed population (rainfall and snowmelt induced) floods which occur in the foothills region of Colorado. Maintain the network of 17 crest-stage gages to provide continued peak flow information in the foothills region.

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 1983

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 groundwater 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: To obtain data requisite to development of a streamflow oriented computer model it is necessary to instrument watersheds to obtain climatic, precipitation, soil moisture, stream discharge, and water-quality information. To provide the necessary data, including variation in land use, nine basins will be selected and instrumented to provide streamflow records. Additionally, flow-oriented suspended sediment samples will be collected at three sites as well as periodic water-quality data at gaged and miscellaneous sites in the Yampa River basin. Two climate stations will be operated.

PROGRESS: Calibration of the streamflow model using data from nine watersheds is complete. Two reports--one describing the calibration procedure; the other describing prediction capabilities of the model in the gaged watersheds and the potential for model transferability to ungaged basins are being prepared. The watersheds used in the 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.

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 southern valley area of the Yampa basin.

PLANS FOR FY 83: Complete the three reports which are in progress. Continue streamflow and water-quality data collection in two basins, Sage and Foidel Creeks, where active mining will continue. Also, the synoptic water-quality program will continue at miscellaneous sites in the Yampa River basin. Initial effort will begin to obtain information in a stream reach on the amounts and timing of water from reclaimed and natural areas.

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 1983

PROBLEM: Coal mining will create large areas of spoils piles. The hydrology and reclamation potential of the piles needs 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 spoils 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-spoils 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 which can easily be used 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 spoils pile. A well has been drilled to the bottom of the spoils 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 total 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 total dissolved-solids content decreased from 1978 to 1979 but increased slightly from 1979 to 1980.

PLANS FOR FY 83: Complete and publish the report currently in progress. Soil-water measurements will continue. Analysis of the chemical quality of spoil-pile leachate will continue. The data collected for this project will be used in Project CO-79-113 to provide definition of percolation rates and quantity for use in modeling applications.

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 1983

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 groundwater quantity and quality.

APPROACH: Five surface-water stations will be located on the Purgatoire River, its major tributaries, and the Apishapa River. Discharge, water-quality, and suspended-sediment data will be collected at all stations. The distribution of gages will provide a general index of the hydrology of the area 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. All data have been evaluated and stored in the computer. A final report to summarize and evaluate data is being prepared.

PLANS FOR FY 83: Complete and publish the final report.

PROJECT TITLE: Monitoring 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: The objectives of this study are to define the hydrologic system of the area, interrelating surface flow, ground-water movement, precipitation, and climate. The availability and quality of surface water will be defined in this study.

APPROACH: Two complete surface-water monitoring stations will be located in the Canadian River drainage, Colorado, and will supplement existing data gathering activities in the North Platte drainage basin. Sediment discharge will be determined and periodic water-quality samples will be analyzed at each site.

PROGRESS: Two continuous-record streamflow stations, each of which is equipped with an automatic sediment sampler and water-quality monitor; two partial-record rainfall-runoff stations; and five additional precipitation gages have provided data for the study area. A climatological station also has been installed to monitor air temperature, wind, and solar radiation. 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 83: Data collection is to continue at the same level as in FY 1982. 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 1983

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. Ground-water reports for the Collom Gulch, the Denver Basin, the Williams Fork Mountains, seismic reflection applications, and the North Fork Gunnison River are in preparation.

PLANS FOR FY 83: Complete all reports in progress

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 water balance has been developed. Preliminary analysis indicated adequate three-dimensional representation could be achieved with a 7-layer model that represents the upper 3,000 feet. Preparation of the 7-layer model has been initiated.

PLANS FOR FY 83: Complete preparation of the 7-layer ground-water model and simulate transient response utilizing calibration and sensitivity testing procedures. Two-dimensional cross-sectional models of steady-state conditions will be developed for the study area. A water-level map report will be completed. A first draft of an interpretive report will be written.

PROJECT TITLE: Sediment Chemistry at Prospective Surface Mining Sites

PROJECT NUMBER: CO-79-129

STUDY LOCATION: Yampa River and White River drainage basins in northwestern Colorado

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

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

PROJECT DURATION: July 1979 to September 1983

PROBLEM: Surface mining of coal can affect stream chemistry by changing the chemical composition of suspended sediment transported by the stream. Spoil-pile leachate may deposit chemical coatings on existing soils and stream-bottom materials or dissolve existing coatings. Material washed from spoil piles may be of a different composition then from native soil material. Data do not exist to define the present chemistry of soil and stream-bottom material at prospective surface mining sites in Colorado.

OBJECTIVE: Define the present composition of soil and stream bottom material in selected basins in Colorado, use these data to interpret the chemistry of suspended material in the streams, and provide a data base against which to evaluate changes in soil and bottom material chemistry following surface mining of coal.

APPROACH: Sieve composited soil samples and bottom material samples from selected hydrologic response units within the basins. Determine the chemistry of insoluble materials for the minus 80-mesh fraction. Compare data within and among basins. Compare ratios of chemical concentration of suspended sediment during periods of peak discharge.

PROGRESS: Sampling of the EMRIA (Energy Mineral Rehabilitation Inventory and Analysis) stream sites in Colorado has been completed. Analysis of soils and stream-bottom materials that contribute to the suspended sediment of tributaries to the Yampa River have indicated that soils and bottom materials do not differ from each other in their content of Cd, Co, Fe, Pb, Mn, Hg, P, Zn, and Cu, although soils do have greater concentrations of aluminum, arsenic, organic carbon, and chromium. Bottom materials have greater concentrations of bicarbonate and selenium. Geology plays a major role in the soil and bottom-material chemistry. An interpretive report is being prepared.

PLANS FOR FY 83: A report summarizing project results will be completed.

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: To define the quantity and quality of streamflow and the quality of selected lakes and impoundments in Larimer and Weld Counties. The principal drainages to be investigated are the Big Thompson River, the Cache La Poudre River, and the South Platte River.

APPROACH: The U.S. Geological Survey will establish and operate streamflow stations, collect and chemically analyze water samples from rivers, lakes, and impoundments.

PROGRESS: Data collection included 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. Monthly water-quality samples were analyzed for Horsetooth Reservoir from April through 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 83: Continue current data collection schedule at all sites except for a reduced analytical frequency for major ions at streamflow sites. Sample schedule at Horsetooth Reservoir will be changed from six monthly surface sample collections at one location on the reservoir to three sample collections at three locations. 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 power plants. 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: The areas in Colorado most susceptible to the influence of acid-rain will be delineated. Within susceptible areas, the lakes with the least buffering capacity and smallest nutrient loading rate will be determined. Select lakes representative of other lakes within the susceptible areas for more detailed study. Baseline chemical quality of precipitation will be determined.

APPROACH: Areas most susceptible to acidification will be selected based on: downwind location from acid gas sources, unreactive bedrock geology, and large snowpack accumulation. Relative buffering capacity of the lakes will be measured by alkalinity titration curves and nutrient loading will be approximated by hypolimnetic nutrient concentrations, snowpack amount and nutrient concentrations, and stream discharge rates and nutrient concentrations. Precipitation gages and weather stations will be installed and operated 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. This work indicates that approximately 370 lakes would be adversely affected by rainfall as acidic as that of the northeastern United States. At this time, however, no impact has been measured.

PLANS FOR FY 83: An index basin has been selected in the Flat Top Wilderness Area and will be instrumented to monitor precipitation quantity and quality, streamflow quantity and quality, lake quality and biological characteristics. The variance in chemical and biological properties will also be measured seasonally for three additional index basins.

PROJECT TITLE: Traveltime and Reaeration Study Along Selected Stream Reaches in Coal Producing Areas of Colorado

PROJECT NUMBER: CO-80-133

STUDY LOCATION: Selected stream reaches in the Yampa and Canadian River Basins in Moffat, Routt, and Jackson Counties of Colorado

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

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

PROJECT DURATION: February 1980 to September 1983

PROBLEM: Various energy developments are now operational, or being planned in Colorado. Energy resource development can have a profound effect on water quality of localized streams in the mining areas. One problem also involves the large population growth associated with mining development and hence large waste-water amounts introduced into the stream. There is a need to study the possible streamflow-quality problems caused by increased waste-water effluents. Stream assimilative capacities must be known to implement management plans for anticipated municipal organic waste input.

OBJECTIVES: To provide planners and managers with information for determining the waste-load assimilative capacities of the stream reaches for possible design and operational alternatives for future wastewater-treatment plants. Other objectives of the study will be to predict the arrival time and concentration of soluble contaminants spilled in a stream, length of stream affected by a municipal wastewater-treatment-plant discharge, and traveltime required for reservoir water released for given downstream needs.

APPROACH: The approach for the reaeration traveltime study involves the injection of both a tracer gas and fluorescent-type dye into a stream. The procedure for the reaeration rate consists of injecting tracer gas into the stream and determining a desorption coefficient from measurements downstream; this is then converted to a reaeration rate for oxygen. The traveltime phase consists of sampling the dye as it moves downstream and a mathematical model is used to project traveltimes for other flow conditions. In addition, at selected sites, benthic organisms, will be collected to assess possible relationships between waste-load assimilative capacity and the stability and composition of benthic communities.

PROGRESS: Analyses of traveltime, unit concentration, and longitudinal dispersion for six streams in northwestern Colorado are being completed. Determination of reaeration by the measurement of reaeration coefficients is complete. A biological report has been written and is ready for publication. A report of results including traveltime coefficient regionalization for the State is in preparation.

PLANS FOR FY 83: A report describing traveltime and reaeration coefficients for selected stream reaches will be completed. This report will include an approach for regionalization of these data to provide a means for estimating traveltime and reaeration coefficients for sites where measurements have not been made.

PROJECT TITLE: Evaluation of a COMSAT General Pilot Program Providing for Real-Time Data Collection From Gaging Stations in Colorado

PROJECT NUMBER: CO-80-135

STUDY LOCATION: Statewide

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

PROJECT CHIEF AND OFFICE: Jerry L. Hughes, Subdistrict Office, Pueblo

PROJECT DURATION: March 1980 to September 1983

PROBLEM: The Water Resources Division has identified numerous needs and benefits for real-time hydrologic data telemetered from remote data-collection sites. Acquisition of real-time data will allow better operation of the hydrologic data collection network, as well as providing information to those segments of the water user community that require responsive and timely data.

OBJECTIVES: To evaluate the operational reliability of hydrologic information services test sites in Colorado provided by COMSAT General contract. The evaluation will include applications and benefits derived by the USGS and other user agencies.

APPROACH: The contractor has been responsible for acquisition and operation of sensors, data-collection platforms and associated hardware. USGS provided shelf space and clear path to water surface or USGS recorder sprocket. Contractor delivered data to the USGS Reston Honeywell computer in real time where it was available to the Colorado District office for retrieval and analysis.

PROGRESS: Data were received for 80 streamfow monitoring sites in the Arkansas River Basin via COMSAT contract. Assistance was provided to COMSAT General to develop computer software for computing discharge using variable shifts. Real-time data were compared to data recorded at each site and computed by conventional methods.

PLANS FOR FY 83: Two reports will be written describing use of real-time data in hydrology and water management in Arkansas River basin, Colorado.

PROJECT TITLE: Baseline Reconnaissance of an Area to be Strip Mined

PROJECT NUMBER: CO-80-138

STUDY LOCATION: The study area is located approximately 8 miles south of Hayden, Colo., in Routt County

COOPERATING AGENCY: U.S. Bureau of Land Management

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

PROJECT DURATION: June 1980 to September 1985

PROBLEM: Recent studies of coal-mining hydrology generally have been started after strip mining has begun. Without an adequate premining data base, it is difficult to separate man-induced effects from the natural conditions.

OBJECTIVES: Define and interpret the undisturbed natural hydrologic regime of an area which is to be strip mined. Define the hydraulic and hydrologic characteristics of the overburden aquifers, coal aquifers, and underburden aquifers. Determine the interaction of these aquifers with each other and with the surface water.

APPROACH: Ground-water levels and quality and surface-water flows and quality will be monitored for a period of 3 years to define premining background conditions. These data will be evaluated to define the natural hydrologic system. Monitoring will continue during and after mining. Postmining data will then be evaluated to define the changes in ground- and surface-water quantity and quality. An interpretive report will be written which evaluates the impacts of coal mining on the hydrologic regime.

PROGRESS: Thirty ground-water wells have been drilled at the proposed strip-mining site. Geological and geophysical logs have been run on each well. Water levels have been measured in the wells and continuous recorders installed on two of them. A basic-data report (Open-File Report 82-874) describes the study and the initial data. Data collection was continued at 28 wells. Water-quality samples were taken three times at seven wells. Soil water measurements were made at six soil-water access tubes. Climatological data collection was continued. Surface-water flow and quality were monitored throughout the year.

PLANS FOR FY 83: This will be the final year of intensive data collection prior to mining. Data collection will be substantially reduced from FY 84 until mining begins. In FY 83 ongoing data collection and data reduction will continue in preparation for a report to be written in FY 84.

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: Thoroughly describe and quantitatively evaluate 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. The allowable drawdown in the unconfined aquifer is 2 feet at the boundary of the project area.

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.

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.

PLANS FOR FY 83: Update digital model. Install 12 new digital water-level recorders to increase network size to 37 sites. Test well-field designs for well spacing, discharge, and drawdown considerations. Supervise six pump tests in the study area.

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 under-utilized 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 to be found in the aquifers.

OBJECTIVES: The principal objective of the study is to learn more about the geologic structure and hydrologic characteristics of the most promising bedrock aquifers. The Colorado part of the study will deal with eight of the aquifers that extend from the Front Range of the Rockies into Kansas, Nebraska, and Oklahoma.

APPROACH: Existing geologic and geophysical data will be compiled and analyzed to define the geologic structure of the aquifers. The structure data can then be used to select wells that penetrate each aquifer. Data from these wells will be used to define the hydrologic characteristics of each aquifer. A regional model of the Dakota Sandstone will be used to check the validity of the interpretative results.

PROGRESS: Drafts of the geologic structure isolith and isopach for all units under investigation are completed. Work was begun on porosity maps for the units.

PLANS FOR FY 83: Plans for FY 1983 are to complete the porosity maps for the units and complete work on the potentiometric surface maps of the units.

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, Colorado

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, here is a need to study current streamflow-quantity and -quality conditions and assess probable impacts of future changes.

OBJECTIVES: This study is designed primarily to describe hydrology in terms of water-resources availability and quality prior to substantial energy development. The study will also help evaluate potential environmental and selected socioeconomic impacts of the energy-resource development plans.

APPROACH: The first objective is addressed by describing 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. The second objective is addressed by modeling the potential impacts of oil-shale development on salt loads in Piceance and Yellow Creeks and the White River; and to evaluate the potential changes in streamflow regime that would result from construction of water-use projects. The water-use projects include effects from proposed reservoirs, canals, tunnels, and pumping plants.

PROGRESS: A journal article describing the potential impacts of oil-shale development on salt loads in the White River has been published. This analysis utilized a regression model based on streamflow and periodic chemical analysis. Seasonal effects were taken into account by the inclusion of simple-harmonic time functions. Changes in salinity were estimated for hypothetically altered flow conditions at selected locations in the basin, using equations derived from the regression model. Ground-water withdrawals for use in the mining operation were assumed to have a constant salinity concentration and discharge. Increases in mean annual discharge on Piceance and Yellow Creeks of about 100 percent and Evacuation Creek of about 200 percent would increase salinity loads by about 10 percent and decrease the mean concentration of the White River at the Green River confluence by about 5 percent. If the use of water for oil-shale development were to cause Piceance Creek, Yellow Creek, and Evacuation Creek to go dry, salinity loads of the White River at the Green River confluence would decrease about 14 percent.

Water-quality characteristics of the White River basin are described in a report in process.

PLANS FOR FY 83: Reports describing water-quality characteristics of the White River basin and hydraulic properties of the White River mainstem will be completed for publication. Work will begin on a reservoir and streamflow model depicting the effects of potential water-use projects. This report will be completed in FY 84.

PROJECT TITLE: Streamflow Analysis, Piceance and Yellow Creeks, Northwestern Colorado

PROJECT NUMBER: CO-81-153

STUDY LOCATION: Piceance and Yellow Creeks basins in Rio Blanco and Garfield Counties, Colorado

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

PROJECT CHIEF AND OFFICE: Thomas A. Herrett, Subdistrict Office, Meeker

PROJECT DURATION: January 1981 to September 1984

PROBLEM: A comprehensive assessment of streamflow information is needed to provide an adequate basis for making future water management decisions. In view of the many demands placed on surface waters by oil-shale development, it is urgent that all available streamflow data are analyzed to determine if the existing network provides an adequate description of the streamflow characteristics as they are prior to mining. Information from other data networks in the area (for example, climatic and precipitation) must also be compiled and analyzed to determine data currently available, future uses, and additional data needs.

OBJECTIVES: (a) Define the natural and existing streamflow regime of study area, (b) determine the relationships between ground water and surface water in the study area by means of a gain-loss investigation during low-flow conditions, (c) identify data and information deficiencies and design a comprehensive hydrologic data network to meet current and long-term data needs to support impact studies on oil-shale development.

APPROACH: The study will be accomplished in three phases. The first phase will be to collate and compile existing hydrologic data from the area and to conduct a gain-loss investigation for Piceance and Yellow Creeks. The second phase will be to analyze the available data using the USGS snowmelt runoff model and regional regression models to describe the natural-flow regime and to describe data deficient areas. Then begin to meet data needs by establishing supplemental areas of data collection. In the third phase, a data network to meet future needs will be designed and implemented based on the results of phases one and two.

PROGRESS: The first phase of the approach has been accomplished and a baseline network of precipitation and snow courses has been established.

PLANS FOR FY 83: Operation of the baseline network of precipitation and snow course network will be continued. Phases two and three of the approach were suspended due to lack of funds.

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 May 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: Objectives are to:

1. Determine recharge-discharge relations of springs to the hydrologic system.
2. Locate, if possible, springs discharging from lower Green River and Wasatch Formations.
3. Determine the chemical quality of springs and relate that information to source formations.
4. Determine concentration and variability of chemical constitutents 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. A geologic map of the study area is to be prepared and mineralogical information on formations compiled. Previous studies have identified springs in the Uinta and upper Green River Formations. These springs will be examined for inclusion in a monitoring network. A field reconnaissance will be made in an attempt to identify springs discharging from the lower Green River and Wasatch Formations. If such springs are found, candidate springs for monitoring will be selected. A spring monitoring network can then be established 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: Twenty-four fall samples and 32 late-spring samples were collected from the upper aquifer springs. Eighteen samples were collected springs in valleys or perimeter areas. Flow studies were done at about 100 springs. Three tritium samples from snowpack and precipitation and eight from springs were collected but have not been analyzed. Chemical sampling of springs in the upper aquifer of the Green River and Uinta Formations of Eocene age indicates a mixed cation-bicarbonate water type. Conductivities of 500 to 800 µS/cm (microsiemen per centimeter at 25°C) were found in the water from most springs, and slightly lower values were found in the water from higher-altitude springs. The water from three springs had conductivities of 900 to 1,200 µS/cm. Trace elements were at relatively low levels except for strontium, whose concentrations ranged from 0.5 to 2.0 mg/L (milligrams per liter). Higher strontium levels often are associated with water with higher dissolved solids and more sulfate.

Springs in valley bottoms are from alluvium whereas other valley springs above the alluvium are probably a mixture of water from locally recharged slope-wash and talus deposits and the lower Green River Formation and the Wasatch Formation of Paleocene and Eocene age. Alluvial waters had conductivities of 900 to 1,500 µS/cm and the other valley springs ranged from 1,000 to 2,500 µS/cm.

Flow studies of about 100 springs indicated brief recharge to the upper aquifer from snowmelt. Measurements of flow in June were often two to three times the baseflow measured the previous fall. Flow at many sites had decreased to near baseflow levels when measured later in the summer. Baseflow at nearly all springs measured was less than 0.04 cubic feet per second, and many were less than 0.2 cubic feet per second.

PLANS FOR FY 83: Collect water-quality samples at approximately 20 upper aquifer springs in fall and again in winter. Resample some alluvial and valley springs, or any new spring that could be a lower aquifer discharge. Parameters include the major ions, nitrogen, phosphorus, and selected trace elements. Send the tritium samples collected in 1982 to lab for analysis. Coordinate plans with district personnel for a gain-loss and sampling study on a selected stream in the basin in an attempt to delineate an area of discharge from the lower Green River aquifer. Plan on ending data collection by March so final report preparation may begin.

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 for 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. Water-quality data will be evaluated using histograms, regression analysis and mass balance approaches. In the Widefield aquifer, collect monthly samples from 5 wells and one-time samples from about 40 additional wells. The data will be evaluated to show areal and seasonal variation of nitrogen species in the Widefield aquifer.

PROGRESS: Water-quality data have been collected monthly at 20 stream sites and from 6 municipal supply wells. Additional data have been collected at 80 wells. The data have been plotted to illustrate seasonal and areal trends and have been summarized statistically. Many wells sampled are within 20 percent of the standard for nitrate in drinking water.

PLANS FOR FY 83: Continue data collection program with modifications based on previous year's data. Evaluate possibility of using solute transport model to help analyze nitrate concentrations in the Widefield aquifer. Write and publish report.

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 only

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

PROJECT DURATION: April 1981 to September 1983

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: The objectives of this project are to 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. The basic information presented will primarily provide a background information base describing hydrologic conditions prior to mining. Where information related to hydrologic impacts of mining are available, a section describing these impacts will be included. For the most part, only existing data will be used.

APPROACH: The STOP report format will be used consistently for each coal region according to guidelines provided by WRD's coal program coordinator. The 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. Authors will be given flexibility in their use of existing data to innovate report subjects and illustrations.

PROGRESS: Reports have been prepared for the North Park (Area 54) and Raton Mesa (Area 61) and are pending approval and publication.

PLANS FOR FY 83: Reports are being prepared for the Denver Basin (Area 59) and the Yampa-White River Basins (Area 53).

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. Groundwater 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: Project objectives are to locate major aquifer systems, to estimate the volume of ground water in storage, to determine the quality of available ground water, and to estimate the hydrologic impacts of major withdrawals and injection.

APPROACH: Hydrologic and geochemical data will be compiled from existing well logs and field inventory of wells and springs. Simulation models will be prepared and used to estimate the effects of withdrawals from and injection into various aquifer systems.

PROGRESS: A plan of study was prepared for the RASA (Regional Aquifer System Analysis) for the Upper Colorado River Basin and is in review. 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. Preliminary report outlines also have been prepared for the first series of hydrologic atlases to be produced in 1983. Data collection and analysis are proceeding for the RASA project. About a thousand industrial drill-stem tests have been analyzed for hydraulic conductivity and shut-in head. Water samples have been collected from springs and wells; resulting analyses have been interpreted. A mathematic model is in preparation for aquifers of Mesozoic age in parts of Utah.

PLANS FOR FY 83: Analysis of major ground-water flow systems will be conducted. The plan of study will be published and several hydrologic studies describing ground water, aquifers, and geologic properties will be initiated.

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 W. 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 over-appropriation 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: To construct and document a model capable of assessing the basinwide quantity and quality impacts resulting from changes in water use. The model would be an interactive, planning-type, stream-network model that would simulate the impact of the adjacent alluvial aquifer, simulate a water quality mix, and include the legal priority system of Colorado Water Law.

APPROACH: The model would be developed and modified from existing stream-network models and stream-aquifer models. Stream-aquifer response functions, precipitation-runoff relationships, water quality-discharge relationships, and irrigation application--recharge factors will have to be developed for entry into the model. The model will then be calibrated and examples of the predictive capabilities of the model will be demonstrated in workshops and described in a report.

PROGRESS: The first of a planned series of river basin models was developed using regression coefficients to compute monthly discharge and specific conductance at 39 nodes in Colorado along the main stem of the Arkansas River and major tributaries. This model was used to demonstrate the color graphics output during interactive computer-simulation runs. Needed hydrologic data, including precipitation, snowpack, streamflow, and ground-water levels were collated and put into compatible computer-data files. A simplified retrieval system was programed to allow interactive retrieval of these data. Work was initiated to develop regression relationships to predict monthly runoff from streams in the Upper Arkansas River basin.

PLANS FOR FY 83: The precipitation-runoff relationships will be completed and the water quality in the basin will be described and regression equations will be developed. A thorough tabulation and description of the water-resources operations within the basin will be compiled. Development of the river basin simulation models will continue.

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 mainstem 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 October 1983

PROBLEM: Proposed river storage and diversion projects in 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.

OBJECTIVES: The objectives of the study are as follows: (1) Describe existing channel geometry, sites of sediment storage, and sediment size distribution, (2) Establish a sediment transport relation, (3) Identify the streamflow critical to existing channel geometry, (4) Attempt to predict the nature of change in sediment transport, geomorphology, and sediment size given reduced streamflow from reservoir construction.

APPROACH: A prediction of general fluvial changes resulting from the construction of water impoundment structures may be made utilizing existing sediment transport and hydraulic geometry relations. Discharge and suspended sediment data from two gaged sites in the study area will be supplemented with discharge, suspended and bedload sediment measurements at two sites in the Monument during the spring and summer of 1982.

PROGRESS: Discharge and hydraulic-geometry measurements were made and sediment and suspended load samples were collected during the 1982 snowmelt runoff season at two sites on the lower Yampa River at the Dinosour Monument, Colorado. Hydraulic-geometry relations have been derived and discharge data analyzed. Processing of sediment samples is continuing. Collection of data from two new study sites, Yampa River below Little Snake River and Yampa River below Box Elder Park is complete.

PLANS FOR FY 83: Plans are processing of sediment samples and computation of sediment discharge and transport rates will be completed. Analysis of data will include comparison of discharge and hydraulic geometry measured at the new study sites with that from two gaged sites upstream and interpretation of sediment-transport data. A report will be prepared summarizing the data and interpretation.

PROJECT TITLE: Effects of Projected Urbanization on Inflows to Chatfield and Cherry Creek Reservoirs

PROJECT NUMBER: CO-82-164

STUDY LOCATION: The study area includes the South Platte River drainage below Cheeseman Reservoir to Chatfield Reservoir and the Cherry Creek drainage above Cherry Creek Reservoir

COOPERATING AGENCY: Denver Regional Council of Governments

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

PROJECT DURATION: November 1981 to September 1983

PROBLEM: Cherry Creek and Chatfield Reservoirs are U.S. Army Corps of Engineers reservoirs used extensively for fishing, swimming, and boating. They are located on the current edge of the Denver metropolitan urban area. Urbanization upstream of both reservoirs will effect the quantity and quality of urban runoff entering the reservoirs. 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 effect the suitability of the reservoirs for recreational activities.

OBJECTIVES: Four objectives are identified as follows: (1) Estimate annual loads of water-quality constituents in the inflows, (2) develop statistical relationships between water-quality loadings and precipitation and basin characteristics, (3) provide assistance to the Denver Regional Council of Governments to estimate future water-quality loadings entering Cherry Creek Reservoir using HSPF (Hydrologic Simulation Program-Fortran), and (4) define ground-water levels and water quality in the alluvium upgradient of Cherry Creek Reservoir.

APPROACH: The following work elements are planned: (1) Monitoring of quantity and quality of surface-water inflow. Nine principal tributaries will be monitored to provide data on seasonal and storm-event flow and water-quality conditions. Precipitation data will be provided by 12 raingages located throughout the basins. Variation in water-quality conditions will be defined by a sampling program that includes monthly and storm-event samples, (2) monitoring of the shallow ground-water system. Monthly water-level measurements and water samples will be collected at approximately 20 wells to define seasonal variations in the alluvial ground-water system near the reservoirs, and (3) analyses of data. Regression analyses will be used to relate runoff and water-quality characteristics to relate runoff and water-quality characteristics 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 probably is Cherry Chreek Tributary No. 1, which drains about 490 acres of urban area. The channel was reportedly dry during ambient conditions until development occurred in the basin, but it now has base flow. Cherry Creek itself has a sand bed and flows intermittently.

The major inflows to Chatfield Reservoir are the South Platte River and Plum Creek. Deer Creek is a minor tributary with perennial flow. The storm runoff in Deer Creek apparently is detained in the marshes just upstream of the monitoring site at the mouth; large storms tend to produce a sudden rise in stage at the monitoring site, but storm runoff from small and intermediate-size storms is barely distinguishable from base flow.

PLANS FOR FY 83: Data collection will be complete by December 1982. A data report will be compiled and prepared for publication. Annual storm-runoff loads for selected water-quality constituents will be compared to annual baseflow loads for each stream monitored. Measured annual constituents loads will also be compared to estimates using predictive relationships developed from the Nationwide Urban Runoff Program project (CO-073). An interpretive report summarizing the results of the study will be prepared.

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, Subdistrict Office, Pueblo

PROJECT DURATION: August 1982 to September 1983

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: Objectives are to: (1) Develop a water budget, (2) determine seasonal variations in spring discharge, stream discharge, ground-water storage, underflow from the drainage, and water quality, (3) determine the transmissivity of the alluvial aquifer, and (4) estimate the impacts on the hydrologic system of using spring flow, surface flow, or alluvial ground water for domestic supply.

APPROACH: Elements of the approach are to (1) inventory all springs and wells in the study area and enter all data into USGS GWSI (Ground Water Site Inventory) computer files, (2) 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, (3) drill and test three wells in alluvium to determine transmissivity, (4) integrate soils and vegetation data (collected and observed), climatic, and other physiographic data into PRMS (Precipitation Runoff Modeling System) model to estimate water budget, (5) conceptualize hydrologic system, and assess impacts with two-dimensional ground-water model.

PROGRESS: The GWSI files have been updated to reflect all available ground-water data. Two surface-water seepage runs have been conducted and quality of water samples collected from springs and surface-water sources in Cottonwood Wash.

PLANS FOR FY 83: Water levels will be measured and water-quality samples collected at three shallow wells to be drilled in the alluvium of Cottonwood Wash. The water resources of Cottonwood Wash will be analyzed through the use of the USGS precipitation runoff model. Data and model results will be illustrated in a final report.

PROJECT TITLE: South Platte River Waste Assimilation

PROJECT NUMBER: CO-82-170

STUDY LOCATION: The South Platte River Mainstem 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 is currently known about the effects of treated wastewater 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: Objectives are to: (1) Determine time-of-travel of the South Platte in the study reach, (2) 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, (3) 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, (4) calculate un-ionized ammonia concentrations in the study reach, (5) calibrate and verify a one-dimensional steady-state water-quality model of the South Platte study reach for subsequent nitrogen concentration simulations.

APPROACH: During conditions of steady-state low-flow on the South Platte River (regulated at Chatfield Reservoir), three intensive 24-hour data collection efforts will be conducted. Water-quality samples and discharge measurements will be taken at selected instream sites and tributaries and municipal and industrial discharge sites. Two time-of-travel runs and one reaeration data collection run will be conducted on the river. Data will be collected on benthic oxygen demand in the river and two data collection efforts will be conducted to determine the extent of the mixing zone below the Bi-City WWTP and selected chemical constituent concentrations in that zone. The USGS's one-dimensional, steady-state water-quality model as documented by Bauer and others (WRI 79-45, 1979) will be used to simulate selected constituent species concentrations based on hypothetical values of constituent species concentrations and levels of effluent discharge.

PROGRESS: The first of three regulated flow data collection periods on the South Platte River through Denver, Colo., was completed during October 1982. Water-quality samples were collected over a 24-hour period at 44 instream, tributary, and municipal-industrial discharges. Results from laboratory analysis are pending. Time-of-travel data were collected at 17 instream sites through the study reach. These data will be used to calibrate the USGS one-dimensional steady-state water-quality model.

PLANS FOR FY 83: Two additional 24-hour sampling runs will be conducted in February and September 1983. The USGS steady state water-quality model will be calibrated and verified. Model simulations will be used to estimate the effects of hypothetical discharges of sewage effluent. A final report will be written 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 1983

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 USGS 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: The primary purpose of the study is to develop regional relations for the prediction of streamflow and sediment characteristics in western Colorado. Regional regression techniques will be used to relate high, mean, and low-flow characteristics and sediment characteristics to channel and basins characteristics where sufficient information is available for this analysis. A secondary purpose of the study is to evaluate the existing network and look at reasons for operation of the gaging stations. This analysis is needed for future planning and adjustment of the streamflow data network.

APPROACH: The principal approach of the study will utilize multiple regression analysis techniques. The major elements in this study are: (1) Determine basin, and climatic characteristics for the gaged basins from the latest maps available, (2) develop flow and sediment characteristics from observed streamflow development in the gaged basins to determine if any changes have occurred following development, (4) utilize state-of-the-art regression techniques to relate streamflow and sediment characteristics to basin, climatic, and channel characteristics, and (5) establish a network evaluation matrix to categorize and prioritize each data collection site in accordance with set of network objectives.

PROGRESS: New project in FY 1983.

PLANS FOR FY 83: Extensive mapwork to determine the basin and climatic characteristics for the study area will be the major thrust for FY 83. Hydrologic characteristics will also be developed based on historical data and a determination of the purpose for each station operation in the study area will be made.

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 Purgatory 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 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: Two objectives are identified: (1) Assess the quantity and quality of both surface- and ground-water resources in the area, and (2) determine the impact of military training on the water resources of the area.

APPROACH: Surface-water flow will be monitored at 10 stations. Two are existing and eight will be installed in FY 83. Specific conductance will be monitored continuously at all stations. Sediment samples will be collected by automatic samplers at seven stations. Water-quality samples will be collected of baseflow and storm runoff. Historic sediment yield will be determined by surveying sediment accumulation in 40 to 50 small reservoirs. These will be resurveyed to determine sediment yield following training. Existing wells will be inventoried and 50 will be sampled. Water levels will be measured monthly in 10 wells.

PROGRESS: New project in Fiscal Year 1983

PLANS FOR FY 83: Install and operate the surface-water monitoring network. Locate 40 to 50 small reservoirs and survey sediment contents to determine sediment yield during use of land for grazing.

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 mainstem and tributaries draining the valley south of the Yampa mainstem. This area is in Routt and Moffat Counties of 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 moves and expansion of coal mines are proposed. These proposals must be considered with respect to the cumulative impacts on the hydrology downstream. From previous water-quality data collection, substantial increases in dissolved solids downstream from existing mining activities are noted.

OBJECTIVES: The objectives of this study are to develop a model for the Yampa River basin to simulate dissolved-solids loads resulting from the existing land use and surface coal mining and to simulate changes in dissolved-solids loads that may result from proposed coal mines.

APPROACH: Dissolved water quality data have been or are being collected for the major and minor tributaries of the Yampa River basin. Analysis of existing water-quality data has been done and additional analysis will be done. These data and analyses will be used to modify the Tongue River Dissolved Solids Model (Woods, 1981, USGS WRI 81-64) for major tributaries of the Yampa River and the Yampa River mainstem.

PROGRESS: New project in Fiscal Year 1983

PLANS FOR FY 83: Additional data needed will be collected. Compilation and analysis of data necessary for the model will be completed and general structuring of the model to this watershed will initiated.

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 alter water quality.

OBJECTIVE: The general objective is to define existing ground- and surface-water conditions in the study area.

APPROACH: Elements of the approach are to: (1) Examine data records, (2) measure water levels, (3) conduct gain and loss measurements for selected stream(s), (4) map water-table or potentiometric contours, (5) analyze records of previous flood events to determine the 100-year flood plain, (6) examine existing subsidence in mined areas within the study area, and (7) determine the suitability of existing and collected information to assess mining impacts.

PROGRESS: New project in Fiscal Year 1983

PLANS FOR FY 83: Work plans are to collect and examine existing data and information, measure water levels in an undetermined number of wells, complete gain and loss measurements for stream(s), examine subsidence areas in local mining sites, and collect any additional data to aid in the description of the area's geohydrology.

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[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. Blattner, J. L., and Rasmuson, B. D., 1982, Water-level records for the northern High Plains of Colorado, 1978-82: U.S. Geological Survey Open-File Report 82-573, 28 p. Paper copy $4.00; microfiche $3.50.
2. Borman, R. G., and Meredith, T. S., 1981, Water-level records for the northern High Plains of Colorado, 1977-81: U.S. Geological Survey Open-File Report 81-637, 29 p. Paper copy $4.25; microfiche $3.50.
3. Cochran, B. J., Minges, D. R., Jarrett, R. D., and Veenhuis, J. E., 1982, Rainfall-runoff data from small watersheds in Colorado, October 1977 through September 1980: U.S. Geological Survey Open-File Report 82-873, 748 p. (in press).
4. Dosch, T. R., 1982a, Flood-prone areas in Elbert County, Colorado: Elbert County Board of Commissioners and Colorado Water Conservation Board, 1 sheet, 36 by 36 inches; 49 quarter-quadrangle maps, scale 1:12,000 (1 inch = 1,000 feet); and 48 aerial photographs, 24 by 24 inches, scale 1 inch = 1,320 feet. Available from Elbert County Land Use Administrator, County Courthouse, P. O. Box 205, Kiowa, CO 80117.
5. _____1982b, Flood-prone areas in Elbert County, Colorado--Technical Addendum: Elbert County Board of Commissioners and Colorado Water Conservation Board, 41 p. Available from Elbert County Land Use Administrator, County Courthouse, P. O. Box 205, Kiowa, CO 80117.
6. Elliott, J. G., Jarrett, R. D., and Ebling, J. L., 1982, Annual snowmelt and rainfall peak-flow data on selected foothills region streams, South Platte River, Arkansas River, and Colorado River basins, Colorado: U.S. Geological Survey Open-File Report 82-426, 86 p. Paper copy $11.00; microfiche $3.50.
7. Gibbs, J. W., 1981, Hydrologic data for urban storm runoff from nine sites in the Denver metropolitan area, Colorado: U.S. Geological Survey Open-File Report 81-682, 142 p. Paper copy $29.50; microfiche $7.00.
8. Gibbs, J. W., and Doerfer, J. T., 1982, Hydrologic data for urban storm runoff in the Denver metropolitan area, Colorado: U.S. Geological Survey Open-File Report 82-872, 553 p. Paper copy $77.50; microfiche $4.50.
9. Kuhn, Gerhard, 1982, Statistical summaries of water-quality data for two coal areas of Jackson County, Colorado: U.S. Geological Survey Open-File Report 82-121, 23 p. Paper copy $3.50; microfiche $3.50.
10. Maura, W. S., 1982, Water-quality data for streams in the southern Yampa River basin, northwestern Colorado: U.S. Geological Survey Open-File Report 82-1017, 115 p. (in press).
11. Patt, R. O., Adams, D. B., and Collins, D. L., 1982, Hydrologic data from Naval Oil Shale Reserves, Parachute Creek basin, northwestern Colorado, 1975-79: U.S. Geological Survey Open-File Report 82-696, 142 p. (in press).

Water-Resources Data Reports--Continued

12. Price, W. E., Jr., compiler, 1981, Water-resources investigations of the U.S. Geological Survey in Colorado--fiscal year 1981: U.S. Geological Survey Open-File Report 81-150, 131 p. Paper copy $19.25; microfiche $4.00.
13. Williams, R. S., Jr., and Driver, N. E., 1982, Plan for hydrologic study of an area to be surface mined for coal in northwestern Colorado: U.S. Geological Survey Open-File Report 82-874, 19 p. Paper copy $2.75; microfiche $3.50.
14. U.S. Geological Survey, 1981, Water resources data for Colorado--Water year 1980, Volume 1, Missouri River basin, Arkansas River basin, Rio Grande basin: U.S. Geological Survey Water-Data Report CO 80-1, 535 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 188 301. Paper copy $38.50; microfiche $4.50.
15. _____1981, Water resources data for Colorado--Water year 1980, Volume 2, Colorado River basin above Dolores River: U.S. Geological Survey Water-Data Report CO 80-2, 387 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 188 293. Paper copy $29.50; microfiche $4.50.
16. _____1981, Water resources data for Colorado--Water year 1980, Volume 3, Dolores River basin, Green River basin, and San Juan River basin: U.S. Geological Survey Water-Data Report CO 80-3, 452 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 202 045. Paper copy $34.00; microfiche $4.50.
17. _____1982, Water resources data for Colorado--Water year 1981, Volume 1, Missouri River basin, Arkansas River basin, Rio Grande basin: U.S. Geological Survey Water-Data Report CO 81-1, 487 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-83 110 874. Paper copy $35.50; microfiche $4.50.
18. _____1982, Water resources data for Colorado--Water year 1981, Volume 2, Colorado River basin above Dolores River: U.S. Geological Survey Water-Data Report CO 81-2, 354 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-83 105 098. Paper copy $28.00; microfiche $4.50.
19. _____1982, Water resources data for Colorado--Water year 1981, Volume 3, Dolores River basin, Green River basin, and San Juan River basin: U.S. Geological Survey Water-Data Report CO 81-3, 436 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161. Paper copy $32.50; microfiche $4.50.

Water-Resources Interpretive Reports

[* = Contact District Chief for availability of report]

1. Adams, D. B., Bauer, D. P., Dale, R. H., and Steele, T. D., 1982, Reservoir-development impacts on surface-water quantity and quality in the Yampa River basin, Colorado and Wyoming: U.S. Geological Survey Water-Resources Investigations 81-30 (in press).
2. Borman, R. G., 1982, Predevelopment and 1980 water table in the northern High Plains of Colorado; and water-level changes, predevelopment to 1980, and 1975 to 1980: U.S. Geological Survey Hydrologic Investigations Atlas HA-670, lat 38°06' to 41°, long 102°03' to 103°50', scale 1:500,000 (1 inch = about 8 miles) and scale 1:1,000,000 (1 inch = about 16 miles, 1 sheet, 30½ by 32½ inches (in press).
3. Borman, R. G., Lindner, J. B., Bryn, S. M., and Rutledge, John, 1982, The Ogallala aquifer in the northern High Plains of Colorado--saturated thickness in 1980; hydraulic conductivity; specific yield; and predevelopment and 1980 probable well yields: U.S. Geological Survey Hydrologic Investigations Atlas HA-671, lat 38°06' to 41°, long 102°03' to 103°50', scale 1:500,000 (1 inch = about 8 miles) and scale 1:1,000,000 (1 inch = about 16 miles), 1 sheet, 31 by 42 inches (in press).
4. Borman, R. G., and Meredith, T. G., 1982, Geology, altitude, and depth of the bedrock surface beneath the Ogallala Formation in the northern High Plains of Colorado: U.S. Geological Survey Hydrologic Investigations Atlas HA-669, lat 38°06' to 41°, long 102°03' to 103°50', scale 1:500,000 (1 inch = about 8 miles), 1 sheet (in press).
5. Borman, R. G., and Reed, R. L., 1982, Location of irrigation wells and application rates for irrigated cropland during 1980 in the northern High Plains of Colorado: U.S. Geological Survey Water-Resources Investigations Map Report 82-629, lat 38°06' to 41°, long 102°03' to 103°50', scale 1:500,000 (1 inch = about 8 miles), 1 sheet, 30 by 35½ inches (in press).
6. Burns, A. W., 1981a, Simulated interactions between the proposed Narrows Reservoir and the water-table aquifer along the South Platte River, Morgan County, Colorado: U.S. Geological Survey Water-Resources Investigations 80-119, 61 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 131 483. Paper copy $9.00; microfiche $4.00.
7. _____1981b, Simulated hydrologic effects of possible ground-water and surface-water management alternatives in and near the Platte River, south-central Nebraska: U.S. Geological Survey Open-File Report 81-1116, 41 p. Paper copy $5.75; microfiche $3.50.
8. _____1982, Simulated hydrologic effects of possible ground-water and possible ground-water and surface-water management alternatives in and near the Platte River, south-central Nebraska: U.S. Geological Survey Professional Paper 1277, Chapter G; supersedes Open-File Report 81-1116 (in press).
*9. Ellis, S. R., and Mann, P. G., 1982, Effects of effluents from a coal-fired, electric-generating powerplant on local ground water near Hayden, Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Report 81-1196, 90 p.

10. Hackbart, J. M., and Bauer, D. P., 1982, Salinity impacts, White River basin, Colorado-Utah, in Water and Energy--Technical and Policy Issues, Western Conference, Fort Collins, Colo., June 27-30, 1982, Proceedings: American Society of Civil Engineers, p. 352-357. [Paper 4, Possible impacts of energy development on salinity loads in streams, White River basin, Colorado-Utah, published in Program, Water Quality Session 2, p. 3.]
11. Hall, D. C., and Duncan, A. C., 1982, Characterization of urban runoff from Grange Hall Creek at Northglenn, Adams County, Colorado: U.S. Geological Survey Water-Resources Investigations 81-28, 50 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 215 039. Paper copy $9.00; microfiche $4.50.
*12. Hall, D. C., and Hillier, D. E., U.S. Geological Survey, and Nickum, Edward, and Dorrance, W. G., Jefferson County Health Department, 1981, Effects of residential wastewater-treatment systems on ground-water quality in west-central Jefferson County, Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Report 81-73, 65 p.
13. Herbert, R. A., 1982, An assessment of the hydrologic information required for the U.S. Bureau of Land Management-U.S. Geological Survey Coal Hydrology Program in the West: U.S. Geological Survey Open-File Report 82-1012 (in press) (will be available from Open-File Services Section, Lakewood, Colo.)
14. Hillier, D. E., and Hutchinson, E. C., 1980a, Depth to the water table (1976-77) in the Colorado Springs-Castle Rock area, Front Range Urban Corridor, Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-857-H, lat 38°37'30" to 39°22'30", long 104°37'30" to 105°, scale 1:100,000 (1 inch = about 1.6 miles), 1 sheet, 29 by 39 inches. $1.50.
15. _____1980b, Well yields and chemical quality of water from water-table aquifers in the Colorado Springs-Castle Rock area, Front Range Urban Corridor, Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-857-I, lat 38°37'30" to 39°22'30", long 104°37'30" to 105°, scale 1:100,000 (1 inch = about 1.6 miles), sheet 1, 20 by 38 inches; sheet 2, 32 by 38 inches. $3.00 per set.
16. Hillier, D. E., Schneider, P. A., Jr., and Hutchinson, E. C., 1982a, Well yields and chemical quality of water from water table aquifers in the Greater Denver area, Front Range Urban Corridor, Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-856-J, lat 39°22'30" to 40°00'00", long 104°37'30" to 105°22'30", scale 1:100,000 (1 inch = about 1.6 miles), 2 sheets (in press).
17. _____1982b, Depth to the water table in the Greater Denver area, Front Range Urban Corridor, Colorado: U.S. Geological Survey Miscellaneous Investigations Map I-856-K, lat 39°22'30" to 40°00', long 104°37'30" to 105°22'30", scale 1:100,000 (1 inch = about 1.6 miles), 1 sheet (in press).
18. Hurr, R. T., 1981, Ground-water hydrology of the Mormon Island Crane Meadows wildlife area, near Grand Island, Hall County, Nebraska: U.S. Geological Survey Open-File Report 81-1109, 16 p. Paper copy $2.50; microfiche $3.50.
19. _____1982, Ground-water hydrology of the Mormon Island Crane Meadows wildlife area, near Grand Island, Hall County, Nebraska: U.S. Geological Survey Professional Paper 1277, Chapter H; supersedes Open-File Report 81-1109 (in press).

20. Jarrett, R. D., and Costa, J. E., 1982, Multidisciplinary approach to the flood hydrology of foothill streams in Colorado, in International Symposium on Hydrometeorology, Denver, Colo., June 13-17, 1982, Session 15: American Water Resources Association, Proceedings, June 1983 (in press). [Abstract published in Program, Session 15, p. 17.]

*21. Kircher, J. E., and Von Guerard, Paul, 1982, Evaluation of sediment yield and sediment data-collection network in the Piceance basin, northwestern Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Report 82-4046, 25 p. (in press).

22. Kuhn, Gerhard, Daddow, P. B., Craig, G. S., Jr., 1982, Hydrology of Area 54, Northern Great Plains and Rocky Mountain Coal Provinces, Colorado and Wyoming: U.S. Geological Survey Open-File Report 83-146 (Water-Resources Investigations) (in press).

23. Livingston, R. K., 1981, Rainfall-runoff modeling and preliminary regional flood characteristics of small rural watersheds in the Arkansas River basin in Colorado: U.S. Geological Survey Water-Resources Investigations 80-112, 43 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-81 224 313. Paper copy $6.50; microfiche $3.50.

24. Minges, D. R., 1982, Selected hydrologic characteristics of the South Platte River in the vicinity of the proposed Narrows Reservoir near Fort Morgan, Colorado: U.S. Geological Survey Water-Resources Investigations 82-4071 (in press).

*25. Mustard, M. H., and Cain, Doug, 1981, Hydrology and chemical quality of ground water in Kiowa County, Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Map Report 81-1023, scale 1:125,000, 2 sheets.

26. Robson, S. G., 1981, Computer simulation of movement of DIMP-contaminated groundwater near the Rocky Mountain Arsenal, Colorado, in Zimmie, R. F., and Riggs, C. O., eds., Permeability and groundwater contaminant transport Symposium, Philadelphia, Pa., 1979: American Society for Testing and Materials, Special Technical Publication 746, p. 209-220.

27. _____1982, Hydraulic characteristics of the principal bedrock aquifers in the Denver basin, Colorado: U.S. Geological Survey Hydrologic Investigations Atlas HA-659, lat 38°35' to 40°25', long 103°45' to 105°15', scale 1:500,000 (in press).

28. Robson, S. G., Romero, J. C., and Zawistowski, Stanley, 1981, Geologic structure, hydrology, and water quality of the Arapahoe aquifer in the Denver basin, Colorado: U.S. Geological Survey Hydrologic Investigations Atlas HA-647, lat 38°35' to 40°25', long 103°45' to 105°15', scale 1:500,000, 3 sheets. $7.50.

29. Robson, S. G., Wacinski, Andrew, Zawistowski, Stanley, and Romero, J. C., 1981, Geologic structure, hydrology, and water quality of the Laramie-Fox Hills aquifer in the Denver basin, Colorado: U.S. Geological Survey Hydrologic Investigations Atlas HA-650, lat 38°35' to 40°25', long 103°45' to 105°15', scale 1:500,000, 3 sheets. $7.50.

30. Saulnier, G. J., Jr., and Goddard, K. E., 1982, Use of mathematical models to predict impact energy minerals on the hydrologic system in northwestern Colorado: Society of Mining Engineers of the American Institute of Mining, Metallurgical, and Petroleum Engineers, Mining Engineering, March 1982, p. 285-293.

31. Steele, T. D., and Hillier, D. E., compilers and editors, 1981, Assessment of impacts of proposed coal-resource and related economic development on water resources, Yampa River basin, Colorado and Wyoming--A summary: U.S. Geological Survey Circular 839, 56 p. Free on application to Branch of Distribution, U.S. Geological Survey, 604 South Pickett Street, Alexandria, VA 22304.

*32. Taylor, O. J., 1982, Three-dimensional mathematical model for simulating the hydrologic system in the Piceance basin, Colorado: U.S. Geological Survey Water-Resources Investigations Open-File Report 82-637, 35 p.

33. Turk, J. T., 1982, Thermodynamic controls on quality of water from underground coal mines in Colorado: American Water Resources Association, Water Resources Bulletin, v. 18, no. 1, p. 75-80.

34. Turk, J. T., and Adams, D. B., 1983, Sensitivity to acidification of lakes in the Flat Tops wilderness area, Colorado: American Geophysical Union, Water Resources Research (in press).

35. Turk, J. T., and Parker, R. S., 1982, Water-quality characteristics of six small, semiarid watersheds in the Green River coal region of Colorado: U.S. Geological Survey Water-Resources Investigations 81-19, 96 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161, as report PB-82 207 390. Paper copy $12.00; microfiche $4.00.

36. Veenhuis, J. E., and Hillier, D. E., 1982, Impact of reservoir-development alternatives on streamflow quantity in the Yampa River basin, Colorado and Wyoming: U.S. Geological Survey WaterResources Investigations 80-113, 72 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161.

37. Warner, J. W., and Dale, R. H., 1982, Digital-transport model study of the potential effects of coal-resource development on the groundwater system in the Yampa River basin, Moffat and Routt Counties, Colorado: U.S. Geological Survey Water-Resources Investigations 81-15, 70 p.; available only from U.S. Department of Commerce, National Technical Information Service, Springfield, VA 22161.

Depositories

Reports are available for inspection at the following U.S. Geological Survey depositories:

Colorado District Office, Water Resources Division, Room H-2103, Building 53 (Mail address: Box 25046, Mail Stop 415), Denver Federal Center, Lakewood, CO 80225.

Public Inquiries Office, Room 169 Federal Building, 1961 Stout Street, Denver, CO 80294.

Library, Denver West Office Park, Building 3, 1526 Cole Boulevard at West Colfax Avenue, Golden, Colo. (Mail address: Box 25046, Mail Stop 914, Denver Federal Center, Lakewood, CO 80225.)

Library, Room 4A100, 950 National Center, 12201 Sunrise Valley Drive, Reston, VA 22092.

Library, 345 Middlefield Road (mail address: Mail Stop 55, Building 5), Menlo Park, CA 94025.

U.S. Department of the Interior, National Resources Library, Gifts and Exchange Section, 18th and C Streets NW, Washington, DC 20240.

PROJECTS COMPLETED DURING FISCAL YEAR
1982 EXCEPT FOR REPORTS

Project Number	Project Name	Project Chief
CO-034	Peak discharge and flood frequency for small watersheds in Colorado	Donald R. Minges
CO-073	Monitoring of storm runoff quality, Denver metropolitan area	Sherman R. Ellis
CO-107	High plains regional aquifer-system analysis of Colorado	Ronald G. Borman
CO-119	Hydraulics of stream channels	John G. Elliott
CO-126	Flow resistance in steep mountain streams and ephemeral streams in Colorado	Robert D. Jarrett
CO-147	Hydrologic modeling of San Luis Valley, Colorado	Edward L. Nickerson
CO-151	Investigation of the concentration and distribution of nitrogen and dissolved ions in ground- and surface-waters of Rio Grande and Alamosa Counties, Colorado	Patrick F. Edelman

GPO 838 - 917