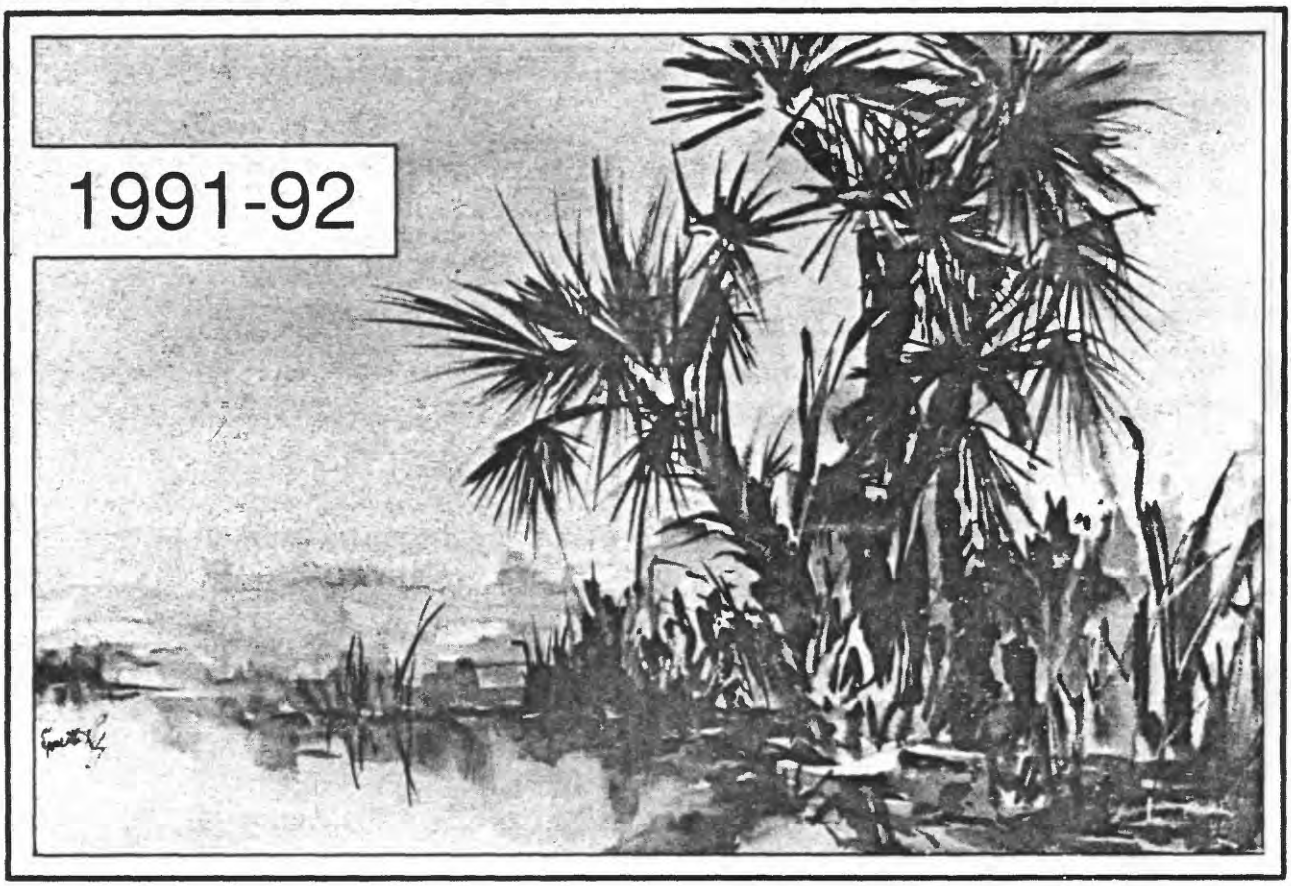
WATER RESOURCES ACTIVITIES IN FLORIDA

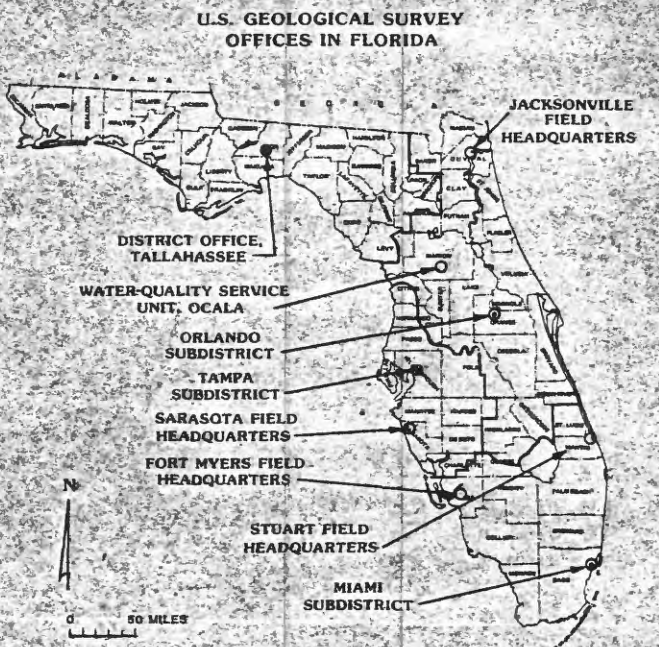


U.S. GEOLOGICAL SURVEY

OPEN-FILE REPORT 92-88

Prepared in cooperation with STATE, FEDERAL, and LOCAL AGENCIES

U.S. DEPARTMENT OF THE INTERIOR
MARCH 3, 1849



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WATER RESOURCES ACTIVITIES IN FLORIDA

1991-92

Mildred E. Glenn, editor

U.S. GEOLOGICAL SURVEY
Open-File Report 92-88

IN COOPERATION WITH

Florida Dept. of Environmental Regulation
Florida Dept. of Natural Resources
Florida Dept. of Transportation
Florida Game & Fresh Water Fish Commission
Florida Institute of Phosphate Research
Florida Keys Aqueduct Authority
Jacksonville Electric Authority
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Tallahassee, Florida

1992

U.S. DEPARTMENT OF THE INTERIOR
MANUEL LUJAN, JR., Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

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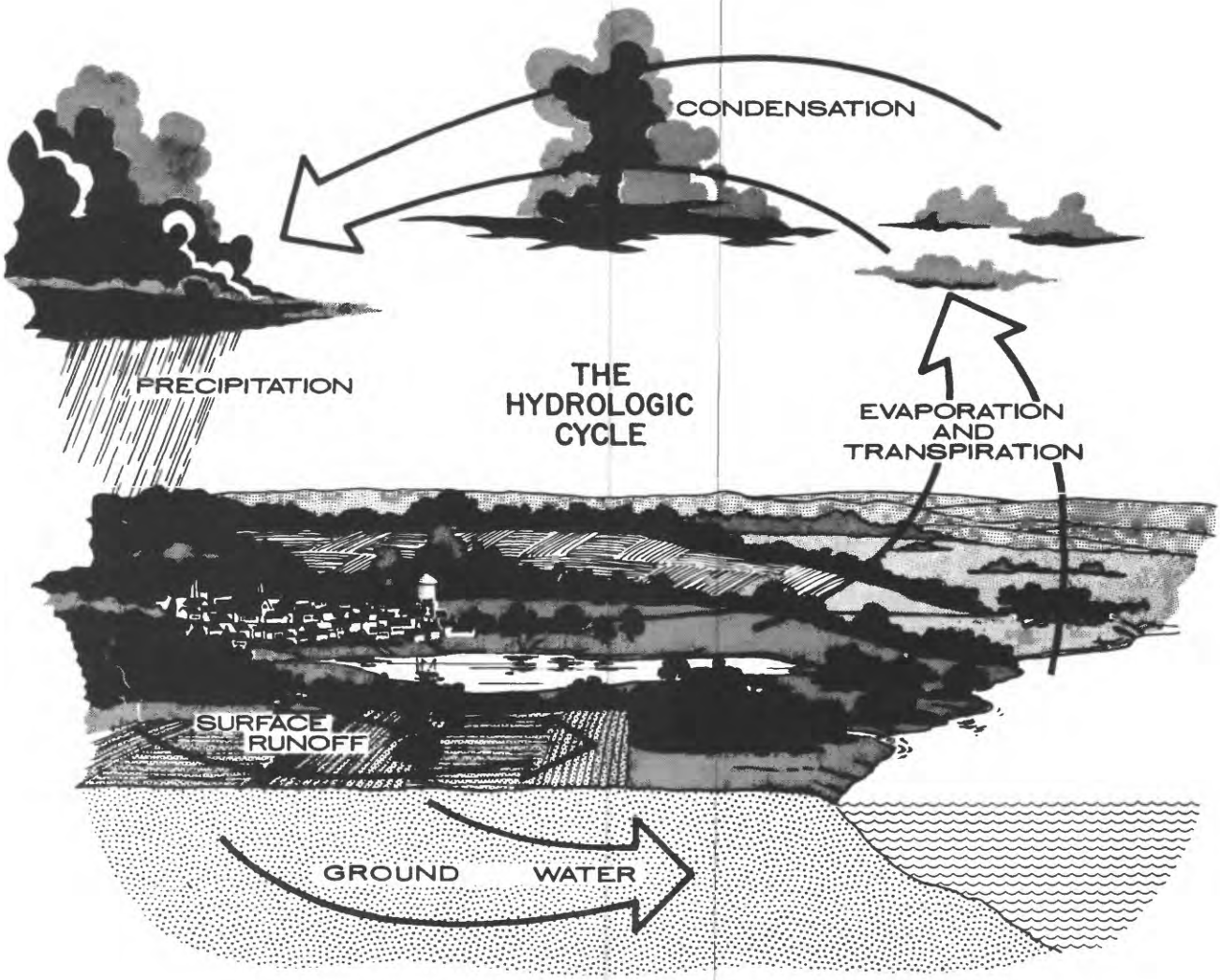
FOREWORD

The U.S. Geological Survey was created by an Act of Congress in 1879, as a bureau of the Department of the Interior, to classify public lands and to examine the geologic structure, mineral resources, and products of the national domain. Since then, the Survey's responsibilities have expanded to include topographic mapping, geochemical and geophysical studies, and the assessment of the quantity, quality, and distribution of water resources. Thus, during the past 100 years, the Survey has become the Nation's principal factfinding and research agency concerned with our physical resources. The mission of the Water Resources Division of the Survey is to provide hydrologic information needed for the development, management, and use of the Nation's water resources.

Although stream gaging began in 1884 as part of a study to identify irrigatable land, the water-resources program of the Survey began in 1894 when a small appropriation was obtained for the specific purpose of "gauging streams and determining the water supply of the United States." In the years following 1884, the need for water-resources information grew rapidly but the Survey was unable to meet the demand because of restricted budgets. Many States initiated water resource programs to fill the deficiency and the Survey worked closely with the various State agencies. However, these efforts did not satisfy the need of the States and the Nation for a comprehensive water resources information program. Accordingly, in 1928 Congress established the cooperative matching program by which the Survey's water resources programs with State agencies may be funded on a 50/50 basis. This cooperative water-resources program has grown over the years into the primary source of water information for the Nation. This is accomplished through cooperation with State and local governments and other Federal agencies by:

- Collecting data on a systematic basis to determine the quantity, quality, and use of surface and ground water.
- Conducting interpretive water-resource appraisals to describe the consequences of alternative plans for developing land and water resources.
- Conducting basic and problem-oriented research in hydraulics, hydrology, and related fields.
- Developing information on water-related natural hazards such as flood, landslides, volcanoes, mudflows, and land subsidence.
- Coordinating the activities of all Federal agencies in the acquisition of water data.
- Disseminating data and findings through reports, maps, and other forms of public release.
- Providing scientific and technical assistance in the hydrologic fields to other Federal agencies, to State and local agencies, and, on behalf of the U.S. Department of State, to international agencies.

The Water Resources, National Mapping, and Geologic Divisions are the three operating Divisions of the Survey. General information pertaining to these Divisions may be obtained from the Information Office, U.S. Geological Survey, 119 National Center, Reston, VA 22092. Circular 900, "A Guide to Obtaining Information from the U.S. Geological Survey," can be obtained free from the U.S. Geological Survey, Branch of Distribution, Federal Center, P.O. Box 25286, Denver, Colorado 80225.


CONDENSATION
PRECIPITATION
THE
HYDROLOGIC
CYCLE
EVAPORATION
AND
TRANSPIRATION
SURFACE
RUNOFF
GROUND WATER

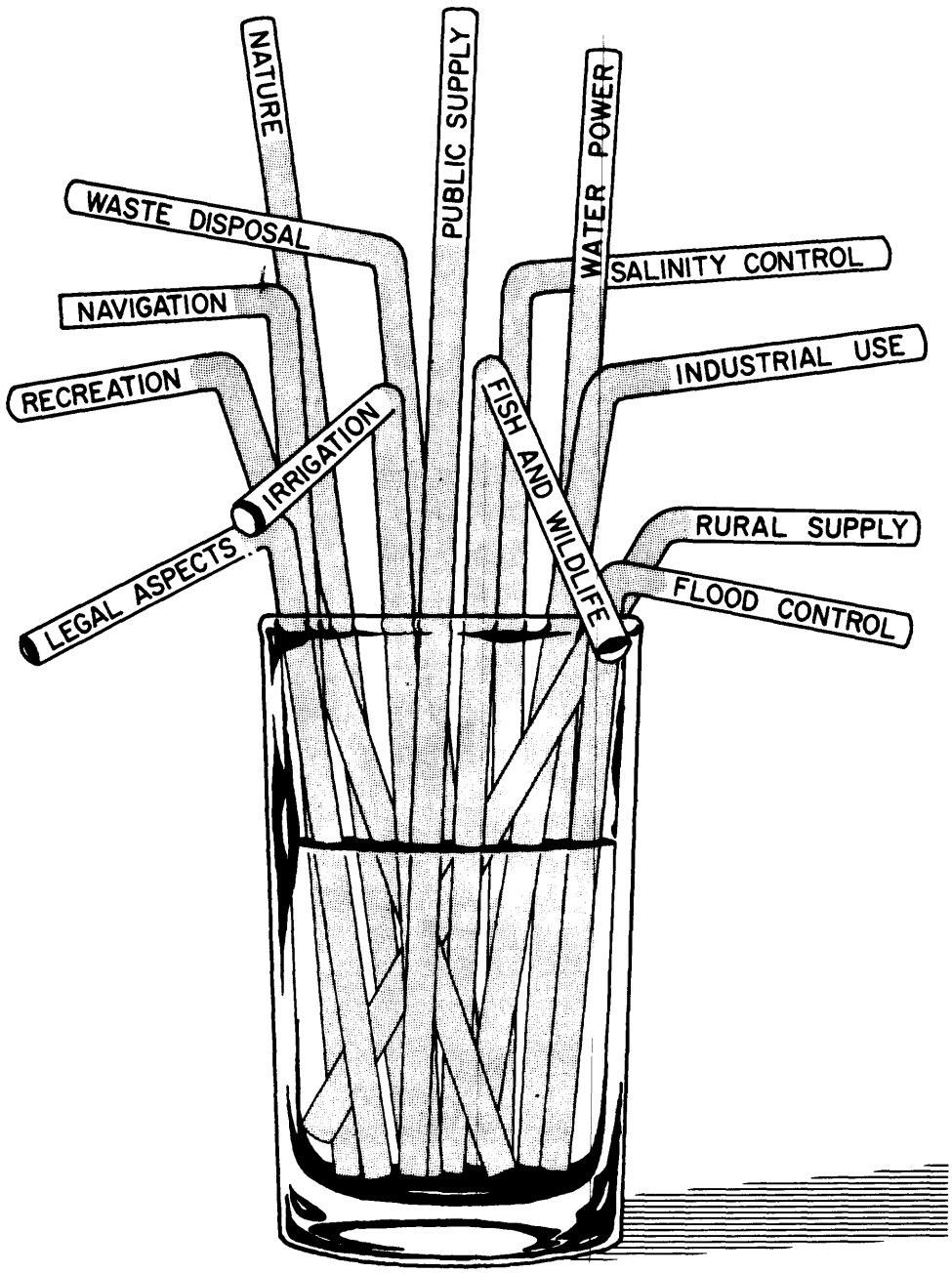
CONTENTS

CONTENTS-Continued

CONTENTS-Continued

ILLUSTRATIONS

COMPETITION FOR WATER



Competition for water is growing. Adequate information and analysis are keys to effective development, protection, and management of a common water resource.

WATER RESOURCES ACTIVITIES IN FLORIDA, 1991-92

Mildred E. Glenn, editor

INTRODUCTION

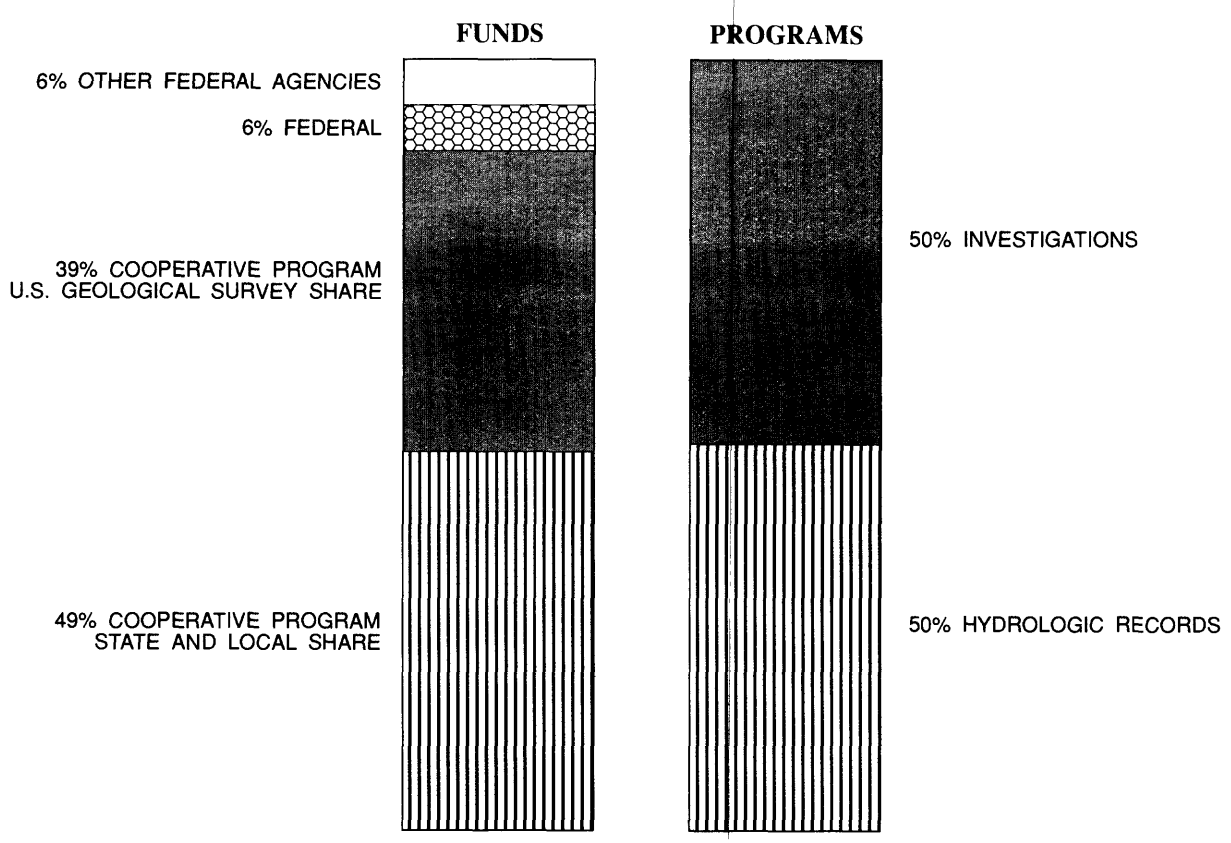
This report contains summary statements of water-resources activities in Florida conducted by the Water Resources Division of the U.S. Geological Survey in cooperation with Federal, State, and local agencies during 1991. These activities are part of the Federal program of appraising the Nation's water resources. Included are brief descriptions of the nature and scope of all active studies, summaries of significant results for 1991, and anticipated accomplishments during 1992.

Florida is a water-oriented State that, for many years, has experienced a mushrooming increase in population, attendant urban growth, and all the problems associated with such growth, particularly problems of protecting and preserving environmental quality. As the Florida environment is largely water sensitive, most environmental problems are water related. The Florida District of the U.S. Geological Survey has the principal responsibility at the Federal level for appraising water resources and for providing basic hydrologic data on both surface and ground water in the State.

Water resources appraisals in Florida are highly diversified, ranging from hydrologic records networks to interpretive appraisals of water resources and applied research to develop investigative techniques. Thus, water-resources investigations range from basic, descriptive, water-availability studies for areas of low-intensity water development and management to sophisticated cause-and-effect studies in areas of high-intensity water development and management. The interpretive reports that are products of the investigations are a principal hydrologic foundation upon which the plans for development, management, and protection of Florida's water resources may be based.

The need for water-resources information is especially great in urbanized areas where concern is being expressed that the "carrying" capacity of the land and water resources is being exceeded. Increasingly intensive and sophisticated water-management programs will have to be implemented in these urban areas to meet the increasing needs for water and to maintain good water quality. Water data and information required to implement sound water-management programs in highly urbanized areas relate to the quantity and quality of stormwater runoff, sources of aquifer contamination, injection of wastes into deep strata, underground storage of freshwater, artificial recharge of aquifers, environmental effects of reuse of water, and effects of land development on changes in ground-water and surface-water quality. In some parts of the State, broad areas are largely rural. Future growth is anticipated in many of these. However, recognition is given to the need for planned development tailored to the environment. The need for water information in these rural areas is related, to a large extent, to the need to provide for primary water development and to provide information on effects of development.

This report is intended to inform those agencies vitally interested in the water resources of Florida as to the current status and objectives of the U.S. Geological Survey cooperative program. The mission of this program is to collect, interpret, and publish information on water resources. Almost all of this work is done in cooperation with other public agencies.



Source of funds and makeup of program, Florida District, 1991-92.

WATER RESOURCES DIVISION PROGRAM

Program development in the Water Resources Division is an evolving activity. Programs are reviewed regularly and future needs for water-data and hydrologic investigations are projected. Water problems and data needs brought out by State and local agencies and the public make up a major part of the planning process; thus, program development is a grassroots effort that is strongly influenced by changes in data needs and water problems.

Water Resources Division programs are of three major types: (a) data collection and dissemination, (b) problem-oriented water-resources appraisals, and (c) research. The programs are strongly interrelated; for example, theories arising from research are the foundation of data collection and problem-oriented water-resources appraisals, and data collection is a major component of all water-resources appraisals and most of the research studies.

The Division's activities may be described under three headings: long-term programs, topical programs and technical-assistance programs.

Long-term programs include the Federal-State Cooperative Program; coordination of Federal water-data acquisition; assistance to other Federal agencies; the National Research Program; the National Water-Use Information Program; the hydrologic data-collection program, including the national stream quality accounting network and the national benchmark program; and the international hydrology program. These programs are fundamental to the Division's mission and they provide the data and research needed for the topical programs.

Topical programs are designed to provide critically needed information on issues of major and immediate concern to the Nation. These programs include hazardous waste hydrology, including high- and low-level nuclear and toxic-chemical wastes; coal and oil-shale hydrology; regional aquifer systems analysis; acid-rain volcano, subsidence, and flood hazards; and a nationwide water-quality assessment.

Technical-assistance programs include the instrumentation programs, a central water-quality laboratory, and the national training center. These programs are internal to the Division but contribute significantly to the continuing development of hydrologic capabilities and thus to the success of the Division's mission.

NEW REPORTS FROM THE U.S. GEOLOGICAL SURVEY FLORIDA DISTRICT, 1991

The results of many of the water resources activities of the U.S. Geological Survey are released in reports for use by water agencies and the public. Most Survey reports on the water resources of Florida are available for inspection at the offices listed on the inside of the front cover, at the offices of the five water management districts, and at libraries of the State University system. Write to the Survey District Office in Tallahassee for information regarding the availability of these publications.

Andrews, W.J., Oliveros, J.P., and Collins, J.J., 1990, Preliminary report on the hydrogeology of Lake Five-O and vicinity, Bay County, Florida: U.S. Geological Survey Water-Resources Investigations Report 90-4148, 1 sheet

Bradner, L.A., 1991, Water quality in the Upper Floridan aquifer in the vicinity of drainage wells, Orlando, Florida: U.S. Geological Survey Water-Resources Investigations Report 90-4175, 57 p.

Duerr, A.D., and Enos, G.M., 1991, Hydrogeology of the intermediate aquifer system and Upper Floridan aquifer, Hardee and DeSoto Counties, Florida: U.S. Geological Survey Water-Resources Investigations Report 90-4104, 46 p.

Glenn, M.E., ed., 1991, Water resources activities in Florida, 1990-91: U.S. Geological Survey Open-File Report 91-78, 84 p.

Goodwin, C.R., 1991, Simulation of the effects of proposed tide gates on circulation, flushing, and water quality in residential canals, Cape Coral, Florida: U.S. Geological Survey Open-File Report 91-237, 43 p.

Goodwin, C.R., 1991, Tidal-flow, circulation, and flushing changes caused by dredge and fill in Hillsborough Bay, Florida: U.S. Geological Survey Open-File Report 88-76, 50 p.

Kantrowitz, I.H., 1991, National Water Quality Assessment Program: The Georgia-Florida Coastal Plain Study: U.S. Geological Survey Fact Sheet.

Knochenmus, L.A., and Thompson, T.H., 1991, Hydrogeology and simulated development of the brackish ground-water resources in Pinellas County, Florida: U.S. Geological Survey Water-Resources Investigations Report 91-4026, 20 p.

Lee, T.M., Adams, D.B., Adams, A.B., Tihansky, A.B., and Swancar, Amy, 1991, Methods, instrumentation, and preliminary evaluation of data for the hydrologic budget assessment of Lake Lucerne, Polk County, Florida: U.S. Geological Survey Water-Resources Investigations Report 90-4111, 42 p.

Leitman, H.M., Darst, M.R., and Nordhaus, J.J., 1991, Fishes in the forested flood plain of the Ochlockonee River, Florida, during flood and drought conditions: U.S. Geological Survey Water-Resources Investigations Report 90-4202, 36 p.

Meadows, P.E., 1991, Potentiometric surface of the Upper Floridan aquifer in the Northwest Florida Water Management District, May 1990: U.S. Geological Survey Open-File Report 90-586, 1 sheet.

Meadows, P.E., 1991, Potentiometric surface of the Upper Floridan aquifer in the Suwannee River Water Management District, May 1990: U.S. Geological Survey Open-File Report 90-582, 1 sheet.

Montgomery, R.T., McPherson, B.F., and Emmons, E.E., 1991, Effects of nitrogen and phosphorus additions on phytoplankton productivity and chlorophyll a in a subtropical estuary, Charlotte Harbor, Florida: U.S. Geological Survey Water-Resources Investigations Report 91-4077, 33 p.

Phelps, G.G., 1991, Geology, hydrology, and water quality of the surficial aquifer system in Volusia County, Florida: U.S. Geological Survey Water-Resources Investigations Report 90-4069, 67 p.

Radell, M.J., and Katz, B.G., 1991, Major-ion and selected trace-metal chemistry of the Biscayne aquifer, southeast Florida: U.S. Geological Survey Water-Resources Investigations Report 91-4009, 18 p.

Spechler, R.M., Murray, L.C., Bradner, L.A., and Phelps, G.G., 1991, Potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity, Florida, September 1990: U.S. Geological Survey Open-File Report 91-190, 1 sheet.

Vecchioli, John, Bridges, W.C., Rumenik, R.P., and Grubbs, J.W., 1991, Ground-water recharge from streamflow data, northwest Florida, in Irrigation and drainage proceedings 1991, American Society of Civil Engineers, p. 153-160.

HOW TO OBTAIN REPORTS PREPARED BY THE FLORIDA DISTRICT

The Florida District has been preparing reports of water resources for several decades. Titles of new reports prepared by the Florida District are included in the free catalog, "New Publications of the U.S. Geological Survey." To subscribe, write to:

"New Publications of the
Geological Survey"
582 National Center
Reston, VA 22092

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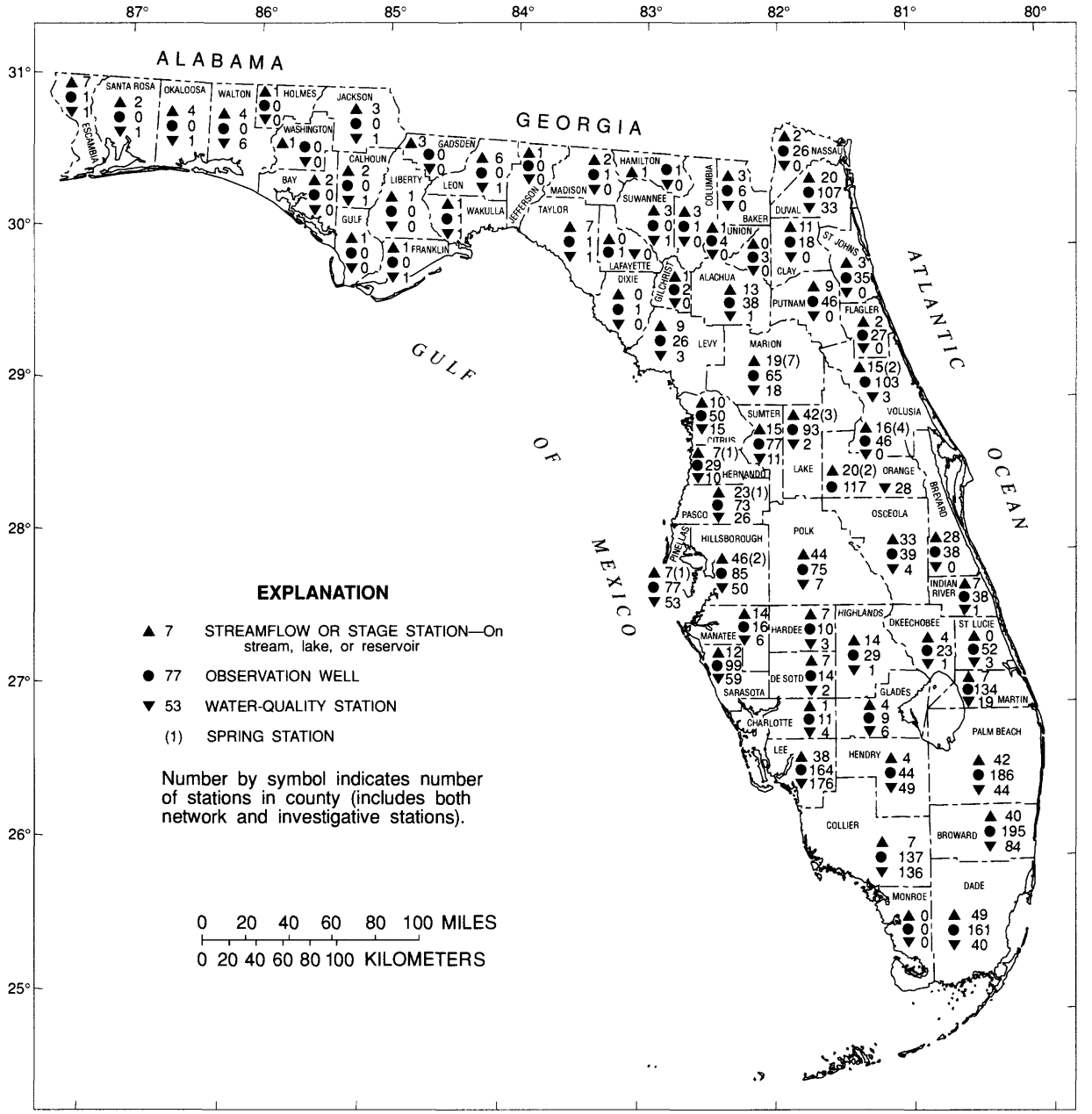
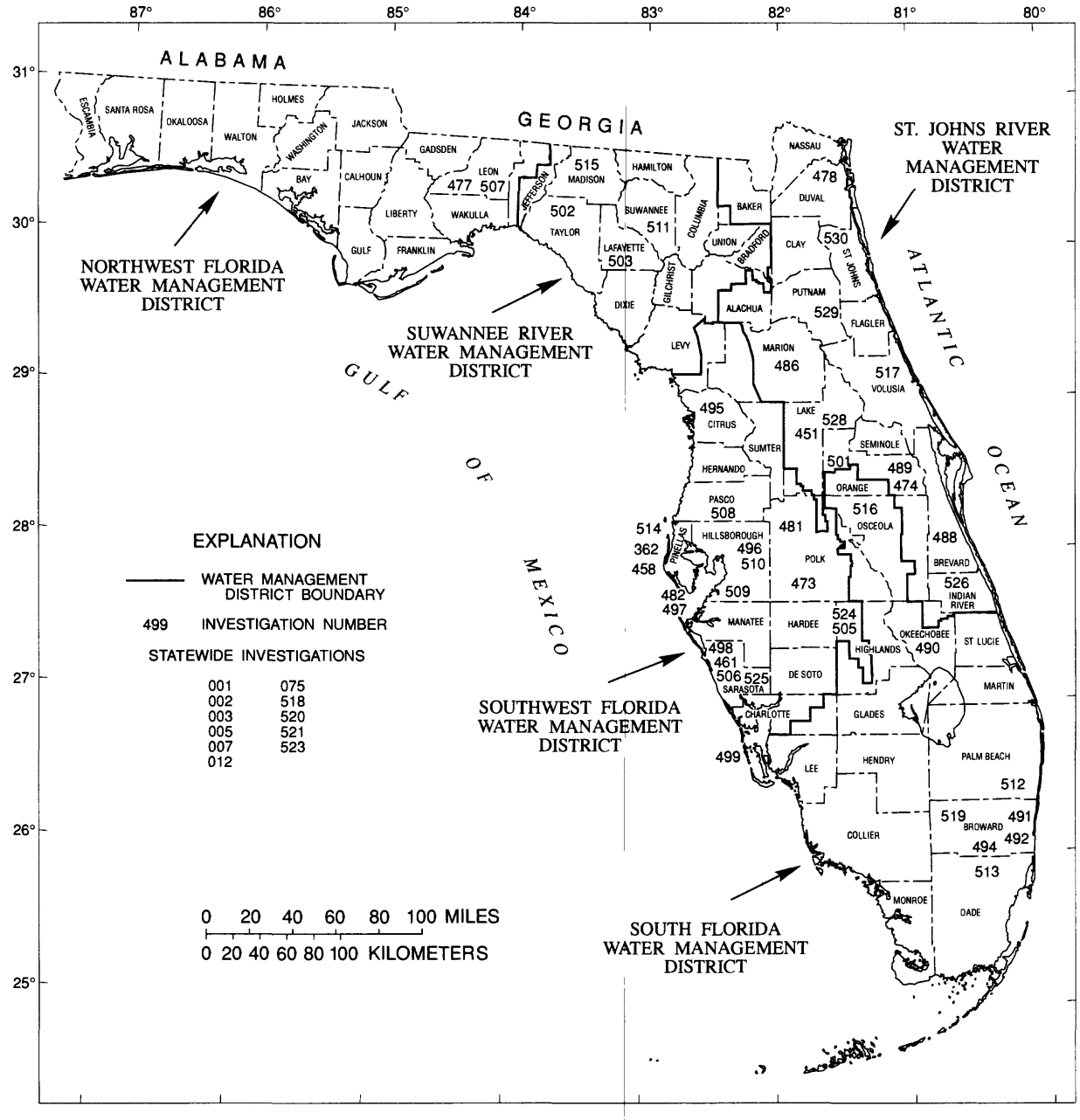
U.S. GEOLOGICAL SURVEY MAPS Hydrologic Investigation Atlases Hydrologic Unit Maps	U.S. Geological Survey Map Distribution P.O. Box 25286 Denver, CO 80225 Phone: (303) 236-7477 (This office also handles topographic maps)
FLORIDA GEOLOGICAL SURVEY (formerly Florida Bureau of Geology) Bulletins Map Series Reports of Investigations Information Circulars	Florida Geological Survey 903 West Tennessee Street Tallahassee, FL 32304 Phone: (904) 488-9380



Hydrologic data stations in Florida as of September 1991.

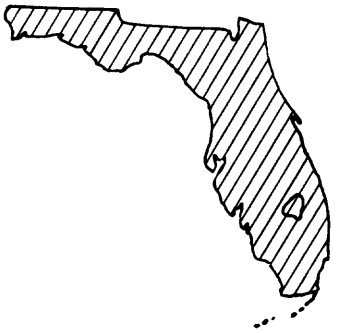
LOCATION OF AREAL INVESTIGATIONS AND THE FIVE WATER MANAGEMENT DISTRICTS



FLORIDA DISTRICT PROJECTS

A brief description of current District projects follows and includes the following information:

- Number
- Title
- Period of project
- Principal Investigator
- Cooperating agency(ies)
- Problem
- Objective(s)
- Approach
- Progress
- Plans for this year
- Reports in process
- Reports released



FL-001 SURFACE-WATER NETWORK STATIONS

DATE PROJECT BEGAN: 1926

DATE PROJECT ENDS: Continuing

PROJECT COORDINATOR: W.C. Bridges, Tallahassee

PRINCIPAL INVESTIGATORS: L.D. Fayard, Orlando; W.J. Haire, Miami; J.E. Coffin, Tampa; M.A. Franklin, Tallahassee

COOPERATING AGENCIES: Most of the agencies shown in the list of cooperators

PROBLEM: Surface-water information is needed for purposes of surveillance, planning, design, hazard warning, operation, and management in water-related fields such as water supply, flood control, irrigation, bridge and culvert design, wildlife management, pollution abatement, flood-plain management, and water resources development. To provide this information, an appropriate data base is necessary.

OBJECTIVE: To obtain and document an unbiased inventory of streamflow, stream, and lake stage data for use in the planning and development of the water resources of the State of Florida.

APPROACH: Collect stream discharge, stream, and lake-stage data from a network of gaging stations that include daily discharge, periodic discharge, daily stage, and periodic stage stations to define streamflow and stage conditions within the State of Florida.

PROGRESS: Streamflow and stage data were collected from 730 network sites and prepared for publication. Streamflow and stage data currently are being obtained at the number of hydrologic data network stations given below.

Station Classification	Number of Stations
Stream stations	**593**
Continuous record:	
Discharge and stage	353
Stage only	152
Partial record:	
Peak (maximum) flow	23
Periodic streamflow	65
Lake and reservoir stations	**137**
Stage and contents	2
Stage only:	
Continuous	67
Periodic	68

(FL-001)

PLANS FOR THIS YEAR: Continue operations as needs are defined.

REPORTS IN PROCESS: Water-resources data for Florida, water year 1991.

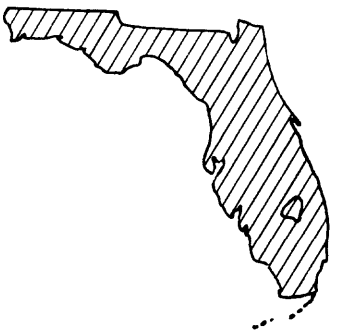
REPORTS RELEASED:

U.S. Geological Survey, 1990, Water resources data, Florida, water year 1990, volume 1A, northeast Florida surface water: U.S. Geological Survey Water-Data Report FL-90-1A, 444 p.

_____1990, Water resources data, Florida, water year 1990, volume 2A, south Florida surface water: U.S. Geological Survey Water-Data Report FL-90-2A, 203 p.

_____1990, Water resources data, Florida, water year 1990, volume 3A, southwest Florida surface water: U.S. Geological Survey Water-Data Report FL-90-3A, 278 p.

_____1990, Water resources data, Florida, water year 1990, volume 4, northwest Florida surface water: U.S. Geological Survey Water-Data Report FL-90-4, 210 p.



FL-002 GROUND-WATER NETWORK STATIONS

DATE PROJECT BEGAN: 1930

DATE PROJECT ENDS: Continuing

PROJECT COORDINATOR: W.C. Bridges, Tallahassee

PRINCIPAL INVESTIGATOR: L.D. Fayard, Orlando; W.J. Haire, Miami; J.E. Coffin, Tampa; M.A. Franklin, Tallahassee

COOPERATING AGENCIES: Most of the agencies shown in the list of cooperators

PROBLEM: Long-term water level records are needed to evaluate the effects of climatic variations on the recharge to and discharge from the ground-water systems, to provide a data base from which to measure the effects of development, to assist in the prediction of future supplies, and to provide data for management of the resource.

OBJECTIVE: To obtain and document an unbiased inventory of water-level data for use in the planning and development of the water resources of the State of Florida.

APPROACH: Collect water-level data for the various aquifers by a network of observation wells that includes 2,042 periodic observation sites and 436 sites where data are recorded continuously.

PROGRESS: Water-level data were collected and published as planned.

PLANS FOR THIS YEAR: Collection and publication of data will continue.

REPORTS IN PROCESS: Water-resources data for Florida, water year 1991.

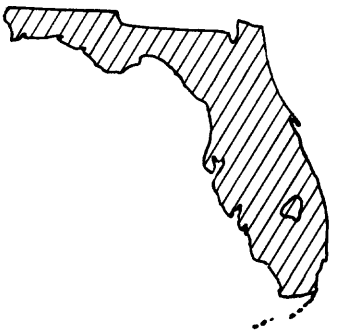
REPORTS RELEASED:

U.S. Geological Survey 1990, Water resources data, Florida, water year 1990, volume 1B, northeast Florida ground water: U.S. Geological Survey Water-Data Report FL-90-1B, 354 p.

_____1990, Water resources data, Florida, water year 1990, volume 2B, south Florida ground water: U.S. Geological Survey Water-Data Report FL-90-2B, 427 p.

_____1990, Water resources data, Florida, water year 1990, volume 3B, southwest Florida ground water: U.S. Geological Survey Water-Data Report FL-90-3B, 241 p.

_____1990, Water resources data, Florida, water year 1990, volume 4, northwest Florida: U.S. Geological Survey Water-Data Report FL-90-4, 210 p.



FL-003 QUALITY OF WATER NETWORK STATIONS

DATE PROJECT BEGAN: 1939

DATE PROJECT ENDS: Continuing

PROJECT COORDINATOR: W.C. Bridges, Tallahassee

PRINCIPAL INVESTIGATOR: L.D. Fayard, Orlando; W.J. Haire, Miami; J.E. Coffin, Tampa; M.A. Franklin, Tallahassee

COOPERATING AGENCY: Most of the agencies shown in the list of cooperators

PROBLEM: Water-resource planning and water-quality assessment require a nationwide basic level of relatively standardized information. For intelligent planning and realistic assessment of the water resource, the chemical and physical quality of surface and ground waters must be defined and monitored.

OBJECTIVE: To obtain and document an unbiased inventory of water-level data for use in the planning and development of the water resources of the State of Florida.

APPROACH: Collect water-quality data from a network of daily, weekly, and periodic stations, which include streams, lakes, springs, and wells, to define water-quality conditions within the State of Florida.

PROGRESS: Water-quality data are obtained at 184 surface-water network stations. These stations are used to monitor the quality of surface water in Florida. Some of these stations also are part of a U.S. Geological Survey nationwide network known as the National Stream Quality Accounting Network which is used to detect nationwide trends in water quality. The types of data determined at these sites are given below. Inasmuch as several types of data may be determined at a particular site, but not all types of data are determined at each site, the number given below will not equal the total number of surface-water sites.

Data Classification	Number of Surface-Water Sites
Physical data:	
Temperature, specific conductance, or pH	132
Sediment	23
Chemical data:	
Inorganic constituents	98
Organic constituents	59
Pesticides	30
Radiochemical data	3
Biological data	25

(FL-003)

Water-quality data are obtained at network observation wells and springs. The types of data determined at these sites are listed below. Inasmuch as several types of data may be determined at a particular site, but not all types of data are determined at each site, the number given below will not equal the total number of ground-water sites.

Data Classification	Number of Wells	Number of Springs
Physical data:		
Temperature, specific conductance, or pH	771	7
Chemical data:		
Inorganic constituents	206	7
Organic constituents	2	2
Biological data	7	1

PLANS FOR THIS YEAR: Collection and publication of data will continue.

REPORTS IN PROCESS: Water-resources data for Florida, water year 1991.

REPORTS RELEASED:

U.S. Geological Survey, 1990, Water resources data, Florida, water year 1990, volume 1A, northeast Florida surface water: U.S. Geological Survey Water-Data Report FL-90-1A, 444 p.

_____1990, Water resources data, Florida, water year 1990, volume 1B, northeast Florida ground water: U.S. Geological Survey Water-Data Report FL-90-1B, 354 p.

_____1990, Water resources data, Florida, water year 1990, volume 2A, south Florida surface water: U.S. Geological Survey Water-Data Report FL-90-2A, 203 p.

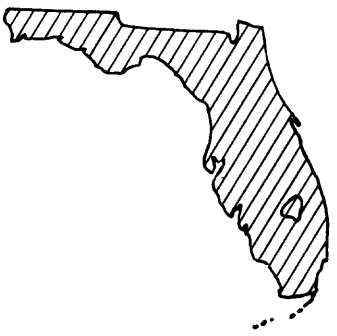
_____1990, Water resources data, Florida, water year 1990, volume 2B, south Florida ground water: U.S. Geological Survey Water-Data Report FL-90-2B, 427 p.

_____1990, Water resources data, Florida, water year 1990, volume 3A, southwest Florida surface water: U.S. Geological Survey Water-Data Report FL-90-3A, 278 p.

_____1990, Water resources data, Florida, water year 1990, volume 3B, southwest Florida ground water: U.S. Geological Survey Water-Data Report FL-90-3B, 241 p.

_____1990, Water resources data, Florida, water year 1990, volume 4, northwest Florida: U.S. Geological Survey Water-Data Report FL-90-4, 210 p.

FL-005 QUALITY OF PRECIPITATION



DATE PROJECT BEGAN: July 1983

DATE PROJECT ENDS: Continuing

PRINCIPAL INVESTIGATORS: Terrie M. Lee, Tampa;
Jerilyn J. Collins, Tallahassee

COOPERATING AGENCY: Federal Program

PROBLEM: The amount of substances dispersed in the atmosphere and deposited by precipitation, aerosols, and bases is expected to continue to increase throughout North America. Thus, there is a need for careful measurements of the amounts, nature, and effects of these substances. Such measurements are essential for responsible management of the agricultural, forest, and aquatic ecosystems of the United States.

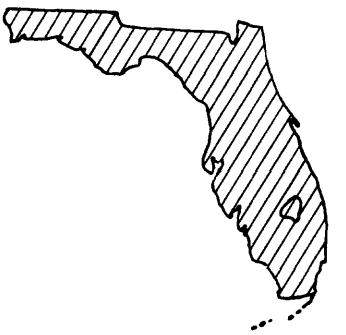
OBJECTIVE: The National Atmospheric Deposition Program (NADP) was created to conduct research on atmospheric deposition and its affect on surface waters and agricultural and forest lands in cooperation with Federal, State and private research agencies. The U.S. Geological Survey (USGS) is participating in this program under the title of the National Trends Network (NTN) by establishing up to 40 stations nationwide with coordination and analytical services provided by NADP. These stations are established for the purpose of long term coordinated data collection for use in local, regional and national studies.

APPROACH: Basic data atmospheric deposition will be collected at a NADP/NTN approved sites (FL14 and FL41). Methods of data collection and instrumentation conform to NADP procedures and guidelines. Data collection will be continuous with weekly sample collections in addition to collection of additional samples for nonstandard events. All samples will be shipped to NADP Central Analytical Laboratory (CAL), which is operated by the Illinois State Water Survey.

PROGRESS: Weekly precipitation samples were collected from an NTN site at the Verna well-field site near Sarasota, FL (FL41), and at the Florida Agricultural Research Center near Quincy, FL (FL14), according to NTN/NADP protocol. During the 1990 calendar year (the most recent year with compiled statistics), 99.2 percent of the precipitation at the site FL41 and 86.0 percent at site FL14 had a valid water-quality sample.

PLANS FOR THIS YEAR: The NTN sites will be maintained and operated according to NADP/NTN standards and schedules.

REPORTS IN PROCESS: No reports planned for this project. Data will be stored in WATSTORE data files.



FL-007 FLORIDA WATER-USE PROGRAM

DATE PROJECT BEGAN: July 1975

DATE PROJECT ENDS: Continuing

PRINCIPAL INVESTIGATOR: Richard L. Marella, Tallahassee

COOPERATING AGENCIES: Florida Department of Environmental Regulation
Northwest Florida Water Management District
St. Johns River Water Management District
South Florida Water Management District
Southwest Florida Water Management District
Suwannee River Water Management District

PROBLEM: Consistent and accurate statewide water-use data are essential for the sound management of Florida's water resources. To date, periodic compilations of water-use data have been hampered by a lack of adequate long-term funding for water use in the cooperative program. The five water management districts are the primary collectors of water-use information. Consequently, within the State, there are five different levels of data collection, storage, compilation, and publications of water-use information.

OBJECTIVE: The water-use program will ensure long-term continuity and technical coordination of water-use data in Florida. Specifically, the water-use program will include: (1) a liaison between the five water management districts, Florida Department of Environmental Regulation, and other State agencies regarding water-use data; (2) consultation and assistance with each water management district to locate, collect, tabulate, and interpret water-use data; and (3) collation, interpretation, and publication of statewide data at 5-year intervals starting in 1990.

APPROACH: The water-use program will compile data for six major categories of water use for all 67 counties and five water management districts on a monthly basis. Data will be collected for all sources of withdrawal including fresh and saline, ground and surface water. Other data collected will include acreage irrigated for specific crop types, wastewater discharge from public and industrial facilities, aquifer withdrawals, water reused for irrigation, water used for desalinization, and site-specific pumpage for commercial, industrial, and power-generation facilities. Special projects to improve collection and accuracy of water-use data will be undertaken during time not devoted to the major assessment every 5 years. Additionally, periodic contact with key personnel at the five water management districts will be maintained on a periodic basis.

PROGRESS: Statewide water-use data for all categories were collected in 1990 in Florida. This data was last collected for all five categories (public-supply, domestic self-supplied, commercial-industrial self-supplied, agricultural irrigation, and thermoelectric power generation) in 1985. Most of the data were obtained from the five water management districts and the Florida Department of Environmental Regulation. Currently, the 1990 data is being compiled by category, county, hydrological unit, and aquifer. This data compilation effort is nearly 90 percent completed. The data will first be

submitted to the USGS Southeast Regional Office as part of the United States compilation effort. Then the 1990 data will be published in several Florida reports. Additionally, statewide public-supply water-use data were collected and compiled for the calender year 1989. These data detail public-supply water-use by county, aquifer, and water management district. Also, water use data for the Apalachicola-Chattahoochee-Flint River Basin for both 1985 and 1990 were compiled. These data have been summarized in a report entitled "Water use in the Apalachicola-Chattahoochee-Flint River Basin for 1990, with historical summaries from 1970 to 1989" which is currently in review. A second publication, which deals with factors that affect public-supply water use and includes projection for public supply in Florida, has been approved.

PLANS FOR THIS YEAR: Continue working on the 1990 statewide data collection and compilation effort. Once data collection and compilation has been completed, efforts will be made to write and publish several statewide reports. Additional efforts will continue on the publication currently under way ("Water use in the Apalachicola-Chattahoochee-Flint River Basin for 1990, with historical summaries from 1970 to 1989").

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Leach, S.D., 1977, Water use inventory in Florida, 1975: U.S. Geological Survey Open-File Report 77-577, 57 p.

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(FL-007)

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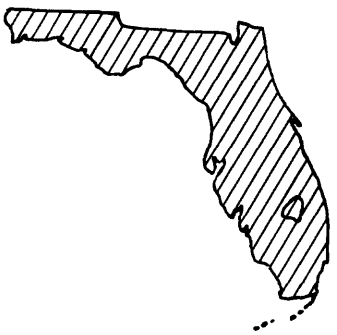

FL-012 FLOOD ASSESSMENTS

DATE PROJECT BEGAN: July 1964

DATE PROJECT ENDS: Continuing

PRINCIPAL INVESTIGATOR: Marvin Franklin, Tallahassee

COOPERATING AGENCY: Florida Department of Transportation

PROBLEM: Local and State governments, highway designers, planners, and zoning commissions have a responsibility to avoid uneconomic, hazardous, or incompatible use and development of the State's flood plains. Prime requisites to meet these criteria are a knowledge of the floodflow characteristics of streams and the ability to make reliable estimates of the flood magnitude and frequency.

OBJECTIVE: To assess the hydraulic and hydrologic characteristics of Florida streams. To collect floodflow data and analyze hydraulic problems for selected stream reaches as well as for hydrologic regions. To document and prepare reports for extreme flood events.

APPROACH: Update and maintain the computer files for basin characteristics and peak flow for use in regional flood-frequency analysis. Respond by letter reports to specific requests for hydraulic and hydrologic information for selected stream reaches. Assess extreme flood events, including indirect flood measurements, analysis, and preparation of reports to disseminate the flood information.

PROGRESS: The computerized peak flow and basin characteristics have been edited and updated to include data through the 1990 water year. First trial flood frequencies are being performed to determine outliers in the data base. Preliminary sizing of drainage areas for regionalization of flood frequencies is complete.

PLANS FOR THIS YEAR: Complete updating the peak flow characteristics files. Perform final station flood frequencies and regression equations. Prepare draft report.

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(FL-012)

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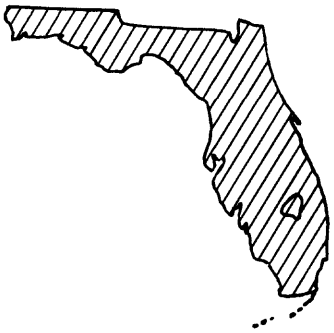

FL-075 FLORIDA WATER ATLAS

DATE PROJECT BEGAN: September 1961

DATE PROJECT ENDS: Continuing

PRINCIPAL INVESTIGATOR: Michael P. Planert, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Water-use planners have repeatedly expressed the need for maps that show the characteristics and availability of water in Florida or that show related information such as climate. Prior to the start of this project, only a few maps had been published that give hydrologic data or other data closely related to hydrologic problems in Florida.

OBJECTIVE: This project seeks to make available the needed information in the form of a water atlas--a series of map reports designed to furnish to the user generalized hydrologic, geologic, and related information, portrayed graphically on standard size maps. These maps are most useful for broad planning to aid legislators, planners, industrialists, laymen, hydrologists, to provide readily available hydrogeologic information for decisionmaking.

APPROACH: The water atlas program presently consists three parts. The first part is the production of statewide map reports prepared using available information and knowledge from other studies. A total of 87 atlas series maps have been published to date. Many of these maps have been published by the Florida Geological Survey. Although money is no longer available for this program, some atlas-type maps are still produced as parts of other projects.

The second part of the atlas program is the production of aquifer recharge maps. These will be produced using Regional Aquifer Systems Analysis (RASA) modeling studies as well as existing soils, runoff, rainfall, potential evaporation, and topographic maps, and information on the base flow of streams.

The third part of the atlas program is a statewide series of maps of interest to planners and water managers that will depict factors that are useful in locating potential sites for future public-water supplies. These factors include recharge, which is already being mapped, aquifer transmissivity/well yields, water quality, and future water demand. The general approach will be to compile map reports for these factors for the Floridan aquifer system first, using existing data. Maps for the other aquifers will be completed later. Some of the maps for the other aquifers will require more than compilation of existing data.

PROGRESS: One report was published, "Transmissivity of the Floridan aquifer." Work continued on compiling the 1990 statewide potentiometric map for the Floridan aquifer system. Continued progress was made evaluating base-flow characteristics of streams that will be useful in upcoming "Bluebelt" amendment-related recharge determinations.

PLANS FOR THIS YEAR: Work will continue on all of the above listed report projects.

(FL-075)

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FL-362 EVALUATION OF STORMWATER DETENTION BASINS IN WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1980

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: William M. Woodham, Tampa

COOPERATING AGENCY: Pinellas County

PROBLEM: Pinellas County is one of the most densely populated counties in Florida, and serious water-quality problems in the Gulf of Mexico and Tampa Bay are caused by the increase in urban runoff. There is a need for data to evaluate the cost effectiveness of the pollution control measures being planned to satisfy receiving water-quality standards.

OBJECTIVE: To determine the effectiveness of runoff detention ponds in reducing suspended solids, nutrients, metals, biochemical oxygen demand loads entering receiving waters from urban areas in Pinellas County.

APPROACH: Runoff quantity and quality of an urban watershed will be monitored for a year before the construction of a stormwater detention pond just upstream from the monitoring station. This will provide background information to compare with data after the completion of the pond in the second year. After completion of the pond, an additional monitoring station will be operated at the inflow. Loads entering and leaving the pond will be compared. An interpretive report will be written in the third year after at least one complete year of inflow and outflow data have been analyzed.

PROGRESS: Daily discharge and rainfall have been recorded for more than 1 year at the inflow site since completion of the detention pond. Samples of storm runoff water quality were collected at both sites and analyzed for chloride, copper, chromium, lead, zinc, mercury, dissolved solids, biochemical oxygen demand, and nutrients. Samples of base flow were collected and analyzed for the same constituents at both sites. Data collection ended September 30, 1991.

PLANS FOR THIS YEAR: Constituent loads of chloride, copper, chromium, lead, zinc, mercury, nitrogen, phosphorous, biochemical oxygen demand, and dissolved solids will be computed for each storm. Report preparation will begin in the second quarter of FY92.

FL-451 NUTRIENT LOADS IN THE APOPKA-BEAUCLAIR CANAL, UPPER OKLAWAHA BASIN, CENTRAL FLORIDA

DATE PROJECT BEGAN: May 1986

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: Donna M. Schiffer, Orlando

COOPERATING AGENCIES: St. Johns River Water Management District and Lake County

PROBLEM: The water entering Lake Beauclair is thought to have high nutrient concentrations. Presently, two sources of nutrients are suspect--Lake Apopka and the muck-farming operations adjacent to the Apopka-Beauclair Canal. The problem is to determine the relative contribution of nutrients from each source.

OBJECTIVE: Collect discharge data and nutrient data for the Apopka-Beauclair Canal in order to determine the nutrient loads leaving Lake Apopka and those entering Lake Beauclair. The difference between the input and output loads of the canal will be considered as the load entering from the muck farms along the canal.

APPROACH: The geographic scope of the study will be the uppermost lakes of the upper Oklawaha basin, with the main emphasis on the northern outlet of Lake Apopka and the Apopka-Beauclair Canal. Data were collected for 2 years; during the second year, a constriction was built in the canal one-half mile downstream from Lake Apopka to facilitate discharge monitoring, and the project was extended to include data collection for an additional 2 years. The last year of the study will be devoted to writing and processing the report.

Instrumentation will include an electro-magnetic current meter for gaging purposes at the upstream site, and monitoring equipment at the lock and dam site to record gate openings and stages for computation of discharge at the site. At both sites, a microprocessor-controlled water-quality monitoring system will be installed, which includes continuous monitoring of temperature, specific conductance, and dissolved oxygen.

Discharge monitoring will be conducted on a continuous basis, limited only by equipment failure and maintenance problems. Routine monthly to biweekly sampling will be carried out, supplemented by additional sampling after storm events. Analysis of the field-collected data will begin by calculating canal discharge and having nutrient concentrations analyzed in the laboratory.

PROGRESS: Data collection and analysis are completed. A final report has been submitted for review.

FL-458 SALTWATER-FRESHWATER INTERFACE IN THE COASTAL AREA OF SOUTHWEST FLORIDA

DATE PROJECT BEGAN: October 1986

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: John T. Trommer, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District and West Coast Regional Water Supply Authority

PROBLEM: Increased ground-water development associated with a rapidly growing population along the southwest coast of Florida poses a threat of contamination to major freshwater supplies through the introduction of saltwater into the upper Floridan and intermediate aquifers. To predict and prevent this occurrence, it is necessary to define the present location of the saltwater-freshwater transition zone in the major ground-water production zones along the southwest Florida coast.

OBJECTIVE: (1) To select and monitor 50 to 75 wells and up to 250 secondary wells in and near the transition zone in the major ground-water producing areas of the coastal area of southwest Florida, (2) to describe each monitor well by defining the hydrogeologic setting, (3) to recommend frequency of sampling, sampling protocol, and chemical analyses, and (4) to describe short- and long-term changes in chloride concentration and specific conductance with time at selected wells, and (5) to use the data collected to define the location of the saltwater-freshwater transition zone.

APPROACH: (1) Compile available data including water-level, water-quality, well-construction, and geophysical data. (2) Collect new data as necessary to supplement and update existing data which will include; (a) surface-DC resistivity and/or electromagnetic (EM) induction surveys; (b) borehole geophysical logging; (c) water-quality analysis for chloride, sulfate, specific conductance, density and temperature; and (d) continuous specific conductance and water-level monitoring at selected sites.

PROGRESS: The first draft, including illustrations, of the report entitled, "Description of the saltwater-freshwater transition zone in aquifers along the west-central coast of Florida," was completed.

PLANS FOR THIS YEAR: Manuscript will be submitted for review, approval, and publication.

FL-461 EVAPOTRANSPIRATION FROM AREAS OF NATIVE VEGETATION IN CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1986

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: William R. Bidlake, Tampa

COOPERATING AGENCY: Sarasota County, Southwest Florida Water Management District, and West Coast Regional Water Supply Authority

PROBLEM: Water availability is becoming a critical issue even in humid, subtropical climates. By understanding and quantifying the components of the water budget in such areas, unique solutions may be developed to manage water resources. Although evapotranspiration (ET) is by far the major component of the water budget in humid, subtropical climates, very little has been done to obtain reliable estimates of ET. Accurate estimates of ET of four common, major native vegetation types in central Florida will be determined by selected energy-budget techniques. The results of this investigation will provide a significant new knowledge by developing more accurate ET values for extensive and ecologically important wetland areas.

OBJECTIVE: (1) To develop accurate estimates of ET from palmetto prairie, pine flatwoods, grass ponds and cypress heads in the Ringling-MacArthur Reserve (RMR), and the Cypress Creek and Big Cypress Swamp area, (2) to estimate total ET from RMR, and (3) to analyze for error in the estimated ET.

APPROACH: Delineate areas of native vegetation in the study area; and evaluate the use of energy-budget techniques (Penman, Bowen ratio and eddy correlation) using 2 years of field data and estimate ET for the study area using the best applicable techniques. Vegetative cover will be delineated with detailed aerial color photography. Field data-collection sites will be selected, assuring that sites are representative for each vegetative type. Periods of monitoring for each site will be (1) permanent-continuous for parameters used in calculating ET by the Penman method and (2) portable short-term for parameters used in energy-budget techniques, generally monthly to bi-monthly for 24- to 48-hour periods.

PROGRESS: The draft Water-Supply Paper entitled, "Evapotranspiration from areas of native vegetation in central Florida," was completed and submitted for review.

FL-473 HYDROLOGIC IMPACTS OF PHOSPHATE MINING ON SMALL BASINS, CENTRAL FLORIDA

DATE PROJECT BEGAN: April 1987

DATE PROJECT ENDS: March 1992

PRINCIPAL INVESTIGATOR: Billy R. Lewelling, Tampa

COOPERATING AGENCY: Florida Institute of Phosphate Research

PROBLEM: The hydrologic characteristics of small basins in central Florida are poorly defined. Permits for mined-land reclamation require that runoff from reclaimed land not exceed pre-mining conditions and there be no degradation of water quality of the receiving streams. There are no data on the hydrologic characteristics of reclaimed land forms.

OBJECTIVE: (1) Define the hydrology and water quality of undisturbed small basins in the phosphate mining area of central Florida; (2) define the hydrology and water-quality characteristics of the four most common reclaimed land forms: a clay settling area, a land and lakes (graded overburden) area, a sand-clay mix settling area, and an overburden capped sandtailings fill area; (3) compare results from 1 and 2 above.

APPROACH: Collect hydrologic data from small, undisturbed basins and from four nearby basins representing the common reclaimed land forms to define streamflow and aquifer characteristics. Collect ground-water samples during high and low water-table conditions to define ground-water quality. Collect streamflow samples during base flow and during related storm runoff to define water quality of streamflow. Compare and describe statistical differences between unmined and reclaimed basin pairs and among various reclamation types.

PROGRESS: Collection and analyses of rainfall, streamflow, and ground-water data were completed. First draft of final report was completed and submitted for final review.

FL-474 EFFECTS OF STRUCTURAL CHANGES ON THE WATER-QUALITY EFFICIENCY OF A STORMWATER DETENTION POND

DATE PROJECT BEGAN: January 1987

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: W. Scott Gain, Orlando

COOPERATING AGENCY: Florida Department of Transportation

PROBLEM: The velocity of water entering a detention pond is dramatically decreased immediately inside the pond. If the traveltime of the water within the pond is significantly lengthened, then an increased particulate load should settle to the bottom of the detention pond. An existing detention pond may be modified to lengthen the flow path of water by placing a wall in the middle of the pond. This structural change could increase the water-quality treatment ability of this facility.

OBJECTIVE: The primary objective of this investigation is to determine the effectiveness of selected structural changes to detention facilities for improving water-quality treatment. Secondary objectives are to: determine and analyze the increased residence time, or detention time, due to the structural changes; and determine if the hydraulic conditions caused by the structural changes can be modeled, either with an existing model or one that is easily modified.

APPROACH: The first task is to perform a hydraulic study of the presently structured pond. Separate tracer studies will run at three different steady-state discharges. Analyses of these data will be used to calculate the pond's hydraulic residence time(s) as a function of live storage or discharge.

PROGRESS: Data collection and analysis are completed.

PLANS FOR THIS YEAR: Complete final report and submit for approval by Director and prepare report for publication.

FL-477 AN EVALUATION OF VARIOUS PHYSCIAL AND BIOLOGICAL INDICATORS USED TO DELINEATE WETLAND BOUNDARIES ON RIVER FLOOD PLAINS IN NORTH FLORIDA

DATE PROJECT BEGAN: October 1987

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: Helen M. Leitman, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Protection of Florida's wetlands is entrusted primarily to the Florida Department of Environmental Regulation (FDER). River wetlands are of particular importance to the State because inflow of nutrients from freshwater river wetland systems are largely responsible for high productivity in estuaries. Additional data are needed to manage and regulate stream wetlands and to evaluate the various techniques used by FDER to delineate wetland boundaries.

OBJECTIVE: To quantitatively describe the occurrence of wetland plants, hydric soils, and other wetland indicators in flood-plain sites along several north Florida streams, and relate these indicators to duration of inundation.

APPROACH: The 4-year study will require data collection and analyses by an interdisciplinary interagency team comprised of hydrologists, botanists, and soil scientists. The U.S. Geological Survey (USGS) will describe depth and duration of flooding at each site based on a long period of gage record. USGS and FDER will work together to describe plant communities, soil types, and other hydrologic indicators at the sites. USGS will relate the various indicators to the long-term hydrologic conditions at each site.

PROGRESS: A report describing the relation of hydrologic conditions to soils and vegetation has been submitted for review. A second report describing the hydrologic conditions associated with swollen bases of trees, cypress knees, moss lines, and other indicators of flooding in forested wetlands is in the final stages of preparation.

FL-478 OCCURRENCE AND SIGNIFICANCE OF SALINE WATER IN THE FLORIDAN AQUIFER SYSTEM, NORTHEAST FLORIDA

DATE PROJECT BEGAN: October 1987

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: Rick Spechler, Orlando

COOPERATING AGENCIES: City of Jacksonville and the St. Johns River Water Management District

PROBLEM: Increased ground-water withdrawals from the Floridan aquifer system have lowered water levels 0.5 to 2.0 feet per year in parts of northeast Florida. Associated with the decline in water levels has been an increased potential for saltwater intrusion into the freshwater zones of the Floridan aquifer system along the coast. Gradual but continual increases in salinity of the water from the aquifer have been observed in several areas along the coast in Nassau, Duval, and St. Johns Counties. Further intrusion of saltwater into the aquifer could seriously affect water supplies.

OBJECTIVE: (1) Provide a refined conceptual model of the hydrogeologic framework of the Floridan aquifer system in northeast Florida, and (2) delineate areas where saline water occurs in the various water-bearing zones of the Floridan aquifer system and possibly deeper zones.

APPROACH: Compile geologic, geophysical, and chemical data to determine lateral and vertical distributions of saltwater in the Floridan aquifer system. Collect new data to supplement and update the existing data base which will include: (a) water-quality analysis for major ions, density, specific conductance and temperature, (b) borehole geophysical logging to determine flow zones and water-quality with depth, (c) marine seismic reflection surveys, and (d) maps showing the thickness and lateral extent of various hydrogeologic units.

PROGRESS: Data collection and data analysis are completed. Report submitted for review.

FL-481 THE RELATIVE IMPORTANCE OF GROUND WATER TO THE CHEMICAL BUDGET OF SEEPAGE LAKES

DATE PROJECT BEGAN: July 1988

DATE PROJECT ENDS: June 1992

PRINCIPAL INVESTIGATOR: Terrie M. Lee, Tampa

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: In order to predict long-term trends in lake pH, there is a need to understand the relative quantitative importance of individual hydrologic and chemical factors regulating acid neutralizing capacity (ANC) in lakes. This is particularly true of Florida's numerous acidic seepage lakes which have hydrologic budgets dominated by precipitation. Even small amounts of ground-water inflow, and certain in-lake processes, contribute ANC to lakes and may play roles in the chemical budget of acidic seepage lakes.

OBJECTIVE: The objectives of this study are: (1) To understand the factors that regulate ANC in seepage lakes, particularly the relative importance of ground-water contributions of ANC to seepage lakes; (2) to improve our conceptual and physical models of the hydrologic and chemical processes affecting the chemistry of seepage lakes; and (3) to use these models to predict the vulnerability of seepage lakes to change in acidic deposition or alterations in ground-water flow.

APPROACH: The approach of the study is to compare and contrast the hydrologic and chemical budgets of two seepage lakes with different acid-neutralizing capacities; acidic Lake Barco in Putnam County and circumneutral Lake Lucerne in Polk County, Florida. The hydrologic budget of each lake will include evaporation losses quantified by the energy budget evaporation method, and ground-water inflows and outflows calculated by flow-net analysis and numerical modeling studies. The evaluation of the geologic setting of each lake will be a central part of the investigation of lake and ground-water interactions. Lake chemical budgets will derive from lake precipitation, ground-water chemical data, and an evaluation of in-lake solute fluxes at the sediment-water interface. An input-output chemical model will be used to simulate trends in lake ANC.

PROGRESS: In 1991, various aspects of the hydrology and chemistry of Lakes Barco and Lucerne have been described in several reports and an abstract. Also, a three-dimensional, transient ground-water flow model has been developed to determine the ground-water exchange with Lake Barco. A particle tracking model is also being used to determine the length and traveltime of ground-water inflow paths to the lake.

PLANS FOR THIS YEAR: The focus will be on preparing interpretive reports on the chemical budget of Lake Lucerne and on the ground-water interactions with Lake Barco. In addition, we will begin preparation of a final report on the chemistry of Lake Barco and Five-0 (FL-487). This report will be completed after the conclusion of the Lake Barco study, but in conjunction with the related study of Lake Five-0.

(FL-481)

REPORTS IN PROCESS:

Lee, T.M., and Sacks, L.A., Determining ground-water inflow sources to a Florida lake using a geochemical tracer approach: American Geophysical Union 1991 Fall Meeting, December 9-13, San Francisco, Calif.

Lee, T.M., Sacks, L.A., and Pollman, C.D., The role of ground water on the chemical composition of Lake Lucerne, a seepage lake in a citrus growing area of Polk County, Florida.

Sacks, L.A., and Lee, T.M., in press, Hydrogeologic setting and preliminary data for the hydrologic-budget assessment of an acidic lake: Lake Barco, Putnam County, Florida: U.S. Geological Water Resources Investigation Report 91-4180.

Sacks L.A., Lee, T.M., and Radell, M.J., Comparison of energy-budget evaporation losses from two morphometrically different Florida seepage lakes.

REPORTS RELEASED:

Pollman, C.D., Lee, T.M., Andrews, W.J., Aucott, W.R., Gherini, S.A., and Munson, R.K., 1990, Preliminary analysis of the hydrologic and geochemical controls on acid neutralizing capacity in two acidic seepage lakes in Florida, abstract National Acidic Precipitation Assessment Program 1990 International Conference on "Acidic Deposition: State of Science and Technology", February 11-16, 1990, Hilton Head Island, S.C.

Pollman, C.D., Lee, T.M., Andrews, W.J., Sacks, L.A., Gherini, S.A., and Munson, R.K., 1991, Preliminary analysis of the hydrologic and geochemical controls on acid-neutralizing capacity in two acidic seepage lakes in Florida, in Water Resources Research, v. 27, no. 9, p. 2321-2335.

FL-482 FINE SEDIMENT RESUSPENSION PROCESSES AND LIGHT ATTENUATION IN SHALLOW ESTUARINE ENVIRONMENTS

DATE PROJECT BEGAN: October 1987

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: David H. Schoellhamer, Tampa

COOPERATING AGENCIES: City of St. Petersburg, Hillsborough County Environmental Protection Commission, Pinellas County, Southwest Florida Water Management District, and Tampa Port Authority

PROBLEM: Fine sediment plays an important role in the overall health of shallow estuaries, such as Tampa Bay, in at least two ways. Elevated concentrations of fine sediment in the water column reduce the depths to which sunlight can support photosynthesis. This could be partly why Tampa Bay has lost more than 80 percent of its seagrass beds during the last 100 years. Fine sediment also absorbs a wide range of toxic organic and inorganic chemicals whose distribution and availability to various biological communities are then primarily governed by fine sediment transport processes. These processes, particularly the mechanisms of resuspension from the bay bottom, are poorly understood and presently contribute little toward proper management of Tampa Bay.

OBJECTIVE: The objectives of the project are to determine the mechanisms that cause resuspension of fine sediments from the bottom of Tampa Bay and to determine the effects of these resuspended materials on light attenuation.

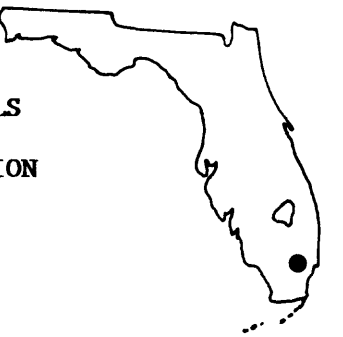
APPROACH: To accomplish the first of these objectives, two sites were selected: one in Hillsborough Bay and one in Old Tampa Bay, each representative of a large part of the bay bottom in relatively deep water. At the Old Tampa Bay site, a platform was built from which vertical profiles of velocity and suspended solids can be monitored and used to detect resuspension caused by tidal currents, cold fronts, tropical storms, thunderstorms, and ship wakes. A submersible instrument package was used to monitor velocity and suspended solids at a companion shallow-water site in Old Tampa Bay. After the hurricane season in 1990, the platform equipment was reconfigured into two new submersible instrument packages for use in Hillsborough Bay in 1991.

To relate the resuspension information to light attenuation and to detect possible interferences from nonresuspension processes (such as photoplankton blooms, river discharges, and stormwater runoff), light and water-quality data are collected at least every month at the two primary sites and at two nearby companion sites with sandy bottoms. The data are analyzed to determine the significance of resuspended sediment on light attenuation and to determine other causes of light attenuation.

(FL-482)

PROGRESS: During FY91, sediment resuspension in Hillsborough Bay was monitored during several deployments of submersible instrument packages. Sediment resuspension associated with a cold front, a trawler experiment, and vessel wakes was observed. Light and water-quality monitoring continued at four sites during FY91.

PLANS FOR THIS YEAR: Data collection for the project is complete and several reports are being prepared during this final year of the project.



FL-486 HYDROGEOLOGY AND EFFECTS OF SELECTED DRAINAGE WELLS AND IMPROVED SINKHOLES ON WATER QUALITY IN THE UPPER FLORIDAN AQUIFER, SILVER SPRINGS BASIN, MARION COUNTY, FLORIDA

DATE PROJECT BEGAN: July 1988

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: G.G. Phelps, Orlando

COOPERATING AGENCIES: City of Ocala, Marion County, St. Johns River Water Management District, and Florida Department of Environmental Regulation

PROBLEM: Because of the highly karstic character of the hydrogeologic system, the potential exists for significant contamination of the Floridan aquifer system in the Silver Springs basin, either from direct emplacement of surface waters into the aquifer, or from an accidental spill. Because the aquifer is the principal source of water supply in the basin, a need exists for documentation of any major potential sources of contamination and a better understanding of the geohydrologic system.

OBJECTIVE: (1) Develop better understanding of geohydrology of the Silver Springs basin; (2) document locations of concentrated points of recharge entering the Upper Floridan aquifer system and major potential sources of contamination; and (3) evaluate the potential movement and effects of contaminants introduced into the aquifer at a few selected sites.

APPROACH: Inventory existing wells, sinkholes, and other points of recharge and potential contamination. Update and analyze existing geologic and hydrologic data. Select several sites for detailed study. At those sites, collect samples of recharge water and water from existing wells; run geophysical logs of selected wells; and perform dye-trace studies to determine local flow systems. Analyze existing tritium data to help determine flow paths. If contaminated sites are found, drill monitor wells to supplement existing wells. Run geophysical logs and collect water samples from new monitor wells.

PROGRESS: Dye traces have been made at two sites and the data analyzed to provide estimates of ground-water flow velocities. Detailed potentiometric mapping of the study area has been completed. The data collected during the 3 years of the study have been analyzed and the first draft of the final report has been written. Final report will be completed and submited for review and approval.

FL-487 WATER BUDGET OF A SOFTWATER SEEPAGE LAKE IN THE FLORIDA PANHANDLE

DATE PROJECT BEGAN: June 1988

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Trey Grubbs, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Acidification of lakes over much of eastern Canada and the northeastern United States has become a serious problem in recent years. Although it has not been demonstrated that Florida lakes have shown a clear trend toward acidity, some of Florida's lakes are acidic. Many lakes may be naturally acidic, but an assessment of the contribution of acidic precipitation to lake acidification has not been made. Softwater seepage lakes having low conductance and low alkalinity may be the most susceptible to further acidification from acid deposition and it is important to establish the relative quantitative importance of hydrologic and chemical parameters on the acid neutralization capacity (ANC) of softwater seepage lakes. An accurate hydrologic budget is essential in assessing the effects of acid precipitation on the ANC of a given lake because ground water may have a significant effect on the degree of ANC.

OBJECTIVE: The primary objectives of this study are to establish a complete hydrologic budget for Lake Five-O and to collect samples of precipitation, ground water, and lake water for chemical analysis.

APPROACH: A network of monitoring wells and piezometer nests distributed vertically within the ground-water flow system will be used to establish detailed water-level maps and to determine horizontal and vertical hydraulic head gradients. Piezometers will be placed in the lake bed. Using these data, ground-water inflows and outflows will be determined by flow-net analysis and numerical modeling studies. Evaporation losses will be determined by the energy-budget method. This requires detailed measurements of various parameters such as wind speed and direction, relative humidity, air and water temperature, and incoming solar radiation. Lake volume will be monitored throughout the study using lake bathymetry data and lake stage data. Precipitation in the lake basin will be measured directly by using two different types of rain gages.

PROGRESS: An interim report was published as U.S. Geological Survey Water-Resources Investigations Report 90-4148, "Preliminary report on the hydrogeology of Lake Five-O and vicinity, Bay County, Florida." Collection of precipitation, lake, and ground-water data was completed and extends from May 1989 to mid-January 1991. The data have been through preliminary screens for accuracy, and computer files were assembled for use in chemical modeling for Lake Five-O.

Estimates of evaporation, by month and by thermal survey period, have been calculated based on the energy budget and mass transfer methods. Preliminary error analyses and sensitivity analyses are complete. Using monthly data for evaporation, precipitation, and change in lake stage, estimates for monthly net ground-water input have been calculated. Interpretation of seismic reflection data indicates the existence of at least three karst "conduits" in the northwest, southwest, and southeast quadrants of the lake which breach confining units and hydraulically connect the lake with the Floridan aquifer system.

Preliminary 3-D ground-water modeling of the study area is in process. Tests have focused on establishing boundary conditions, parameter estimates, recharge to the water table, and hydraulic connection between the lake and underlying aquifers. Model results for low and high ground-water level conditions have been compared to the observed potentiometric data for the initial steady-state model calibration.

PLANS FOR THIS YEAR: Finalize evaporation calculations for the energy budget, mass transfer, and pan evaporation comparison. Complete error analysis and sensitivity analysis for energy-budget estimates. Compute independent estimates of recharge to the water table using chloride concentrations in precipitation and in ground water, and compare continuous records of precipitation and ground water during and subsequent to storm events. Evaluate spatial variability of recharge in the study area. Calibrate 3-D ground-water model to high and low ground-water-level conditions and run transient model for response to perturbations to the system in the form of storm events to validate the model. Compute monthly water budget based on precipitation, evaporation, and ground-water model results. Compare hydrologic processes controlling the water budgets at Lake Five-0 and Lake Barco (FL-481), and incorporate hydrologic modeling into chemical modeling for the Hydrology and Acidity of Seepage Lakes (HASL) Project, an interdisciplinary project of which the Lake Five-0 project is a part.

FL-488 FRESHWATER INFLOW TO INDIAN RIVER LAGOON, FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Leel Knowles, Jr., Orlando

COOPERATING AGENCY: St. Johns River Water Management District

PROBLEM: Estuarine-dependent fish are adversely affected by lower salinities that are caused by excessive freshwater inflows to the Indian River Lagoon. Data are needed to quantify the natural inflows so that controlled flows can be more effectively managed.

OBJECTIVE: Define the runoff of freshwater from the natural basins that empty into the Indian River Lagoon by: (1) operating gaging stations, or simulating discharges using a computer model; and (2) using inference techniques.

APPROACH: Traditional gaging will be used on some of the sites. Flow in tide-affected areas will be defined using the 1-D BRANCH model. Discharge on some of the smaller streams will be defined by using regionalization, rainfall-runoff, or other inference techniques.

PROGRESS: Established one gaging station, two rainfall stations, and one crest-stage station. Data collections, processing, and site-levels accounted for much of the time spent during this period. Successful calibration of BRANCH model to compute discharges for the South Prong Sebastian River was performed. A procedure for adjusting tipping-bucket rain-gage data bias as a result of rainfall intensity was developed and submitted for review. A small subbasin was investigated to define its characteristics for use in a rainfall-runoff study. Base map was compiled.

PLANS FOR THIS YEAR: Complete data collection and processing. Measure discharge at all model sites during two full tide cycles. Calibrate and verify BRANCH model used for computing discharges at tidal sites. Perform rainfall-runoff study using DR3M on a small subbasin. Complete final report on study emphasizing high discharge periods. Prepare outlines for data report presenting data collected on rainfall and discharge unit value with emphasis on storm events.

FL-489 WATER QUALITY IN THE WINTER PARK CHAIN OF LAKES, AND IMPACT OF DEVELOPMENT, CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: E.R. German, Orlando

COOPERATING AGENCIES: City of Winter Park and the St. Johns Water Management District

PROBLEM: Although data are sparse, there are indications that the lakes are eutrophic and are receiving phosphorus loading in excess amounts. Lake water clarity may be decreasing and inflow of vegetative and other debris with stormwater runoff may be contributing to excessive sediment buildup in the lakes. Because of the lack of knowledge of the relative inputs from the various nutrient sources, a practical water-quality management strategy is not possible.

OBJECTIVE: Establish a systematic program of data collection to determine rainfall quantity, lake level and water quality, and surface inflow quality and quantity. Investigate composition of lake sediments and rate of sediment buildup. Estimate loads of nutrients and bacteria to the lakes from atmospheric deposition, storm runoff, and ground-water seepage. Determine contribution of coarse, fine, very fine, and dissolved material to the total stormwater loading to the lakes, for nutrient and oxygen demand.

APPROACH: Install and operate discharge stations on the three major surface-inflow canals, and the outflow canal. Install and operate lake-level recorder and rain gage. Begin a bimonthly schedule of lake water-quality sampling. Sample bottom sediments and conduct bathymetric surveys with sound reflection and ground-penetrating radar. Determine major source of nutrient inflow by sampling stormwater inflow, surface inflow from upstream lakes, and ground water. Select two stormwater inflow sites for determination of loading of oxygen demand and nutrient inflow due to coarse, fine, very fine, and dissolved materials in the runoff.

PROGRESS: Quantities of tributary inflow, storm runoff, and direct rainfall to the lakes were determined. Lakes and inflow were sampled at bimonthly intervals. The stormwater monitoring sites were made operational, and collection of stormwater samples was begun. Discharge-weighted samples were collected for 12 storms at the Webster Drive site, and for 9 storms at the Elizabeth Drive site. Preliminary analysis using the Vollenweilder model indicates that the Winter Park lakes behave according to the assumptions of the model and that the eutrophic state of the lakes could be affected by stormwater discharged directly to the lakes.

PLANS FOR THIS YEAR: Continue to monitor quality and quantity of inflow, and quality of the lakes. Continue to sample stormwater. Sample ground-water inflow to the lakes, and estimate inflow quantities. Conduct a ground-penetrating radar and sonar survey of the lakes to determine water depth and sediment thickness. Complete vegetative mapping of the lakes.

FL-490 GROUND-WATER RESOURCES OF OKEECHOBEE COUNTY, FLORIDA

DATE PROJECT BEGAN: October 1998

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: Anne Bradner, Orlando

COOPERATING AGENCY: South Florida Water Management District

PROBLEM: A countywide ground-water resource study of Okeechobee County has never been done. Data needed to assess and interpret the occurrence and quality of water in the surficial, intermediate, and Floridan aquifer systems in Okeechobee County are lacking. In some areas, ground water is too highly mineralized even for irrigation use. A description of the county's ground-water resources is needed for orderly planning, management, and the best use of the resource. Evaluation of water use and water supply potential is particularly needed for additional municipal supply and for expanding irrigation use.

OBJECTIVE: The primary objective of the investigation is to supply the framework of water-resources data needed to conserve, and manage the ground-water resources of Okeechobee County. Elements involved in the primary objective are: (1) an evaluation of ground-water use, water level trends, and availability of water from the major aquifers; (2) a description of selected water-quality characteristics of the major aquifers, such as chloride and iron concentrations, and their individual and collective response to changes in water levels and to pumping; (3) reconnaissance appraisal of priority-type pollutants in the surficial aquifer system; (4) delineation of areas where nonpotable saline ground water is or may become a problem; and (5) a description of the water-bearing characteristics of the geologic formations.

APPROACH: Collect and analyze historical water-resources information from published and unpublished reports and from records of the South Florida Water Management District, the St. Johns River Water Management District, municipalities and their consulting firms, and from local well drillers. Inventory existing wells by interviewing well owners to obtain information on water levels, well yields, and water quality. Sample for major constituents (including chloride and nitrate) and priority pollutants at selected sites to assess water quality of the major aquifers. Use surface and subsurface geophysics to aid in evaluation of geology and water quality. Drill 5 to 12 test-observation wells to collect information on water levels, lithology, and water quality. Conduct specific-capacity and long-term aquifer tests on selected wells as necessary to determine hydraulic characteristics of aquifers. Establish a hydrologic network and install instruments where necessary to collect continuous and periodic data. Collect and compile data on amounts and sources of water used by municipalities and other public suppliers, industry, agriculture, and private owners.

PROGRESS: Field-data collection and data analysis were completed. Report has been submitted for review.

FL-491 ASSESSMENT OF SALTWATER INTRUSION IN COASTAL BROWARD COUNTY, FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Michael Merritt, Miami

COOPERATING AGENCIES: Broward County and the South Florida Water Management District

PROBLEM: Water management agencies need simulation modeling to reduce the cost of data collection in assessing the degree of saltwater intrusion and to permit assessments of scenarios for amelioration.

OBJECTIVE: The objectives of the study are to collect special data that quantitatively describe the mechanisms of saltwater intrusion and to develop, evaluate, and apply digital simulation methodology for representing the saltwater intrusion process and for predicting future changes under hypothetical scenarios.

APPROACH: Approximately 10 additional pairs of sampling wells will be added to the current observation network. These wells are intended to locate the position of the saltwater intrusion where it is not presently known. In addition, geologic test wells and hydraulic test wells will be installed that will provide data to be used for hydrologic models. Simulation efforts using a cross-sectional model will be conducted at a well field located near the saltwater interface. When the vertical layering is adequately simplified, the model will be extended into three dimensions, which will include additional well fields, canals, and other local features for more realistic and precise simulations.

PROGRESS: Drilling of saltwater reconnaissance wells was completed. Modeling activities to date have consisted of runs with a 2-D cross-sectional model to assess computational characteristics of the solute-transport (convective diffusion) code and to determine the best approach to calibration of a 3-D model.

PLANS FOR THIS YEAR: Work on the 3-D model will be completed and a draft of the final report will be prepared.

FL-492 DEVELOPMENT OF AN ARTIFICIAL INTELLIGENCE ROUTINE IN BROWARD COUNTY, FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Roy Sonenshein, Miami

COOPERATING AGENCIES: Broward County and the South Florida Water Management District

PROBLEM: The Florida Department of Environmental Regulation requires each of the five water-management districts within the State to design and implement a monitoring network that will be utilized to determine the effects of land use on ground-water quality. However, a cost-effective method to design a monitoring network that describes land-use effects has not been technically defined.

OBJECTIVE: (1) Develop a routine within the framework of an existing artificial intelligence (AI) software package that will analyze hydrogeologic and anthropogenic information, and (2) develop the computer program for interfacing ground-water flow model results and Geographic Information System (GIS) information with AI.

APPROACH: The first phase of the development of the AI software will be accomplished using the commercial AI program "Insight." This program will house the decision tree elements, and a search aspect will be developed using a FORTRAN routine that will interface initially with GIS programs. The second phase will use an operational AI that interfaces with a number of data bases from ground-water model output.

PROGRESS: A draft of the final report is near completion.

PLANS FOR THIS YEAR: Complete report and submit for review and approval.

FL-493 HYDROGEOLOGY AND THE EFFECTS OF DEGRADATION OF THE AIRPORT LANDFILL MATERIALS ON GEOCHEMISTRY OF GROUND WATER SOUTHWEST OF TALLAHASSEE, FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: Marian P. Berndt, Tallahassee

COOPERATING AGENCY: City of Tallahassee, Department of Public Works

PROBLEM: Ground-water samples from wells located around the perimeter of a landfill, in operation from approximately 1959-76, show local contamination of ground water. Sulfate, tetrachloroethane, nitrate, sodium, and manganese concentrations have been detected in concentrations above maximum contaminant levels (MCL's) in ground-water samples. The seven wells at the site are not adequate to provide the information necessary to characterize the hydrogeology, determine the direction of ground-water flow, and determine the processes of degradation of the landfill materials.

OBJECTIVE: (1) Characterize the geology and hydrogeology of the site, (2) determine the areal and vertical extent of contamination, and (3) determine the processes of degradation of landfill materials.

APPROACH: Electromagnetic terrain conductivity measurements will be used as a reconnaissance tool to determine the approximate extent of contamination. Public and private wells in the area will be sampled and additional wells will be drilled so the hydrogeology of the site can be described, water levels measured, and water samples collected to determine the extent of contamination.

PROGRESS: Report in review. Complete report, submit for approval, and prepare for publication.

FL-494 ASSESSMENT OF CANAL-AQUIFER INTERACTION IN THE SURFICIAL AQUIFER SYSTEM USING A COUPLED SURFACE-WATER FLOW MODEL, BROWARD COUNTY, FLORIDA

DATE PROJECT BEGAN: October 1988

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Eric Swain, Miami

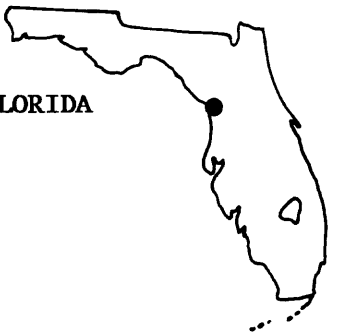
COOPERATING AGENCY: South Florida Water Management District

PROBLEM: Simulation techniques for surface-water/ground-water flow modeling need improvement to better analyze canal-aquifer interaction on a regional scale. Several ground-water flow models have been developed by the U.S. Geological Survey and others who incorporate surface-water routing models. These models are generally developed for two dimensional ground-water flow and would be inadequate for simulating flow in the multilayer or multiple aquifer systems of south Florida.

OBJECTIVE: To develop a hybrid ground-water/surface-water flow model by modifying the USGS modular three-dimensional finite-difference ground-water flow (MODFLOW) model to incorporate the flow routing techniques of the USGS surface-water flow (BRANCH) model to better simulate canal-aquifer interaction. After testing and verification, the model will be used to simulate regional ground-water flow and canal flow in Broward County, Florida.

APPROACH: The MODFLOW ground-water flow model will be modified to include the BRANCH model as a replacement for the RIVER module. An interactive procedure will be designed within the main program to solve the resulting nonlinear system of equations. The modified model will be extensively tested to verify that no coding or computational errors have been introduced. Documentation of changes made to the two computer codes will be provided to the South Florida Water Management District along with a user's guide describing additional input data requirements for the modified MODFLOW model. Once the modified MODFLOW model has been tested and verified as computationally correct, data collected in this investigation will be used to simulate coupled ground-water and surface-water flow in the area. The results of these simulations will be compared to those obtained using the original MODFLOW model to demonstrate the improvement in simulation capabilities and the model's effectiveness as a management tool.

PROGRESS: The MODFLOW and BRANCH models have been successfully interfaced, and test runs have shown that the linked models are functioning properly. A paper, "A coupled surface-water and ground-water model," was given at the ASCE National Conference on Irrigation and Drainage (July 1991). The final report, "A coupled ground-water and surface-water model for simulation of stream-aquifer interactions," has been submitted for review.



FL-495 WATER MOTION AND RETENTION TIMES IN KINGS BAY, FLORIDA

DATE PROJECT BEGAN: January 1989

DATE PROJECT ENDS: September 1991

PRINCIPAL INVESTIGATOR: G. Larry Sanders, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: Kings Bay is presently producing large, standing crops of nuisance algae, Hydrilla and Lyngbya, that are having a negative effect on the use of the resource by fish, wildlife, and the many residents and visitors to the area. The water resource management problem in Kings Bay, as in most water bodies with similar conditions, is the identification of the primary causes and contributors to the algal blooms. The specific aspect of the management problem is the lack of information on the movement, mixing, and retention time of water and an evaluation of how these physical elements may influence the distribution of nutrients in Kings Bay.

OBJECTIVE: The purpose of this study is to determine the dynamics of water motion in Kings Bay (including velocity, mixing, and retention time) and to evaluate the effects of such water motion on the distribution of nutrients and salinity. The study will include development of a two-dimensional, hydrodynamic simulation model and collection of tidal stage, tidal velocity, tidal discharge, and bathymetry data.

APPROACH: The first year of the study included compilation of existing data and collection of new data for development of a preliminary two-dimensional hydrodynamic model of Kings Bay. This included boundary condition information for bathymetry, tidal stage, and the quantity and distribution of spring discharge within the study area. Results from initial data collection and preliminary model results helped in planning data-collection efforts during the second year. The second year included continued collection of tidal-stage data and intensive tidal-cycle velocity measurements at the bay mouth and throughout the bay. These data were collected in conjunction with tidal-cycle, water-quality sampling by the cooperating agency. This concurrent stage, discharge, velocity, and water-quality information is used to calibrate and verify the model. The model is then applied to determine water motion and constituent retention times in Kings Bay.

PROGRESS: Data from the tidal-cycle measurement, made in June 1990, have been analyzed and stored in the NWIS-I system. The calibration of the hydrodynamic model is almost complete. The model predicts various circulation features that have been confirmed by other studies of the biota and water quality in Kings Bay. Coordination with the cooperator is continuing so that suitable application runs can be designed. The calibrated model will be used in application simulations to test the circulation and retention times in Kings Bay. Interpretation of the application runs will provide insight to the questions presented by the cooperator. The final report is in preparation. The report will be completed and sent forward for review and approval.

FL-496 TRACER TESTS OF GROUND-WATER FLOW IN A KARST AQUIFER IN WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1989

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: James T. Robinson, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: The rationale for delineating protection zones, which considers the Upper Floridan aquifer a homogeneous medium, probably is not valid for west-central Florida. If the aquifer cannot be treated as a homogeneous porous medium, which appears to be the case, there is the need to reconsider the guidelines for establishing protection zones.

OBJECTIVE: The study will provide information and hydrogeologic data needed to evaluate ground-water flow near pumping wells in a karst aquifer system and apply this knowledge to wellhead protection strategies for west-central Florida. Specific objectives are: (1) estimate the extent of fracture systems/solution cavities within a selected wellhead protection zone; (2) define the hydraulic properties of the aquifer system in the protection zone; (3) measure movement of tracers in the protection zone; (4) simulate the measured tracer movement and quantify transport properties of the karst aquifer within the protection zone, and (5) propose guidelines to assist in evaluating the adequacy of present well-head protection strategies for west-central Florida.

APPROACH: The study will consist of four main phases: (1) geophysical studies will be conducted at a suitable test site with well-developed karst features; (2) aquifer tests will be conducted to define hydraulic properties that control flow to a production well and observation wells for tracer injection and monitoring; (3) tracer tests will be conducted over large and small depth intervals of the aquifer and tracer movement monitored for up to six months; and (4) the U.S. Geological Survey (USGS) modular ground-water flow model, with a recently developed particle tracking module or another existing analytical method, will be used to simulate tracer movement and to test the validity of relations among aquifer heterogeneity, hydrodynamic dispersion, and porosity.

PROGRESS: Surficial and downhole geophysical investigations have been performed at the test site. Borehole video logging was conducted to determine the vertical distribution of apparent secondary porosity. Four aquifer tests have been performed at the test site. A tracer test over a large depth interval of the aquifer was completed in November 1990. The USGS modular ground-water flow model (MODFLOW) was used to simulate the aquifer response to pumping. The USGS particle tracking model MODPATH was used to simulate tracer movement in the aquifer.

PLANS FOR THIS YEAR: Report is in preparation.

FL-497 LIGHT ATTENUATION IN THE ESTUARINE AND COASTAL WATERS OF SOUTHWEST FLORIDA--CAUSE AND IMPLICATIONS

DATE PROJECT BEGAN: October 1989

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Benjamin F. McPherson, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: The amount of photosynthetically active radiation (PAR) in estuarine and coastal waters is of fundamental importance in determining growth and vigor of aquatic plants. The availability of PAR in these waters may be severely limited by dissolved (color) and suspended material, so that plants compete with one another for light. In deep-water environments, phytoplankton have an advantage over benthic plants and may flourish in the upper sunlit waters and thereby shade benthic algae, periphyton, and seagrasses. In shallow water, drift algae and periphyton may cover seagrasses and reduce light available to the seagrasses. Cultural enrichment of estuarine waters favors the growth of phytoplankton, drift algae, and periphyton, and that growth may greatly reduce light penetration and light available to seagrasses. Understanding the causes of light attenuation that result from the complex interaction of these physical, chemical, and biological processes will be necessary to help set long-term goals for properly managing our estuarine and coastal water resources.

OBJECTIVE: The overall objective of this study is to provide information to help guide management strategies in the estuarine and coastal waters of southwestern Florida by determining the causes of light attenuation. The causes of light attenuation includes the identification of both the material (i.e., dissolved organic material, suspended sediment, phytoplankton, periphyton, drift algae) and the processes that contribute to its presence in the water column or on seagrasses (i.e., wind, tide, water depth, type of shoreline, benthic plants and animals, bottom and suspended sediment characteristics, freshwater inflow, nutrient concentrations and loads, etc.). The study area will include Tampa Bay, Charlotte Harbor, and nearshore waters of the Gulf of Mexico. The study will include 6 months of method development and testing, and approximately 2 years of data collection and analysis, including two summers of intensive sampling.

APPROACH: Ten study areas in Tampa Bay and Charlotte Harbor that represent different regional environments and different levels of basin development were sampled for this study. Within each of these areas, several stations were established to characterize the light-attenuating properties of different benthic and shoreline environments. If seagrasses occurred in the study area, a station was established within the seagrass meadow and another was established beyond the meadow in deeper water.

(FL-497)

The study areas were sampled approximately 20 times over 2 years. The most intensive sampling was during May through September. The 2-year span provides the minimum time needed for an annual comparison. Measurements were made of light attenuation (PAR) in the water column and in seagrass and drift algae communities. Physical, chemical, and biological data that may affect light attenuation were collected.

PROGRESS: Sampling trips to measure light attentuation and water quality were carried out in Tampa Bay and Charlotte Harbor each month from May through September and bimonthly during the remainder of the year. Intensive sampling over a period of several days was carried out in Old Tampa Bay in November 1990 and June 1991 to measure hourly-to-daily changes in light attenuation. Incoming solar radiation was measured for a series of days during each month. All data were processed.

PLANS FOR THIS YEAR: Continue to develop a model to predict the available PAR at selected water depths and for given light attenuation coefficients for estuarine waters of southwestern Florida. Prepare a report on the predictive model and on the causes of light attenuation in Tampa Bay and Charlotte Harbor.

FL-498 CIRCULATION AND CONSTITUENT TRANSPORT IN SARASOTA BAY, FLORIDA

DATE PROJECT BEGAN: January 1990

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Kathleen M. Hammett, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: Sarasota Bay was selected by the U.S. Environmental Protection Agency for inclusion in the National Estuary Program (NEP). As part of the NEP, a comprehensive management plan that includes strategies for preservation, restoration, and enhancement will be developed for Sarasota Bay. To preserve, restore, or enhance the estuary, it is necessary to describe and quantify the circulation and constituent transport characteristics of the system. A hydrodynamic model provides a tool for evaluating both circulation and constituent transport. No hydrodynamic model presently exists for the whole Sarasota Bay study area.

OBJECTIVE: The primary purpose of this investigation is to develop a calibrated and verified hydrodynamic model of water circulation and constituent transport in Sarasota Bay. The model will closely simulate the existing system and will be able to evaluate the changes to circulation and constituent transport due to natural and proposed manmade physical changes in the system. A related objective is to develop the hydrodynamic model so that, as understanding is gained about the physical, chemical, and biological processes that affect water clarity, these processes eventually can be incorporated into the model.

APPROACH: This investigation will be a joint effort between the U.S. Geological Survey and the University of Florida (UF) Coastal and Oceanographic Engineering Department. Bathymetric and tidal-stage data collection will be started while the workplan is being prepared. Following approval of the workplan, preliminary modeling and intensive data collection will begin. Model calibration will begin when reliable data are available from the field and will be documented in an interim report prepared by UF. Following calibration, an independent data set will be used to verify the model.

PROGRESS: The scope of work, time schedule for completion, and division of responsibility between the U.S. Geological Survey and the University of Florida were substantially revised this year because of reductions in funding. The four recording gages in the southern part of the study area were retained, but three gages in the northern part were removed during the year. Intensive measurements were made of flow through the passes into and out of the southern part of the study area. Off-shore conductance meters were deployed. The university deployed monitoring towers for intensive data collection within the estuary. A preliminary three-dimensional model has been developed.

(FL-498)

PLANS FOR THIS YEAR: Recording gages in the southern part of the study area will be removed and gages in the northern part will be reactivated. Measurements of flow through the passes into and out of the northern part of the study area will be made in coordination with tower deployments by the University. The hydrodynamic model will be calibrated and an interim modeling report will be prepared.

FL-499 HYDRAULIC AND SALINITY CHARACTERISTICS OF MATLACHA PASS ESTUARY, LEE COUNTY, FLORIDA

DATE PROJECT BEGAN: July 1989

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Gary Russell, Stuart

COOPERATING AGENCIES: Florida Department of Environmental Regulation, Lee County, and the City of Cape Coral

PROBLEM: The western spreader canal system in Cape Coral has altered the sheetflow patterns of freshwater runoff into Matlacha Pass. The Florida Department of Natural Resources (DNR) has expressed concern that altering the freshwater runoff patterns into the pass have a detrimental effect on salinity distribution which, in turn, affect the aquatic system of the pass. Adequate data are not available to evaluate the effects of redistribution of freshwater inflow, its movement, and mixing. This proposed study will help identify the hydrodynamic aspects for managing the estuary.

OBJECTIVE: The objectives of the study are to determine the hydrodynamics of tidal-flow freshwater inflow and water circulation in Matlacha Pass estuary and to evaluate the effects that water circulation has on the distribution of selected physical and chemical characteristics of the pass. The study will provide baseline information on bathymetry, salinity, and selected water-quality data. The main focus of the study will include development of a two-dimensional hydrodynamic simulation model of Matlacha Pass. The model will be calibrated by the use of bathymetry, tidal stage, tidal velocity, tidal discharge, freshwater inflow, and selected water-quality data.

APPROACH: (1) A preliminary two-dimensional flow and circulation model will be simulated by the use of an existing two-dimensional model of the Charlotte Harbor estuary, (2) continuous collection of calibration data in the estuary will be compared with data generated from the initial model, and concurrent water-quality information will be used in conjunction with stage and velocity measurements to calibrate and verify the model, and (3) documentation of the model will be prepared.

PROGRESS: The initial field data collection has begun and a bathymetry map of Matlacha Pass has been completed. Model framework has begun.

PLANS FOR THIS YEAR: Complete of data collection with several synoptics, which will be used to calibrate and verify the model. Start draft of final report.

FL-501 AVAILABILITY OF GROUND WATER IN THE ORLANDO METROPOLITAN AREA, EAST-CENTRAL FLORIDA

DATE PROJECT BEGAN: April 1990

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: Louis Murray, Orlando

COOPERATING AGENCIES: St. Johns River Water Management District and South Florida Water Management District

PROBLEM: Growth in the Orlando metropolitan area is expected to cause ever-increasing demands on the ground-water resources. Available well-field locations are constrained by the occurrence of salty water, contaminated ground water, and zones of low aquifer transmissivity, and by the proximity of existing well fields. At present, there is insufficient interpretive information to assess what long-term effect that land-use changes and increasing water use will have on the ground-water resources.

OBJECTIVE: To assess the potential for developing additional large ground-water supplies in the Orlando metropolitan area, to identify favorable locations for well fields, and to develop a strategy for monitoring changes in the geohydrology.

APPROACH: (1) Assimilate all ground-water and geologic information from published and unpublished reports. (2) Use existing current and historical ground-water quality data to prepare interpretive thematic maps of the areal and depth distribution of selected water-quality constituents. (3) Construct and calibrate a high-resolution, 3-D finite-difference ground-water flow model, a particle-tracking model, and an optimizing model for identifying areas where aquifer characteristics are suitable for development. (4) Outline a strategic ground-water monitoring network to observe changes in ground-water quality and quantity.

PROGRESS: The predevelopment, steady-state flow model has been calibrated to reflect estimated predevelopment spring flows and the potentiometric interpretive surface of the upper Floridan aquifer.

PLANS FOR THIS YEAR: (1) Perform steady-state and transient flow simulations for current (1988-1989) stressed conditions. Required input will include municipal, industrial, and agricultural pumpages, drainage-well recharge, and effluent disposal recharge (Conserv II basins). (2) Write report on results of both the predevelopment and current simulations. (3) Collect water-quality data (chlorides, sulfates, and dissolved solids) for project area.

FL-502 TRANSPORT OF SELECTED CHEMICAL CONSTITUENTS IN FIELDS AMENDED WITH CRAB-SCRAP COMPOST

DATE PROJECT BEGAN: January 1990

DATE PROJECT ENDS: October 1991

PRINCIPAL INVESTIGATOR: Hilda H. Hatzell, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Composting of crab scrap with wood products provides a possible solution for two situations. The first is the need to reduce the amount of materials entering landfills. Wastes from crab-processing operations may consume as much as 20 percent of the landfill space in several Florida counties. The second is the need to increase the agricultural productivity of acid-sand soils in a way that is compatible with the environment. An organic amendment, such as compost, can increase water infiltration, levels of soil moisture, and cation-exchange capacity. Although the use of compost may provide beneficial soil effects, the crab compost may also affect the quality of ground water.

OBJECTIVE: The potential effects of crab compost on ground water will be evaluated to (1) determine if organic compounds, trace elements, and nitrates released during decomposition of compost made from blue-crab scrap can be leached, and (2) determine if crab-scrap compost can influence the potential leaching of an insecticide-nematicide and fertilizer nitrogen applied to soil-compost mixtures.

APPROACH: The project will be conducted in a greenhouse and will consist of two parts, an incubation study and a tub lysimeter study. Composted crab scrap will be mixed with field soil and incubated in a warm, moist state to encourage decomposition. After the incubation period, the soil-compost mixtures will be leached. The leachate will be analyzed for priority pollutants, selected trace elements and forms of nitrogen. The tub lysimeters will contain soil-compost mixtures inoculated with nematodes and planted with tomatoes. The nematicide, ethoprop, will be added to soil compost mixtures. Leachate collected after two leaching events will be analyzed for levels of ethoprop, for selected organic and inorganic pollutants identified from the incubation study, for selected trace elements, and for forms and levels of nitrogen.

PROGRESS: The incubation study was completed and results were presented at the 1991 meetings of the American Society of Agronomy. Solutions extracted from 100 grams of each decomposed material and 500 grams of water were analyzed for 175 organic and inorganic constituents. No organic constituents were detected. Inorganic constituents exceeding maximum concentration limits for Florida drinking water standards were: As, Fe, Mn, Se, Cl^-, and $SO_4^=$ for decomposed raw crab waste; Se and Cl^- for decomposed compost; and, NO_3^- for a soil-compost mix. The lysimeter work, scheduled to be done by another agency, was cancelled because of technical problems. No further work is planned.

FL-503 EFFECTS OF DAIRY FEEDLOTS ON GROUND- AND SURFACE-WATER QUALITY IN NORTH FLORIDA

DATE PROJECT BEGAN: November 1989

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: William Andrews, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: In the past few years, an increasing number of dairies have been located near the Suwannee River in Lafayette and Suwannee Counties. Dairy cows deposit approximately 75 kilograms of nitrogen per year per animal as manure, much of which can be converted to nitrate, which is highly soluble and mobile in ground-water systems and can cause human health problems. The area where the dairies are located is highly susceptible to ground-water contamination because the principal source aquifer in the area, the Upper Floridan aquifer, consisting of the Suwannee and Ocala Limestones, is unconfined, near the land surface, and in many places is directly connected to the land surface by karstic drainage features. The Suwannee River, designated as an Outstanding Florida Water requiring the highest priority of protection, is directly connected to the Upper Floridan aquifer in the area through numerous springs which flow from the aquifer into the river. Elevated nutrient concentrations in surface waters can cause undesirable eutrophication of those waters.

State regulatory agencies require more detailed information on the effects that these dairy operations are having on water quality in north Florida in order to identify waste-management practices that minimize ground- and surface-water contamination from these operations.

OBJECTIVE: To determine the extent of contamination of ground water beneath and surface water flowing from dairy operations and how the contamination relates to varying waster-management practices and hydrogeological conditions in LaFayette and Suwannee Counties.

APPROACH: Twelve to thirteen monitoring wells have been installed at each of four dairies located near the Suwannee River. In addition, three springs in the vicinity of the river will be sampled. Water samples are being analyzed for dissolved nitrogen species, chloride, inorganic carbon, oxygen, denitrifying bacteria, and physical parameters in order to assess the role of denitrification in reducing nitrate concentrations in ground water in the region.

PROGRESS: Ground water in the vicinity of waste-disposal sites has been sampled and analyzed for concentrations of nitrate-nitrogen. Deeper production wells in the area have also been sampled for chemical analysis. Analysis of the water-quality data is underway.

PLANS FOR THIS YEAR: Wells and springs will be sampled through the remainder of the year. The last samples will be collected in March 1993, with report writing to be completed by August 1993.

FL-505 HYDROLOGY AND EFFECTS OF WATER-RESOURCES DEVELOPMENT IN THE HIGHLANDS RIDGE OF WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: July 1989

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: D.K. Yobbi, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: The Highlands Ridge, occupying 700 square miles in central Polk and Highland Counties, is an uplands recharge area along the axis of the Floridan Peninsula. Many large sinkhole lakes occur along the crest of the ridge. Since the early 1960's, significant declines in lake levels have occurred in this important citrus-producing area. The problem of declining lake levels may be related to several factors, including below normal rainfall, increased ground-water pumpage for agricultural and industrial use, reduced recharge and drainage related to the channelization of the Kissimmee River, and agricultural drainage practices. In order to maintain the lake environment, it is important to understand and quantify the flow to, from, and within the ground-water system.

OBJECTIVE: To develop an understanding of the hydrogeologic regime and the effects of water-resources development in a regional lake environment that is strongly affected by pumping. A numerical model of ground-water flow will be used to simulate the response of the water table and lake levels to hydrologic stress.

APPROACH: Literature and file searches will be made and existing data will be compiled and geologic maps and cross sections will be prepared. The hydrogeologic system in the Highlands Ridge will be simulated using the USGS finite-difference modular computer code. Existing coarsely gridded models will be divided into 1-square mile or 1-minute (latitude and longitude) grid blocks. Starting heads, recharge, evapotranspiration, streamflow, pumping, and aquifer hydraulic properties will be estimated using the best available information. The initial steady-state calibration will be based on September 1989 hydrologic conditions. A transient model calibration will be made for the time period September 1989-September 1990. A sensitivity analysis of the model-input parameters will be performed following the steady-state and transient calibrations. Simulation runs will be made to demonstrate how the model can be used to assess the regional effects of water-resources development.

PROGRESS: Input of hydrogeologic data to the model was completed. The water-level map of the surficial aquifer was revised to incorporate data from wells recently drilled along the ridge. Steady-state and transient modeling efforts continued. Monthly variations of effective recharge to the surficial

aquifer were estimated for the time period October 1989 through September 1990. The rate of effective recharge is based on monthly average of rainfall, runoff, and evapotranspiration.

PLANS FOR THIS YEAR: Complete calibration of transient model and conduct a sensitivity analysis. Perform verification and prediction model runs. Begin report preparation.

FL-506 NEAR-SURFACE WATER BALANCE FOR A SITE IN CENTRAL FLORIDA: A CASE STUDY AND MODELING INVESTIGATION

DATE PROJECT BEGAN: July 1990

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: W.R. Bidlake, Tampa

COOPERATING AGENCIES: Southwest Florida Water Management District and Sarasota County

PROBLEM: Water and energy exchanges between the atmosphere and terrestrial ecosystems are crucial components of the hydrologic cycle. Recharge and contaminant transport to saturated ground-water systems are regulated by hydrologic processes that occur near the soil surface. A greater understanding of these processes is needed to help elucidate potential effects of management decisions and climate change.

OBJECTIVES: Study objectives are to provide a site-specific example of the near-surface water balance and to develop predictive capabilities for key near-surface hydrologic processes through the use of a physically based hydrologic process model.

APPROACH: Investigators will conduct a detailed examination of the near-surface water balance for a site in a prevalent type of native vegetation in west-central Florida. Principal water-balance components to be monitored include: precipitation, evapotranspiration, and changes in soil-water storage. A physically based model will be used to simulate the water balance of the unsaturated zone. The model will be used to examine and predict evapotranspiration and other water-balance components under different vegetative conditions.

PROGRESS: The data-collection network has been installed and water-balance components are being monitored.

PLANS FOR THIS YEAR: The data-collection network will be operated. Hydrologic parameters will be measured at the site to enable the quantitative description of the site water balance, and to provide parameters for the simulation of the unsaturated zone water balance.

FL-507 DEFINITION OF THE UPPER FLORIDAN FLOW SYSTEM IN THE CITY OF TALLAHASSEE AND LEON COUNTY

DATE PROJECT BEGAN: July 1990

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: Hal Davis, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: The city of Tallahassee discontinued the use of several city supply wells due to contamination. The city and the Florida Department of Environmental Regulation (FDER) realize the importance of protecting ground-water resources. One approach is to delineate wellhead protection areas. This cannot be done effectively until the aquifer's flow system is well understood. The Tallahassee/Leon County area is an ideal location in which to evaluate the efficacy of different wellhead protection methods in an environment of complex, possibly anisotropic, fracture/conduit flow.

OBJECTIVE: To improve understanding of the flow system in the complex fracture/conduit dominated environment of the city of Tallahassee and Leon County in order to allow local officials to develop ground-water protection strategies including wellhead protection.

APPROACH: (1) Assemble existing hydrogeologic and well information. This includes a detailed well inventory and study of well logs and other published materials. (2) Collect additional hydrogeologic and well information. A potentiometric-surface map will be constructed for the Upper Floridan aquifer in the study area and aquifer tests will be conducted to determine anisotropy. This may include installation of 2-4 monitor wells. (3) Construct a detailed ground-water flow model and delineate areas contributing water to pumping centers based on capture areas and time criteria. The USGS modular model will be used. (4) Conduct a preliminary evaluation of wellhead protection methods.

PROGRESS: A detailed well inventory for the study area has been completed. Published material concerning the geology and hydrology of the study area has been complied. Preliminary modeling, using the USGS MODFLOW model, has been completed. A grid of wells has been selected for water-level measurements.

PLANS FOR THIS YEAR: Water-level data will be collected and a potentiometric-surface map will be constructed. Aquifer tests will be conducted; monitoring wells may be installed if existing wells are unavailable. Regional modeling of the ground-water flow system will be completed.

FL-508 TECHNIQUES FOR ESTIMATING AREAS THAT CONTRIBUTE GROUND WATER TO PUBLIC-SUPPLY WELLS IN WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: July 1990

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: L.A. Knochenmus, Tampa

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: The Upper Floridan aquifer is the primary source of public water supply in west-central Florida. Over most of the area of northern Hillsborough and Pinellas Counties, and most of Pasco County, the aquifer is at or near land surface and is vulnerable to contamination. To protect public water supplies from possible sources of contamination, areas that contribute water to these wells must be known as well as factors that affect the size and shape of the contributing area.

OBJECTIVE: Define ground-water flow in a carbonate aquifer system and apply this knowledge to wellhead protection strategies for west-central Florida. Test the validity of Darcian ground-water flow in a carbonate aquifer. Simulate the flow system to indicate which factors affect the size and shape of the contributing areas. Compare methods for area delineation. Suggest areas in the State where methodologies can be applied.

APPROACH: Experimentally use analytical and numerical-mathematical models to estimate ground-water flow pathlines, velocity fields, time-of-travel, and contributing areas to wells. The hydrologic parameters will be compiled from previous numerical modeling results, aquifer-test data, and laboratory values of effective porosity from core samples. Vary the controlling factors including model grid size, pumping rate, transmissivity, porosity, anisotropy and well penetration depth to evaluate the effects on size and shape of the contributing area. Compare the results of the study with previous wellhead protection strategies.

PROGRESS: Twenty-two core samples were selected and analyzed for total and effective porosity. Used graphical and numerical methods to analyze existing aquifer test data for anisotropy in the Upper Florida aquifer. Compiled and standardized figures from previous studies to look for trends or relations that might indicate predominance of effective macroporosity. Compared borehole geophysical and television logs to determine the vertical distribution of effective macroporosity in the Upper Floridan aquifer.

PLANS FOR THIS YEAR: Compare the simulated areas of contribution to well fields using porous media and dual-porosity models.

FL-509 MEASUREMENT OF NONPOINT-SOURCE NUTRIENT LOADING TO ESTUARIES WITH EMPHASIS ON TIDALLY DOMINATED RIVERS: A CASE STUDY OF HILLSBOROUGH BAY, FLORIDA

DATE PROJECT BEGAN: August 1990

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: W.M. Woodham, Tampa

COOPERATING AGENCY: Southwest Florida Water Management District

PROBLEM: The effects of land-use changes and other human activities on the water quality and ecology of estuaries and other coastal waters is a national concern that is being addressed in many coastal areas of the country. Increased nutrient availability in estuaries and coastal waters creates conditions conducive to eutrophication. There is a lack of recent measurements of major point-source loads and little information on nonpoint source loads of nutrients from three major tributaries: the Hillsborough, Palm, and Alafia Rivers. It is essential that these nutrient loads be measured in order to help develop a realistic estimate of the nutrient budget of both Hillsborough and Tampa Bays. Standard constituent loading measurement techniques for streams are of limited usefulness because tidal conditions extend for large distances upstream. Standard stage/discharge relations cannot be established in tidal reaches and large parts of the drainage basin cannot be measured for nutrient load contributions in a cost-effective manner.

OBJECTIVE: Provide realistic estimates of the nonpoint-source loading of nutrients to Hillsborough Bay in order to satisfy the need to develop a nutrient budget and provide reliable data for input to a eutrophication model to be developed at some future time. Develop and operate a cost-effective technique for measuring nutrient loads in a tidally dominated river at its most downstream point in order to eliminate unmeasured loads from parts of the drainage basin.

APPROACH: The overall approach for developing reliable and nonpoint-source nutrient loading estimates for Hillsborough Bay is based on an extensive program of field measurements and sampling. An innovative application of state-of-the-art velocity measuring equipment and automated water sampling will be tested and evaluated for continual measurement of tidal discharge and appropriate nutrient concentrations at the mouth of the Alafia River for determining nutrient loading rates from the entire basin. If successful, such techniques could later be applied to other major tributaries to Tampa Bay. Results will be used to design a data collection program which will provide yearly constituent loading and seasonal variability from the Alafia River basin.

PROGRESS: Stage and velocity-index recorders continued in operation at the Alafia River. Discharge measurements for outgoing and incoming tidal flow were made and used in the development of satisfactory index velocity-mean velocity and stage-area relations for Alafia River. Stage and velocity-index recorders were installed at the mouth of the Hillsborough River. A monthly

sample collection schedule for the Alafia, Palm, and Hillsborough Rivers was implemented. Field-meter measurements were made of water temperature, specific conductance, dissolved oxygen, and pH at 2-foot vertical intervals. Sampled constituents included dissolved and total ammonia, nitrate plus nitrite, organic nitrogen, carbon, orthophosphate, phosphorus; dissolved silica; chlorophyll a and b; total suspended solids; conductance; chloride, and 5-day biochemical oxygen demand. An ultrasonic velocity meter was installed at Alafia River.

PLANS FOR THIS YEAR: Continue operation of all stage and velocity-index recorders. Define index velocity-mean velocity and stage-area relations for Hillsborough River. Continue monthly sample collection schedule for the Alafia, Hillsborough, and Palm Rivers through March 1992. Compile and analyze velocity and water-quality parameters. Define load computation procedures. Begin preparation of report.

REPORTS RELEASED: A paper, "Discharge measurement techniques for nutrient load computations in tidally dominated rivers," by William M. Woodham and Yvonne E. Stoker was published in the proceedings of the Second Tampa Bay Area Scientific Information Symposium, Tampa, Fla., February 27-March 1, 1991.

FL-510 SOURCE AND EXTENT OF NITRATE-NITROGEN CONTAMINATION OF GROUND-WATER NEAR THE STAFF HOUSING AREA, MACDILL AIR FORCE BASE, FLORIDA

DATE PROJECT BEGAN: August 1990

DATE PROJECT ENDS: April 1992

PRINCIPAL INVESTIGATOR: Mario Fernandez, Jr., Tampa

COOPERATING AGENCY: MacDill Air Force Base

PROBLEM: Findings from a reconnaissance study to determine the possible source of elevated nitrate-nitrogen indicated three sites of elevated nitrate distribution in ground water beneath the base golf course. The study concluded that, at present, it is not possible to positively know whether the nitrate sources are from excessive overfertilization during recent past, effluent irrigation, or materials that may have been buried earlier.

OBJECTIVE: To collect additional data on the nitrate distribution and other chemical constituents in order to provide information to satisfactorily remediate the problem at the base.

APPROACH: This study is composed of four major tasks: (1) to evaluate the study area for buried materials using surface geophysical techniques, which include ground-penetrating radar, electromagnetic induction, and magnetometry; (2) to obtain a detailed description of the water-table configuration and ground-water movement; (3) to better define the nitrate distribution, to establish the presence or absence of other possible contaminants, to characterize the types of water in the ground-water system, and to determine whether lake sediments from a lake within the study area are a repository of contaminants, and (4) to evaluate the activity of denitrifying bacteria in the aquifer, which may be a key factor in determining the most cost-effective site remediation method.

PROGRESS: Surface geophysical investigations were completed and analyzed. Water levels were measured and a water-table map was prepared. Water samples were collected and analyzed for nutrients, trace metals, pesticides, volatile organic compounds, phenols, and explosives. An interim progress report was prepared.

PLANS FOR THIS YEAR: Final report will be prepared and submitted for review and approval.

FL-511 AN EVALUATION OF THE EFFECTS ON NONPOINT-SOURCE POLLUTION FROM SWINE AND POULTRY OPERATIONS ON GROUND- AND SURFACE-WATER QUALITY IN NORTH FLORIDA

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: March 1993

PRINCIPAL INVESTIGATOR: Hilda H. Hatzell, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: The presence of swine and poultry operations in north Florida poses a potential threat to the water quality of the Suwannee River and the Floridan aquifer. Data obtained from a statewide monitoring network show elevated nitrate concentrations in wells in the vicinity of the river. Ammonium in livestock waste is oxidized to nitrate, a form of nitrogen that is not readily retained by sandy soils. In areas where swine and poultry wastes are concentrated, nitrates may be lost by runoff to surface water or by leaching to ground water.

OBJECTIVE: To determine the degree to which ground water and surface water flowing from swine and poultry operations are contaminated and to relate the contamination to varying waste-management practices and hydrogeology in LaFayette and Suwannee Counties in northern Florida.

APPROACH: Swine and poultry sites representative of differing production and waste-disposal practices will be selected. Monitoring wells will be located within or adjacent to areas of animal activity and waste disposal. The wells will be used to examine concentrations of nitrogen species and other waste tracers such as phosphorus, chloride, and sulfates. Surface water from holding ponds and small creeks draining the areas will also be sampled. The relative abundance of 15N and 14N isotopes in nitrates will be used to evaluate the pattern of organic and inorganic nitrate sources in the study area.

PROGRESS: A questionnaire was mailed to poultry producers in the study area. The results of the questionnaire were used to identify average poultry production practices and to locate potential sites for monitoring wells. Of 14 sites visited, 5 were selected for installation of monitoring wells. After extensive interviews with the agricultural community in the Suwannee River area, it was determined that the current level of swine production in the area was insufficient to warrant monitoring. Monitoring of swine farms was relocated to Jackson County in the Florida Panhandle. A geostatistical analysis of nitrogen concentrations was used to define the area in the vicinity of the Suwannee River to be sampled for nitrogen isotope analysis. Ninety private drinking-water wells were sampled.

PLANS FOR THIS YEAR: Monitoring wells will be installed on the selected poultry farms in the Suwannee River area. Quarterly monitoring of these wells will begin in late January. Swine farms will be selected in Jackson County, monitor wells will be drilled, and quarterly sampling will begin. The analysis of the nitrogen isotope samples will be completed.

FL-512 EFFECTS OF THE HILLSBORO CANAL PUMPAGE ON WATER QUALITY OF THE SECONDARY CANALS IN BOCA RATON, FLORIDA

DATE PROJECT BEGAN: October 1989

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Donald McKenzie, Miami

COOPERATING AGENCY: City of Boca Raton

PROBLEM: The major source of water, other than local rainfall and runoff, to maintain stages of the Lake Worth Drainage District (LWDD) canals in the Boca Raton area is the Hillsboro Canal. Rapidly increasing water demands in the Boca Raton area have required that increasing amounts of water be pumped from the Hillsboro Canal. The city of Boca Raton is concerned that the quality of the water of the LWDD canals flowing through the city and near its well field may be degraded by pumpage from the Hillsboro Canal. This concern has arisen partly because water in the Hillsboro Canal flows from Lake Okeechobee, through an area of organic soils and intensive agriculture, receiving highly mineralized ground water. There have been sporadic water-quality analyses of the Boca Raton canals in recent years, but because of varying sampling sites and infrequent sampling, appraisal of water-quality conditions and trends has not been feasible.

OBJECTIVE: The objectives of the investigations are to (1) collect and compile all available historical data, and select target constituents for long-term trend analysis and (2) characterize the present water quality of the Boca Raton canal system and determine the effect of pumpage from the Hillsboro Canal.

APPROACH: All available canal-water analyses for the area of investigation will be evaluated. Canal sampling sites will be selected according to the movement of water from the Hillsboro Canal, land-use patterns, and sediment deposition. The sampling frequency for most of the constituents will be determined by seasonal rainfall distribution and the discharge from the Hillsboro Canal pump station. High-flow sampling will be emphasized. Samples collected will be analyzed for major inorganic constituents, nutrients, and metals. GC-FID reconnaissance sampling also will be conducted to qualitatively detect organic contaminants. All data collected will be evaluated and analyzed using summary statistics for individual sampling sites. An analysis will be made for constituent trends with attention to seasonal effects (rainfall) and pumpage at the Hillsboro Canal. Relations of constituents to land use and point sources of contamination will be developed. A long-term water-quality monitoring program is anticipated, following the 3-year investigation.

PROGRESS: Data collection and analysis continued.

PLANS FOR THIS YEAR: Complete data analyses and prepare final report.

FL-513 GEOCHEMISTRY AND WATER QUALITY OF THE FLORIDAN AQUIFER SYSTEM, DADE COUNTY, FLORIDA

DATE PROJECT BEGAN: August 1990

DATE PROJECT ENDS: September 1992

PRINCIPAL INVESTIGATOR: Ron Reese, Miami

COOPERATING AGENCIES: Miami-Dade Water and Sewer Authority Department; South Florida Water Management District

PROBLEM: There is a need for additional public-water supply as the population of southeastern Florida increases. Use of the Floridan aquifer system can provide additional supply. Three methods are being considered for using the Floridan. One is to blend brackish ground water from the Floridan aquifer system with the freshwater of the overlying Biscayne aquifer at the well field. A second method is to temporarily store excess freshwater in the Upper Floridan aquifer, withdrawing it when needed by aquifer storage and recovery (ASR). The third method is to treat Upper Floridan water directly by reverse osmosis (RO). Study of the water quality of the Floridan aquifer system in southern Florida has not been done on a comprehensive basis, and an evaluation of background data is needed.

OBJECTIVE: Objectives for the characterization of the geochemistry of the Floridan aquifer system are as follows: (1) delineate zones of high permeability in the Floridan, (2) delineate geochemical zones in the Floridan (zones of similar water quality), (3) determine possible geochemical areal trends in constituents that may affect the use of Floridan aquifer system water for RO processing or blending with freshwater, and (4) use geochemical modeling techniques to determine the state of equilibrium of ground water with respect to present mineralization with the aquifer and determine the equilibrium effects of mixing Upper Floridan water with freshwater.

APPROACH: Zones of high permeability will be defined, along with geologic units, on cross sections using geophysical logs of key wells and data from aquifer tests and core samples at existing wells. Zones of similar water chemistry will be delineated based upon dissolved solids and major-ion concentrations using samples produced from specified intervals in the Floridan. Placement of geochemical zone boundaries will be made taking into account the hydrogeology and flow system boundaries. Areal geochemical trends within a zone will be mapped using constituents such as dissolved solids and chloride. Consideration will be given to the hydrogeology, ground-water movement, and possible recharge areas when defining a trend. Geochemical modeling of the Upper Floridan will involve using U.S. Geological Survey models, such as PHREEQE and NETPATH. These models output thermodynamic speciation calculations, the equilibrium state with respect to minerals (saturation index), and reaction path simulations.

(FL-513)

PROGRESS: Completed data tables for study area--well data, water-quality data, and hydrogeochemical data.

PLANS FOR THIS YEAR: Develop a geochemical flow-path model in the Upper Floridan aquifer to determine reactions which may be occurring. A report, "Distribution and origin of salinity in the Floridan aquifer system, southeast Florida," will be prepared and submitted for review.

FL-514 APPLICATION OF GROUND-PENETRATING RADAR METHODS IN HYDROGEOLOGIC STUDIES IN A KARST AREA, WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1989

DATE PROJECT ENDS: December 1991

PRINCIPAL INVESTIGATOR: G.L. Barr, Tampa

COOPERATING AGENCY: Pinellas County

PROBLEM: Ground-penetrating radar (GPR) is a relatively new surface geophysical method that produces a continuous high-resolution profile of the shallow subsurface. Experimental testing in west-central Florida has demonstrated the method's potential for defining the stratigraphy of shallow formations, depth to water table, in-filled sinkholes, underground cavities, and burial tanks and pipes. Although GPR records are easy to obtain, their interpretation should be made by an experienced geophysicist. There is a need for a study of GPR methods and a handbook that explains how to interpret records obtained in Florida's karst environment.

OBJECTIVE: The study will investigate the use of GPR to profile, and subsequently delineate, subsurface features in a karst area. Several hydrogeologic settings will be explored to determine the limitations and uses of GPR methods in hydrogeologic studies.

APPROACH: Study sites in Pinellas and Hillsborough Counties will be profiled. The Pinellas County sites include the sinkhole-riddled Eldridge-Wilde well field, the swampy Eastlake well field, a proposed tract for well-field expansion, and a karst area in Hillsborough County where photolineaments were delineated. Each site has an area greater than 1 square mile. At least ten 500-foot-long test profiles will be made at each site. Subsurface features that should be recognizable in the GPR records include: (1) depth to water table, (2) depth to bedrock, (3) thickness of confining beds, (4) breaches in confining beds, (5) fractures and joints, (6) underground cavities, (7) buried objects, and (8) structure beneath a lake. Records made on land will be compared to those made on water to evaluate how organic substances affect the record. Topographic and geologic controls for the GPR profiles will be obtained by surveying and auger drilling, with at least one test hole along each transect. Shallow wells will be installed at selected breaches in the intermediate confining unit. Water-level measurements and GPR profiles will be used to detect depressions in the water table, thereby substantiating or refuting the hypothesis that downward leakance is enhanced in such areas.

PROGRESS: Evaluation of ground-penetrating radar data was completed for the East Lake, Eldridge-Wilde, Pemberton Creek, Northwest Pinellas Sewage Treatment Plant, and C.F. Industries sites. Four sites were representative of various karst settings in Pinellas and Hillsborough Counties, and a fifth site in Hardee County included a phosphate-reclamation area. A final report was

(FL-514)

prepared as a USGS Water-Resources Investigations Report entitled, "Application of ground-penetrating radar methods in hydrogeology studies in a karst area, west-central Florida," and is in review.

FL-515 REGIONALIZATION OF LOW-FLOW CHARACTERISTICS IN STREAMS IN NORTHERN FLORIDA

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: March 1994

PRINCIPAL INVESTIGATOR: Roger P. Rumenik, Tallahassee

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Demands for low-flow information in many areas of Florida exceed the capabilities of existing data-collection resources. To meet these demands, methods of estimating low-flow characteristics at sites with little or no streamflow data (ungaged sites) are needed. Methods using multiple regression analysis could provide significant benefits for managers responsible for protecting surface-water quality, and allocation of surface-water supplies. In addition, new measurement sites are needed in basins that lack an adequate number of low-flow measurement sites. This additional information is needed to establish an acceptable network of low-flow stations to support regional models or other methods of estimating low-flow characteristics.

OBJECTIVE: (1) To develop regional models using multiple-linear regression analysis to estimate the magnitude and frequency of low flows at sites where little or no streamflow information is available, (2) to develop alternate methods for estimating low-flow frequency data in areas where use of the models does not provide favorable results, and (3) to augment low-flow information by designing a network of low-flow data-collection stations. This network will increase the coverage of data available for regional analyses.

APPROACH: Analysis of variance (ANOVA) will be used to test approximately 10-15 basin characteristics for their significance to regional variability of low flow. Ordinary least squares and estimated generalized least-squares regression analysis will be used to estimate functional relations between low-flow characteristics and basin characteristics found to be significant by the ANOVA analysis. Alternate methods of estimating low-flow characteristics at ungaged sites will be examined concurrently when testing regression techniques.

The adequacy of the data base, as it applies to each river basin, will be evaluated. The results of the evaluation will be used to design a data-collection network of selected sites where base-flow measurements are needed.

PROGRESS: Data in the USGS streamflow and basin characteristics file were reviewed and data were updated for use in multiple-linear regression analyses. The source and availability of coverages developed through a Geographic Information System (GIS), as variables of stream and basin characteristics, were researched. Coverages for topography, soils, drainage areas, basin slope, and environmental geology are being prepared or reviewed for digital format using ARC/Info software. These combined data will serve as variables for use in regionalization models for estimating low-flow frequencies at ungaged sites in areas in northern Florida. Two continuous-record gaging

stations were established in the Suwannee River basin to serve as small-basin index stations for low-flow correlation procedures. Approximately 50 extreme low-water measurements were made during October and November at a network of low-flow sites in northern Florida east of the Apalachicola River.

PLANS FOR THIS YEAR: Continue to update, prepare, and review streamflow and basin characteristics that are planned for use in regression analyses for model studies. Make preliminary model runs. Collect additional low-flow data at 40-60 sites. Update workplan and begin preparation of a report.

FL-516 UNSATURATED FLOW AND TRANSPORT UNDER RAPID INFILTRATION BASINS

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: David Sumner, Orlando

COOPERATING AGENCY: Reedy Creek Improvement District

PROBLEM: Beginning in 1991, the Reddy Creek Improvement District will discharge up to 15 million gallons per day of treated sewage effluent into rapid infiltration basins (RIBS) southwest of Orlando. The effects of this practice on the quality and quantity of local surface-water and ground-water resources are unknown. Because infiltration is largely an unsaturated-flow process, a better understanding of unsaturated flow and transport in the soil and surficial aquifer system under and around the RIBS is necessary to predict the effect of the RIBS on local hydrology. What is known of unsaturated flow and transport in this area and their interaction with the regional ground-water system is principally derived from limited laboratory investigations or studies of the upper soil horizons only.

OBJECTIVE: (1) Characterize flow and transport in the unsaturated zone beneath RIBS in central Florida, (2) evaluate the long-term effects on chemical and physical properties of the surficial aquifer system beneath RIBS, and (3) assess the interaction of RIBS hydrology with local water-table and ground-water recharge.

APPROACH: (1) Two basins will be instrumented to measure the rate and quality of moisture moving vertically and horizontally through the surficial aquifer system during infiltration events, and to monitor changes in the water table and underlying aquifer system. Inverse problem techniques (advancing front, or others) will be applied to determine principal hydrologic characteristics that describe or control flow and transport (hydraulic conductivity function, soil moisture retention curves, among others) and the results will be compared to values determined from cores in laboratory tests. (2) Soil samples will be collected from six basins before discharge infiltration begins and after 2 years of normal operation. Changes in soil chemistry and physical properties will be related to the quality, duration, and intensity of inflow. (3) Observations of unsaturated flow and transport will be combined with regional ground-water flow models and hydrologic budgets to assess RIBS effects on subregional and local hydrology.

PROGRESS: Work has progressed along two lines: (1) field and lab instrumentation and (2) formulation of modeling approach. Equipment construction and purchase now allows for measurement of soil matrix potential, water content, moisture characteristic curve, and hydraulic conductivity. The modeling approach allows for the uncertainty in hydraulic properties at the 1,000-acre site through a stochastic-problem formulation.

(FL-516)

PLANS FOR THIS YEAR: A considerable amount of data will be collected at the site and through lab analysis of soil samples to characterize the statistical nature of the hydraulic parameters of the basin soils. These data will act as the basis for stochastic-numerical modeling of the basin response to water application. Additionally, work will begin to identify the nature and variability of soil-water chemical evolution as flow occurs from the basins downward to the water table.

FL-517 A DIRECT METHODOLOGY FOR PREDICTING WETLAND RESPONSES TO HYDROLOGIC STRESSES

DATE PROJECT BEGAN: April 1991

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: Edward R. German, Orlando

COOPERATING AGENCIES: Volusia County and St. Johns River Management District

PROBLEM: Deterministic models simulating ground-water/wetlands flow are usually mathematically complex, regional in scope, and require large amounts of time and expense to develop. Site-specific models to quickly evaluate effects of development on wetland hydrologic systems are often not practical for use by water-resources managers.

OBJECTIVE: To develop a direct, simple methodology for estimating the effects of development on wetland hydrology when given measurable, physical parameters and variables.

APPROACH: The overall design of the study is to use a surface-water/ground-water simulation model, the parameters of which are controlled by experimental design, to provide results that can be analyzed by regression techniques to produce simple analytical tools useful for estimating the effects of hydrologic stresses on a wetland environment.

A calibrated flow model will be initially prepared, covering a wetlands area of Volusia County, an adjacent uplands area, and a surface-water outflow channel. After calibration, numerous model runs will be made, each time changing some of the parameter and external-variable values of the model, as directed by experimental-design techniques. Statistical methods (most likely linear regression analysis) will be used to analyze model output to generate simple equations, plots, and/or nomographs relating model results with input parameters and variables. These analyses represent the final product of this study and can be readily used by water-resource managers in place of further flow modeling to help evaluate the effects of hydrologic stresses on a site-by-site basis.

PROGRESS: The study area and sites for installation of monitoring wells were selected. Information and documentation concerning applicable models were compiled. A series of conceptual models of wetland systems were defined in preparation for flow modeling. A study of various methods for fitting model-generated response surfaces with predictive equations was begun.

PLANS FOR THIS YEAR: Install and operate monitoring sites. Compile data base of geohydrologic information for the area. Begin modeling conceptual wetlands designs and fitting model-generated response surfaces with predictive functions.

FL-518 INFLUENCE OF TREATED MUNICIPAL WASTEWATER ON THE LEACHING AND RETENTION OF PESTICIDES IN THE UNSATURATED ZONE

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: R.L. Miller, Tampa

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: Reuse of treated municipal wastewater for nonpotable uses, such as irrigation of public and private green areas, is expected to become an important part of sound water-conservation practices, especially in areas experiencing water shortages. The effect of humic and fulvic acids, surfactants, and other soluble organic compounds on the solubility, adsorption, degradation, and movement of pesticides in the unsaturated zone is poorly understood. This lack of information limits the ability of environmental scientists and regulators to wisely balance the need to reuse municipal wastewater for irrigation with the need to provide adequate protection of potable ground-water supplies.

OBJECTIVE: (1) To determine if selected pesticides applied to golf courses receiving treated municipal wastewater are leached into ground water, and (2) to evaluate the effect of treated municipal wastewater on leaching potential by studying the mechanisms of interaction between wastewater and pesticides.

APPROACH: In phase I, three pairs of golf courses will be selected. Each pair will consist of one golf course that uses municipal wastewater for irrigation and another golf course with similar hydrogeology and pesticide-application practices that does not receive wastewater. Monitoring wells will be installed and ground water will be sampled quarterly for 1 year for pesticides, nutrients, major ions, and trace elements. A limited number of tension lysimeters will be installed to sample water from the unsaturated zone for selected pesticides. In phase II, laboratory, green house, or test-plot experiments will be devised to study the mechanisms that increase or decrease the leaching of selected pesticides from the unsaturated zone.

PROGRESS: Questionnaires were prepared and distributed. Two pairs of golf courses were selected. A quality-assurance (QA) plan was partially prepared. Most of the project's equipment was ordered.

PLANS FOR THIS YEAR: A project QA plan will be submitted for approval. Select last pair of golf courses for study in phase I. Wells will be installed and sampled quarterly thereafter for 1 year. Begin evaluation of phase I data and planning for phase II. Begin early work for phase II.

FL-519 EVALUATION AND DESIGN OF GROUND-WATER MONITORING NETWORKS FOR BROWARD COUNTY, FLORIDA

DATE PROJECT BEGAN: January 1991

DATE PROJECT ENDS: June 1993

PRINCIPAL INVESTIGATOR: Roy Sonenshein and Eric D. Swain, Miami

COOPERATING AGENCIES: South Florida Water Management District
Broward County Office of Natural Resources Protection

PROBLEM: Networks to monitor saltwater intrusion, ground-water quality, and water-table elevation have been developed in Broward County, but these networks have not kept up with the growth in the county. Other networks, such as those set up by well-field operators for well-field protection, have not been included in a comprehensive ground-water monitoring system. New canals and water-management structures, changing land use, and expansion of municipal well fields have resulted in wells no longer monitoring the situations they were originally designed to monitor. Thus a need exists to evaluate the current ground-water monitoring network, develop criteria for future monitoring needs, and design optimal regional monitoring networks.

OBJECTIVE: (1) Develop criteria for monitoring saltwater intrusion, water-table elevation, well-field protection zones, and regional water quality; (2) develop methods for designing monitoring networks based on mathematical models and statistical techniques; and (3) design regional monitoring networks, with the ultimate objective of eliminating existing monitoring wells that do not meet criteria or are redundant, and determining the location and type of additional wells where data are lacking.

APPROACH: (1) Develop criteria for each of the monitoring requirements with officials of the cooperating agencies based on consideration of cost, well construction, quantities to be monitored, adequacy of past collected data, and predicted changes in water quality in important locations; (2) develop techniques for evaluating the monitoring network using geostatistical techniques, ground-water flow models, and GIS data; (3) evaluate existing network and design new network for Broward County using the criteria and techniques developed in the first two parts; and (4) prepare documentation reports describing the techniques developed and the results of the analysis. A final Water-Resources Investigations Report, tying together all the phases, will be prepared.

PROGRESS: The data-collection phase continued. Water-supply utilities have been contacted regarding existence of monitoring wells. A letter has been sent to the utilities requesting data about these wells. Initial responses indicate few monitoring wells. An initial examination of the statistical characteristics of known wells in Broward has begun, with evaluation of techniques to be applied.

PLANS FOR THIS YEAR: Create initial set of criteria for monitoring wells and obtain comments on these criteria from various agencies. Complete compilation and development of well data base. Continue analysis and development of statistical techniques.

FL-520 NATIONAL WATER QUALITY ASSESSMENT PROGRAM: GEORGIA-FLORIDA COASTAL PLAIN NAWQA

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: December 1999

PRINCIPAL INVESTIGATOR: Edward T. Oaksford, Tallahassee

COOPERATING AGENCY: Federal Program

PROBLEM: There is a need to describe the status and trends of the water quality of the Nation's ground- and surface-water resources in order to provide a sound understanding of the natural and manmade factors affecting the usability of these resources. The Georgia-Florida Coastal Plain Study Unit is one of 60 representative areas chosen to comprise a national assessment. Within the study unit, water is generally of good chemical quality suitable for most uses, but in some areas quality has been impaired as the result of agricultural practices, mining, waste disposal, storage and use of toxic chemicals, stormwater disposal, and water withdrawals. Naturally occurring constituents and properties have also affected the usability of water locally, and saltwater in coastal areas has been induced to move into freshwater aquifers and rivers as these resources are developed for use.

OBJECTIVE: The three major objectives of the National Water Quality Assessment Program (NAWQA) are (1) to provide a consistent description of current water-quality conditions for a large part of the Nation's water resources; (2) define long-term trends (or lack of trends) in water quality; and (3) identify, describe, and explain, as possible, the major factors that affect observed water-quality conditions and trends.

APPROACH: During the first 2 years, a project team will be assembled, an extensive project work plan will be developed, and existing data will be summarized and analyzed. A 3-year period of intensive data collection, analysis, and interpretation will begin in 1993. A long-term monitoring network will be established for trend analysis, subbasins will undergo synoptic surveys to better define sources of pollutants, and selected sites will undergo intensive process-oriented study to provide a better understanding of the cause-and-effect relationship between man and the environment. Intensive data-collection and interpretation efforts will be followed by a period of report writing and low-level sampling and analysis.

PROGRESS: A preliminary workplan for fiscal years 91 and 92 has been submitted to Region and Headquarters for review and comment. Results of a STORET retrieval have identified approximately 10,000 unique non-Survey sampling sites in the study area. Contacts with many key agencies willing to share data have been initiated and a liaison committee meeting has been scheduled. Digital spatial data have been obtained for several key themes and processing requirements are being determined. Project staffing has continued and a biologist and a lead hydrologic technician have been added to the project team. New computer hardware and software have been acquired for project staff and related training has been initiated. The project's first liaison committee meeting was held in Valdosta, Ga., and many new agency contacts were

made to acquire existing ground-water, surface-water, and biological data. Discussions are currently taking place to coordinate existing sampling activities and extract representative subsets of existing data-collection sites. Utilization of existing District and cooperator analytical capabilities has been initiated to expedite analysis, minimize sample shipment costs, and improve sample turnaround time.

PLANS FOR THIS YEAR: Plans for the upcoming year will focus on the preparation of a final project workplan, compilation and analysis of existing water-quality and biologic data, initiation of a reconnaissance sampling effort, and the preparation of draft reports highlighting the current status of water-quality conditions in the study area.

Existing ground-water, surface-water, and biological sampling sites will be carefully examined and a representative subset of sites will be incorporated into the project sampling networks if adequate construction detail or site specifications exist and future sampling requirements can be met. Historical data will be retrieved and screened for adherence to necessary quality-control criteria prior to data analysis. Initial data analysis will be primarily conducted on historical nutrient, pesticide, and biological data. Only a limited number of reconnaissance samples will be collected during the analysis of existing data. Analysis results will be presented to display the geographic distribution of constituents as well as statistical relations between sample-site groupings stratified to reflect variation in hydrogeologic, physiographic, ecologic, or anthropogenic conditions.

FL-521 RECOGNITION OF HYDROCHEMICAL PROCESSES IN THE UNCONFINED UPPER FLORIDAN AQUIFER USING ENVIRONMENTAL ISOTOPES, ANTHROPOGENIC TRACERS, AND GEOCHEMICAL REACTION MODELING

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: Brian G. Katz, Tallahassee

COOPERATING AGENCY: Federal Program

PROBLEM: There is a substantial lack of knowledge regarding the hydrochemical processes that control the observed water chemistry in unconfined and semiconfined areas of the Upper Floridan aquifer. As a result, it is difficult to assess the susceptibility of these areas to contamination from surface sources. In north and central Florida, where significant recharge to the aquifer occurs from precipitation or direct input from the surface through sinkholes, there is a high potential for widespread contamination of the aquifer system. To more completely understand the processes that affect the rate and movement of water and solutes (contaminants) from land surface to the unconfined upper Floridan aquifer system, information on water chemistry and hydrogeology needs to be integrated with more specialized analyses of ground water, such as environmental isotopes and selected anthropogenic organic compounds.

OBJECTIVE: (1) Collect specialized information on environment isotopes, anthropogenic tracers, and other water-quality parameters in unconfined and semiconfined areas of the Upper Floridan aquifer, and (2) integrate this information with hydrogeologic processes to better understand and quantify the geochemical processes that control the water chemistry along regional flow paths in these areas and to characterize waters moving vertically through the surficial aquifer and Upper Floridan aquifer.

APPROACH: Approximately 30 wells will be sampled along four selected flow paths in unconfined and semiconfined areas of the Upper Floridan aquifer and two vertical profiles in the surficial and the Upper Floridan aquifers. The relative age of water and its rate of movement at the six sites will be determined using analyses of chlorofluorocarbons in conjunction with detailed hydrogeologic information and analyses for tritium, deuterium, sulfur-34, carbon-13, carbon-14, and oxygen-18. Geochemical reactions along flow paths and vertical profiles will be evaluated from detailed chemical analyses of water from wells using WATEQF, NETPATH, and PHREEQE. Samples of rainfall will be collected at a station in central Florida four times per year and will be analyzed for environmental isotopes. Chlorofluorocarbons will be measured on recent precipitation collected in the field during selected rainfall events and on selected surface-water sources. Minerals in samples of aquifer material will be analyzed for selected environmental isotopes.

(FL-521)

PROGRESS: Twenty-eight wells were sampled along horizontal and vertical ground-water flow paths for chlorofluorocarbons, environmental isotopes (tritium, carbon-13, carbon-14, deuterium, oxygen-18, and sulfur-34), and major and minor dissolved inorganic constituents. A rainfall collector was set up at the Lake Barco site (north-central Florida) for seasonally composited samples for analysis of environmental isotopes.

PLANS FOR THIS YEAR: Determine mineralogy and isotopic composition of aquifer material. Information will be processed on environmental isotopes and major and minor dissolved constituents to begin geochemical modeling of reactions along horizontal and vertical flow paths. Continue to collect seasonally composited rainfall samples for analysis of selected environmental isotopes.

FL-523 CHARACTERISTICS OF THE SECONDARY POROSITY OF CARBONATE INJECTION ZONES AND CONFINING UNITS UNDERLYING PENINSULAR FLORIDA

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: September 1993

PRINCIPAL INVESTIGATOR: A.D. Duerr, Tampa

COOPERATING AGENCY: Florida Department of Environmental Regulation

PROBLEM: For approximately the past 20 years, cavern porosity has been assumed to be the principal type of secondary porosity in most of the carbonate injection zones underlying peninsular Florida. Also, it has been assumed that an apparently dense dolomite above and within injection zones contained no vertically interconnected secondary porosity. However, a recent study (Safko and Hickey, WRIR 91-4168) concluded that, along the east coast of Florida, fracture porosity is the principal type of secondary porosity both within the injection zones and in the dolomite rocks that lie above and within injection zones. Because of these findings, the traditional assumptions about cavern porosity and the lack of fracturing in the dolomites should be reassessed.

OBJECTIVE: To determine the principal types of secondary porosity that occur in carbonate injection zones and confining units at subsurface-injection sites throughout peninsular Florida.

APPROACH: The selected injection sites will use borehole television surveys and other borehole data to characterize secondary porosity of carbonate rocks penetrated by test holes. Borehole data used in the approach will include drilling records, and caliper, flowmeter, and temperature logs. The goal of this approach is to identify secondary porosity features that are spatially interconnected beyond the immediate vicinity of a borehole. Such secondary porosity features would have their origin in geologic processes rather than being caused by drilling.

PROGRESS: The project description, planning document, and preliminary report outline were completed. Borehole videos for city of Tampa wells near Plant City were examined to test methods for determining macroporosity features. Software programs were revised to allow digitized geophysical logs and macroporosity symbols to be printed at a uniform scale. Geophysical logs for five injection wells were digitized and borehole videos, lithologic logs, and other data were examined to characterize the macroporosity type of the carbonate rocks. A detailed written summary of three sites was completed.

PLANS FOR THIS YEAR: Borehole data from injection well sites in peninsular Florida will be gathered and organized. Geophysical logs will be digitized and borehole videos, lithologic logs, and other data will be examined to characterize the macroporosity at each site. A detailed description of each site will be prepared for future inclusion in the final report.

FL-524 EXTENT OF DIESEL-FUEL COMPONENTS IN GROUND WATER BENEATH AN ORDNANCE DISPOSAL AREA, AVON PARK AIR FORCE BASE, FLORIDA

DATE PROJECT BEGAN: October 1990

DATE PROJECT ENDS: March 1992

PRINCIPAL INVESTIGATOR: John T. Trommer, Tampa

COOPERATING AGENCY: MacDill Air Force Base

PROBLEM: Explosive ordnance is collected from the bombing range, piled in a bunker, sprayed with diesel fuel and ignited. Samples of water from one down-gradient well has showed detectable levels of benzene. The Florida Department of Environmental Regulation is concerned about the quality of the ground water beneath the disposal site.

OBJECTIVE: Evaluate the effects of diesel-fuel seepage on the quality of ground water in the zone around the treatment site. Contaminant plumes will be delineated and their chemical content will be assessed.

APPROACH: A network of shallow wells will be installed to measure water levels and determine the direction of ground-water flow. One deep well will be drilled onsite and the stratigraphy defined. Water-quality samples will be collected near the three existing monitor wells to determine the vertical distribution of diesel-fuel components. Water-quality samples will be collected using drive-point technology, to determine the areal distribution of the plume. A portable gas chromatograph will be used to screen samples in the field before samples are sent to the lab. Data will be used to produce maps showing the extent of contamination at the site.

PROGRESS: Twenty-three surficial-aquifer wells were installed to map the water table and determine the direction of flow. Approximately 100 samples were collected using a drive-point system, and were analyzed in the field using a portable gas chromatograph. A plume consisting of diesel-fuel components was delineated and mapped. Thirty additional samples were collected and sent for analysis to verify and quantify the field results. Report preparation began.

PLANS FOR THIS YEAR: Finish report and submit for review and approval.

FL-525 COMPARISON AND EVALUATION OF TECHNIQUES USED TO ESTIMATE STORMWATER RUNOFF FROM LOW-GRADIENT STREAMS IN WEST-CENTRAL FLORIDA

DATE PROJECT BEGAN: April 1991

DATE PROJECT ENDS: March 1995

PRINCIPAL INVESTIGATOR: John Trommer, Tampa

COOPERATING AGENCY: Sarasota County

PROBLEM: Low topographic relief, flat water-surface gradients, and prolonged or intense rainfall can produce recurring stormwater-flooding problems. Several techniques for estimating the volume of stormwater runoff exist; however, it is necessary to extrapolate empirical relationships beyond tested ranges to apply these techniques to the coastal lowlands of west-central Florida. The economic and environmental consequences of inaccurately estimating the volume of stormwater runoff can be substantial. If projects for carrying stormwater are underdesigned, property can be needlessly flooded. If projects are overdesigned, unnecessary tax dollars are spent for overabundant land acquisition, construction, and maintenance.

OBJECTIVE: Evaluate the reliability and accuracy of traditional techniques for estimating stormwater runoff by comparing computed estimates to field measurements. Define the range of watershed characteristics for which traditional techniques produce reliable results. Possibly develop techniques for estimating stormwater runoff from watersheds outside the range where traditional techniques can be applied.

APPROACH: Install six to eight new rainfall and discharge sites in low-gradient coastal basins in Sarasota County. Three or four basins would be developed basins and the remaining will be undeveloped basins. Use traditional engineering techniques and measured runoff results to estimate stormwater runoff for each basin. Using statistical techniques, evaluate the relative importance of basin characteristics on the accuracy of the estimated runoff.

PROGRESS: Installed stage-recording gages on streams in six small basins in Sarasota County. Took 27 periodic discharge measurements to compile data base for rating flow in the streams.

PLANS FOR THIS YEAR: Install rain gages in each basin above the stage-recording gages. Convert one of the six stream stage-recording gages to a real-time station that can be accessed by satellite telemetry. Continue making periodic measurements when conditions warrant.

FL-526 MODELING THE HYDRODYNAMICS AND SALINITY OF THE SEBASTIAN CREEK CONFLUENCE

DATE PROJECT BEGAN: August 1991

DATE PROJECT ENDS: September 1994

PRINCIPAL INVESTIGATOR: Robert A. Miller, Orlando

COOPERATING AGENCY: St. Johns River Water Management District

PROBLEM: Major surface-water inflows to the Sebastian Creek area occur from several directions. One canal tributary to Sebastian Creek is controlled, and waters released from the canal during periods of flooding could cause high discharges within Sebastian Creek. The results of such releases could have effects on the salinity of the Indian River that are difficult to anticipate.

OBJECTIVE: The objectives of this study are to (1) enhance the understanding of the hydraulics of the confluence, including the patterns of circulation within Sebastian Creek, (2) simulate the hydraulic and salinity changes within the Sebastian Creek under extreme discharges (both large and small); and (3) use the calibrated and verified model to simulate the full range of flow and the direction of flow at all gaged locations.

APPROACH: The hydraulics and salinity of the Sebastian Creek confluence will be modeled using the U.S. Geological Survey model for two-dimensional hydrodynamic/transport - SWIFT2D. After acceptance of the boundary conditions and parameter values through calibration and verification, the model will be used to simulate responses to varied discharge at the Sebastian Creek stations, and varied tidal and salinity conditions at the open boundaries. Because of the interest in the effects on salinity produced by freshwater entering the confluence from the west, most of the work will involve high freshwater discharges.

PROGRESS: The sites for data collection were selected, and permits for building stations were requested. Equipment for stations was ordered. Salinity verticals at 15 sites were collected.

PLANS FOR THIS YEAR: Build station structures and install equipment. Collect data for remainder of year. Start modeling effort.

FL-528 HYDROLOGY OF THE WOLF BRANCH CREEK SINKHOLE BASIN, LAKE COUNTY, EAST-CENTRAL FLORIDA

DATE PROJECT BEGAN: October 1991

DATE PROJECT ENDS: April 1994

PRINCIPAL INVESTIGATOR: Donna Schiffer, Orlando

COOPERATING AGENCY: Lake County Water Authority

PROBLEM: The Wolf Branch sink is a direct conduit through which surface water can enter the Upper Floridan aquifer, the principal source of water for public and domestic supplies in north Lake County, central Florida. Although the basin is undeveloped at present, the potential exists for degradation of the aquifer from surface contaminants from roads and some businesses in the area. Possible plans to protect the aquifer from this potential contamination include partial or total plugging of the sinkhole. However, the hydrology of the basin is not understood well enough to predict the degree and extent of flooding which may result from the plugging of the basin.

OBJECTIVE: (1) Quantify the surface-water hydrology (flow frequency, duration, and volume) of the Wolf Branch basin and estimate the possible effects of sinkhole plugging on flooding in the lower basin, assuming a normal range of rainfall and discharge conditions. (2) Define the general relation of the sinkhole to the ground-water hydrology of the area, and estimate the direction and rate of movement, and the dispersion of a conservative contaminant entering the Upper Floridan aquifer at the sinkhole. This information will help water managers better understand the present contamination potential and possible effects of alterations to the sinkhole or Wolf Creek basin.

APPROACH: (1) Evaluate surface-water hydrology by monitoring rainfall and surface-water discharge in the basin and determine a runoff-rainfall relation for the basin, then estimate long-term flow characteristics from existing rainfall record for the area. (2) Evaluate flooding potential resulting from plugging of the sink by evaluating the hydraulic conductivity of the sinkhole and estimating the rates at which the sinkhole would receive water when the conductivity is reduced by plugging. Based on these rates, estimate water levels in the basin using topographic maps and additional topographic data obtained during the study. (3) Inventory Upper Floridan aquifer wells in the basin, and summarize available data on ground-water quality and geology from previous studies. (4) Construct local potentiometric-surface maps of the Upper Floridan aquifer for both wet and dry periods and determine gradients in the area. (5) Determine direction and rate of travel, and dispersion (if possible) of potential contaminants through one or two dye studies.

PROGRESS: New project.

PLANS FOR THIS YEAR: Install rain-gage and stream-gage sites. Inventory ground-water wells in basin. Develop rainfall-runoff relation using data collected this year. Conduct dye study to determine ground-water flow paths.

FL-529 ESTIMATED QUANTITY AND QUALITY OF UPPER FLORIDAN AQUIFER DISCHARGE TO THE MAIN STEM OF THE LOWER ST. JOHNS RIVER, NORTHEAST FLORIDA

DATE PROJECT BEGAN: August 1991

DATE PROJECT ENDS: February 1993

PRINCIPAL INVESTIGATOR: Rick M. Spechler, Orlando

COOPERATING AGENCY: U.S. Army Corps of Engineers

PROBLEM: The quantity and quality of natural ground-water inflow to the lower St. Johns River is unknown. This has caused difficulties with the implementation of State regulatory agencies' management plans to control point and nonpoint sources of various types of man-derived effluents that are discharged to the lower St. Johns because some of the man-derived constituents, such as chloride and sulfate, are also present in Floridan ground water that leaks into the river. It is believed that in some areas, ground-water inflow from the Upper Floridan aquifer system is likely to be mineralized. It is possible that some constituent loads in the river caused by Upper Floridan ground-water inflow are greater than that caused by man.

OBJECTIVE: Estimate the quantity and quality of Upper Floridan aquifer ground water that discharges naturally (upward leakage and spring flow) into the main stem of the lower St. Johns River.

APPROACH: Obtain spring-flow data and confining bed leakances from existing, approved regional aquifer systems analysis (RASA) ground-water flow models. Use aquifer-river and aquifer-water-table head differences and leakance values to estimate upward leakage from the Upper Floridan aquifer. Use existing maps of water quality in the Upper Floridan to estimate the likely range of concentrations of selected chemical constituents in the inflow waters. Compute constituent loading for selected reaches of the lower St. Johns River using computed inflow rates and estimates of constituent concentrations.

PROGRESS: New project.

PLANS FOR THIS YEAR: Complete literature search. Collect, compile, and analyze hydrogeologic data. Complete most illustrations and tables.

FL-530 LOCATIONS OF PREVIOUSLY UNDETERMINED UPPER FLORIDAN AQUIFER DISCHARGE TO THE ST. JOHNS RIVER, JACKSONVILLE AREA AND VICINITY, NORTHEAST FLORIDA

DATE PROJECT BEGAN: October 1991

DATE PROJECT ENDS: March 1994

PRINCIPAL INVESTIGATOR: Rick M. Spechler, Orlando

COOPERATING AGENCY: City of Jacksonville

PROBLEM: Potentiometric-surface maps of the Upper Floridan aquifer system show extensive depressions along the St. Johns River south of Jacksonville and in the vicinity of Green Cove Springs. Previous notions of other natural spring flows or upward leakage from the Upper Floridan that would help explain the potentiometric-surface depressions have been dismissed because of the presence of relatively thick confining beds that should hydraulically isolate the Floridan aquifer system from overlying aquifers and surface-water bodies. However, it is possible there are unknown submerged springs as well as a substantial amount of diffuse upward leakage.

OBJECTIVE: (1) Locate and attempt to quantify Upper Floridan aquifer system discharges to the St. Johns River in the Jacksonville-Greencove reach. (2) Determine the quality of Upper Floridan aquifer system water that is being discharged as springs or upward leakage.

APPROACH: Refine maps of the Upper Floridan potentiometric surface in order to verify and better define the cone of depression in the Jacksonville-Greencove reach. Collect subsurface geologic and structural information by geophysical methods. Attempt to locate submerged springs by using remote sensing and by performing vertical and horizontal temperature and specific conductivity traverses to determine significant differences in river-water quality that may be due to ground-water discharge.

PROGRESS: New project.

PLANS FOR THIS YEAR: Complete literature search. Conduct remote sensing and marine seismic reflection surveys, and analyze data.

*U.S. Government Printing Office: 1992 — 631-117/40015