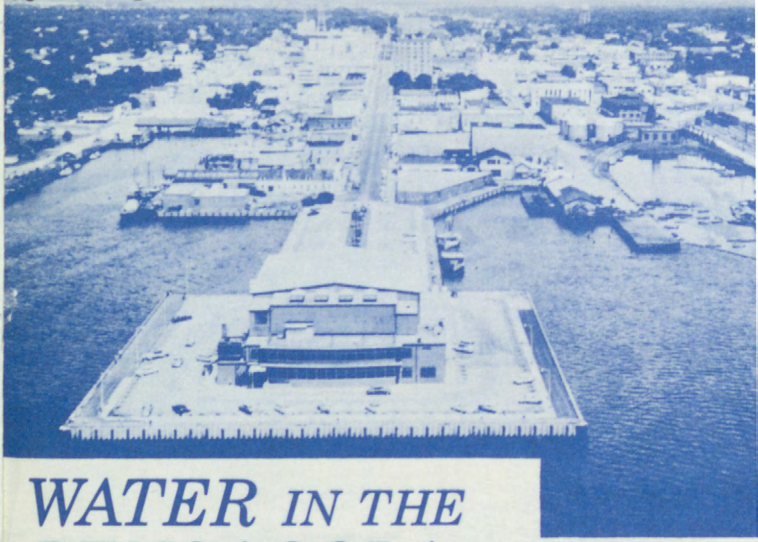
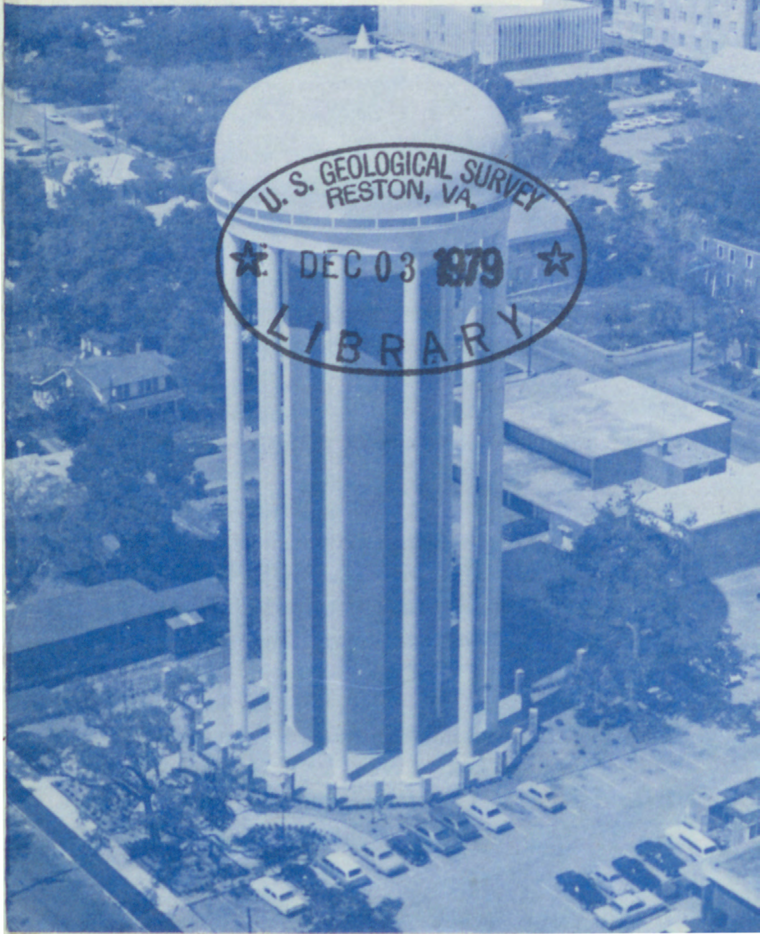


# *WATER* IN THE *PENSACOLA, FLORIDA,* AREA



UNITED STATES DEPARTMENT OF THE INTERIOR
CECIL D. ANDRUS, Secretary

GEOLOGICAL SURVEY
H. William Menard, Director

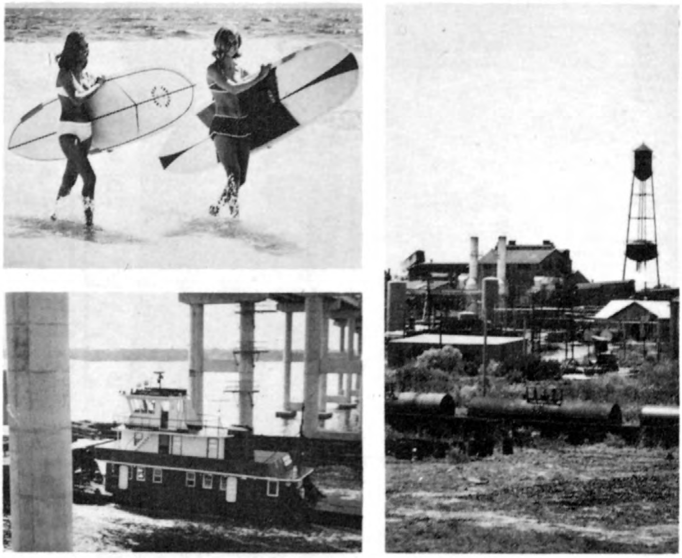
TEXT PREPARED IN COOPERATION WITH THE
CITY OF PENSACOLA

U.S. GEOLOGICAL SURVEY
Water-Resources Investigations
Open-File Report 79-89

Revised by Henry Trapp, Jr., U.S. Geological Survey from Florida Department of Natural Resources, Bureau of Geology, 1965 Leaflet No. 3 by R. H. Musgrove, J. T. Barraclough, and R. G. Grantham, U.S. Geological Survey.

# WATER IN THE PENSACOLA, FLORIDA, AREA

The Pensacola area is endowed with a vital and bountiful natural resource—WATER. Available in large quantities, it is easily obtained, is remarkably soft, and contains very small amounts of dissolved minerals. The quality of much of this water is far better than that required for public supply and for many industries.

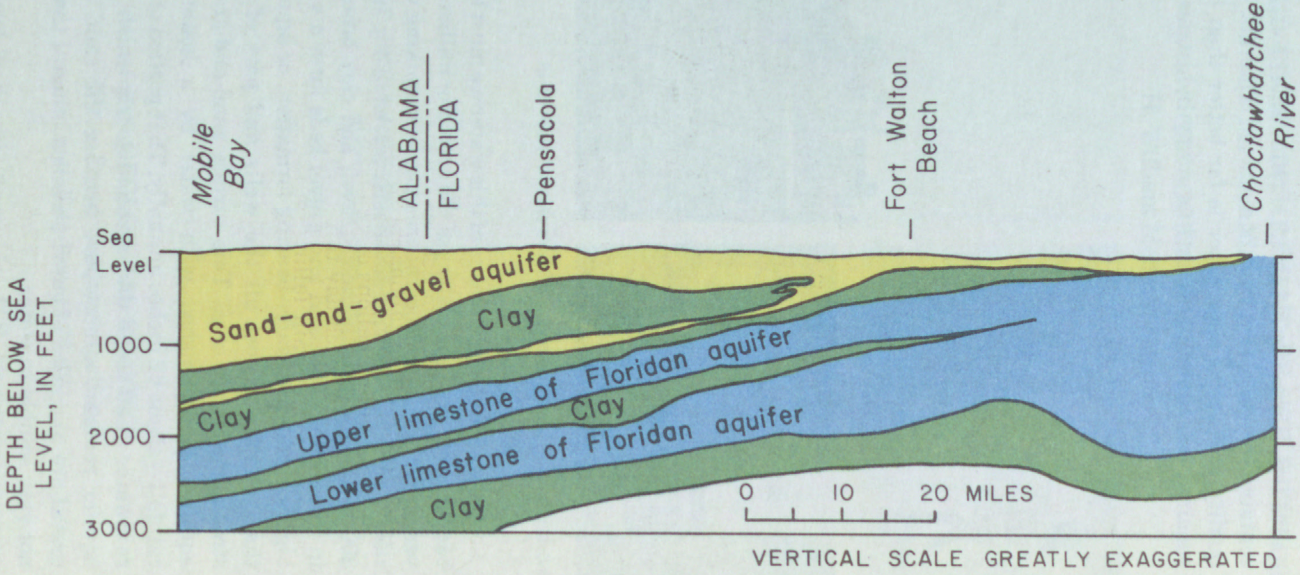


Industry, shipping, and recreation . . . there's plenty of water for all.

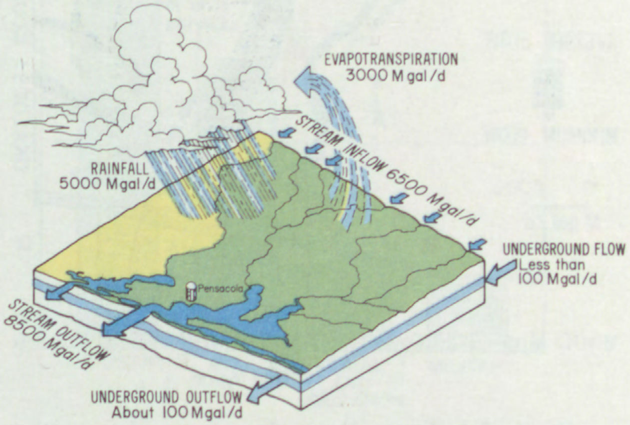
To explain the occurrence of this water we must look back into the geologic history of the area. For millions of years part of the gulf coastal area has been sinking very slowly. This lowered area has been covered to depths of 300 to 1,000 feet with sand, gravel, and clay brought in by streams. The sand and gravel beds form a vast, highly productive water-bearing formation, or aquifer, that supplies almost all the wells and part of the streamflow in the area. This surface sand-and-gravel aquifer is replenished with water by a bountiful rainfall—about 62 inches annually. That portion of the rainwater that seeps underground to replenish the aquifer remains almost pure because the sand and gravel are composed of quartz, a silica mineral that is not very soluble in water.

Beneath the sand-and-gravel aquifer are two thick strata of limestone that make up the extensive Floridan aquifer. They, too, contain large amounts of water, but for several reasons very little water is used from these

# GEOLOGIC SECTION ALONG THE GULF COAST

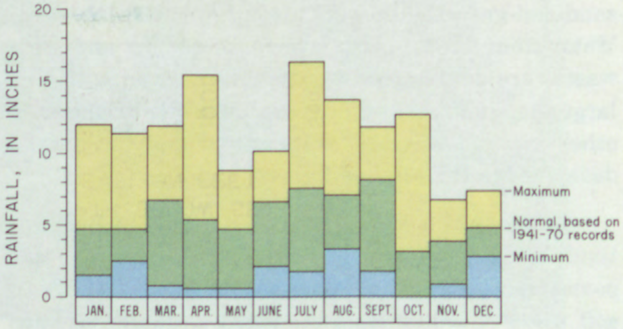


limestones in Escambia County: they are deeper than the sand-and-gravel aquifer, the water contains more dissolved minerals, and, in the area around Pensacola, they contain saltwater. The lower limestone is being used for disposal of industrial wastes in Escambia and Santa Rosa Counties. The natural formation water in the lower limestone is salty in the southern parts of the two counties.



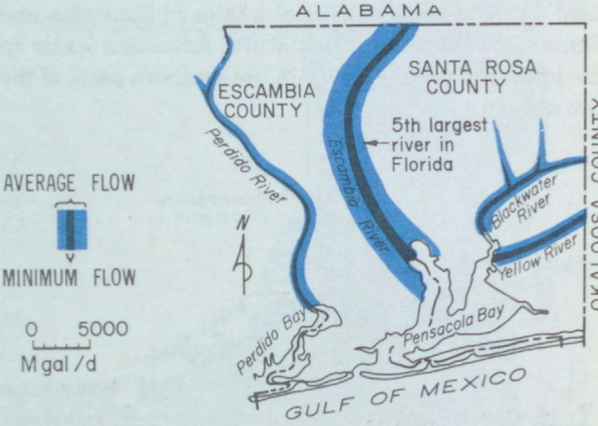

WATER BUDGET
ESCAMBIA AND SANTA ROSA COUNTIES

The Pensacola area receives freshwater from three sources—rain falling directly on the area, streams flowing in from adjacent areas, and flow through the underground system. Escambia and Santa Rosa Counties receive each year on the average 62 inches of rain, which amounts to 5 billion gallons of water per day. Streams bring in 6½ billion gallons per day from adjacent areas. About 0.1 billion gallons of ground water flow into the Pensacola area each day through the limestone strata that are fed by rain falling on the northern parts of




MONTHLY RAINFALL AT PENSACOLA

Escambia and Santa Rosa Counties and on southern Alabama. The sand-and-gravel aquifer, recharged by local rainfall, supplies most of the ground water being used.

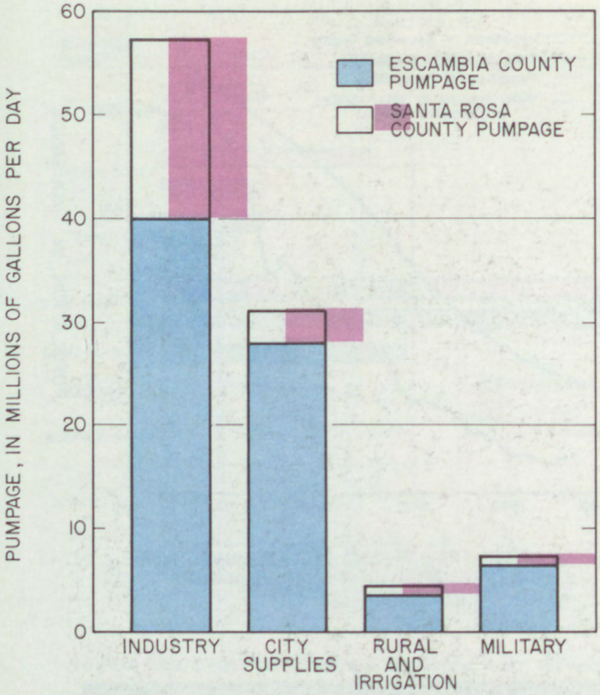



8500 Mgal/d FLOWS INTO BAYS FROM FOUR MAJOR RIVERS

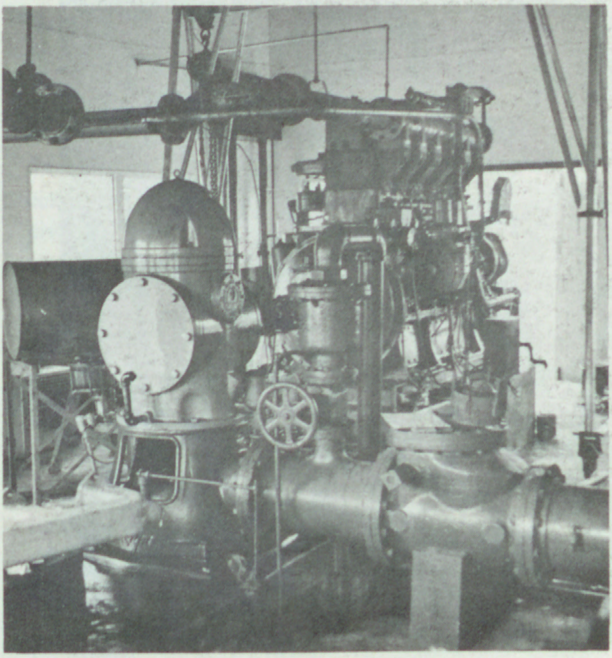
Of the 5 billion gallons of water per day, on the average, that falls as rain on Escambia and Santa Rosa Counties, about 3 billion is returned to the atmosphere through the processes of evaporation and transpiration (water given off by plants and trees). Two billion gallons of this rainwater enters the streams as overland flow or as seepage from the ground and runs off into the estuaries. Streams receive about two-thirds of their flow from the ground, resulting in stable flows even during dry seasons. Only a small part of the rainwater leaves the area as underground flow.

Although huge quantities of water are used every day, vast amounts remain untapped. Most of the 101 million gallons of fresh ground water used each day in Escambia and Santa Rosa Counties is taken from the sand-and-gravel aquifer in the southern half of the area. Water from streams also is used for cooling and some wastes are discharged into the rivers. Even with this large use, additional water is available. Pensacola, as do other communities, derives its water supply from wells developed in the sand-and-gravel aquifer.

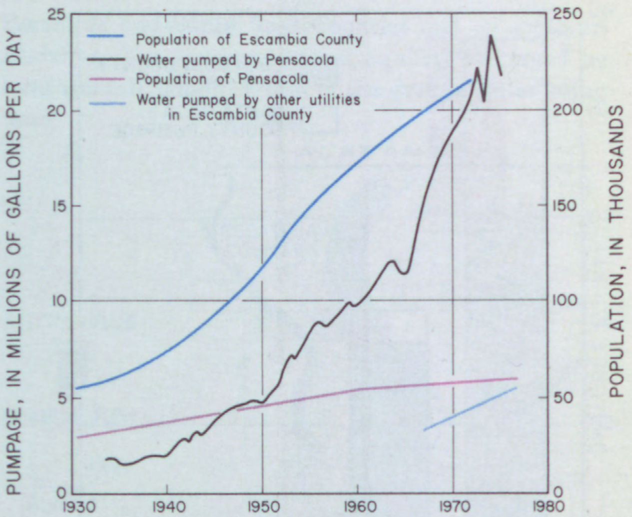
In the northern half of the area only a comparatively small quantity of water is used. Almost all of this comes from wells, but much of the billion gallons of clear, soft water that flow from the small tributary streams each day could also be used.




GROUND-WATER PUMPAGE BY VARIOUS CLASSES OF WATER USERS IN ESCAMBIA AND SANTA ROSA COUNTIES, 1975

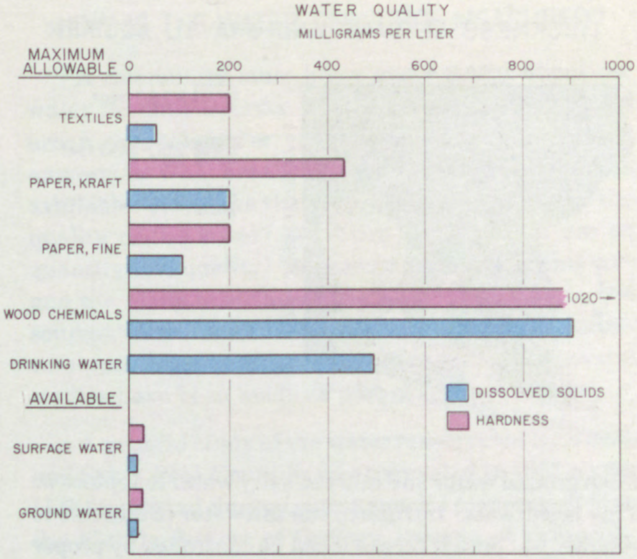


Most of Pensacola's public-supply wells can pump 2000 gallons per minute.




POPULATION TRENDS AND WATER PUMPED FOR PUBLIC SUPPLY IN PENSACOLA AND ESCAMBIA COUNTY

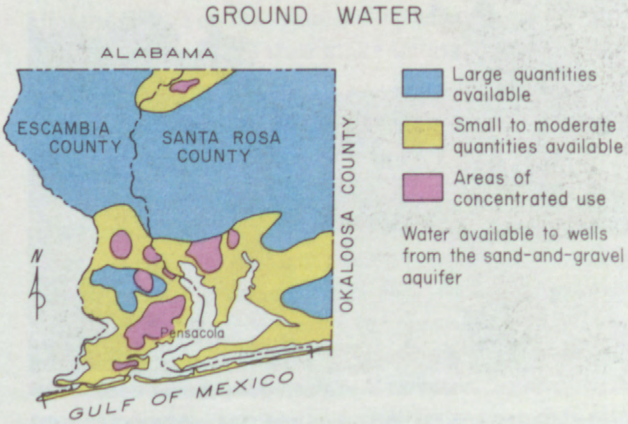
Gaging a stream.



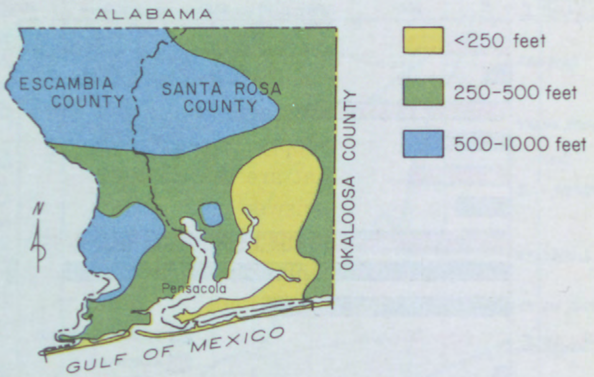

MAXIMUM ALLOWABLE CONCENTRATIONS OF DISSOLVED SOLIDS AND HARDNESS IN WATER FOR VARIOUS USES COMPARED TO CONCENTRATIONS IN THE AVAILABLE WATER

Are there any problems associated with developing and using this supply of water? There certainly are. Excessive withdrawals of ground water can dry up streams, consume what could be a renewable resource, induce saltwater encroachment, and, under certain conditions, cause land subsidence and flooding. Unwise handling of wastes or industrial products can contaminate both ground water and streams. Works of man frequently have detrimental effects on our water resources.

For the immediate future in the Pensacola area, the dangers of excessive withdrawals of ground water are confined to small areas of concentrated pumping. Excessive pumping in isolated areas has lowered the level of



THICKNESS OF SAND-AND-GRAVEL AQUIFER




fresh ground water and allowed salty water to replace it. This is saltwater intrusion; the saltwater is difficult to remove, but once it occurs it can be controlled by proper management. There is no evidence of significant advance of saltwater into the aquifer around Pensacola in recent years.

Industrial wastes and drainage from landfills, leaky sewers, and septic tanks may seep underground and contaminate water wells and streams. Storm runoff carries a variety of pollutants and also sediment from new construction sites into surface bodies of water. One municipal well was abandoned in Pensacola because part of the sand-and-gravel aquifer was contaminated by industrial waste. Many years are required for an aquifer to recover from contamination. It also may take many years of diligent effort and large sums of money to clean up a stream, bayou, or bay after it has received excessive wastes.

Streams and bayous in the Pensacola area are vulnerable to pollution by storm runoff.

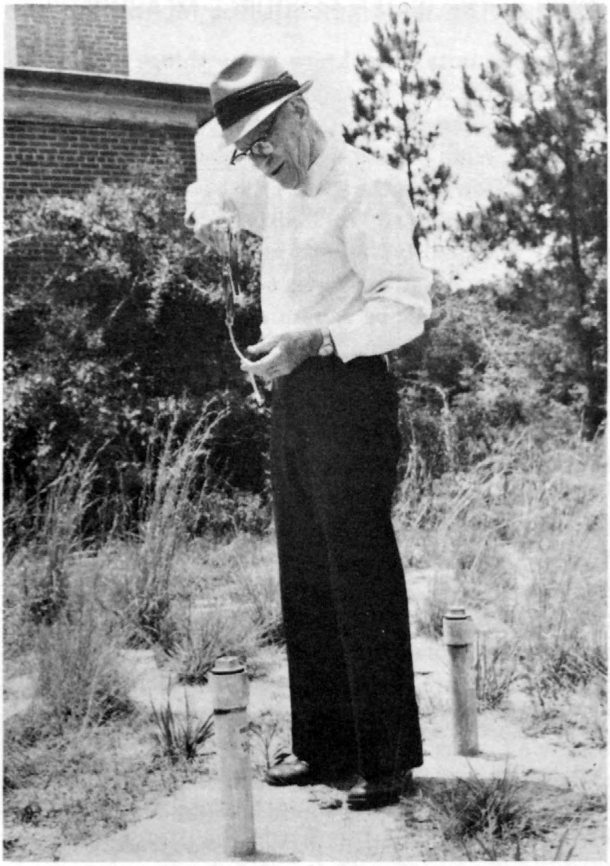
## HOW IS THE WATER RESOURCE MEASURED?

A community must know many things about the water resource in order to plan orderly industrial and urban expansion. For example, they must know the answers to: What are the sources of water? How much is available? How does the supply fluctuate? What is the quality of the water? What are the effects of use on quantity and quality? To answer questions of this sort and the many other questions pertaining to water resources, there must be a planned program of water-resources investigations. In the Pensacola area, several studies have been made as part of such a program.

A general study of the water resources of Escambia and Santa Rosa Counties was completed in 1962 by the U.S. Geological Survey with financial cooperation from the Florida Bureau of Geology, the city of Pensacola, Escambia County, and Santa Rosa County. The U.S. Geological Survey has been conducting a more detailed study of the hydrology of the sand-and-gravel aquifer in southern Escambia County in cooperation with the city of Pensacola from 1970 to the present (1979). In addition, the Survey has long-term cooperative agreements with Escambia County, Florida Department of Environmental Regulation, the Florida Department of Transportation, and the Northwest Florida Water Management District to gage and sample streams and measure water levels in wells, and with the Florida Department of Environmental Regulation to monitor the effects of deep-well waste injection.

For the long term, the limit to the quantity of water available to the Pensacola area depends on the adverse effects on the environment that can be tolerated and the price, in dollars, that people in the area are willing to pay for additional supplies. Hydrologic studies can predict the effects on the system of withdrawing water from various sources, and thus make informed choices possible.

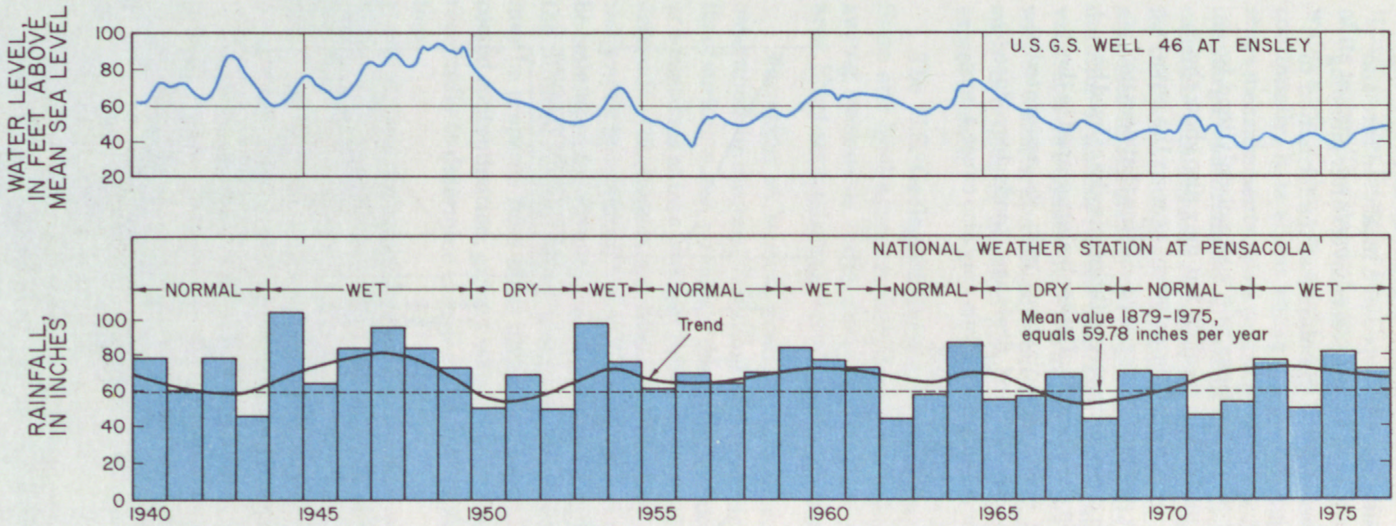
*Mapping and measuring water-bearing formations:* We can only imagine the confusion that would exist if there were no maps or plans of Pensacola's waterworks showing the source of water and the location and size of the underground pipe system. Community life might go smoothly until a break in a line occurred or an expansion of this system was necessary to take care of a population increase. At that time many questions would have to be answered before progress could be made, some of which are: Where are the pipes? Are they large enough to allow



Otto Reichmann, Jr., of Pensacola has measured water levels in observation wells for the U.S. Geological Survey since 1942.

for the expansion? How long has the system been here? Do the pipes leak? Where does the water come from and in what amounts? Difficult as these questions are to answer, those concerned with a natural water-resource system that serves a complex industrial society are many times more difficult. The earth structure that serves both as a storage reservoir and as a distribution system is mapped by piecing together information from many sources. The services of experienced hydrologists, geologists, engineers, and chemists are necessary to identify and measure the extent and water-bearing characteristics of the materials that make up the earth.

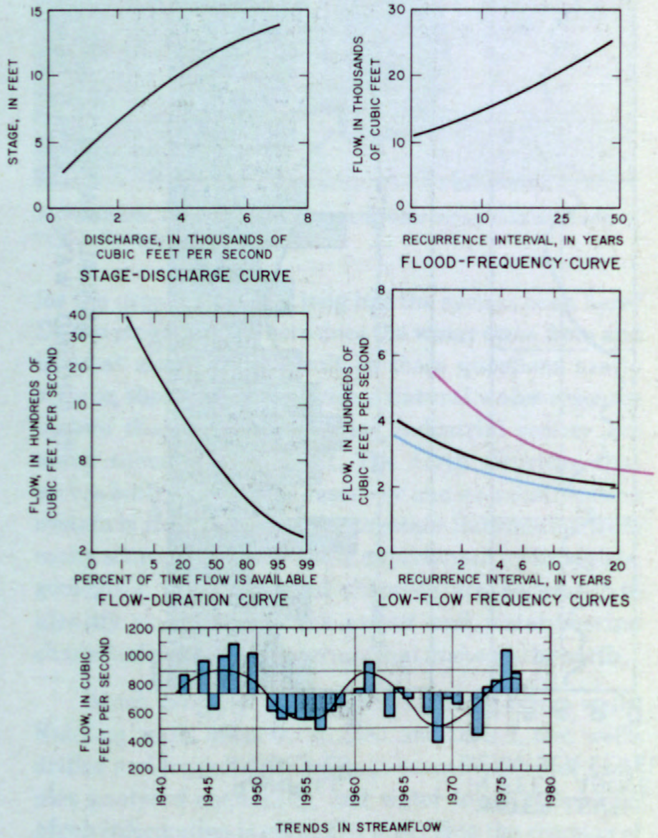
Much geologic information is obtained from wells. Existing wells must be studied and tested, test wells drilled and logged, drill cuttings examined, water samples analyzed chemically, and water levels measured. Much information is gained by observing the reaction of ground-water levels to rainfall and to pumping. When a




ANNUAL RAINFALL AND FLUCTUATIONS
IN GROUND-WATER LEVELS NEAR PENSACOLA, 1940-1976

well is pumped the water level underground lowers to form a depression, similar in shape to a cone, but with the point down. The rate and amount of this lowering while the well is being pumped at a measured rate and the rate at which the water level recovers after pumping ceases are measures of the ability of the formation to transmit and store water.

Water-level fluctuations in a well not only tend to parallel fluctuations in rainfall, but may also show the effects of people's use of water or changes in the environment. For example, a long-term decline that does not coincide with a decline in precipitation may be caused by an increase in the quantity of water being pumped in the surrounding area. Urbanization, with its associated construction, paving, and drainage, tends to reduce ground-water recharge, and thus may also cause a long-term decline in water levels.




THE BEHAVIOR OF A STREAM
(PERDIDO RIVER AT BARRINEAU PARK, FLORIDA)

*The behavior of a stream:* Certain physical aspects of a stream must be measured at least several times over a period of years in order to determine how much water it carries, how its water level fluctuates, and the quality of its water. The stage of a stream, or the height of its water surface above an established datum, is changing continually. It is either rising or falling. Continuous stage measurements over a period of time, together with discharge measurements at various stages, are used to calculate a continuous record of the stream's discharge for that period. Stage and discharge measurements are also used in calculating the frequency of floods and the duration of various rates of discharge. Recurrence interval graphs are used to show the average interval of time within which a hydrologic event of given magnitude, such as a flood or low-flow period, will be equalled or exceeded once.

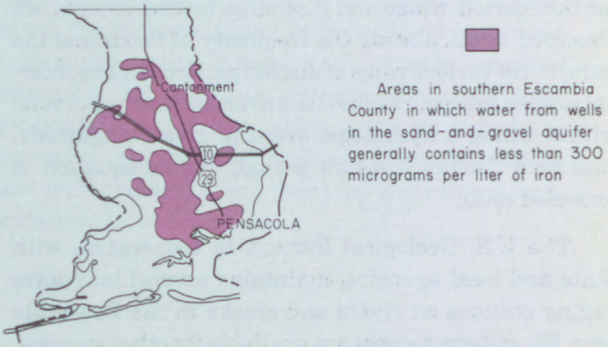
The U.S. Geological Survey, in cooperation with State and local agencies, maintains several long-term gaging stations on rivers and creeks in the Pensacola area. Short-term records are available for other streams.

*Variations in mineral concentration of water:* To determine the seasonal variations in the chemical quality of surface water, samples of the water are taken daily or sometimes at less frequent intervals for analysis. To determine the chemical quality of ground water, several wells must be sampled, but often only one sample need be collected from each well for analysis. Maps showing the mineral concentration of the water in an aquifer may be prepared from these analyses. In areas of suspected contamination, ground water must be analyzed repeatedly to determine changes in mineral concentration.

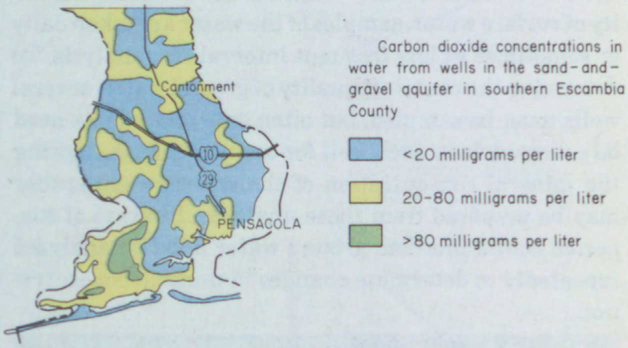
Pensacola's Water Production Technician Tommy Stevens testing a water sample at a city well.

Although ground water in the Pensacola area contains a much lower concentration of dissolved mineral matter than most ground water throughout the world, there are problems of high iron concentration, corrosiveness, and, in places, the water is contaminated or is in danger of being contaminated.

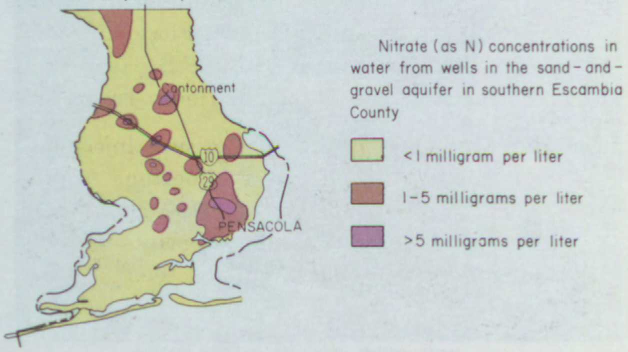
IRON CONCENTRATIONS IN GROUND WATER




CARBON DIOXIDE CONCENTRATIONS IN GROUND WATER




NITRATE (as N) CONCENTRATIONS IN GROUND WATER



Some of the iron in ground water originates from the corrosion of well casing, and some is naturally present. Detailed sampling of water from wells in the southern part of Escambia County shows that the ground water in some areas is free of excessive iron. High concentrations of carbon dioxide are associated with corrosiveness. Ground water in the southwestern part of Escambia County was found to have especially high concentrations of carbon dioxide. Although nitrate is an indicator of contamination by human, animal, or industrial wastes, it is not a dependable one—it may occur naturally. Nitrate is generally absent or is low in water from rural areas in southern Escambia County; rarely does it exceed the limit of 10 milligrams per liter as nitrogen recommended by the Florida Department of Environmental Regulation for drinking water. In rural areas, water may be contaminated from septic tanks or livestock operations.

## AVAILABILITY OF ADDITIONAL INFORMATION

Additional information on the water resources of the Pensacola area is contained in the following reports by personnel of the U.S. Geological Survey:

Availability of Ground Water for Public-Water Supply in Central Southern Escambia County, Florida, Interim Report, July 1972: U.S. Geol. Surv. open-file rept., by Henry Trapp, Jr.

Availability of Ground Water for Public-Water Supply in the Pensacola Area, Florida, Interim Report, June 1971: U.S. Geol. Surv. open-file rept., by Henry Trapp, Jr.

Geology of Escambia and Santa Rosa Counties, Western Florida Panhandle: Fla. Geol. Surv. Bull. No. 46, by O.T. Marsh.

Hydrology of the Sand-and-Gravel Aquifer in Central and Southern Escambia County, Florida, Preliminary report—November 1973: U.S. Geol Surv., Open-File Rept. FL-74-027, by Henry Trapp, Jr.

Monitoring Regional Effects of Pressure Injection of Industrial Wastewater in a Limestone Aquifer: Ground Water, v. 13, no. 2, p. 197–208, by G.L. Faulkner and C.A. Pascale. (Reprints available through U.S. Geol. Surv., Tallahassee.)

Water Resources Data for Florida, Water Year 1975, Vol. 1, Northern Florida: U.S. Geol. Surv. Water Data Rept. FL-751-1, by U.S. Geol. Surv.

Water Resources of Escambia and Santa Rosa Counties, Florida: Fla. Geol. Surv. Rept. of Inv. No. 40, by R.H. Musgrove, J.T. Barraclough, and R.G. Grantham.

Water Resources Records of Escambia and Santa Rosa Counties, Florida: Fla. Geol. Surv. Inf. Circ. No. 50, by R.H. Musgrove, J.T. Barraclough, and R.G. Grantham.

These reports are available in many libraries and the following office:

U.S. Geological Survey
325 John Knox Rd., Suite F-240
Tallahassee, FL 32303

For use of those readers who may prefer to use metric (SI) units rather than inch-pound units, the conversion factors for the terms used in this report are listed below:

| Multiply inch-pound unit | By | To obtain metric (SI) unit |
|---|---|---|
| inch | | millimeter |
| foot | 25.4 | meter |
| cubic foot per second | .3048 | cubic meter per second |
| gallon per minute | .0282 | cubic meter |
| | .00006309 | per second |
| millions of gallons | | cubic meter |
| billions of gallons | 3,785 | cubic meter |
| million gallon | 3,785,000 | |
| per day (Mgal/d) | | cubic meter per second |
| billion gallon | .04301 | |
| per day (Bgal/d) | 43.01 | cubic meter per second |

As the Nation's principal conservation agency, the Department of the Interior has responsibility for most of our nationally owned public lands and natural resources. This includes fostering the wisest use of our land and water resources, protecting our fish and wildlife, preserving the environmental and cultural values of our national parks and historical places, and providing for the enjoyment of life through outdoor recreation. The Department assesses our energy and mineral resources and works to assure that their development is in the best interests of all our people. The Department also has a major responsibility for American Indian reservation communities and for people who live in Island Territories under U.S. administration.

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

1879 · CENTENNIAL · 1979 · U.S. GEOLOGICAL SURVEY