THE SHALLOW AQUIFER - A PRIME FRESHWATER RESOURCE IN EASTERN PALM BEACH COUNTY, FLORIDA

U.S. GEOLOGICAL SURVEY

Water-Resources Investigations 76-21

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Prepared in cooperation with the
PALM BEACH COUNTY BOARD OF COMMISSIONERS and
CENTRAL AND SOUTHERN FLORIDA FLOOD CONTROL DISTRICT

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16. Abstracts

The shallow aquifer underlies all of Palm Beach County and is the source of almost all fresh-water supplies in the eastern part of the county. It consists of mixtures of sand, shell sandstone, and limestone. In this area the concentration of dissolved solids in the ground water usually does not exceed 500 milligrams per litre.

A section of cavity-riddled limestone and other permeable rocks is located several miles inland and extends north to south almost the entire length of the county. This section yields up to 2,000 gallons per minute (130 litres per second) of water to large wells and offers an excellent potential for the development of future ground-water supplies.

Sea-water intrusion into the shallow aquifer is a potential threat to several coastal well fields. The wells nearest the coast are most vulnerable.

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UNITED STATES DEPARTMENT OF THE INTERIOR

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FACTORS FOR CONVERTING ENGLISH UNITS TO INTERNATIONAL SYSTEM (SI) UNITS

Multiply English Units	By	To obtain metric units
feet (ft)	0.3048	metres (m)
miles (mi)	1.609	kilometres (km)
gallons per minute (gal/min)	0.06309	litres per second (l/s)

THE SHALLOW AQUIFER--A PRIME FRESHWATER RESOURCE IN EASTERN PALM BEACH COUNTY, FLORIDA

By

H. G. Rodis and L. F. Land

ABSTRACT

The shallow aquifer underlies all of Palm Beach County and is the source of almost all fresh-water supplies in the eastern part of the county. It consists of mixtures of sand, shell sandstone, and limestone. In this area the concentration of dissolved solids in the ground water usually does not exceed 500 milligrams per litre.

A section of cavity-riddled limestone and other permeable rocks is located several miles inland and extends north to south almost the entire length of the county. This section yields up to 2,000 gallons per minute (130 litres per second) of water to large wells and offers an excellent potential for the development of future ground-water supplies.

Sea-water intrusion into the shallow aquifer is a potential threat to several coastal well fields. The wells nearest the coast are most vulnerable.

INTRODUCTION

The shallow aquifer is the most important source of fresh water in Palm Beach County, southeast Florida (see figure 1). It provides more than 90 percent of all drinking water, virtually all water used by industry and for golf-course irrigation, and a large percentage of water needed for growing crops, including citrus, in the east part of the county. The deeper Floridan aquifer system yields only brackish or salty water. Although canals and lakes in the east part of the county are other sources of fresh water, many receive runoff from urban areas. In some cases contaminants such as sewage effluents and industrial wastes have rendered the water unfit for recreation or as a source of potable water. Canal water (from Lake Okeechobee) is used to irrigate sugar cane and winter vegetables in the large agricultural areas south and southeast of Lake Okeechobee.

The authors thank the Palm Beach County Board of Commissioners and officials of the Central and Southern Florida Flood Control District for their support in this water resources investigation.

SHALLOW AQUIFER

Occurrence and Availability of Water

The shallow aquifer underlies the entire county. Using recent test drilling data the configuration of its base is shown by contour lines on figure 2. The aquifer's thickness ranges from 75 ft (23 m) in the west to 250 ft (76 m) at some locations in the east.

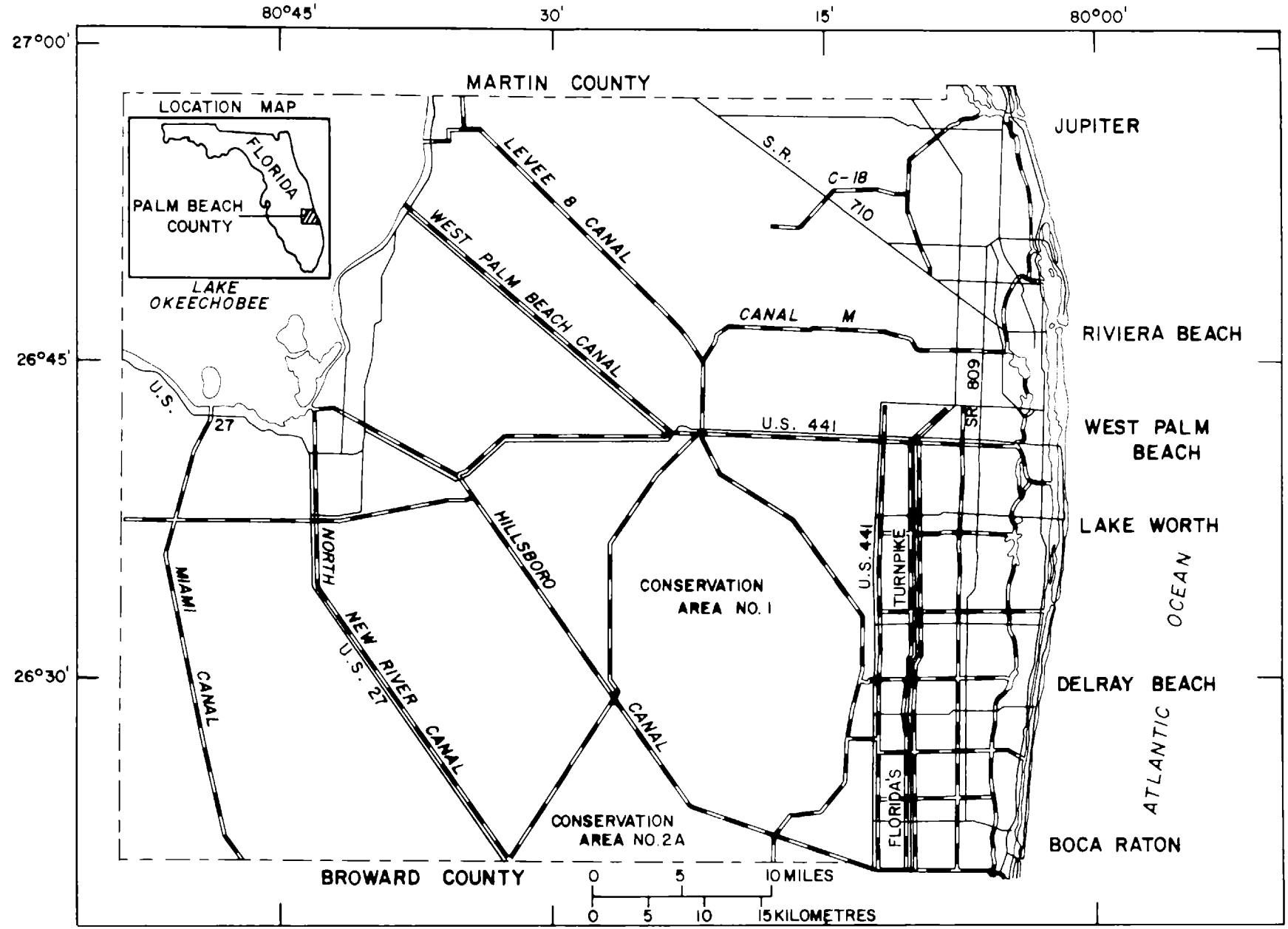


Figure 1.--Location of Palm Beach County and major roads, canals and cities.

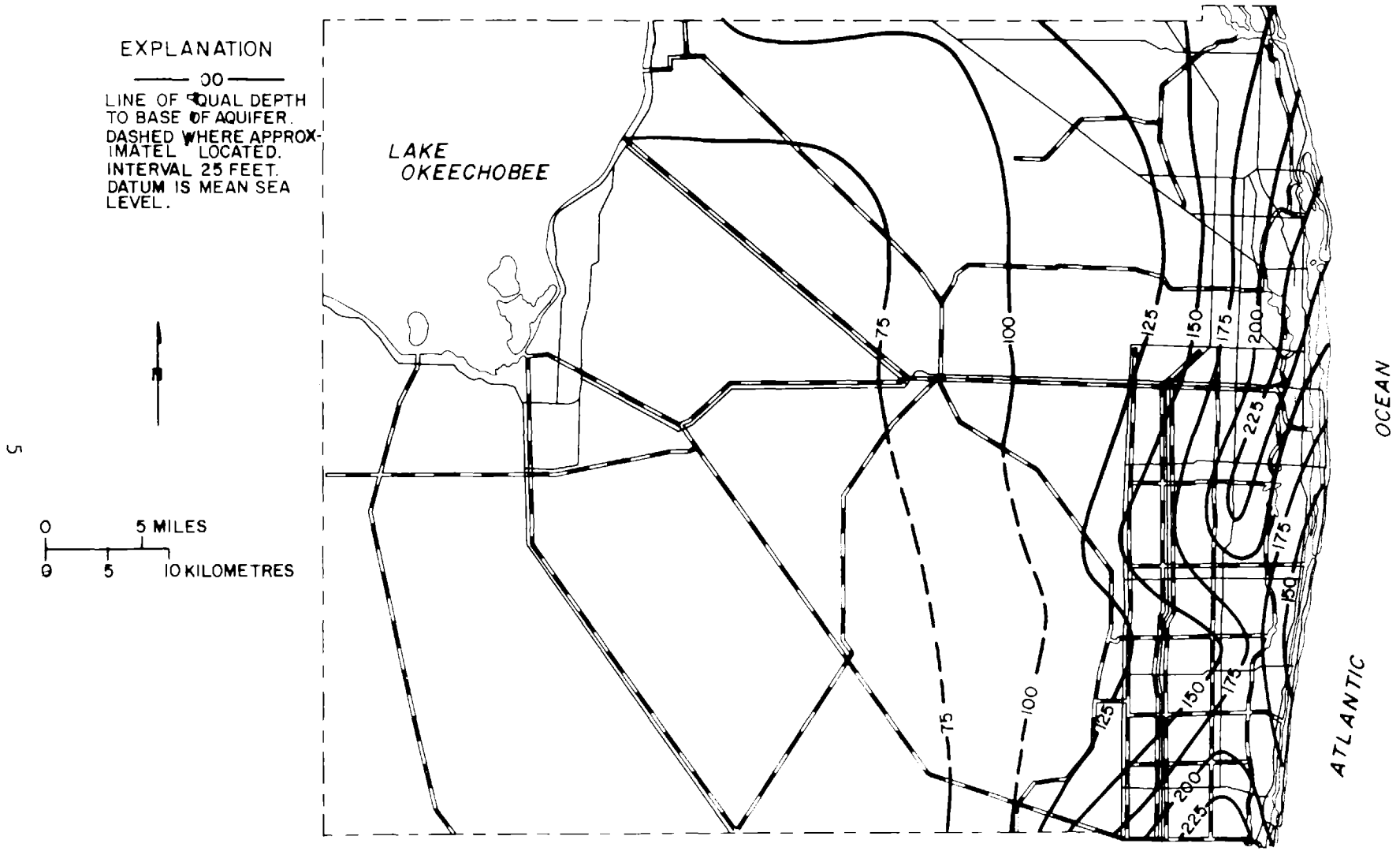


Figure 2.--Configuration and altitude below sea level of the shallow aquifer's base.

In most of the county the shallow aquifer consists of sand, sandstone, limestone, and shells, or mixtures of these materials. Locally, in an elongate north-south area several miles inland from the coast (fig. 3), the aquifer is composed of cavity-riddled sandy limestone. This cavity-riddled sandy limestone is the most permeable part of the shallow aquifer and offers excellent potential for the development of large quantities of water.

The shallow aquifer is underlain by a section of less permeable sediments composed primarily of fine sand, marl and silt. This section contains discontinuous zones of limestone and shell that are capable of yielding minor quantities of water to wells. The bottom of the less permeable section conforms with the top of a green, shelly clay that occurs at depths of more than 400 ft (120 m) in the southeast corner of the county and almost 175 ft (53 m) in the west part. The green clay of the Hawthorn Formation forms the main confining unit that separates the water in the shallow sediments from that in the Floridan aquifer system.

Nearly all wells in the shallow aquifer are between 30 and 250 ft (9 and 76 m) deep. In the southeastern part of the county and along the section of cavity-riddled rock, wells yield as much as 2,000 gal/min (130 l/s). Northward along the coast, and to the west where the aquifer becomes less permeable, wells commonly yield less than 500 gal/min (32 l/s). Despite the changes in permeability, the shallow aquifer can yield sufficient water to wells for household or lawn sprinkling purposes nearly everywhere.

Ground-Water Movement and Fluctuations

Water in the shallow aquifer generally occurs under water-table conditions. The ground-water flow is generally toward the coast in the east half of the county and to the south in the western half (fig. 4). The high water level in the Corbett Wildlife Area and in the conservation areas influences the general movement of water in the central and eastern parts of the county. Regulation of water levels in canals by water management agencies and the operation of high capacity supply wells causes local variations in the regional flow pattern. The shallow aquifer is replenished primarily by local rainfall. During the wet season (June-October) the water table rises 2 to 4 ft (0.6 to 1.2 m) in remote areas and, in places, reaches land surface contributing to local flooding or the prevalence of swampy conditions. During the day season (November-May), the water table slowly declines because of the high rate of evapotranspiration, which constitutes the greatest loss of water from the shallow aquifer. In municipal well fields where the aquifer is heavily pumped, the water table fluctuates as much as 10 ft (3 m) between the wet and dry seasons. Hydrographs for October 1973 - September 1974 are shown in figure 5 for an observation well 10 mi (16 km) west of Riviera Beach, and an observation well in Riviera Beach's well field.

Quality of Water

Water in the shallow aquifer generally becomes more mineralized (higher in dissolved solids) with depth and distance inland. The concentrations and areal variations are shown in figure 6. For areas A and B the aquifer generally yields water of less than 500 mg/l dissolved solids. Exceptions are coastal

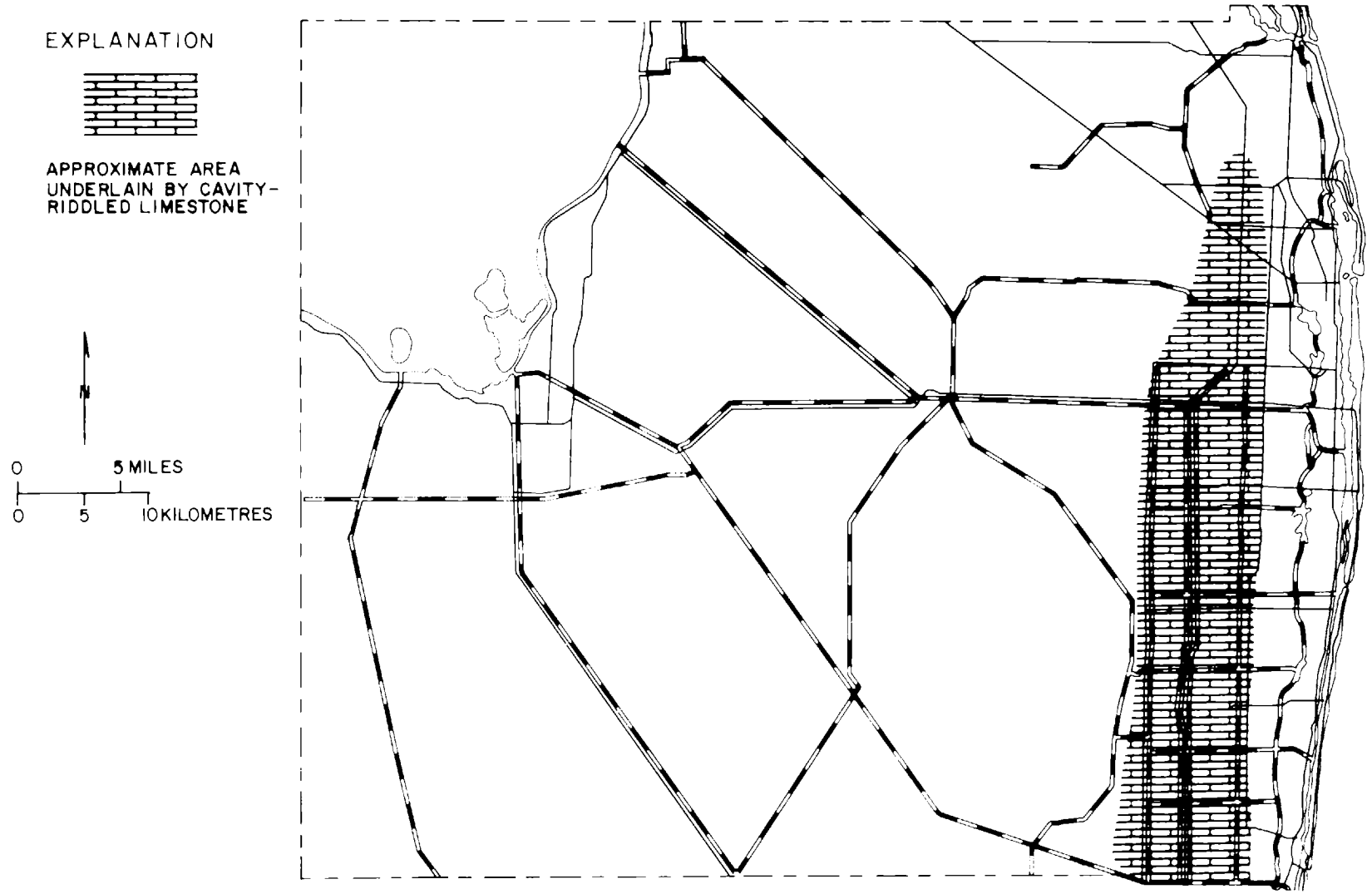
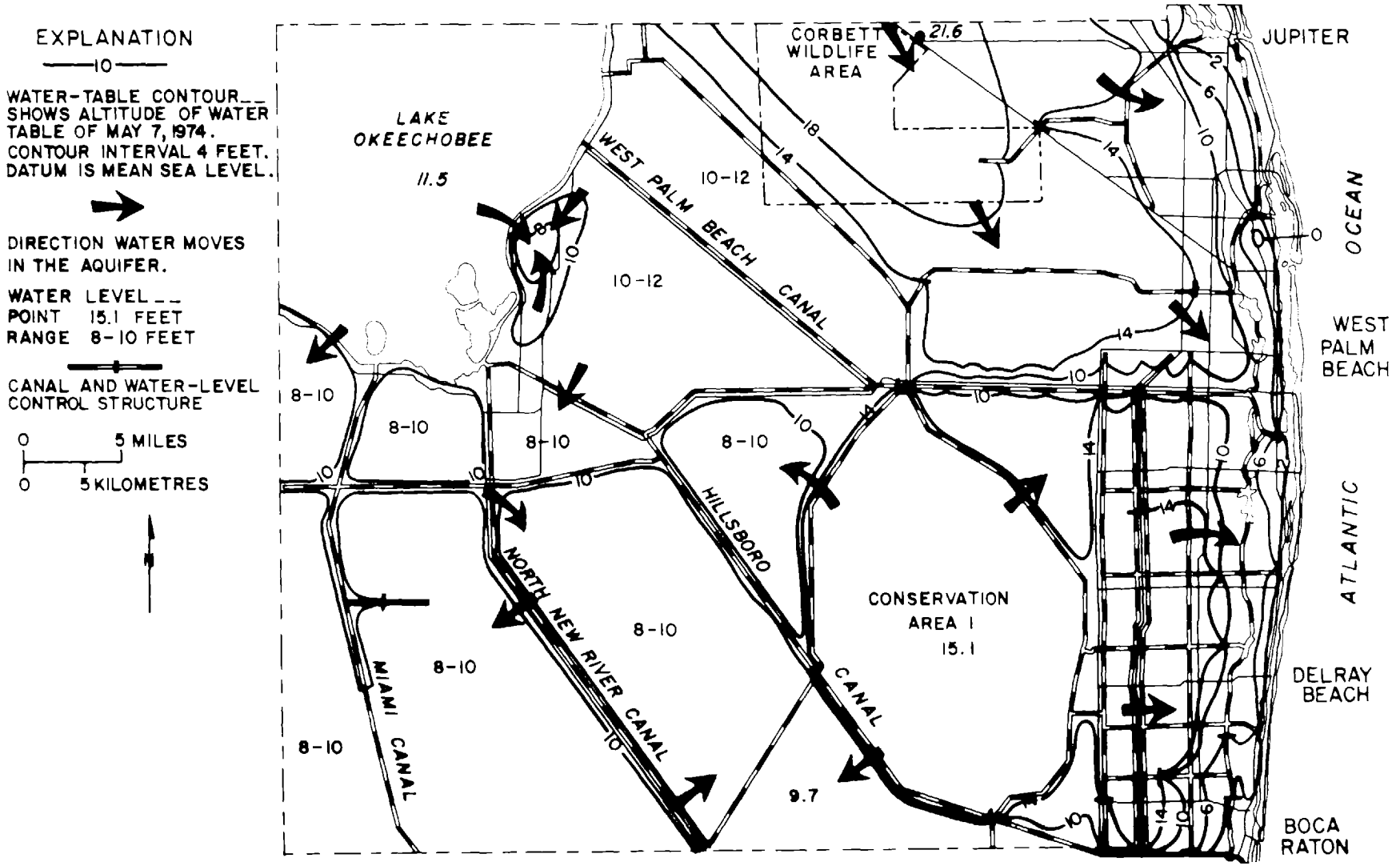


Figure 3.--Approximate areal extent of the cavity-riddled limestone section.


EXPLANATION
10
WATER-TABLE CONTOUR SHOWS ALTITUDE OF WATER TABLE OF MAY 7, 1974. CONTOUR INTERVAL 4 FEET. DATUM IS MEAN SEA LEVEL.
DIRECTION WATER MOVES IN THE AQUIFER.
WATER LEVEL
POINT 15.1 FEET
RANGE 8-10 FEET
CANAL AND WATER-LEVEL CONTROL STRUCTURE
0 5 MILES
0 5 KILOMETRES
LAKE OKEECHOBEE
11.5
CORBETT WILDLIFE AREA
21.6
JUPITER
OCEAN
WEST PALM BEACH
ATLANTIC
DELRAY BEACH
BOCA RATON
WEST PALM BEACH CANAL
HILLSBORO CANAL
NORTH NEW RIVER CANAL
MIAMI CANAL
CONSERVATION AREA 1
15.1
9.7
10-12
8-10

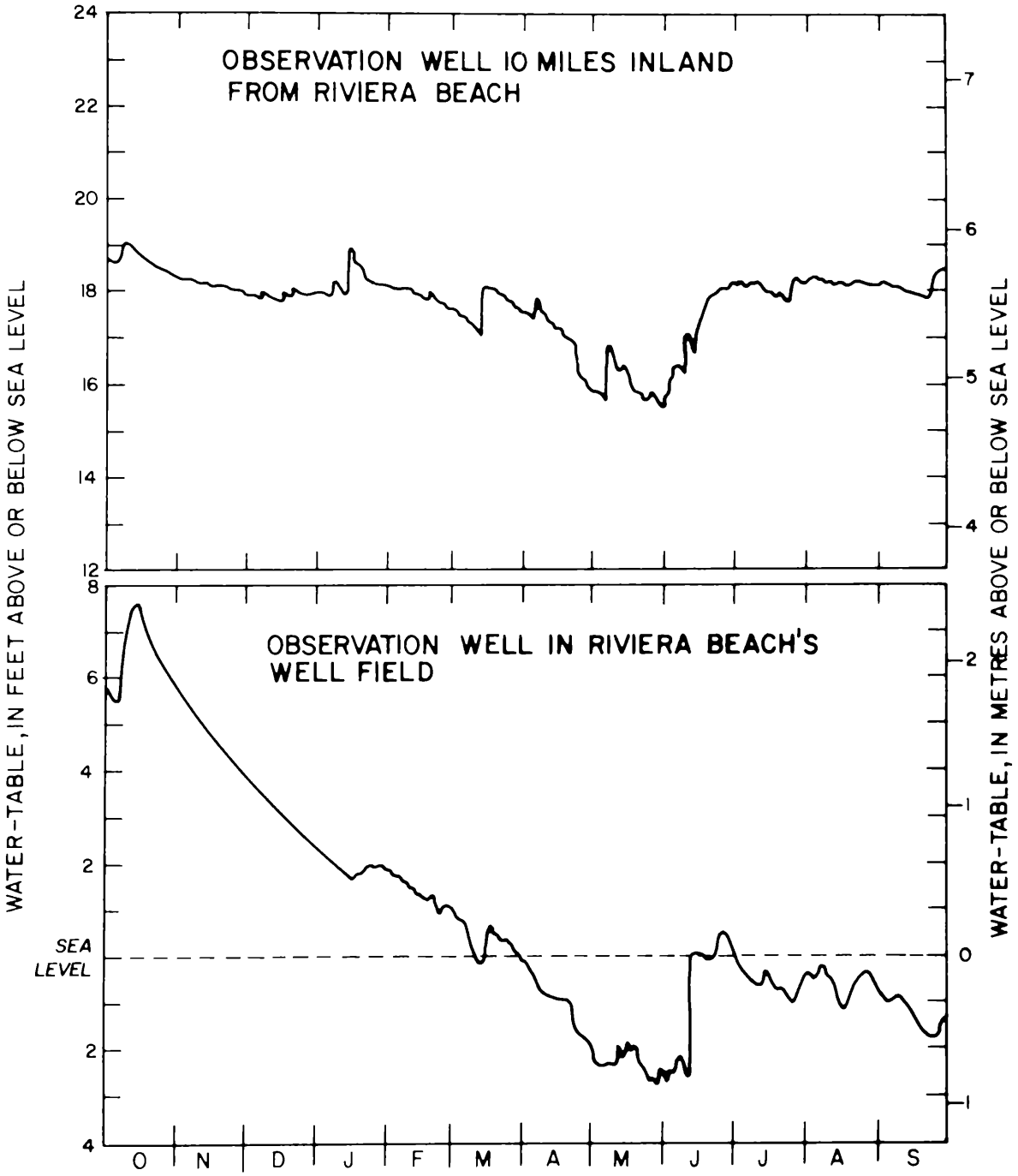
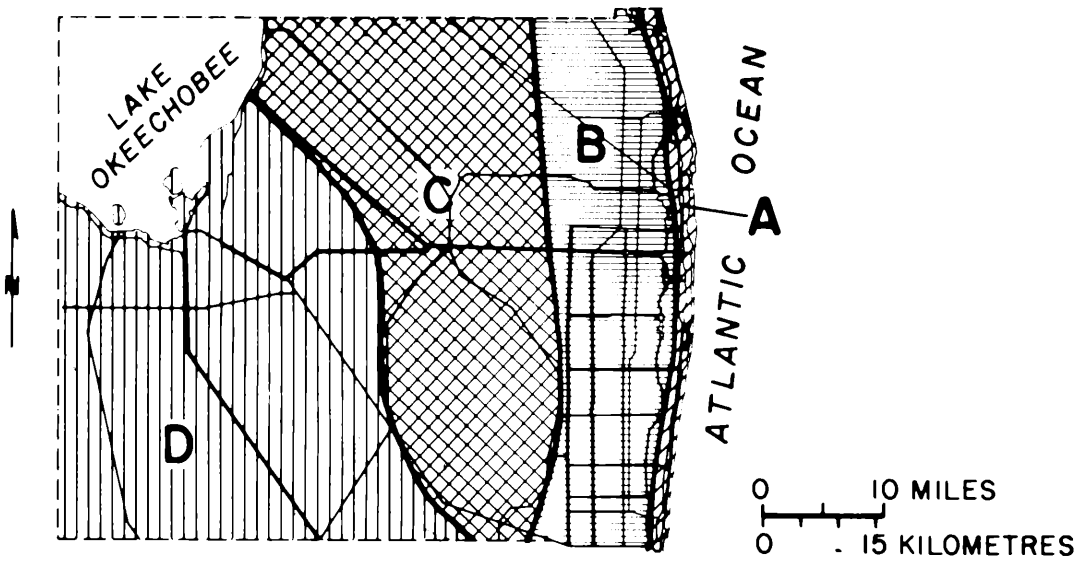


Figure 5.--Water-table fluctuations 10 miles inland from Riviera Beach and in the Riviera Beach well field for October 1973 - September 1974.



Below Land Surface(ft)	Average range of concentrations of total dissolved solids in ground water (milligrams per litre)			
	A	B	C	D
To 50	200 to 300	200 to 400	200 to 800	200 to 1,000
50 to 100	200 to 400	300 to 1,000	600 to 1,500	
100 to 150	200 to 500	300 to 1,000		
More than 150	300 to 500	300 to 1,000	Generally brackish 1,500 to 5,000	

Note: Florida Air and Water Pollution Control Commission drinking water standards specify that dissolved solids should not exceed 500 mg/l as a monthly average.

Figure 6.--Areal and depth variations of dissolved solid concentrations of water from the shallow aquifer.

areas affected by sea-water intrusion and inland areas where connate sea water remains from ancient seas. For areas C and D, water containing dissolved solids ranging from 200 to 1,000 mg/l generally occurs at depths of less than 50 ft (15 m). Much of the water below 50 ft (15 m) in map areas C and D is connate sea water which has been partly flushed out by fresh water. Water containing more than 500 mg/l dissolved solids typically contains objectionable amounts of chloride, iron, and sulfate, has an odor, and is hard.

Sea-water intrusion into the shallow aquifer resulted when man upset the natural balance between fresh water and sea water in the aquifer. Before the county was settled the water table was sufficiently high so that the sea water extending into the shallow aquifer was limited to a few hundred feet of the coast. When the water table in the coastal areas was lowered, largely by drainage and by large withdrawals of water, sea water began to move landward. Although most coastal wells are not now in imminent danger of being contaminated by sea water, some have been affected and others are threatened. High capacity wells pumping near the coast and operating in conjunction with other high capacity wells are most vulnerable.

Potential aquifer contamination from canals, although negligible now, could pose problems as the quantity of wastes such as sewage and agricultural nutrients (Land and others, 1973) entering the hydrologic system increases. Excessive drainage and over pumping in the eastern part of the county could result in the eastward migration of ground water of inferior quality.

SUMMARY

The shallow aquifer in Palm Beach County supplies more than 90 percent of all drinking water and much of the water used by industry and agriculture in the east part of the county. It underlies the entire county and ranges in thickness from 75 ft (23 m) in the west to 250 ft (76 m) at some locations in the east. The aquifer is generally under water-table conditions. The aquifer is composed of sand, shell sandstone, limestone, and various mixtures of these materials. A north-south trending cavity-riddled sandy limestone section located several miles inland and extending almost the entire length of the county is most permeable. High-capacity wells in this section and also in the southeast part of the county yield up to 2,000 gal/min (130 l/s). The cavity-riddled section offers excellent potential for development of future ground-water supplies. This is in contrast to the ground-water supplies in the vicinity of the coast where sea-water intrusion is a threat and has already caused some damage.

The movement of the ground water is generally toward the coast in the east half of the county and to the south in the west half. Water-management activities and pumping of wells cause many local variations. The aquifer is recharged primarily by local rainfall. Except along the coast the water table is within a few feet of the land surface. In some areas it is very near or at the land surface and causes swampy conditions.

The concentration of dissolved solids of water from the shallow aquifer in the eastern part of the county, is generally less than the 500-mg/l State standard for drinking water. The concentrations tend to increase with depth and to the west. Potable water supplies from the shallow aquifer are very limited in the west half of the county.

SELECTED REFERENCES

Land, L.F., Rodis, H.G., and Schneider, J.J., 1973, Appraisal of the water resources of Eastern Palm Beach County, Florida: Florida Geol. Survey, Rept Inv. 67, 64 p.

Rodis, H.G., 1973, Encroaching salt water in north east Palm Beach County, Florida, Florida Geol. Survey Map Series 59.

Schneider, J.J., 1973, Effects on the water quality in the shallow aquifer due to operation of the cross-state dump, Palm Beach County, Florida., U.S. Geol. Survey open-file rept., 42 p.

Schneider, J.J., 1973, Tidal relations along the Intracoastal Waterway, Palm Beach County, Florida, U.S. Geol. Survey open-file rept., 22 p.

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