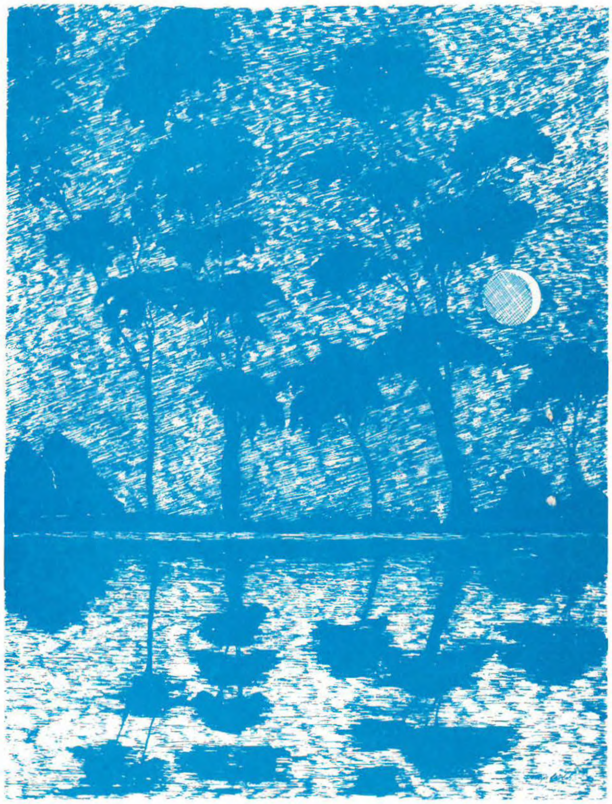
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY

PROGRESS REPORT ON THE WATER RESOURCES INVESTIGATION OF MARTIN COUNTY, FLORIDA



OPEN-FILE REPORT FL-75-521

Prepared in cooperation with
MARTIN COUNTY BOARD OF COMMISSIONERS

Tallahassee, Florida
1975

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ABSTRACT

The base of the shallow aquifer ranges from 125 feet (38 m) below sea level in the northwest part of Martin County to about 280 feet (85.3 m) below sea level in the southeast part of the county. Test holes also indicate a thick, highly permeable zone in the east part of the county which becomes thinner and interlaced with zones of lower permeability in the west part.

Water levels decline about 2 to 5 feet (0.6 to 1.5 m) during the dry season (October 1973 to May 1974) in most areas of Martin County. Within the area influenced by the pumping of Stuart's public supply wells, water level declined 6 feet (1.8 m) between October 1973 and May 1974. Water levels during January - May 1974 in this area were 3 to 6 feet (0.0 to 1.8 m) lower than they were in January - May 1965. This difference was due to a three-fold increase in pumpage (0.8 to 2 mgd) from 1965 to 1974.

Chloride concentrations in four salt water monitoring wells around the Stuart well field ranged from 35 to 45 mg/l during the rainy season of 1973. No appreciative increase in chlorides was found by the end of the next dry season.

Water from five surface water sites had higher concentrations of phosphorus than water found in a typical urban area in Fort Lauderdale. Water from seven sites contained concentrations of nitrogen less than the typical rural site average.

Expansion of the test drilling program, observation of salt-water intrusion, water-level monitoring and continued nutrient sampling are planned for future study. An interpretative report will be prepared at the end of this investigation.

INTRODUCTION

Martin County (fig. 1) is at the north edge of the rapidly urbanizing part of the southeast coast of Florida. Population in the county increased 66 percent from 1960 to 1970 and 31 percent from 1970-73.

Water resources investigations were conducted in 1953 and 1956-57. The 1953 work consisted of a preliminary inventory of wells, and the 1956-57 work was a study of the geology and ground-water resources of Martin County and the Stuart area. Two reports have resulted from this

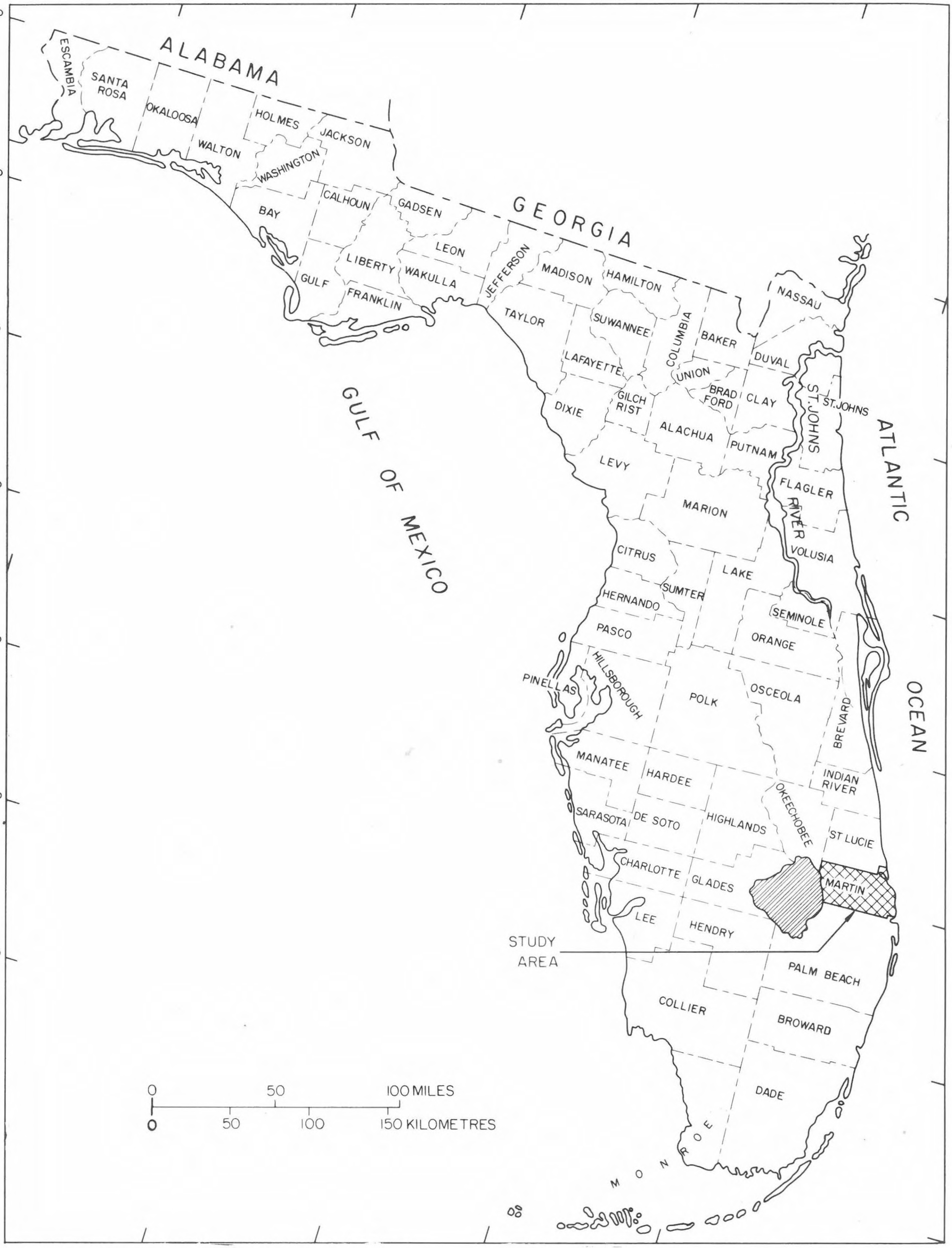


Figure 1. Location of Martin County.

work, Lichtler (1957) and Lichtler (1960). Many changes have taken place in the County in the ensuing 15 years. These changes have brought about a pressing need for detailed hydrologic data so that planning and management of the land and water resources of the County can take place in an orderly manner.

In response to this need the U.S. Geological Survey and the Martin County Board of Commissioners began another water resources investigation in Martin County in April 1973. The investigation involves a study of short-and long-range objectives which must be reached in order to define water resources problems of Martin County and provide possible solutions to them.

Short-range objectives include: (1) defining the extent of salt-water encroachment into the fresh-water aquifer in the vicinity of the Stuart municipal wells and along the entire coastline of the county, (2) establishing a base network of water-level gages to determine the magnitude and characteristics of water-table fluctuations, and (3) establishing a network of sampling sites for ground and surface water to determine water-quality characteristics and possible sources of chemical or biological contamination.

Long-range objectives include: (1) determining the thickness, areal extent, and composition of the shallow aquifer as they relate to water availability, and (2) evaluating the effects on the water resources caused by rapid urbanization, land use changes, and overall drainage and development.

This report presents and explains the data obtained from April 1973 through June 1974, the first year of the study. Water-quality, water-level, and salt-water intrusion monitoring networks have been established (in accordance with the short-range objectives) and results for the first year are contained in this report. Test holes were drilled to begin the necessary accumulation of data for the determination of aquifer properties with respect to long-range water availability. A final report will be prepared at the conclusion of the study.

For use of those readers who may prefer to use metric units rather than English units, the conversion factors for the terms used in this report are listed below:

Multiply English unit	by	To obtain metric unit
feet (ft)	0.3048	metres (m)
miles (mi)	1.609	kilometres (km)
inches (in.)	25.4	millimetres (mm)
gallons (gal)	3.785	litres (l)
million gallons per day (Mgal/day)	.04381	cubic metres per second (m^3/s)

DATA COLLECTION

Test holes for determination of thickness, areal extent, and zones of high permeability in the shallow aquifer were rotary-drilled 6-inch (150-mm) holes. Each hole was drilled through the shallow aquifer into 30 feet (9 m) of the underlying confining materials. Samples of subsurface material were collected at 10-foot (3-m) intervals or where the color or composition of the material changed. After being drilled, the holes were logged with electric and gamma-ray probes so that correlations could be made with the subsurface samples.

Observation wells for salt-water intrusion were cased with 2-inch (50-mm) pipe, driven to the base of the aquifer. The pipes were then pulled back to a producing zone and pumped until the water became clear (approximately 30 gal/min, 1.9 l/s). The wells were sampled periodically for chloride analysis.

Seven automatic water-level recording gages were installed on wells which were cased with 6-inch (150-mm) pipe and driven or jetted into the shallow aquifer. These recorders, in addition to four installed before 1958, provide a continuous record of ground-water-level fluctuations in the shallow aquifer. A tide gage was installed in the Intracoastal Waterway near Stuart to determine the total range and yearly extremes.

Surface-water samples throughout the county were collected with a Kemmerer water sampler, preserved, filtered, or treated if required, and sent to laboratories for analyses in accordance with currently recommended procedures (M. E. Beard, written commun., 1969).

SHALLOW AQUIFER

The shallow aquifer is the principal source of fresh water for individual use and public water supplies in Martin County. The aquifer, which extends throughout the county, is composed chiefly of sand with lenses of limestone, sandstone, and shell. Below the aquifer is a thick section of sandy clay which yields little or no water. It forms the confining layer between the shallow aquifer and the deep Floridan artesian aquifer. In Martin County, the Floridan yields brackish water.

Eleven test holes were drilled in Martin County during 1973 to begin determination of the areal extent, depth, and composition of the shallow aquifer. Additional test holes to be drilled and pumping tests to be made during the remaining part of the investigation will provide the data necessary to determine aquifer properties and the ability of the aquifer to meet long-range pumping needs.

The water table in the shallow aquifer ranges from land surface to about 15 feet (5 m) below land surface. The depth to the base of the shallow aquifer was determined at each test hole by examining samples of the material and by electrical and gamma-ray logging. The base of the aquifer generally slopes to the south and east; it is about 125 feet (38 m) below msl (mean sea level) in the northwest part of the county and about 280 feet (85 m) below msl in the southeast part of the county (fig. 2).

A generalized geologic section (fig. 3) along State Road 714 (line A-A' in fig. 2) shows three zones in the shallow aquifer that are delineated by differences in lithology and permeability; zone A is composed of surficial soils and sand; zone B, of sand and layers of sandstone, limestone, and shell of varying thicknesses; and zone C, of fine sand and sandy clay. The permeability of zone C is the lowest and that of zone B the highest. Although of lower permeability than zone B, zone A does not prevent the infiltration of rainfall into zone B. The permeability of both the upper and lower parts of zone C is so low that virtually no water can be withdrawn from either.

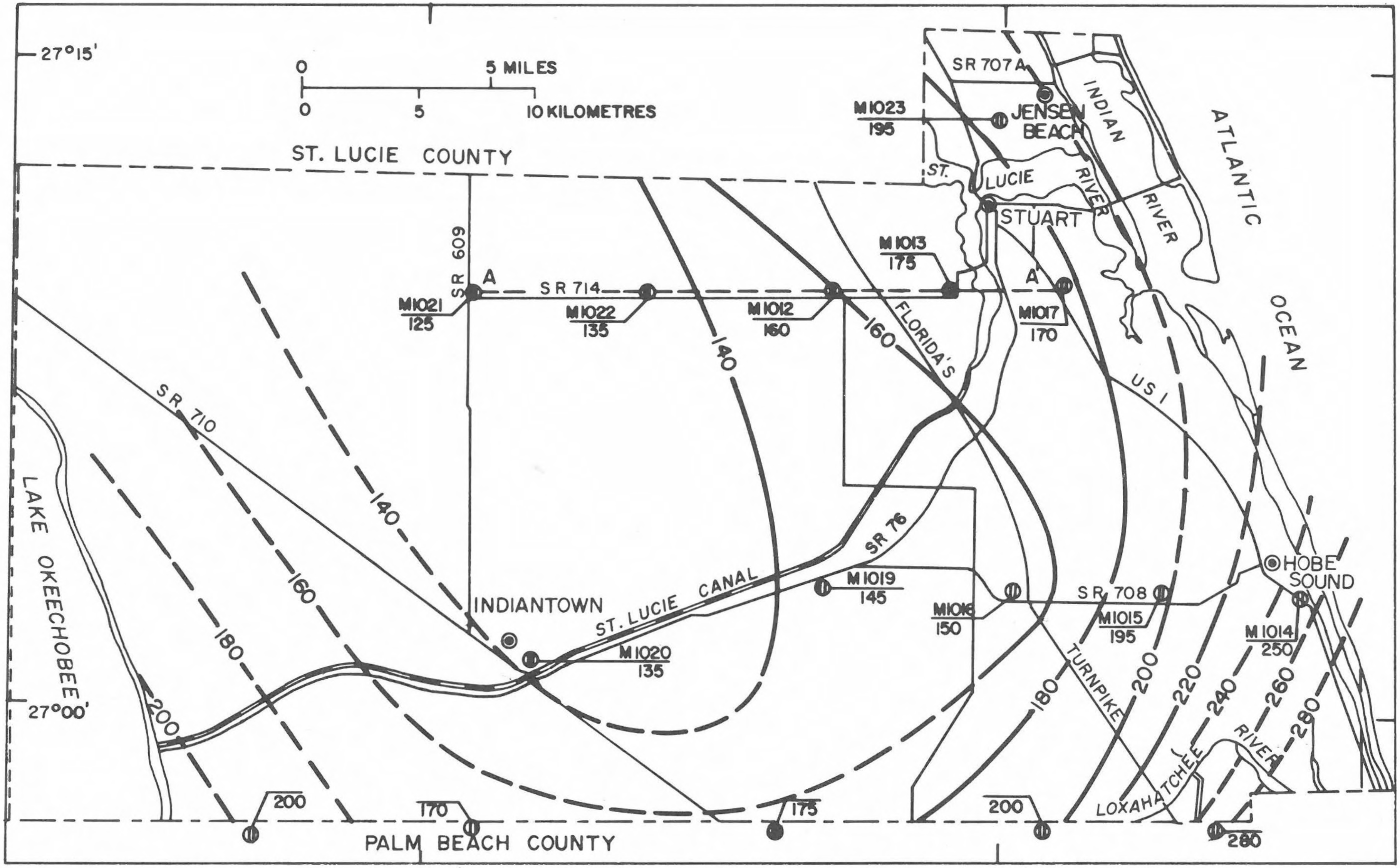
Water Levels

Ground-water levels fluctuate in relation to the amount of discharge from or recharge to the shallow aquifer. In Martin County, infiltration from rainfall is the major recharge to the aquifer and results in a high water table. A low water table is due to evapotranspiration losses, drainage to canals and natural waters, and withdrawals by pumping. Ground-water levels are usually at their highest in September or October (fig. 4), the peak of the rainy season, and lowest in May (fig. 5), the end of the dry season.

Ground water flows perpendicular to water-level contours. Large distances between contours, as in the western part of the county, indicate that the slope of the water table is gentle and that ground-water movement is slow; small distances between contour line, as in the eastern part of the county, indicate that the slope is steep and ground-water movement fast--providing the permeability is the same in both parts of the county. In the western part of the county ground water generally moves eastward. In and north of Stuart ground water moves outward from the centers of the peninsulas and into the St. Lucie and Indian Rivers.

The 5- and 10-foot contours near the St. Lucie River converge at the St. Lucie Lock and Dam on the St. Lucie Canal. St. Lucie Canal is part of the Okeechobee Waterway and upstream water levels are held near the water level in Lake Okeechobee, which is about 15 feet (5 m) above sea level; downstream water levels are near sea level. Discharge from the lock and dam is chiefly leakage and lockage, estimated at 12 ft^3/sec (0.3 m^3/sec).

The highest tide of 2.83 feet (0.86 m) above msl occurred on



EXPLANATION

—180— CONTOUR LINE ON BASE OF SHALLOW AQUIFER, FEET BELOW SEA LEVEL. DASHED WHERE INFERRED

M1020 / 135 TEST HOLE. UPPER NUMBER IS WELL NUMBER; LOWER NUMBER IS DEPTH TO BASE OF SHALLOW AQUIFER, FEET BELOW SEA LEVEL.

Figure 2. Location of test holes, and contours of the base of the shallow aquifer.

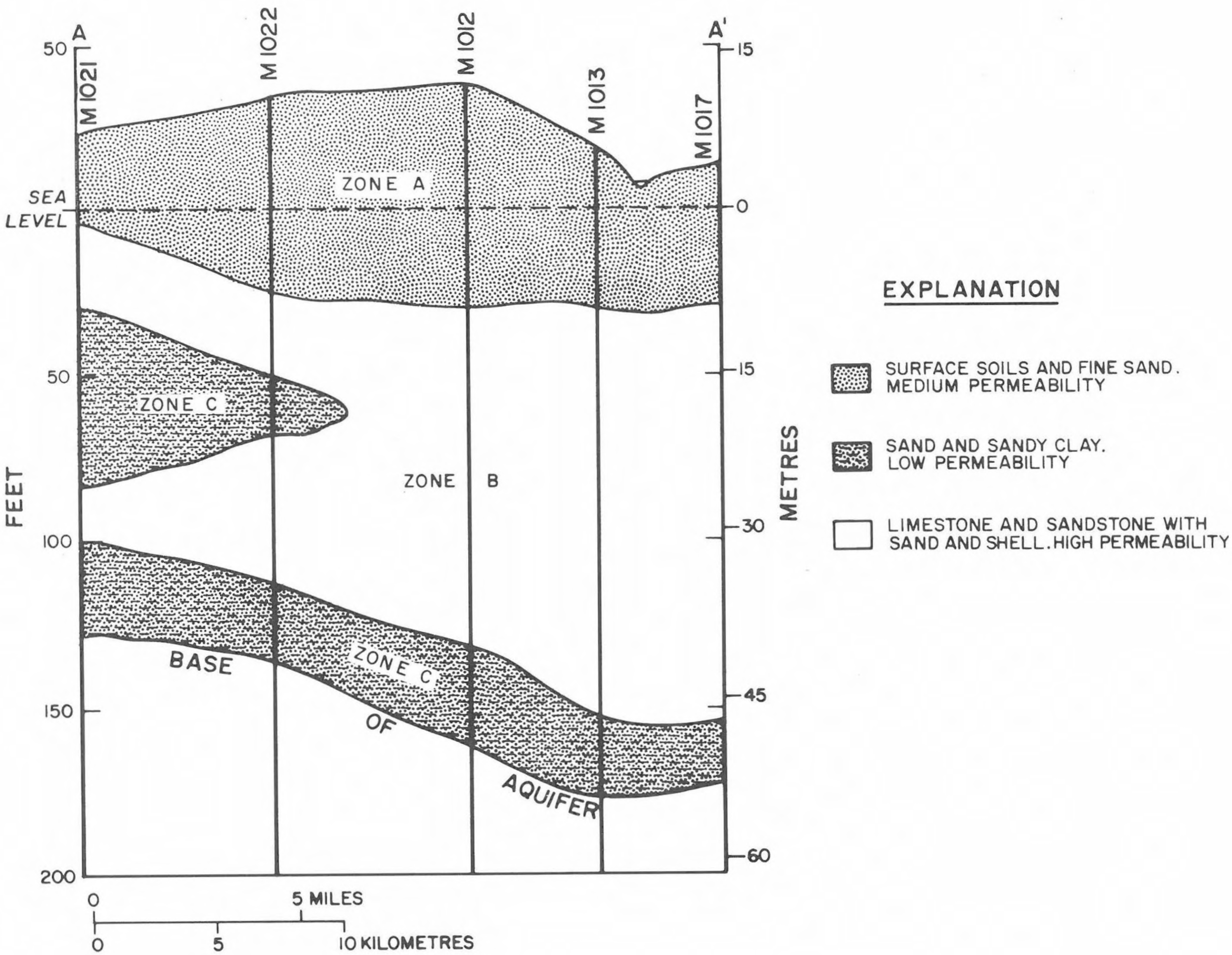
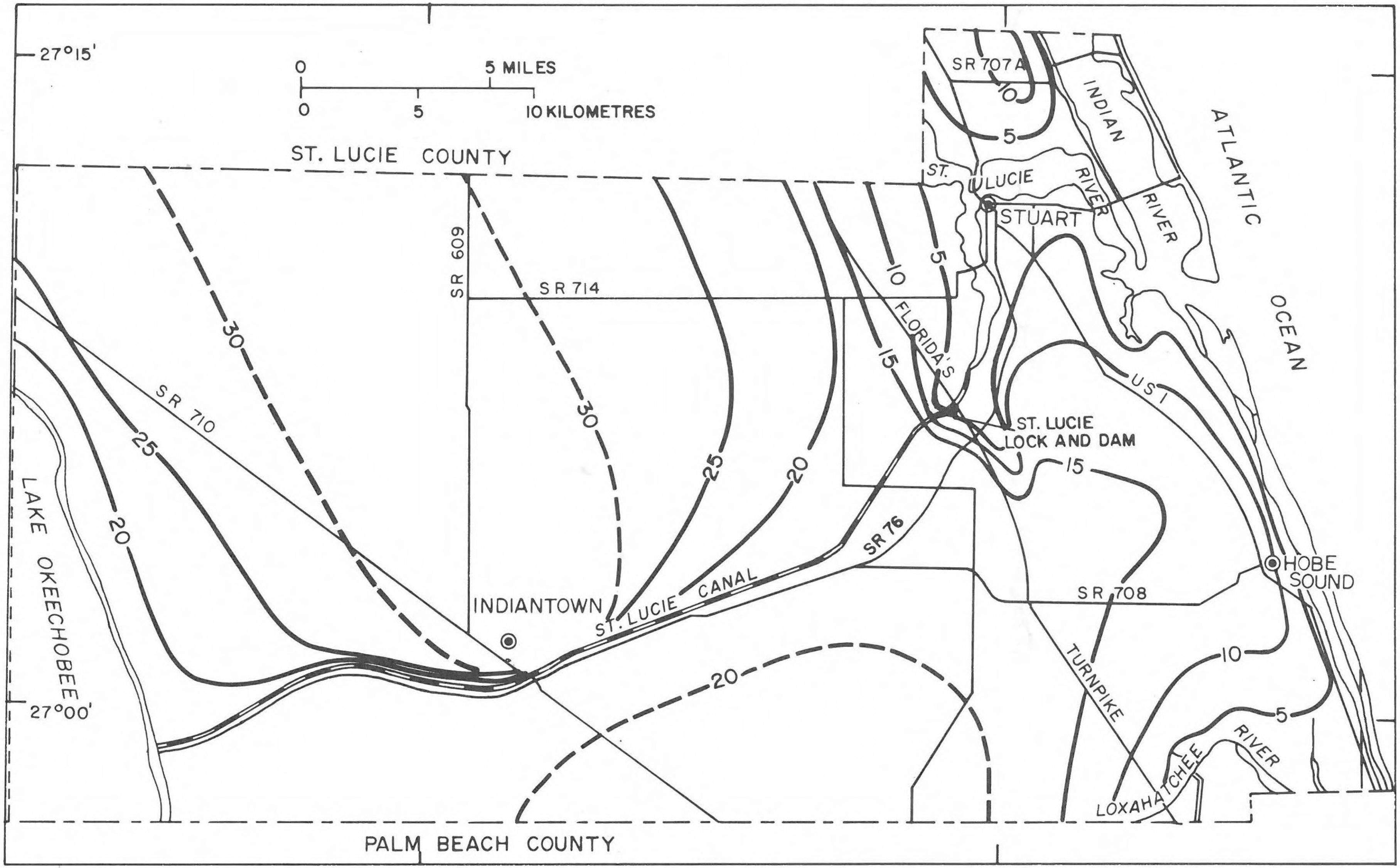


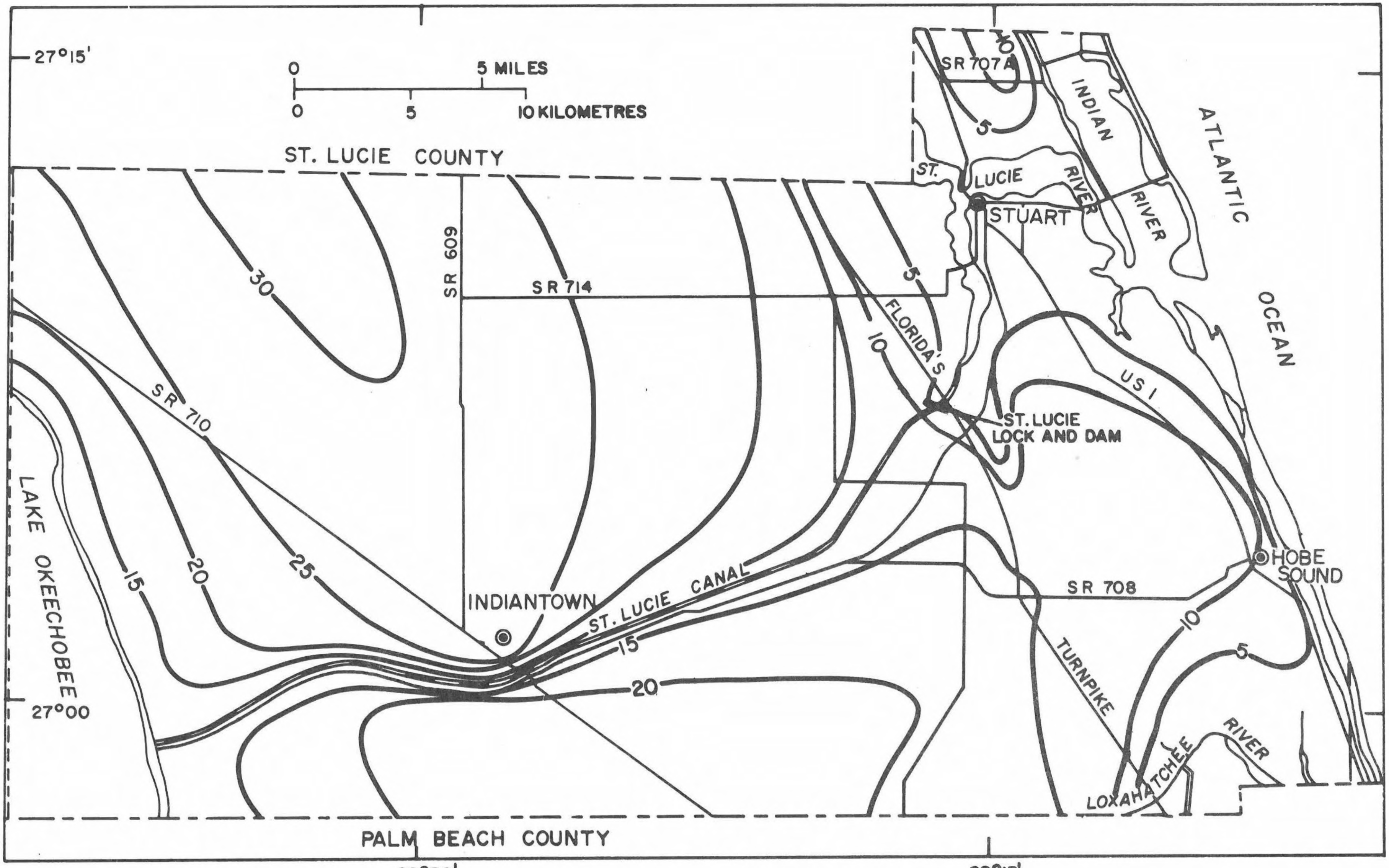
Figure 3. Geologic section showing zones of high and low permeability.



EXPLANATION

——20— — — ELEVATION OF WATER TABLE, FEET ABOVE SEA LEVEL; DASHED WHERE INFERRED.

Figure 4. Ground-water elevations in the shallow aquifer, October 29, 1973.



EXPLANATION

—20— ELEVATION OF WATER TABLE, FEET ABOVE SEA LEVEL

Figure 5. Ground-water elevations in the shallow aquifer, May 7, 1974.

October 25, 1973 (fig. 6) and the lowest tide of 1.40 feet (0.43 m) below msl occurred on August 5, 1973. The mean tide was 0.40 foot (0.12 m) above msl, July 26, 1973 through April 26, 1974.

From October 1973 to May 1974, water levels in the shallow aquifer declined 2 to 5 feet (0.6 to 1.5 m) in most of the county (fig. 7). Levels declined less than 2 feet (0.6 m) in a marsh area near the coast, on the basis of water-level measurements in well M 1004. The decline of more than 5 feet (1.5 m) in Stuart, on the basis of measurements in well M 147, was caused by the consistent pumping of several of the 22 wells, all supplying the city of Stuart.

Water levels in well M 147 were 3 to 6 feet (1 to 2 m) lower during the dry season (January-May) in 1974 than they were during the same period in 1965 (fig. 8). Inasmuch as rainfall was 7 inches (180 mm) below normal in 1965 and 8 inches (200 mm) below normal in 1974, the decline is attributed to the nearly threefold increase in pumpage from 1965 to 1974.

Lichtler (1960) showed that water levels in M 147 during 1952-57 were always about 7 feet (2 m) higher than the low shown on figure 8 for May 1974. The low as reported by Lichtler (1960) occurred in late 1956 and early 1957. In 1956 rainfall was deficient by about 15 inches (380 mm).

Salt-Water Intrusion

The Stuart well field is bounded on the north, east, and west by the saline tidal water of the St. Lucie River. The shaded area in figure 9 is the area influenced by pumping from Stuart's 27 supply wells. As much as 3 Mgal/day (.13 m^3/s) are pumped from the Stuart wells during the dry season (January-May). Little recharge from rainfall reaches the well field area during this period and water levels decline more than 6 feet (1.8 m) from wet season levels. As ground-water levels decline, salt water can move inland toward the city's wells. However, with the start of the rainy season levels begin to rise, thereby establishing a seaward movement of salt water.

Wells M 1008 and M 1010 are about 1.2 miles (1.9 km) from the center of the well-field area. Well M 1011 is about 0.8 mile (1.3 km) from the center and well M 1009 is near the center of the well field area. Well M 1008, M 1010, and M 1011 are all about 0.25 mile (0.40 km) from the coast.

Chloride concentrations of water collected from the bottom of these wells in October 1973 ranged from 35 to 45 mg/l (milligrams per litre). Samples collected on May 8, 1974 showed no appreciable increase in chloride concentrations for any of the wells.

Lichtler (1960) identified high chloride water adjacent to the St.

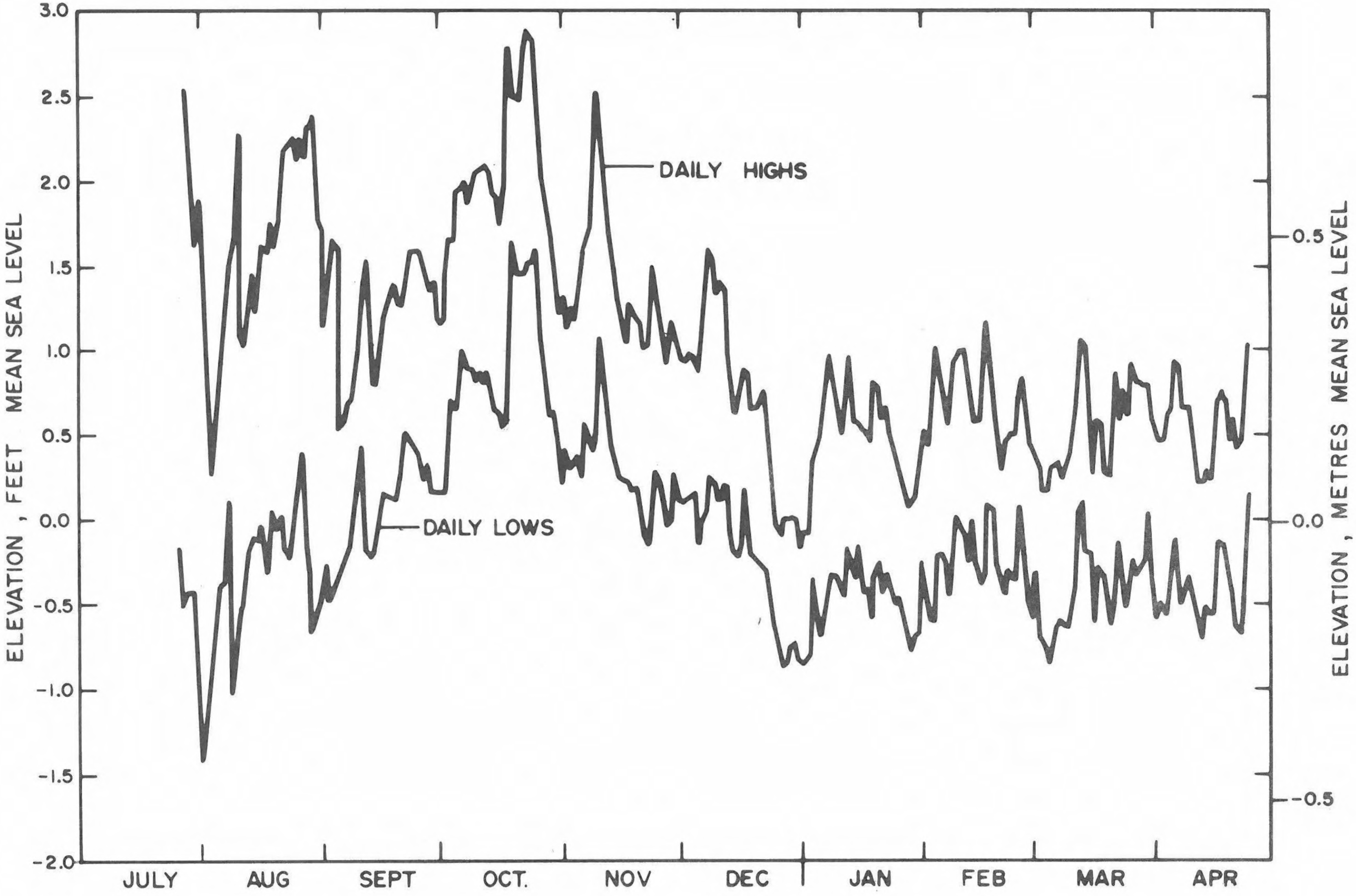


Figure 6. Hydrograph of tide near Stuart, July 26, 1973 - April 26, 1974.

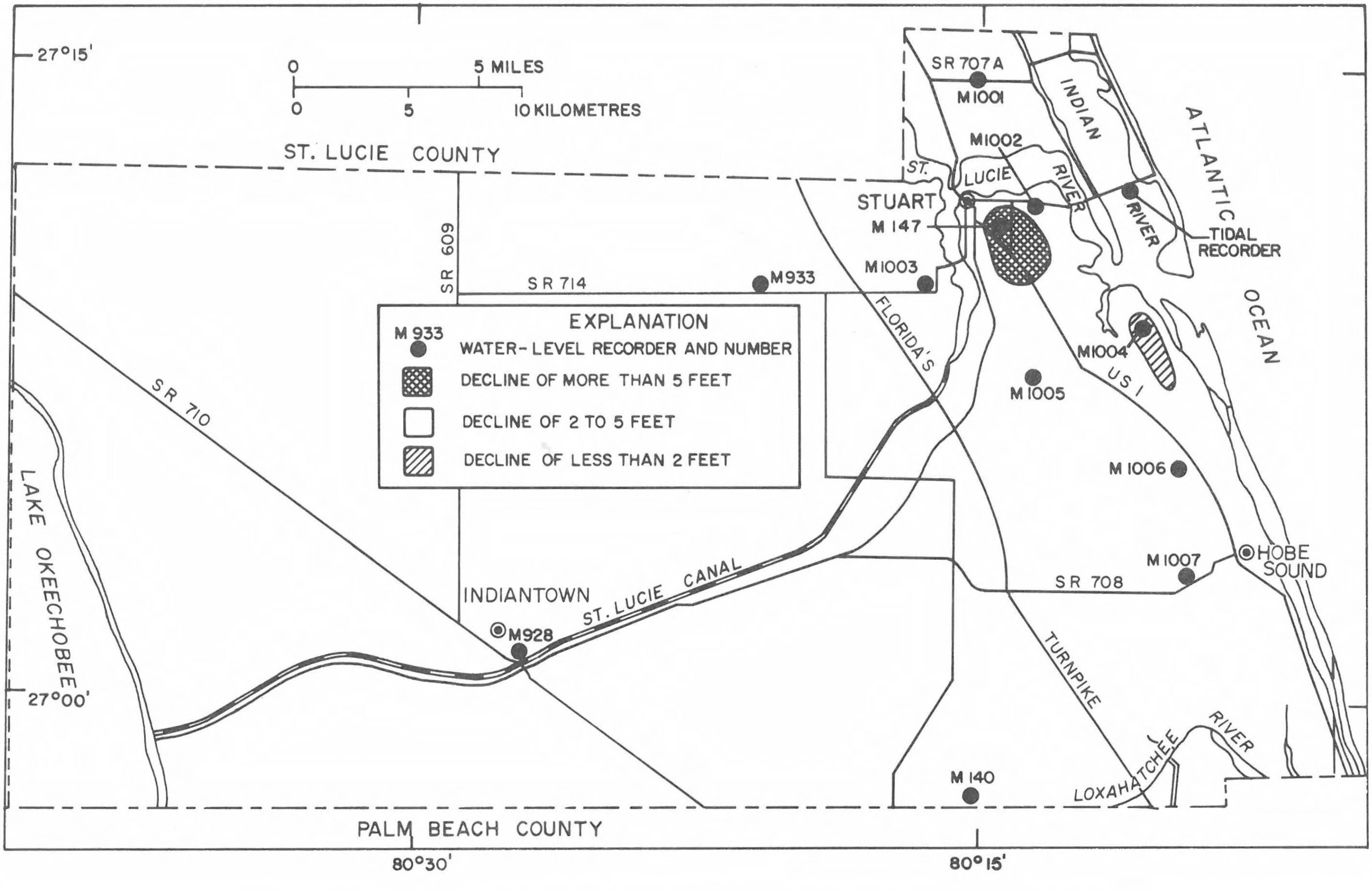


Figure 7. Location of water-level recorders, and decline in water level in the shallow aquifer between October 1973 and May 1974.

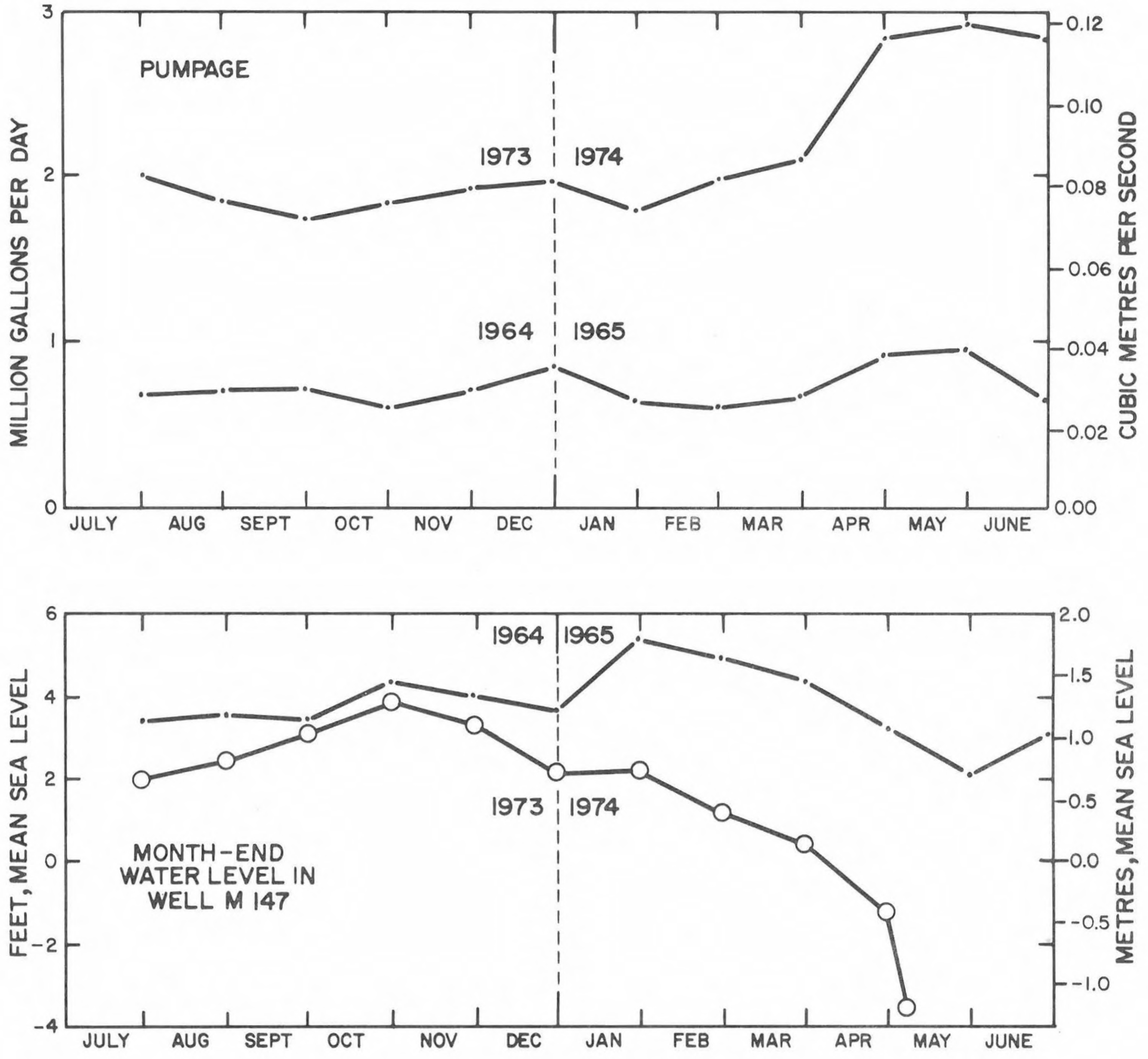


Figure 8. Pumpage from municipal supply wells at Stuart, and the water level in well M 147 for July 1964 - June 1965 and July 1973 - June 1974.

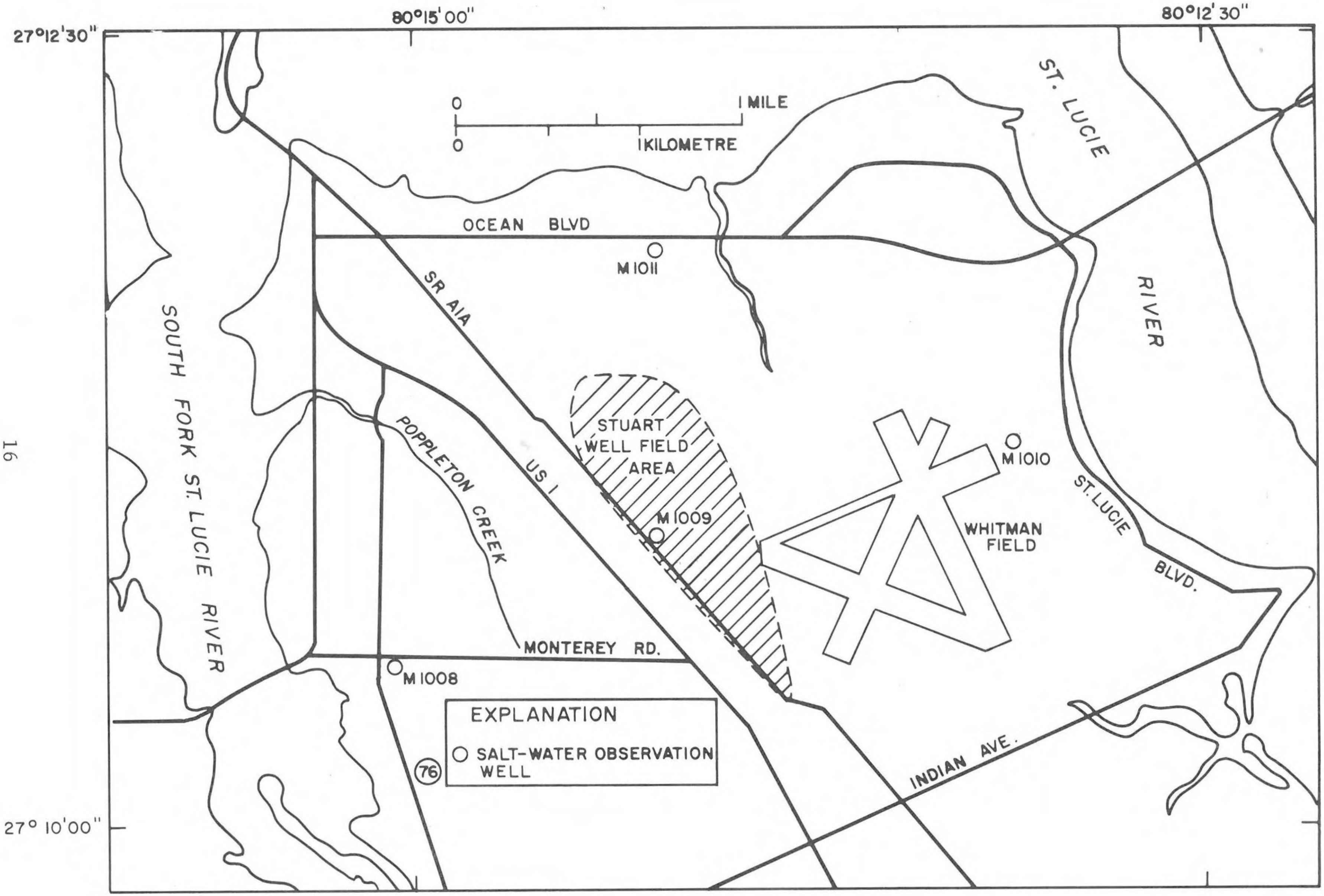


Figure 9. Location of salt-water observation wells.

Lucie estuary and the potential threat of salt-water intrusion to the Stuart well field area. More complete information is needed through a wet and dry cycle to determine the effect that an increase in pumpage from the well field is having on the chloride concentrations in the observation wells.

WATER QUALITY

In addition to monitoring wells for chloride concentration around the Stuart well-field area, surface-water sites were sampled in July and October 1973 and January 1974 for nutrient analysis (fig. 10). A list of the locations sampled and range of values are shown in table 1. For comparison, average concentrations of total nitrogen and phosphorus are given for water in the South New River Canal in typically urban and rural areas in and west of Fort Lauderdale in Broward County. Higher concentrations of nitrogen and phosphorus in urban areas result from sewage disposal, industrial wastes, and runoff from fertilized lawns.

Water in the South and North Fork St. Lucie River, Danforth Creek, Bessey Creek and Loxahatchee River sites contained more phosphorus than water in the typically urban and rural sites in Broward County. Total phosphorus at all other sites varied between the rural and urban averages.

Concentrations of total nitrogen were higher than the typical urban site only at Danforth Creek. The range in total nitrogen concentration in water from Bessey Creek was between the urban and rural averages. Total nitrogen at all other sites was below the average for the rural area.

Water samples of ground water entering the Stuart water treatment plant were analyzed for trace metals, inorganic ions, and nutrients. All values were below the upper limits considered safe for drinking water (U.S. Public Health Service, 1962).

PLANS

Plans for the next phase of the project include: (1) Expansion of the test drilling program in the west part of Martin County in order to refine data on composition and depth of permeable zones in the shallow aquifer; (2) Expansion of the salt-water observation well network into Jensen Beach and Hobe Sound; (3) Installation and monitoring of additional water-level observation wells to obtain detailed coverage of the water-table elevation in the Stuart well field and other areas; and, (4) continued macronutrient sampling and periodic chemical analyses of water from Stuart's municipal wells and throughout the county, to delineate areas of potential pollution.

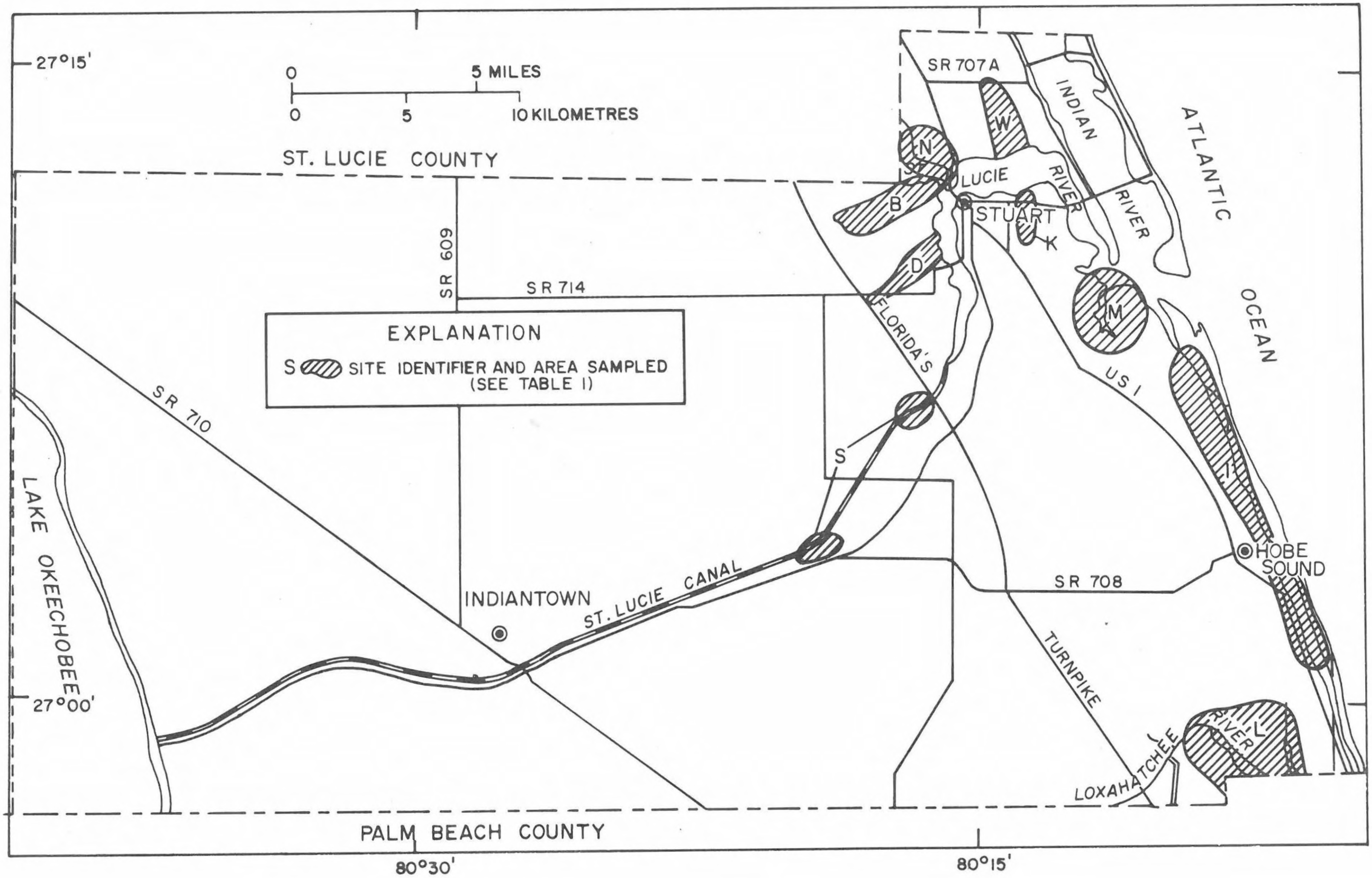


Figure 10. Location of water-quality sampling sites.

Table 1. List of surface-water sites for nutrient sampling.

Site	Location	RANGE[a] Total Nitrogen	RANGE[a] Total Phosphorus
S_1-S_{13}	South Ford St. Lucie River and St. Lucie Canal	0.12-0.42	0.05-0.9
D_1-D_9	Danforth Creek	1.7 -4.7	.07-1.7
B_1-B_{10}	Bessey Creek	.23-2.2	.07- .53
N_1-N_{12}	North Fork St. Lucie River	.13- .30	.08- .13
W_1-W_8	Warner Creek	.09- .30	.01- .06
K_1-K_7	Krueger Creek	.18- .41	.05- .09
M_1-M_7	Manatee Pocket	.13- .46	.02- .04
I_1-I_{10}	Intracoastal Waterway	.11- .28	.03- .05
L_1-L_{12}	Loxahatchee River	.03- .27	.02- .10
		AVERAGE[a]	
urban area	South New River Canal @ Ft. Lauderdale	2.3	.09
rural area	South New River Canal west of Ft. Lauderdale	1.5	.02

a In milligrams per litre

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