STATE OF FLORIDA
STATE BOARD OF CONSERVATION
DIVISION OF GEOLOGY

FLORIDA GEOLOGICAL SURVEY

Robert O. Vernon, *Director*

REPORT OF INVESTIGATIONS NO. 36

HYDROLOGY OF THE BISCAYNE AQUIFER IN THE POMPANO BEACH AREA, BROWARD COUNTY, FLORIDA

By
George R. Tarver

Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
CITY OF POMPANO BEACH
and the
FLORIDA GEOLOGICAL SURVEY

Tallahassee
1964

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LETTER OF TRANSMITTAL

Florida Geological Survey

Tallahassee

December 5, 1963

Honorable Farris Bryant, *Chairman*
Florida State Board of Conservation
Tallahassee, Florida

Dear Governor Bryant:

The Florida Geological Survey is publishing, as Report of Investigations No. 36, a study of the "Hydrology of the Biscayne Aquifer in the Pompano Beach Area, Broward County, Florida." This study was prepared by Mr. George R. Tarver, geologist with the U. S. Geological Survey, and its publication is quite timely.

The Biscayne aquifer is the only source of fresh ground water in much of the southeastern part of Florida. The aquifer is extremely permeable, and many of the large wells may yield 2,000 gallons per minute, with less than 4 feet of drawdown. The aquifer is composed of quartz sand, calcitic sandstone and sandy limestone that extends from the land surface to depths of as much as 400 feet. Replenishment of the ground water is largely from rainfall, and, because of the extreme permeability of the formation, it is anticipated that increased use of water in the area in the future will be offset through salvage from loss to evapotranspiration and transpiration.

The steadily increasing population in the southeastern area of Florida will require large amounts of additional water in the future, and the details of this study will help to meet these needs.

Respectfully yours,
Robert O. Vernon
Director and State Geologist

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By
George R. Tarver

ABSTRACT

The Biscayne aquifer is the only source of fresh ground water in northeastern Broward County, Florida. The aquifer extends from the land surface to a depth of about 400 feet and is composed of quartz sand, calcareous sandstone, and sandy to nearly pure limestone. Replenishment to the aquifer is chiefly by local rainfall. The permeable rock zones are erratic in their occurrence within the aquifer, but they are generally more prevalent and thicker at greater depths. Small water supplies can be obtained from thin permeable lenses that generally occur at depths less than 60 feet. Large water supplies can be obtained from wells drilled to thick permeable layers that occur at greater depths. Many of the large wells yield 2,000 gpm (gallons per minute) with less than 4 feet of drawdown.

Chemical analyses of ground-water samples show that the water is hard and is high in iron content, but is easily treated. Periodic analyses of the chloride content of the ground water show that some areas near the Intracoastal Waterway and uncontrolled reaches of major canals become increasingly salty when water levels are lowered. Data collected from test wells indicate that during 1960-61 salt-water encroachment was of no major significance to the Pompano Beach well field.

Aquifer test data indicate that the coefficient of transmissibility is about 1,500,000 gpd (gallons per day) per foot and the coefficient of storage is about 0.30. The test data also indicate that the more permeable rock layers act initially as an artesian system, but with continued development change to water-table conditions, at which time the entire aquifer reacts as a hydrologic unit.

Water-level, rainfall, salinity, and quantitative data indicate that much larger quantities of water can be obtained from the ridge area provided that well spacing is adequate, pumping is regulated, and salt water in canals is controlled.

INTRODUCTION

The population growth in southeastern Florida during recent years has created numerous problems. One problem which has plagued most of the coastal cities is supplying water to the expanding population. The principal difficulty has been to locate and produce water without inducing salt water into the well field areas. Salt-water intrusion has occurred in several areas along the lower east coast where water use has greatly increased. The officials of Pompano Beach, cognizant of salt-water intrusion problems in southeastern Florida and of the need for additional data to solve their present and future problems, requested that the U. S. Geological Survey make an investigation of the ground-water resources of the area and furnished cooperative funds. The Florida Geological Survey also furnished cooperative funds as part of its program to appraise the water resources of Florida.

PURPOSE AND SCOPE

The purpose of the ground-water investigation was to determine, insofar as possible, (1) the ground-water potential, (2) the quality of the water, (3) the occurrence of saline water in the Biscayne aquifer, (4) the hydraulic coefficients of the aquifer, and (5) the relation of ground-water levels and salt-water movement in the aquifer and in canals.

The study consisted of the following: (1) An inventory of wells, (2) installation of two automatic water-level recording gages, (3) installation of shallow wells for water-level observations, (4) drilling of four deep test wells to determine the character of the sediments and the quality of the water in the Biscayne aquifer, (5) leveling to refer measuring points to mean sea level altitudes, (6) periodic water-level measurements, (7) periodic determination of the chloride content of water from wells and bodies of surface water; and (8) pumping tests to determine the water transmitting and storing properties of the aquifer.

PREVIOUS INVESTIGATIONS

No detailed investigation of the ground-water resources of the Pompano area has been made previously. However, considerable information on the hydrology and geology of the area has been published by the Florida Geological Survey and the U. S. Geological Survey. Most of the publications have been reviewed and some of the data have been used in this report. Publications most pertinent and frequently used are reports by Cooke (1945), Black and Brown (1951), Parker and others (1955), Schroeder and others (1958), and Sherwood (1959).

PERSONNEL AND ACKNOWLEDGMENTS

The investigation was under the immediate supervision of M. I. Rorabaugh, district engineer, Tallahassee, and Howard Klein, geologist-in-charge, Miami, Florida, of the U. S. Geological Survey. C. B. Sherwood of the U. S. Geological Survey gave much valuable help and advice during the study.

The investigation was greatly aided by residents of the area who furnished information on and permitted access to their wells. The author further appreciates the information and aid given by personnel of the city of Pompano Beach and other municipalities in the area. Special acknowledgment is expressed to the Maxson Well Drilling Co.; Philpott, Ross and Saarinen, consulting engineers; and S. W. Wells of the General Development Corporation.

WELL-NUMBERING SYSTEM

The well-numbering system used in this report is based on parallels of latitude and meridians of longitude which divide the study area into 1-minute quadrangles. Each 1-minute quadrangle is assigned a number consisting of the degree and minute of the parallel on the south side of the quadrangle and the degree and minute of the meridian on the east side of the quadrangle. Each well number consists of three sets of digits separated by hyphens. The first and second sets are the quadrangle number, abbreviated to three digits by omitting the left digit of each latitude and longitude value of the quadrangle number. The third set is the number assigned consecutively to each well within the 1-minute quadrangle as it was inventoried. For example, well 615-006-4 was the fourth well inventoried in the 1-minute quadrangle bounded on the south by 26°15′ north latitude and on the east by 80°06′ west longitude.

The same system is used in numbering surface-water observation points, except the third set of digits is prefixed by the letters "SW." For example, the stage of the Hillsboro Canal was measured periodically on the upstream side of the locks and is designated by the number 619-007-SW1. Wells and surface-water observation points, referred to by number in the text, are located on figure 3.

GEOGRAPHY

LOCATION AND GENERAL FEATURES

The Pompano Beach area in this report includes the area of study shown in figure 1. The area comprises about 60 square miles and is bounded on the north by the Hillsboro Canal, on the west by the Everglades and Conservation area 2, on the south by Canal C14 (Pompano Canal), and on the east by the Atlantic Ocean (fig. 2).

POPULATION

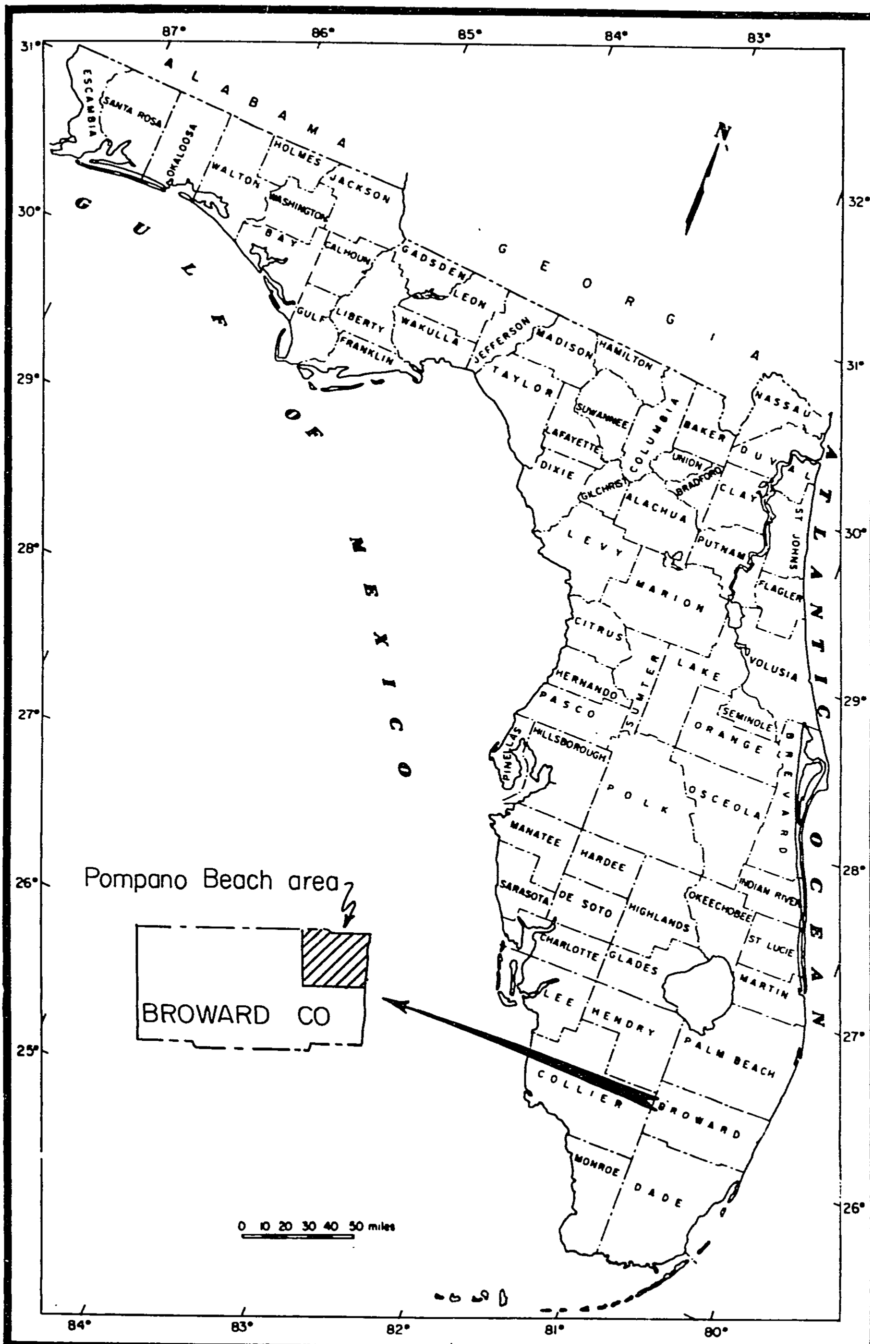
The area has experienced a tremendous influx of people since 1950. In 1950, Pompano Beach and Deerfield Beach had a combined population of 7,770 and the entire study area probably had less than 10,000 people. The area has changed from a rural economy to a tourist and retirement center with a population of 60,000 in 1960, an increase of 600 percent in 10 years. The projected population increase has been estimated at about 12 percent per year during the 1960's.

CLIMATE

The climate of Pompano Beach is subtropical and generally quite humid. The average monthly temperature ranges from 65.4°F to 81.7°F. During the period 1950-60 the average temperature was 74°F, and the average monthly rainfall was 64 inches. The highest temperature and heaviest rainfall generally occur during May through October, and the lightest rainfall occurs during the winter. The average temperature and rainfall data given in table 1 were furnished by the U.S. Weather Bureau.

TOPOGRAPHY AND DRAINAGE

The study area is part of the Atlantic Coastal Ridge, which is bounded on the east by the Atlantic Ocean and on the west by the Everglades. The land surface rises to about 22 feet above msl (mean sea level) at the crest of the ridge, which is about 2 miles inland and is parallel to the coast. The ridge is mantled by white quartz sand, which is thickest at the crest and thins to less than 5 feet in the backswamp area where it is underlain by a thin permeable limestone layer.



Base taken from 1933 edition of map of Florida by U S Geological Survey

Figure 1. Peninsular Florida showing location of Pompano Beach area.

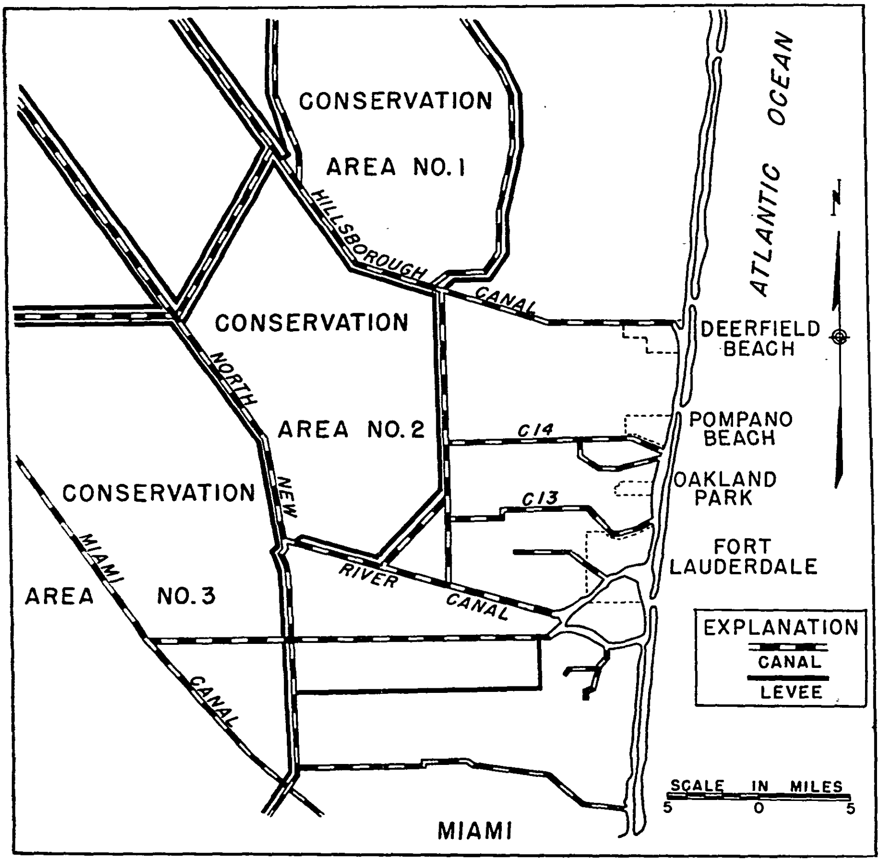


Figure 2. Parts of Broward and Palm Beach counties showing canals and levees of the Central and Southern Florida Flood Control District.

West of the divide or crest of the ridge the land surface descends rapidly to the backswamp area, which is about half a mile west of the divide. The backswamp area slopes gently to the west 5 miles to the Everglades, and consists of swampy sloughs and low intraswamp ridges.

Originally, the backswamp area remained wet for long periods, being poorly drained by sloughs toward the west and by underground flow toward the ocean. Subsequently, it was developed for farming by the construction of a series of canals, ditches, dams, and pumping stations to control water levels. Presently, the backswamp area is irrigated and drained through secondary canals which connect with the Hillsboro Canal on the north and the

TABLE 1. Average Monthly Temperature and Rainfall at Pompano Beach, 1950-60

Month	Temperature °F	Rainfall (inches)
January	65.4	2.02
February	67.6	2.34
March	69.5	3.00
April	73.7	4.25
May	76.9	5.49
June	79.8	7.19
July	81.2	5.99
August	81.7	6.90
September	80.6	10.60
October	76.6	9.10
November	72.1	3.48
December	67.1	3.40
Yearly average	74.4	63.76

Pompano Canal on the south. These major canals flow eastward to the ocean (fig. 2).

The Hillsboro and Pompano canals drain water from the Pompano Beach area and they are also a part of the Central and Southern Florida Flood Control District network of canals that drain parts of the Everglades. The flow of the Pompano Canal is controlled by a spillway structure a short distance east of the Florida East Coast Railroad, and a gated dam 2 miles farther upstream (fig. 3). During periods of heavy rainfall, these structures are adjusted to prevent local flooding; however, during most of the year they are operated to hold high stages in the canal. Major floodwaters in the western area are removed by the diversion canal south of the Pompano Canal (fig. 3), and through the Hillsboro Canal in the northern part of the area. The Hillsboro Canal is controlled 2 miles upstream from the Florida East Coast Railroad.

The west slope of the ridge area drains to the backswamp area; the east slope of the ridge drains to the Intracoastal Waterway. In recent years drainage east of the ridge divide has been highly developed to accommodate urbanization, and the area now drains to the Intracoastal Waterway through storm sewers, streets west of U. S. Highway 1, and by a massive system of finger-canals east of U. S. Highway 1 (fig. 3).

BISCAYNE AQUIFER

The Pompano Beach area is underlain by the Biscayne aquifer which is composed chiefly of permeable limestone, sandstone, and sand that range in age from late Miocene through Pleistocene. The

Biscayne aquifer is thickest near the coast, where its base is about 400 feet below msl, and it thins to the west. Hydrologically the aquifer is a unit, but geologically it comprises the following formations: Tamiami Formation, upper Miocene; Anastasia Formation, Pleistocene; Miami Oolite, Pleistocene; and Pamlico Sand, Pleistocene. The entire section of sediments in this area probably is of marine origin. The Biscayne aquifer is underlain to a depth of 950 feet by a massive section of marine sediments of middle and early Miocene age that are predominantly greenish sandy clay and marl of low permeability. This material forms the upper confining layers for the Floridan aquifer, a regional artesian system which, in the Pompano Beach area, yields salty water to flowing wells.

Detailed lithologic logs of four test wells in the Pompano Beach are a are given in the section of well logs.

GEOLOGIC FORMATIONS COMPOSING THE BISCAYNE AQUIFER

TAMIAMI FORMATION

The Tamiami Formation is the oldest and lowest formation in the Biscayne aquifer. As redefined by Parker (1951, p. 823), it includes all the upper Miocene material in southern Florida. The Tamiami Formation ranges in composition from pure quartz sand to nearly pure limestone, which is generally white to gray in color. Rock layers are formed at random depth but they cannot be correlated over large areas because wedging and lensing of the sediments is common. The percentage of carbonate material in the sediments shows a general increase with depth.

The numerous indurated zones are quite permeable, and open-end wells in the limestone layers are capable of yielding large quantities of water. The formation is tapped by only a few wells because equally good water and comparable yields can be obtained from wells that penetrate shallower limestones in the Anastasia Formation.

ANASTASIA FORMATION

The Anastasia Formation of Pleistocene age was named by Sellards (1912, p. 18) after studying coquina pits at St. Augustine, Florida. Since 1912, the formation has been noted along the coastal ridge as far south as Dade County. In the Pompano Beach area

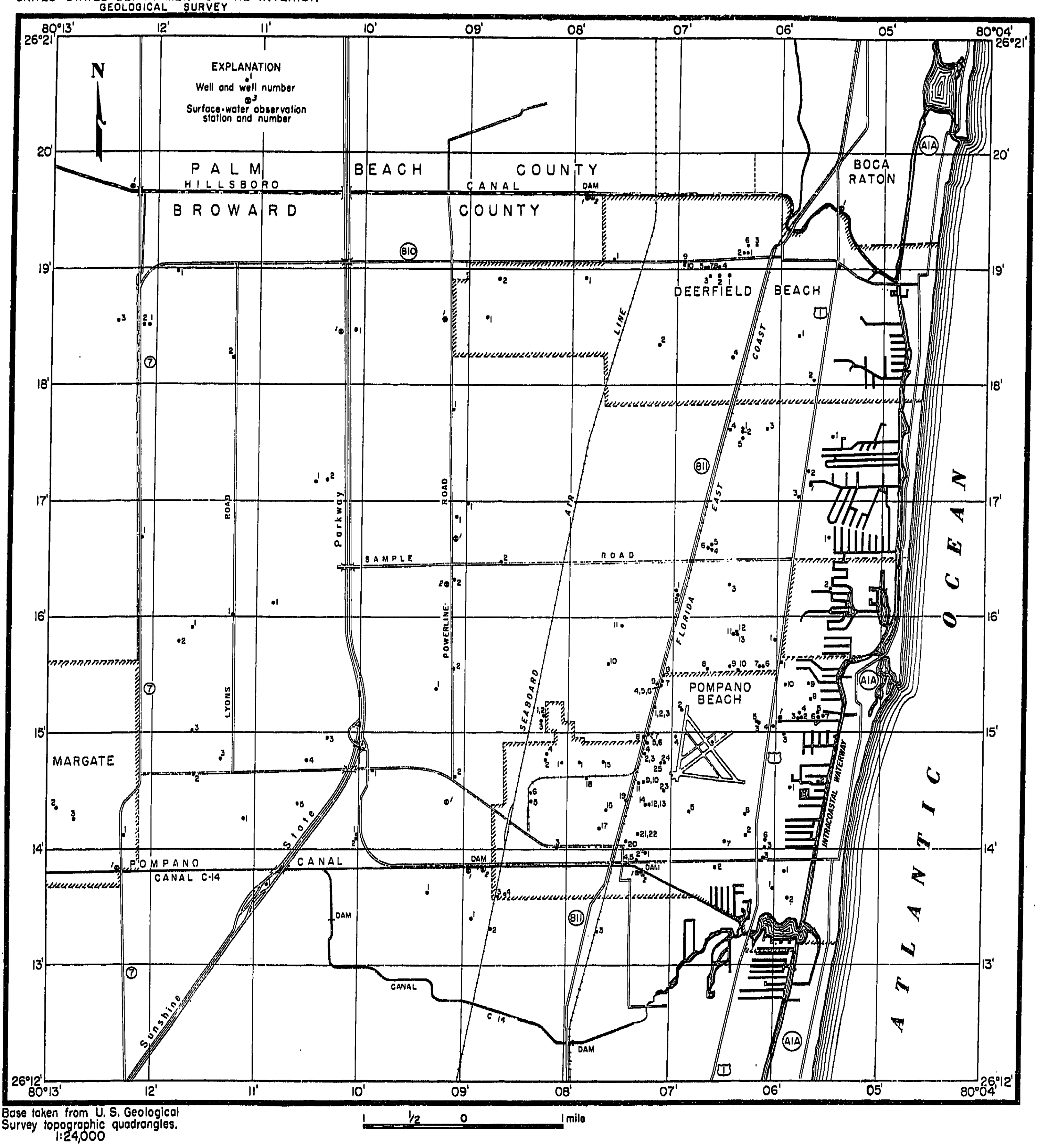


Figure 3. Northeastern Broward County showing locations of wells and surface-water observation stations.

the formation overlies the Tamiami Formation and is covered by the Pamlico Sand and the Miami Oolite. The Anastasia Formation, as defined by Schroeder (1958, p. 21), includes all pre-Pamlico marine deposits of Pleistocene age along the coastal areas. It consists of heterogeneous mixtures of very fine to very coarse quartz sand, finely broken shells, and redeposited calcium carbonate either in the form of calcite crystals or as cryptocrystalline cementing materials. The colors range from white to gray or tan.

The indurated zones are generally highly permeable and yield very large quantities of water (2,000 gpm) to open-end wells. The Anastasia Formation is the most important component of the Biscayne aquifer in the Pompano Beach area.

MIAMI OOLITE

Miami Oolite was named by Sanford (1909, p. 211-214) and redefined by Cooke and Mossom (1929, p. 204-207) to include all the oolitic limestone in southern Florida. The Miami Oolite of Pleistocene age, overlies the Anastasia Formation in the Pompano Beach area and is covered by the Pamlico Sand. It is fairly persistent west of the coastal ridge but occurs discontinuously in the ridge area along the Pompano and Hillsboro canals. The formation is a sandy, oolitic limestone containing many pelecypod shells. It is a white thin-bedded to massive, very permeable limestone which may occur locally as a solid rock to a depth of 40 feet below the land surface.

Where the rock is appreciably thick it is an excellent aquifer, but because it is discontinuous very little water is derived from it. The Miami Oolite is strip mined and used extensively as road base building material, and decorative building stone.

PAMLICO SAND

The Pamlico Sand is a late Pleistocene terrace deposit of marine origin. Parker and Cooke (1944, p. 74-75) extended the term Pamlico Sand from North Carolina to southern Florida, and defined it to include all the marine Pleistocene deposits younger than the Anastasia Formation. The Pamlico Sand blankets the study area except in the north-central part, where the Miami Oolite crops out. The sand west of the ridge is generally 2 to 5 feet thick, and on the ridge it attains a maximum thickness of 18 feet. It is very fine to coarse, mostly of medium size, subangular, and contains varying amounts of iron oxide.

Numerous sand-point wells completed in this material will yield small quantities of water (50 gpm or less), which commonly has a high iron content.

GROUND WATER

Ground water is the subsurface water in the zone of saturation, the zone in which all pore spaces are filled with water under greater than atmospheric pressure. The chief source of ground-water replenishment in the Pompano Beach area is local rainfall. Part of the rainfall is evaporated, part is absorbed by plants and transpired, and a part is lost by surface runoff; the remainder infiltrates downward to the zone of saturation. After entering the zone of saturation, ground water flows by gravity from areas of recharge, where water levels are high, to areas of discharge, where water levels are low. A formation, group of formations, or part of a formation within the zone of saturation that is capable of transmitting water in usable quantities is called an aquifer.

OCCURRENCE OF GROUND WATER

Ground water in the Pompano Beach area occurs under both water-table (nonartesian) conditions and artesian conditions. Where water occurs in an unconfined aquifer and its upper surface is free to rise and fall, the aquifer is referred to as a water-table aquifer and its upper surface is the water table. In the Pompano Beach area all fresh ground-water supplies are derived from the Biscayne aquifer, a water-table aquifer.

Ground water contained in an aquifer that is confined by impermeable beds, and that is under sufficient pressure to rise above the top of the aquifer, is defined as artesian water. The height to which the water will rise in a tightly cased well that penetrates an artesian aquifer is the pressure, or piezometric, surface. Artesian ground water occurs beneath the area but the top of the artesian (Floridan) aquifer is about 950 feet deep and contains salty water.

RECHARGE AND DISCHARGE

The Biscayne aquifer is recharged by rainfall and by surface water pumped into the area through canals. About 50 percent of the rainfall (estimated by Parker and others, 1955, p. 221, for a

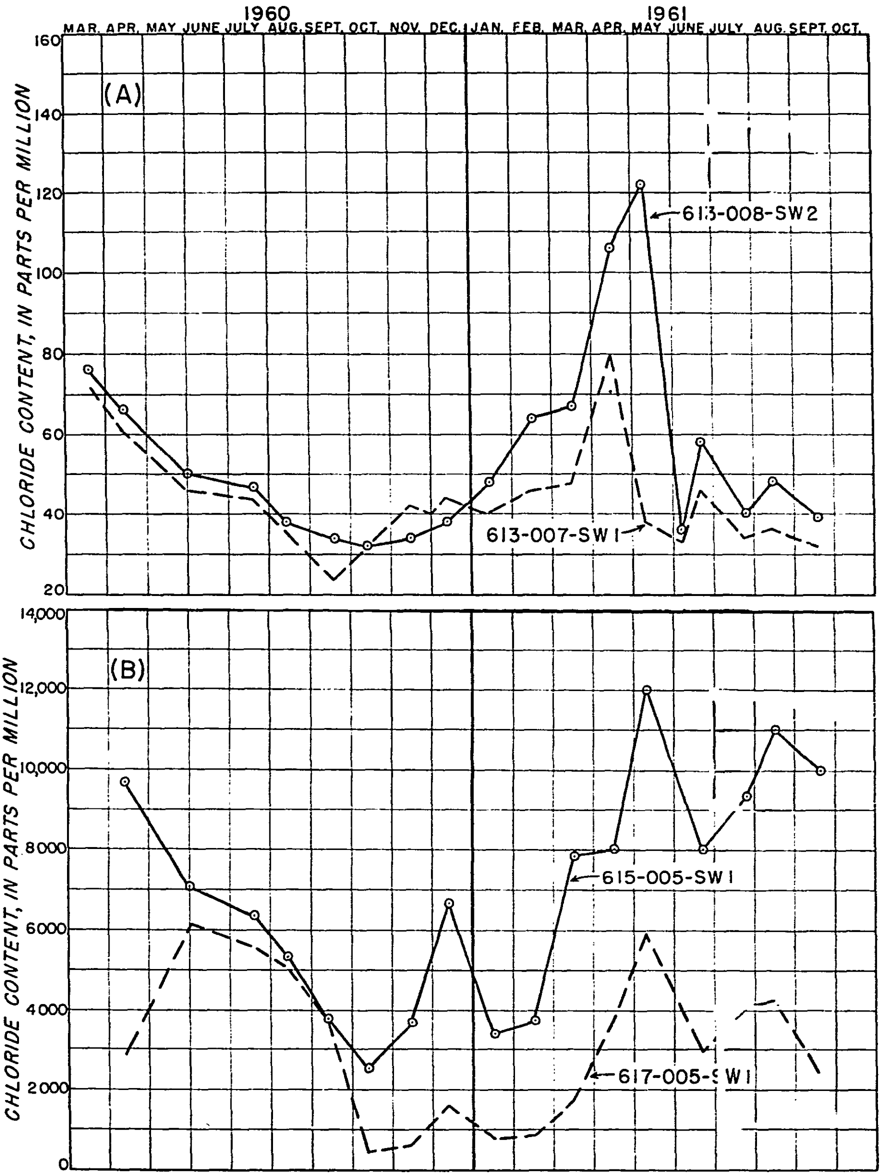


Figure 4. Graphs of fluctuations of chloride content of the water from the Pompano Canal and two finger canals.

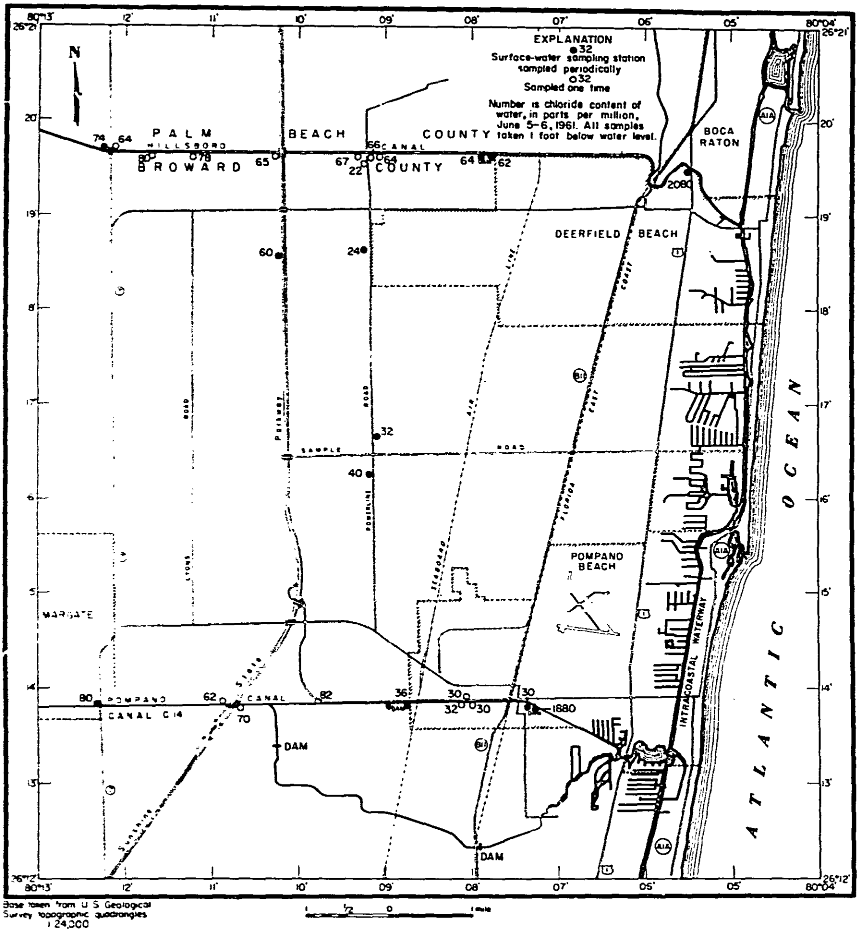


Figure 5. Northeastern Broward County showing the chloride content of water samples from surface-water bodies June 5-6, 1961.

similar area in North Miami), infiltrates to the zone of saturation and becomes ground water. In the western part of the Pompano Beach area great volumes of water are pumped through a system of irrigation canals which maintain high ground-water levels during the dry seasons. The pumping procedures are reversed during rainy seasons to prevent flooding of croplands.

Discharge from the Biscayne aquifer occurs by evapotranspiration, by ground-water outflow to canals and to the ocean, and by pumping from wells. Evapotranspiration and ground-water outflow probably account for more than 80 percent of the total discharge. The losses are greatest during the rainy season in late spring to early fall when temperatures and water levels are highest.

Evidence of the discharge of ground water into canals is shown by the periodic changes in the quality of the water in several canals in the area. Figure 4 compares the chloride content of the water from two observation stations (613-007-SW1 and 613-008-SW2) along the lower controlled reach of the Pompano Canal during 1960-61. Throughout most of the sampling period the water at station 613-007-SW1 had a slightly lower chloride content than the water at station 613-008-SW2. The chloride content is lowest during the rainy seasons and highest during dry seasons. Water moving from the west in the Pompano Canal generally contains more salt than does the ground water in the Pompano Beach area. During wet periods, such as July to October 1960, a large part of the increased flow of the Pompano Canal was the result of heavy ground-water discharge into the canal in the Pompano Beach area which caused dilution of the canal water as it moved to the ocean. During the ensuing dry season of 1961, a large part of the canal flow was contributed by areas west of Pompano Beach, as a result the chloride content of the canal water increased.

Figure 5 shows the chloride content of the surface water at points in major canals, irrigation laterals, and ponds or rock pits June 5-6, 1961. The distribution shows that the chlorides are higher in the western areas than they are near the coast. In the Hillsboro Canal, water entering the area from the west contained 74 ppm (parts per million) of chloride and was diluted by ground-water discharge along the lower reach to 64 ppm at the control dam. Similarly, the water in the Pompano Canal was diluted from 80 ppm of chloride at the western edge to 30 ppm above the control in Pompano Beach.

WATER USE

The greatest use of ground water in northeastern Broward County is for public supplies. During 1960-61 the total pumpage for public supplies in the area was 7 to 8 billion gallons (fig. 6). In 1961 the municipalities pumped about 4.3 billion gallons, at a rate of about 12 mgd (million gallons per day); about one-half was used for lawn irrigation.

The maximum withdrawals normally are during the winter season, when the population is greatest, when the rainfall is least, and when irrigation is heaviest. The normal condition seldom exists; therefore, during some years the largest withdrawals are

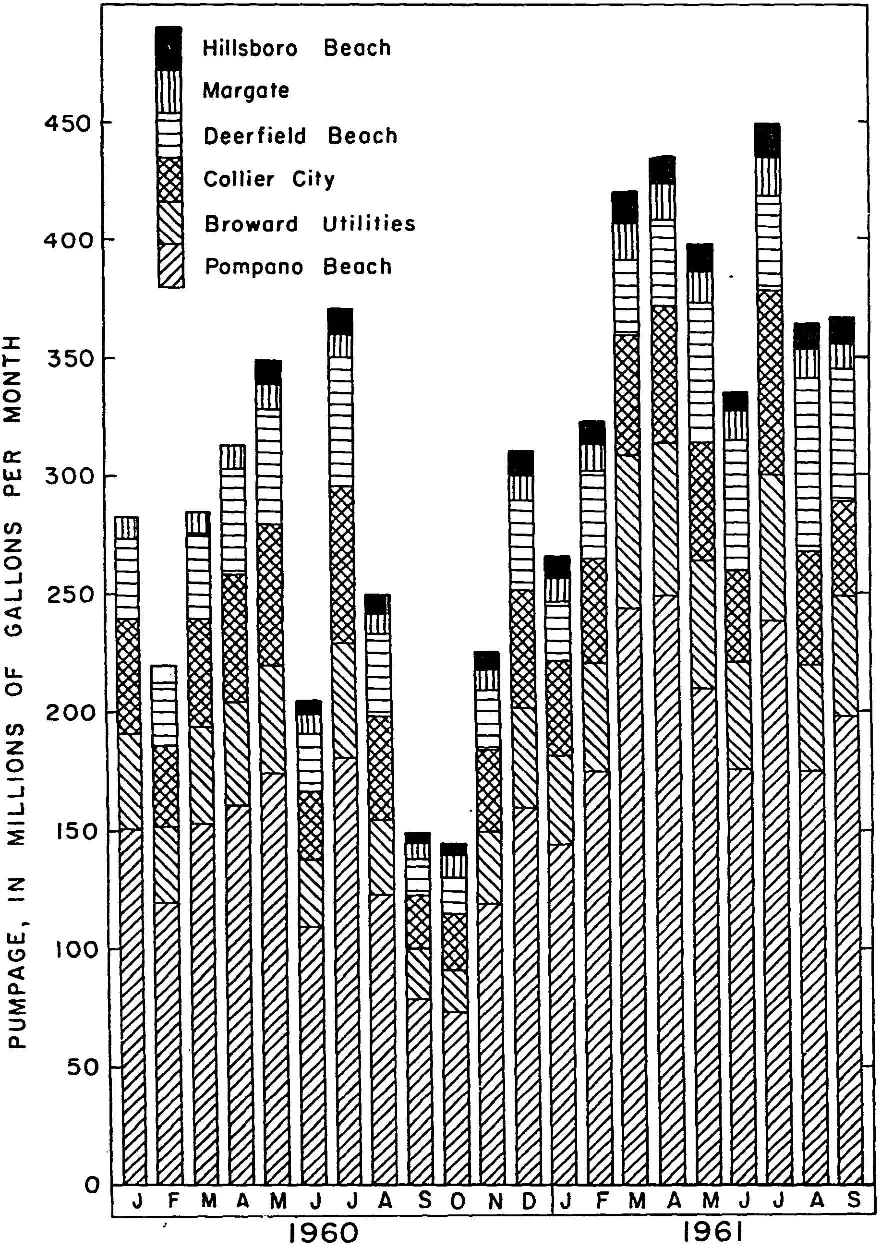


Figure 6. Graph showing monthly pumpage of municipal supplies in northeastern Broward County.

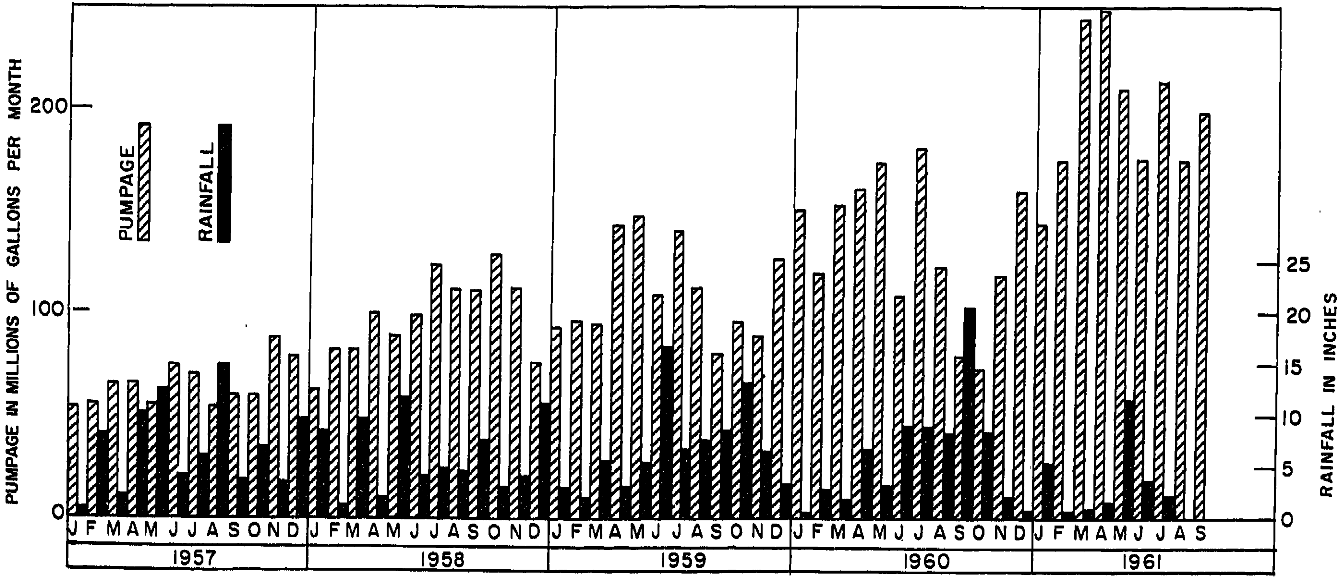


Figure 7. Monthly pumpage from the Pompano Beach well field and monthly rainfall at Pompano Beach, 1957-60.

in the summer, when rainfall is deficient. Figure 7 shows the monthly pumpage from the Pompano Beach well field and the monthly rainfall at Pompano Beach. A relation between pumpage and rainfall is evident. The graph also shows the large increase in annual pumpage from 1957 to 1961. It is estimated that the pumpage by 1970 will be twice that of 1961.

A large quantity of water is used by residents who irrigate lawns from privately owned wells. The use of water for industry is very small except for the seasonal use by the vegetable packing plants in the western part of the area. Most water for crop irrigation in the west is obtained from surface-water sources.

WATER-LEVEL FLUCTUATIONS

Major fluctuations of ground-water level in the Pompano Beach area are caused by recharge to and discharge from the Biscayne aquifer. The magnitude of the fluctuations and the day-by-day changes were determined from automatic recorders installed on selected wells in Pompano Beach during 1960-61. Also, monthly measurements of water level were made in wells of random depth in the aquifer. The continuous water-level records provided information on short term fluctuations and furnished a complete record of the seasonal fluctuations. The periodic measurements provided information to determine the configuration and altitude of the water table at different times. The water-table maps were used to determine areas of recharge and discharge, the direction of flow in the aquifer, and changes in ground-water storage.

The most pronounced and rapid water-level fluctuations are the result of recharge by rainfall and discharge by pumping. The effect of recharge is shown in figure 8 by the rise of the water table when appreciable rainfall occurs, such as on September 23 and October 22, 1960. The combined effect of discharge by evapotranspiration, ground-water outflow, and pumpage is indicated by the relatively slow decline of the water table as compared to the rapid rise caused by recharge. The effect of pumping ground water on water levels is very pronounced near a discharging well, but is included in and masked by the general effect of the other discharge factors.

Figure 9 compares the hydrograph of well 614-007-11, in the Pompano Beach well field, with that of well 614-008-1, nearly 1 mile west of the well field. The rate of decline of the water level in well 614-007-11 is slightly more rapid than that in well 614-008-1 and can be attributed to the effect of withdrawals in the well field. The

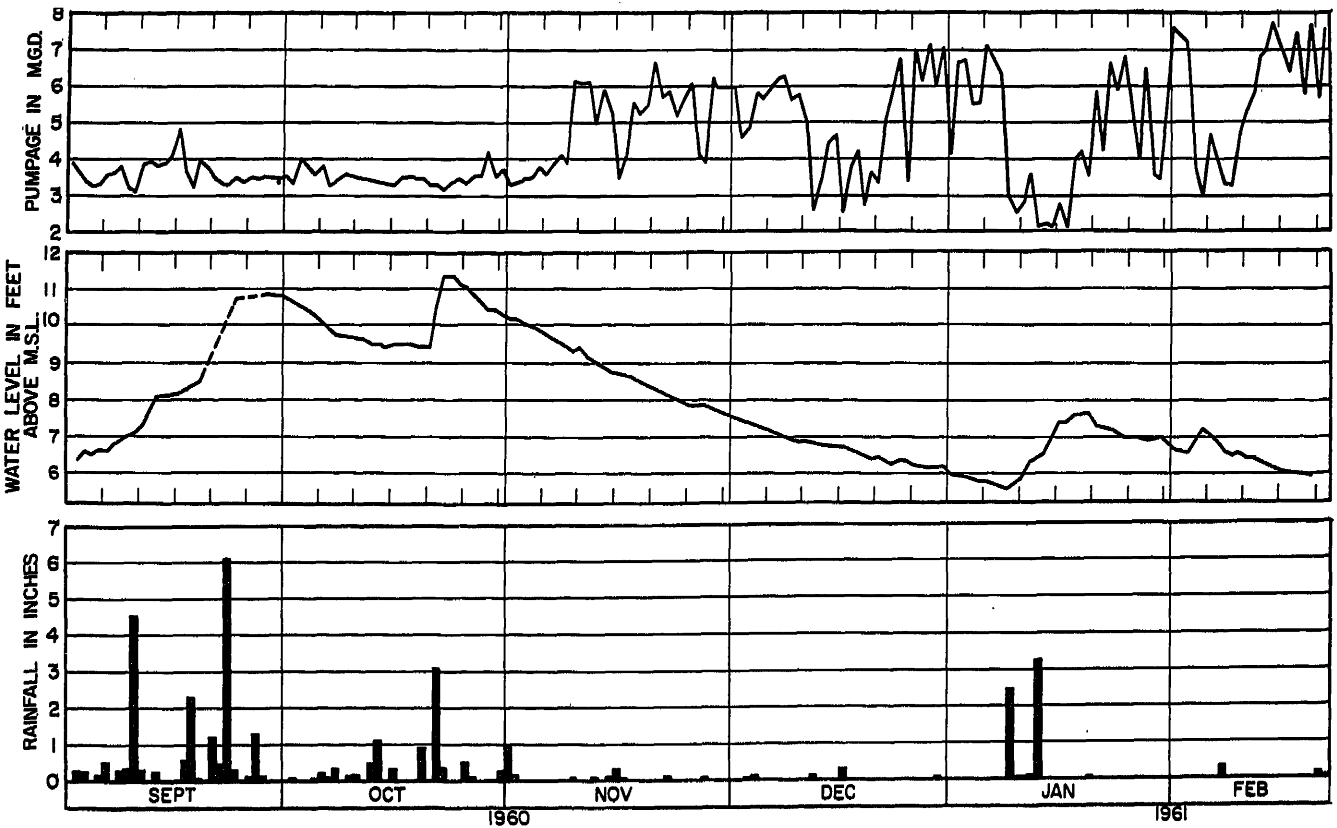


Figure 8. Hydrograph of well 614-007-11, daily municipal pumpage and daily rainfall at Pompano Beach, Sept. 1960-Feb. 1961.

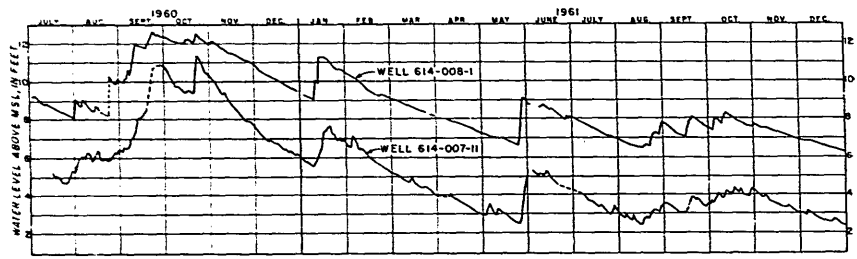


Figure 9. Hydrographs of wells 614-007-11 and 614-008-1 at Pompano Beach.

rate of water-level recession in well 614-008-1 suggests no reflection from well field pumping. The relative effect of pumping also is suggested in part by a comparison of the range of fluctuations in the two wells. The total range in well 614-007-11 was 9 feet, whereas that in well 614-008-1 was slightly more than 6 feet. When water levels are high, the effect of outflow to drainage canals has some differential effect on the rates of decline; when water levels are low, ground-water outflow to canals is reduced and the rate of decline of water levels is reduced accordingly.

During September and October 1960, water levels in the area generally rose about 5 feet as a result of heavy rainfall (fig. 8). Very little water was pumped for irrigation and withdrawals from the Pompano Beach well field were reduced to 3.5 mgd. During the next 6 months, deficient rainfall and increased pumping for irrigation and municipal purposes caused water levels to fall below the pre-September levels.

Contour maps were prepared from water-level data in the area to represent high, average, and low-water conditions in the Biscayne aquifer for the period of record. Figure 10 represents the approximate configuration and altitude of the water table on October 13, 1960, when water levels were abnormally high owing to the extremely heavy September rainfall. The map shows steep ground-water gradients toward the Hillsboro Canal, the Intracoastal Waterway, and the Pompano Canal, indicating heavy discharge of ground water throughout the area.

The large depression in the water table in the center of the area, between Powerline Road and the Seaboard Air Line Railroad, is caused by heavy pumping from rock pits to lower water levels so that the pits can be mined. The trough in the water table, southwest of the rock pits indicates that the canal that connects the pits with the Pompano Canal was effectively draining ground water from storage in the aquifer. Significant recharge was

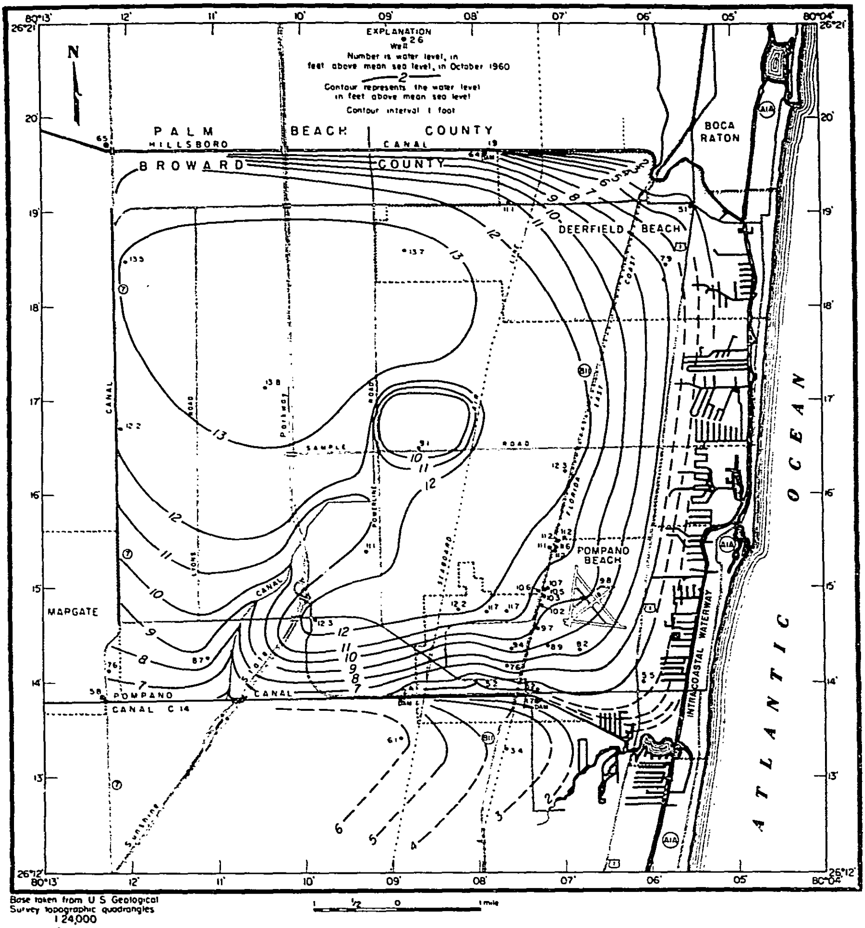


Figure 10. Northeastern Broward County showing contours on the water table October 13, 1960, when water levels were high.

occurring in the northwestern part of the area, as indicated by the large ground-water mound within the 13-foot contour. The close spacing of the contours adjacent to the Hillsboro Canal, on the north, suggests a thinning or a decrease in permeability of the Biscayne aquifer.

Figure 11 represents the water table on March 16, 1961, when water-level conditions were about average. The water-table depression at the rock pits is still evident but it is much less pronounced than it was in October 1960; however, the canal to the southwest of the rock pits continues to drain ground water from storage from the adjacent area. The high ground-water mound

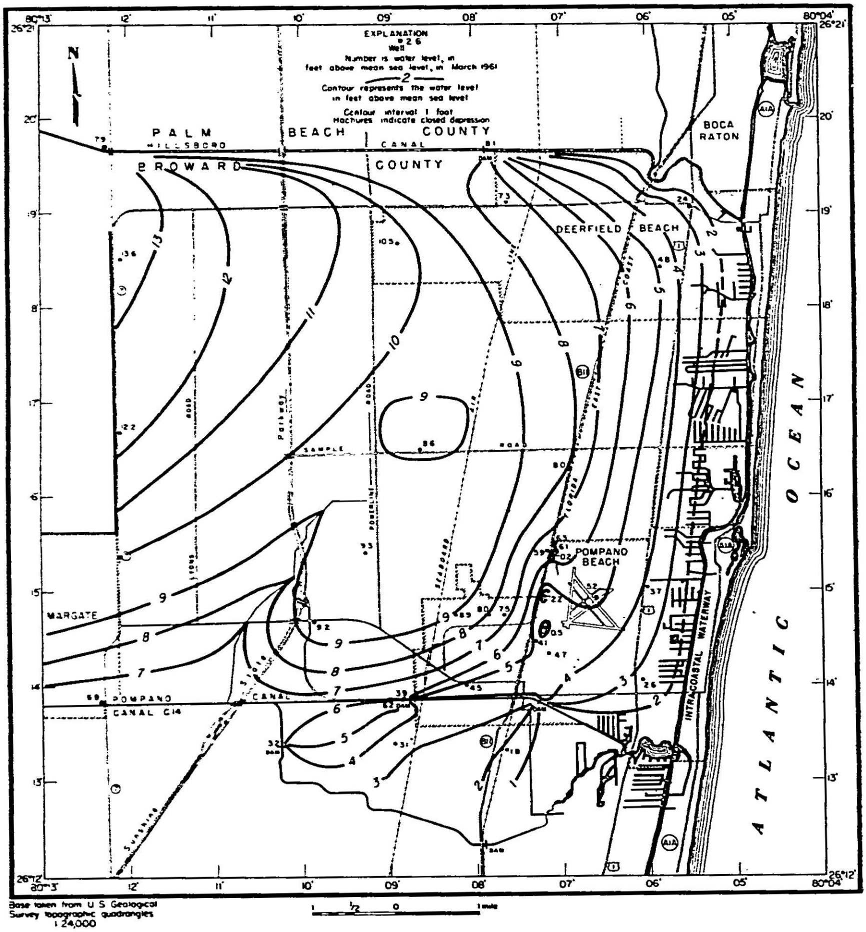


Figure 11. Northeastern Broward County showing contours on the water table March 16, 1961, when water levels were about average.

in the northwest has been dissipated and the 13-foot water-level contour has shifted westward. The pattern of the contours indicates that the northern reach of the canal adjacent to State Highway 7 was the main source of recharge to the Biscayne aquifer in the Pompano Beach area. Canal C14 was completed by March 1961 and its flow was controlled by a dam a short distance downstream from its confluence with the Pompano Canal and another located at the Florida East Coast Railroad.

Within the Pompano Beach well field area, the water-table contours show considerably more distortion as compared to the contours for October 1960. The pronounced distortion is the result

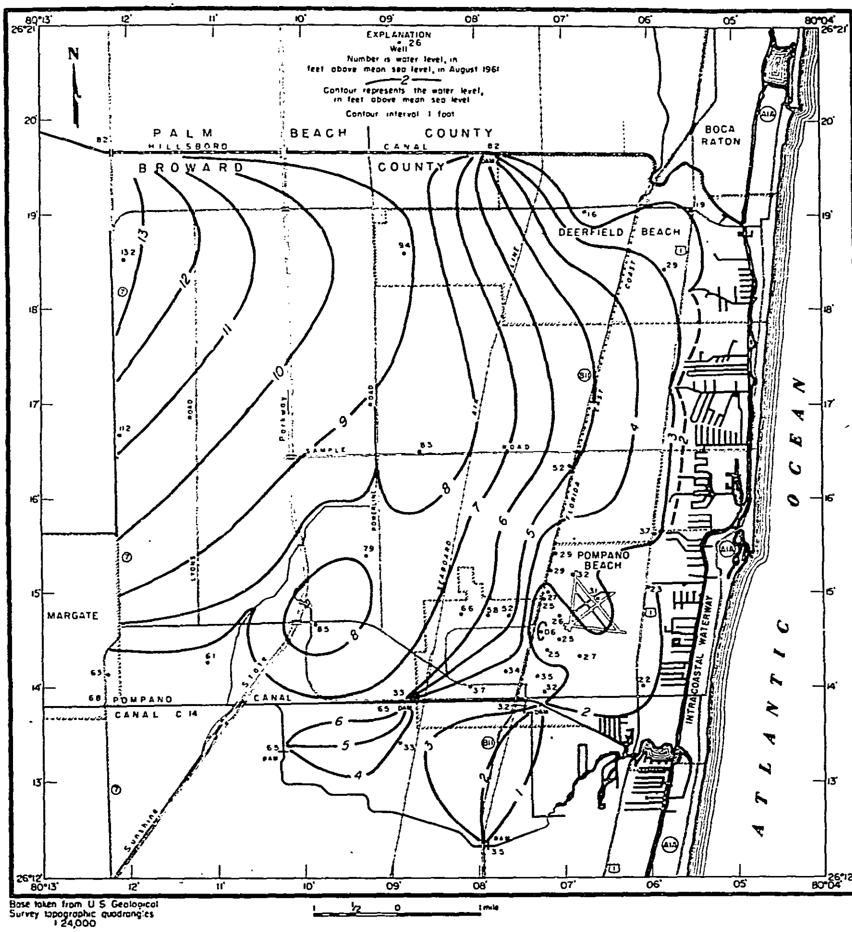


Figure 12. Northeastern Broward County showing contours on the water table August 15, 1961.

of heavier pumping in the well field during March 1961 (about 8 mgd). The gradients toward the canals are less, indicating less outflow than in October 1960.

Figure 12 represents the altitude and configuration of the water table on August 15, 1961, when water levels were low as a result of generally deficient rainfall. The general pattern of the contours is about the same as that in March, but the distortion of the contours in the vicinity of the Pompano Beach well field is more acute because of the continuous heavy pumping throughout the period of deficient rainfall. A noticeable distortion in the contours also occurs

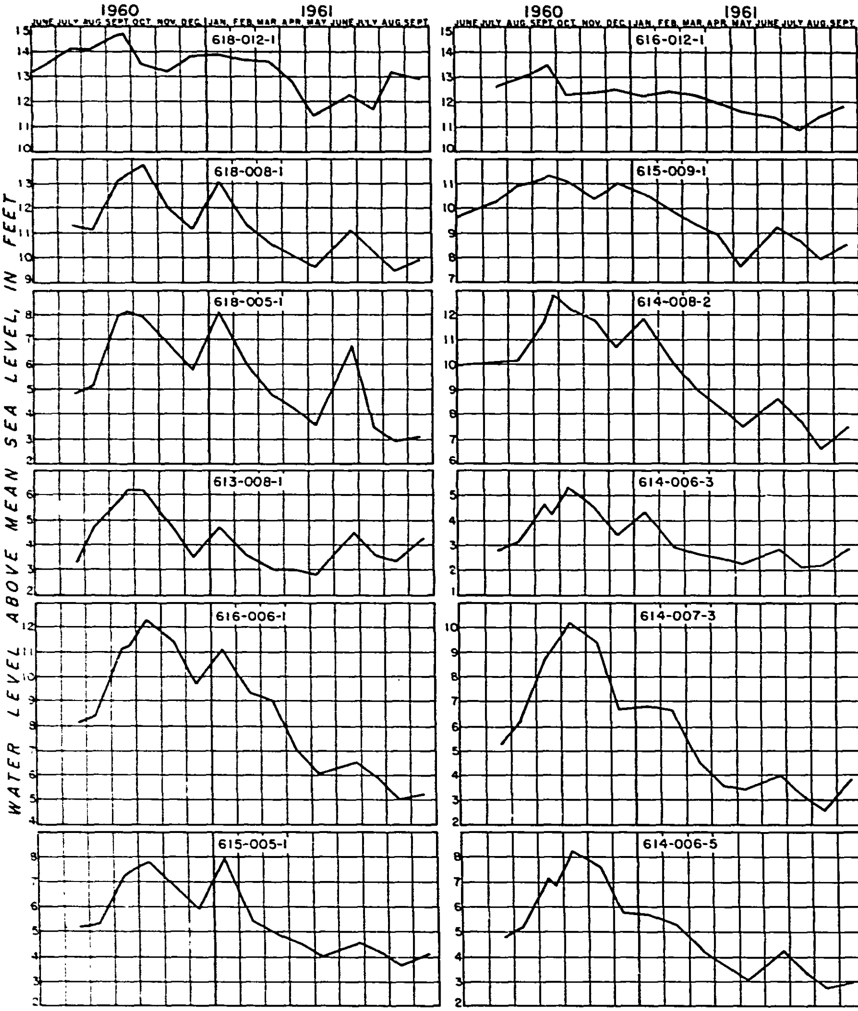


Figure 13. Hydrographs of wells in northeastern Broward County.

in the vicinity of the Deerfield Beach well field, about half a mile west of the Florida East Coast Railroad, as a result of relatively heavy pumping in the area.

The flat gradient of the water table in the southeast indicates that much of the water that normally moves toward the Intracoastal Waterway is being intercepted by the heavy withdrawals in the Pompano Beach well field. Water levels in the western part of the area remained relatively high during the period of record, because of water-control activities in that area. Water levels are

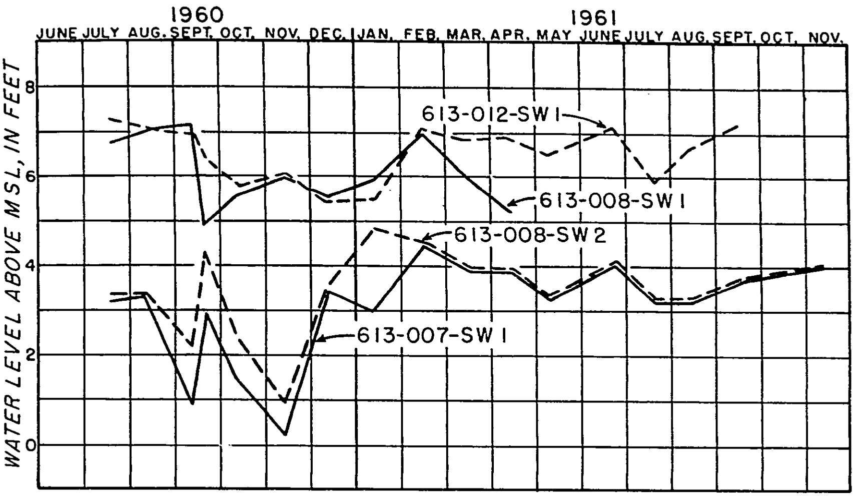


Figure 14. Hydrographs of Pompano Canal showing stage at several locations during 1960-61.

maintained at fairly constant altitude for agricultural purposes by control dams in irrigation canals and by pumping water from the west into the irrigation canals.

Representative water-level fluctuations throughout the study area are shown by the hydrographs in figure 13. Hydrographs of wells 618-012-1 and 616-012-1, located near the perimeter canal (adjacent to State Highway 7) on the west side of the area show relatively small ranges in fluctuations and continuous high water levels as a result of the water-control practices in the area. Conversely, hydrographs of wells 614-007-3, in the Pompano Beach well field, and 616-006-1, near the coast, show the large range of fluctuations that occur in discharge and downgradient areas.

The hydrographs in figure 14 represent periodic water-stage measurements at several locations in the Pompano Canal. The largest fluctuations occur during the wet season when the control dams are open to permit discharge of flood water. During the dry period (1961) the controls were generally closed and water levels were maintained relatively constant and high to furnish replenishment by outflow into the aquifer. The difference between the paired hydrographs indicates the ability to control water levels in the Pompano Canal at desired heads. During the dry season high canal stages are desirable but during flood period canal stages are lowered to accommodate flood waters.

QUALITY OF WATER

The chemical quality of ground water depends upon the amount and type of constituents contained in the recharge, the composition and solubility of the rocks through which the recharge moves, and the presence of connate water in the aquifer. In the Pompano Beach area rainfall is the principal source of recharge. As the rainfall infiltrates to the water table it acquires organic acids and dissolves calcium carbonate from the rocks which imparts hardness to the water. The occurrence of connate water and the encroachment of sea water into the aquifer will be discussed under another section.

Ground-water samples were collected from wells at several locations and from different depths in some wells in the Biscayne aquifer. The samples were analyzed by the U. S. Geological Survey and are presented in table 2. Included also are other analyses made by the General Development Corporation and the Florida State Board of Health. The analyses show that the ground water is hard, but is suitable for most uses, without being treated, or with relatively simple treatment.

Iron derived from iron-bearing minerals within the aquifer or from the action of iron-fixing bacteria is the most noticeable and objectionable constituent in the ground water of this area. Untreated ground water used for lawn irrigation has caused iron staining on shrubs, trees, sidewalks, and houses. In the samples analyzed iron was present in amounts ranging from 0.01 to 4.3 ppm. Iron in concentrations in excess of 0.3 ppm is objectionable in water used for public supply, and in concentrations in excess of about 0.5 ppm it imparts a noticeable taste to the water. The amount of dissolved iron in ground water in the area is very erratic and cannot be predicted with any accuracy even for short distances horizontally or vertically. Iron is most easily and inexpensively removed by aeration and filtration in the large volumes used by municipal supplies.

Hardness is caused by calcium and magnesium dissolved from shell material, limestone, and dolomite in the aquifer. Water having a hardness in excess of 120 ppm is considered hard. Hardness of the water samples ranged from 22 to 316 ppm. The hardness is generally low in the sand ridge area at shallow depths and generally high in the west and at greater depths in the aquifer. This is compatible with the character of quartz sand which is the main component of the aquifer at shallow depths in the ridge area and

TABLE 2. Analyses of Water from Wells in Northeastern Broward County

Analyses by U. S. Geological Survey. Chemical constituents are expressed in parts per million, except pH and color.

Location and well number	Date of collection	Depth of well (feet)	Temperature (°F)	Silica (SiO_2)	Iron (Fe)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids (residue at 180°C)	Hardness as $CaCO_3$: Calcium, magnesium	Hardness as $CaCO_3$: Noncarbonate	Specific conductance (micromhos at 25°C)	pH	Color
613-007-1	1- 3-61	304	77	7.5	4.3	82	4.3	16.0	1.4	266	5.2	28	0.3	0.1	283	222	4	493	7.9	5
613-007-2	8-27-51	190		18.0	0.13	44	2.5	9.8	0.3	136	9.0	14	.1	.9	170	120	9	261	7.4	6
613-010-1[1]	2- 5-57	80	74		2.4	118	4.9	....	....	393	3.0	33	.25	....	414	316	6	....	6.9	22
614-006-1	8-10-60	158	77	3.5	.44	36	1.0	8.3	.6	113	3.6	13	.2	.1	124	94	2	228	8.0	5
614-007-1	8-10-60	220	78	1.7	.30	8.4	0.2	12	.6	11	2.4	18	.2	.1	58	22	0	116	9.8	5
614-007-2	1-24-61	140	77	7.8	.72	54	2.8	8.5	.6	164	10.0	14	.2	.4	182	146	12	315	7.9	10
614-007-9	8-23-51	103	....	12.0	.89	44	.25	9.2	.6	140	8.0	14	.3	.6	168	120	5	267	7.6	7
	9-10-56	....	....	18.0	.01	47	1.1	9.8	.8	140	12.0	16	.1	.4	182	122	8	291	7.8	5
614-007-10	9- 5-51	203	....	14.0	.07	70	3.5	11.0	.7	222	6.5	15	.4	.8	252	189	7	370	7.6	28
614-010-12	6-18-58	147	76	....	1.2	94	6.8	....	....	322	10.0	18	.3	....	320	264	0	....	6.9	10
	6-18-58	168	74	....	.1	88	4.9		....	305	.0	17	.3	....	307	240	0		7.5	10
615-006-4	1-24-61	183	78	9.5	.57	52	2.1	7.7	.4	162	2.8	12	.3	.1	167	138	5	295	8.0	5
615-006-11[1]	3- 5-56	90	76	....	.36	46	.9	....	....	139	27.0	9	.15	....	149	118	4	....	7.5	5
617-006-1[2]	2-24-55	178	75	....	.4	51	2.9	....	....	168	35.0	13	.5	....	186	138	2	....	7.5	7
	3-22-56		76	....	.45	50	2.4	....	....	166	6.0	9	.15	....	183	136	0	....	7.5	10
	5-11-59		77	....	.3	55	1.4	....	....	180	.0	16	.15	....	183	144	4	....	7.3	5
	11- 3-59		77	....	.3	54	2.4	....	....	188	20.0	17	.25	....	175	146	0	....	7.3	5
617-006-2[2]	2-24-55	180	75	....	.4	50	2.9	....	....	168	35.0	15	.5	....	164	138	0	....	7.5	6
	5-11-59		77	....	.4	58	.5	....	....	188	.0	14	....	....	180	148	6	....	7.3	5
	11- 3-59		77	....	.3	55	2.4	....	....	188	20.0	17	.35	....	170	148	0	....	7.3	5
617-006-3[2]	4-18-58	150	76	....	.4	62	4.0	....	....	210	19.0	18	.2	....	225	172	0	....	7.3	8
	5-11-59		78	....	.7	66	1.4	....	....	217	.0	14	.15	....	209	172	6	....	7.2	3
	11- 3-59		78	....	.45	65	2.9	....	....	224	10.0	18	.25	....	210	174	0	....	7.3	7
617-006-4[2]	11- 3-59	122	77	....	.1	50	2.9	....	....	176	30.0	17	.35	....	185	138	0	....	7.3	7
617-006-5[2]	8-27-61	139	76	....	.3	50	1.4	....	....	185	.0	22	.3	....	142	132	0	....	7.4	10
619-006-1[1]	1-15-52	80	78	....	1.3	66	.0	....	....	193	.0	18	.1	....	230	158	6	....	7.3	25

[1]Analyses by Florida State Board of Health.
[2]Analyses by General Development Corporation.

the shell beds and limestone which are the main components throughout the aquifer in the western sections and at great depths beneath the ridge.

The hydrogen-ion concentration (pH) is a measure of the acidity or alkalinity of water. Distilled water has a pH value of 7.0 and thus is neither acid nor alkaline; decreasing values below 7.0 denote increasing acidity and usually indicate a corrosive water; conversely, increasing values above 7.0 denote increasing alkalinity. The pH of the water analyzed ranged from 6.9 to 9.8 and is mostly about 7.5, which is slightly alkaline and should be noncorrosive.

Color in water usually is derived from the decomposition of organic matter. Peat and muck deposits are common in the western part of the area and in buried mangrove swamps in the east. Visible coloration of drinking water is undesirable. Water having concentrations in excess of 20 units is considered by the U. S. Public Health Service (1946) to be unsuitable for human consumption. The range of concentration in this area is from 3 to 28 units. Highly colored water often retains an earthy odor similar to the organic material from which the color was derived. Part of the color of the water in this area is from iron. Color is generally lower than 10 in the sand ridge area and generally high in the west, where several large irrigation wells produce highly colored water.

Dissolved hydrogen sulfide and methane gases were noted in several wells. The gases are derived from the decomposition of organic matter, and they impart undesirable odors. The odors are easily removed by aeration.

SALT-WATER CONTAMINATION

Salt-water contamination in the Biscayne aquifer in northeastern Broward County could occur from two general sources: (1) the direct encroachment of sea water into the coastal parts of the aquifer or along uncontrolled canals; and (2) the upward movement of saline water that may exist in beds below the Biscayne aquifer. If saline water occurs in the underlying beds it may be connate, trapped in the sediments when they were deposited, or it may be sea water that infiltrated the beds during Pleistocene interglacial stages when the ocean inundated the area several times. During this study no certain evidence was found that saline water exists within the aquifer beneath the sand ridge, except for a few local areas immediately adjoining finger canals in Pompano Beach. West of the ridge the chloride content of the water increases slightly and is 30 to 40 ppm along State Highway 7. Farther west, the chloride content increases progressively westward and with depth. Five miles west of State Highway 7 and 1.5 miles south of the Palm Beach County line a 104-foot well yielded water containing 520 ppm of chloride. This increase of salinity with depth is well defined by Parker and others (1955, p. 820), who present several maps showing chloride concentrations in ground water at different depths.

The local occurrences of saline water along the coastal finger canals may be from downward infiltration of salt water from the canals, or from the encroachment of sea water at depth in the Biscayne aquifer. The system of uncontrolled finger canals has lowered water levels along the coast to permit an inland extension of sea water in the aquifer. Also, with the development of the area and the increased use of water, much of the water that normally would have discharged to the sea was intercepted by municipal and irrigation wells, causing further lowering of water levels and reduction of seaward flow.

The movement of salt and fresh water in a coastal aquifer is controlled to a large degree by the relative height of the fresh water above sea level and by the difference in the densities of fresh and salt water. Under static conditions the relation is that of a U-tube whose arms contain two fluids of different densities, and it is expressed by the Ghyben-Herzberg principle (Brown, 1925, p. 16-17) as follows:

$$h = \frac{t}{g - 1}$$

where h = depth of fresh water below sea level
t = height of fresh water above sea level
g = specific gravity of sea water
1.0 = specific gravity of fresh water.

When the approximate value of the specific gravity of sea water (1.025) is inserted in the equation, $h=40t$, or for every foot the fresh water is above sea level, there will be 40 feet of fresh water below sea level. This theoretical condition is modified somewhat by the movement of the fresh water toward points of discharge, by variations in the permeability of the aquifer materials, and by the salinity of the sea water. The variations have only a minor effect so the general relation is adequate for determining the minimum depth at which salt water will occur in coastal parts of the aquifer. One of the inconsistencies is the assumption that the encroaching saline water has a specific gravity of 1.025. The

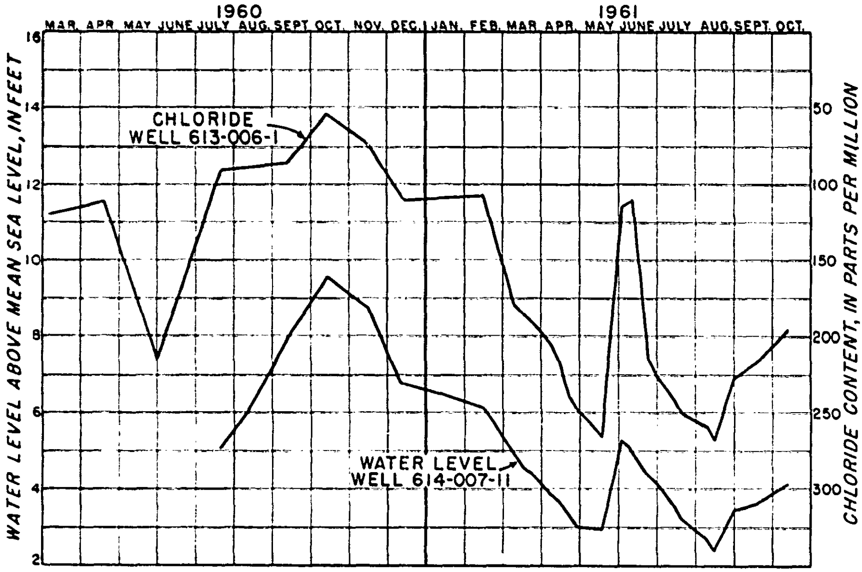


Figure 15. Fluctuations of chloride content of water from well 613-006-1 and water level in well 614-007-11.

inconsistency applies particularly to some of the finger canals that are long and shallow. These canals receive much fresh water from ground-water inflow which causes periodic dilution as shown by two canals in figure 4b.

Because 91 percent of the dissolved constituents in sea water are chloride salts, analyses of the chloride content of ground-water samples can be reliably used to determine the extent of sea-water encroachment in an aquifer. Salt-water encroachment occurs in Pompano Beach adjacent to the uncontrolled finger canals that dissect most of the area east of U. S. Highway 1. This system of canals constitutes a persistent drain of ground water from storage, thereby causing a general lowering of the water table to near sea level during dry seasons. Also, it provides open channels for salt water to move inland. Encroachment is indicated by the changes in chloride content of the water from well 613-006-1, a 70-foot well in the southern part of Pompano Beach (fig. 15).

Figure 15 also shows a comparison of the chloride content of water from well 613-006-1 and the water-level fluctuations in well 614-007-11, less than a mile to the northwest. Well 613-006-1 is flanked on three sides by tidal canals and is pumped heavily during dry periods. The changes in the salinity of the water from the well show an excellent correlation with water levels in the well less than

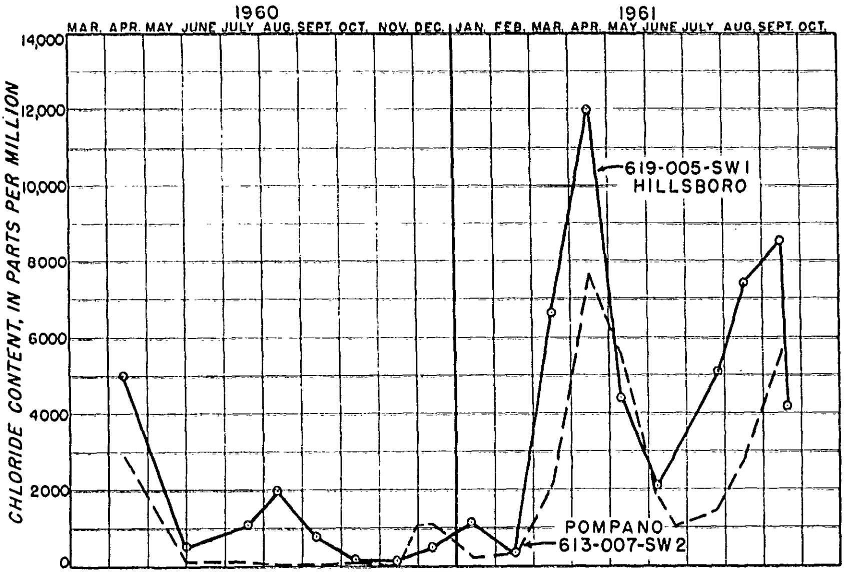


Figure 16. Fluctuations of chloride content of water from uncontrolled reaches of the Hillsboro and Pompano canals.

a mile away. The aquifer in this area probably will become progressively more saline as pumpage from Pompano Beach well field increases and intercepts more of the natural ground-water flow to the southeast.

Figure 16 shows the chloride content of water samples from the observation stations immediately downstream (tidal reach) from the lower control dams in the Hillsboro and Pompano canals. The low chloride contents during most of 1960 are the result of the nearly continuous discharge of fresh water through the control dams. The two large increases in chloride content in 1961 occurred when drought conditions prevailed, ground-water levels were low, and little or no water was being discharged over the control dams.

Water from several wells near the coast showed very small increases in chloride content during 1961 when rainfall was deficient. The changes have a general correlation with water-level fluctuations; that is, an increase in chloride occurs with a decrease in water levels and vice versa. The four lower graphs in figure 17 show periodic chloride changes in two municipal wells (wells 617-006-1 and 619-006-1) that are 4,400 and 2,400 feet, respectively, from saline canals, and two private lawn-irrigation wells (wells 616-005-1 and 613-006-2) that are 200 and 1,000 feet, respectively,

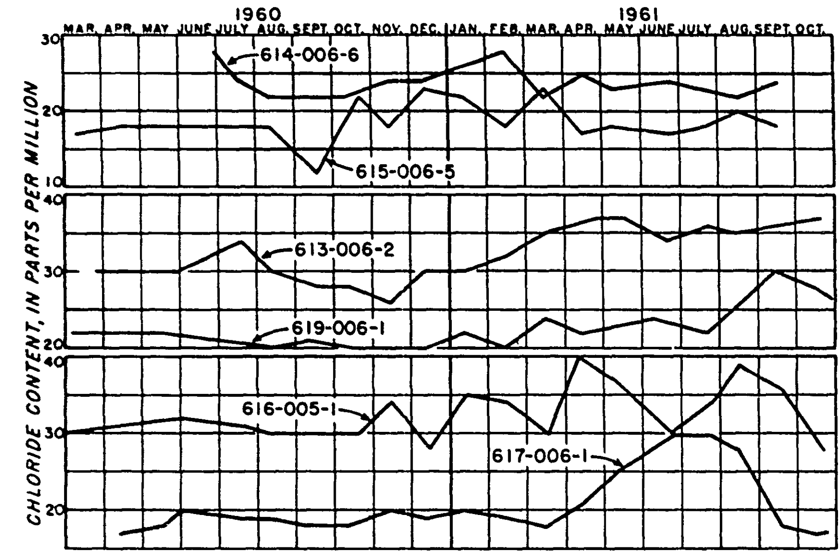


Figure 17. Fluctuations of chloride content of water from wells near bodies of saline surface water.

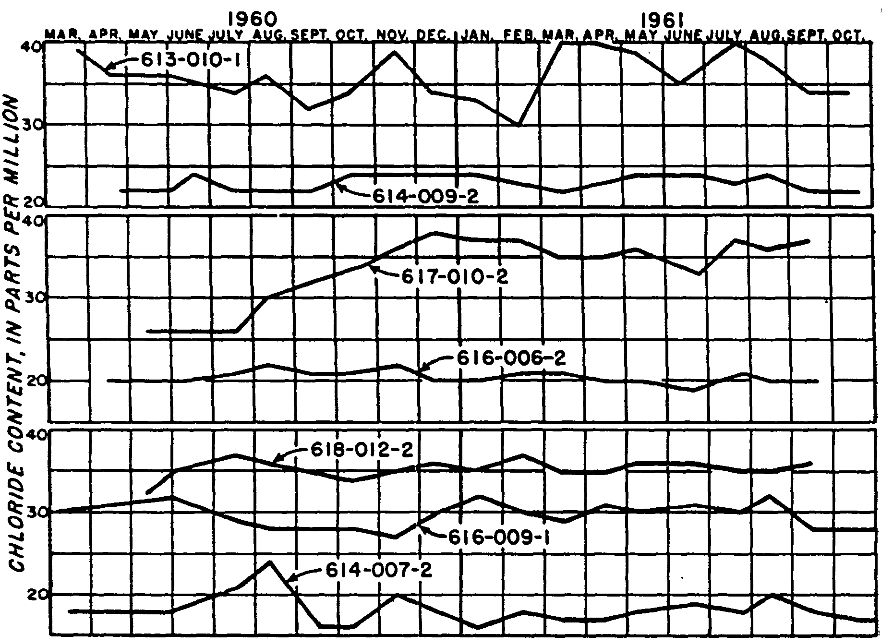


Figure 18. Fluctuations of chloride content of water from wells distant from bodies of saline surface water.

from saline canals. None of these supplies had a chloride content that was in excess of the normal chloride content of the area, indicating that seawater encroachment was not yet a problem in these areas.

Another chloride graph in figure 17 is for the golf course 190-foot irrigation well (well 615-006-5) 900 feet from a saline canal. The well was pumped heavily at regular intervals during 1961. The average water level near this well was about 3.5 feet above msl during most of the summer of 1961. Pumping lowered water levels nearly to sea level in the immediate vicinity of the well, but only a small increase in chloride content was noted.

Analyses of water from wells farther from the coast (fig. 18), similarly showed little or no variation in the chloride content during the study. An exception was well 617-010-2, which showed an increase from 26 ppm to 38 ppm. This change can be associated with the reactivation of a large irrigation well in the immediate vicinity.

In 1948, well 613-006-3 was drilled to salt water at a reported depth of 210 feet. An analysis of the water in 1961 showed a concentration of 4,650 ppm of chloride. If future samples from this well show increases in the chloride content, the increase may be the result of the drainage effect of the uncontrolled part of the Pompano Canal (and connected finger canals) to the south and the series of finger canals to the northeast and the interception of water by the Pompano Beach well field.

Water samples for chloride analysis were collected periodically from selected wells in the area; water samples from 15 of these selected wells were analyzed each month to detect changes in the chloride content. The maximum chloride content in each well was used in the preparation of figure 19. Water samples also were collected during the drilling of test holes to determine the variations of chloride with depth in the Biscayne aquifer in areas between the Pompano Beach well field and bodies of salt water.

Test well 613-007-1, located between the south edge of the Pompano Beach well field and the lower control dam on the Pompano Canal, was drilled to a depth of 304 feet. The average chloride content of water samples from this well was 29 ppm, indicating that the proper operation of the control dam was effectively maintaining high water levels in the southern part of the area, thereby preventing the inland movement of salt water from the controlled reach of the canal.

Test well 615-006-4 was drilled to 183 feet below the land surface near the upstream end of a long finger canal east of the Pompano

Beach airport. Water from all zones sampled in this well contained less than 25 ppm of chloride. Periodic analyses of water from this well determine the effect that the adjacent tidal canal and the heavy pumping at the golf course, immediately to the east, have on the inland movement of salt water. Analyses of samples from wells adjacent to and north of this finger canal show that salty water occurs at relatively shallow depth in the aquifer. Also, samples from wells in the southeastern part of Pompano Beach indicate an inland extension of the salt front.

A potential area of salt-water encroachment could develop in Deerfield Beach adjacent to the tidal reach of the Hillsboro Canal. As shown in figure 19, water of high chloride content has occurred in the canal as far upstream as the control dam. During low-water periods, the effect of heavy pumping in the Deerfield Beach well field, about half a mile south of the canal, could extend northward to the canal and cause a reversal of the normal gradient and a resultant southward migration of salt water. The distortion of the 2-foot contour in the Deerfield Beach area, in figure 12, suggests that a gradient reversal might have been occurring in August 1961.

QUANTITATIVE STUDIES

Knowledge of the hydraulic properties of the aquifer of the Pompano Beach area is essential to an evaluation of its ground-water resources. The foremost hydraulic properties of an aquifer are its ability to transmit and to store water. These properties are expressed as the coefficients of transmissibility and storage. The coefficient of transmissibility is defined by Theis (1938, p. 892) as the number of gallons of water, at the prevailing water temperature, that will move in 1 day through a vertical strip of the aquifer having a width of 1 foot and a height equal to the saturated thickness of the aquifer, under a hydraulic gradient of unity. The coefficient of storage is defined as the volume of water released from or taken into storage per unit surface area of the aquifer per unit change in the component of head. Water transmitted through overlying and underlying semiconfining materials into the principal producing zone is termed leakage. The leakage coefficient (Hantush, 1956, p. 702) indicates the ability of semiconfining beds to transmit water into the section being tested. It is defined as the rate at which water moves through a unit area of the semiconfining bed, if the head between the main aquifer and the bed supplying the leakage is unity.

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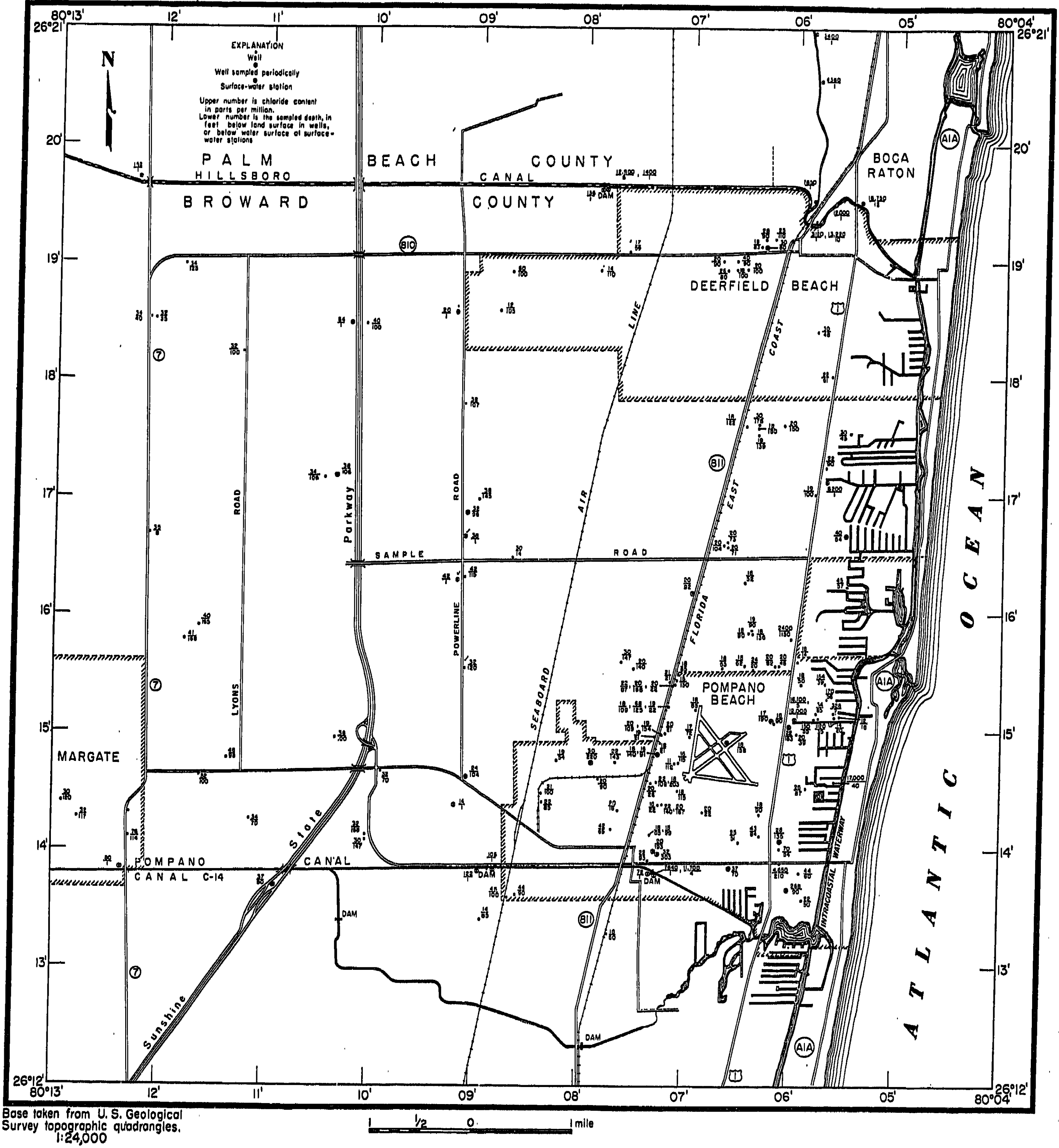

Figure 19. Northeastern Broward County, showing the maximum chloride content of water samples from wells and surface-water bodies, 1960-61.

The hydraulic coefficients are generally determined by pumping water from an aquifer and observing the effect of the withdrawal on the water levels in adjacent areas. Normally one well is pumped, and water levels in several nearby nonpumping wells are observed to relate the lowering of water level to distance and time. This lowering of water level has the general shape of an inverted cone and is referred to as the cone of depression. The shape of the cone of depression depends upon the rate and period of pumping, the water-storing and transmitting properties of the aquifer, and the natural changes in storage in the aquifer.

Pumping tests were made on wells in the Pompano Beach municipal well field during early February 1961, and at the Deerfield Beach municipal well field at the end of August 1961. Well 615-007-4 in the Pompano Beach well field was pumped at the rate of 2,000 gpm for 100 hours and the water was discharged to the water plant. For a period of 3 days prior to the test, no wells were pumped within a distance of 3,700 feet of well 615-007-4. Water-level measurements made during the 3-day period showed that antecedent water-level conditions were nearly stable, and the effects of other pumping in the area were small. After pumping started, water levels were measured in observation wells shown in figure 20 to determine the drawdown of levels at different distances from the pumped well. In the Deerfield Beach test, well 619-006-5 was pumped for 8 hours at the rate of 450 gpm and drawdowns were measured in the observation wells as shown in figure 20. No other pumping occurred within 2,000 feet of the Deerfield Beach test site during the test.

In both the Pompano Beach and Deerfield Beach well field areas the municipal wells are developed in a permeable rock zone that is overlain by thick sections of sand, shells, or silt. In the Pompano Beach area the overlying material is mostly clean sand, but in the Deerfield Beach area the overlying material consists of less permeable heterogeneous mixtures of silt and shell. Because of the low permeability of the shallow sediments, the aquifer in Deerfield Beach acts initially as an artesian system when pumping begins, proceeds through a leaky-aquifer transitional condition, and ultimately, with time, to a water-table system. The time required for this transition to be completed may be a few hours or days, depending upon the rate of pumping and the nature of the overlying semiconfining beds supplying the leakage.

The drawdown data obtained from the Pompano Beach test were analyzed by the Theis graphical method as described by Wenzel (1942, p. 87-89). This method is best applied when the following

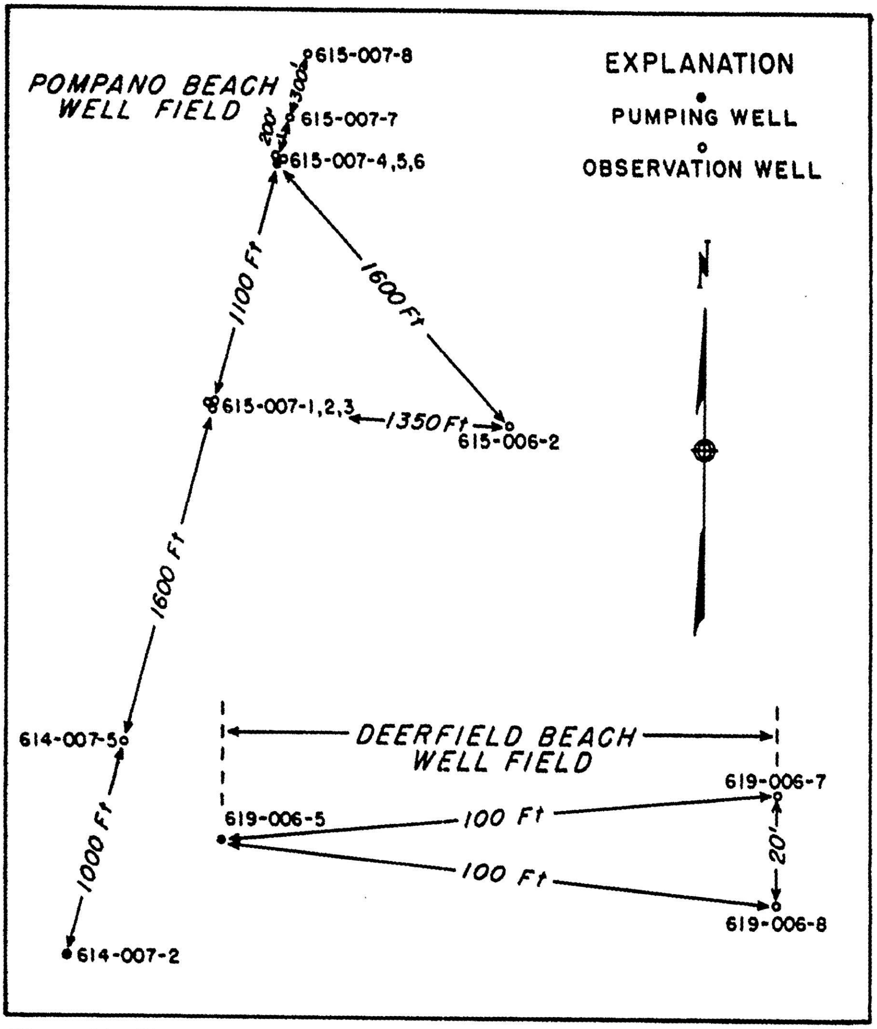

Figure 20. Sketch of pumping test sites in the Pompano Beach and Deerfield Beach well fields.

ideal conditions are met: the aquifer is homogeneous, isotropic, uniformly thick, areally infinite, and receives no recharge; the well being pumped has an infinitesimal diameter and penetrates the entire thickness of the aquifer; the water is all discharged through the pumped well and water taken from storage is discharged instantaneously with the decline in head. Not all these conditions were met in the field, but the determined coefficients provide valuable indications of the capacities of the aquifer. The coefficients of transmissibility and storage can be computed from a series of drawdown measurements made at different times in one observation well, or from drawdowns measured at one time in several observation wells, by use of the following formula:

$$s = \frac{114.6\,Q}{T} \int_u^\infty \frac{e^{-u}}{u}\,du = \frac{114.6\,Q}{T}\,W(u)$$

where $u = \dfrac{1.87\,r^2\,S}{Tt}$

s = drawdown in feet
r = distance from the discharging well, in feet
Q = rate of discharge, in gallons per minute
t = time well was discharging, in days
T = coefficient of transmissibility, in gallons per day per foot
S = coefficient of storage.

The test data were plotted and matched with the type curve, figure 21. The coefficient of transmissibility was computed to be 1,400,000 gpd per foot and the coefficient of storage was computed to be 0.34. Analysis of the data by the straight line method (Cooper and Jacob, 1946) resulted in a coefficient of transmissibility of 1,500,000 gpd per foot and a coefficient of storage of 0.25.

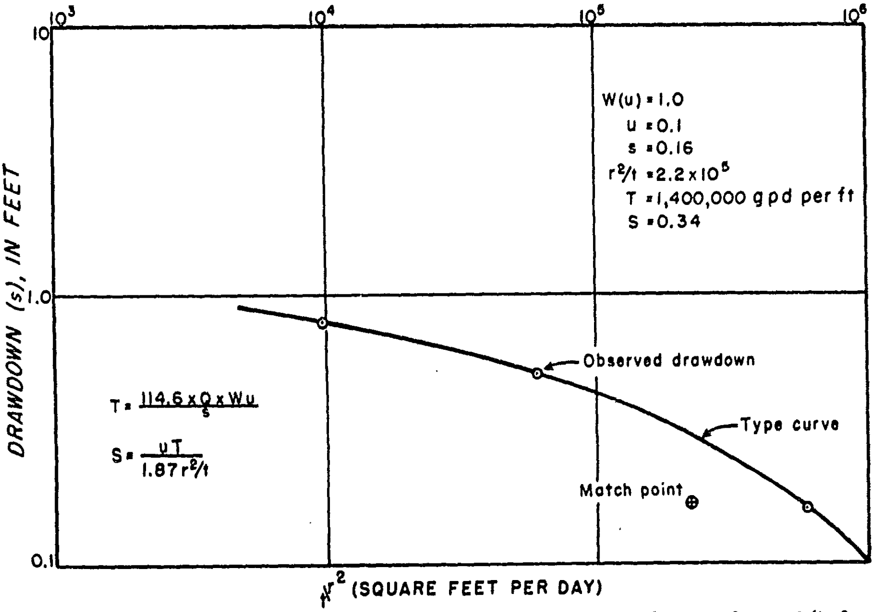

Figure 21. Logarithmic graphs of type curve and plot of s against r^2/t for observation wells 615-007-7, 615-007-8, and 615-006-2.

Because of the presence of semiconfining beds within the aquifer, the Deerfield Beach pumping test was analyzed both by the Theis method and by the leaky-aquifer method outlined by Hantush (1956), which is based on the theory of ground-water flow in a leaky artesian aquifer (Hantush and Jacob, 1955). The leaky-aquifer method involves the same assumptions as does the Theis method, except that the aquifer is assumed to be recharged by leakage through semiconfining beds and the leakage rate is maintained by a constant head. This method also involves matching the plotted data with a set of type curves developed by Cooper (in press). At the Deerfield Beach test the coefficient of transmissibility was computed to be 400,000 gpd per foot, the coefficient of storage 0.0004, and the coefficient of leakage 3.6 gpd per square foot per foot of head differential. The small transmissibility in the Deerfield Beach area as compared with the Pompano Beach area could be due to a thinning of the aquifer or a general change in permeability, or a combination of both factors; however, sufficient geologic information is not available to determine the reasons for the lower transmissibility.

If it is assumed that ideal hydrologic conditions prevail in Pompano Beach, theoretical drawdowns that would occur in the vicinity of a pumped well can be computed by the Theis nonequilibrium formula. The graphs in figures 22 and 23 were developed for the Pompano Beach well field on the basis of a coefficient of transmissibility of 1,500,000 gpd per foot and a coefficient of storage of 0.30. Figure 22 shows the theoretical drawdowns caused by pumping a well at a rate of 1,000 gpm for different periods. This graph can be used to determine the drawdown that would be expected with continuous pumping from storage, no rainfall or recharge occurring, and natural discharge from the aquifer not being affected. Figure 23 shows the drawdowns that would result if the well were pumped at different rates for 1 and 10 days. This graph can be used to determine the drawdown in other wells at any distance for the times indicated. For a given time and distance, the drawdown is proportional to the pumping rate.

Because the period of heaviest pumpage normally coincides with the dry season in southeastern Florida, computations were made to determine the overall drawdown caused by increased pumping from the Pompano Beach well field during a prolonged drought. A water-table contour map was constructed to show the effects of withdrawing 20 mgd from the well field throughout a 6-month rainless period.

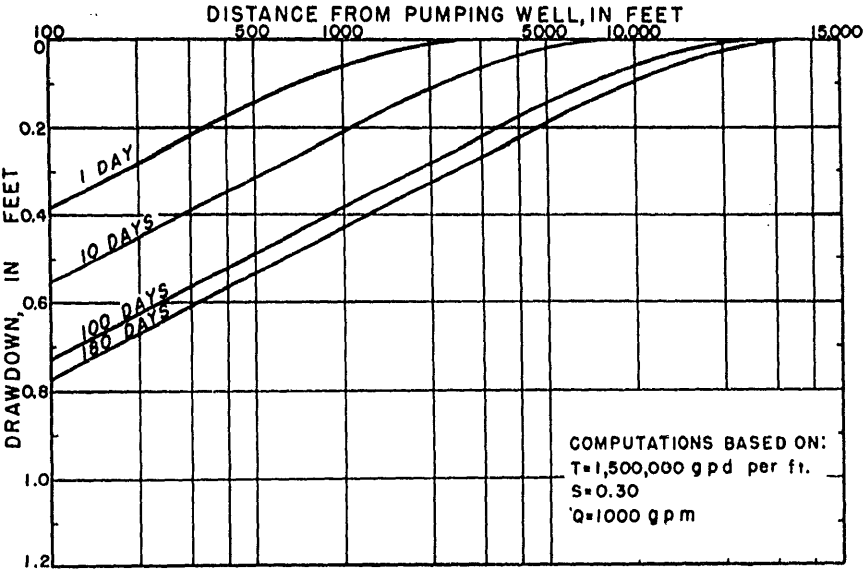

Figure 22. Predicted drawdowns in the vicinity of a well discharging 1,000 gpm for selected periods of time.

By use of a plotting method described by Conover and Reeder (1962), the drawdown caused by each pumping well was plotted on a grid system covering the area of influence, and summed to determine the net effect of all pumpage. These net drawdowns were superimposed on the water-level contour map for these assumed conditions. Figure 24 shows the combined effect of pumping 20 mgd (3 times the pumping rate for 1961) continuously from the Pompano Beach well field for a 6-month prolonged drought (no rainfall).

The predicted water levels may be lower than might actually occur because the September 1961 water levels, selected to represent the beginning of a dry season, were near record low after a 4-month period of deficient rainfall. However, the total drawdown caused by the 20 mgd pumping rate is in proportion to that shown at the 6.5 mgd rate in figure 12. Figure 24 shows that water levels in the immediate vicinity of the municipal well field would be drawn down to 2 feet below msl, and that diversion of ground water toward the well field would result in a reduction of head along the coast and along the lower reach of the Pompano Canal.

If this large increase in pumping were to lower water levels permanently along the coast, a slow inland movement of salt water could occur on a broad front in the aquifer and the well field would

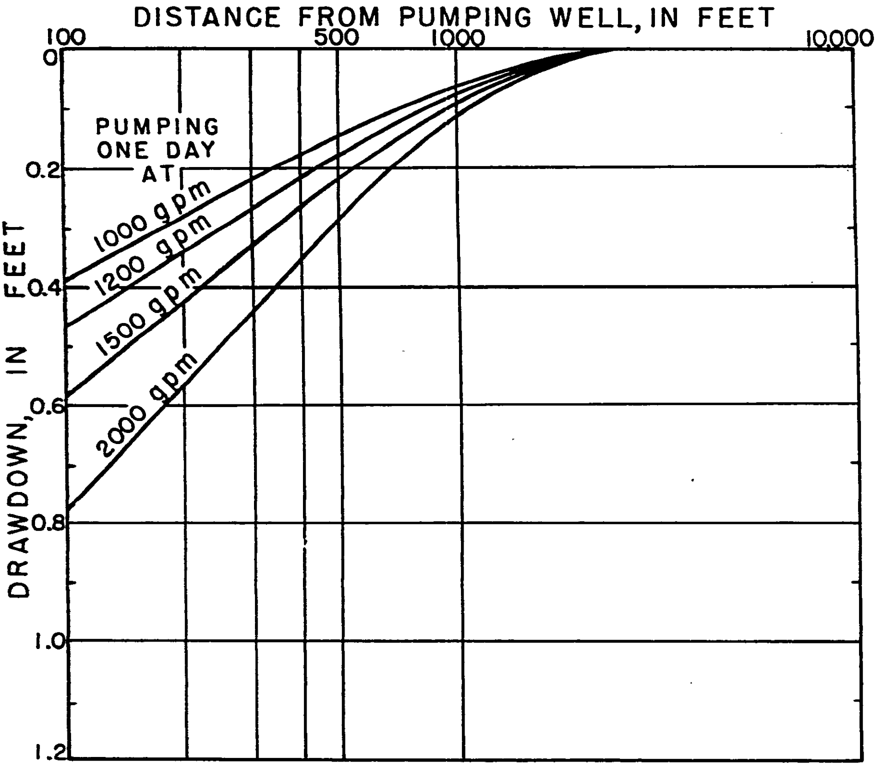

Figure 23. Predicted drawdowns in the vicinity of a well discharging at selected times and rates.

be threatened. Thus, it would not be advisable to withdraw the 20 mgd without expanding the well field facilities. Expansion could be northward, along the sandy ridge, or westward. The northward extension of the field would have the advantage of the availability of water of excellent quality, but ultimately the problem of salt-water encroachment would recur.

A westward extension of the well field would take advantage of the perennially high water levels maintained in the vicinity of the controlled reaches of the Pompano Canal. Replenishment to the field would be by continuous infiltration from the canal, under high gradients. The resulting drawdowns would be small, thereby reducing any threat of salt-water encroachment. A disadvantage to westward extension of the well field is the slightly inferior quality of the ground water.

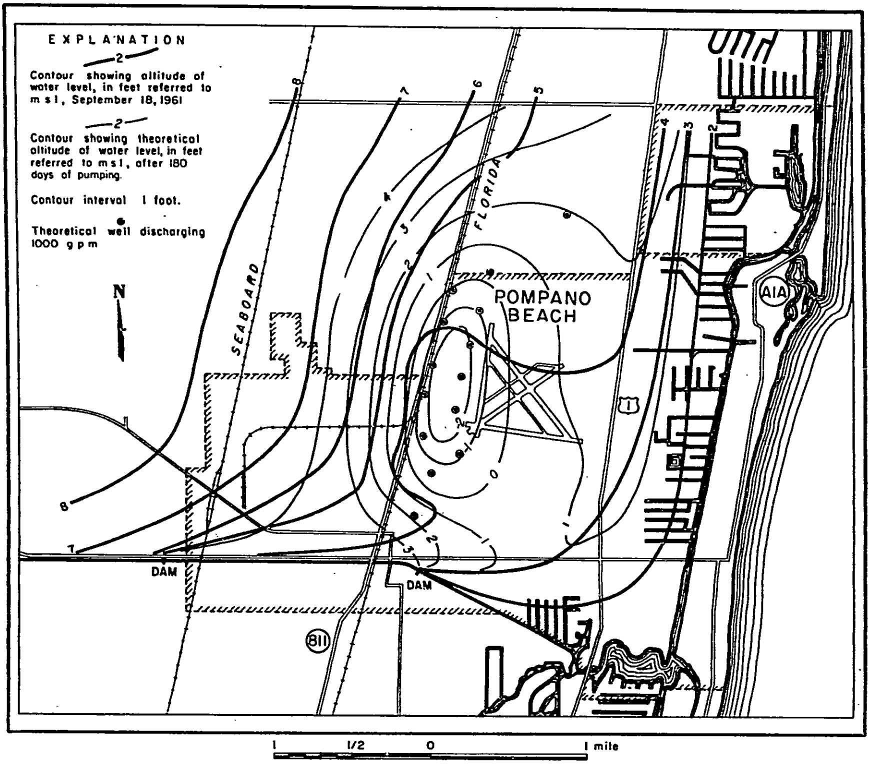

Figure 24. Pompano Beach well-field area showing predicted levels after pumping 20 mgd for 180 days without rainfall.

CONCLUSIONS

The Biscayne aquifer is the only source of fresh ground water in the Pompano Beach area. The chief source of recharge to the aquifer is rainfall on the immediate area; an additional source is the surface water pumped through canals into the western part of the area for irrigation. The ground water is of good quality except for the high iron content and the hardness and color, which increase toward the west.

The aquifer is composed of marine deposits of quartz sand, calcareous sandstones, and sandy to nearly pure limestones, which extend from the land surface to a depth of about 400 feet. The distribution of the rock zones in the aquifer is erratic, but generally, thin rock layers that are sufficiently permeable to supply small water systems are present within the upper 60 feet. Thicker rock zones from which large supplies can be developed by open-end wells commonly occur at greater depths.

The water table has a gentle gradient from the interior to the coast. Its configuration is greatly influenced by the Hillsboro and Pompano canals and by pumping. Relatively high water levels are maintained by the control structures in these canals, primarily for irrigation purposes but also to retard the inland movement of salt water. When pumping increases in future years, a large part of the recharge to well fields will be from the controlled reaches of the major canals. Pumping from the Pompano Beach well field in 1961 has not lowered the water levels significantly to cause appreciable inland movement of salt water. Future pumping at greater rates could lower water levels to altitudes where sea water would encroach into the aquifer.

Salt-water encroachment could occur from numerous tidal, salt-water canals. The uncontrolled reaches of the Hillsboro and Pompano canals are the most likely sources of encroachment, because they allow salt water to extend appreciable distances inland and they are adjacent to large well fields. The water from some wells near the Intracoastal Waterway shows an increase in chloride content when water levels are lowered. Salt-water encroachment from subjacent beds is unlikely as no salt water was found by drilling test holes into the lower zones of the Biscayne aquifer in the Pompano Beach well field. Future threats of salt-water encroachment could be diminished by controlling water levels in canals at locations farther seaward, and by distributing the effect of pumping more equally along the ridge area.

Pumping tests and water-level data indicate that much larger quantities of ground water can be obtained in the ridge area, and that even larger amounts could be produced farther west, with little probability of salt-water encroachment.

Some of the major water problems that will face the city of Pompano Beach in future years will be those problems associated with rapid urbanization. As urbanization proceeds, water needs will accelerate; at the same time, urbanization will require drainage and flood control in the western part of the area. It is important, therefore, to determine the effects that lowering water levels in the west will have on the continued movement of water eastward and on salt-water encroachment. These effects can be evaluated by a continuing program of data collection and data analysis on the availability of water. The continuing studies will point out changes in the hydrology of the area and will aid in establishing an orderly program of water control and water management in the area.

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TABLE 3. Lithologic Logs of Test Holes

WELL 615-006-4

Material	Depth in feet below land surface
Sand, quartz, gray to tan, very fine to very coarse, angular to subrounded, iron-stained	0 - 20
Sand, quartz, as above, slightly silty; and thin layer of limestone	20 - 30
Sand, quartz, white, medium, and tan, shelly limestone	30 - 40
Sand as above; and pink, sandy, shelly, very silty limestone	40 - 43
Sand, quartz, white to gray, medium to coarse, mostly coarse, slightly phosphatic	43 - 48
Sand as above; and dense, hard, shelly limestone	48 - 54
Limestone, white to tan, dense, shelly; some fine sand	54 - 59
Sand, quartz, white, fine, angular to subrounded, phosphatic and white shelly limestone	59 - 64
Limestone, white, crystalline, sandy, phosphatic	64 - 69
Sand, quartz, tan, mostly coarse and granular, slightly phosphatic, partly indurated to sandstone	69 - 78
Sand, quartz, white, mostly fine, silty, phosphatic; some sandstone	78 - 83
Sandstone composed of materials above	83 - 88
Limestone, very sandy, white, shelly	88 - 94
Sand, quartz, mostly fine but some very coarse grains, calcareous and phosphatic	94 - 99
Sand, fine to coarse, very calcareous, shelly, phosphatic	99 - 122
Marl, fresh-water? tan and brown, shelly, sandy; contains some heavy minerals, wood material, and peat	122 - 124
Limestone, very sandy, shelly, phosphatic	124 - 135
Limestone, slightly sandy, shelly; sand, mostly medium, very hard, 140-143	135 - 155
Limestone, almost pure, very slightly sandy; contains small shell fragments	155 - 187

WELL 614-006-1

Material	Depth in feet below land surface
Sand, quartz, cream, very fine to coarse; small amount of iron oxide	0 - 10
Sand, quartz, fine to medium, angular and subangular, shelly near bottom	10 - 20
Sand, as above; and thin layer of yellowish limestone at 25 feet	20 - 25
Sand, as above, shelly; contains phosphate and heavy minerals	25 - 42
Limestone, tan and cream, sandy, very hard at top; much recrystalized calcite	42 - 45

Limestone, white and cream, fairly pure, sugary to coarsely crystalline; few shells	45 - 83
Sand, quartz, very fine to coarse, shelly; contains thin interbedded white sandy limestone	83 - 115
Limestone, white and cream, sandy, shelly, slightly phosphatic, very hard at 130 feet	115 - 130
Limestone, white to tan, much recrystallized calcite, sandy, shelly	130 - 150
Sand, very fine to medium, angular, phosphatic, slightly shelly	150 - 155
Limestone, white to cream, very sandy, shell fragments	155 - 157

WELL 614-007-1

Material	*Depth in feet below land surface*
Sand, quartz, fine to medium, subrounded, clear, frosted and and iron-stained; bottom 2 feet shelly, sandy limestone	0 - 20
Sand, quartz, fine to coarse, angular to subrounded, silty	20 - 58
Limestone, white and cream, very sandy, slightly phosphatic and iron-stained	58 - 65
Sand, quartz, tan and white; contains specks of phosphate and limonite	65 - 71
Sandstone, cream, very calcareous, poorly indurated, phosphatic	71 - 82
Sand, fine to medium at top, becoming very coarse near bottom, shelly, white; bottom shows traces of peat	82 - 103
Sandstone, very calcareous, shelly, phosphatic; some inclusions appear oolitic	103 - 118
Sand, quartz, mostly medium to very coarse, slightly marly, phosphatic, shelly; bottom 2 feet indurated	118 - 146
Limestone, sandy, phosphatic; contains beach-worn shell fragments (rubble bed)	146 - 151
Sand, mostly fine to medium, but some coarse grains, shell fragments; contains few thin layers of sandstone	151 - 203
Sandstone, very calcareous, shelly, phosphatic	203 - 220

WELL 613-007-1

Material	*Depth in feet below land surface*
Sand, quartz, tan, medium, iron-stained	0 - 15
Limestone, soft, tan, oolitic; and hard, dense shelly limestone	15 - 20
Sand, quartz, tan and cream, medium, subrounded, iron-stained	20 - 48
Limestone, hard, dense, tan to brown	48 - 50
Sand, quartz, fine to very coarse and some shell fragments; hard limestone layer at 61 feet	50 - 76
Sand, quartz, fine to coarse, but mostly coarse; and interbedded thin layers of hard shelly sandstone	76 - 92

Sand, quartz, medium, subangular; and wave-worn shell fragments, phosphatic	92 - 105
Limestone and sandstone, gray, porous, shelly, phosphatic and containing heavy minerals	105 - 135
Sand, quartz, mostly fine, silty, shelly, phosphatic, glauconitic; few thin sandstone layers	135 - 188
Sandstone, very calcareous, shelly, porous	188 - 195
Limestone, hard, dense, and shelly sandstone contains lenses of sand	195 - 213
Sand, quartz, gray, mostly fine, shelly and phosphatic contains thin beds or lenses of sandstone	213 - 292
Limestone, hard, dense, shelly	292 - 296
Limestone, sandy, fairly soft, shelly	296 - 304

TABLE 4. Records of Wells in Northeastern Broward County

Use: A, air conditioning; Di, disposal; Do, domestic; In, industrial; Ir, irrigation; Li, lawn irrigation; N, none; O, observation; P, public supply, S, stock; T, test well. Remarks: Ca, complete analysis; Cut, cuttings; W-l, additional water-level data available.

Well number	Location	Owner	Total depth of well (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Elevation above mean sea level (feet)	Water level: Above (+) or below land surface (feet)	Water level: Date of measurement	Chloride content: Parts per million	Chloride content: Date sampled	Temperature (°F)	Use	Remarks
613-005-1	500 ft. S. and 2,690 ft. E. of NW cor., sec. 6, T. 49 S., R. 43 E.	G. N. Earhart	±60	----	1½	----	----	----	----	----	44	3-28-60	77	Li	
-2	1,850 ft. S. and 2,150 ft. W. of NE cor., sec. 6, T. 49 S., R. 43 E.	Donald Wilson	±50	----	1½	----	----	----	----	----	22	3-28-60	77	Li	
613-006-1	1,400 ft. S. and 2,175 ft. E. of NW cor., sec. 6, T. 49 S., R. 43 E.	City of Pompano Beach	90	----	8	----	----	----	----	----	118	3- 3-60	76	In	
-2	200 ft. S. and 900 ft. W. of NE cor., sec. 1, T. 49 S., R. 42 E.	Bernard Millman	±70	----	2	----	----	----	----	----	30	3-28-60	76	Li	
-3	100 ft. N. and 500 ft. E. of SW cor., sec. 31, T. 49 S., R. 43 E.	J. P. Finnigan	210	----	----	----	----	----	----	----	4,650	9-15-61	77	In	
613-007-1	650 ft. N. and 775 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	U. S. Geological Survey	304	303	3- 2	Top of 3-inch casing collar	0.0	16.35	10.70	1- 3-61	32 28 29 28	1-12-61 1- 3-61 4-17-61 9- 8-61	77	T	Ca, Cut
-2	700 ft. N. and 850 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	City of Pompano Beach	±190	±180	12	----	----	----	----	----	18 20 18 20	3-14-60 5-24-60 12- 2-60 7-25-61	77	P	Ca, Pompano No. 1

613-007-3	3,850 ft. N. and 3,775 ft. E. of SW cor., sec. 2, T. 49 S., R. 42 E.	J. J. and M. I. Ogden	60	——	6	Top of 6-inch cross	2.0	6.41	2.32	6-29-60	18	10-18-60	77	O	Destroyed
-4	150 ft. N. and 1,200 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	First Baptist Church of Pompano Beach	59	——	1¼	Top of 1¼-inch casing	.0	15.29	11.51	6- 6-60	——	——	——	O	Do.
-5	100 ft. N. and 1,225 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	W. D. Green	93	——	2	——	——	——	——	——	18 22	10-17-60 1-19-62	80	Li	
613-008-1	2,750 ft. S. and 2,700 ft. E. of NW cor., sec. 3, T. 49 S., R. 42 E.	Pompano Raceways, Inc.	85	——	2	Top of 2-inch casing	1.5	9.50	4.75	7-20-60	14	10-10-60	78	O	
-2	3,250 ft. S. and 1,800 ft. W. of NE cor., sec. 3, T. 49 S., R. 42 E.	U. S. Geological Survey	——	——	——	——	——	——	——	——	——	——	——	O	
-3	1,650 ft. S. and 1,400 ft. W. of NE cor., sec. 3, T. 49 S., R. 42 E.	Ready Mix Concrete Co.	±100	——	4	——	——	——	——	——	46	3- 2-60	77	In	
-4	1,550 ft. S. and 1,000 ft. W. of NE cor., sec. 3, T. 49 S., R. 42 E.	Larry Marable	±90	——	3	——	——	——	——	——	44	3-29-60	77	Do	
613-009-1	1,325 ft. S. and 400 ft. E. of NW cor., sec. 4, T. 49 S., R. 42 E.	Pompano Raceways, Inc.	120	——	4	——	——	——	——	——	15	10-18-40	——	N	Ca
613-010-1	700 ft. S. and 2,400 ft. E. of NW cor., sec. 5, T. 49 S., R. 42 E.	State of Florida	80	——	6	——	——	——	——	——	39	3-24-60	78	P	Ca, Cut
614-005-1	1,425 ft. S. and 1,620 ft. E. of NW cor., sec. 31, T. 48 S., R. 42 E.	C. W. Hendricks	87	——	3	——	——	——	——	——	22 26	8-16-60 11- 9-61	76	Li	

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
614-005-2	1,310 ft. S. and 3,070 ft. E. of NW cor., sec. 31, T. 48 S., R. 43 E.	H. F. Wiersch	40	----	2	----	----	----	----	----	17,000	4-19-60	---	A	
-3	1,400 ft. N. and 1,200 ft. E. of SW cor., sec. 30, T. 48 S., R. 43 E.	Martin Michelson	59	----	1½	----	----	----	----	----	18 20	1-14-61 11- 9-61	77	Li	
614-006-1	1,075 ft. N. and 2,900 ft. E. of SW cor., sec. 25, T. 48 S., R. 42 E.	U. S. Geological Survey	160	158	2	Top of 2-inch casing	2.0	16.05	8.12	7-18-60	13 16 18 17 17	8-10-60 10-21-60 1-10-61 4-17-61 9- 8-61	76	T	Ca, Cut
-2	1,405 ft. N. and 720 ft. W. of SE cor., sec. 36, T. 48 S., R. 42 E.	H. D. Thomas	84	----	2	----	----	----	----	----	48 28	3-23-60 1-19-62	77	Li	
-3	725 ft. N. and 275 ft. E. of SW cor., sec. 31, T. 48 S., R. 43 E.	W. D. Bennett	70	----	1½	Top of 1½-inch casing	1.0	9.60	5.95	3-10-60	42 52 54 44 48	4-12-60 6- 1-60 7-18-60 10-18-60 5-15-61	76	O	
-4	1,200 ft. N. and 950 ft. E. of SW cor., sec. 25, T. 48 S., R. 42 E.	City of Pompano	73	----	1½	----do----	1.5	19.07	16.48	3-14-60	17	6-15-60	76	O	W-1, partially plugged at 12 feet
-5	2,640 ft. S. and 1,650 ft. E. of NW cor., sec. 36, T. 48 S., R. 42 E.	U. S. Geological Survey	16	16	1¼	Top of 1¼-inch casing	.0	16.87	12.07	7-18-60	20	6-18-60	---	O	

-6	1,150 ft. N. and 825 ft. E. of SW cor., sec. 31, T. 48 S., R. 43 E.	Hugh Walter	135	——	2	——————	——	——	——	———	28	6-29-60	78	Do	
-7	1,175 ft. N. and 1,815 ft. W. of SE cor., sec. 36, T. 48 S., R. 42 E.	Wilson	51	——	2	——————	——	——	——	———	25 20	6- 3-57 8-15-61	77	Li	
-8	2,550 ft. S. and 750 ft. W. of NE cor., sec. 36, T. 48 S., R. 42 E.	City of Pompano	±90	——	8	——————	——	——	——	———	18 18 18	9-25-60 6- 6-61 9-18-61	76	P	
614-007-1	25 ft. N. and 1,200 ft. E. of SW cor., sec. 26, T. 48 S., R. 42 E.	U. S. Geological Survey	220	220	2	Top of 2-inch casing	0.0	12.52	4.39	6-18-60	18 22 20 24 30	8-10-60 10-21-60 1-10-61 4-17-61 9- 8-61	76	T	Ca, Cut
-2	425 ft. N. and 700 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	City of Pompano	140	——	16	——————	——	——	——	———	18	3-14-60	77	P	Pompano Prod. No. 4
-3	425 ft. N. and 710 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	do	191	——	2	Top of 2-inch casing	.5	20.70	14.97	3-10-60	16	10-21-60	77	T	
-4	1,000 ft. N. and 550 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	U. S. Geological Survey	21	21	1¼	Top of 1¼-inch casing	.0	20.18	14.93	7-18-60	18	7-18-60	—	O	W-1
-5	1,500 ft. N. and 425 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	City of Pompano	109	——	16	Top of air-line hole in pump base	1.0	22.04	18.75	3-17-61	18 20 18	3-14-60 4-18-60 4-15-61	77	P	Pompano Prod. No. 5
-6	1,475 ft. N. and 425 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	do	154	——	2	Top of 2-inch casing	.0	20.85	14.47	3-14-60	19	10-17-60	77	T	
-7	1,495 ft. N. and 335 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	U. S. Geological Survey	21	21	1¼	Top of 1¼-inch casing	1.0	20.79	14.89	7-18-60	20	7-18-60	78	O	

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
-8	1,800 ft. N. and 675 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	do	21	21	1¼	do	0.0	21.64	16.32	7-18-60	19	7-18-60	78	O	
-9	1,000 ft. S. and 725 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	City of Pompano	108	—	16	Top of air-line hole in pump base	.0	20.22	20.76	3-16-61	18 20 22 16	3-18-60 4-18-60 8-11-60 4-15-61	77	P	Ca, Pompano No. 3
-10	1,010 ft. S. and 725 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	do	203	—	2	Top of 2-inch casing	2.0	19.56	15.98	3-14-60	18	10-21-60	77	P	Ca
-11	1,060 ft. S. and 975 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	U. S. Geological Survey	22	21	4	Top of 2-inch casing	1.0	20.14	14.01	7-18-60	20	7-12-60	78	O	
-12	2,150 ft. S. and 500 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	City of Pompano	140	—	16	—	—	—	—	—	19 22 17	3-18-60 4-18-60 4-15-61	76	P	Pompano Prod. Well No. 2
-13	2,149 ft. S. and 497 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	do	167	—	2	Top of 2-inch casing	.0	18.54	12.65	2-12-61	20	10-21-60	77	O	
-14	2,140 ft. S. and 600 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	U. S. Geological Survey	22	—	1¼	Top of 1¼-inch casing	1.0	18.47	13.25	7-18-60	18	7-18-60	76	O	

-15	25 ft. N. and 2,650 ft. E. of SW cor., sec. 26, T. 48 S., R. 42 E.	City of Pompano	143	—.	2	Top of 2-inch casing	0.0	17.72	10.73	4-13-60	22	10-18-60	76	O	
-16	2,500 ft. S. and 2,800 ft. E. of NW cor., sec. 35, T. 48 S., R. 42 E.	U. S. Geological Survey	16	16	1¼	Top of 1¼-inch casing	.0	15.77	9.57	7-19-60	20	7-18-60	—	O	
-17	1,950 ft. N. and 2,400 ft. E. of SW cor., sec. 35, T. 48 S., R. 42 E.	Alice Lewis	65	—	1¼	do	.5	11.36	3.70	9-20-60	42	10-14-60	77	O	
-18	750 ft. S. and 1,725 ft. E. of NW cor., sec. 35, T. 48 S., R. 42 E.	Acme Concrete, Inc.	±90	—	3	—	—	—	—	—	20	3- 8-60	77	In	
-19	1,930 ft. S. and 1,630 ft. W. of NE cor., sec. 35, T. 48 S., R. 42 E.	E. V. Jackson	27	—	1¼	Top of 1¼-inch casing	1.0	—	10.06	9-19-60	—	—	—	N	
-20	1,150 ft. N. and 1,700 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	J. I. and M. I. Ogden	189	—	8	—	—	—	—	—	—	—	—	—	Complete analysis available, destroyed
-21	1,575 ft. N. and 1,100 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	City of Pompano	85	85	2	Top of 2-inch casing	1.0	19.20	14.75	8-31-61	18	7-27-61	76	O	Originally drilled to 130 feet
-22	1,590 ft. N. and 1,110 ft. W. of SE cor., sec. 35, T. 48 S., R. 42 E.	do	90	90	16	Top of 16-inch casing	2.0	20.42	14.60	8-31-61	18	7-27-61	77	P	Pompano No. 8, Cut
-23	1,500 ft. S. and 325 ft. E. of NW cor., sec. 36, T. 48 S., R. 42 E.	do	115	±105	2	Top of 2-inch casing	1.5	19.10	13.40	6-24-61	18	5-22-61	76	O	
-24	75 ft. S. and 325 ft. E. of NW cor., sec. 36, T. 48 S., R. 42 E.	do	115	±105	2	do	1.5	18.97	13.05	6-24-61	18	6- 2-61	76	O	

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Elevation above mean sea level (feet)	Water level: Above (+) or below land surface (feet)	Water level: Date of measurement	Chloride content: Parts per million	Chloride content: Date sampled	Temperature (°F)	Use	Remarks
-25	75 ft. S. and 250 ft. E. of NW cor., sec. 36, T. 48 S., R. 42 E.	do	112	93	16	Top of 16-inch casing	1.5	----	13.52	9-18-61	18	9-18-61	77	P	Pompano No. 10 Cut
614-008-1	50 ft. N. and 450 ft. E. of SW cor., sec. 26, T. 48 S., R. 42 E.	E. W. Betts, et al.	56	----	4	Top of 4-inch casing	1.0	18.07	2.90	7- 2-60	----	----	----	O	
-2	150 ft. N. and 425 ft. W. of SE cor., sec. 27, T. 48 S., R. 42 E.	English and Bessie Erwin	27	----	1¼	Top of pump base	3.0	17.16	4.21	4-18-60	----	----	----	O	
-3	950 ft. N. and 350 ft. E. of SW cor., sec. 35, T. 48 S., R. 42 E.	George Rawls	90	----	1¼	High point of 1¼-inch casing	3.0	11.35	3.36	5- 2-60	----	----	----	O	
-4	450 ft. N. and 400 ft. W. of SE cor., sec. 27, T. 48 S., R. 42 E.	English and Bessie Erwin	54	----	1¼	Top of 1¼-inch casing	2.0	----	7.89	5-18-60	19	5-18-60	78	N	
-5	1,900 ft. S. and 1,200 ft. W. of NE cor., sec. 34, T. 48 S., R. 42 E.	De Marco, Inc.	±85	----	1½	----	----	----	----	----	22	3- 8-60	77	In	
-6	1,500 ft. S. and 1,275 ft. W. of NE cor., sec. 34, T. 48 S., R. 42 E.	De Marco, Inc.	160	----	2	----	----	----	----	----	21	3- 8-60	78	In	

614-009-1	125 ft. S. and 1,150 ft. E. of NW cor., sec. 33, T. 48 S., R. 42 E.	Phillips Petroleum Co., Inc.,	70	----	1¼	Top of pump base	2.0	15.91	2.68	7-19-60	32	10-14-60	76	O	
-2	500 ft. S. and 200 ft. E. of NW cor., sec. 34, T. 48 S., R. 42 E.	Broward County, Farm Bureau	104	----	2	----	----	----	----	----	22	4-27-60	78	Do	
614-010-1	1,700 ft. N. and 375 ft. E. of SW cor., sec. 33, T. 48 S., R. 42 E.	Collier City Water Works, Inc.	168	165	6	----	----	----	----	----	32	3- 3-60	78	P	Ca
-2	1,600 ft. N. and 375 ft. E. of SW cor., sec. 33, T. 48 S., R. 42 E.	do	147	----	2	----	----	----	----	----	30	3- 3-60	78	N	
-3	1,600 ft. N. and 1,700 ft. W. of SE cor., sec. 29, T. 48 S., R. 42 E.	W. H. Blount	±100	----	16	----	----	----	----	----	36	4-18-60	75	Ir	
-4	500 ft. N. and 2,350 ft. W. of SE cor., sec. 29, T. 48 S., R. 42 E.	do	65	----	1¼	Top of 1¼-inch casing nipple	1.0	----	4.49	4-18-60	----	----	----	N	
-5	1,700 ft. S. and 2,900 ft. W. of NE cor., sec. 32, T. 48 S., R. 42 E.	Bateman Co., Inc.	±65	----	3	Top of 3-inch casing	.5	----	6.32	5-16-60	----	----	----	N	
614-011-1	2,725 ft. N. and 325 ft. W. of SE cor., sec. 31, T. 48 S., R. 42 E.	do	70	----	2	Top of 1¼-inch nipple	1.0	17.31	8.97	5-16-60	34	10-14-60	----	O	
-2	60 ft. S. and 2,850 ft. E. of NW cor., sec. 31, T. 48 S., R. 42 E.	Unknown	±100	----	12	----	----	----	----	----	52	4-11-60	74	Ir	
-3	725 ft. N. and 1,550 ft. W. of SE cor., sec. 30, T. 48 S., R. 42 E.	Moore	98	----	8	----	----	----	----	----	46	4-11-60	75	Ir	

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
614-012-1	1,900 ft. N. and 975 ft. W. of SE cor., sec. 36, T. 48 S., R. 41 E.	Margate Fire Dept.	114	—	1¼	Top of 1¼-inch casing	1.0	—	3.03	9-22-60	76	10-11-60	76	O	
-2	1,250 ft. S. and 950 ft. E. of NW cor., sec. 36, T. 48 S., R. 41 E.	Margate Utilities	120	110	8	—	—	—	—	—	30	9-12-61	76	P	Margate No. 1
-3	1,750 ft. S. and 1,850 ft. E. of NW cor., sec. 36, T. 48 S., R. 41 E.	do	117	111	12	—	—	—	—	—	32	9-12-61	76	P	Margate No. 3
615-005-1	300 ft. S. and 1,100 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	U. S. Geological Survey	14	14	1¼	Top of 1¼-inch casing	.0	11.96	6.76	7-18-60	18	7-18-60	78	O	
-2	2,200 ft. N. and 2,190 ft. E. of SW cor., sec. 30, T. 48 S., R. 43 E.	C. B. Miles	±35	—	1½	—	—	—	—	—	1,120 1,060 840	3-22-60 8-11-60 4-15-61	78	Li	
-3	2,200 ft. N. and 2,100 ft. E. of SW cor., sec. 30, T. 48 S., R. 43 E.	E. J. Gaynor, III	±55	—	—	—	—	—	—	—	150 112	4-14-60 8- 5-61	78	Li	
-4	2,450 ft. N. and 2,100 ft. E. of SW cor., sec. 30, T. 48 S., R. 43 E.	Boyd Sleeth and Pat Murray	±65	—	1¼	—	—	—	—	—	34	10-18-60	78	Li	

-5	2,960 ft. S. and 2,670 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	R. B. Moore	—	—	—	—	—	—	—	—	328	3-24-60	77	Li	
-6	3,160 ft. S. and 2,720 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	Frank Bennett	20	20	2	—	—	—	—	—	14	4-26-60	78	Li	
-7	3,060 ft. S. and 3,350 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	W. W. Bivans	18	18	2	—	—	—	—	—	12	4-26-60	77	N	
-8	2,200 ft. S. and 2,750 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	Michael Doyle	56	—	1½	—	—	—	—	—	170 104	3-24-60 8-15-61	77	Li	
-9	1,400 ft. S. and 2,600 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	Al Aiudi	39	37	1½	—	—	—	—	—	164 88	3-24-60 8-15-61	--	Li	
-10	1,410 ft. S. and 1,430 ft. E. of NW cor., sec. 30, T. 48 S., R. 42 E.	W. R. Zudrell	±50	—	1½	—	—	—	—	—	18	4-27-60	77	Li	
615-006-1	950 ft. N. and 900 ft. E. of SW cor., sec. 19, T. 48 S., R. 43 E.	Broward Utilities	1,150	1,104	16-10	Top of 12-inch flange	2.8	14.90	22.4	6- 2-59	2,400	—	73	Di	Cut, Floridan aquifer
-2	2,800 ft. N. and 1,275 ft. E. of SW cor., sec. 25, T. 48 S., R. 43 E.	City of Pompano	85	85	2	Top of 2-inch casing	1.0	16.41	8.88	3-14-60	18 14 20	10-17-60 1- 2-61 1-10-61	77	O	Originally drilled to 147 feet
-3	2,110 ft. N. and 10 ft. W. of SE cor., sec. 25, T. 48 S., R. 42 E.		90	—	2	—	—	—	—	—	17 18 16 18	3-10-60 8-11-60 4-15-61 11- 9-61	76	Do	
-4	1,835 ft. N. and 730 ft. E. of SW cor., sec. 30, T. 48 S., R. 43 E.	U. S. Geological Survey	183	176	2	Top of 2-inch casing collar	.0	10.34	5.90	1-24-61	16 12 16 16	1-19-61 1-24-61 4-17-61 9- 8-61	78	T	Ca, Cut

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Elevation above mean sea level (feet)	Water level: Above (+) or below land surface (feet)	Water level: Date of measurement	Chloride content: Parts per million	Chloride content: Date sampled	Temperature (°F)	Use	Remarks
-5	2,181 ft. N. and 42 ft. W. of SW cor., sec. 25, T. 48 S., R. 43 E.	City of Pompano	100	......	8	Top of pump base	......	......	Flowed	10- -60	17	3-10-60	76	Ir	
-6	500 ft. S. and 250 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	B. C. Wells	48	......	2	......	......	......	......	......	20	3-30-60	76	Li	
-7	500 ft. S. and 50 ft. E. of NW cor., sec. 30, T. 48 S., R. 43 E.	E. F. Smichdt	82	......	1½	......	......	......	......	......	20	3-23-60	77	Li	
-8	500 ft. S. and 2,700 ft. W. of NE cor., sec. 28, T. 48 S., R. 42 E.	R. J. Corcoran	53	......	1½	......	......	......	......	......	18	4-11-60	77	Li	
-9	400 ft. S. and 1,400 ft. W. of NE cor., sec. 25, T. 48 S., R. 42 E.	Carson Spencer	62	......	1½	......	......	......	......	......	18	4-11-60	77	Li	
-10	600 ft. S. and 1,100 ft. W. of NE cor., sec. 25, T. 48 S., R. 42 E.	Robert Davis	20	......	1½	......	......	......	......	......	24	4-29-60	78	Li	
-11	1,290 ft. N. and 1,210 ft. W. of SE cor., sec. 24, T. 48 S., R. 42 E.	Broward Utilities	90	......	6	......	......	......	......	......	18	9-18-61	77	P	Ca, Collier Mannor No. 1

-12	1,240 ft. N. and 1,200 ft. W. of SE cor., sec. 24, T. 48 S., R. 42 E.	do	90	----	6	----	----	----	----	----	19	9-18-61	77	P	Collier Mannor No. 2
-13	1,240 ft. N. and 1,100 ft. W. of SE cor., sec. 24, T. 48 S., R. 42 E.	do	136	124	8	----	----	----	----	----	18	9-18-61	77	P	Collier Mannor No. 3
615-007-1	2,950 ft. N. and 100 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	City of Pompano	109	----	16	Top of air-line hole in pump base	1.0	20.38	15.13	3-16-61	18 18	3-14-60 4-15-60	77	P	Pompano No. 6
-2	2,940 ft. N. and 110 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	do	125	----	2	Top of 2-inch casing	1.0	19.66	12.44	3-14-60	18	10-17-60	77	O	
-3	2,941 ft. N. and 111 ft. W. of SE cor., sec. 26, T. 48 S., R. 42 E.	do	22	----	2	do	.0	18.56	12.44	3-14-60	19	10-17-60	78	O	
-4	1,325 ft. S. and 250 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	do	87	80	16	Top of air-line hole in pump base	1.5	21.29	19.56	3-16-61	22 16 18 16	4-18-60 9-18-60 11-14-60 4-15-61	76	P	Cut
-5	1,318 ft. S. and 253 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	do	168	----	2	Top of 1½-inch casing collar	3.0	22.62	12.82	3-14-60	20	5-16-60	77	O	
-6	1,320 ft. S. and 253 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	do	22	----	2	Top of 2-inch casing	.0	19.64	12.96	3-14-60	20	5-16-60	77	O	
-7	1,125 ft. S. and 300 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	do	85	85	2	do	1.0	20.10	12.20	7-18-60	16	10-17-60	77	O	Originally drilled to 130 feet
-8	825 ft. S. and 375 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	do	85	85	2	do	1.0	21.17	13.10	3-14-60	18 16	10-17-60 1-10-61	77	O	Originally drilled to 167 feet

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing: Depth (feet)	Casing: Diameter (inches)	Measuring point: Description	Measuring point: Height above land surface (feet)	Measuring point: Elevation above mean sea level (feet)	Water level: Above (+) or below land surface (feet)	Water level: Date of measurement	Chloride content: Parts per million	Chloride content: Date sampled	Temperature (°F)	Use	Remarks
-9	1,250 ft. S. and 100 ft. E. of NW cor., sec. 25, T. 48 S., R. 42 E.	U. S. Geological Survey	21	21	1¼	Top of 1¼-inch casing	0.0	19.21	12.39	7-18-60	21	7-18-60	78	O	
-10	50 ft. S. and 2,900 ft. E. of NW cor., sec. 26, T. 48 S., R. 42 E.	Fairlawn Cemetery, Inc.	147	.....	6	....	.....	.....	.....	.....	30 28 29 29	7-18-60 12- 2-60 9- 8-61 11- 9-61	76	Ir	
-11	450 ft. S. and 3,500 ft. E. of NW cor., sec. 26, T. 48 S., R. 42 E.	Broward Utilities	140	.....	6	....	.....	.....	.....	.....	20	9- 8-61	76	P	
615-008-1	2,440 ft. S. and 500 ft. W. of NE cor., sec. 27, T. 48 S., R. 42 E.	Southern Wood Ind., Inc.	73	.....	6	Top of 6-inch tee	3.00	15.97	5.41	4-25-60	.....	.....	.....	N	
-2	2,440 ft. S. and 525 ft. W. of NE cor., sec. 27, T. 48 S., R. 42 E.	..........do..........	70	.....	6	Top of 6-inch casing	3.00	.....	5.41	4-25-60	.....	.....	.....	N	
-3	2,445 ft. S. and 495 ft. W. of NE cor., sec. 27, T. 48 S., R. 42 E.	..........do..........	.....	.....	2	....	.....	.....	.....	.....	.....	.....	.....	N	
615-009-1	1,200 ft. S. and 800 ft. W. of NE cor., sec. 28, T. 48 S., R. 42 E.	Jacob McBride	16	16	1¼	Top of pump base	3.00	14.96	2.50	5-16-60	.....	.....	.....	S	

-2	100 ft. S. and 500 ft. E. of NW cor., sec. 27, T. 48 S., R. 42 E.	Southern Factories, Inc.	120	—	2	—	—	—	—	—	32	2-24-60	77	In	
615-011-1	2,150 ft. N. and 2,850 ft. E. of SW cor., sec. 19, T. 48 S., R. 42 E.	W. P. Brown	165	—	12	—	—	—	—	—	40	5-16-60	75	Ir	
-2	1,500 ft. N. and 2,100 ft. E. of SW cor., sec. 19, T. 48 S., R. 42 E.	do	168	—	12	Elev. equal to lower lip of discharge pipe	0.0	—	2.54	5-16-60	41	5-16-60	75	Ir	
-3	2,200 ft. N. and 2,775 ft. E. of SW cor., sec. 30, T. 48 S., R. 42 E.	Unknown	+200	—	12	Top of 12-inch flange	3.00	—	.73	3-31-60	—	—	—	Ir	
616-005-1	1,100 ft. N. and 1,600 ft. W. of SE cor., sec. 18, T. 48 S., R. 43 E.	Pearl Dews	54	—	2	—	—	—	—	—	30	3- 3-60	76	Li	
-2	3,600 ft. N. and 3,800 ft. E. of SW cor., sec. 19, T. 48 S., R. 43 E.	W. A. Arensen	57	—	2	—	—	—	—	—	45	5-10-60	—	Li	
616-006-1	1,600 ft. S. and 1,050 ft. E. of NW cor., sec. 24, T. 48 S., R. 42 E.	W. D. McDoughald	20	20	1¼	Top of 1¼-inch casing collar	1.5	20.70	12.14	4-12-60	—	—	—	O	
-2	1,840 ft. S. and 1,125 ft. E. of NW cor., sec. 24, T. 48 S., R. 42 E.	do	92	—	2	—	—	—	—	—	20	4-12-60	77	Do	
-3	1,325 ft. S. and 1,500 ft. W. of NE cor., sec. 24, T. 48 S., R. 42 E.	G. H. McCall	52	50	2	—	—	—	—	—	18 18	3-29-60 4-15-61	77	Li	
-4	500 ft. N. and 2,350 ft. W. of SE cor., sec. 18, T. 48 S., R. 42 E.	Town of Hillsboro Beach	71	61	8	Top of 8-inch casing	—	—	9.96	6-30-52	20	9-11-61	77	P	Hillsboro No. 1

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
-5	700 ft. N. and 2,850 ft. W. of SE cor., sec. 13, T. 48 S., R. 42 E.	do	73	64	8	----	----	----	----	----	20	9-11-61	77	P	Hillsboro No. 1
-6	520 ft. N. and 2,550 ft. W. of SE cor., sec. 13, T. 48 S., R. 42 E.	do	104	90	12	----	----	----	----	----	20	9-11-61	77	P	Hillsboro No. 3
616-008-1	3,200 ft. N. and 925 ft. E. of SW cor., sec. 15, T. 48 S., R. 42 E.	R. H. Wright, Inc.	145	----	12	----	----	----	----	----	38	3- 4-60	75	In	Two identical wells tied together
-2	25 ft. N. and 2,600 ft. E. of SW cor., sec. 15, T. 48 S., R. 42 E.	U. S. Geological Survey	14	14	1¼	Top of 1¼-inch casing	1.0	16.71	7.64	7-19-60	30	7-19-60	----	O	
616-009-1	2,500 ft. N. and 225 ft. E. of SW cor., sec. 15, T. 48 S., R. 42 E.	R. H. Wright, Inc.	96	----	2	----	----	----	----	----	30	3- 4-60	76	In	
-2	750 ft. S. and 150 ft. E. of NW cor., sec. 22, T. 48 S., R. 42 E.	A. A. Accardi	115	----	2	----	----	----	----	----	18 42	3-21-60 11- 9-61	76	Do	
616-010-1	1,000 ft. S. and 1,250 ft. E. of NW cor., sec. 20, T. 48 S., R. 42 E.	Mrs. H. L. Lyons	33	----	1¼	Top of 1¼-inch casing	.0	----	1.31	5-31-60	----	----	----	N	

616-011-1	2,475 ft. S. and 750 ft. W. of NE cor., sec. 19, T. 48 S., R. 42 E.	do	+200	—	24	Top of 24-inch casing flange	−3.00	—	0.46	5-17-60	—	—	—	N	
616-012-1	1,550 ft. N. and 50 ft. E. of SW cor., sec. 18, T. 48 S., R. 42 E.	U. S. Geological Survey	8	8	1¼	Top of 1¼-inch casing	.0	14.11	1.50	7-19-60	35	7-19-60	—	O	
617-005-1	950 ft. N. and 4,000 ft. E. of SW cor., sec. 7, T. 48 S., R. 43 E.	G. J. Jeschke	±45	—	1½	—	—	—	—	—	30	3-16-60	77	Li	
-2	800 ft. S. and 2,700 ft. E. of NW cor., sec. 18, T. 48 S., R. 43 E.	Mr. Anderson	90	—	2	—	—	—	—	—	22	5- 2-60	78	In	
-3	2,150 ft. S. and 2,200 ft. E. of NW cor., sec. 18, T. 48 S., R. 43 E.	A. J. Forand	100	—	1¼	—	—	—	—	—	19	5- 2-60	77	Do	
617-006-1	1,400 ft. N. and 800 ft. W. of SE cor., sec. 12, T. 48 S., R. 42 E.	General Development Co., Inc.	178	—	8	—	—	—	—	—	17	4-11-60	77	P	Ca, Gen. Dev. No. 1
-2	1,300 ft. N. and 800 ft. W. of SE cor., sec. 12, T. 48 S., R. 42 E.	do	180	—	12	—	—	—	—	—	18	4-11-60	77	P	Do
-3	1,400 ft. N. and 500 ft. E. of SW cor., sec. 7, T. 48 S., R. 43 E.	do	150	—	8	—	—	—	—	—	20	4-11-60	77	P	Ca, Gen. Dev. No. 3
-4	1,400 ft. N. and 1,450 ft. W. of SE cor., sec. 12, T. 48 S., R. 42 E.	do	122	107	18	—	—	—	—	—	18	9- 8-61	77	P	Ca, Gen. Dev. No. 4
-5	950 ft. N. and 800 ft. W. of SE cor., sec. 12, T. 48 S., R. 42 E.	do	139	125	12	Top of 12-inch casing	—	—	9.25	1- -61	19	9- 8-61	77	P	Ca, Gen. Dev. No. 5

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
617-009-1	2,800 ft. N. and 175 ft. E. of SW cor., sec. 10, T. 48 S., R. 42 E.	J. H. Doran, Inc.	107	......	2	......	......	......	......	......	38	3-28-60	76	In	
617-010-1	850 ft. S. and 1,750 ft. W. of NE cor., sec. 17, T. 48 S., R. 42 E.	P. C. Vinkemulder	106	......	4	Top of 4-inch casing	3.0	16.63	1.88	5-13-60	34 30	7-15-61 9-16-61	76	Ir	
-2	750 ft. S. and 1,150 ft. W. of NE cor., sec. 17, T. 48 S., R. 42 E.	......do......	106	......	2	......	......	......	......	......	26	5-13-60	76	Do	
618-005-1	900 ft. N. and 2,300 ft. E. of SW cor., sec. 6, T. 48 S., R. 43 E.	Unknown	48	......	4	Top of 4-inch casing	3.0	11.98	4.15	7-18-60	24 30	10-10-60 9- 8-60	77	O	
-2	1,400 ft. S. and 3,000 ft. E. of NW cor., sec. 7, T. 48 S., R. 42 E.	Sel Bon, Inc.	61	57	2	Top of 2-inch casing	.5	......	7.02	3-15-60	22	3-15-60	77	In	
618-006-1	1,690 ft. S. and 1,480 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	City of Deerfield Beach	±100	......	12	......	......	......	......	......	20	2-19-60	77	P	Deerfield No. 4
-2	1,690 ft. S. and 2,090 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	......do......	±100	......	12	......	......	......	......	......	18	2-19-60	77	P	Deerfield No. 5

-3	1,690 ft. S. and 2,540 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	do	80	----	12	----------	----	----	----	----------	26	8-15-61	77	P	Deerfield No. 7
-4	170 ft. S. and 1,200 ft. W. of NE cor., sec. 12, T. 48 S., R. 42 E.	Henry Myers	21	----	1¼	Top of pump base	3.00	----	12.62 12.47	5-26-60 7-18-60	----	----------	----	Do	
618-007-1	1,650 ft. S. and 1,800 ft. E. of NW cor., sec. 2, T. 48 S., R. 42 E.	O. W. Goolsby	±110	----	3	----------	----	----	----	----------	14 12 14 14	2-22-60 10-10-60 4-15-61 11- 9-61	77	S	
-2	600 ft. N. and 300 ft. E. of SW cor., sec. 1, T. 48 S., R. 42 E.	American Neighbors, Inc.	62	----	1½	Top of 1½-inch casing	1.0	----	6.82	6- 6-60	----	----------	--	N	
618-008-1	2,400 ft. S. and 1,600 ft. E. of NW cor., sec. 3, T. 48 S., R. 42 E.	O. W. Goolsby	105	----	1½	Top of 1½- x 1¼-inch tee	.0	14.14	3.49	2-22-60	12	10-10-60	76	S	
-2	1,700 ft. S. and 2,575 ft. E. of NW cor., sec. 3, T. 48 S., R. 42 E.	do	±100	----	3	----------	----	----	----	----------	34 36 60	2-22-60 6- 1-60 11- 9-61	77	S	
618-010-1	1,450 ft. N. and 450 ft. E. of SW cor., sec. 4, T. 48 S., R. 42 E.	Earl Johns	±100	----	2	----------	----	----	----	----------	38 30 40	5-10-60 8-11-60 5-15-61	75	S	
618-011-1	1,200 ft. S. and 2,050 ft. E. of NW cor., sec. 6, T. 48 S., R. 42 E.	John Thompson	125	----	2	----------	----	----	----	----------	34 32	2-24-60 5-15-61	77	S	
-2	25 ft. N. and 550 ft. W. of SE cor., sec. 6, T. 48 S., R. 42 E.	H. D. and T. W. Henson	±100	----	2	----------	----	----	----	----------	32	5-10-60	76	In	
618-012-1	1,800 ft. N. and 500 ft. E. of SW cor., sec. 6, T. 48 S., R. 42 E.	Unknown	35	----	1¼	Top of 1¼-inch casing	3.00	17.63	1.85	5-11-60	32 34	10-10-60 4-15-61	76	O	

TABLE 4. (Continued)

Well number	Location	Owner	Total depth of well (feet)	Casing		Measuring point			Water level		Chloride content		Temperature (°F)	Use	Remarks
				Depth (feet)	Diameter (inches)	Description	Height above land surface (feet)	Elevation above mean sea level (feet)	Above (+) or below land surface (feet)	Date of measurement	Parts per million	Date sampled			
-2	1,790 ft. N. and 200 ft. E. of SW cor., sec. 6, T. 48 S., R. 42 E.	do	40	----	--	----	----	----	----	----	32	5-10-60	76	Do	
-3	3,775 ft. S. and 1,100 ft. W. of NE cor., sec. 1, T. 48 S., R. 41 E.	do	20	----	1¼	Top of 1¼-inch casing nipple	3.00	----	0.80	6-29-60	----	----	---	N	
619-005-1	1,000 ft. S. and 1,150 ft. W. of NE cor., sec. 6, T. 48 S., R. 43 E.	U. S. Geological Survey	8	7	1¼	Top of 1¼-inch casing	.0	8.30	5.92	6-18-60	----	----	---	O	
619-006-1	420 ft. S. and 430 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	City of Deerfield Beach	80	----	8	----	----	----	----	----	22	2-23-60	78	P	Ca, Deerfield No. 1
-2	420 ft. S. and 530 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	City of Deerfield Beach	83	----	12	----	----	----	----	----	18	2-23-60	78	P	Deerfield No. 2
-3	50 ft. S. and 5 ft. E. of NW cor., sec. 6, T. 48 S., R. 43 E.	do	110	----	12	----	----	----	----	----	25	2-23-60	79	P	Deerfield No. 3
-4	1,250 ft. S. and 2,090 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	do	90	80	12	----	----	----	----	----	20	2-23-60	77	P	Deerfield No. 6

-5	1,250 ft. S. and 2,640 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	do	90	80	12	Top of 1¼-inch air-line	0.0	12.02	9.78	9-18-61	20	8-31-61	77	P	Deerfield No. 8
-6	50 ft. S. and 400 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	do	90	80	12	—	—	—	—	—	28	8-31-61	78	P	Deerfield No. 9
-7	1,240 ft. S. and 2,540 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	American Neighbors, Inc.	35	35	6	Top of 6-inch casing	2.5	13.40	8.61	9-18-61	—	—	—	T	
-8	1,260 ft. S. and 2,540 ft. W. of NE cor., sec. 1, T. 48 S., R. 42 E.	do	95	80	6	do	2.5	13.14	8.41	9-18-61	—	—	—	T	
-9	950 ft. S. and 1,600 ft. E. of NW cor., sec. 1, T. 48 S., R. 42 E.	do	90	80	6	do	2.5	11.92	6.26	9-18-61	—	—	—	T	
-10	980 ft. S. and 1,600 ft. E. of NW cor., sec. 1, T. 48 S., R. 42 E.	do	35	35	6	do	2.5	12.14	6.04	9-18-61	—	—	—	T	
619-007-1	700 ft. S. and 3,250 ft. E. of NW cor., sec. 2, T. 48 S., R. 42 E.	Edmond L. McDonald	59	—	1½	Top of 1½-inch tee	1.0	14.67	7.48	4-13-60	17	10-11-60	76	O	