RECHARGE AREAS OF THE FLORIDAN AQUIFER IN SEMINOLE COUNTY AND VICINITY, FLORIDA

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INTRODUCTION

The Floridan aquifer is the most important source of water supply in Seminole County. Virtually all public and domestic water supplies and most of the water used for irrigation are from wells that tap the Floridan. Hence, delineating the areas that recharge the aquifer is important. The purpose of this report is to show those areas where the Floridan aquifer is subject to recharge or discharge. Lichtler (1972) also made a somewhat general description of recharge areas in Seminole County. But this map report presents a more detailed representation of the recharge areas on the basis of further study and field work accomplished from July 1971 to May 1973.

This report was prepared in cooperation with the Seminole County Board of Commissioners as part of a comprehensive study of the water resources of Seminole County that began in July 1971. The investigation was made under the general supervision of C. S. Conover, Florida District Chief, and the immediate supervision of J. O. Kimrey, Subdistrict Chief, both of the U. S. Geological Survey.

GEOHYDROLOGY

In Seminole County, the Floridan aquifer is composed of limestone alternating with layers of dolomite and dolomitic limestone. Depth to the top of the aquifer ranges from about 75 feet in the northwest, northeast (except the Geneva area) and southeast parts of the county to as much as 200 feet in the southwest parts and 130 feet in the Geneva area. The thickness of fresh water (chloride content less than 250 milligrams per liter) in the aquifer ranges from zero to as much as 2,000 feet (Shampine, 1965).

The Floridan aquifer is overlain by confining beds that are generally composed of clay and clayey sand. Their thickness and permeability vary throughout the county and exert a partial control on the amount of water that can recharge the Floridan aquifer. Because the Floridan aquifer is confined, the water level in a tightly cased well in the aquifer will stand above the level at which the aquifer was first penetrated. This water level is called the potentiometric surface. Where the potentiometric surface is above land surface, a well that is drilled into the aquifer will flow at the surface. The main areas of artesian flow in Seminole County are along the Wekiva, Econlockhatchee, Little Econlockhatchee, and St. Johns Rivers, much of the Sanford and Oviedo areas, and in the area around Lake Jessup. These areas are shown in yellow on figure 1.

The water table, or nonartesian, aquifer is composed primarily of fine to very fine sand and is the uppermost ground-water reservoir in Seminole County. The aquifer is recharged from local rainfall and, in areas where the potentiometric surface of the Floridan aquifer is above the water table, by upward leakage from the Floridan aquifer. Water leaves the nonartesian aquifer by downward leakage to the Floridan aquifer, pumpage, seepage to lakes, ditches, and streams, and, where the water table is near land surface, by evapotranspiration. In Seminole County, the water table occurs at depths ranging from land surface to 30 feet below land surface. In general, the depth to the water table is greatest in the southwest and northwest sections of the county, the Oviedo area, the Chulouta area, and in the Geneva area. Throughout the rest of the county, the water table occurs at or near the land surface during much of the year. In some areas, the water table has been artificially lowered by ditching and draining.

RECHARGE

The Floridan aquifer is recharged by downward leakage of water from the water table aquifer. Discharge from the Floridan aquifer occurs as pumpage, as springflow, and by upward leakage in areas where the potentiometric surface of the Floridan is above the water table.

Recharge to the Floridan aquifer is that component of the rainfall which percolates to the water table and continues to move downward through the confining beds and into the aquifer. That part of the rainfall not considered as recharge either evaporates from the land or water surfaces; is transpired by plants; or runs off or seeps toward lakes and streams and ultimately discharges into the ocean.

Some of the water that runs off or seeps into lakes or streams may ultimately contribute to recharge through the lake or stream bottom, thence to the Floridan aquifer. However, the amount of water that can recharge the Floridan aquifer through a lake or stream bottom depends upon the effectiveness of the hydraulic connection between the water body and the aquifer.

Recharge to the Floridan aquifer can occur wherever the water table (or a lake surface) is above the potentiometric surface of the Floridan. However, the rate of recharge is governed by: 1) the thickness and permeability of the intervening confining beds and 2) the degree of hydraulic potential, or head difference, between the water-table aquifer and the Floridan aquifer.

Information concerning the position and configuration of the potentiometric surface of the Floridan is obtained periodically and the thickness of the confining beds was determined by Barraclough (1962). However, data concerning water-table altitudes and permeability of the confining beds are sparse and have little transfer value from one location to another. Therefore, it is necessary to resort to indirect methods of evaluating those factors and their effect on the recharge potential of an area.

METHODS OF LOCATING AND EVALUATING RECHARGE AREAS

The indirect methods used in defining and evaluating the recharge areas shown on figure 1 consist of analyzing rainfall-runoff relationships in stream basins; evaluating the configuration of the potentiometric surface of the Floridan aquifer; observing the significance of the degree of mineralization of water in the Floridan aquifer; and evaluating the topography and landforms with respect to altitude of the potentiometric surface of the Floridan aquifer. In addition, analysis of soils maps helps determine the location of recharge areas. Such maps are prepared and made available by the U.S. Soil Conservation Service (U.S. Department of Agriculture, 1966).

Rainfall-runoff relationships provide only a rough estimate of the quantity of water that is available for recharge. The most important variable is the amount of evapotranspiration that occurs in each surface-water drainage basin. Even within the same basin, the relationship of rainfall to runoff may vary considerably. In general, a basin that has a small amount of runoff per unit area has more water available for recharge.

A map of the potentiometric surface of the Floridan aquifer (figure 1) is useful in detecting and delineating areas where recharge or discharge occurs. "Bulges" on the potentiometric surface (as in the Geneva area) generally coincide with areas of recharge; "holes" (Sanlando Springs area) or "troughs" (west end of Lake Jessup) generally coincide with areas of discharge. This map must be used with caution in selecting areas of recharge because areal changes in aquifer transmissivity (the ability of the aquifer to transmit water) and the effects of pumping can also exert control on the configuration of the potentiometric surface.

The degree of mineralization of water in the Floridan aquifer generally reflects the solubility of the rock materials and, also, the length of time the water has been in contact with the materials. The dissolved solids content of water from the upper 200 feet of the Floridan aquifer can be generalized areally as shown on figure 2. The dissolved-solids content is a measure of the degree of mineralization. In Seminole County, some of the mineralization is due to sea water that entered the aquifer during interglacial periods of the Pleistocene epoch or from sea water that was trapped in the rocks when they were deposited (Barraclough, 1962). Water in the Floridan aquifer moves from places of recharge to places of discharge. The less mineralized water that enters the aquifer as recharge reacts with the rock materials as it moves through the aquifer and also dilutes and flushes out the more highly mineralized sea water. In Seminole County, areas where the Floridan aquifer contains water with a relatively small amount of dissolved solids are areas where recharge is either occurring or occurring nearby.

The evaluation of topography and landforms with respect to the altitude of the potentiometric surface can be used to help determine the relative effectiveness of recharge areas.

In areas where the potentiometric surface of the Floridan is many tens of feet below land surface, the water table may be near land surface or it may be many feet below and only slightly above the potentiometric surface of the Floridan. Where the potentiometric surface of the Floridan is at considerable depth below land surface and where the head difference between the water table and the potentiometric surface is small and where the surface drainage is not well developed (such as the area along Interstate 4 between State Roads 434 and S-46A), the confining beds are only slightly effective and recharge is occurring. A well-developed surface drainage system on relatively high land (such as along Gee Creek, Howell Creek, and the Econlockhatchee and Little Econlockhatchee Rivers), may indicate that, even though the potentiometric surface of the Floridan is several tens of feet below land surface and the water table is several feet below land surface (therefore, little water is lost to evapotranspiration), some of the potential Floridan recharge water may ultimately seep laterally via the water-table aquifer and discharge into streams. Where the altitude of land surface is relatively high and the potentiometric surface is far below land surface, the water table may be near land surface (because of relatively effective confining beds) and the area may have little surface drainage. An example would be the area about 1.5 miles west of Longwood. Here, the head difference between the water table and the potentiometric surface is sufficient to drive the recharge water across the confining beds and into the aquifer while the remainder is lost to evapotranspiration.

Where the potentiometric surface is near or, perhaps, above land surface, the water table is usually near land surface. These areas are generally not effective recharge areas because 1) there is little downward head difference between the water table and the potentiometric surface (the potentiometric surface of the Floridan aquifer, in some areas, may actually be above the water table and (or) land surface and upward leakage is occurring, thereby precluding recharge); 2) evapotranspiration rates are generally high because the water table is at or near land sufrace; and 3) surface drainage is usually developed to such an extent that it removes any water that is not lost to evapotranspiration.

Areas that are pocked with sinkholes and lakes of probable sinkhole origin are generally effective recharge areas even though the lakes and sinks themselves may, or may not, contribute the majority of the recharge water. The fact that there was previous sinkhole formation is evidence that large quantities of water were (and probably still are) being recharged throughout the entire area. The sinkholes were formed because slightly acid water (formed from the contact of rainfall with carbon dioxide in the atmosphere and soil) percolated downward and slowly dissolved the limestone. When caverns in the limestone become so large that their roofs are unable to sustain the weight of the overburden, the roofs collapse and the overlying sands flow into the caverns. The depressions formed on the land surface are merely the surface expressions of subsurface subsidence.

The recharge areas of varying effectiveness that are shown in figure 1 were delineated on the basis of all the previously-discussed methods except the analysis of a soils map. The soils map was not referred to until the recharge map was almost completed; so the soils map was a final check. The results obtained from analysis of the soils map was in very close agreement with the results obtained by the other independent methods of analysis. However, as a tool to delineate recharge areas, soils maps cannot be used exclusively. For example, a well-drained soil may be the result of ultimate lateral drainage to lakes and streams as well as vertical drainage (recharge) to the Floridan aquifer. Also, the fact that a soil is not well-drained does not preclude the possibility that recharge is taking place.

DESCRIPTIONS OF RECHARGE AREAS

The most effective recharge areas to the Floridan aquifer in Seminole County and vicinity are shown in red on figure 1. These areas are generally described as follows: 1) the natural surface drainage system is poorly developed and the amount of runoff with respect to rainfall is relatively low; 2) the potentiometric surface of the Floridan aquifer may show "bulges" as in the Geneva area; 3) the mineralization of water in the Floridan aquifer (fig. 3) is less than that in the poor and very poor recharge areas; 4) the land surface is many feet above the potentiometric surface of the Floridan and is characterized by many closed depressions, lakes, and ponds that are indicative of past sinkhole activity; 5) the soils are generally well drained. The data available indicate that recharge rates in the most effective recharge areas probably range from 10 inches to as much as 21 inches of rainfall per year.

The moderately-effective recharge areas are shown in blue on figure 1 and are described as follows: 1) the surface drainage system tends to be more developed than in the most effective recharge areas and the amount of runoff with respect to rainfall is relatively higher. In these areas, the surface drainage system may be entirely natural or it may have been enhanced by man's activities. In either case, more runoff is likely to occur than in the most effective recharge areas; 2) the potentiometric surface of the Floridan may show evidence of "bulging" although it is generally less pronounced than in the most effective recharge areas; 3) the mineralization of water in the Floridan aquifer (fig. 3) is about the same as that in the most effective recharge areas but less mineralized than that in the poor and very poor recharge areas; 4) the distance between land surface and the potentiometric surface is generally not as great as in the most effective recharge areas and there is less evidence of past sinkhole activity (that is, closed depressions, lakes, and ponds); 5) the soils are generally well drained. The recharge rates in the moderately- effective recharge areas probably range from 3 to 10 inches of rainfall per year.

The poor recharge areas are shown in green on figure 1. These areas are described as follows: 1) the surface drainage system may or may not be well developed. Where the surface drainage system is well developed, the percentage of rainfall that runs off is relatively high. Where the surface drainage system is poorly developed, much of the rainfall that doesn't ultimately run off to streams stands in marsh or wet areas and is lost to evapotranspiration, therefore; 2) the land may be characterized by swamps and other areas where water stands on or near the surface throughout most of the year; 3) the potentiometric surface of the Floridan generally tends to be featureless with no well-defined naturally-occurring "bulges" or "troughs" that can be attributed to natural recharge or discharge; 4) the degree of mineralization of the water in the Floridan aquifer (fig. 3) generally is higher than in the better recharge areas; 5) the soils generally tend to be poorly drained. The recharge rates in poor recharge areas probably range from 0 to 3 inches of rainfall per year.

Very poor recharge areas are shown in yellow on figure 1. These areas are described as follows: 1) the potentiometric surface of the Floridan aquifer is above land surface (and, hence, the water table) so these are areas of artesian flow and upward leakage, or rejected recharge; 2) the surface drainage system may or may not be well developed although much of the very poor recharge areas shown in yellow is of agricultural importance and, except for the area south of State Road 46 along the Wekiva River, Little Wekiva River, and Rock Springs Run, much ditching and draining has been done to facilitate farming activity. Where not ditched and drained, many of these areas are swampy and water stands on the surface most of the year. All of the rainfall that does not run off is lost to evapotranspiration; 3) the mineralization of water in the Floridan aquifer (fig. 3) is generally greater than in the most effective and moderately effective recharge areas; 4) the soils are generally poorly drained. The recharge rate in those areas classified as very poor recharge areas could actually be considered as zero or some negative amount because discharge, rather than recharge, is likely to be occurring most of the year.

CONFIGURATION OF POTENTIOMETRIC SURFACE OF FLORIDAN AQUIFER

The contours (fig. 1) depict the configuration of the potentiometric surface, or pressure surface, of the Floridan aquifer in Seminole County and vicinity. The movement of water in the aquifer is at right angles to the lines of equal head (pressure) in the direction of decreasing head and from areas of recharge to areas of discharge. Thus, figure 1 shows that most of the ground water that flows into Seminole County from Orange County by way of the Floridan aquifer is subsequently discharged from the aquifer into the Wekiva River via Wekiva, Sanlando, Palm, and Starbuck Springs. A small amount of inflow from Orange County occurs in the extreme southeast part of Seminole County. Thus, aside from the southwest and extreme southeast parts of the county, Seminole County is largely self-sufficient in its ground-water supply because, in the remainder of the county, all of the water in the Floridan aquifer originated as rainfall on the county. Even in the southwest section of the county, it is estimated that 44 percent of the water being discharged from Sanlando, Palm, and Starbuck Springs is derived from local (within the county) recharge. Further, it is estimated that 18 percent of the water being discharged from Wekiva Spring originated as rainfall on Seminole County.

From 1961 to 1973, Seminole County and vicinity has been, on the whole, about 38 inches deficient in rainfall (fig. 3) with about 19 inches of the deficiency having occurred since 1969. As a result, potentiometric levels of the Floridan aquifer (fig. 3) have declined.

Since 1969, Seminole County has experienced unprecedented growth resulting in increased stress on the ground-water resources. However, even in southwest Seminole County, where most of the recent growth has occurred, there is no evidence to show that the declining potentiometric levels can be attributed to anything other than deficient rainfall. This may be due in part to the fact that most of the increase in ground-water withdrawals has occurred in an area that is predominately drained by Sanlando, Palm, and Starbuck Springs, major discharge points for the Floridan aquifer. It is possible that the effects of man's increased ground-water withdrawals on potentiometric levels have been partially offset by a reduction in springflow, or natural discharge.

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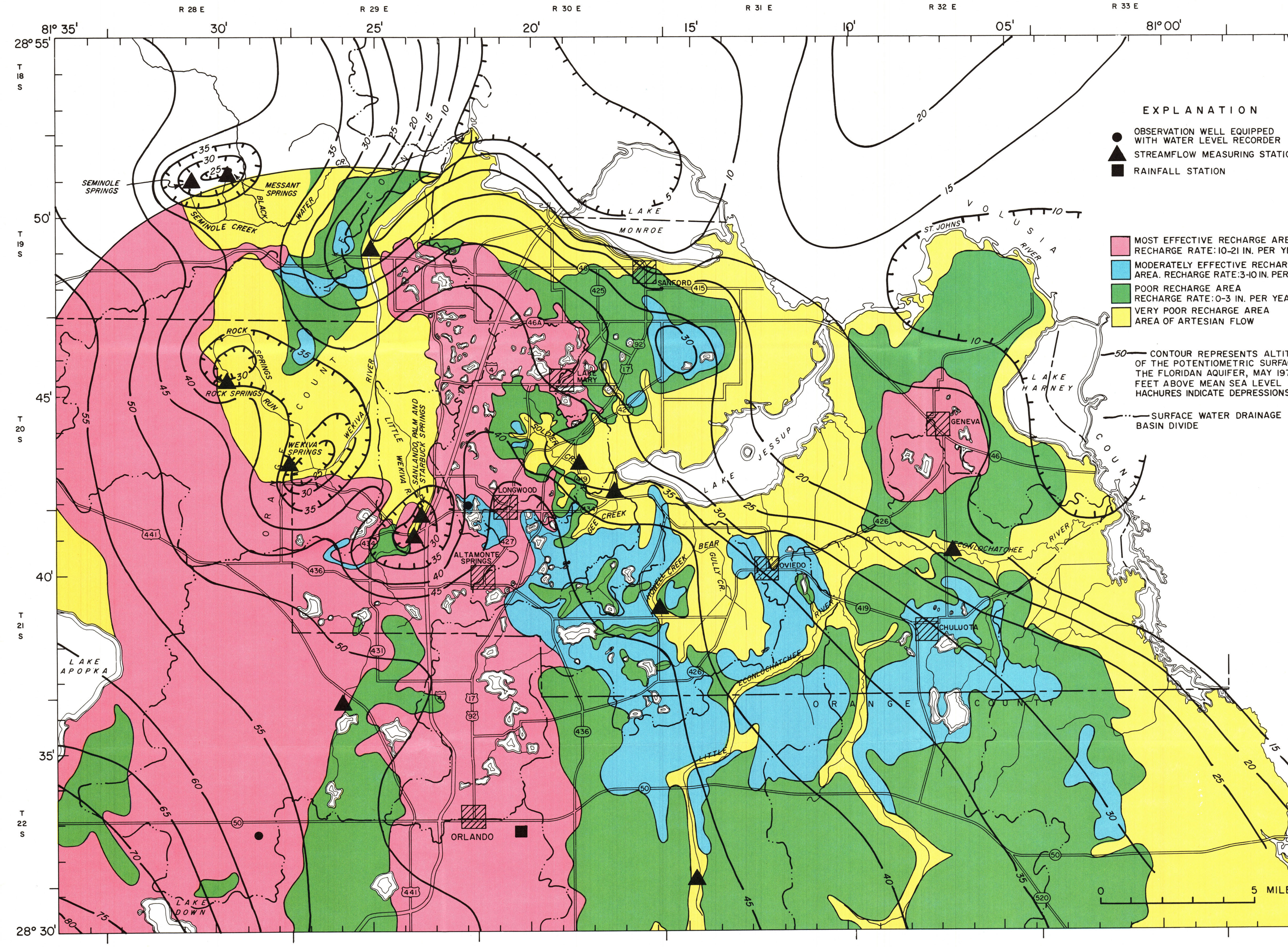

Figure 1. Map of Seminole County and vicinity showing recharge areas, selected drainage basins, selected hydrologic data collection stations, and potentiometric surface of the Floridan aquifer, May 1973. Recharge areas in Orange County taken from Lichtler (1968).

LOCATION OF INVESTIGATION, (SEMINOLE COUNTY AND SURROUNDING AREAS)

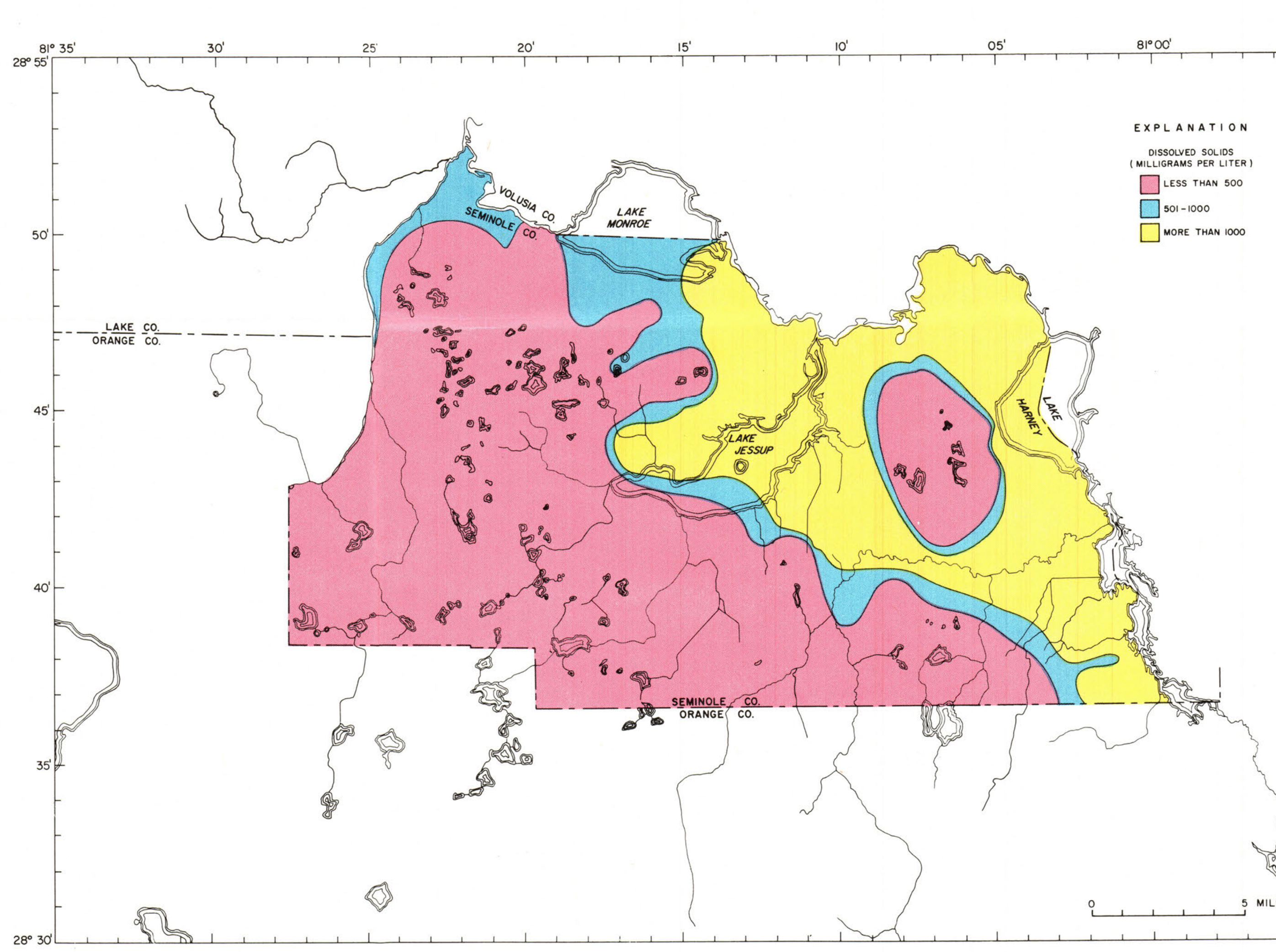

Figure 2. Map of Seminole County showing dissolved solids content of water from the upper 250 feet of the Floridan aquifer (from Hoy and Teel, 1962).

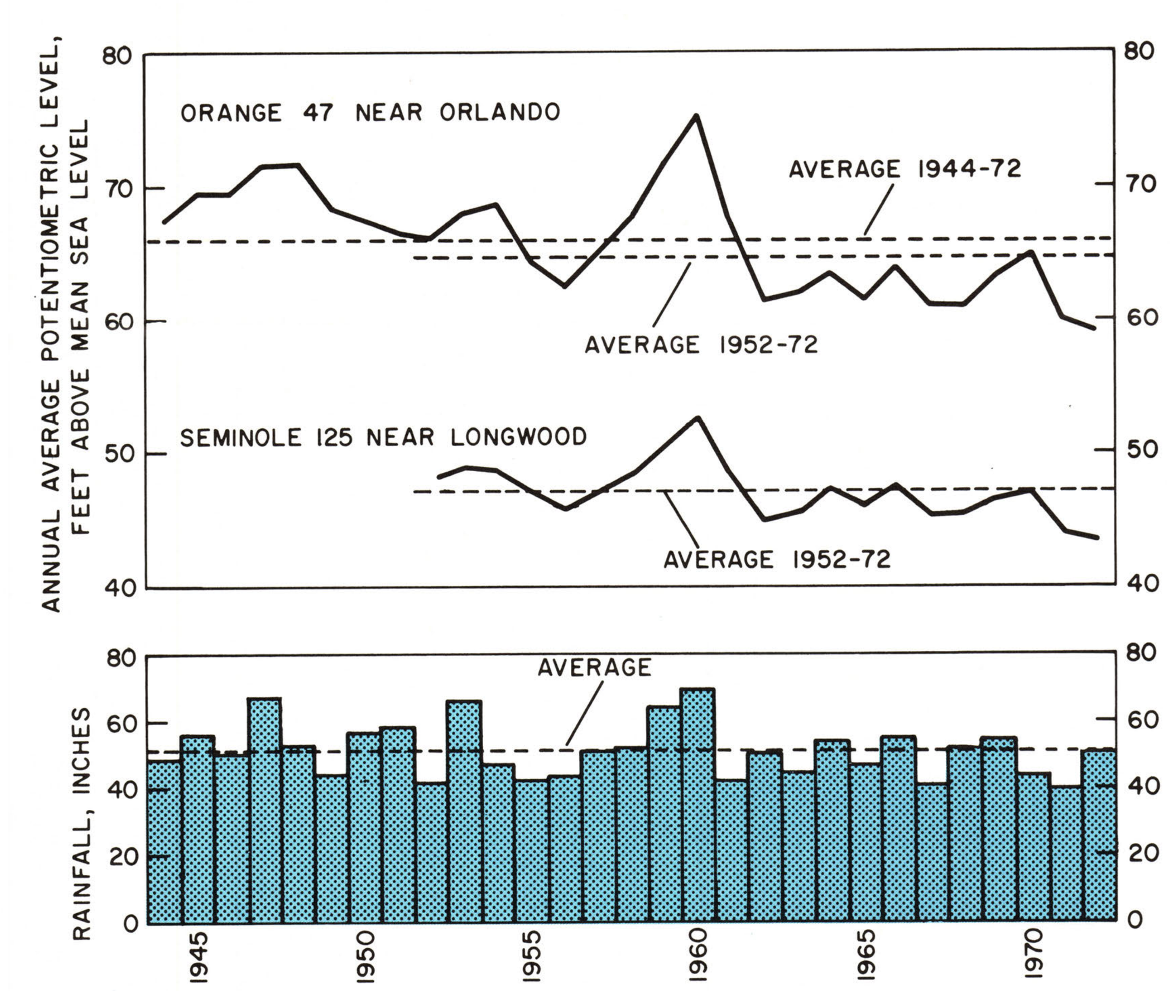

Figure 3. Hydrographs showing rainfall at Orlando (Hernando Airport) and potentiometric levels of the Floridan aquifer in Seminole County and vicinity.

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