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ESTIMATED YIELD OF FRESH-WATER WELLS IN FLORIDA

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INTRODUCTION

Well yield is an important aspect in designing ground-water supply systems and planning for water-supply development. The number and size of wells and pumps needed to supply the required water depend upon the amount of water which can be yielded from each well.

All of Florida is underlain by ground-water reservoirs (aquifers) generally capable of yielding water in usable quantities to wells. In some areas, well yields are low while in others hundreds and even thousands of gallons per minute per well can be obtained. This map report depicts the great geographical variation of well yield for four major aquifers used to supply potable water in Florida. The map is too generalized to be used to locate specific wells; important environmental factors have been neglected which must be considered when actually locating water-supply wells. Some of these factors include the effect ground-water withdrawals will have on the water levels in nearby wells or in wetlands or lakes, the reduction of flow in nearby streams, or the flow of salt water or contaminants toward wells. Some areas shown on the map may yield much less water than that amount shown, and others much more because of variation in aquifer characteristics.

Aquifers are rock formations sufficiently permeable to yield water in usable quantities to wells and springs. Their water-yielding characteristics depend in part on the number and size of openings between rock particles that compose the aquifer and the extent to which those openings are interconnected.

Because hydraulic conductivity (the ease with which water will pass through a formation) of the aquifers is not everywhere the same, well yield at a given location can best be determined by drilling wells and performing aquifer tests. If test information is not available, the yield of a well can usually be estimated on the basis of the specific capacity and transmissivity data from nearby wells. The specific capacity of a well is its yield, in gallons per minute, divided by the drawdown of the water level in it, that is, yield per foot of drawdown. Transmissivity is the rate at which water is transmitted through a unit width of the aquifer under a unit hydraulic gradient. The specific capacity and transmissivity data used to estimate the yields of wells were obtained from well information on file, supplemented by areal reports published by the Florida Bureau of Geology and open-file reports of the U. S. Geological Survey.

Well yields increase with increasing diameter of well bore and decrease with increasing pumping time. To show this graphically, curves were developed using an equation derived by Theis (1935). The curves in figure 1-A show that in a water-table aquifer a 20-inch diameter well yields about 16 percent more water than a 5-inch diameter well, and in an artesian aquifer, about 12 percent more. Curves in figure 1-B show that well yields decrease rather rapidly during the early stages of pumping, and then decrease gradually during extended periods of pumping, for both water-table and artesian aquifers.

Because well yields vary with well diameter and pumping period, and also depend upon drawdown, the yields of wells portrayed on the large map of Florida pertain to one specific set of conditions: a well diameter of 12 inches tapping the full thickness of the aquifer, a pumping period of 24 hours, and a drawdown of 10 feet.

Most of the potable ground water used in Florida (3 billion gallons per day in 1970) comes from four major aquifers. They are the Floridan aquifer, the Biscayne aquifer, the sand-and-gravel aquifer, and the shallow aquifers throughout Florida (Hyde, 1965). Figure 2 shows the approximate area where each aquifer constitutes the principal source of potable ground water. In some areas, these aquifers contain water whose chloride or dissolved-solids concentration is substantially in excess of the limit recommended by the U. S. Public Health Service (1962) but for the lack of better water are still used as a source of supply. In areas where more than one major aquifer exists, only the principally used aquifer is shown. Other aquifers occur in the State but they have a limited areal extent and low water yield.

FLORIDAN AQUIFER

The Floridan aquifer—the most extensive and widely used aquifer—is composed chiefly of limestone and dolomite. In some places the Floridan aquifer is exposed but in most, the top of the aquifer lies from 100 feet to several hundred feet below land surface. Its thickness varies; in parts of central Florida it is as much as 1,500 feet thick. The Floridan is recharged by downward leakage from overlying aquifers where the water table is higher than the potentiometric surface of the Floridan aquifer and where the confining beds that separate the aquifers are semipermeable, thin, or breached by sinkholes. Where the aquifer is exposed it is recharged directly by infiltrating rainfall and by lakes and streams. Where the Floridan aquifer is overlain by confining beds, the water in wells tapping the aquifer is generally under artesian pressure and rises to some level above the top of the aquifer. This level, the potentiometric surface of the Florida aquifer, is illustrated in figure 3 (Healy, 1962). In parts of the State, the potentiometric surface of the Floridan aquifer is above land surface (fig. 3) and wells penetrating the aquifer will flow, some as much as several thousand gallons per minute. A flow of 12,000 gal/min (gallons per minute) was reported for one well in Putnam County, and 20,000 gal/min for a well in Lake County.

Wells that tap the Floridan aquifer generally yield at least 250 gal/min throughout the State except for a few areas. In general, wells that yield at least 1,000 gal/min tap limestone containing interconnected solution cavities. In northwest Florida, wells inland have greater yields because the Floridan aquifer along the coast contains much limey clay and sand, which reduce its transmissivity.

BISCAYNE AQUIFER

The Biscayne aquifer, underlying Dade and Broward and part of Palm Beach Counties, is the prime source of water for populous southeast Florida. According to Schroeder and others (1958, p. 1-26), the aquifer is composed mainly of limestone, coquina, coralline reef rock, and sand. The aquifer extends from land surface to a depth of about 10 feet in western Broward and Dade Counties and to a depth of about 200 feet along the coast. Water in the Biscayne aquifer is unconfined and the water table slopes generally eastward toward the coast except where influenced locally by canals. The aquifer is recharged by rainfall, and in some coastal areas by water infiltrating the aquifer from controlled canals (Appel, 1973).

The Biscayne aquifer is highly productive; well yields commonly exceed 2,000 gal/min. The limestone of the Biscayne aquifer contains large interconnected solution cavities that greatly facilitate the ground-water movement (Schroeder and others, 1958, p. 38.).

SAND-AND-GRAVEL AQUIFER

The sand-and-gravel aquifer underlies Walton, Okaloosa, Santa Rosa, and Escambia Counties in northwest Florida, but it is the principal source of ground water only in Santa Rosa and Escambia Counties. The aquifer is composed of quartz sand and gravel and discontinuous layers of clay and extends from land surface to depths ranging from less than 250 feet along the coast and from 400 feet in northeast Santa Rosa County to 700 feet in south-central Escambia County (Musgrove and others, 1961, fig. 4, p. 14). Generally the water in the sand-and-gravel aquifer is unconfined and the shape of the water table nearly everywhere conforms to the topography. In some areas the water is confined by clay lenses and the water is under artesian pressure (Musgrove and others, 1961, p. 17). The aquifer is recharged by rainfall that infiltrates to the water table.

Except along the coast, in Escambia and Santa Rosa Counties, wells tapping the sand-and-gravel aquifer generally yield 250 gal/min or more. Along the coast the aquifer is less than 250 feet thick and contains clay beds that reduce the transmissivity. Wells there yield less than 250 gal/min.

SHALLOW AQUIFERS

The shallow aquifers consist of sand, shell, and limestone and are mostly less than 100 feet in thickness. In south Florida they range in thickness from about 30 feet in Hendry County to about 300 feet in western and central Palm Beach County. Along the east coast, north of Palm Beach County, the aquifers range in thickness from 20 to 150 feet. The water table generally slopes toward water bodies such as streams, lakes, the gulf, and the ocean. The aquifers are recharged by infiltrating rainfall. Many shallow aquifers are not shown in figure 2—they are not widely used as a water source owing to the availability of other more productive aquifers.

Wells that tap the shallow aquifer along the east coast generally yield less than 250 gal/min because the aquifer in that area consists of sediments of low permeability, such as fine sand, clay, shell, and occasional thin layers of dense limestone. The shallow aquifer in northern Collier and southern Hendry Counties is composed of highly permeable limestone (Klein and others, 1964, p. 44); wells in this area generally yield at least 2,000 gal/min.

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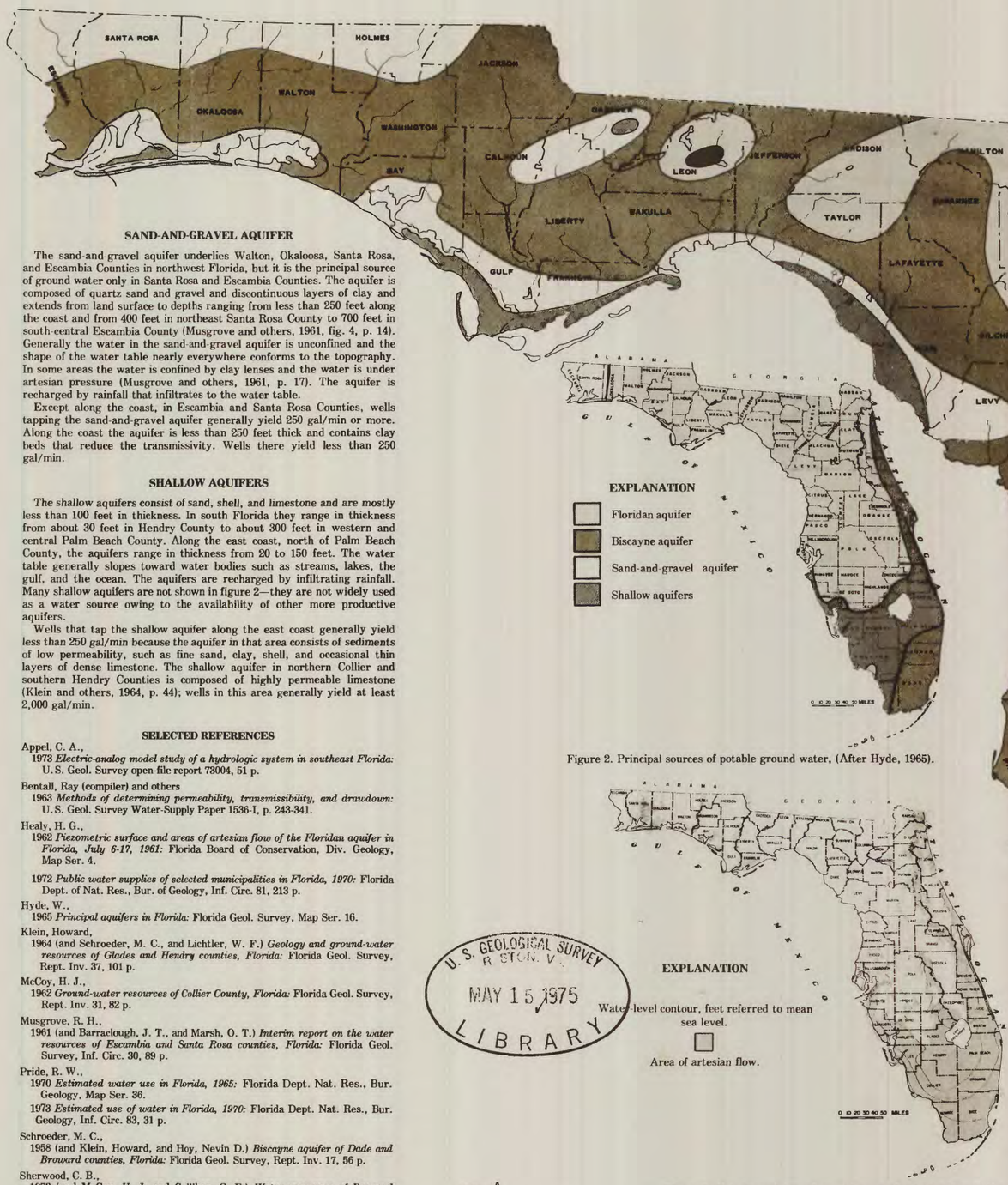
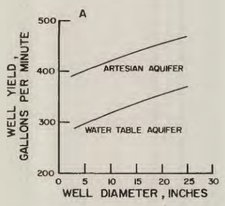


Figure 2. Principal sources of potable ground water, (After Hyde, 1965).

Figure 3. Potentiometric surface and areas of artesian flow of the Floridan aquifer in Florida, 1961, (Healy, 1962).



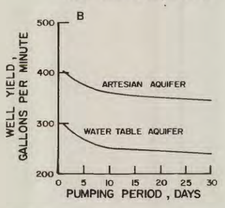
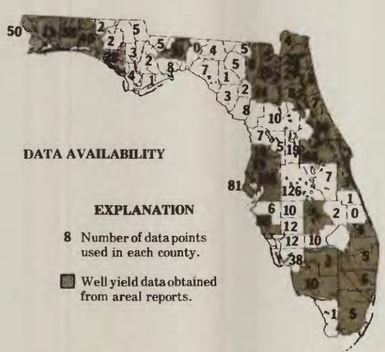


Figure 1. Theoretical relation between yield and well diameter (A) and pumping time (B).



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