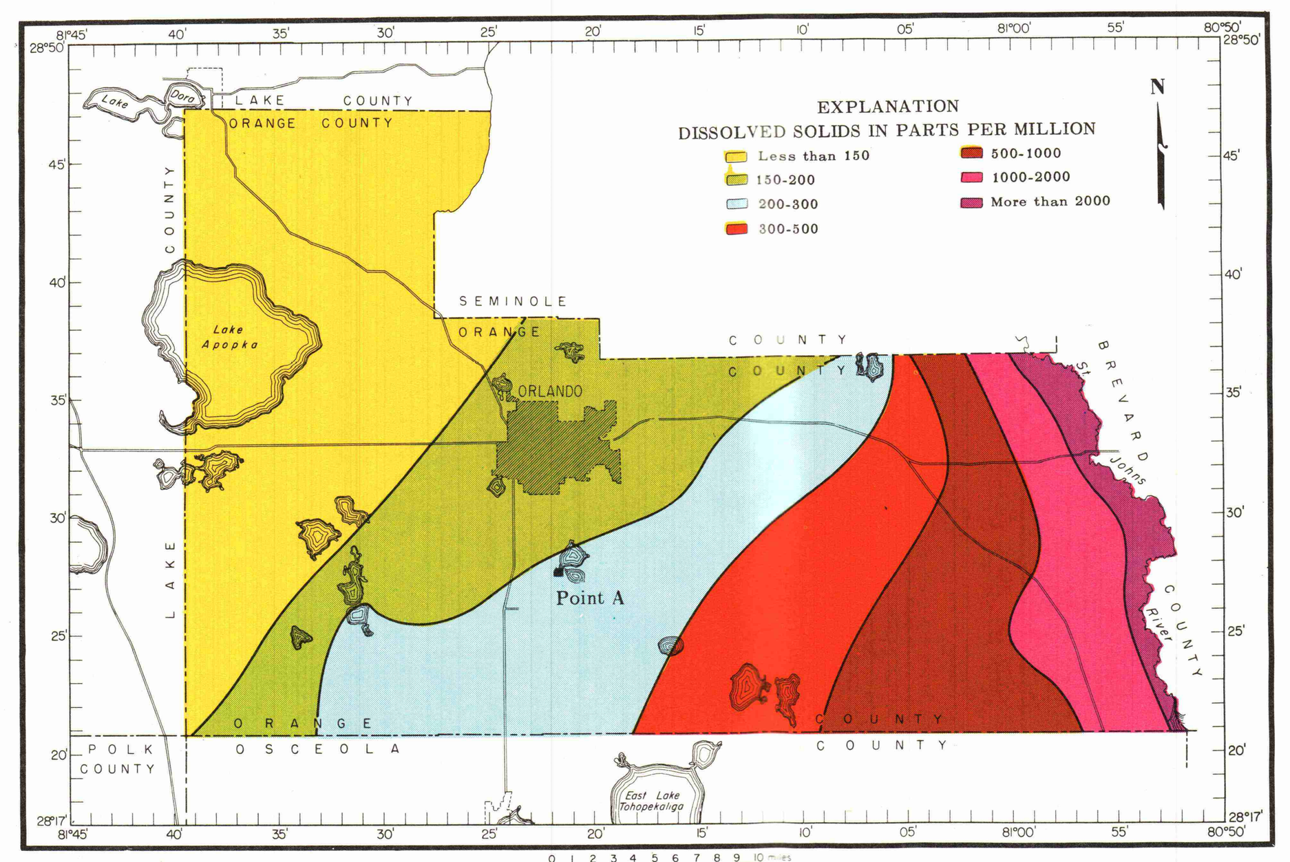

Figure 1. Dissolved solids in parts per million in water from the Floridan aquifer.

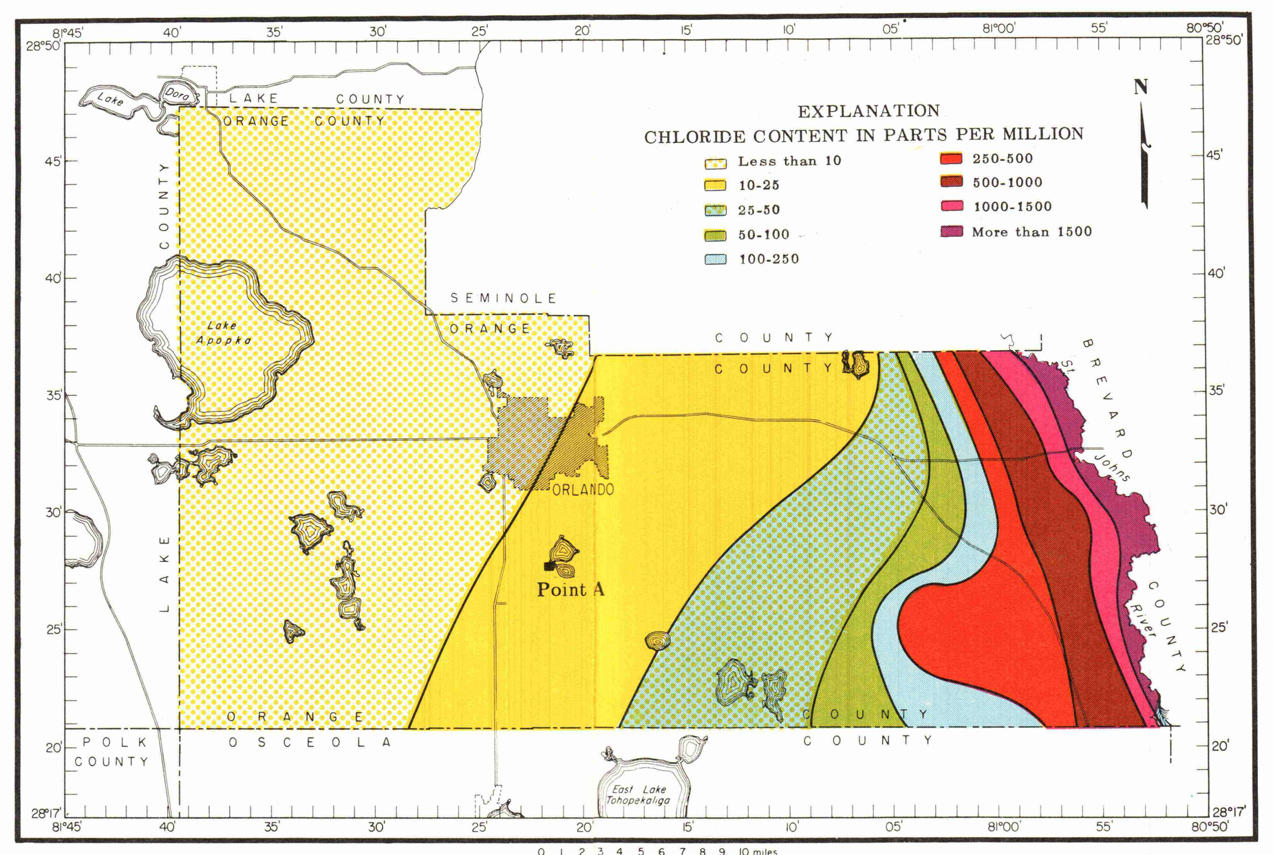

Figure 2. Chloride content in parts per million in water from the Floridan aquifer.

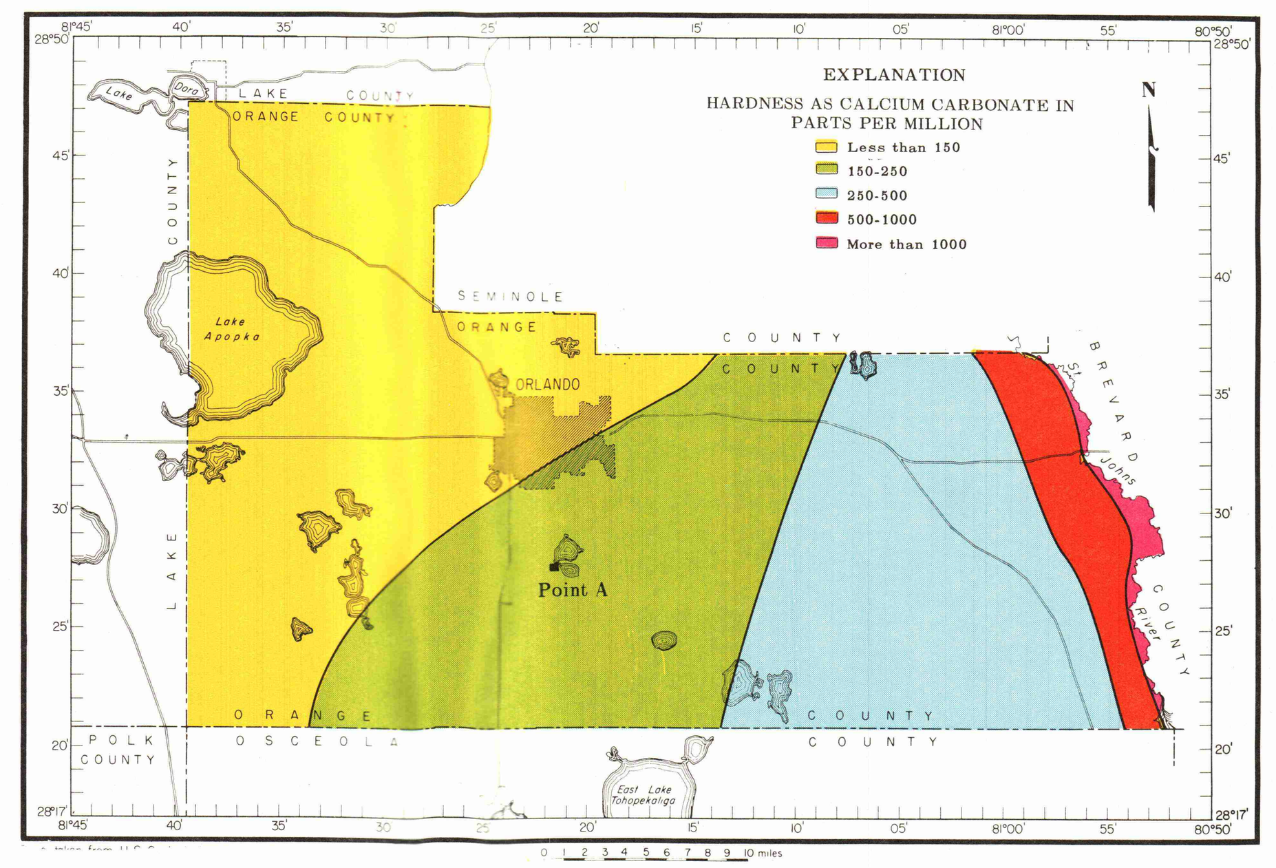

Figure 3. Hardness as calcium carbonate in parts per million in water from the Floridan aquifer.

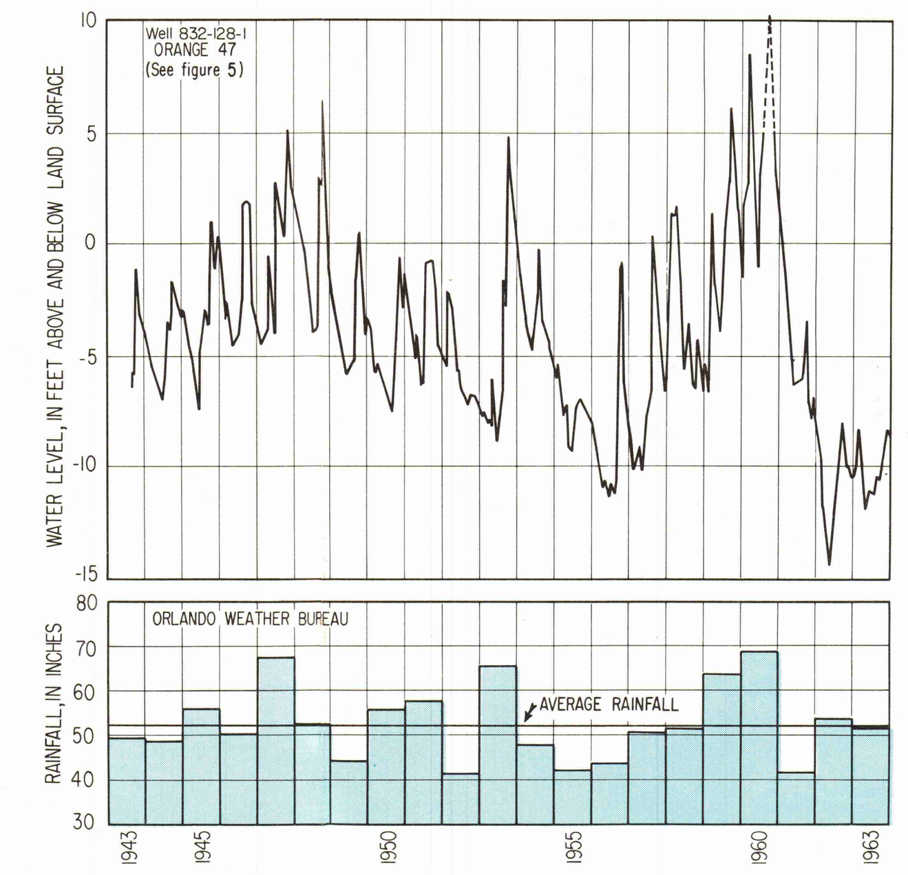

Figure 4. Hydrograph of water levels in well Orange 47 (832-128-1) in the Floridan aquifer and bar graph of annual rainfall at Orlando.

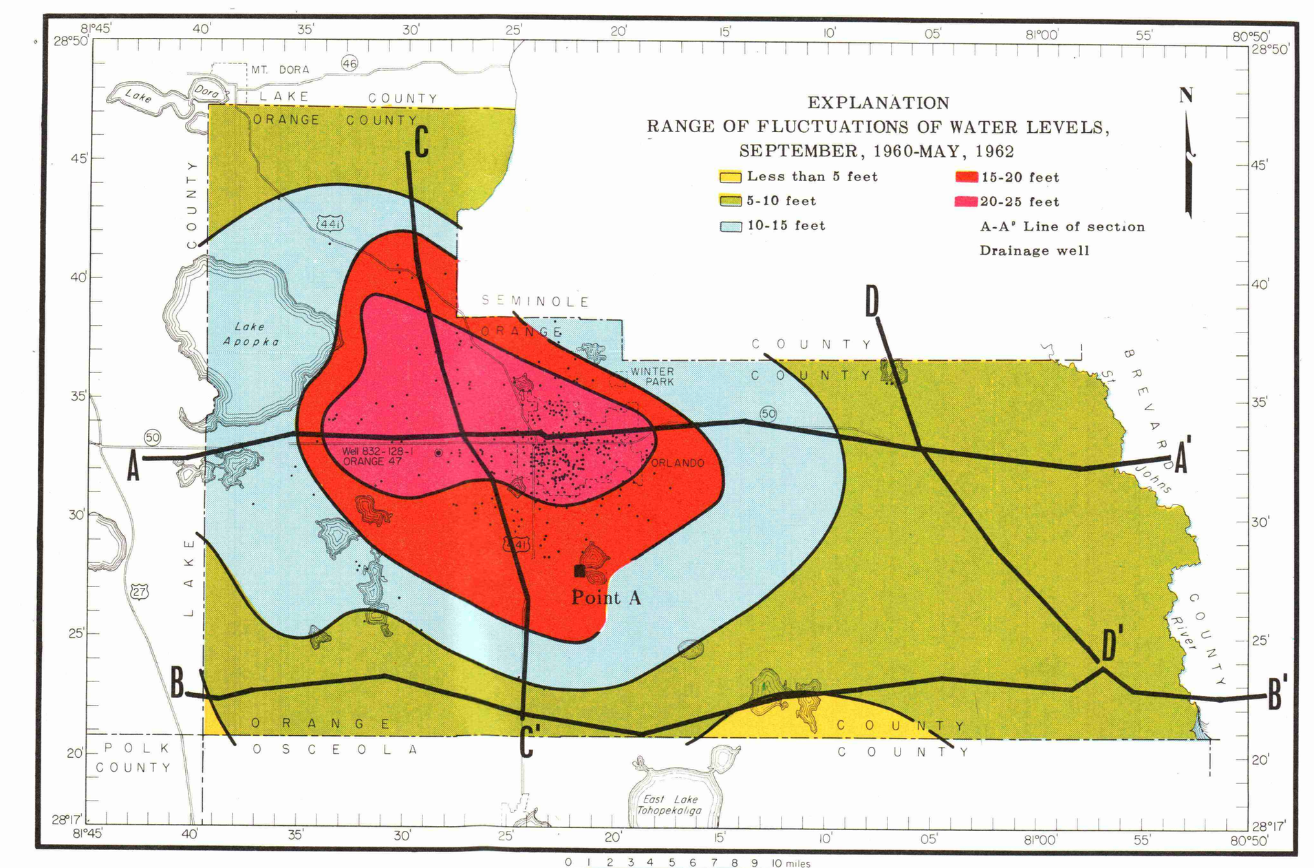

Figure 5. Range of fluctuation of water levels in the Floridan aquifer, September 1960-May 1962.

Figures 1, 2, and 3 show the range of dissolved solids, chlorides, and hardness of water from the artesian Floridan aquifer in Orange County. Hardness is caused by the solution of alkaline earth metals in water; calcium and magnesium are the most common. Other major mineral constituents commonly dissolved in water are silica, iron, sodium, carbonate, and bicarbonate, sulfate, nitrate, and fluoride.

As shown in figures 1, 2, and 3, the mineral content is lowest in the western part of the county where dissolved solids are less than 150 ppm. Mineralization gradually increases eastward to about 500 ppm dissolved solids and then increases more rapidly to more than 2,000 ppm in water from the flowing wells along the St. Johns River. The high mineral content of artesian water in the eastern part of the county is probably due to incomplete flushing of saline water that entered the aquifer where this part of Florida was under the sea. In the western and central part of the county, the mineral content of water from the artesian aquifer shows no appreciable change to a depth of at least 1,500 feet. In the eastern part of the county, however, mineralization often increases rapidly with depth. This is particularly evident in the southeastern part of the county where fresh water overlies saline water. Heavy pumpage in these areas can cause saltier water to move toward the pumping wells.

Figures 1, 2, and 3 show that the artesian water in Orange County is of good usable quality except in the eastern lowlands along the St. John's River. According to U.S. Public Health Service standards, the dissolved solids content of water for human consumption should not exceed 500 ppm although water with 1,000 ppm is allowed when better water is not available. The chloride concentration should not exceed 250 ppm but 500 ppm is allowed when fresher water is not available. The chloride content of ocean water is about 19,000 ppm. Water with a hardness of 0-60 ppm is considered soft; 61 to 120 ppm, moderately hard; 121 to 200 ppm, hard and over 200 ppm, very hard.

Well Orange 47 (fig. 4) is developed in the Floridan aquifer about 4 miles west of Orlando. The graph shows that the water levels in this well fluctuate about 24 feet between 1960 and 1962 due to variations in recharge and discharge.

Water levels in wells generally rise during periods of heavy rainfall and decline during periods of drought. Both rainfall and the hydrograph in figure 4 are generalized and the water level-rainfall relationship are sometimes masked, but a detailed study shows that water levels begin to rise shortly after the start of heavy rainfall.

The high level in 1960 was caused by normal rainfall in 1957 and 1958, followed by above normal rainfall in 1959 and 1960. The low level in 1962 reflected a period of deficient rainfall that started in the last quarter of 1960 and continued until the middle of 1962. The record high water level in the well during 1960 was partly caused by water that reached the Floridan aquifer quickly through numerous recently installed drainage wells. The record low level in 1962 was partly caused by increased pumpage in and near the City of Orlando.

The piezometric surface responds rapidly to local rainfall (fig. 5) and reached record highs in 1960 because of natural recharge from excessive rainfall in 1959-60 and flood water that entered the aquifer through the drainage wells (shown on the map by the black dots). The exceptionally dry period in 1961-62 coupled with increased pumpage in and near Orlando caused the piezometric level to decline to a new low of record in 1962. The contours show that the range of fluctuation from September 1960 to May 1962 was greater in and near Orlando than in the outlying parts of the county. The area of greatest fluctuation corresponds roughly to the area of greatest concentration of drainage wells and the area of greatest pumpage.

The heavy black lines on figure 5 are the locations of the four geologic sections shown in figure 6.

Figure 6 shows the subsurface geology in the county by color patterns. The first materials encountered in the drilling of a well will generally be undifferentiated sediments consisting of sand, clay, shell, and organic material. This deposit is shown on the four sections by the yellow color with diagonal lines. Unconfined ground water occurs in the undifferentiated sediments and small to moderate supplies can usually be obtained from sand-point wells about 20 to 40 feet deep. In some areas the water is soft and clear, but in other areas it is high in iron and has a brownish color.

The Hawthorn Formation, which underlies undifferentiated sediments, consists of sand, silt, clay, phosphatic sand, shell, and impure limestone. The Hawthorn Formation is shown on the sections by the yellow color with a dot pattern. Most of the formation is relatively impermeable, but in some areas shell and gravel beds yield enough water for domestic purposes. The Hawthorn Formation is the confining bed for the underlying artesian Floridan aquifer.

The Floridan aquifer, which consists of limestone with layers of dolomite, is shown by the blue color on the geologic sections. The aquifer is composed of several limestone formations but only the Ocala Group (designated as a formation by the U.S. Geological Survey) and the Avon Park Limestone are shown on the sections. The uppermost unit, the Ocala Group, is composed mostly of cream colored porous limestone that is fine grained and dolomitic in places. The Ocala Group was deeply eroded in Orange County and entirely removed in some areas before the overlying Hawthorn Formation was deposited. The Ocala Group lies entirely within the zone of saturation and contains many interconnected solution cavities that will yield moderate to very large quantities of water. The water is slightly higher in mineral content than that from the deeper dolomitic zones but it is usually lower in hydrogen sulfide content and does not require aeration. Many domestic wells draw water from the Ocala Group.

The Avon Park Limestone is about 400 to 600 feet thick and consists of beds of porous, fossiliferous limestone and cavernous dolomitic limestone. Solution cavities in the Avon Park yield water to many high-capacity irrigation wells. Many of the drainage wells in and around Orlando terminate in the Avon Park Limestone.

Water-bearing zones in the Floridan aquifer extend for at least 700 feet below the Avon Park Limestone. The supply wells of the City of Orlando draw water from layers of porous dolomite in the Lake City Limestone which underlies the Avon Park Limestone. The Avon Park and Lake City Limestones are similar in lithology and water bearing characteristics. The water in the Lake City is somewhat less mineralized than water from the overlying, softer zones but similar to water from dolomite zones in the Avon Park Limestone, probably because the dolomite is less soluble than the softer rocks. The hydrogen sulfide content of the water in the lower zones of the aquifer is usually high, but this gas can be removed by aeration.

The limestones that form the Floridan aquifer are of Eocene age (about 60 million years old). The Hawthorn Formation is of Miocene age (about 25 million years old) and the undifferentiated sediments probably range in age from late Miocene to Recent.

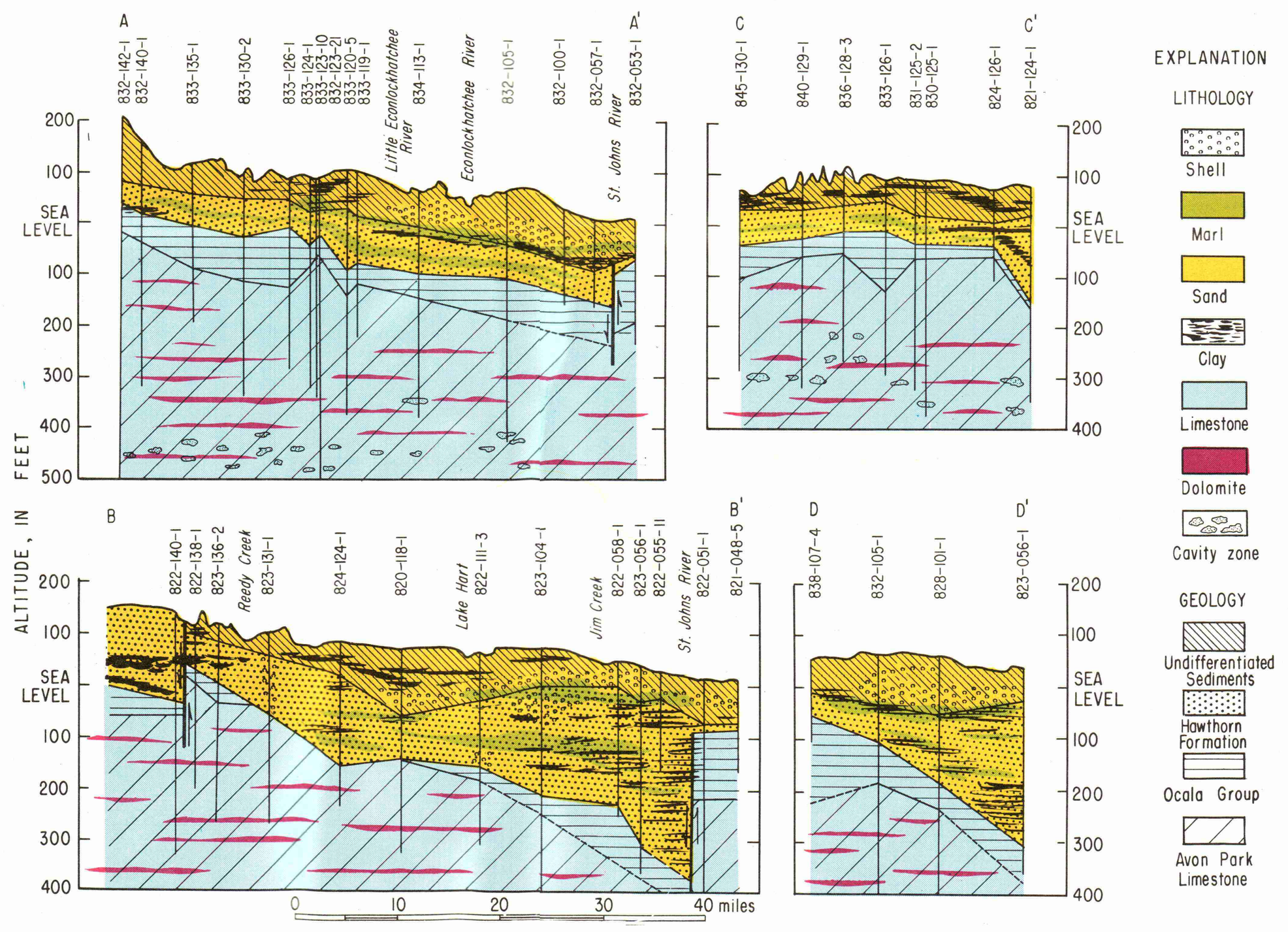

Figure 6. Cross sections showing geology and lithology.

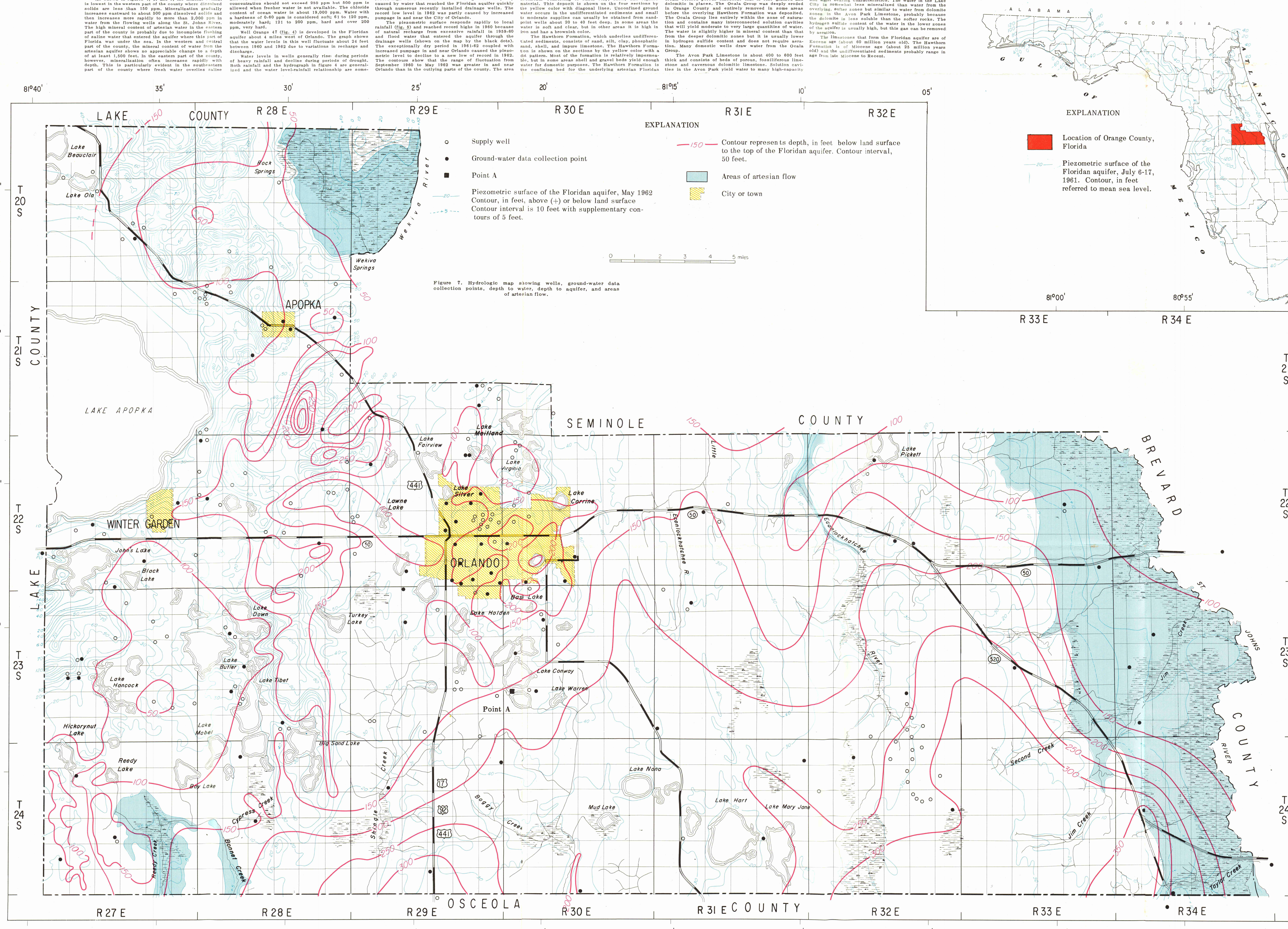

Figure 7. Hydrologic map showing wells, ground-water data collection points, depth to water, depth to aquifer, and areas of artesian flow.

AVAILABILITY OF GROUND WATER IN ORANGE COUNTY, FLORIDA

By
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Prepared by the
UNITED STATES GEOLOGICAL SURVEY
in cooperation with the
BOARD OF COUNTY COMMISSIONERS OF ORANGE COUNTY
and the
FLORIDA GEOLOGICAL SURVEY
TALLAHASSEE, FLORIDA

Orange County is most favorably located for the development of large ground-water supplies.

Most water for municipal, industrial and domestic use and much irrigation water in Orange County is obtained from the highly productive Floridan aquifer which underlies all of Florida and parts of Georgia and Alabama. The Floridan aquifer in Orange County is composed of more than 1300 feet of dense to extremely porous limestone and dolomitic limestone.

The dissolving action of circulating ground water has increased the porosity and permeability of the Floridan aquifer. Solution cavities, ranging in size from a fraction of an inch to more than 90 feet have been encountered during well drilling operation. A well may draw most of its water from a single large solution cavity or from many small openings.

The yield of a well usually varies with its size, the amount of open hole in the limestone, and the power of the pump rather than with its location within the county. Yields of 4,000 gpm (gallons per minute) or more can be obtained from properly designed wells in almost any part of the county. Most less successful wells are in or near sink holes which were formed when the surface sand and clay filtered down and filled the solution cavities in the limestone, thereby decreasing the permeability of the aquifer and increasing the length of casing needed to exclude the sand.

In the western part of Orange County, most of the water from the Floridan aquifer is relatively low in mineral content with a dissolved solids content of less than 150 ppm (parts per million). In the eastern part of the county, fresh water in the aquifer is underlain at depth by salty water which limits the rate at which fresh water can be pumped because a significant lowering of the piezometric surface (artesian pressure level) may allow salt water to move upward into the well. In the extreme eastern part of the county, along the St. Johns River, even the water in the upper part of the Floridan aquifer is so highly mineralized that it is unfit for most purposes. Here the mineral content of the water may exceed 1,800 ppm of dissolved solids.

The Floridan aquifer is recharged where the local water table is higher than the piezometric surface of the Floridan aquifer and the material between the water table and the Floridan aquifer is permeable enough to allow water to move downward into the aquifer. In the highlands of western Orange County and adjacent parts of Lake and Polk counties, much of the surficial material is either thin or permeable enough to allow water to recharge the aquifer. Part of the ground water leaving this highlands area moves northeastward to discharge at points such as Wekiva and Rock Springs and part of the water moves eastward across the county to discharge along the St. Johns River and other areas to the east. The piezometric surface is above land surface in the Wekiva and St. Johns River valleys and artesian wells will flow at the surface in these areas.

How To Use The Maps

The illustrations present much useful information to aid home owners, well drillers and others in the development of ground water supplies in Orange County. The maps show the availability of ground water, the quality of water that can be expected, and the approximate depth and the length of the casing required in wells. Their use is illustrated by the following example.

Suppose a ground water supply is needed south of Orlando near the western edge of Lake Conway (Point A). This point is shown by a square on all the maps to aid the discussion. The site lies between the 150 and 200-foot red contours on the large map, figure 7, which show the depth below land surface to the top of the Floridan aquifer. Interpolating between contours places the top of the aquifer about 155 feet below land surface. This means that approximately 155 feet of casing will be needed plus enough extra to seal off any sand in the top of the aquifer. The blue contours on figure 7 show the relation of the piezometric surface of the Floridan aquifer to land surface. They indicate that the piezometric surface at the site lies between 40 and 50 feet below the land surface. The depth to water contours were drawn during 1962, a period of extremely dry weather (the low point on figure 4), and therefore the depth to water in the completed well is likely to be less than 40-50 feet during periods of normal rainfall. Figure 5 shows the range of water-level fluctuations in the Floridan aquifer. The figure shows that water levels as much as 15 to 20 feet higher than indicated on figure 7 can be expected at the Lake Conway site (Point A) during periods of above normal rainfall.

In areas where the piezometric surface is below land surface, the value shown by the blue contours is the minimum distance that water will have to be raised during pumping. The drawdown in the well due to pumping will have to be added to this figure to get the operating pumping lift. The drawdown in a well varies with well size, pumping rate and permeability of the aquifer at that point. In large-diameter wells (20 inches or more) the drawdown ranges from less than 3 inches per 100 gpm to more than 1 foot per 100 gpm. If the operating lift is much more than about 20 feet, a suction-type pump will not work and a jet, submersible or turbine pump must be used.

The heavy lines on figure 5 are the locations of the four geologic sections A-A', B-B', C-C', and D-D' shown in figure 6. The geologic sections show the thickness and character of the rock material that will be penetrated by wells. The yellow area with the green and black overprint represents the surficial deposits and the blue area with the purple overprint represents the Floridan aquifer. The Lake Conway well site (Point A) is slightly east of section C-C' and projects to a point about seven miles north of C'. The well site falls nearly midway between wells 830-125-1 and 824-126-1. At this site about 90 feet of undifferentiated sediments and about 65 feet of the Hawthorn Formation will be penetrated before the well reaches the Floridan aquifer. This depth of 155 feet (same depth as shown by red contours on figure 7) is equal to the minimum length of casing that will be needed to case off the sand and clay above the Floridan aquifer. Probably 50 feet of penetration into the aquifer will furnish enough water for a domestic supply. As much as 300 feet of penetration into the aquifer may be needed if the well is to furnish enough water for irrigation or municipal purposes.

Figures 1, 2, and 3 show the quality of the water in the Floridan aquifer by color patterns. Figure 1 shows that the dissolved solids content of the ground water at the well site is between 200 and 300 ppm. Figure 2 shows that the chloride content is between 10 and 25 ppm. Figure 3 shows that the hardness of the water is between 150 and 250 ppm.

Figure 7 is a generalized availability map. The density and quality of the data upon which the map is based is highly variable in different parts of the county. Also, many local variations in land surface altitude and limestone altitude cannot be included in a map of this size. Therefore, the depth to water and depth to the top of the aquifer will not be as precise at all locations as it is in the above example.