Outcrop from Lipp, 1976

EXPLANATION

—200— POTENTIOMETRIC SURFACE CONTOUR -- Shows altitude at which water would have stood in tightly cased wells. Dashed where approximately located. Contour interval 50 feet. Hachures indicate depressions. Datum is National Geodetic Vertical Datum of 1929

AQUIFER RECHARGE AREA BOUNDARY

OBSERVATION WELL -- Well in which water-level or artesian-pressure measurement was made in Fall, 1982

WILCOX CO. T-10 OBSERVATION WELL FOR WHICH HYDROGRAPH IS SHOWN

WITHDRAWAL RATES AT MAJOR PUMPING CENTERS (in million gallons per day)

0.25 - 0.49

0.50 - 0.99

1.00 - 2.99

≥ 3.00

INTRODUCTION

The U.S. Geological Survey began a nationwide program in 1978, termed Regional Aquifer-System Analysis (RASA), to study a number of the major aquifer systems that provide a significant part of the country's water supply. One of the aquifer systems chosen for study was the thick and extensive sequence of sands of Cretaceous and early Tertiary age that underlies the Coastal Plain of the Southeastern United States. This system, which extends from Mississippi eastward to South Carolina, is called the Southeastern Coastal Plain aquifer system. It can be divided hydrogeologically into several separate aquifers. The map presented here, one of a series that portray the potentiometric surface, ground-water withdrawals, and recharge areas for the aquifers in Alabama that are included in the regional system, deals with the Providence-Ripley aquifer.

HYDROGEOLOGY

The Providence-Ripley aquifer includes the Providence Sand and the Ripley Formation (including the Cusseta Sand Member). It is composed of consolidated and unconsolidated sand and minor clay beds of Cretaceous age. Where the aquifer is present it is underlain by the Demopolis Chalk in western and central Alabama, and by the Blufftown Formation in the east. It is overlain by the Prairie Bluff Chalk and the Clayton Formation. The chalk underlying the Providence-Ripley aquifer in western and central Alabama forms an extensive and competent confining bed. The degree of hydraulic connection between the Providence-Ripley aquifer and sands of the Blufftown Formation (a poor aquifer) is not certain, but intervening clay beds probably form effective aquacludes. The limestones and clays in the overlying Prairie Bluff Chalk and Clayton Formation provide varying degrees of confinement, and may allow upward leakage from the Providence-Ripley aquifer to the overlying Nanafalia-Clayton aquifer in southeastern Alabama. The area of direct recharge for the aquifer (outcrop) extends across the State from Barbour County westward to Marengo County in a slightly curving, gradually narrowing band that is as much as 30 miles wide in eastern Alabama. The aquifer disappears in Marengo County where the Ripley Formation is composed primarily of clays and the Providence Sand is equivalent to and replaced by the Prairie Bluff Chalk. In general, the Providence-Ripley aquifer is less productive than most other Alabama Coastal Plain aquifers. Potential well yields increase from west to east and downdip, and range from about 0.1 to 2.0 Mgal/d (millions gallons per day)(Lipp, 1976, chap. 7, p. 11-12).

Potentiometric Surface

The accompanying map is a generalized depiction of the potentiometric surface of the Providence-Ripley aquifer based on water-level measurements made primarily in the fall of 1982, and in some instances on stream stage. A potentiometric map illustrates, by means of contour lines, the altitude of the water table or the altitude to which water would rise in tightly cased wells tapping an artesian (confined) aquifer. The potentiometric surface depicted generally represents an average for the aquifer; the water-level altitude in any particular well may differ from the average to some extent depending on well depth and local geology. The orientation and shape of the contour lines are influenced by the geologic structure of the aquifer, the rate at which water passes through the aquifer (its transmissivity), and the location of discharge points such as wells, springs, or streams. Ground-water flow in the aquifer is approximately perpendicular to the contour lines.

Recharge and Discharge

Recharge of the Providence-Ripley aquifer occurs by the infiltration of water from precipitation falling directly on the outcrop, and possibly by downward leakage from updip areas of the overlying aquifer. Discharge from the aquifer occurs in as many as four ways: water may 1) leak upward or downward into adjacent aquifers, 2) emerge at the land surface as springs, 3) be withdrawn from wells, or 4) drain to streams in the recharge area.

Large streams and rivers drain significant amounts of water from an aquifer, often controlling regional flow patterns. These drains lower the aquifer water table in their vicinity, which results in potentiometric surface contours that bend upstream. This effect is particularly evident near the Chattahoochee and Alabama Rivers. Heavy pumpage can also lower water levels locally, resulting in a depression in the potentiometric surface that causes the contours to be distorted from natural, unstressed conditions. In a graphic depiction of the potentiometric surface, the contour lines may bend around the pumping center, as near Camden in Wilcox County, for example.

Streams in the unconfined zone of Alabama Coastal Plain aquifers act as ground-water drains due to their lower altitude relative to recharge areas. The flow patterns depicted on this map indicate that the major ground-water drains in the Providence-Ripley aquifer are the Tombigbee, Alabama, Conecuh, and Chattahoochee Rivers. Water entering the aquifer that is not intercepted in the recharge area by streams or pumpage has a longer flow path downdip through the confined part of the aquifer. Low permeability rocks and highly mineralized water far downdip in the aquifer present a barrier to flow, which causes fresh ground water recharging the deeper parts of the aquifer to leak upward into the overlying aquifer or to move updip and eventually discharge to the rivers.

GROUND-WATER USE

Major Pumping Centers

The Providence-Ripley aquifer provides water for several municipalities and industries, as well as for a large rural area across central Alabama. Public-supply water systems drawing water from the aquifer at a rate of 1 Mgal/d or greater are the cities of Greenville, Troy, Ozark, and Dothan. Several smaller public suppliers and industries use more than 0.25 Mgal/d. The total rate of withdrawal from the aquifer by all of these users was approximately 12 Mgal/d in 1982; individual rates are shown by pumpage category on the map. Self-supplied domestic consumption is difficult to quantify, but probably is not significant. Public-supply systems have replaced domestic wells to a large degree in areas where the Providence-Ripley aquifer is the primary source of water.

Water-Level Fluctuations

Water-level observation wells have been monitored for several years to assess the effects of water withdrawals on the aquifer. The hydrographs shown on this map are a record of water levels measured in some of those wells. Before production wells are drilled and withdrawal begins, an aquifer is in a state of "dynamic equilibrium", where water levels in the aquifer rise and fall in an annual cycle corresponding to seasonal changes in precipitation. Water levels may also show fluctuations of longer duration due to long-term departures from normal rainfall amounts. On the average, however, the water levels remain nearly the same because the amount of water that enters the aquifer as recharge is also naturally discharged, either to other aquifers, to the land surface as springs, or to streams in the aquifer recharge area. Pumping changes this balance, and, as shown by the hydrographs, water levels usually begin to decline near major pumping centers. They will continue to decline until either an increase in recharge or a decrease in discharge balances the quantity of water being pumped.

The hydrographs show that water levels have remained stable in wells located in the aquifer recharge area (Pike County G-2 and Bullock County U-15), but that there has been a general water-level decline in wells where the aquifer is confined (Wilcox County T-10, Butler County H-12, Pike County Q-8, and Dale County F-17). Water-level measurements from virtually all other wells screened in the Providence-Ripley aquifer for which there are records demonstrate the same trend. These data suggest that where it is confined, the aquifer is being stressed by pumping beyond the point at which recharge rates can match withdrawal rates, despite the fact that well yields may be higher there than farther updip. Because the rates of water-level declines are not slowing (at least near the pumping centers that have been monitored by observation wells), there is no indication that the aquifer will soon reach equilibrium given current (1986) pumping rates.

The significance of whether an aquifer in the area of a pumping center reaches equilibrium is that, if equilibrium is attained, the current pumping rate for that center may be considered dependable. However, if water levels continue to decline, a condition could arise where further withdrawal from the aquifer at the current pumping rate would be impossible.

Future Ground-Water Development

The potential for future development of the Providence-Ripley aquifer for public supply or industrial uses will depend on the proposed geographic location of wells and on proper well placement. Due to the relatively low productivity of the aquifer in its western extent, and in the recharge area in general, extensive development in those areas may not be possible. In south-central and southeastern Alabama, where the aquifer is more productive, adequate spacing between wells such that mutual interference is avoided may allow some further ground-water development. However, any future development near existing major pumping centers is contingent upon the eventual equilibration of the aquifer in the vicinity. Failing that, future ground-water withdrawal rates would have to be reduced from current rates in areas where equilibrium cannot be attained, and alternate sources of water (other aquifers or surface water) utilized.

Another factor governing aquifer development is the chemical quality of the water. Excessive mineralization of ground water from the Ripley formation in Marengo County southwest of Linden and in western Wilcox County has restricted its use there (Newton and others, 1961, p. 136; Lipp, 1976, chap. 7, p. 16). Water from the aquifer is generally of better quality elsewhere, but excessive hardness is common (Scott, 1957, p. 20; Avrett, 1968) and may make treatment necessary for some applications in some areas.

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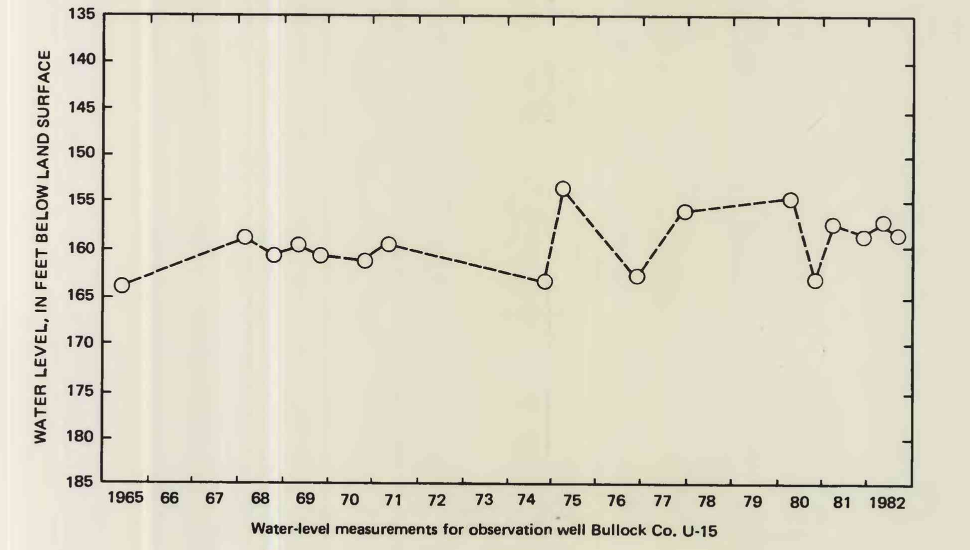
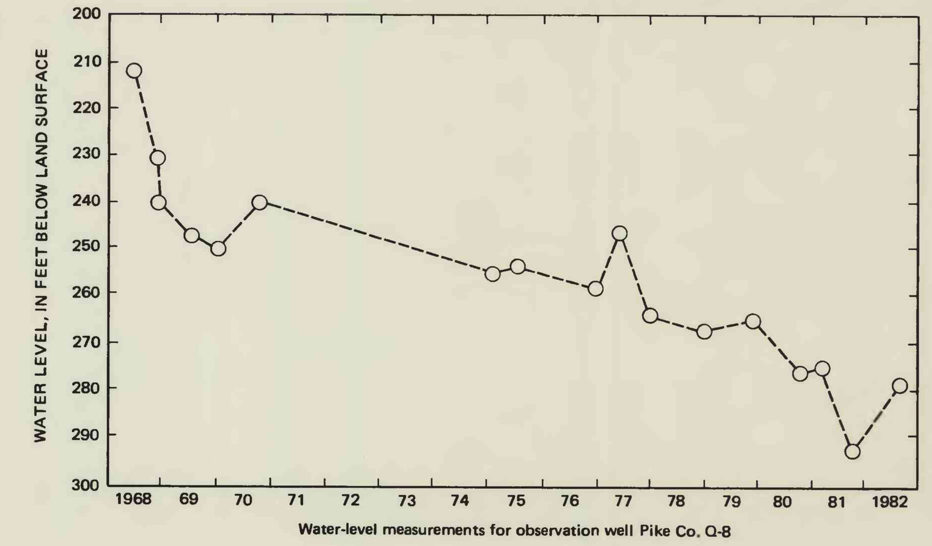
POTENTIOMETRIC SURFACE, GROUND-WATER WITHDRAWALS, AND RECHARGE AREA FOR THE PROVIDENCE-RIPLEY AQUIFER IN ALABAMA, FALL 1982

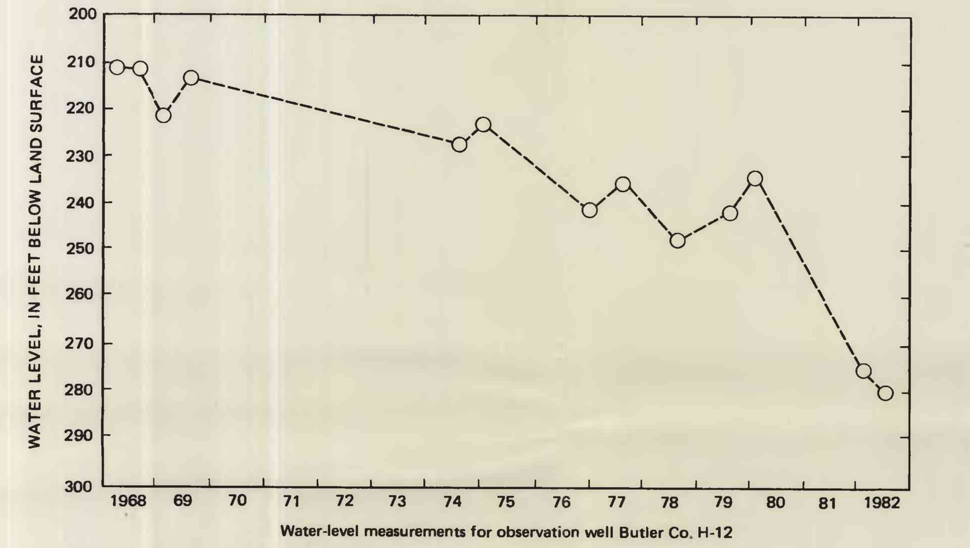
by John S. Williams, Michael Planert and Sydney S. DeJarnette



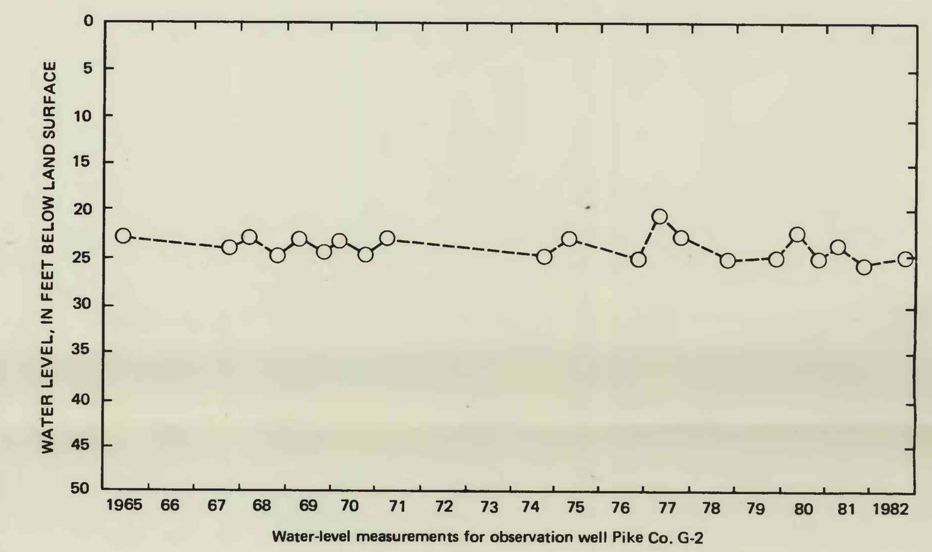
Water-level measurements for observation well Bullock Co. U-15



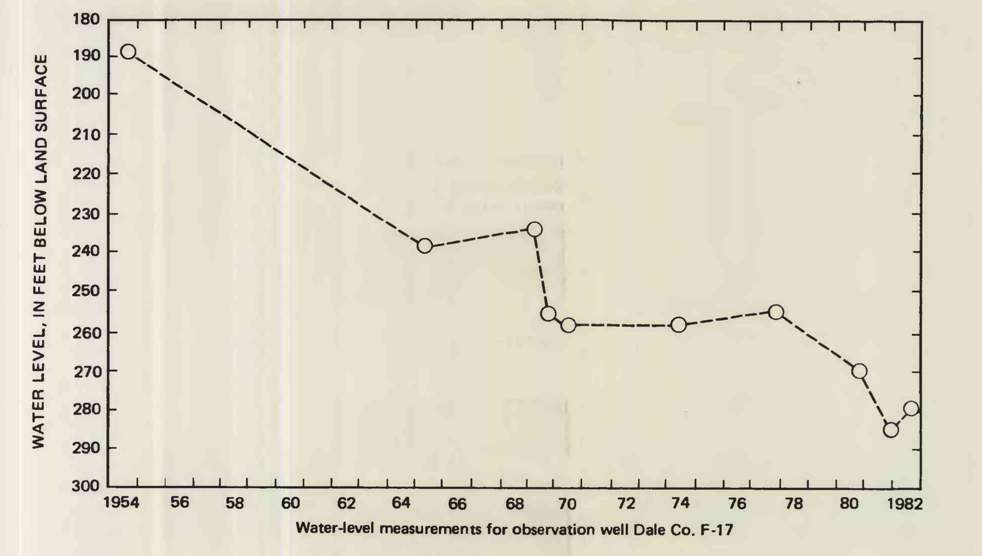
Water-level measurements for observation well Pike Co. Q-8



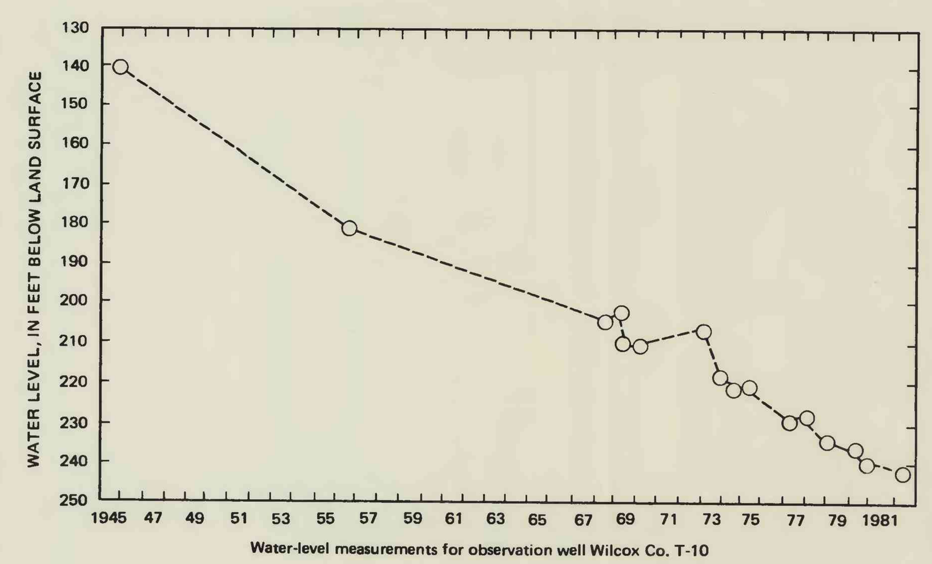
Water-level measurements for observation well Butler Co. H-12



Water-level measurements for observation well Pike Co. G-2



Water-level measurements for observation well Dale Co. F-17



Water-level measurements for observation well Wilcox Co. T-10

Generalized correlation of hydrogeologic units and rock-stratigraphic units of the Southeastern Coastal Plain Aquifer System in Alabama

Period	Epoch	Hydrogeologic Unit	Rock - Stratigraphic Unit: Western Alabama	Eastern Alabama
Tertiary	Eocene	Confining unit	Yazoo Clay	Ocala Limestone
		Lisbon aquifer	Moodys Branch Formation; Gosport Sand; Lisbon Formation; Tallahatta Formation; Hatchetigbee Formation; Bashi Formation; Upper part of Tuscahoma Formation	Moodys Branch Formation; Gosport Sand and Lisbon Formations, undifferentiated; Tallahatta, Hatchetigbee, and Bashi Formations, undifferentiated; Upper part of Tuscahoma Formation
	Paleocene	Confining unit	Middle part of Tuscahoma Formation[1]	Middle part of Tuscahoma Formation
		Nanafalia - Clayton aquifer	Lower part of Tuscahoma Formation; Nanafalia Formation; Naheola Formation	Lower part of Tuscahoma Formation; Baker Hill and Nanafalia Formations, undifferentiated; Porters Creek Formation; Upper part of Clayton Formation
		Confining unit	Porters Creek Formation; Clayton Formation; Prairie Bluff Chalk	Lower part of Clayton Formation[2]
Cretaceous	Late	Providence - Ripley aquifer	Ripley Formation	Providence Sand; Ripley Formation
		Confining unit	Demopolis Chalk; Mooreville Chalk	Demopolis Chalk; Mooreville Chalk; Blufftown Formation
		Eutaw aquifer	Eutaw Formation	Eutaw Formation
		Confining unit	Upper part of Gordo Formation	Upper part of Tuscaloosa Formation[2]
	Late / Early	Tuscaloosa aquifer	Lower part of Gordo Formation, Coker Formation } Tuscaloosa Group; Unnamed Early Cretaceous rocks[3]	Tuscaloosa Formation; Unnamed Early Cretaceous rocks[3]
Pre - Cretaceous		Confining unit	Pre - Cretaceous rocks	Pre - Cretaceous rocks

[1] May be only partially confining or absent in western Alabama
[2] May be only partially confining or absent in eastern Alabama
[3] Largely unstudied; may be locally hydraulically connected with overlying sediments