Simulated Effects of Ground-Water Development on the Potentiometric Surface of the Floridan Aquifer, West-Central Florida

GEOLOGICAL SURVEY PROFESSIONAL PAPER 1217

Prepared in cooperation with the Southwest Florida Water Management District

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By WILLIAM E. WILSON *and* JAMES M. GERHART

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CONVERSION FACTORS

[For use of those readers who may prefer to use metric (SI) units rather than inch-pound units, the conversion factors for the terms used in this report are listed as follows:]

Multiply inch-pound unit	*By*	*To obtain metric (SI) unit*
	Length	
inch (in.)	25.40	millimeter (mm)
foot (ft)	.3048	meter (m)
mile (mi)	1.609	kilometer (km)
	Area	
acre	0.4047	hectare (ha)
square mile (mi^2)	2.590	square kilometer (km^2)
	Volume	
gallon (gal)	3.785	liter (L)
	3.785×10^{-3}	cubic meter (m^3)
million gallons (Mgal)	3,785	cubic meter (m^3)
inch per acre (in./acre)	62.76	millimeter per hectare (mm/ha)
	Flow	
gallon per minute (gal/min)	0.06309	liter per second (L/s)
	6.309×10^{-5}	cubic meter per second (m^3/s)
million gallons per day (Mgal/d)	.04381	cubic meter per second (m^3/s)
inch per year (in./yr)	25.40	millimeter per year (mm/yr)
cubic foot per second (ft^3/s)	2.832×10^{-2}	cubic meter per second (m^3/s)
	Transmissivity	
foot squared per day (ft^2/d)	0.09290	meter squared per day (m^2/d)
	Hydraulic conductivity	
foot per day (ft/d)	0.3048	meter per day (m/d)
	Leakance	
gallon per day per cubic foot [$(gal/d)/ft^3$]	0.1337	meter per day per meter [(m/d)/m]
foot per day per foot [(ft/d)/ft]	1.000	meter per day per meter [(m/d)/m]

EXPLANATION OF TERMS

Ground-water term		*Original form*		*Reduced form*
Transmissivity, T	=	$(m^3/d)/m$	=	m^2/d
	=	$(ft^3/d)/ft$	=	ft^2/d
	=	(gal/d)/ft	=	----
Hydraulic conductivity, K	=	$(m^3/d)/m^2$	=	m/d
	=	$(ft^3/d)/ft^2$	=	ft/d
	=	$(gal/d)/ft^2$	=	----

National Geodetic Vertical Datum of 1929 (NGVD of 1929):

A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called "Mean Sea Level." NGVD of 1929 is referred to as "sea level" in this report.

SIMULATED EFFECTS OF GROUND-WATER DEVELOPMENT ON THE POTENTIOMETRIC SURFACE OF THE FLORIDAN AQUIFER, WEST-CENTRAL FLORIDA

By WILLIAM E. WILSON and JAMES M. GERHART

ABSTRACT

A digital model of two-dimensional ground-water flow was used to predict changes in the potentiometric surface of the Floridan aquifer in a 5,938-square-mile area of west-central Florida for the years 1976 to 2000.

In 1975, ground water withdrawn from the Floridan aquifer for irrigation, phosphate mines, other industries, and municipal supplies averaged about 649 million gallons per day. Rates are projected to increase to about 840 million gallons per day by 2000.

The model was calibrated under steady-state and transient conditions. Input parameters included transmissivity and storage coefficient of the Floridan aquifer; thickness, vertical hydraulic conductivity, and storage coefficient of the upper confining bed; altitudes of the water table and potentiometric surface; and ground-water withdrawals.

Simulation for May 1976 to May 2000, using projected combined pumping rates for municipal supplies, irrigation, and industry (including existing and proposed phosphate mines), resulted in a projected rise in the potentiometric surface of about 10 feet in Polk County and a decline of about 35 feet in parts of Manatee and Hardee Counties. The lowest simulated potentiometric level was about 30 feet below sea level. Simulated declines for November 1976 to October 2000 were generally 5 to 10 feet less than those for May 1976 to May 2000.

INTRODUCTION

BACKGROUND

Long-range projections of water use in west-central Florida suggest that substantial increases in ground-water withdrawals will occur for municipal supplies, irrigation, and phosphate mines. Population growth, particularly in coastal areas, will require new and expanded public water-supply systems. Although the area of agricultural land is not expected to increase, the proportion of agricultural land that is irrigated will increase. In the mid-1970's, principal interest was focused on the phosphate industry, whose mines and associated chemical plants each used millions of gallons of ground water per day for processing. In 1975, phosphate mining was confined to Polk County, but as the ore became depleted, mining companies, through permit applications to regulatory agencies, were seeking to expand operations into Hardee, Hillsborough, De Soto, and Manatee Counties over the next several decades.

Most demands for water will be met by ground water from the Floridan aquifer. The combined withdrawals could have major effects on the hydrology of the area. One possible effect is saltwater encroachment resulting from lowered potentiometric levels. In 1975, the U.S. Geological Survey started a cooperative investigation with the Southwest Florida Water Management District to determine the regional hydrologic effects of anticipated ground-water withdrawals by major users, including municipalities, irrigators, and the phosphate industry.

In 1976, the President's Council on Environmental Quality directed the U.S. Environmental Protection Agency to prepare an areawide environmental impact statement to analyze cumulative interrelated impacts of present and proposed phosphate development in central Florida. In 1977, the Geological Survey published preliminary findings on the effects of withdrawals by the phosphate industry (Wilson, 1977a) in order to provide timely results in support of the Environmental Protection Agency's investigation.

PURPOSE AND SCOPE

This report presents the results of the first phase of a planned two-phase investigation. The objective of the first phase was to determine the amount of change in the potentiometric surface of the Floridan aquifer to be expected as a result of proposed or anticipated ground-water development in west-central Florida. The objective was accomplished principally through the calibration and application of a regional digital model of ground-water flow. In the second phase of the investigation, potential effects of development on the saltwater-freshwater interface along coastal west-central Florida will be assessed.

This report updates and expands the preliminary report (Wilson, 1977a), which considered the effects of withdrawals for phosphate mining only. This report includes the effects of withdrawals for phosphate mines, municipal supplies, and irrigation, separately and in combination. The effects of phosphate mining shown in this report differ from those described in the preliminary one because modifications were made in boundary conditions and input parameters.

The study area covers 3,533 mi² in west-central Florida, south and east of Tampa (fig. 1). The area includes all of Hardee, De Soto, Manatee, and Sarasota Counties, the southeastern part of Hillsborough County, and the southwestern part of Polk County. To determine effects of ground-water development in the area, hydrogeologic data were evaluated and a ground-water flow model was calibrated for a larger region. The modeled area covers 5,938 mi² and, as shown in figure 1, includes, in addition to the study area, parts of Charlotte, Highlands, Lee, and Pinellas Counties, additional parts of Hillsborough and Polk Counties, and the eastern part of the Gulf of Mexico.

Hydrogeologic interpretations in this report were based on existing data, except for field data collected for irrigated acreage and for ground-water withdrawals in 1975–76. Whenever feasible, results of test drilling and aquifer tests conducted by others during the course of this investigation were incorporated into the study.

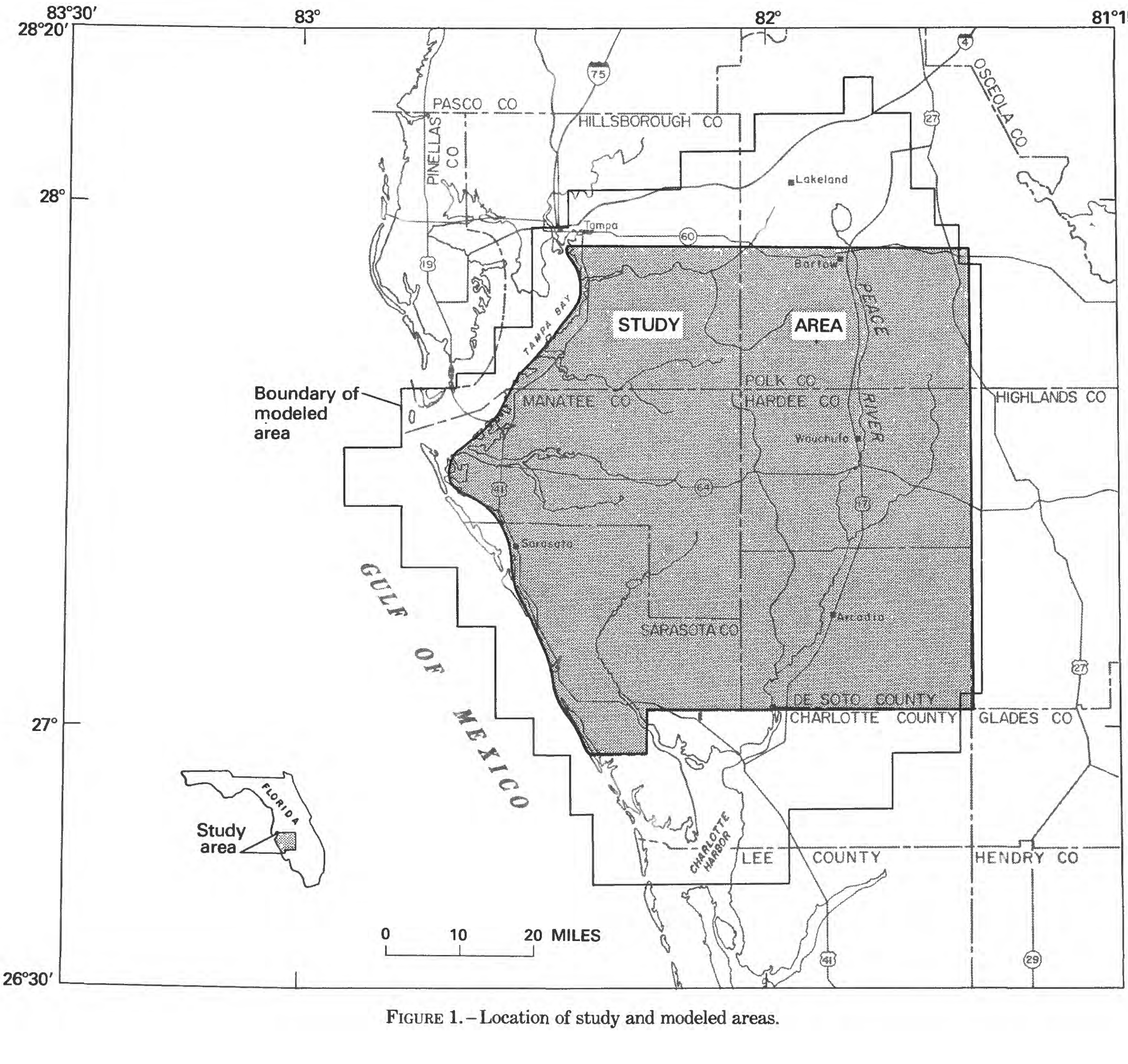

FIGURE 1.—Location of study and modeled areas.

These included detailed tests done by private consultants for phosphate mining companies.

The report presents input data for the digital model in Supplementary data I – Model input data, in the Appendix. The data can serve as a basis for refining the model or for testing effects of alternative schemes of ground-water development.

PREVIOUS INVESTIGATIONS AND ACKNOWLEDGMENTS

The geology and ground-water resources of the study area and adjoining counties have been the subject of many investigations, including some currently (1979) underway. Most studies cover counties or small areas. Among the countywide ground-water investigations are those for Highlands County (Bishop, 1956), Polk County (Stewart, 1966), Hillsborough County (Menke and others, 1961), Manatee County (Peek, 1958), De Soto and Hardee Counties (Wilson, 1977b), and Charlotte County (Sutcliffe, 1975; Wolansky, 1978).

Many of the published geologic reports for the area are related to the phosphate mineral resource. Included are reports by Bergendahl (1956), Carr and Alverson (1959), Cathcart (1966), and Ketner and McGreevy (1959).

In a regional appraisal of ground-water resources, Geraghty and Miller, Inc., and Reynolds, Smith and Hills (1977) evaluated the availability of ground water in the Southwest Florida Water Management District and presented alternative schemes of development. Regional potentiometric maps representing conditions in May and September are published each year by the U.S. Geological Survey. Three of these maps were used in this report: September 1975 (Mills and others, 1976), May 1976 (Stewart and others, 1976), and September 1976 (Ryder and others, 1977). Changes in potentiometric surface were mapped for 1964–69 (Stewart and others, 1971) and for 1969–75 (Mills and Laughlin, 1976).

The authors are grateful for information obtained from many sources during this investigation. The U.S. Environmental Protection Agency and their contractors, Texas Instruments Incorporated, Geraghty and Miller, Inc., and Thomasino and Associates, Inc., provided valuable information. Many consulting firms, including P. E. LaMoreaux and Associates, William F. Guyton and Associates, Dames and Moore, Inc., and Richard C. Fountain and Associates, provided, through their clients, results of detailed site investigations in the study area. The Florida Phosphate Council provided detailed ground-water pumpage records for the phosphate industry. The authors are particularly grateful to Peter Schreuder, Geraghty and Miller, Inc.; William L. Guyton, William F. Guyton and Associates; and Peter MacGill, formerly with the Florida Bureau of Geology, for insights gained during many discussions concerning the hydrology and geology of west-central Florida.

GEOGRAPHY

PHYSIOGRAPHY

The study area lies in the western half of Florida's midpeninsular physiographic zone, as defined by White (1970). Land-surface altitudes range from sea level at the coastline to about 245 ft at the eastern border. The land surface is composed of a series of gently sloping marine terraces or plains. The older and higher surfaces have been slightly dissected by erosion, but large segments of the younger and lower ones remain nearly undissected. North and east of the study area, in Polk and Highlands Counties, is a series of subparallel eroded sandy ridges and intervening valleys containing numerous lakes.

The principal rivers in the study area are the Peace and Myakka Rivers, which flow into Charlotte Harbor; and the Manatee, Little Manatee, and Alafia Rivers, which flow into Tampa Bay.

CLIMATE

The climate of the study area is subtropical humid and is characterized by long, warm, relatively wet summers and mild, relatively dry winters. Long-term (1915–76) annual rainfall averages at stations in and near the study area generally are between 50 and 54 in. Precipitation is unevenly distributed throughout the year; about 60 percent falls during the four summer months, June through September. Most of the summer rainfall is in the form of afternoon and evening thundershowers, but the rainfall may be substantially augmented by tropical storms that occasionally affect the peninsula. Spring months are characteristically warm and dry, and these are the months of heaviest irrigation of crops.

LAND USE

Land use for 1975 and projected land use for the year 2000 for counties in the study area were tabulated by Texas Instruments Incorporated (1977b), applying categories of the U.S. Geological Survey Land Use Data and Analysis (Anderson and others, 1976). Four counties (De Soto, Hardee, Manatee, and Sarasota) lie wholly within the study area. In the two inland counties, De Soto and Hardee, agricultural land constituted about 44 percent of the total area in 1975, and urban areas covered less than 2 percent. In the two coastal counties, Sarasota and Manatee, agricultural land covered 23 percent, and urban areas about 12 percent. In the four counties, rangeland covered 32–51 percent, and barren land, which includes mined lands, covered less than 5 percent.

In Polk County, 112,670 acres were in barren land in 1975. Most of this land was being actively mined for phosphate or being reclaimed from mining. Nearly all of the barren land in Polk County was in the study area.

The projected distribution of land uses in 2000 shows an increase in urban areas and small declines in agricultural and rangeland areas. In De Soto and Hardee Counties, urban areas are projected to increase slightly, to about 5 percent of the total area of the counties. In Sarasota and Manatee Counties, urban areas are projected to increase to about 16 percent. The projections by Texas Instruments Incorporated (1977b) do not show increases in barren land for De Soto, Hardee, and Manatee Counties, as would be expected with an introduction of phosphate mining into these counties. Anticipated continued mining and reclamation activities in Polk County resulted in a projected increase of barren land in that county to about 146,000 acres by 2000.

POPULATION

The distribution of population directly affects the development of and competition for the area's water resources. Estimated total population of the study area in 1976 was about 420,000; projections indicate that the population will more than double by 2000 (Texas Instruments Incorporated, 1977a). As shown in figure 2, almost three-fourths of the population, or about 309,000

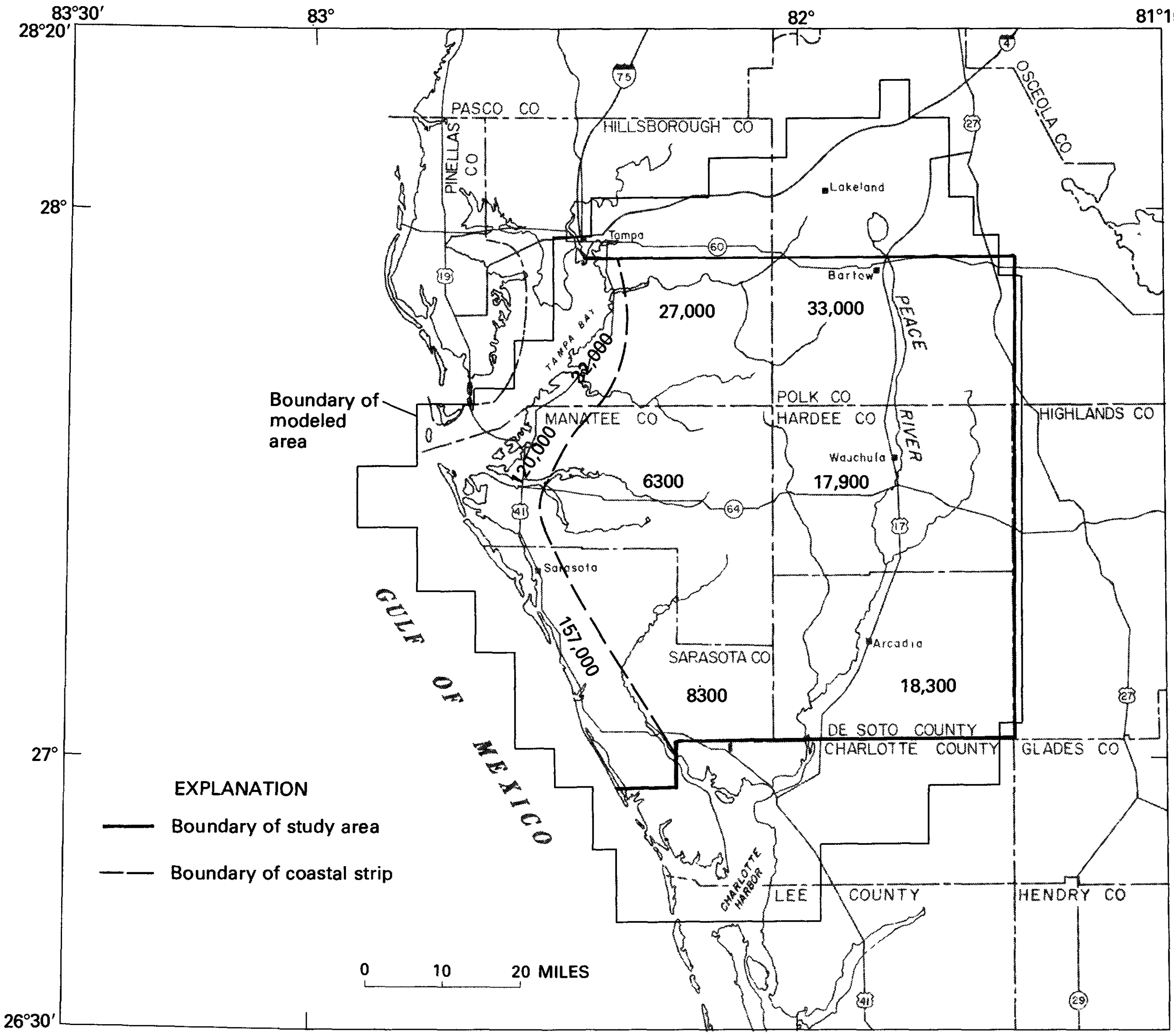

FIGURE 2.–Estimated population of inland areas and coastal strip, July 1976.

people, are concentrated along a coastal strip from Tampa Bay to Charlotte Harbor. Potable ground-water resources along this strip are severely limited or nonexistent. Principal coastal urban centers are Sarasota (estimated 1976 population, 47,156) and Bradenton (estimated 1976 population, 26,204).

Inland areas are sparsely populated (fig. 2). The total estimated 1976 population of De Soto and Hardee Counties, for example, was only 36,200. Principal inland communities are Bartow, Wauchula, and Arcadia.

Population figures for 1976 for Hillsborough and Polk Counties (fig. 2) are from the files of the Hillsborough and Polk County Planning Commissions; all other county and city totals are from the University of Florida (1977).

GEOLOGY

The study area lies in the Florida peninsular sedimentary province, a part of the eastern Gulf of Mexico sedimentary basin (Puri and Vernon, 1964). Rock units of interest in this investigation are principally marine sedimentary rocks of Eocene and younger ages. Beneath the surficial sands, the formations include, from youngest to oldest, a section of undifferentiated deposits, including the Caloosahatchee Marl, Bone Valley Formation, and Tamiami Formation; Hawthorn Formation; Tampa Limestone; Suwannee Limestone; Ocala Limestone; Avon Park Limestone; and Lake City Limestone. Formation ages and descriptions are shown in table 1.

The formations can be grouped lithologically into four major sequences of hydrologic significance. From youngest to oldest these include the following:

1. Surficial sand deposits, generally less than 100 ft thick;
2. A heterogeneous clastic and carbonate section of interbedded limestone, dolomite, sand, clay, and marl, generally a few tens of feet to several hundred feet thick;
3. A carbonate section of limestone and dolomite, generally more than 1,000 ft thick;
4. Carbonate rocks containing intergranular anhydrite and gypsum.

The Bone Valley Formation is one of the world's most important sources of phosphate, and hundreds of millions of gallons of ground water are used each day in the extraction and processing of phosphate ore. The ore deposit underlies about 2,000 mi^2 in central Florida and is a shallow-water, marine and estuarine phosphorite of Pliocene age (Altschuler and others, 1964). The phosphate occurs in the form of grains of fluorapatite in a deposit of pebbly and clayey sands.

As described by Fountain and others (1971), the most widely held theory on the origin of phosphate ore is that the Bone Valley Formation was derived principally from the reworking of the underlying weathered Hawthorn Formation. Phosphate in the Hawthorn Formation is probably the result of precipitation from upwelling phosphorus-rich water along the continental shelf during Miocene time.

TABLE 1.—*Hydrogeologic framework*

System	Series	Stratigraphic unit	General lithology	Major lithologic unit	Hydrogeologic unit
Quaternary	Holocene, Pleistocene, Pliocene.	Surficial sand, terrace sand, phosphorite.	Predominantly fine sand; interbedded clay, marl, shell, limestone, phosphorite.	Sand.	Surficial aquifer.
		Undifferentiated deposits.[1]	Clayey and pebbly sand; clay, marl, shell, phosphatic.	Carbonate and clastic.	Upper confining bed of Floridan aquifer.
Tertiary	Miocene.	Hawthorn Formation.	Dolomite, sand, clay, and limestone; silty, phosphatic.		
		Tampa Limestone.	Limestone, sandy, phosphatic, fossiliferous; sand and clay in lower part in some areas.		
	Oligocene.	Suwannee Limestone.	Limestone, sandy limestone, fossiliferous.		
	Eocene, Paleocene.	Ocala Limestone.	Limestone, chalky, foraminiferal, dolomitic near bottom.	Carbonate.	Floridan aquifer.
		Avon Park Limestone.	Limestone and hard brown dolomite.		
		Lake City, Oldsmar, and Cedar Keys Limestones.	Dolomite and chalky limestone, intergranular gypsum and anhydrite.	Carbonate with intergranular evaporites.	Lower confining bed of Floridan aquifer.

[1]Includes all or parts of Caloosahatchee Marl, Bone Valley Formation, and Tamiami Formation.

The ore generally occurs 10 to 60 ft below the land surface and is 5–50 ft thick (Fountain and others, 1971). The ore is mined from open pits. Water is used to transport a matrix slurry to beneficiation plants, to separate the phosphate from the matrix, and to convert the phosphate into useful products.

HYDROGEOLOGY

GENERALIZED FRAMEWORK

Ground water in the study area occurs in two principal aquifers, the surficial aquifer and the Floridan aquifer. The two aquifers are separated by a confining bed, and the Floridan aquifer is underlain by a lower confining bed. Stratigraphic and lithologic equivalents of these hydrogeologic units are summarized in table 1.

Ground water in the surficial aquifer is generally unconfined, and that in the Floridan aquifer is confined. The water table of the surficial aquifer and the potentiometric surface of the Floridan aquifer fluctuate continuously in response to changes in recharge and discharge. Gradients of these surfaces indicate generalized directions of ground-water flow. Recharge to and discharge from the Floridan aquifer are principally by leakage through the upper confining bed of the aquifer. The direction of vertical leakage is determined by the relative positions of the water table and potentiometric surface. Vertical flow between the Floridan aquifer and its lower confining bed is assumed to be negligible. The freshwater flow system is bounded along the gulf coast by a saltwater-freshwater interface.

THE SURFICIAL AQUIFER

DESCRIPTION

The surficial aquifer underlies most of the study area and consists predominantly of fine to very fine sand and clayey sand (table 1). Lithology is highly variable, and the aquifer may include beds of limestone, gravel, marl, and shell deposits. Clay content commonly increases with depth, and the contact between the aquifer and the underlying confining bed is in many places indistinct. The aquifer includes deposits referred to as surficial sand, terrace sand, and phosphorite.

Aquifer thickness is generally a few tens of feet, but it ranges from a few feet or less, where limestone or clay crops out or is near the surface, to several hundred feet, beneath some ridges along the eastern boundary of the study area (Stewart, 1966, p. 79).

Hydraulic properties of the surficial aquifer vary widely because of large differences in lithology and thickness. Geraghty and Miller, Inc., and Reynolds, Smith and Hills (1977) reported a range of transmissivity for the water-table (surficial) aquifer of about 200 ft^2/d (feet squared per day) to about 6,700 ft^2/d in the Southwest Florida Water Management District. Transmissivity approaches zero where aquifer thickness is a few feet or less. Average transmissivity in De Soto and Hardee Counties was reported to be about 1,100 ft^2/d (Wilson, 1977b). Storage coefficients are probably within the range common for unconfined sand aquifers, about 0.05 to 0.3.

WATER TABLE

A generalized map of the altitude of the water table in the surficial aquifer is shown in figure 3. Water-table altitudes in the modeled area range from near sea level at the coast to more than 150 ft in the northeastern part of the area. The water table is generally a subdued reflection of topography. Relatively steep water-table gradients adjoin the major stream courses, and relatively gentle gradients exist in the broad interstream areas. In poorly drained areas of little topographic relief, the water table is commonly at or within a few feet of the land surface. Elsewhere the water table is generally 5–50 ft below land surface. Figure 3 is based on a water-table contour map prepared by Texas Instruments Incorporated (William Underwood, written commun., 1977). The contour map was based on interpretation of topographic maps and represents generalized conditions and not a particular year or season.

Most ground-water flow in the surficial aquifer is toward local points of discharge, including lakes, streams and ditches, and wells. Flow is also vertical, as leakage from or into underlying confining beds.

The water table fluctuates seasonally, as illustrated by two hydrographs in figure 4. Peak altitudes occur during rainy seasons, commonly in late winter and midsummer. Minimum altitudes occur during dry seasons, commonly in May. The seasonal range is generally from 2 to 5 ft. No significant trends in the peaks of the hydrographs are noted for the 1965–76 period, indicating that recharge from summer rains was generally adequate to replenish the aquifer. Altitudes of the troughs in the hydrographs show more variability, primarily because they reflect variability in the timing of the onset of summer rains.

THE FLORIDAN AQUIFER

DEFINITION

The principal sources of ground water are highly transmissive zones in the Floridan aquifer. The Floridan aquifer was originally defined by Parker (Parker and others, 1955, p. 189) to include all or parts of the Lake City Limestone, Avon Park Limestone, Ocala Group,

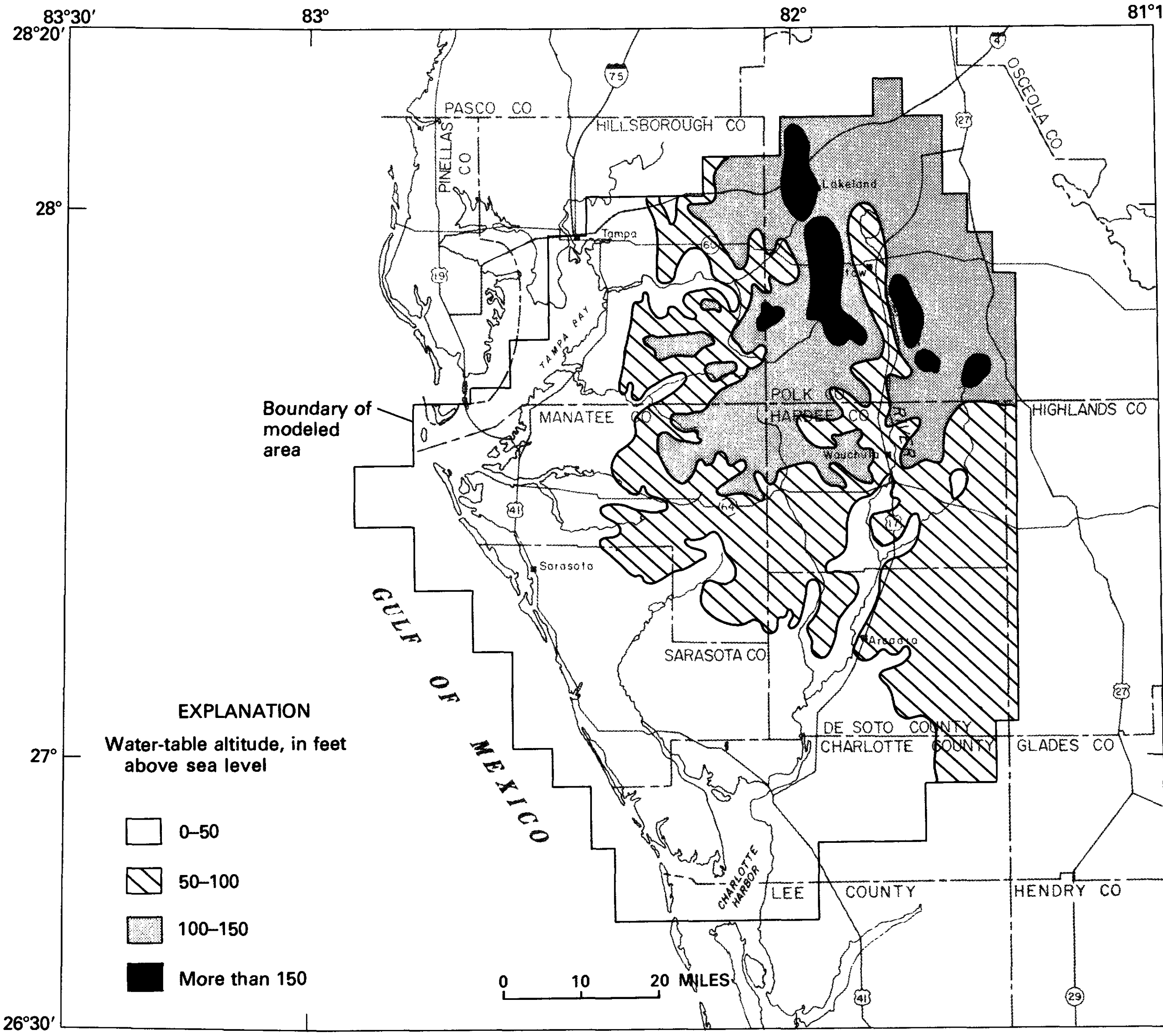

FIGURE 3.—Generalized altitude of the water table of the surficial aquifer (modified from a map by William Underwood, written commun., 1977).

Suwannee Limestone, Tampa Limestone, and "permeable parts of the Hawthorn Formation that are in hydrologic contact with the rest of the aquifer." This definition is closely followed in this report, except for differences in the identity of the top and base of the aquifer.

In this report, the top of the Floridan aquifer is the horizon below which carbonate rocks persistently occur. In the study area, this surface generally coincides with the top of either the Tampa Limestone or the Suwannee Limestone. As shown on the contour map in figure 5, the top of the Floridan aquifer ranges in altitude from about 0 to about −700 ft. The surface generally slopes to the south, but because it crosses formational boundaries and in many areas is erosional, the surface is highly irregular.

For this investigation, the base of the Floridan aquifer is considered to be at the top of the persistently occurring intergranular evaporites in the carbonate rocks. Permeability and porosity of the section of carbonates containing intergranular evaporites is significantly lower than where evaporites are absent. The stratigraphic position of the aquifer base varies, probably because of original variations in the depth of evaporite deposition or because of removal and subsequent redeposition by circulating ground water. In the study area, the aquifer base generally occurs in the lower part of the Avon Park Limestone or at the contact of the Avon

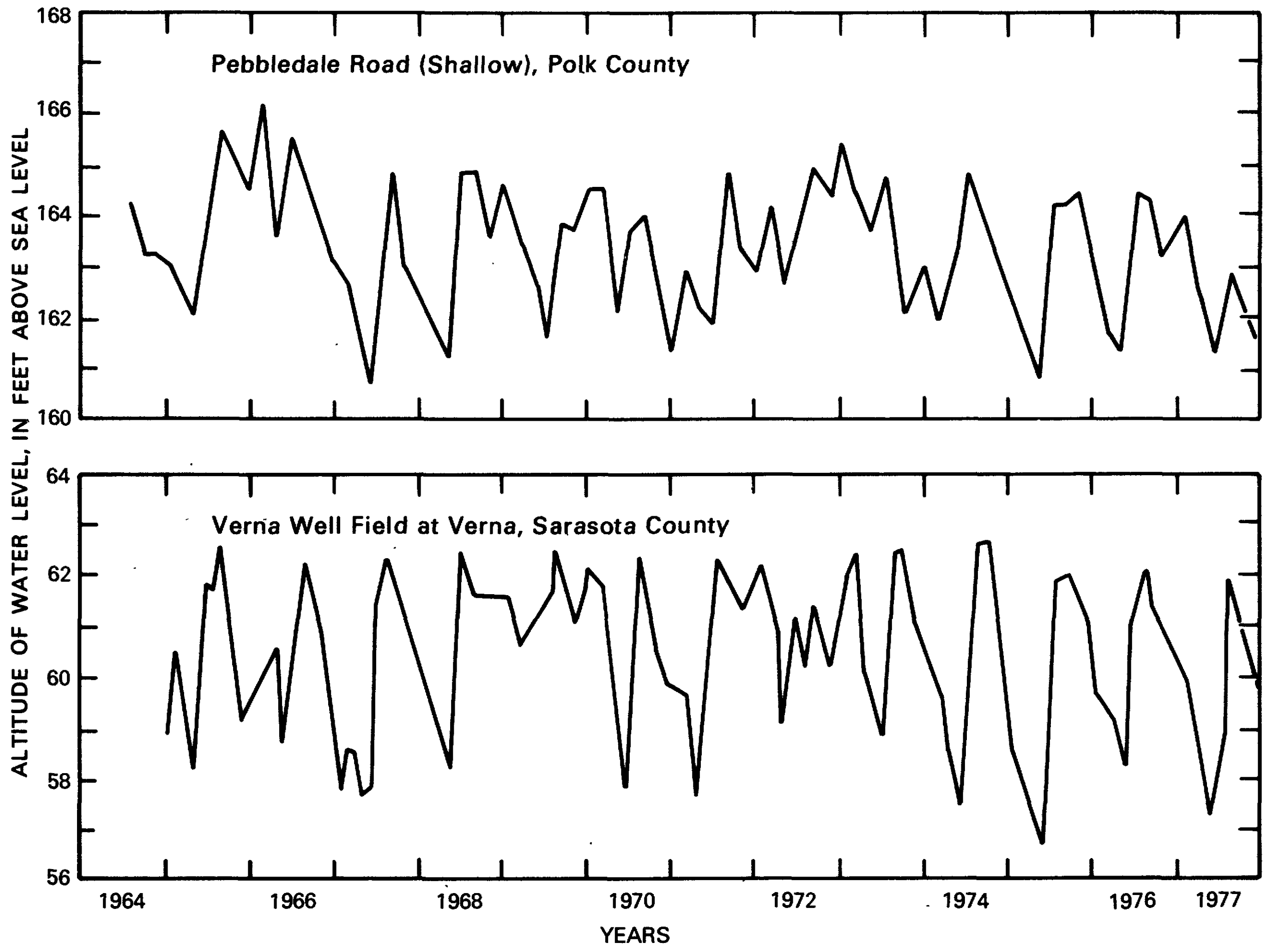

FIGURE 4.—Hydrographs of wells open to the surficial aquifer. (Well locations are shown on plate 1.)

Park Limestone with the underlying Lake City Limestone. For convenience, and because from a practical standpoint the position of the base is difficult to ascertain, the base of the Floridan aquifer is considered to correspond to the top of the Lake City Limestone. As shown on the contour map (fig. 6), the base of the aquifer ranges in altitude from about −900 ft to about −2,400 ft. Because of sparse control, the map is highly generalized.

As defined herein for modeling purposes, the Floridan aquifer constitutes a single hydrologic unit. In reality, the system is complex. For example, in the southern part of the study area, two or more distinct artesian water-bearing zones have been described within the aquifer (Sproul and others, 1972; Sutcliffe, 1975; Wilson, 1977b). In addition, in this area many wells tap secondary artesian aquifers that overlie the Floridan in order to obtain water of suitable quality. Nonetheless, on a regional scale and over long periods of time, the ground-water flow system in the Floridan aquifer probably functions as a single unit.

PROPERTIES

The Floridan aquifer consists of limestone and dolomite containing solution-enlarged fractures and bedding planes that commonly yield abundant supplies of water to wells. The aquifer ranges in thickness from about 900 to about 1,900 ft (fig. 7). The map in figure 7 is highly generalized and is based on contour maps of the top and base of the aquifer (figs. 5, 6). The most transmissive part of the aquifer generally occurs in a widespread dolomite section within the Avon Park Limestone. The dolomites in this section are the principal sources of water to large-capacity wells, except along the coast, where those rocks contain mineralized water.

Modeled transmissivity of the Floridan aquifer ranges from about 80,000 ft²/d to 500,000 ft²/d (fig. 8). The map is highly generalized and does not reflect differences in transmissivity that occur locally.

Transmissivities were based in part on the results of 12 aquifer tests, shown in figure 8. Test data are from publications and the files of the U.S. Geological Survey.

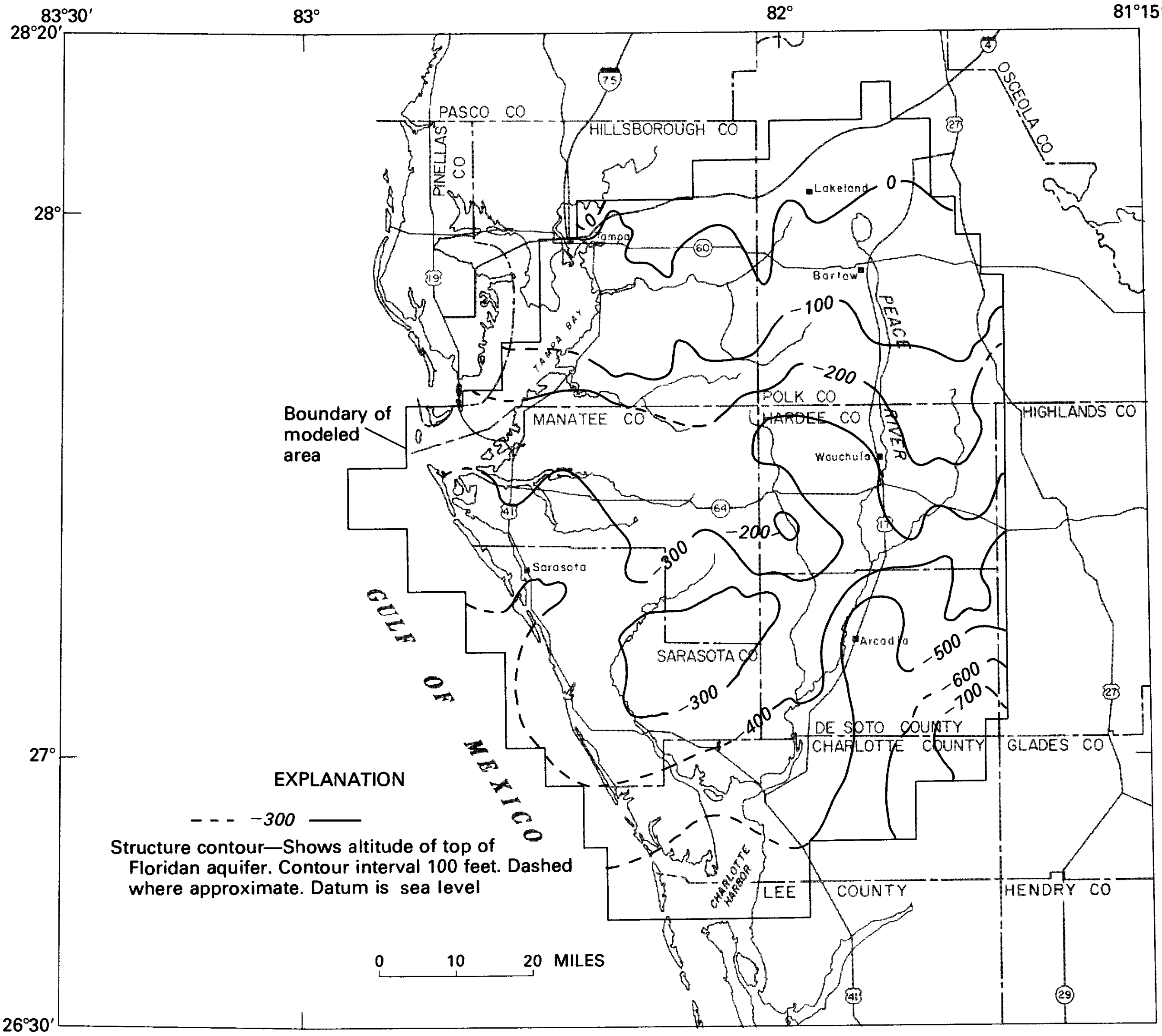

FIGURE 5.—Altitude of top of the Floridan aquifer.

The tests were conducted under a wide variety of conditions, including various durations, open-hole sections, number and spacing of observation wells, pumping rates, and organizations conducting the tests. All data were analyzed by the Geological Survey to provide consistency and uniformity to interpretations.

Site data shown in figure 8 were regionalized, using as guides variations in the gradient of the potentiometric surface of the Floridan aquifer and adjustments resulting from model calibration. No test sites occur in the southwestern part of the modeled area, where transmissivity was mapped as 80,000 ft²/d (fig. 8). The relatively low transmissivity was based primarily on calibration results and was required to simulate the relatively steep gradient of the potentiometric surface in that area. The mapped potentiometric surface in this area is based largely on wells that tap only the upper part of the Floridan aquifer. Thus the transmissivity values required to match this surface probably reflect characteristics of the upper part of the aquifer and not of the full thickness.

The storage coefficient of the Floridan aquifer ranges from about 8.8×10^{-4} to about 1.9×10^{-3} in the modeled area, as determined by multiplying an estimated average specific storage of the aquifer of $1.0 \times 10^{-6} \mathrm{ft}^{-1}$ times aquifer thickness (fig. 7). According to Lohman

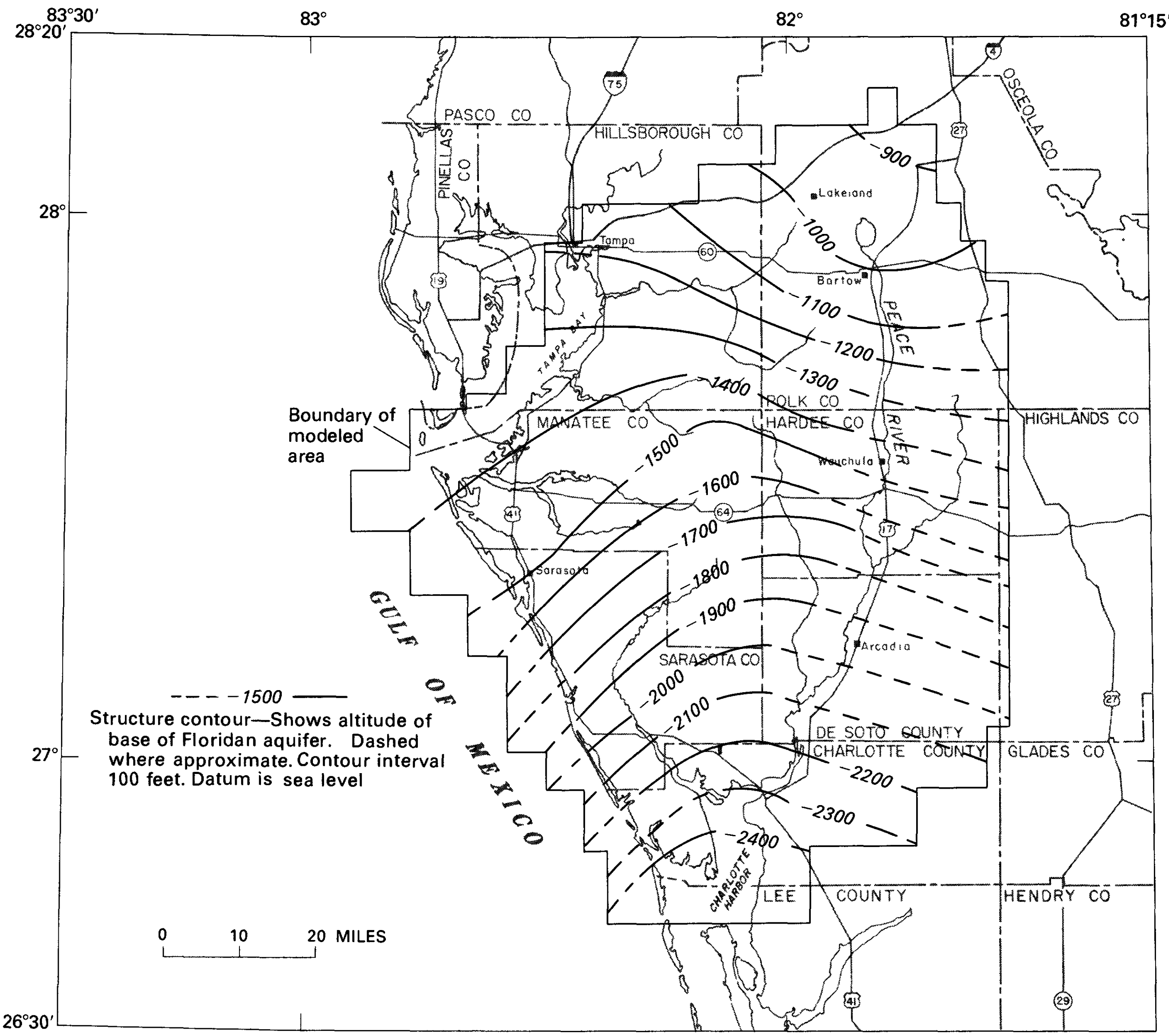

FIGURE 6.—Altitude of base of the Floridan aquifer.

(1972, p. 8), $1.0\times10^{-6}ft^{-1}$ is an approximate value of specific storage for most confined aquifers. Use of this value for the Floridan aquifer is supported by compressibility data from cores taken from the aquifer in Pinellas County, northwest of the study area.

Laboratory compressibility results from six core samples of dolomite and five core samples of limestone were reported by Hickey (1977, 1978). The samples were taken from the depth interval 629–1,043 ft. Using an estimated porosity of 20 percent for the dolomite and 30 percent for the limestone, specific storage was computed to be as follows: Dolomite ranged from $3.3\times10^{-7}ft^{-1}$ to $1.2\times10^{-6}ft^{-1}$ and averaged $5.2\times10^{-7}ft^{-1}$, and limestone ranged from $5.6\times10^{-7}ft^{-1}$ to $6.0\times10^{-6}ft^{-1}$ and averaged $3.1\times10^{-6}ft^{-1}$.

For regional mapping, storage coefficients determined from the specific storage estimate and aquifer thickness were considered to be more reliable than the highly variable results of aquifer tests. Storage coefficients of the Floridan aquifer, determined from 11 of the aquifer-test sites shown in figure 8, ranged from 3.2×10^{-4} to 1.8×10^{-2}. In general, the coefficients obtained by multiplying aquifer thickness by specific storage are probably higher than a practical field coeffi-

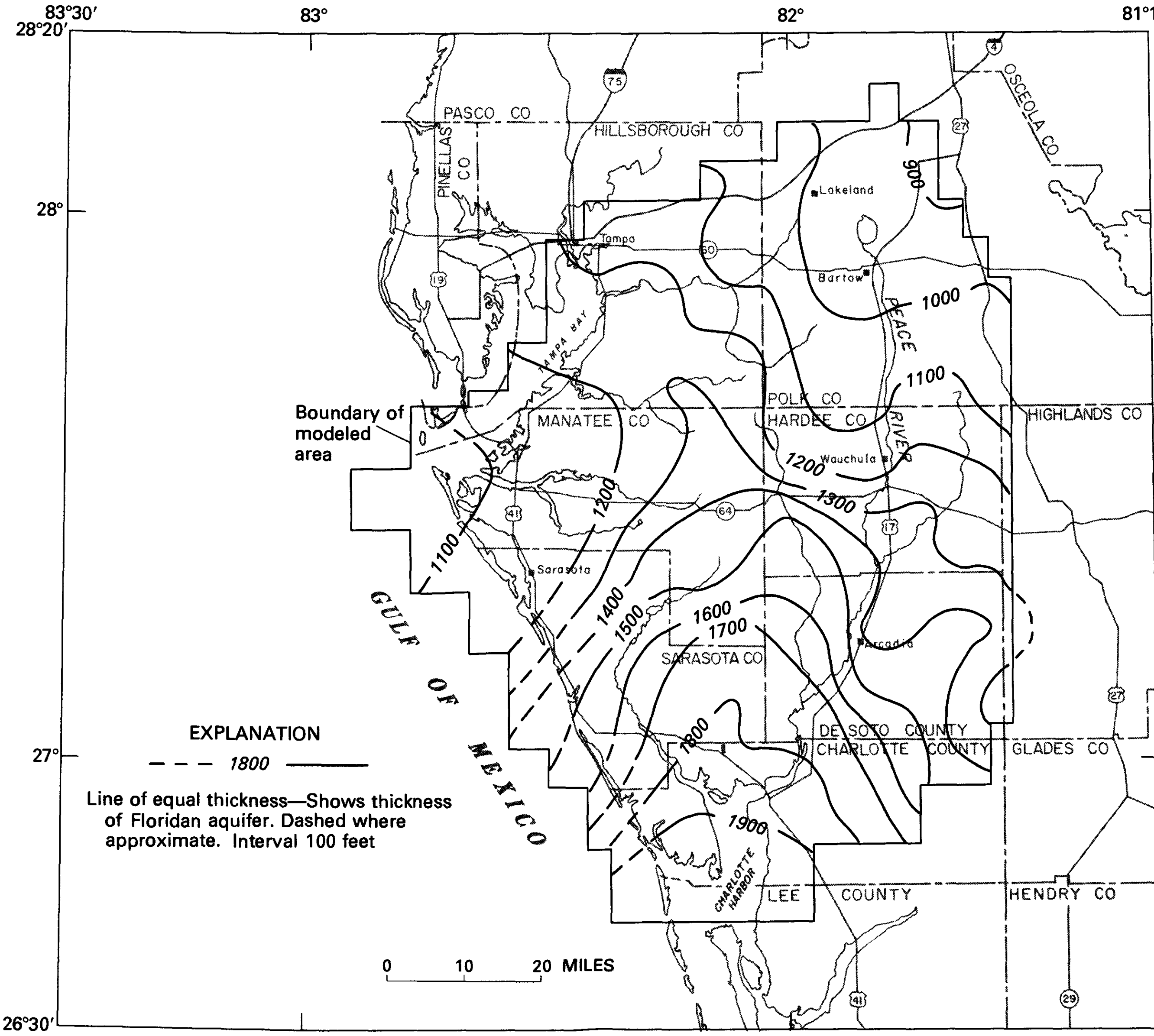

FIGURE 7.—Thickness of the Floridan aquifer.

cient. As discussed later in this report, reducing storage coefficient by 80 percent made little difference in computed heads during transient calibration.

THE POTENTIOMETRIC SURFACE

GENERAL FEATURES

Figure 9 shows the 1949 regional configuration of the potentiometric surface of the Floridan aquifer in peninsular Florida. This surface represents nearly unstressed conditions for the aquifer. Although man's activities have since altered the configuration of the surface, the major feature, a centrally located dome or ridge, has remained unchanged. Figure 9 shows that the study area lies along the southwestern flank of this potentiometric dome and that the eastern boundary is approximately along its crest.

Since 1975 the potentiometric surface in the Southwest Florida Water Management District has been mapped semiannually by the U.S. Geological Survey at times of normally highest water levels (September) and lowest water levels (May). The maps are based on nearly synchronous measurements of water levels in hundreds of wells open to the Floridan aquifer. However, observation wells in Sarasota and Charlotte Counties are scarce, and the maps are less accurate in these counties than elsewhere.

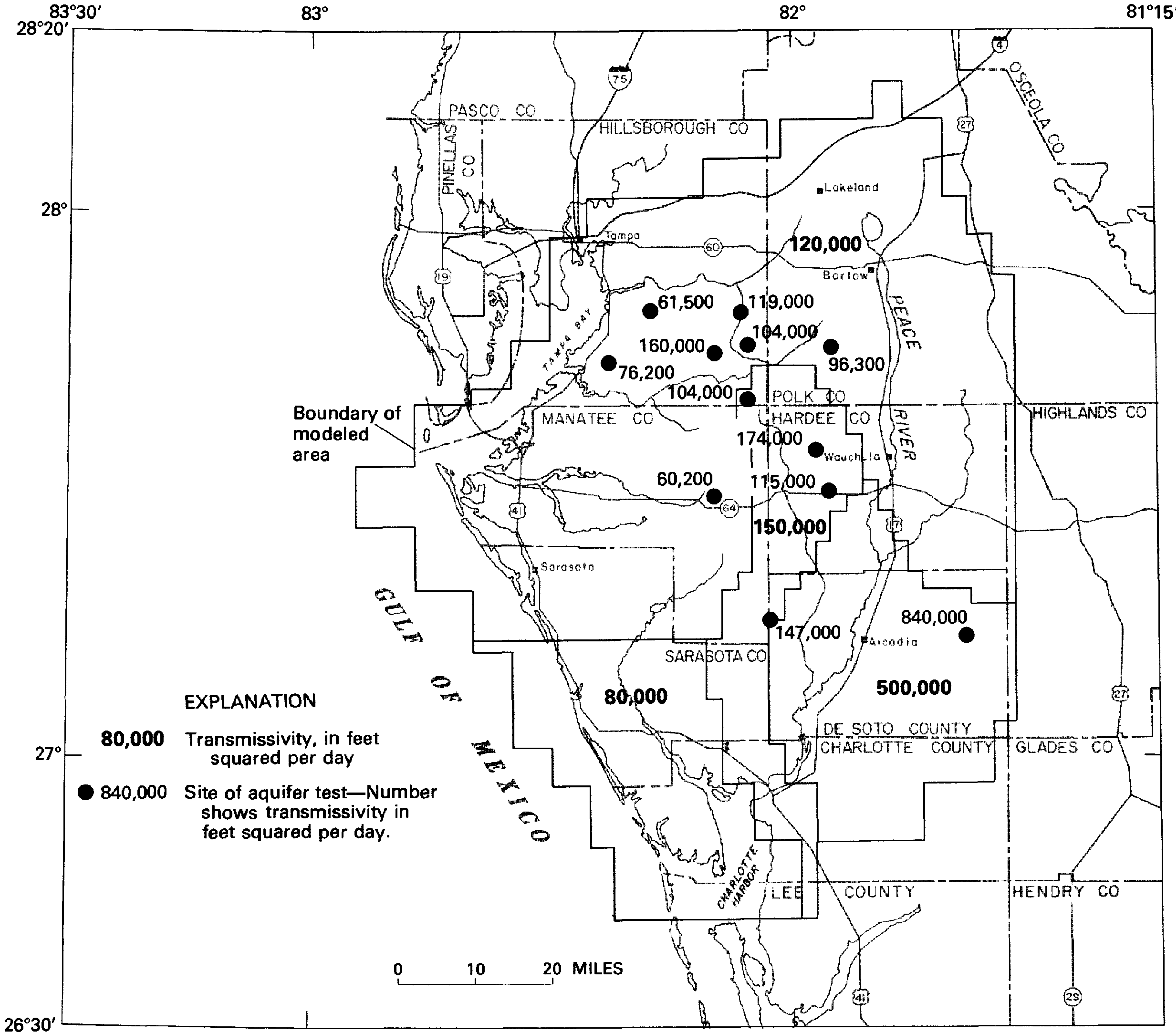

FIGURE 8.—Transmissivity of the Floridan aquifer, as used in the model.

Figure 10 shows the potentiometric surface for September 1975 for west-central Florida. This potentiometric surface represents conditions near the end of the summer rainy season, at a time when the aquifer was practically unstressed by irrigation pumping. Altitudes in the modeled area ranged from less than 5 ft near Tampa Bay and offshore in the gulf to more than 120 ft in the northeastern part of the area. Positions of contour lines in the Gulf of Mexico were extrapolated, based on mapped onshore gradients. Around Tampa Bay, the map was modified slightly from that of Mills and others (1976) in order to represent Tampa Bay as a ground-water discharge area.

Major features of the potentiometric surface in figure 10 are the ridge having relatively steep gradients in the eastern and northeastern parts of the modeled area, the closed depression in southwestern Polk County, the relatively gentle gradient in De Soto County, and the overall coastward slope. Marked areal differences in gradient are believed to represent, in part, differences in aquifer transmissivity, and these differences were used as guides in selecting boundaries for transmissivity map units shown in figure 8. The closed depression in Polk County is in an area of ground-water withdrawals for phosphate mining, other industries, municipalities, and, seasonally, agriculture.

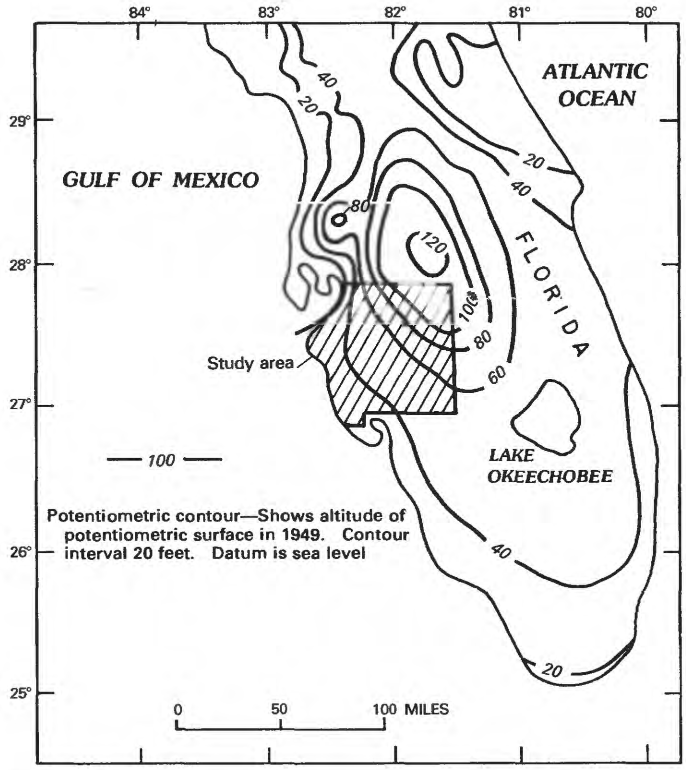

FIGURE 9.—The potentiometric surface of the Floridan aquifer, peninsular Florida, 1949 (from Stringfield, 1949, fig. 29).

Figure 11 shows the potentiometric surface in May 1976. The surface represents conditions near the end of a long dry season during which extensive irrigation pumpage occurred. Altitudes ranged from about 10 ft below sea level to about 120 ft above. Like the September 1975 map, figure 11 was modified slightly in the Tampa Bay area from the published May 1976 map (Stewart and others, 1976).

Major changes from September to May include a general decline in potentiometric surface, except along the crest of the eastern ridge; the development of a large closed depression, centered in Manatee County; and a shift in the divide along the eastern boundary. A comparison of figures 10 and 11 shows that the potentiometric surface declined as much as 35 ft between September 1975 and May 1976. In May, the potentiometric surface in about 700 mi^2 in Hillsborough, Manatee, and Sarasota Counties was below sea level. These seasonally low levels may have first occurred in the late 1960's, but the depression was not mapped until May 1975 (Mills and Laughlin, 1976), when data control was adequate to define it. The depression nearly disappears by September, suggesting that its development is principally related to seasonal stresses on the aquifer, namely, ground-water withdrawals for irrigation.

In May 1976, a trough in the potentiometric surface extended eastward from the depression through Hardee and De Soto Counties. The formation of this trough shifted the lower part of the axis of the major ground-water divide eastward and reoriented it in a northwest-southeast direction.

Figure 12 shows the potentiometric surface in September 1976. The map is similar to that of September 1975, except that in 1976 the depression in southwestern Polk County is gone, and a small residual of the May depression in Manatee County remains. These differences probably reflect differences in pumping patterns during the two years. All four potentiometric maps (figs. 9–12) were used in calibrating the model, as described in later sections of this report.

SEASONAL FLUCTUATIONS AND LONG-TERM TRENDS

Seasonal fluctuations and long-term trends of the potentiometric surface are illustrated by three well hydrographs in figure 13. The graphs show that during any year the potentiometric surface may undergo several cycles of decline and rise but that generally the surface is highest in autumn and lowest in late spring. The steep downward trend in spring is reversed, often abruptly, by the onset of summer rains in May or June and the consequent cessation of irrigation pumping. At this time, water levels rise rapidly, often several feet in one or two weeks.

The hydrographs in figure 13 also show a slight downward trend in the annual peaks, and an increase in range between the seasonal lows and highs, especially since the early 1960's. Wilson (1977b, p. 50) concluded that the potentiometric surface in De Soto and Hardee Counties showed little or no net decline from 1934 to 1949, but from 1949 to 1973 declines ranged from a few feet in much of De Soto County to about 20 ft in northeastern Hardee County. Most of this change occurred during 1962–73. Comparison of figures 9 and 10 indicates a decline of at least 50 ft in parts of southwestern Polk County between 1949 and 1975.

As suggested by the hydrographs of figure 13, September-to-September declines were of lesser magnitude than May-to-May declines. The declines in the September peaks do indicate, however, that discharge from the Floridan aquifer exceeded recharge during the period of decline. Increases in seasonal range probably reflect long-term increases in ground-water withdrawals for irrigation and widespread substitution of deep turbine pumps for centrifugal pumps in irrigation wells in the 1960's.

GROUND-WATER FLOW

Generalized directions of ground-water flow in the Floridan aquifer are shown in the potentiometric maps for September 1975 (fig. 10) and May 1976 (fig. 11). As

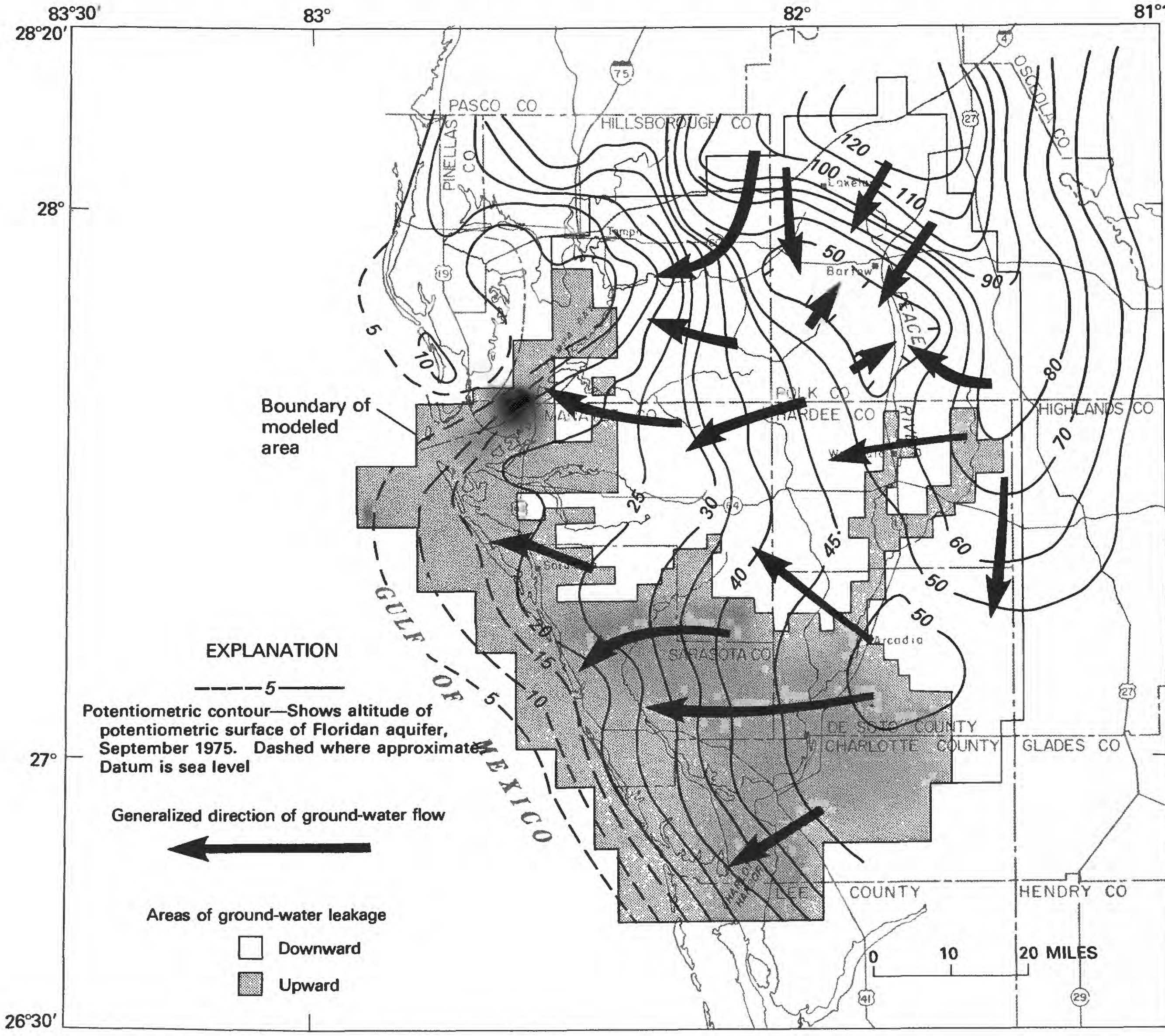

FIGURE 10.—The potentiometric surface of the Floridan aquifer, September 1975 (modified from Mills and others, 1976).

indicated by the arrows, regional flow is from areas of high altitude of the potentiometric surface to areas of low altitude. Although flow is generally coastward, flow in areas of closed depressions occurs radially from all directions. The arrows indicate that the seasonal formation of the depression and trough in May substantially alters the directions of ground-water flow.

SALTWATER-FRESHWATER RELATIONS

The freshwater flow system in the study area is bounded coastward by a saltwater flow system. The two systems are separated by a zone of transition, in which the chloride concentration is highly variable. In much of the inland area, chloride concentration is 10–25 mg/L (milligrams per liter). Values in this range can be considered "background" values for fresh ground water unmixed with saltwater in the modeled area. Along the coast, at least part of the Floridan aquifer contains saltwater and commonly has a chloride concentration of about 19,000 mg/L. This concentration is approximately the same as the chloride concentration of gulf seawater, and the 19,000-mg/L isochlor can be considered to delineate the saltwater front.

The saltwater front and zone of transition have not been mapped in detail in the study area. The trace of the intersection of the front with the top of the aquifer probably occurs offshore. The front dips inland as the poten-

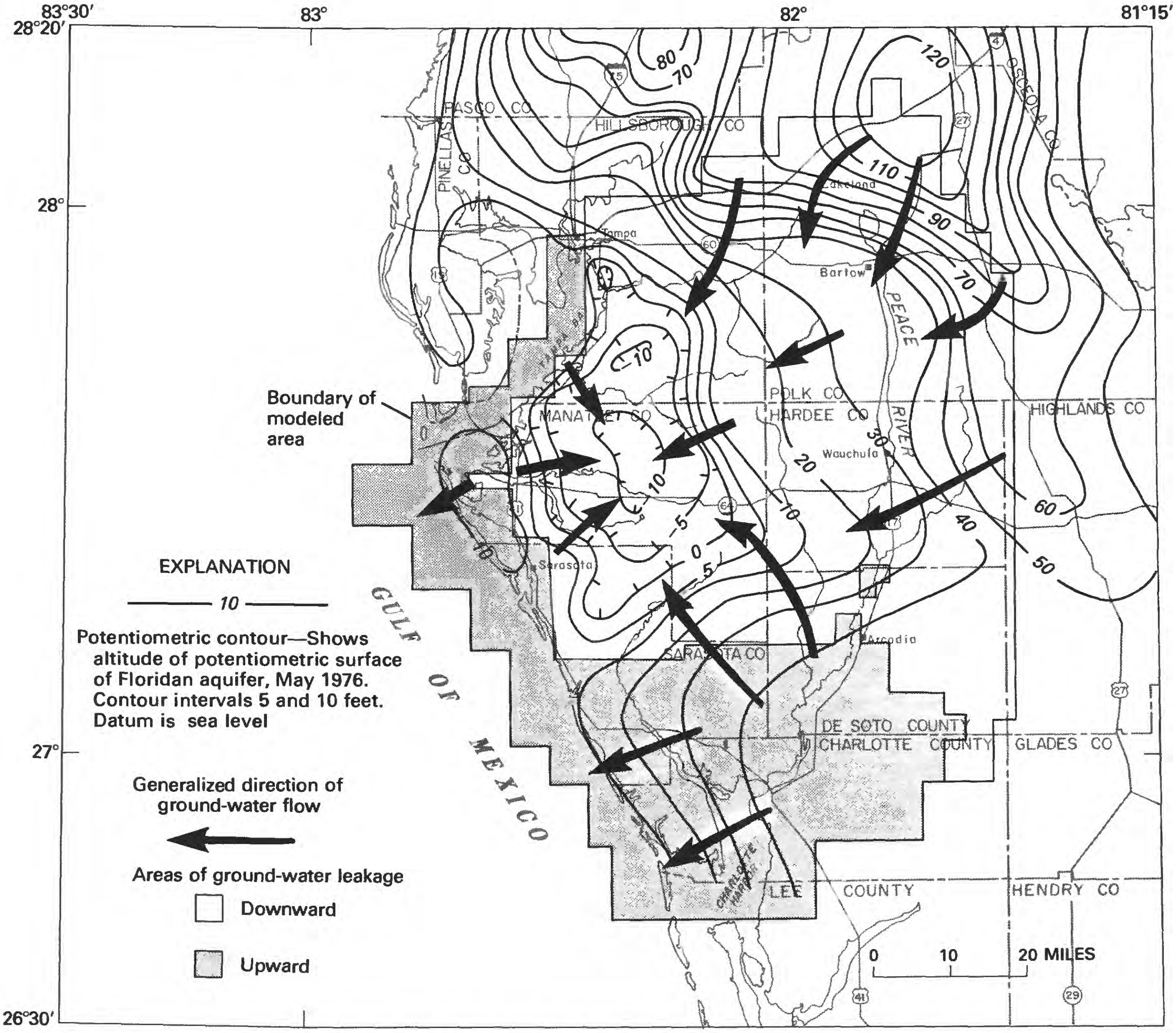

FIGURE 11.–The potentiometric surface of the Floridan aquifer, May 1976 (modified from Stewart and Laughlin, 1976).

tiometric surface rises. The intersection of the toe of the front and the base of the Floridan aquifer probably ranges from a few miles to about 20 mi inland from the coastline, as indicated by unpublished water-quality data. Beneath most of Sarasota, De Soto, and Charlotte Counties, the lower part of the Floridan aquifer contains either saltwater or water in the zone of transition.

CONFINING BEDS

DEFINITIONS

Confining beds occur above and below the Floridan aquifer. As used in this report the upper confining bed of the Floridan aquifer is the full clastic and carbonate sequence between the surficial aquifer and the Floridan aquifer. This sequence may include all or part of the Bone Valley Formation, Tamiami Formation, Hawthorn Formation, Tampa Limestone, and other undifferentiated, predominantly clastic deposits of late Miocene to Pleistocene age. Although in places these formations contain permeable beds of limestone and dolomite, well yields are generally substantially less than those from the underlying carbonate section of the Floridan aquifer. Furthermore, the carbonates in the upper confining bed are generally underlain by clastic deposits of low permeability and thus are hydraulically separated from the Floridan aquifer. For modeling purposes the clastic and carbonate sequence is considered to be a single confining unit overlying the Floridan aquifer.

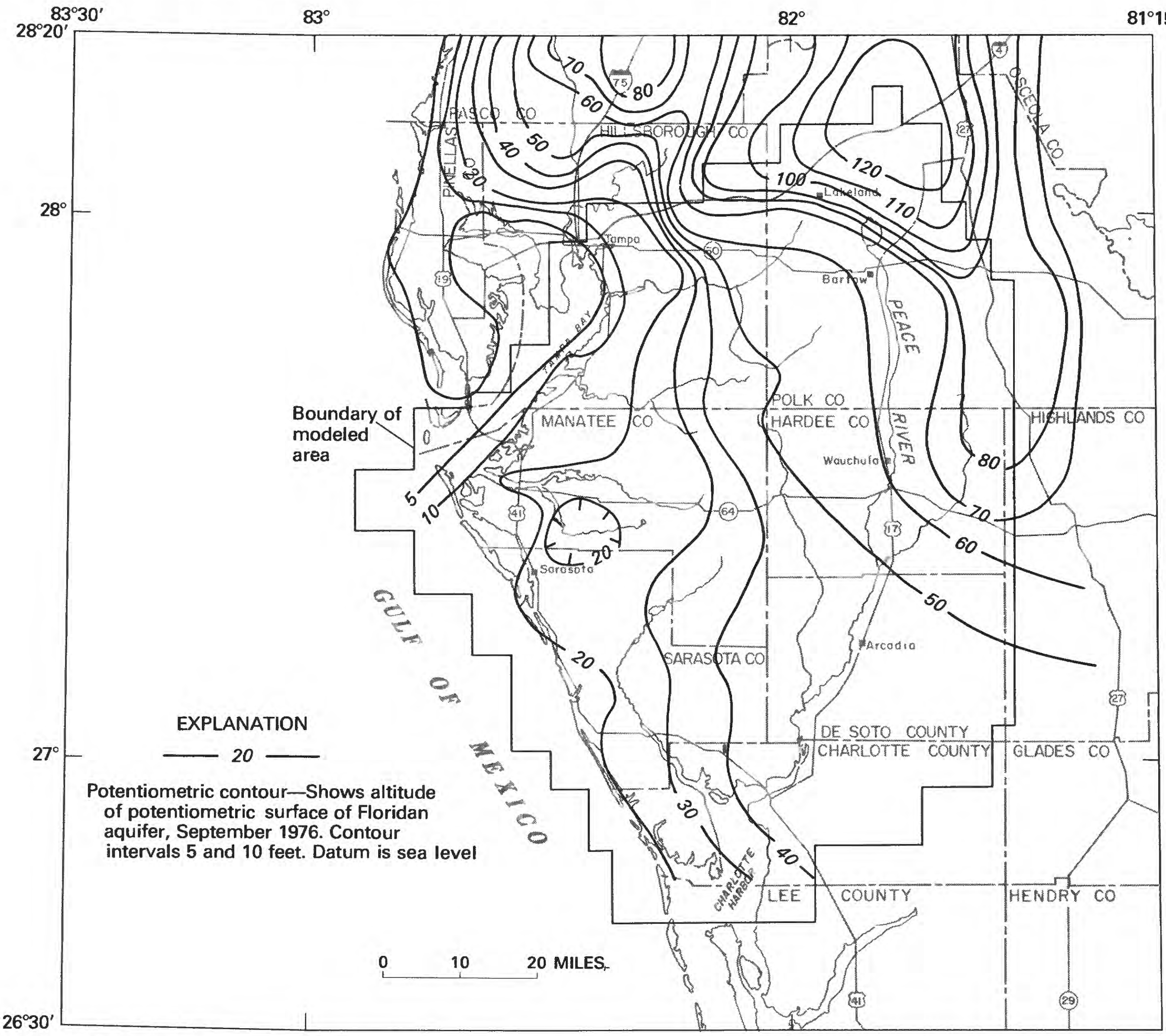

FIGURE 12.–The potentiometric surface of the Floridan aquifer, September 1976 (modified from Ryder and others, 1977).

The lower confining bed of the Floridan aquifer is the section of relatively impermeable rocks that underlie the Floridan aquifer. As used in this report, these rocks include the Lake City Limestone, Oldsmar Limestone, and Cedar Keys Limestone. These formations are predominantly carbonate rocks that contain thin beds and nodules and pore fillings of anhydrite, gypsum, and selenite. The Cedar Keys Limestone also contains thick massive beds of anhydrite. Also present are zones of relatively evaporite-free carbonate rocks that probably could yield water to wells. Nonetheless, in the overall flow system, this section functions predominantly as a confining bed to the Floridan aquifer.

The top of the lower confining bed is equivalent to the base of the Floridan aquifer (fig. 6). The top of the confining bed, like the top of the Floridan aquifer, generally slopes to the south.

UPPER CONFINING BED

The upper confining bed of the Floridan aquifer is a heterogeneous section consisting of clay, sand, marl, limestone, and dolomite. In much of the eastern part of the study area, the basal part of the upper confining bed is the sand and clay unit of the Tampa Limestone, which overlies the Suwannee Limestone. The sand and clay unit was recognized by Wilson (1977b) to occur in the eastern two-thirds of De Soto County and most of Hardee County. Similar clay beds in the lower part of the Tampa Limestone occur in Polk County (Stewart, 1966), and the unit probably extends westward into

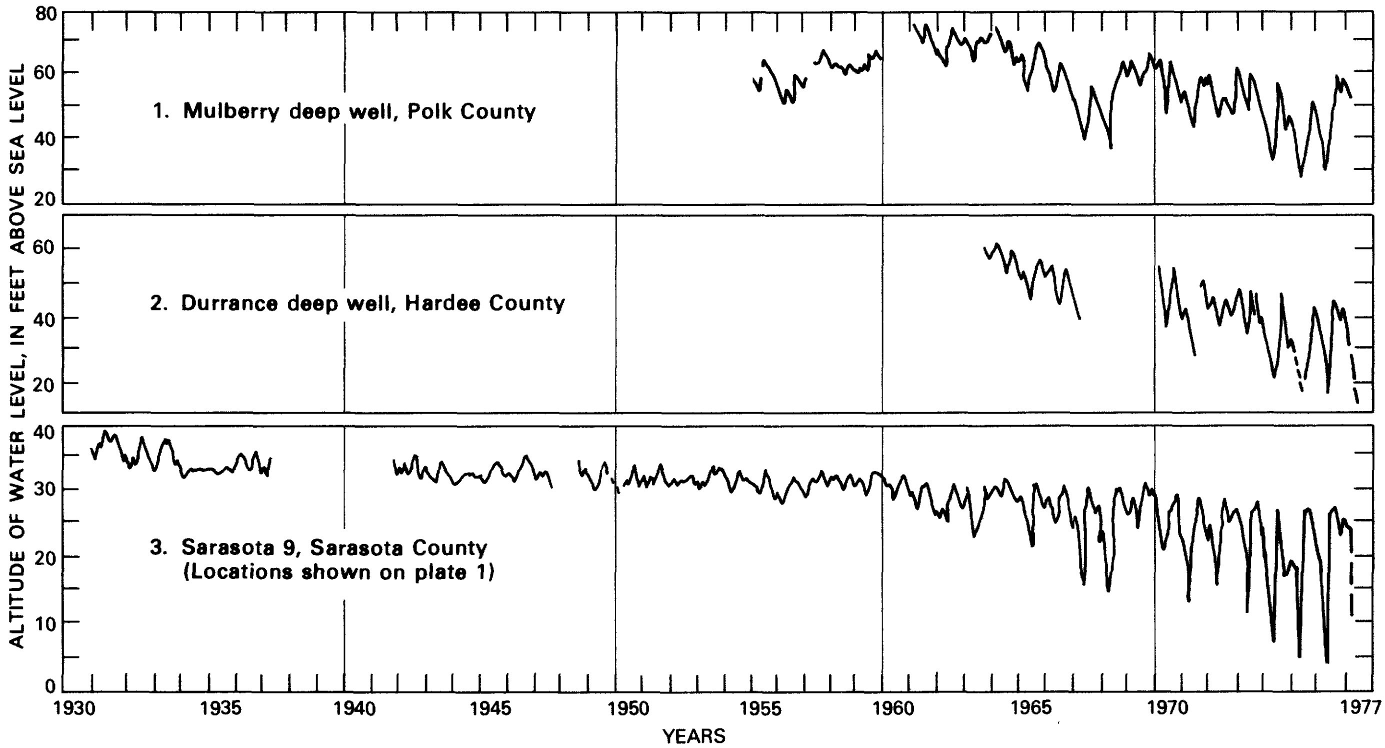

FIGURE 13. – Hydrographs of wells open to the Floridan aquifer.

Manatee and Hillsborough Counties and southward into Charlotte County. In these areas, the upper part of the upper confining bed includes clay, marl, limestone, and dolomite.

In coastal parts of the study area, including much of Sarasota, Manatee, and southeastern Hillsborough Counties, the sand and clay unit of the Tampa Limestone is commonly replaced by sandy limestone and limestone, which are included in the Floridan aquifer. In this area, the upper confining bed generally corresponds to the Hawthorn Formation and consists predominantly of sand and clay and minor limestone and dolomite.

A preliminary map of the thickness of the upper confining bed was prepared for the model. The map was later revised for separate publication (R. M. Wolansky, written commun., 1979). Thickness ranged from 20 ft in the northern part of the modeled area to 780 ft in the southern part (see Supplementary data I – Model input data, in the Appendix).

Vertical hydraulic conductivity of the upper confining bed, as used in the model, is shown in figure 14. Preliminary values of vertical hydraulic conductivity (K') were determined by multiplying leakance coefficients (K'/b'), determined from aquifer tests, by confining-bed thickness (b') at each aquifer-test site. An initial map of vertical hydraulic conductivity, based on these results, was modified during calibration of the steady-state and transient models. The resulting map of vertical hydraulic conductivity (fig. 14) is primarily a calibration map, but values are within the probable range of error of original aquifer-test estimates.

Leakance coefficient (K'/b') of the upper confining bed, as used in the model, is shown in figure 15. This map was prepared from values of confining-bed vertical hydraulic conductivity and confining-bed thickness used in the model (see the Appendix, Supplementary data I – Model input data).

The storage coefficient of the upper confining bed was determined from the product of an estimated average specific storage of $1.0 \times 10^{-5} ft^{-1}$ and confining-bed thickness. The storage coefficient ranged from 2.0×10^{-4} in the northern part of the area to 7.8×10^{-3} in the southeastern part (see the Appendix, Supplementary data I – Model input data).

Few data are available on storage properties of the upper confining bed. Laboratory determinations of specific storage of five clay samples from the upper confining bed in southeastern Manatee County ranged from $3.4 \times 10^{-5} ft^{-1}$ to $3.2 \times 10^{-4} ft^{-1}$ (Geraghty and Miller, Inc., 1978). On the basis of a review of literature reporting values for similar preconsolidated deposits elsewhere in the country, William F. Guyton and Associates (1976) assumed a value of $1.0 \times 10^{-5} ft^{-1}$ for an average specific storage of the upper confining bed at a test site in northeastern Manatee County.

Results of detailed testing of the upper confining bed in the Osceola National Forest in northern Florida were reported by Miller and others (1978). In that area, the

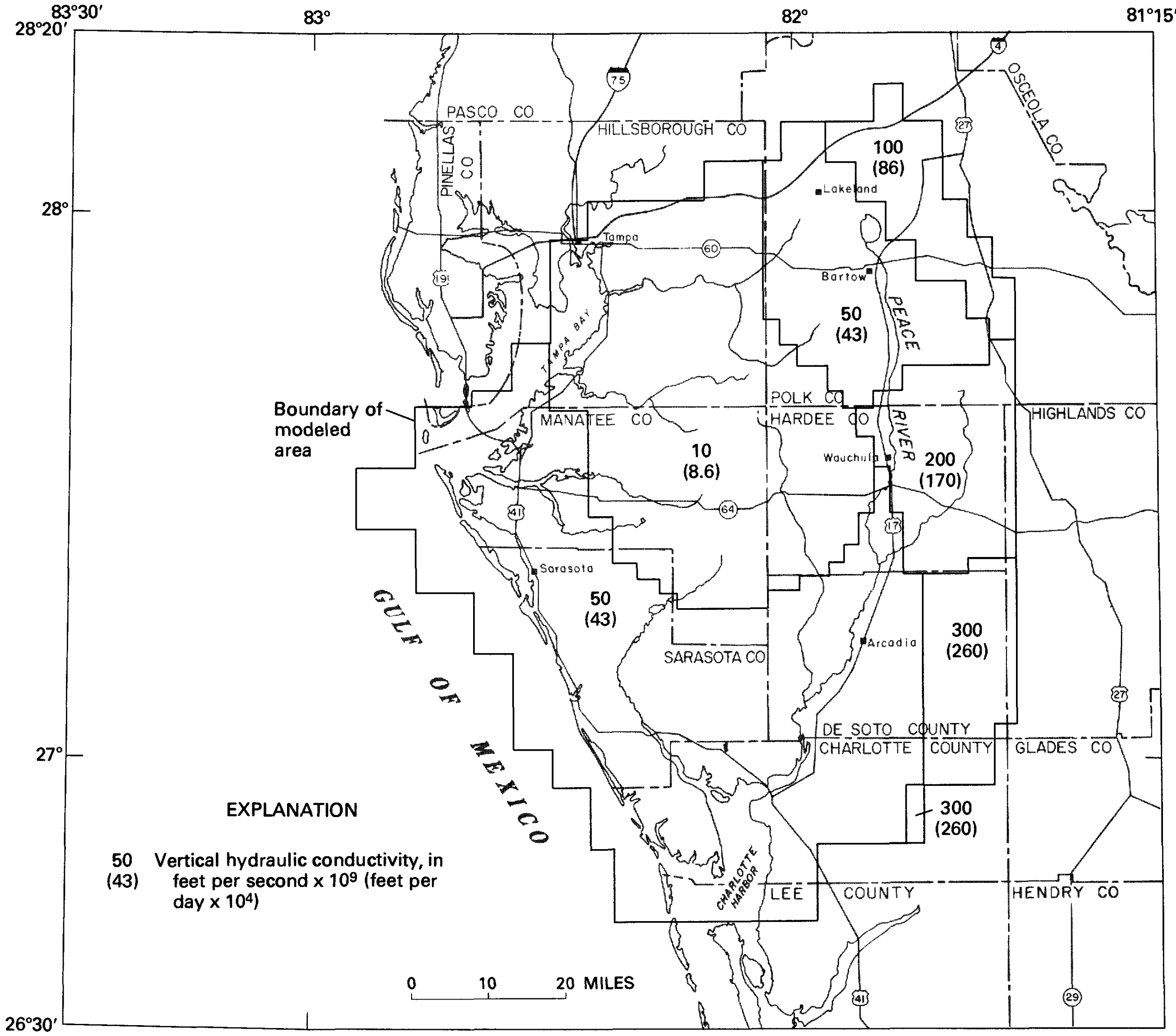

FIGURE 14. – Vertical hydraulic conductivity of the upper confining bed of the Floridan aquifer, as used in the model.

confining bed consists of the Hawthorn Formation. Specific storage, determined from laboratory tests and extensometer data analyses, was 1.8×10^{-5}ft^{-1} for a clay bed and 2.2×10^{-6}ft^{-1} for a calcareous sandstone bed. Similar lithologies occur in the upper confining bed in this study area. In areas where the upper confining bed contains limestone and dolomite, average specific storage is probably less than 1×10^{-5}ft^{-1}.

LOWER CONFINING BED

Few water wells penetrate the lower confining bed of the Floridan aquifer, and little testing has been done to determine its hydraulic characteristics. Thickness of the full section of Lake City Limestone, Oldsmar Limestone, and Cedar Keys Limestone is on the order of 2,000–3,000 ft (Puri and Vernon, 1964). Of significance in this investigation, however, are the properties of the upper part of the confining bed and its capacity to leak ground water to or from the Floridan aquifer.

Probably the most detailed testing of the lower confining bed was conducted in northeastern Manatee County. Test procedures and results were reported by William F. Guyton and Associates (1976). Pertinent aspects of that report are summarized in the following paragraphs.

At the site, a test well was drilled to 2,000 ft, ending in the Lake City Limestone. The top of the confining bed is at 1,685 ft, corresponding to the first occurrence of a trace of gypsum in calcitic dolomite. Below 1,700 ft,

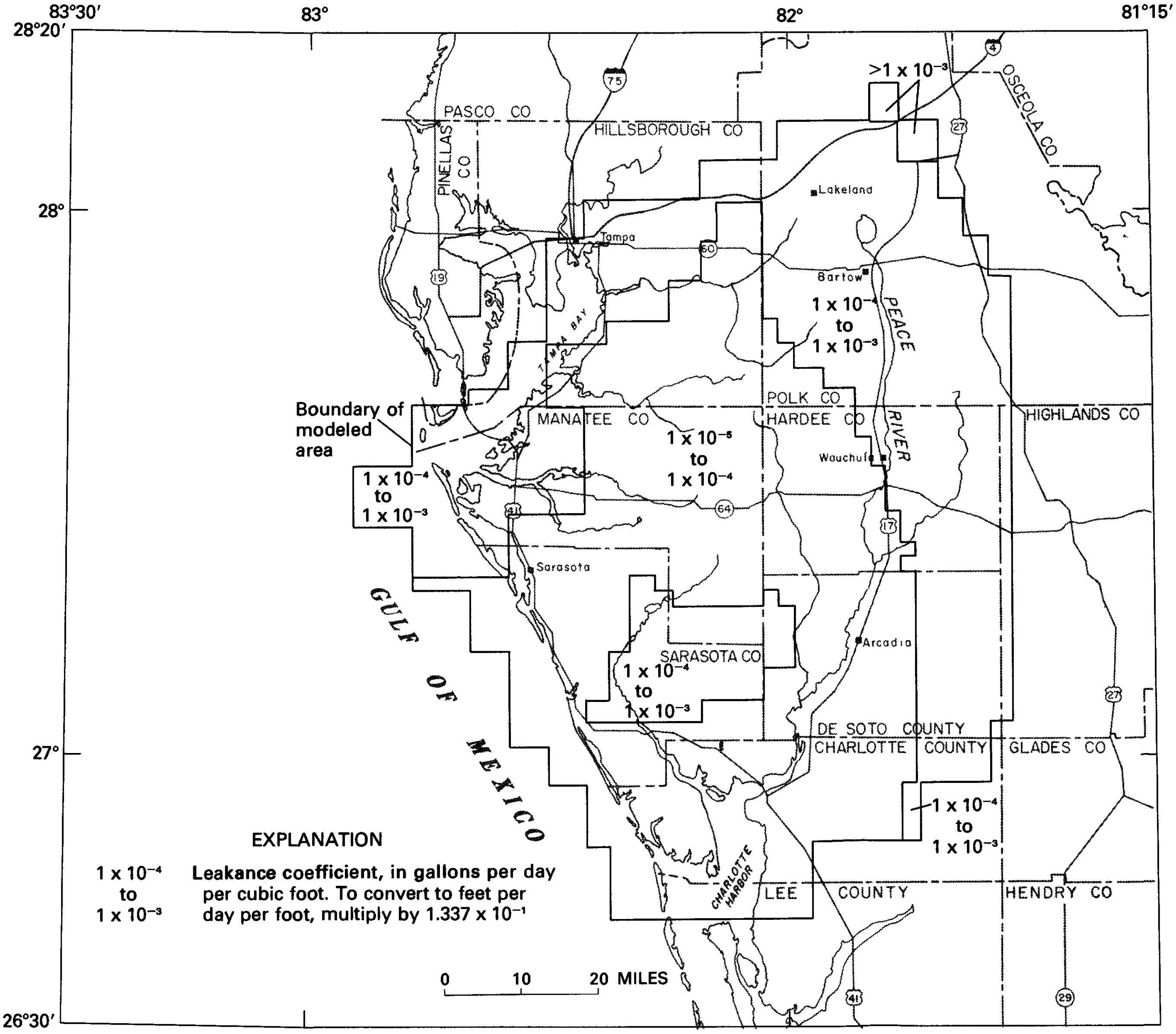

FIGURE 15. – Leakance coefficient of the upper confining bed of the Floridan aquifer, as used in the model.

rocks are predominantly calcitic dolomite with an average of about 10 percent gypsum or anhydrite.

The major producing zone in the Floridan aquifer occurs in the Avon Park Limestone at about 1,210–1,230 ft. Borehole-temperature and fluid-resistivity logs indicate that a small producing zone occurs at 1,500 ft; below 1,500 ft, very little water entered the test hole. In a packer test, the open-hole interval of 1,740–1,800 ft was pumped at 1.5 gal/min (gallons per minute), with a drawdown of more than 300 ft. On the basis of specific-capacity tests, average hydraulic conductivity of deposits from 1,740 to 2,000 ft was estimated to be about 0.1 ft/d; some beds probably have much lower permeability.

In a 10-day aquifer test, a well open to the major producing zone in the Avon Park Limestone was pumped at 2,500 gal/min. The pumping had no discernible effect on water levels in a deep monitor well that was near the pumping well and open at 1,930–2,000 ft to a relatively evaporite-free zone in the lower confining bed. Furthermore, no seasonal change in water level was observed in the deep monitor well from November 1975 through June 1976, although the head in the Floridan aquifer fluctuated 30 ft.

At the Manatee County test site, the lower confining bed contains ground water that is more highly mineralized than that in the Floridan aquifer. Dissolved-solids concentration of water in the Floridan aquifer is approximately 280–350 mg/L. Estimated dissolved-solids concentration for the interval 1,500–1,700 ft is about 1,000 mg/L. Below 1,700 ft, the dissolved-solids concentration was estimated to range from 4,000 to 9,000 mg/L or more.

Information obtained at the test site suggests that the lower confining bed has a sufficiently low permeability to effectively retard leakage. Some indirect evidence exists to suggest that this condition may be widespread in the study area. Logs of deep wells in Polk County (Stewart, 1966) and Sarasota County (Horace Sutcliffe, Jr., written commun., 1977), for example, show intergranular and bedded anhydrite and gypsum in the formations that constitute the confining bed, indicating that similar lithologies are widespread. Although long-term declines in the potentiometric surface in parts of southern Polk County amounted to 40 to 60 ft during 1949–69 (Stewart and others, 1971), no upward encroachment of mineralized water was reported.

On the basis of this sparse evidence and as a modeling expediency, the lower confining bed was assumed to be nonleaky throughout the modeled area. However, because in some areas mineralized water occurs within the Floridan aquifer and because in reality the leakance of the lower confining bed is probably variable, development in some areas could result in upconing of mineralized ground water.

GROUND-WATER LEAKAGE

Where the altitude of the water table is higher than the altitude of the potentiometric surface, ground water leaks downward from the surficial aquifer through the upper confining bed to the Floridan aquifer. Where the relative positions of the water table and potentiometric surface are reversed, ground water leaks upward from the Floridan aquifer through the confining bed to the surficial aquifer. As shown in figures 10 and 11, downward leakage occurs in most inland areas and upward leakage occurs along coastal areas and along the incised valleys of major streams, such as the Peace River. Boundaries between the two areas in figures 10 and 11 are generalized and correspond to nodal boundaries used in the model.

The area of upward leakage corresponds closely to the area in which wells tapping the Floridan aquifer flow at the land surface. In most of this area, the water table is at or very close to the land surface. Thus, wherever the potentiometric surface is above the water table, it is also generally above the land surface.

The area of upward leakage is smaller in May than it is in September because from September to May the potentiometric surface generally declines more than the water table. Thus, in some areas where flow is upward in September, the potentiometric surface in May is below the water table and the direction of vertical leakage is reversed. In actuality, the rate of flow through the upper confining bed is relatively slow, and a lag time probably occurs following the reversal of heads before the direction of flow changes.

GROUND-WATER WITHDRAWALS

Ground water from the Floridan aquifer is the major source of supply in the modeled area. Withdrawals from this aquifer in the modeled area averaged about 649 Mgal/d (million gallons per day) in 1975, and withdrawals were expected to increase substantially in the decades ahead (fig. 16). Ground water is used principally for industrial, public-supply, and agricultural purposes.

Withdrawals for each type of use were inventoried for 1975 and projected to 1985 and 2000, as discussed in following paragraphs. These withdrawal rates served as a basis for predicting changes in the potentiometric surface. Locations and amounts of withdrawal for municipal and nonphosphate industrial supplies were obtained from the 1975 water-use inventory by the U.S. Geological Survey (Leach, 1977). Amounts and locations of withdrawals for phosphate mines and chemical plants were obtained mostly from data supplied by the Florida Phosphate Council. These data included locations, average pumping rates, and hours pumped during 1975 for wells at each phosphate mine and chemical plant. The pumping rates included all Floridan-aquifer withdrawals reported to the Florida Phosphate Council by companies. Major existing and proposed ground-water withdrawal sites are shown on plate 1.

INDUSTRIAL USES

Ground water is withdrawn for a variety of industrial uses, principally phosphate mining, phosphate chemical plants, and citrus processing. Industrial ground-water withdrawals for 1975 and projected amounts for 1985 and 2000 are summarized in tables 2 and 3. The tables show that in 1975, more than one-half (174 Mgal/d) of the industrial withdrawals were for phosphate mining, nearly all of which was in Polk County. Ground water was pumped for such uses as transport and beneficiation of ore, drying plants, preparation plants, and shops. Pumping for phosphate chemical plants in 1975 was 128 Mgal/d in Polk and Hillsborough Counties.

Projections of ground-water withdrawal rates for existing and proposed phosphate mines are shown in table 2. Existing mines are those that were permitted as of August 1, 1976; proposed mines are those that plan to begin operations after that date. Proposed mines include 7 listed by the U.S. Environmental Protection

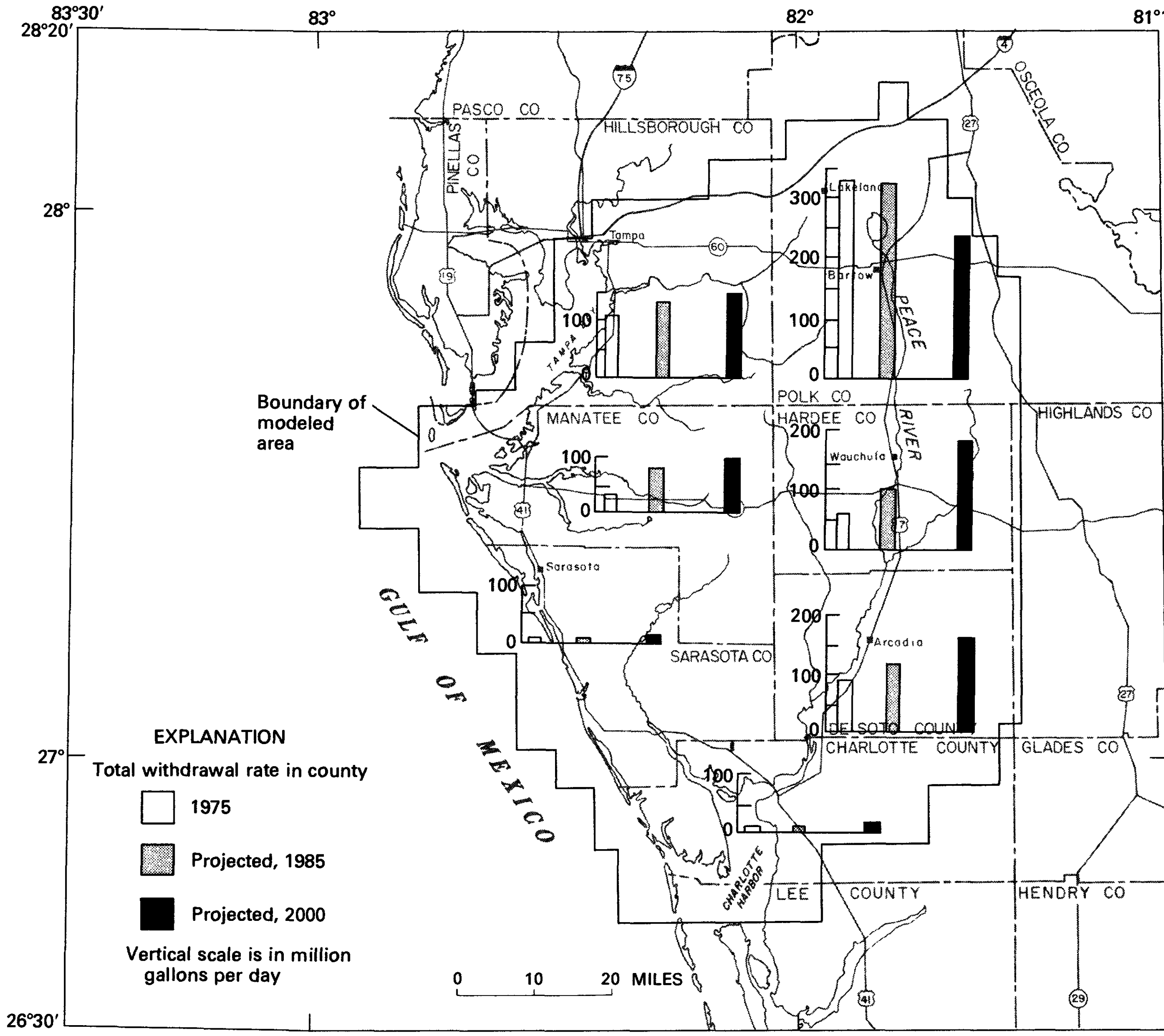

FIGURE 16.–Ground-water withdrawal rates, modeled area, 1975, 1985, and 2000.

TABLE 2.–*Ground-water withdrawal rates, in million gallons per day, for phosphate mines, Floridan aquifer, 1975, 1985, and 2000*

County[1]	1975[2] Existing mines	1985 Existing mines[3]	1985 Proposed mines[4]	1985 Total	2000 Existing mines[3]	2000 Proposed mines[4]	2000 Total
Charlotte	0	0	0	0	0	0	0
De Soto	0	0	9.45	9.45	0	9.45	9.45
Hardee	0	0	25.7	25.7	0	61.3	61.3
Hillsborough	.82	5.43	14.6	20.0	.65	25.3	26.0
Manatee	0	0	34.2	34.2	0	41.7	41.7
Polk	173	128	0	128	10.6	12.3	22.9
Sarasota	0	0	0	0	0	0	0
Total	174	133	84.0	217	11.2	150	161

[1]Includes only those parts of the counties in the modeled area.
[2]Based on data from the Florida Phosphate Council (B. Barnes, written commun., 1977).
[3]Rates based on 1975-77 pumping data from Florida Phosphate Council and on projected life spans of existing mines (U.S. Environmental Protection Agency, 1978).
[4]Based on projected life spans and pumping rates of proposed mines (U.S. Environmental Protection Agency, 1978; John Heuer, oral commun., December 1978).

TABLE 3. – *Ground-water withdrawal rates, in million gallons per day, for phosphate chemical plants and other self-supplied industries, Floridan aquifer, 1975*

County[1]	Phosphate chemical plants[2]	Other self-supplied industries[3]	Total
Charlotte	0	0	0
De Soto	0	.48	.48
Hardee	0	1.31	1.31
Hillsborough	45.6	.71	46.3
Manatee	0	.65	.65
Polk	82.6	22.6	105
Sarasota	0	0	0
Total	128	25.8	154

[1]Includes only those parts of the counties within the modeled area.

[2]Data from Florida Phosphate Council (B. Barnes, written commun., 1977).

[3]Data from information obtained during U.S. Geological Survey water-use inventory (Leach, 1977). Excludes withdrawals for phosphate mining.

Agency (1978, fig. 2.2) as "DRI mines" (those for which Development of Regional Impact applications were pending on August 1, 1976) and 13 planned for later development. Withdrawal rates listed under "Existing mines" in table 2 reflect the expected phasing out of mines in Polk County, as indicated by successively decreasing rates in 1985 and 2000. Rates listed under "Proposed mines" reflect the potential shift of mining activity to the south and west of Polk County, by the increasing rates for De Soto, Hardee, and Manatee Counties in 1985 and 2000. Total withdrawal rates for phosphate mining, including proposed mines, are projected to increase to 217 Mgal/d in 1985 and to decrease to 161 Mgal/d in 2000, compared with 174 Mgal/d in 1975.

Projected withdrawal rates for 1985 and 2000 for chemical processing plants and other self-supplied industries (unrelated to phosphate mining) were assumed to be the same as for 1975 (table 3). Production rates and water demands for chemical processing plants are not expected to change (Texas Instruments Incorporated, 1978, p. 1.87). Water demands for citrus processing and other industries have been projected to increase slightly by 2000 (Texas Instruments Incorporated, 1978, tables 1.16, 1.26, 1.27). However, for purposes of this investigation, withdrawal rates were assumed to remain constant because the amounts are relatively small compared with other uses and because locations of future withdrawal sites are unknown.

MUNICIPAL SUPPLIES

Most municipalities depend on ground water from the Floridan aquifer for public supplies. Table 4 lists 1975 daily withdrawal rates, based on average annual withdrawals for 13 municipalities, and projected 1985 and 2000 rates for these and other water-demand areas. In 1975 about 50 Mgal/d was withdrawn for municipal supplies in the modeled area; Lakeland had the largest rate, 17.1 Mgal/d.

Table 4 shows that withdrawal rates for municipal supplies are expected to more than double the 1975 rates by 1985 and to nearly triple them by 2000. These projections include expansions of existing well fields and the establishing of new inland well fields. Some of the new well fields have been proposed to meet coastal water demands, and others have been proposed to meet local

TABLE 4. – *Ground-water withdrawal rates, in million gallons per day, for municipal supplies, Floridan aquifer, 1975, 1985, and 2000*

Municipal supply	[1]1975	[2]1985	[3]2000
De Soto County			
1. Arcadia	0.76	1.43	1.89
2. Nocatee area[4]	0	1.40	2.52
Total	.76	2.83	4.41
Hardee County			
3. Bowling Green[4]	([5])	1.35	2.15
4. NW. Hardee[6]	0	3.74	9.55
5. SW. Hardee[6]	0	4.50	11.5
6. Wauchula	.91	2.82	4.33
7. Zolfo Springs[4]	([5])	1.35	2.41
Total	.91	13.8	29.9
Hillsborough County			
8. Brandon	4.00	4.00	4.00
9. Plant City	1.85	3.78	4.27
10. Riverview	1.79	1.79	1.79
11. Ruskin	3.04	3.04	3.04
12. Sun City	1.25	1.25	1.25
Total	11.9	13.9	14.4
Manatee County			
13. SE. Manatee[6]	0	1.49	3.80
Polk County			
14. Auburndale	1.30	1.44	1.64
15. Bartow	3.39	3.48	3.62
16. Ft. Meade area[4]	0	1.80	2.26
17. Lake Alfred area[4]	0	1.05	1.43
18. Lake Wales	2.36	2.76	3.37
19. Lakeland	17.1	44.5	49.4
20. Mulberry area[4]	0	2.70	3.26
21. SW. Polk[6]	0	5.27	13.5
22. W. Frostproof area[4]	0	.45	.63
23. Winter Haven	5.43	5.69	5.99
Total	29.6	69.1	85.1
Sarasota County			
24. Sarasota (Verna)	7.11	7.11	7.11
Total for all counties	50.3	108	145

[1]From Healy (1977).

[2]From unpublished water-demand projections of Geraghty and Miller, Inc. (Peter Schreuder, written commun., 1977).

[3]Interpolated from water-demand projections for 1985 and 2035 (Geraghty and Miller, Inc., and Reynolds, Smith and Hills, 1977, table 3.01).

[4]Proposed or existing well field to supply inland municipal water-demand area, determined by Geraghty and Miller, Inc., and Reynolds, Smith and Hills (1977, fig. 3.01).

[5]Existing municipal well field in 1975 but not reported by Leach (1977); 1975 withdrawal rate unknown.

[6]Proposed well field to supply coastal municipal water-demand areas (Geraghty and Miller, Inc., and Reynolds, Smith and Hills, 1977, p. 5.16-5.17).

inland needs (Geraghty and Miller, Inc., and Reynolds, Smith and Hills, 1977). County totals in table 4 reflect withdrawal rates within the modeled area for each county, not necessarily water demands for that county.

IRRIGATION

The largest single use of ground water is for irrigation of crops, principally citrus trees, vegetables, and pasture. In 1975-76, irrigation withdrawals averaged about 271 Mgal/d (table 5). Unlike those for other major uses, withdrawals for irrigation are highly seasonal. Commonly, two irrigation seasons occur during the year, a fall season and a winter-spring season. During the rainy summer months, little or no withdrawals are made.

In 1975–76, the fall season was estimated to be from November 1, 1975, through December 20, 1975, and the winter-spring season from December 21, 1975, through May 12, 1976. Table 5 shows that the largest withdrawal rates were in De Soto and Hardee Counties. Withdrawal rates during the fall season were slightly more than half of those in the winter-spring season, and rates in the winter-spring season were generally about twice the average annual rates.

The 1975–76 values shown in table 5 are based on an inventory of irrigation that was conducted during this investigation because no irrigation-use inventory existed that showed the areal and seasonal distribution of withdrawals within counties. The study was conducted by (1) inventorying irrigated crop types and acreages, (2) determining the approximate starting and ending dates of the two irrigation seasons, and (3) estimating average application rates for each crop type.

Irrigated crop types and acreages were inventoried on a section-by-section basis from an examination of maps and aerial photographs, field checks, and consultation with county agricultural agents, ranchers, farmers, and others involved in irrigation. From examinations of observation-well hydrographs, rainfall records, and records of monitored irrigation wells, two irrigation seasons during 1975–76 were identified. Figure 17 shows an example of the interrelationships of rainfall, irrigation pumping, and potentiometric surface for 1975–76. The potentiometric surface is a sensitive indicator of regional irrigation pumpage for several reasons:

1. Irrigation is widespread throughout the area, as indicated on plate 1.
2. During irrigation seasons, rainfall occurs principally as the result of frontal systems passing through the region and thus is widespread rather than localized.
3. Irrigators tend to reduce or cease ground-water withdrawals during rainy periods and resume pumping shortly after rains stop.
4. The potentiometric surface of the artesian aquifer responds promptly and over a large area to changes in withdrawal rate.

As shown in figure 17, the potentiometric surface generally declined during the fall and winter-spring irrigation seasons, with occasional minor rises during brief rainy periods. With the onset of summer rains about May 12, the potentiometric surface rose abruptly, marking the end of the winter-spring irrigation season.

The amount of water pumped for irrigation during the two irrigation seasons was estimated for each crop by multiplying a constant application rate (inches per acre) for each crop times the irrigated acreage of that crop. Average application rates for the two seasons for various crops are shown in table 6. The seasonal application rates were selected after considering the opinions of many agriculturalists on rates that were generally applied to each crop type. The opinions varied considerably, and in practice probably a wide range of rates was actually used, as data in table 7 suggest for citrus-tree irrigation. Citrus irrigation, monitored at 20 groves in addition to Joshua Groves (pl. 1), showed a wide range in irrigation rates. Thus, the values shown in table 6 should be considered as estimates of average application rates.

On the basis of average annual irrigation withdrawals, rates in the modeled area are projected to increase to 315 Mgal/d in 1985–86 and to 380 Mgal/d in 1999–2000 (table 5). Increases are projected for all counties except Hillsborough and Polk Counties, where no changes are projected within the modeled area.

The 1985–86 and 1999–2000 rates are based on projected average annual rates for 2020, as estimated by Southwest Florida Water Management District (John Wehle, oral commun., 1977). The rate of increase within each county, expressed as a percent per year increase over 1975 values (table 5), was assumed to be uniform during 1975–2020. Average withdrawal rates for the irrigation season in 1985–86 and 1999–2000 were calculated from the average annual rates, assuming all the irrigation occurred during a 193-day or 194–day irrigation season, November 1 through May 12, as was the case in 1975–76.

THE HYDROLOGIC MODEL

DESCRIPTION

A digital simulation model was used to compute hydraulic-head changes in time and space in the Floridan aquifer in response to applied hydraulic

TABLE 5.—*Ground-water withdrawal rates for irrigation, Floridan aquifer*

[Mgal/d, million gallons per day; mi², square miles]

County[1]	1975-76							1975-2020		1985-86		1999-2000	
	Fall season[2]		Winter-spring season[3]		Irrigation season average[4]		Average annual[5]	Projected increase	Percent per year change[6]	Irrigation season[4]	Average annual[5]	Irrigation season[4]	Average annual[5]
	Acres	Mgal/d	Acres	Mgal/d	Mgal/d	(Mgal/d)/mi²	Mgal/d	Mgal/d		Mgal/d	Mgal/d	Mgal/d	Mgal/d
Charlotte	7,850	21.0	7,850	22.4	22.0	1.80	11.6	12.1	+1.17	24.6	13.0	28.5	15.0
DeSoto	68,221	93.9	76,171	187	163	1.37	86.2	83.3	+2.78	208	110	276	146
Hardee	50,975	73.6	51,015	124	111	1.39	58.6	88.2	+2.14	135	71.2	170	90.0
Hillsborough	30,676	57.2	37,002	120	104	1.83	55.0	0	0	104	55.0	104	55.0
Manatee	12,604	28.5	21,004	73.6	61.9	1.89	32.7	18.1	+1.50	71.2	37.6	85.1	45.0
Polk	23,060	26.4	24,515	47.8	42.2	1.10	22.3	0	0	42.2	22.3	42.2	22.3
Sarasota	701	4.5	2,298	10.2	8.7	2.43	4.6	19.3	+2.07	10.6	5.6	13.3	7.0
Total (rounded)	194,000	305	220,000	585	513	----	271	232	------	595	315	719	380

[1]Includes only those parts of the counties within the modeled area.
[2]November 1, 1975, through December 20, 1975 (50 d).
[3]December 21, 1975, through May 12, 1976 (144 d).
[4]November 1 through May 12 (194 d); rate per square mile is based on acres irrigated during 1975-76 winter-spring irrigation season.
[5]November 1 through October 31 (366 d); no irrigation withdrawals during May 13 through October 31 is assumed.
[6]Projections from Southwest Florida Water Management District (John Wehle, oral commun., 1977).

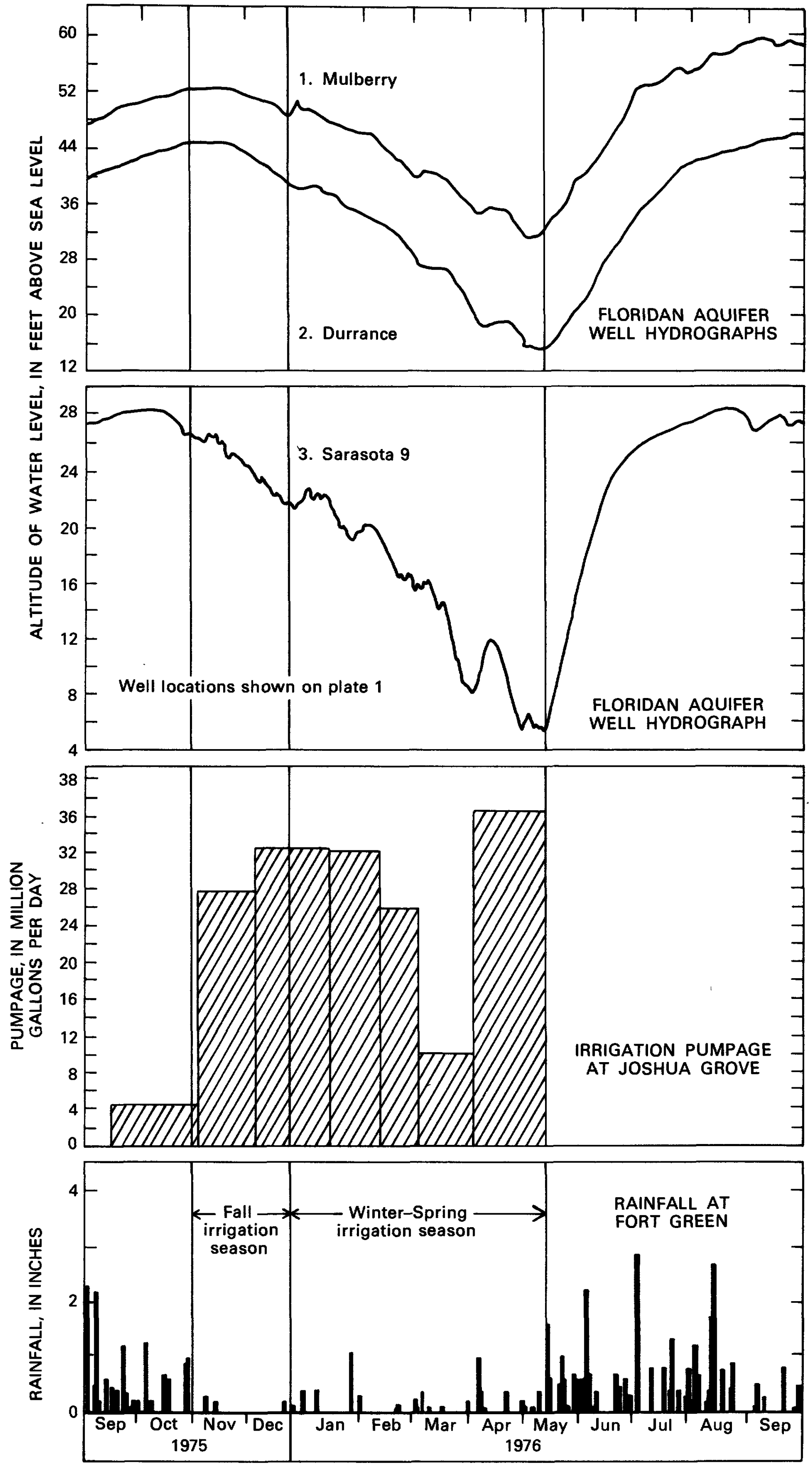

FIGURE 17.—Ground-water levels, irrigation pumpage, and rainfall, 1975-76.

TABLE 6.—*Water application rates, in inches per acre, for selected agricultural uses, 1975–76*

Water Use	Fall[1]	Winter-spring[2]	Annual Total, 1975–76[3]
Citrus	2	8	10
Vegetables[4]	13	32	45
Flowers	25	90	115
Fish farms	6	12	18
Golf courses	12	37	49
Pastures	2	16	18
Sod farms	2	16	18
Hay	2	16	18
Grain	2	16	18

[1]November 1, 1975, through December 20, 1975.
[2]December 21, 1975, through May 12, 1976.
[3]No application from May 13, 1976, through October 31, 1976, is assumed.
[4]Includes tomatoes, strawberries, watermelons, cucumbers, squash, corn, and peppers.

stresses. The model uses a finite-difference method in which differential equations describing ground-water flow are solved numerically. The equations require that hydraulic properties, boundaries, and stresses be defined for the area modeled. The digital model of two-dimensional flow was described by Trescott and others (1976).

A rectangular finite-difference grid was superimposed on the modeled area (pl. 2). Block sizes in the grid range from 2×2 mi to 10×10 mi. The node at the center of each block is designated by row and column numbers; for example, the node at row 20, column 5 is expressed as 20–5.

Within the gridded area, model boundaries were selected to coincide as closely as possible with hydrologic boundaries. The area within the model boundaries, or modeled area, covers 5,938 mi^2.

Major assumptions made in the model analysis are as follows:

1. Ground water moves horizontally in the Floridan aquifer in a single-layer, isotropic medium.
2. Water moves vertically into or out of the Floridan aquifer through the upper confining bed. No leakage occurs through the lower confining bed.
3. The head in the surficial aquifer does not change in response to any imposed stress.
4. Movement of the saltwater-freshwater interface is assumed to have little or no effect on calculated heads.

The ground-water flow system is shown schematically in figure 18. Regionally the system approximates the assumed conditions, although locally, deviations occur. Most wells are finished as open holes and tap most of the thickness of the Floridan aquifer. A confining bed overlies the Floridan aquifer throughout the area, and natural aquifer discharge and recharge occur principally as vertical leakage through this confining bed. Aquifer tests have shown the lower confining bed to be relatively impermeable. The seasonal range of fluctuation of the water table in the surficial aquifer is generally less than a few feet, and in most of the study area the water table is little affected by withdrawals from the Floridan aquifer.

On the other hand, the model greatly oversimplifies a complex system. The model is inadequate to simulate vertical flow components in recharge and discharge areas, multiple zonation of the Floridan aquifer, and movement of the saltwater-freshwater interface. Some of the errors remaining in the calibrated model are due to these inadequacies. Nonetheless, the model used was the most appropriate one available at the time the investigation began, considering the size of study area, objectives of the investigation, and state of knowledge about the hydrogeology.

BOUNDARIES

Ideally, model boundaries should be chosen so that they coincide with hydrologic boundaries that do not shift during the time frame of the model analysis. In addition, the specified boundary conditions should remain unchanged during all calibration and prediction runs; otherwise, boundary conditions become another variable that could affect simulation results. In order to simulate both steady-state and transient boundary conditions without shifting the positions of the model boundaries, a head-controlled flux boundary condition was developed. This condition was utilized during all simulations for all lateral model boundaries. The two-dimensional flow model described by Trescott and others (1976) was modified to include this boundary condition (see the Appendix, Supplementary data II – Model program modifications).

The inland model boundaries were located approximately along the September 1975 hydrologic boundaries within the study area by drawing the boundaries approximately perpendicular to the September 1975 potentiometric contours (fig. 10). The coastal model boundary was located between the shoreline and the inferred position of the zero potentiometric contour, or along the trace of an intermediate point on the sloping saltwater-freshwater interface (fig. 18). In designating nodes adjacent to these boundaries as head-controlled flux boundary nodes, it was assumed that beyond each

TABLE 7.—*Amount of ground water applied, in inches, for irrigation at monitored citrus groves, 1975–76*

Citrus grove	Acres irrigated	Amount of water applied		
		Fall season[1]	Winter-spring season[2]	Total, 1975–76
20 pilot groves[3]:				
Average	65	0.7	14.4	15.1
Range	10–400	0 –4.5	0 –39.4	---
Joshua Grove[4]	21,614	2.4	7.0	9.4

[1]November 1, 1975, through December 20, 1975 (50 d).
[2]December 21, 1975, through May 12, 1976 (144 d).
[3]See Robertson and others (1978) for description of pilot-grove irrigation systems.
[4]See Wilson (1972) for description; location shown on plate 1.

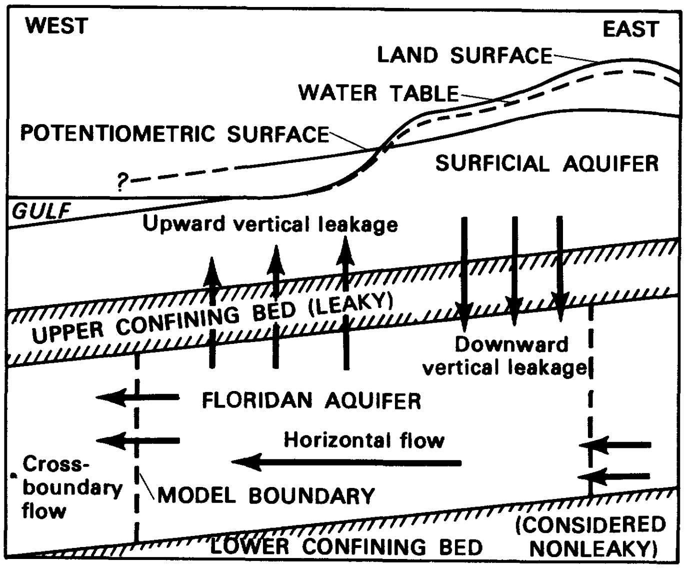

FIGURE 18. – Generalized conceptual model of steady-state flow.

boundary node there exists a point where the head in the Floridan aquifer does not change. These constant-head points were assumed to be from 20 to 40 mi beyond the model boundaries, or far enough from the modeled area so that they would not significantly alter simulation results. Between boundary nodes and constant-head points, hydrologic properties of the Floridan aquifer were assumed to be uniform and the same as the properties in the boundary nodes.

A change in potentiometric head in a head-controlled flux boundary node causes lateral flow across that boundary in an amount determined by the magnitude of head change. Boundary flow is calculated as the product of the head change and a coefficient. The coefficient is obtained for each boundary node through an analytical solution of the partial differential equation describing flow in the region between the model boundary and the constant-head point. Boundary flow calculated by this method is taken into account in the model by adding it to or subtracting it from the vertical leakage term in each boundary node at each time step.

For short-term transient simulations, the head-controlled flux boundary condition is not accurate. The condition is based on a steady-state solution and, therefore, does not apply in the early part of a simulation, during which significant changes in aquifer storage take place. In this model, all simulations were run for a long enough period of time to assume that changes in storage were negligible by the ends of the runs.

CALIBRATION PROCEDURE

The model was calibrated before simulating effects of projected changes in ground-water withdrawals. In this report, calibration refers to the process of adjusting input hydrologic parameters to the model until differences between model simulations and field observations were within acceptable limits. Calibration was checked by comparing model computations with different sets of field observations, namely by comparing simulated and observed potentiometric surfaces. The model was calibrated under steady-state and transient conditions.

The calibration activity was a complex, interwoven process of adjustment and readjustment. Care was maintained not to vary input parameters much from known field values, and changes were made on an areal rather than node-by-node basis. Parameters that were considered to be least reliably known, principally confining-bed vertical hydraulic conductivity, were modified more than other parameters.

The calibration process was a means of modifying and improving conceptual views of the aquifer system. Simulated potentiometric surfaces obtained early in the process represented an initial conceptual view based on available data. The match between the computed and observed potentiometric surfaces was improved and the conceptual view was modified by adjusting input parameters, while staying within a reasonable expected range of error in their values. Although final simulated heads do not fit observed heads precisely, the differences can generally be accounted for by the likely range of error or uncertainty in one or more of the input parameters.

CALIBRATION OF THE STEADY-STATE MODEL

In the calibration of the steady-state model, a simulated potentiometric surface was compared with the observed September 1975 potentiometric surface (fig. 10), which was assumed to reflect steady-state conditions.

A steady-state condition exists when there are no changes in aquifer storage with time. Such a condition was approximated in September 1975. Hydrographs indicated that in September 1975, the potentiometric surface was near the end of the summer-long recovery period and was changing little with time (fig. 17). Principal stresses on the aquifer system in September were withdrawals for municipal supplies, phosphate mining, and other industrial supplies. Pumping rates for these uses vary during the year, but the variations are generally too small to have much impact on the regional fluctuations of the potentiometric surface. Withdrawals for irrigation were assumed to be insignificant in September 1975. Field checks indicated that little irrigation occurred during and immediately following the summer rainy season. Hydrographs indicated that in most areas the potentiometric surface in 1975 did not start declining as a result of fall irrigation until October or early November (fig. 17).

INPUT PARAMETERS

Input parameters to the steady-state model included pumpage, water-table altitude, aquifer transmissivity, and confining-bed thickness and vertical hydraulic conductivity. All input data for the steady-state and transient calibrations are listed by node in Supplementary data I – Model input data, in the Appendix.

Withdrawals from the Floridan aquifer in September 1975 were assumed to be the same as average 1975 ground-water withdrawal rates. These included withdrawals for phosphate mines (table 2), phosphate chemical plants and other self-supplied industries (table 3), and municipal supplies (table 4). No irrigation pumpage was included. Average altitudes of the September 1975 water table were estimated for each node from Geological Survey topographic quadrangle maps (scale 1:24,000; contour interval 5 ft). The water table in the surficial aquifer was assumed to be a few feet or less below land surface in flat swampy areas, river flood plains, and near lakes; depths of 5–20 ft below land surface were assumed for sand-ridge areas.

The maps of aquifer transmissivity (fig. 8) and confining-bed vertical hydraulic conductivity (fig. 14) represent the final products of the calibration process. Values shown on those maps were used as input to the calibrated steady-state model.

SIMULATION OF THE SEPTEMBER 1975 POTENTIOMETRIC SURFACE

The steady-state potentiometric surface simulating September 1975 conditions is shown in figure 19. This surface may be compared with the actual September 1975 potentiometric surface as mapped in figure 10. Differences between computed and observed heads at nodes of the model grid ranged from 0 to 34 ft. The difference was less than 10 ft at 89 percent of the nodes and more than 20 ft at 2 percent of the nodes. All differences greater than 15 ft were in the northern part of the modeled area, mostly in Polk County, and occurred in nodes where withdrawals were being made, where the potentiometric gradient was relatively steep, and adjacent to boundaries.

A test was made to determine if the differences between computed and actual heads could be accounted for by a likely range of error in input parameters. The test thus provided a measure of the reasonableness of calibration. Principal input parameters (transmissivity, vertical hydraulic conductivity, and ground-water withdrawal rates for phosphate and other industries) were each independently changed by plus or minus a constant factor throughout the model, while other parameters were unchanged. The range of values differed for each parameter and reflected a subjective estimate of the likely range of error of each parameter. Withdrawals for municipal supplies were not varied because of their probable small range of error. Results are shown along two profiles in figure 20. The profiles, taken north-south along column 23 and east-west along row 15 of the model, show differences between actual September 1975 heads and heads computed using various values of input parameters.

Figure 20 indicates that departure of the steady-state calibrated heads from the September 1975 measured heads could be reduced by varying one or more of the parameters within the ranges shown. The close spacing of the curves in the south, along column 23, indicates that computed heads in this area are relatively insensitive to input parameters, perhaps reflecting in part the inadequacy of the model to represent conditions in that area. However, for purposes of this analysis, departures in this area are in an acceptable range, generally less than 8 ft.

The effects of varying water-table altitude and boundary conditions were also checked. Raising or lowering the water table by 5 ft throughout the modeled area resulted in a corresponding rise or drop in computed potentiometric head of 3 to 4 ft along row 15 and along column 23, compared with calibrated heads. Changing all boundary nodes to constant head resulted in a maximum rise in computed head of 8 ft at the boundary nodes, but elsewhere along row 15 and column 23 the rise was generally less than 1 ft. Changing all boundary nodes to a no-flow condition resulted in a maximum rise of 6 ft, but generally the rise was less than 2 ft.

SIMULATION OF THE 1949 POTENTIOMETRIC SURFACE

The simulated potentiometric surface for 1949 is shown in figure 21. This map can be compared with the observed 1949 potentiometric surface (fig. 9), as a further check on the reliability of the steady-state calibration. All input parameters except pumpage were kept the same as in the September 1975 calibration. Withdrawal rates for 1949 were estimated to be about 22 percent of 1975 rates for municipal supplies and phosphate mining and 29 percent of 1975 rates for other self-supplied industries. These estimates were based on data in Robertson and Mills (1974), which show historical pumpage data from municipalities and industries and production data for phosphate mining for the upper Peace River and upper Alafia River basins.

The 1949 potentiometric map (fig. 9) is highly generalized because of the lack of data points, poor vertical control, and nonsynchronous water-level measurements (V. T. Stringfield, oral commun., 1978). Nonetheless, the map does represent water-level conditions at a time when stresses on the aquifer system were consider-

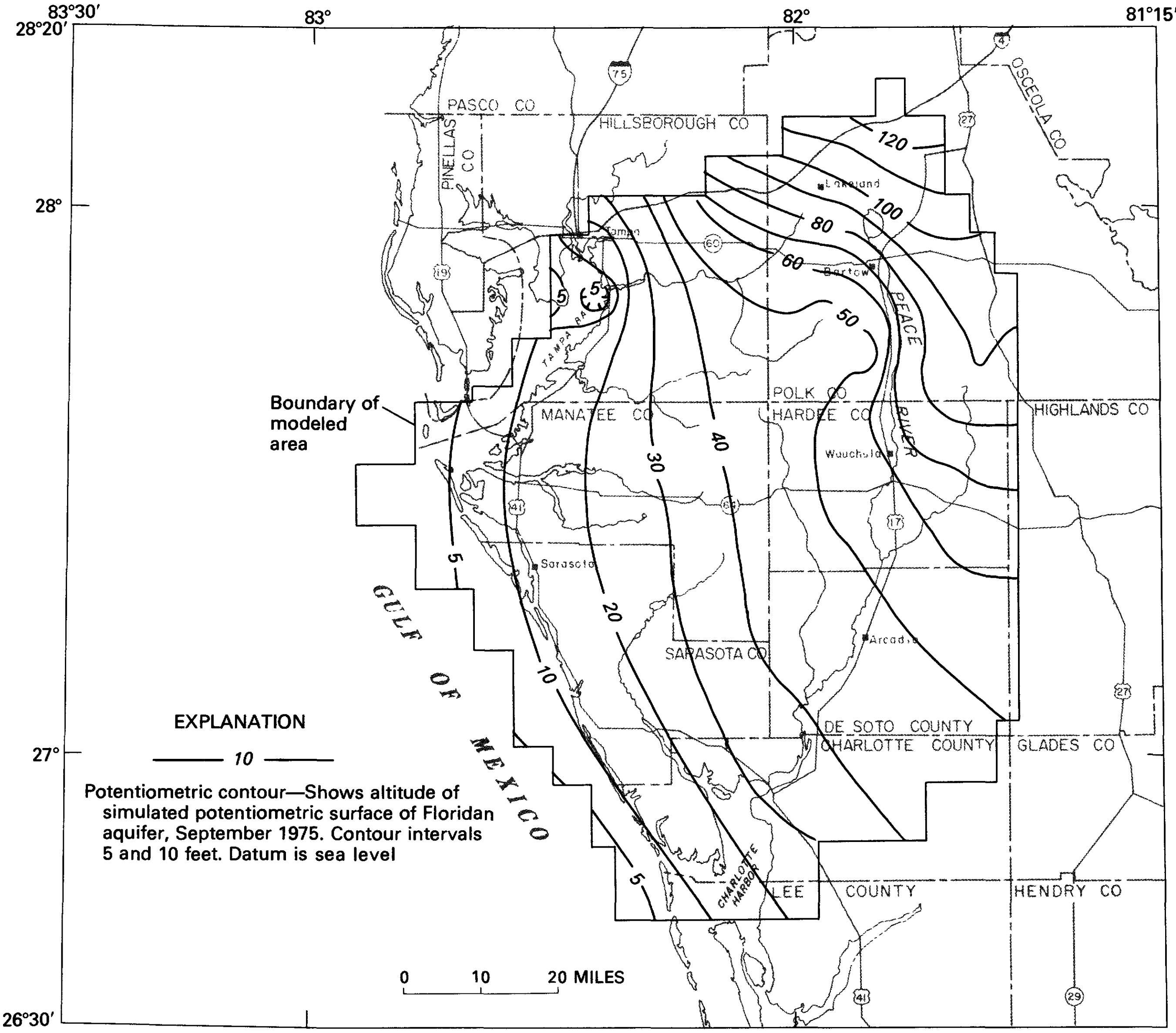

FIGURE 19.–Simulated steady-state potentiometric surface of the Floridan aquifer, September 1975.

ably less than at present, prior to the years of rapid population growth and development of ground-water resources. The simulated surface (fig. 21) matches the observed surface reasonably well (fig. 9), especially at altitudes of the potentiometric surface below about 70 ft, where differences between the two surfaces are generally less than 5 ft.

CALIBRATION OF THE TRANSIENT MODEL

Model calibration was extended to transient flow. In the transient model, computed hydraulic head is a function of starting conditions and time, and therefore storage coefficients were incorporated into the model. Following a procedure similar to the steady-state calibration, the simulated May 1976 potentiometric surface was compared with the observed May 1976 surface. The simulated surface was obtained by computing drawdowns from the simulated steady-state potentiometric heads, after simulating a 194-day pumping period representing the irrigation season (November 1, 1975, through May 12, 1976). Computed drawdowns were then subtracted from the observed September 1975 potentiometric map to obtain the simulated May map. In this analysis, it was assumed that the potentiometric surface on November 1, 1975, was approximately the same as that of September 1975. These assumptions are generally borne out by hydrographs of wells in the study area (fig. 17). The computed drawdowns for May 1976

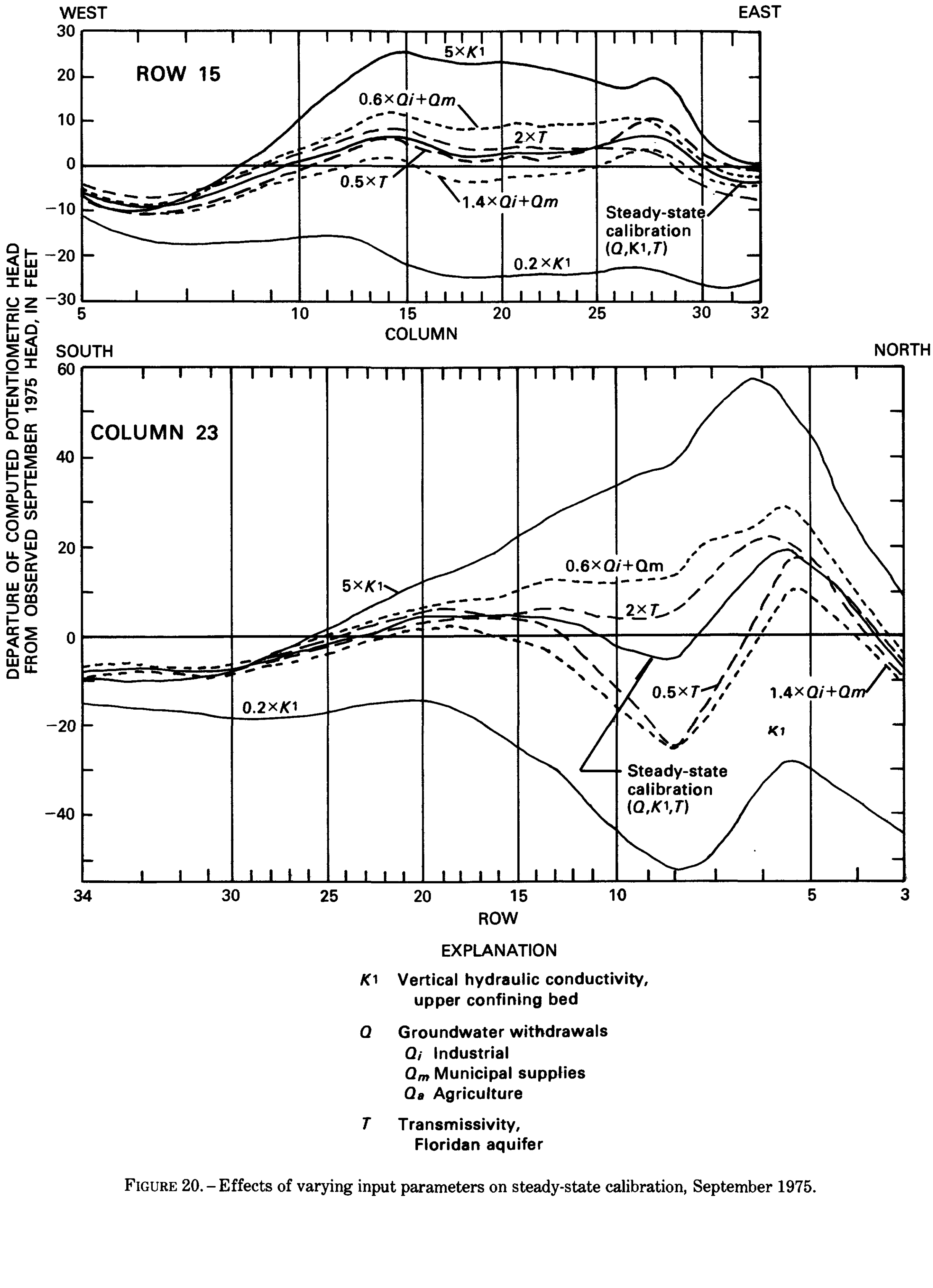

FIGURE 20.—Effects of varying input parameters on steady-state calibration, September 1975.

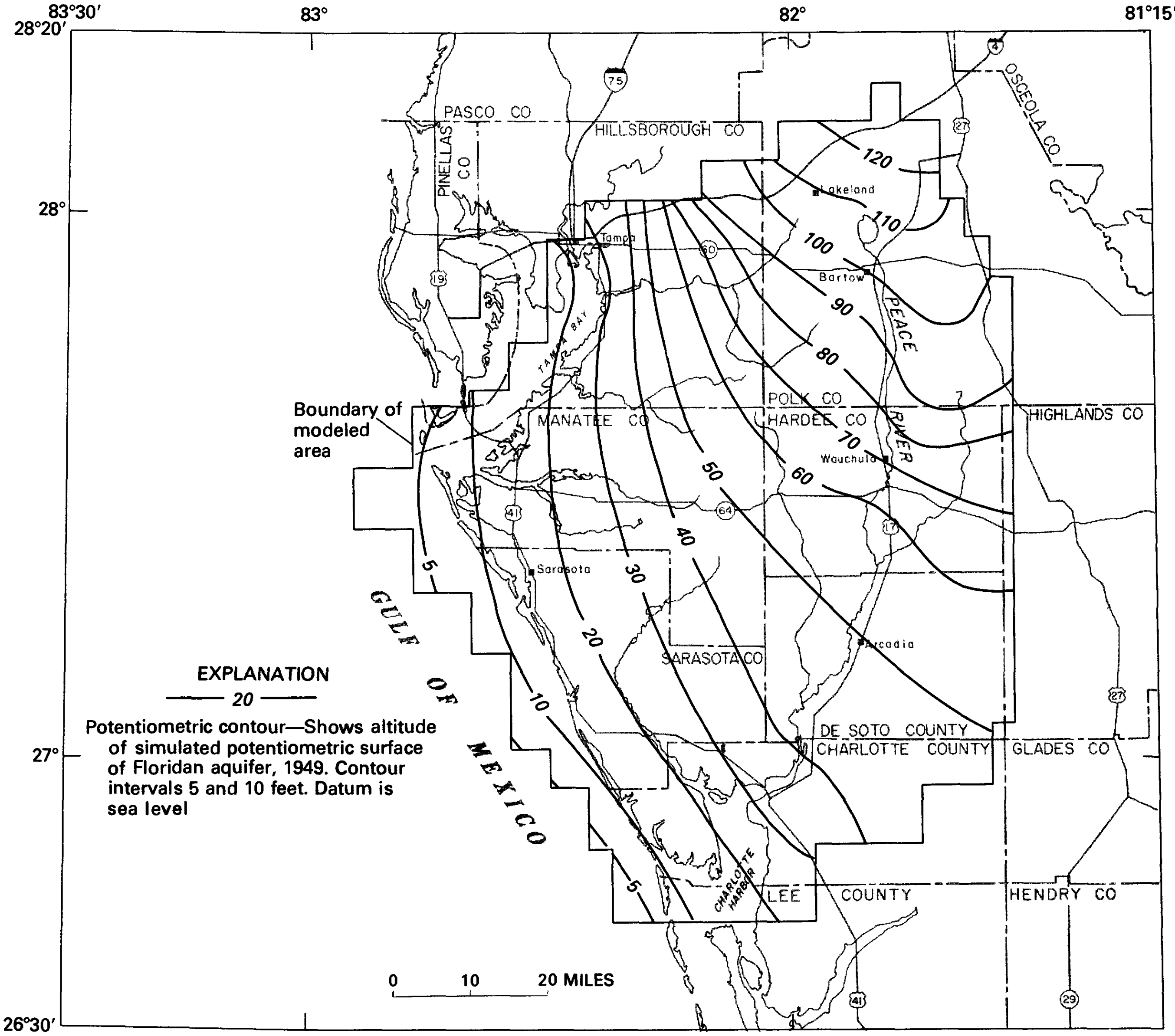

FIGURE 21.—Simulated potentiometric surface of the Floridan aquifer, 1949.

were arrived at in two time steps, corresponding to the fall irrigation season (November 1 through December 20) and winter-spring irrigation season (December 21 through May 12).

INPUT PARAMETERS

Input parameters for the transient-model calibration were the same as for the steady-state model, with the addition of aquifer and confining-bed storage coefficients and irrigation pumpage. Initially, values of aquifer transmissivity and vertical hydraulic conductivity were not changed; in succeeding runs, these values were modified to improve calibration. Appropriate values of ground-water withdrawal rates and water-table altitudes were used to fit changing conditions from November 1975 to May 1976. All input values are shown in Supplementary data I–Model input data, in the Appendix.

Irrigation pumpage was simulated by using the appropriate application rate for each irrigation season and crop type, as shown in table 6, with the estimated irrigated acreages assigned to each node. Withdrawal rates for municipal supplies, phosphate chemical plants, and other self-supplied industries were the same as for the calibration of the September 1975 steady-state model. For phosphate mines, average 1975 withdrawal rates (the same as for the calibration of the steady-state model) were used for the 1975 fall irrigation season, and average 1976 values were used for the winter-spring irrigation season. Some new mines that began operation during the calibration period were included.

Throughout the study area, the water table of the surficial aquifer during the fall irrigation season was assumed to average 1 ft lower than in September 1975. The water table during the winter-spring irrigation season was assumed to average 3 ft lower than that in September. These values were selected based on 1975–76 hydrographs of observation wells in the surficial aquifer; two examples are shown in figure 4.

The storage coefficient of the Floridan aquifer was determined for each node by multiplying an assumed average specific storage of $1.0\times10^{-6}ft^{-1}$ times the thickness of the Floridan aquifer, shown in figure 7. Similarly, the storage coefficient of the upper confining bed was determined by multiplying the confining-bed specific storage ($1.0\times10^{-5}ft^{-1}$) and the thickness. All values of storage coefficients are shown in Supplementary data I – Model input data.

SIMULATION OF THE MAY 1976 POTENTIOMETRIC SURFACE

The transient-model potentiometric surface simulating May 1976 conditions is shown in figure 22. This surface may be compared with the observed May 1976 potentiometric surface (fig. 11). Differences between computed and observed heads at nodes in the model grid ranged from 0 to 19 ft. The difference was less than 10 ft at 78 percent of the nodes. The most significant difference between the simulated surface and the observed May 1976 potentiometric surface is in the position of the depression in the western part of the modeled area. The depression in the simulated surface is centered in Hillsborough County rather than in Manatee County.

Tests similar to those made for the steady-state model were made to determine the reasonableness of the transient-model calibration (fig. 23). Each input parameter was independently varied by a constant amount throughout the model, while holding other parameters at their transient-model-calibration values. The range of values used for each parameter reflected the likely range of error of that parameter. Different ranges were used for different types of ground-water withdrawals. Irrigation withdrawal rates were varied the most because these data were considered to be the least accurate. Municipal withdrawal rates were not varied at all because of their small probable range of error.

Figure 23 indicates that the departure of the computed heads from the observed heads for May 1976 could be significantly reduced by varying withdrawal rates within the ranges shown. For example, the poor correspondence between the observed and the simulated closed depression in Manatee and Hillsborough Counties could be accounted for if the actual withdrawal rates in Manatee County were greater than the inventoried values used to calibrate the model.

For clarity, the effects of changing water-table altitude, boundary conditions, and storage coefficients are not shown in figure 23. Raising or lowering the water table by 5 ft throughout the modeled area resulted in a corresponding rise or drop in the computed potentiometric head of about 2–3 ft (maximum about 4 ft), compared with calibrated heads. Changing all boundary nodes to constant head resulted in a maximum rise in computed heads of 12 ft at boundary nodes but generally 2–4 ft elsewhere along rows 15 and 30 and columns 11 and 23. Changing all boundary nodes to a no-flow condition resulted in a maximum decline of 15 ft at the north boundary node (column 11); generally the change elsewhere in the selected rows and columns was 3–4 ft.

Reducing aquifer storage coefficient to 20 percent of its calibrated value resulted in a maximum decline in computed potentiometric heads of about 4 ft; generally the decline was 2 ft or less. Changes in confining-bed storage had about the same effect on computed heads.

SIMULATION OF THE SEPTEMBER 1976 POTENTIOMETRIC SURFACE

The simulated potentiometric surface for September 1976 is shown in figure 24. The map can be compared with the observed September 1976 potentiometric surface (fig. 12) as a check on the reliability of the transient-model calibration. In simulating the September condition, all input parameters were kept the same as in the May transient-model calibration, except irrigation pumpage was shut off starting May 13, 1976. The system was allowed to recover until the start of the next irrigation season, assumed to be November 1, 1976.

The simulated surface compares reasonably well with the observed surface, especially in the western part of the area, where differences are generally less than 5 ft. In eastern Hillsborough and southwestern Polk Counties, the simulated surface is generally 5–10 ft lower than the observed.

SIMULATED GROUND-WATER BUDGET, 1975–76

Table 8 shows sources and discharges of ground water in the modeled area for 1975–76. Results are based on model mass-balance computations for the calibration runs of the 1975–76 steady-state and transient models. Ground water was derived from aquifer storage, cross-boundary flow, recharge wells, and downward leakage through the upper confining bed. Ground water was discharged from the aquifer by movement into aquifer storage and by pumpage, upward leakage through the

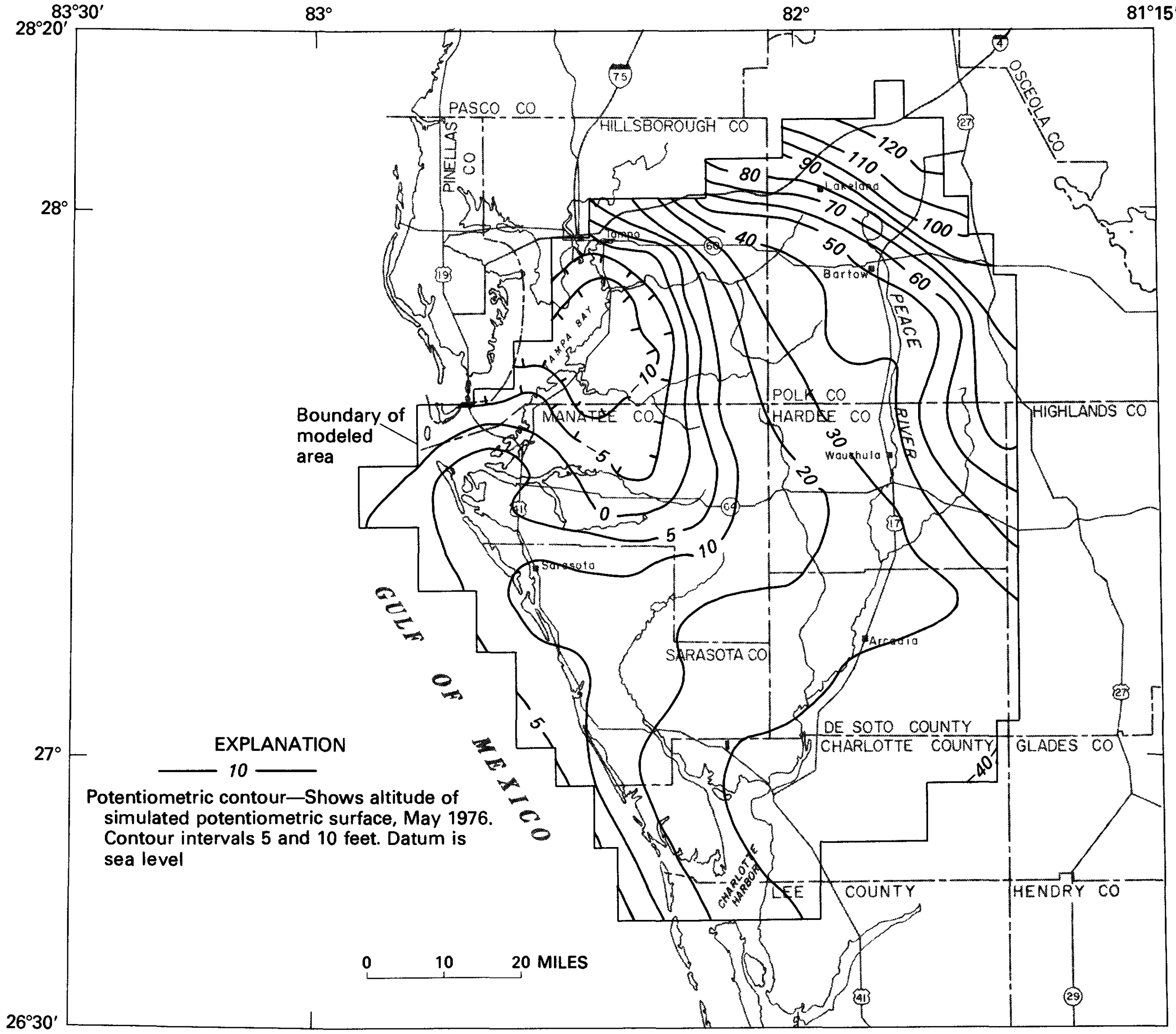

FIGURE 22. – Simulated potentiometric surface of the Floridan aquifer, May 1976.

upper confining bed, and cross-boundary flow. Table 8 shows that, except for rounding errors, the total recharge from all sources balances the total discharge.

In the run of the steady-state model, most of the water pumped was obtained from downward leakage. As shown for all calibrations, water was discharged mostly by pumping, but a significant amount (22 percent) also discharged across boundaries. As the potentiometric surface declined during the irrigation season, water was obtained mostly from downward leakage, but about 13 percent came from aquifer storage, and about the same amount came from cross-boundary flow. Water flowing in across the boundaries indicates that drawdown had reached the model boundary.

During the nonirrigation season, total pumpage decreased substantially. As the potentiometric surface rose, a lesser proportion of water came from cross-boundary flow, and an increased proportion (85 percent) came from downward leakage. Ground water returned to aquifer storage, and the amount of upward leakage increased.

In table 8, averages for the year are time-weighted averages for the irrigation and nonirrigation seasons. For the year, about 83 percent of ground-water discharge was pumpage. Most of the water pumped (76 percent) was derived from downward leakage, and about 13 percent was derived from cross-boundary flow. The amount of downward leakage (representing the

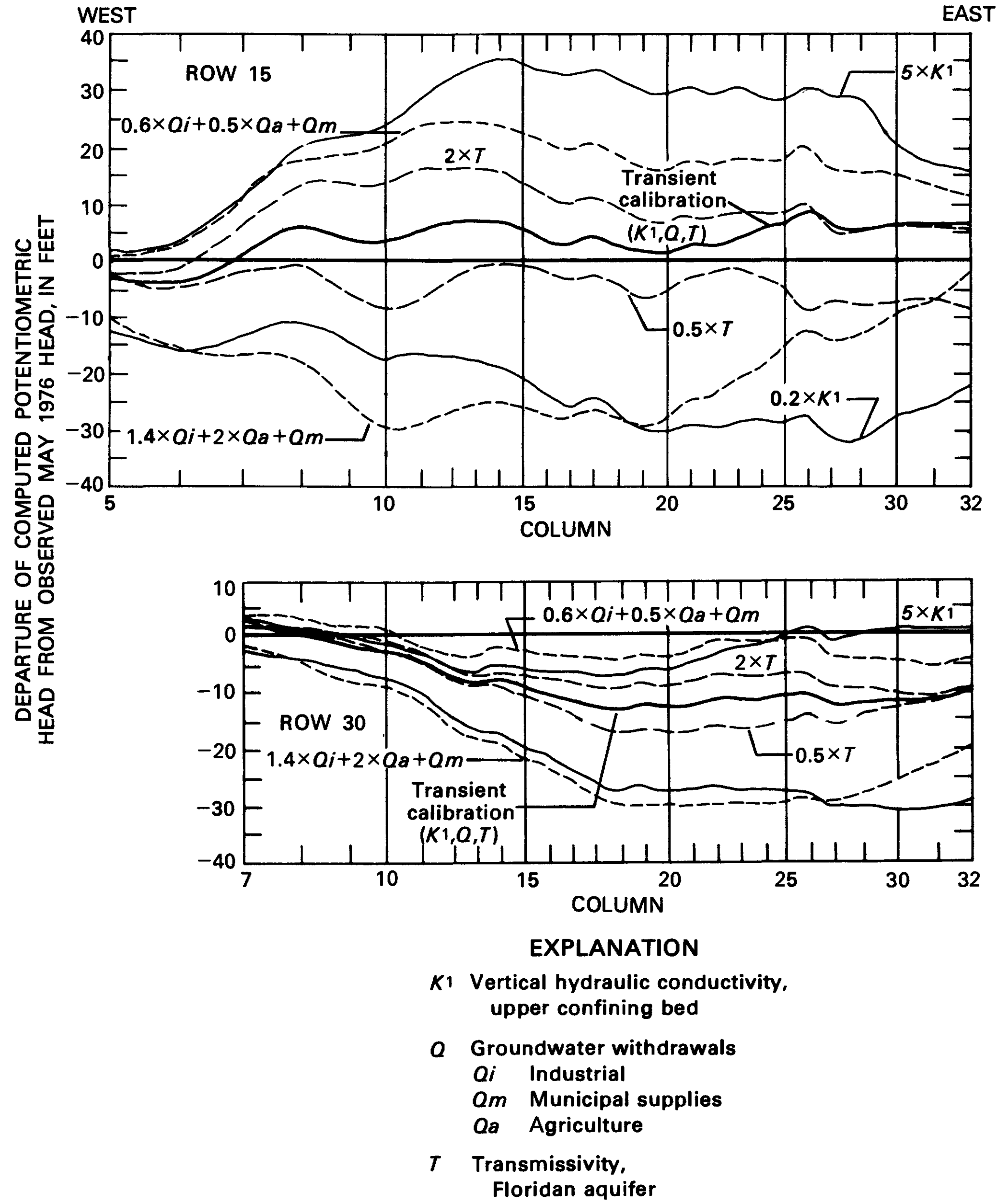

FIGURE 23.—Effects of varying input parameters on transient-model calibration, May 1976.

amount of natural recharge within the modeled area) was equivalent to 2.01 in. of water over the modeled area. Table 8 shows that for the year slightly more water was derived from storage than was returned to storage, indicating a net loss and a decline of the potentiometric surface.

SIMULATED EFFECTS OF GROUND-WATER WITHDRAWALS

Transient-model analyses were used to simulate changes in the potentiometric surface during 1976–2000 resulting from projected ground-water withdrawals for irrigation, municipal supplies, and phosphate mines. The effect of each major use was considered separately and in combination. Withdrawals for phosphate chemical plants and for other self-supplied industries (except phosphate mining) were assumed to remain constant, and the effects of these uses were not evaluated. In evaluating the effects of each major use independently, all other withdrawal rates were held at their 1975, or where known, 1976 rates.

Two plans for phosphate mining were considered:

1. An existing-mines plan, in which only the effects of the continuation and eventual phasing out of withdrawals for existing mines were evaluated;

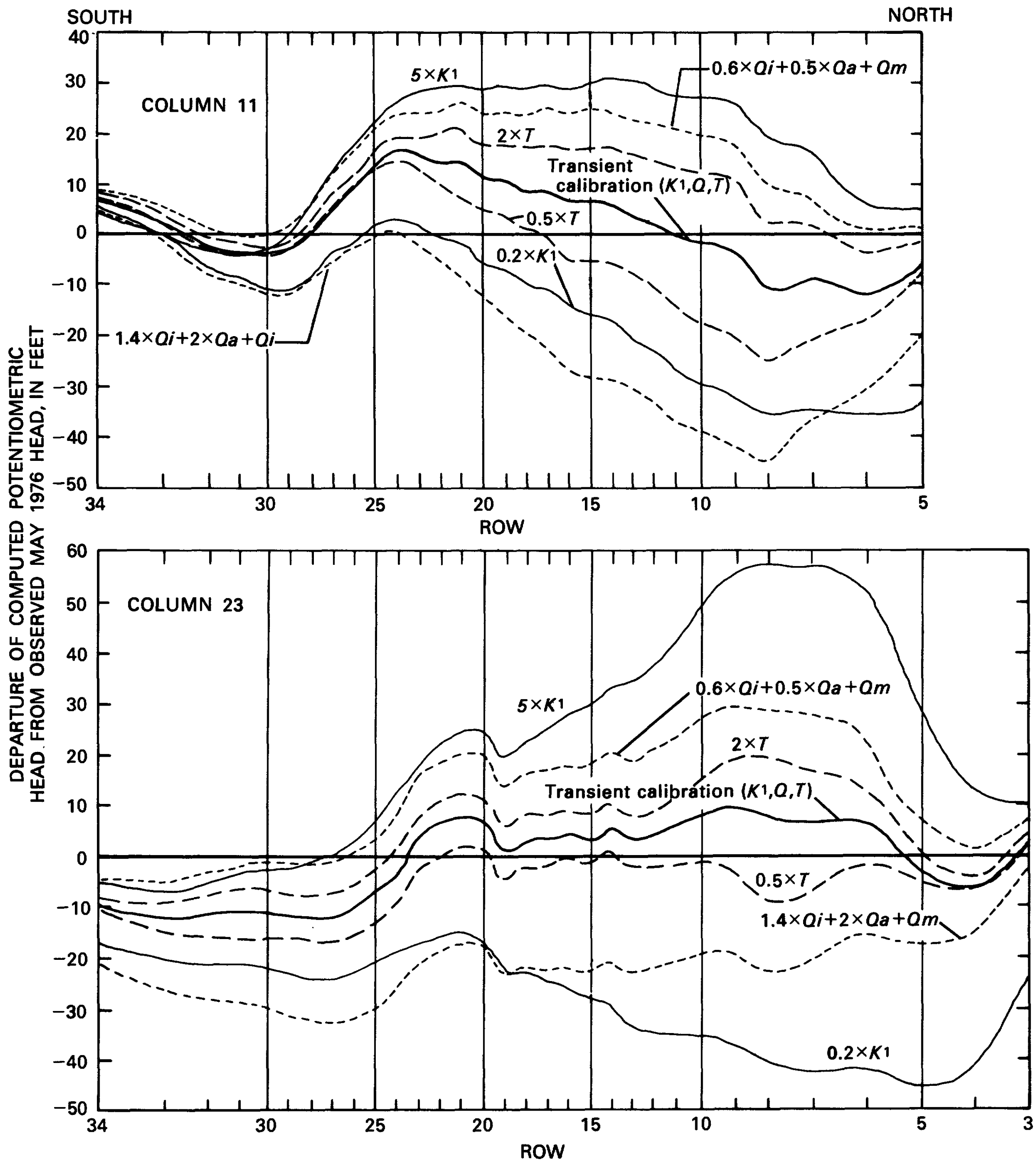

FIGURE 23.–Continued.

2. A proposed-mines plan, in which the effects of the continuation and phasing out of existing mines plus the introduction of proposed mines were evaluated.

In the model runs using projected pumpage, the transient model was used as calibrated. Results are presented primarily as a series of contour maps showing simulated changes in the potentiometric level. Positions of lines of equal change on these maps are based on linear interpolations between data points, plotted at the centers of nodal blocks.

All runs that included projected irrigation withdrawals were made with two phases each year, a single irrigation season (November 1 to May 12) and a nonirrigation season (May 13 to October 31). For these runs, simulated head-change maps are given for both May 2000 and October 2000. For the combination runs, maps of the simulated potentiometric surfaces for May 2000 and October 2000 are given in addition to head-change maps.

TABLE 8.—*Sources and discharges of ground water in the modeled area, 1975-76*

[Mgal/d, million gallons per day]

	Steady-state model calibration[1]		Transient-model calibration				Average for year[4]		
			Irrigation season[2]		Nonirrigation season[3]				
	Mgal/d	Percent	Mgal/d	Percent	Mgal/d	Percent	Mgal/d	in./yr[5]	Percent
Sources									
From storage	0	0	122	13	0	0	65	0.23	9
Across boundaries	44	8	125	14	61	11	95	.34	13
Recharge wells	18	4	23	3	24	4	23	.08	3
Downward leakage	445	88	645	70	478	85	567	2.01	76
Total	507	100	915	100	563	100	750	2.66	101
Discharges									
Into storage	0	0	0	0	109	19	51	0.18	7
Across boundaries	112	22	50	5	83	15	66	.23	9
Pumpage	378	74	856	94	363	65	624	2.21	83
Upward leakage	17	4	7	1	7	1	7	.02	1
Total	507	100	913	100	562	100	748	2.64	100

[1]September 1975.
[2]November 1975 to May 1976, 194 days.
[3]May 1976 to October 1976, 172 days.
[4]November 1975 to October 1976, 366 days.
[5]Over the modeled area (5,938 mi^2).

IRRIGATION

PROCEDURE

In the modeled area, ground-water withdrawals for irrigation are projected to increase in all counties except Hillsborough and Polk (table 5). For each of the other counties, the total irrigation-season increase for 1976–2000 (table 5) was divided into periods of analysis by 2-year time steps (1976–85) and by 3-year time steps (1986–2000), and countywide pumpage during each time step was computed. These projected amounts were distributed throughout each county on the basis of agricultural use as shown on county land-use maps (Roy F. Weston, Inc., 1976). Amounts assigned to each node in each time step were based on the number of acres of agricultural land still available for new or additional irrigation in the node. No more than 2 ft^3/s (cubic feet per second) were assigned to a node at any given time step. When the countywide average application rate, in cubic feet per second per square mile (derived from values given in table 5), for the 1975-76 irrigation season was reached for agricultural land in a node, no further irrigation pumpage was assigned to that node. New irrigation withdrawals were not assigned to urban and urbanizing areas or to proposed phosphate mining areas, even if mapped as containing agricultural land.

Model runs were made simulating head changes from May 1976 to May 2000 and from November 1976 to October 2000. A single irrigation season (November 1 to May 12) and nonirrigation season (May 13 to October 31) were simulated each year.

RESULTS

Simulated changes in the potentiometric surface due only to projected increases in ground-water withdrawals for irrigation are shown in figures 25 and 26. Figure 25 shows that by May 2000 more than 15 ft of decline is predicted to occur in a small area in northwestern De Soto County and more than 5 ft of decline in most of the modeled area. Net decline in October 2000, however, is generally less than 3 ft (fig. 26). Thus, the maps suggest that with continued increased withdrawals for irrigation, the May potentiometric lows would decline at a rate greater than would the October potentiometric highs, continuing a trend evidenced by hydrographs in the 1960's and 1970's (fig. 13).

MUNICIPAL SUPPLIES

Increased demands for potable water are expected throughout the area as population growth continues. Various alternatives have been proposed to meet these demands (Geraghty and Miller, Inc., and Reynolds, Smith and Hills, 1977). One alternative uses inland well fields to meet both local and coastal public-supply needs. To determine the effects that such a plan would have on the potentiometric surface, the proposed well fields and their projected pumping rates and the projected increased pumping rates for existing well fields were incorporated into the model (table 4; pl. 1). Existing coastal well fields were held at 1975 pumping rates, on the assumption that increased pumping by these well fields would be undesirable because of the potential for saltwater encroachment. Withdrawal rates for 2000 were obtained by linearly increasing rates for inland well fields above those of 1975 in eleven 2-year intervals, starting in 1978.

Figure 27 shows simulated head changes in October 2000 due to projected increased withdrawals for municipal supplies. The map indicates several localized

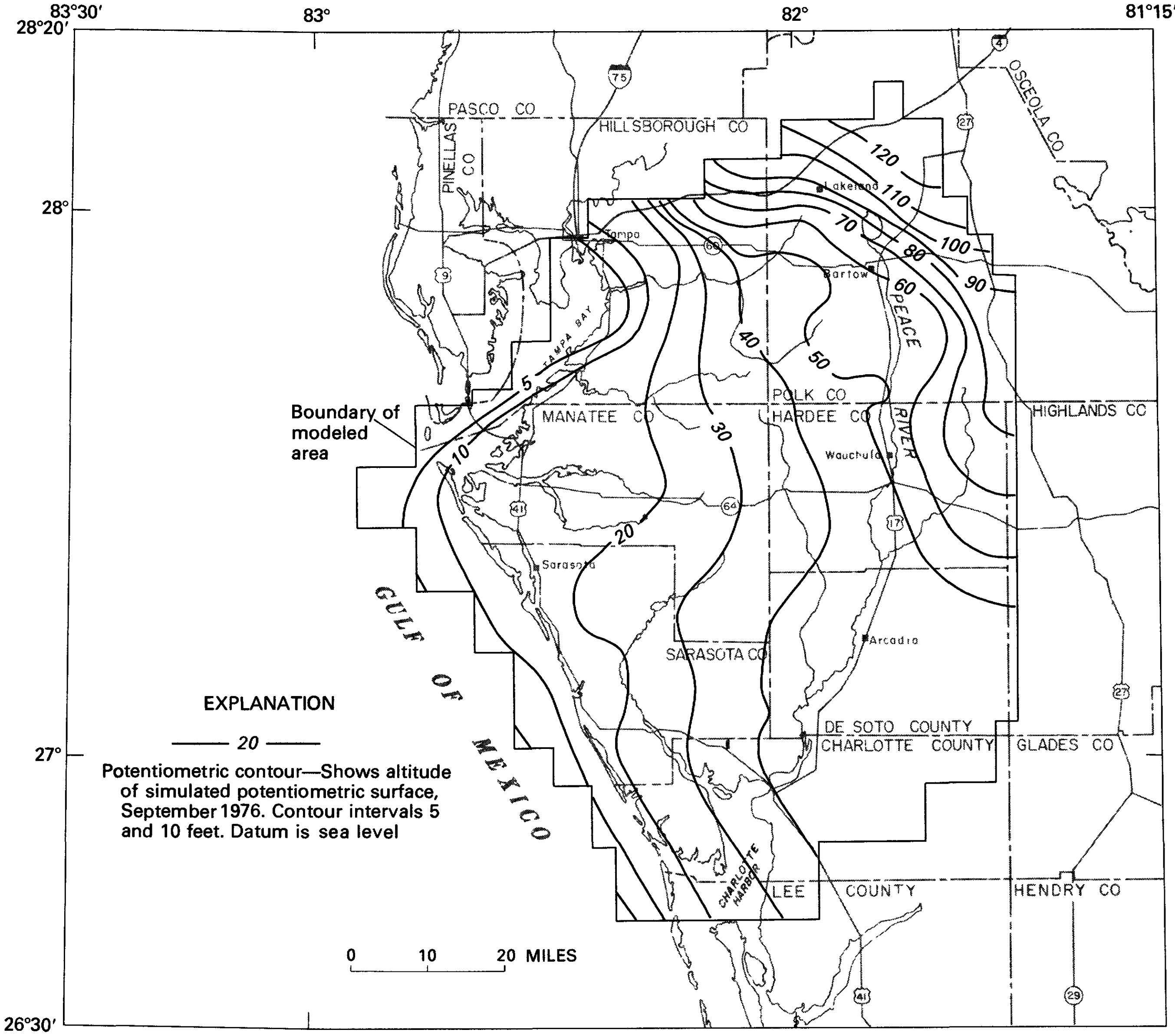

FIGURE 24.—Simulated potentiometric surface of the Floridan aquifer, September 1976.

cones of depression where declines are 10 ft or more. Simulated declines exceed 5 ft in the north-central part of the area; a decline of at least 1 ft occurs over almost all the modeled area.

PHOSPHATE MINES

EXISTING

Each existing phosphate mine is expected to continue withdrawals until the ore underlying the mine property is depleted. Projected rates of ground-water withdrawal and expected life spans of existing mines are shown, by node, in figure 28; withdrawal sites are shown on plate 1. Projected withdrawal rates are based on 1975 and 1976 inventories of phosphate pumpage provided by the Florida Phosphate Council. In the simulation, withdrawal rates at each mine were held constant during the life of the mine. As existing mines phase out, withdrawal rates are expected to decline to about 133 Mgal/d by 1985 and to about 11.2 Mgal/d by 2000. Also included was about 24 Mgal/d of aquifer recharge through connector wells in 1975; recharge amounts for each mine were held constant during the life of the mine. Data for projected life spans were provided by Texas Instruments Incorporated (William Underwood, written commun., 1977).

Simulated changes in the potentiometric surface resulting from projected changes in withdrawal rates

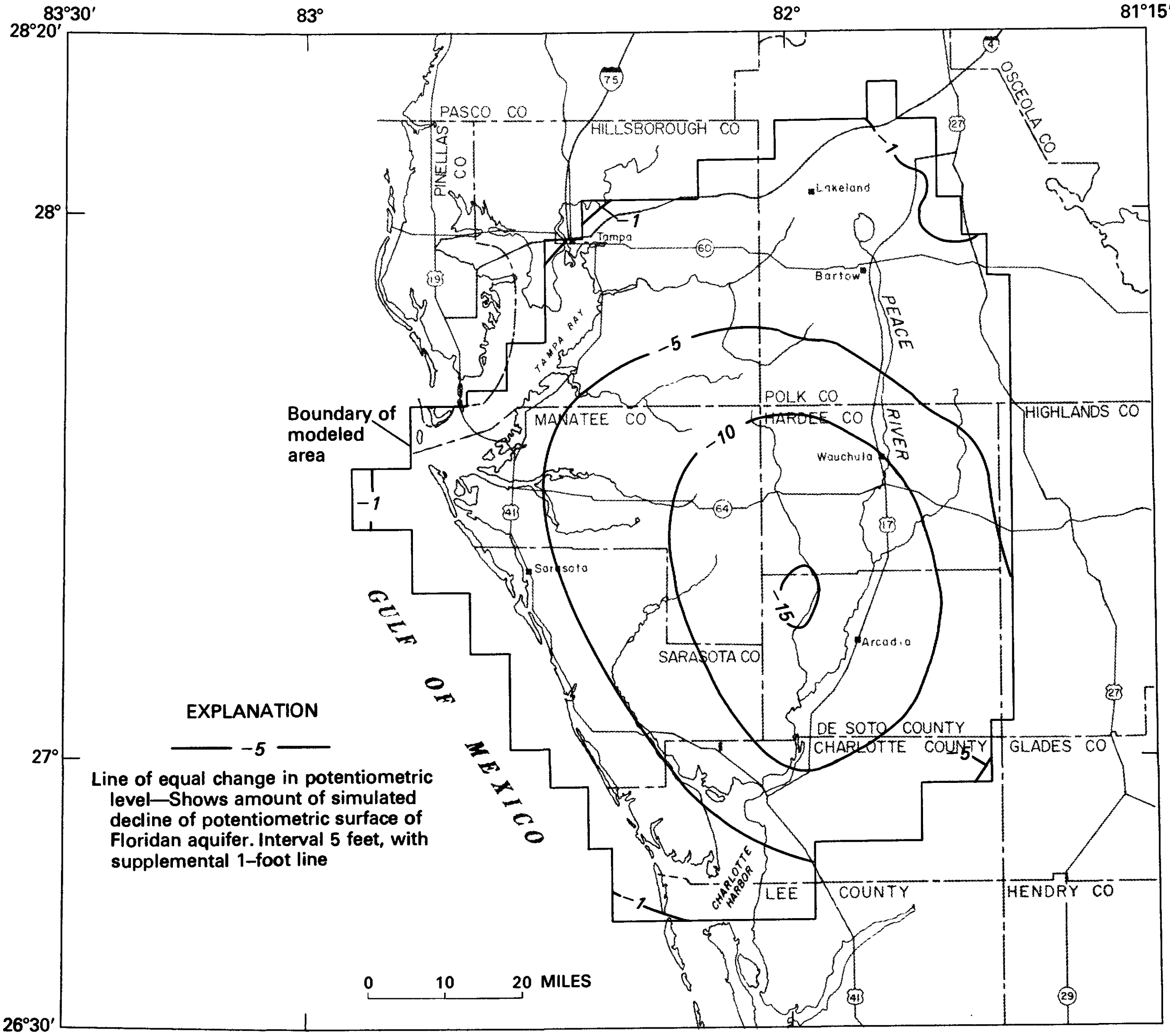

FIGURE 25. – Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, May 1976 to May 2000.

for existing mines are shown in figure 29. The map shows a rise throughout most of the area; maximum rise is more than 25 ft in southwestern Polk County. The rise would be expected because of the projected declines in the withdrawal rates for existing mines.

PROPOSED

At least 20 new mines are proposed to begin mining operations before 2000, mostly in Hardee, De Soto, and Manatee Counties. The projected rates of ground-water withdrawals and expected life spans of proposed mines are shown, by node, in figure 30; withdrawal sites are shown on plate 1.

Withdrawal rates and life spans are based on data provided by Texas Instruments Incorporated (William Underwood, written commun., 1977) and by the Southwest Florida Water Management District (John Heuer, written commun., 1978). Most rates are based on an assumed requirement of 1,500 gal of ground water per ton of phosphate mined (U.S. Environmental Protection Agency, 1978, p. 2.16). By the end of 1985, withdrawal rates for proposed mines are expected to be about 84 Mgal/d; by 2000, the rates are expected to increase to about 150 Mgal/d (table 2).

Assignment of proposed mine withdrawal sites to nodes was determined by overlaying the model grid on a map showing areas of proposed mines. Where a mine

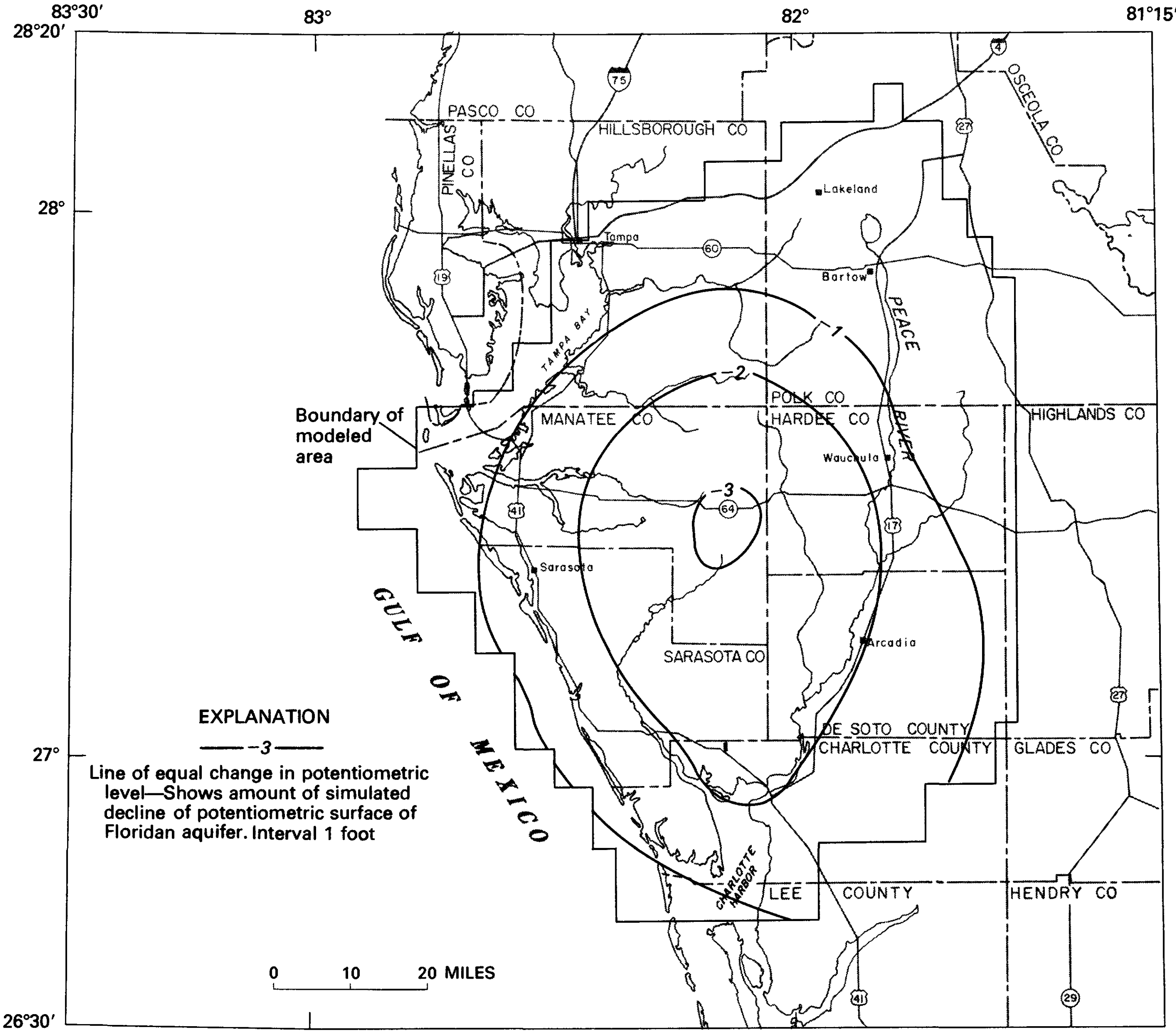

FIGURE 26.—Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, November 1976 to October 2000.

was in more than one node, a single node was selected to represent all the mine's withdrawals. Actual well locations may differ from those selected, but this difference should not significantly affect the regional distribution or amount of head change.

Simulated changes in potentiometric head resulting from withdrawal rates for proposed mines are shown in figure 31. The map shows a decline throughout most of the area. The maximum decline is about 20 ft in eastern Manatee County and western Hardee County.

EXISTING AND PROPOSED

Figure 32 shows the combined effects of existing and proposed mines. In this simulation, the withdrawal rates and durations for proposed mines were superimposed on those for existing mines. The map shows a rise of the potentiometric surface in Polk County (maximum of about 20 ft) and a decline elsewhere (maximum of about 15 ft). The areal extent and magnitude of both the rise and the decline are smaller than when the effects of pumping for existing and proposed mines are considered separately.

COMBINED EFFECTS

WITHOUT PROPOSED PHOSPHATE MINES

Figure 33 shows simulated changes in the potentiometric head resulting from the combined projected

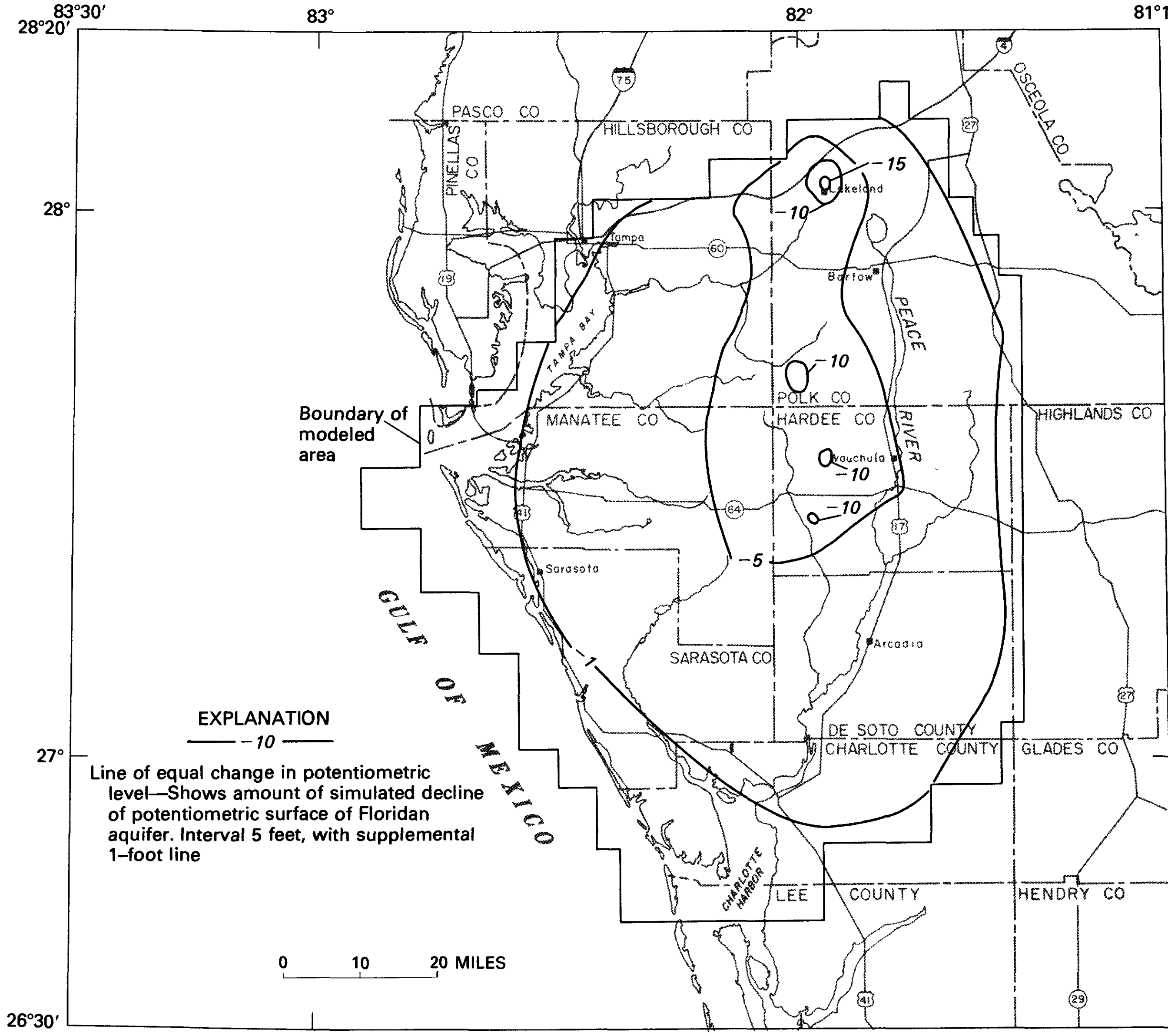

FIGURE 27.–Simulated changes in the potentiometric surface due to projected ground-water withdrawals for municipal supplies, November 1976 to October 2000.

withdrawals for irrigation, municipal supplies, and existing mines (without proposed mines) from May 1976 to May 2000. The map shows about 15 ft of rise in southwestern Polk County and about 15 ft of decline in parts of Manatee, Hardee, and De Soto Counties. Another area of decline, as much as about 10 ft, occurs in the Lakeland area of Polk County.

Simulated changes for May 2000 were superimposed on the May 1976 potentiometric map (fig. 11) to obtain a map of the simulated potentiometric surface for May 2000, as shown in figure 34. The principal change is a deepening and broadening of the large cone of depression centered in Manatee County. In May 2000, the potentiometric surface is 20 ft below sea level in a small area of central Manatee County. The – 10-ft contour line encloses much of the central and eastern parts of the county, and the zero contour line extends into southwestern Hardee County. The rise in southwestern Polk County is reflected in the southwestward shift of the 40-ft contour line.

Simulated changes in the potentiometric surface resulting from the combined effects of pumping, excluding pumping for proposed phosphate mines, from November 1976 to October 2000 are shown in figure 35. The map illustrates net simulated changes expected between the end of the nonirrigation season in 1976 and

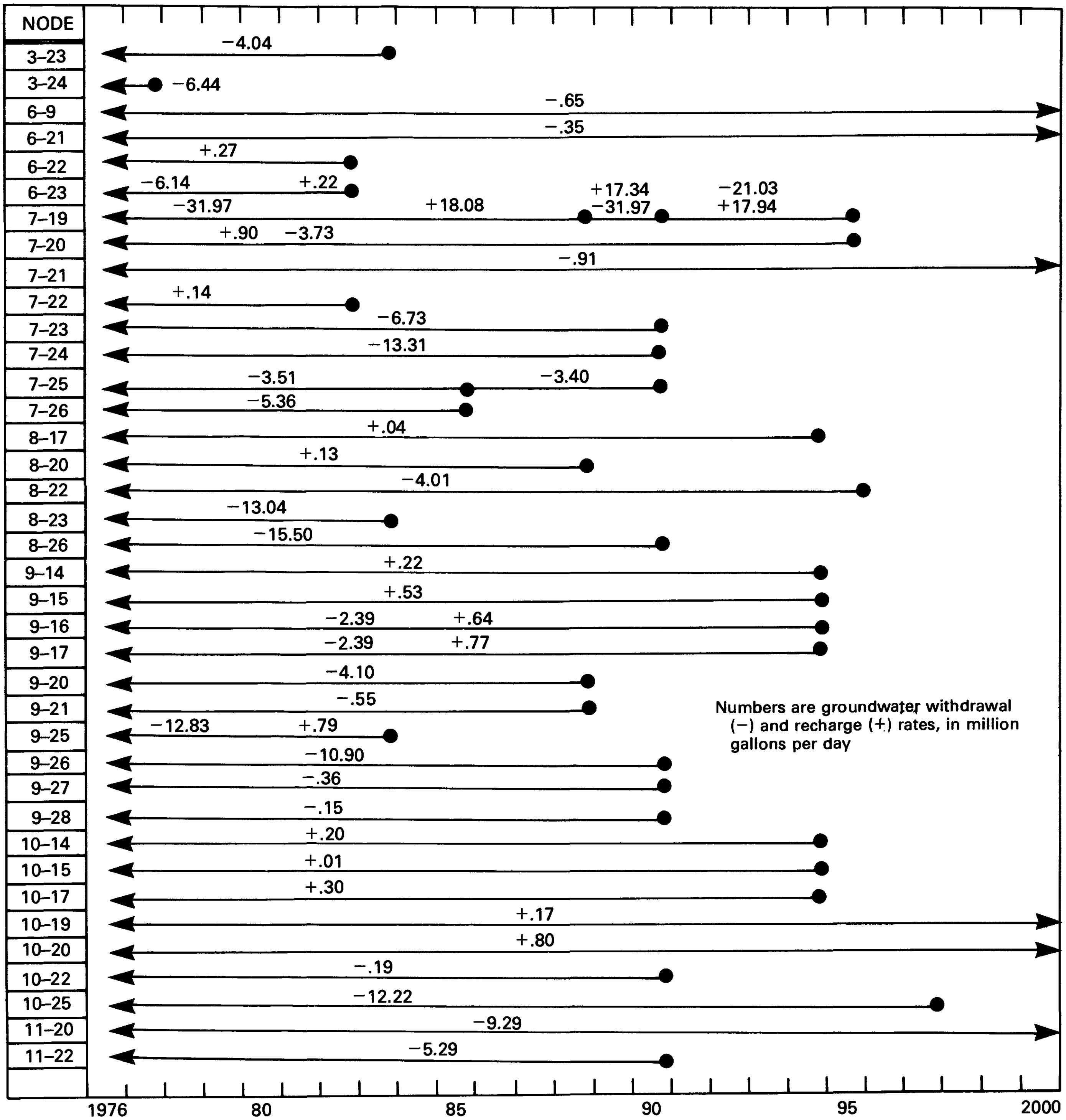

FIGURE 28.—Projected ground-water withdrawal rates for existing phosphate mines, 1976–2000.

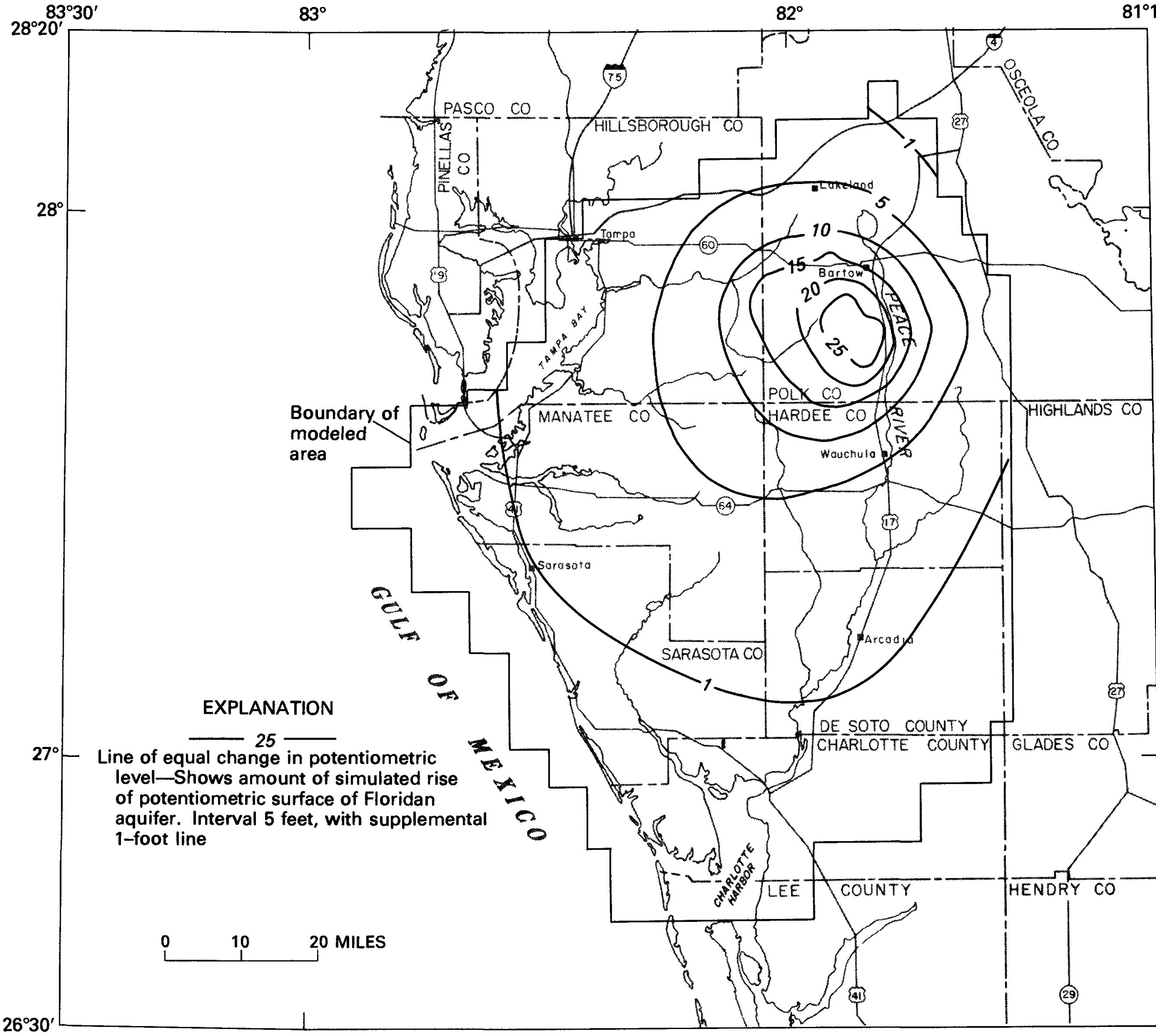

FIGURE 29.–Simulated changes in the potentiometric surface due to projected ground-water withdrawals for existing phosphate mines, November 1976 to October 2000.

the end of the nonirrigation season in 2000. For November 1976 to October 2000, a rise of about 20 ft occurs in southwestern Polk County, and a decline of 5 ft or less occurs in the southern part of the area. These changes are less than the projected changes for May 1976 to May 2000 (fig. 33).

Simulated changes for October 2000 were superimposed on the September 1976 potentiometric map (fig. 12) to obtain a map of the simulated potentiometric surface for October 2000, as shown in figure 36. The principal change is the southwestward shift of the 60- and 70-ft contour lines in Polk County and the eastward shift of the 40-ft contour line in Hardee, De Soto, and Charlotte Counties in October 2000.

WITH PROPOSED PHOSPHATE MINES

Figure 37 shows simulated changes in the potentiometric head resulting from the combined projected withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines from May 1976 to May 2000. The map shows about a 10-ft rise in Polk County and about a 35-ft decline in parts of Manatee and Hardee Counties. Almost all of the southern two-thirds of the modeled area shows a decline of more than 5 ft.

Simulated changes for May 2000 (fig. 37) were superimposed on the May 1976 potentiometric map (fig. 11) to obtain a map of the simulated potentiometric surface for May 2000, as shown in figure 38. The principal change is a broadening and deepening of the major cone

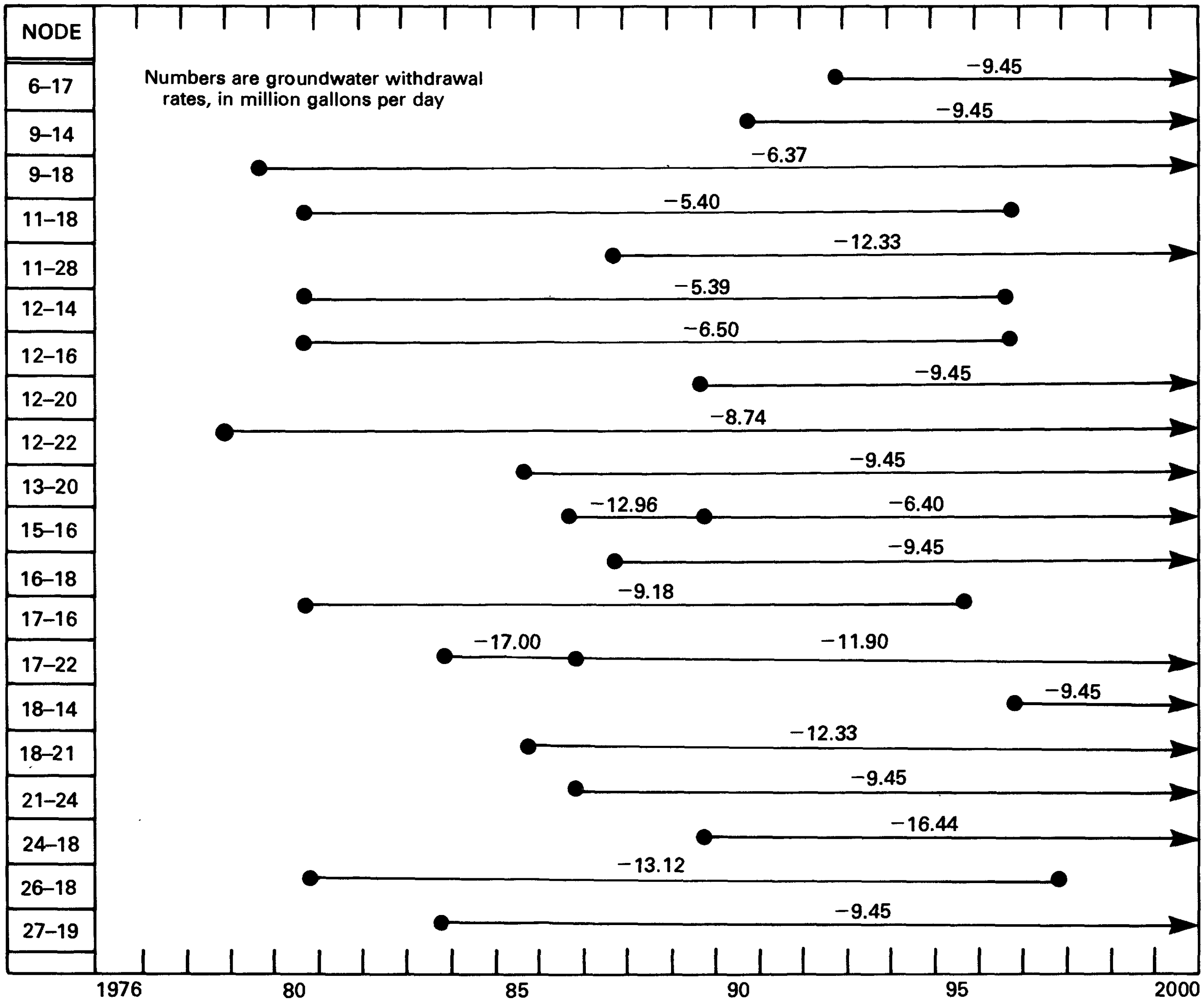

FIGURE 30.—Projected ground-water withdrawal rates for proposed phosphate mines, 1976–2000.

of depression. In May 2000, the lowest level is about 30 ft below sea level, and the zero potentiometric contour line extends eastward to the Peace River in Hardee County. The potentiometric surface is also below sea level along a part of coastal Sarasota County.

Simulated changes resulting from the combined effects of pumping, including that for proposed phosphate mines, from November 1976 to October 2000, are shown in figure 39. The pattern of change is similar to that shown in the May 2000 map (fig. 37), with a rise in parts of Polk County and declines elsewhere. Maximum rise is about 15 ft, and maximum decline is about 25 ft, in Manatee and Hardee Counties (fig. 39). Declines during November 1976 to October 2000 are generally 5–10 ft less than declines during May 1976 to May 2000 (figs. 37, 39).

Simulated changes for October 2000 (fig. 39) were superimposed on the September 1976 potentiometric map (fig. 12) to obtain a map of the simulated potentiometric surface for October 2000, as shown in figure 40. The October 2000 map shows an eastward shift of the 20-, 30-, and 40-ft contour lines and a re-entrant 10-ft line in eastern Manatee County, reflecting a remnant of the closed depression shown in May 2000. The rise in Polk County is reflected in a shift of the 60- and 70-ft contour lines southwestward compared with September 1976.

Figure 41 shows, for selected sites, the effects of combined withdrawals for irrigation, municipal supplies, and existing and proposed mines. The effects are expressed as projected hydrographs for observation wells. Records for 1960–76 and computed heads for May and October in

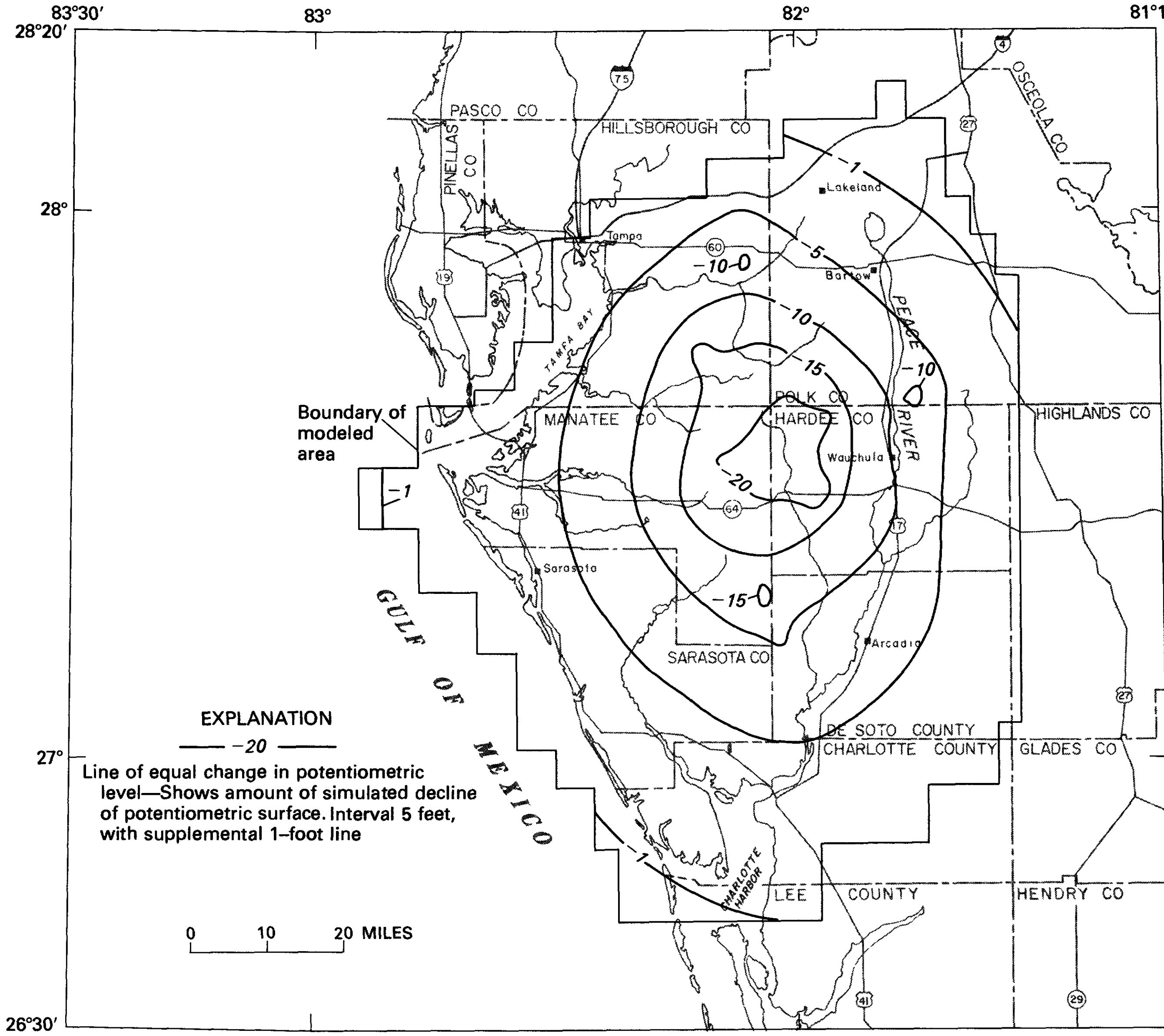

FIGURE 31.–Simulated changes in the potentiometric surface due to projected ground-water withdrawals for proposed phosphate mines, November 1976 to October 2000.

1985 and 2000 are shown. Hydrographs for the wells for the entire periods of record to 1976 are shown in figure 13; locations are shown on plate 1. Figure 41 indicates that projected withdrawals would result in a continuing decline of water levels, except at the Mulberry well in Polk County, where October water levels first decline then rise slightly as a result of reductions in withdrawal rates for existing mines. As has been the case since 1960, the May-to-May declines would be greater than the October-to-October declines.

APPRAISAL OF RESULTS

The modeling activity described in this report represents an initial effort to integrate all hydrologic parameters that affect potentiometric head changes and to determine net effects of combined withdrawals on a regional scale. The model used was the most advanced and appropriate one available at the time the investigation began. Nonetheless, certain assumptions underlying use of the model were not fully met by the field con-

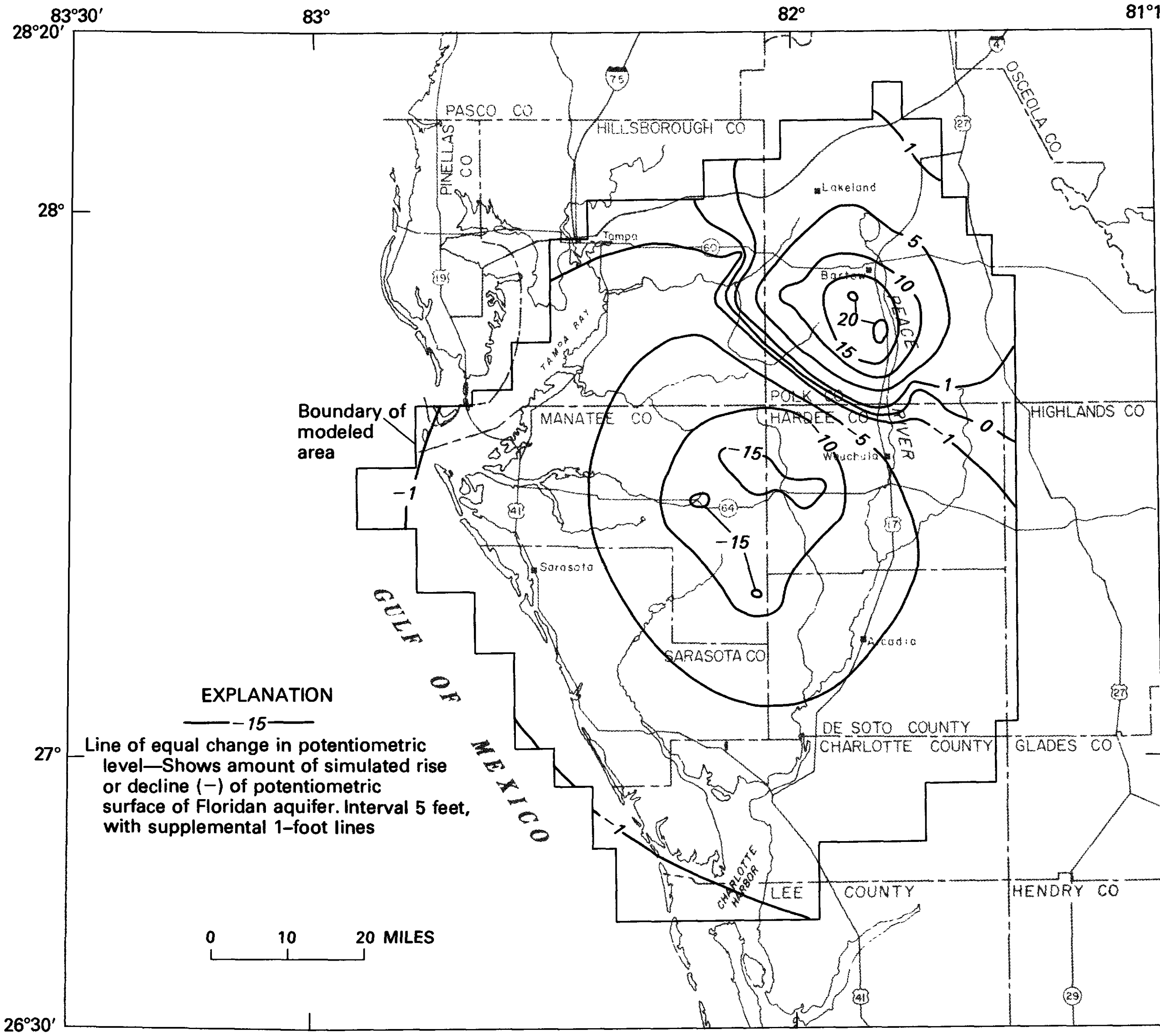

FIGURE 32.—Simulated changes in the potentiometric surface due to projected ground-water withdrawals for existing and proposed phosphate mines, November 1976 to October 2000.

ditions. For example, in some areas vertical components of flow exist within the Floridan aquifer, the aquifer is anisotropic, some leakage probably occurs through the lower confining bed, and the water table fluctuates seasonally and in response to pumping stresses in the Floridan aquifer. Boundary conditions can only be approximated by the model, and the effect of a moving saltwater-freshwater interface on the distribution of heads in coastal areas cannot be assessed by the model. All these limitations may serve to introduce errors in calibration and in predicted head changes.

The model was calibrated by simulating heads from four potentiometric maps, under steady-state and transient conditions. In some areas, computed heads changed by as much as 50 ft when ranges of probable values of input parameters were used. Even the best combination of parameters evaluated, that is, the combination producing the least error in the calibration process, still yielded computed heads that in places substantially differed from observed heads. These differences were considered acceptable as long as they could be accounted for by reasonable ranges of values of the input parameters.

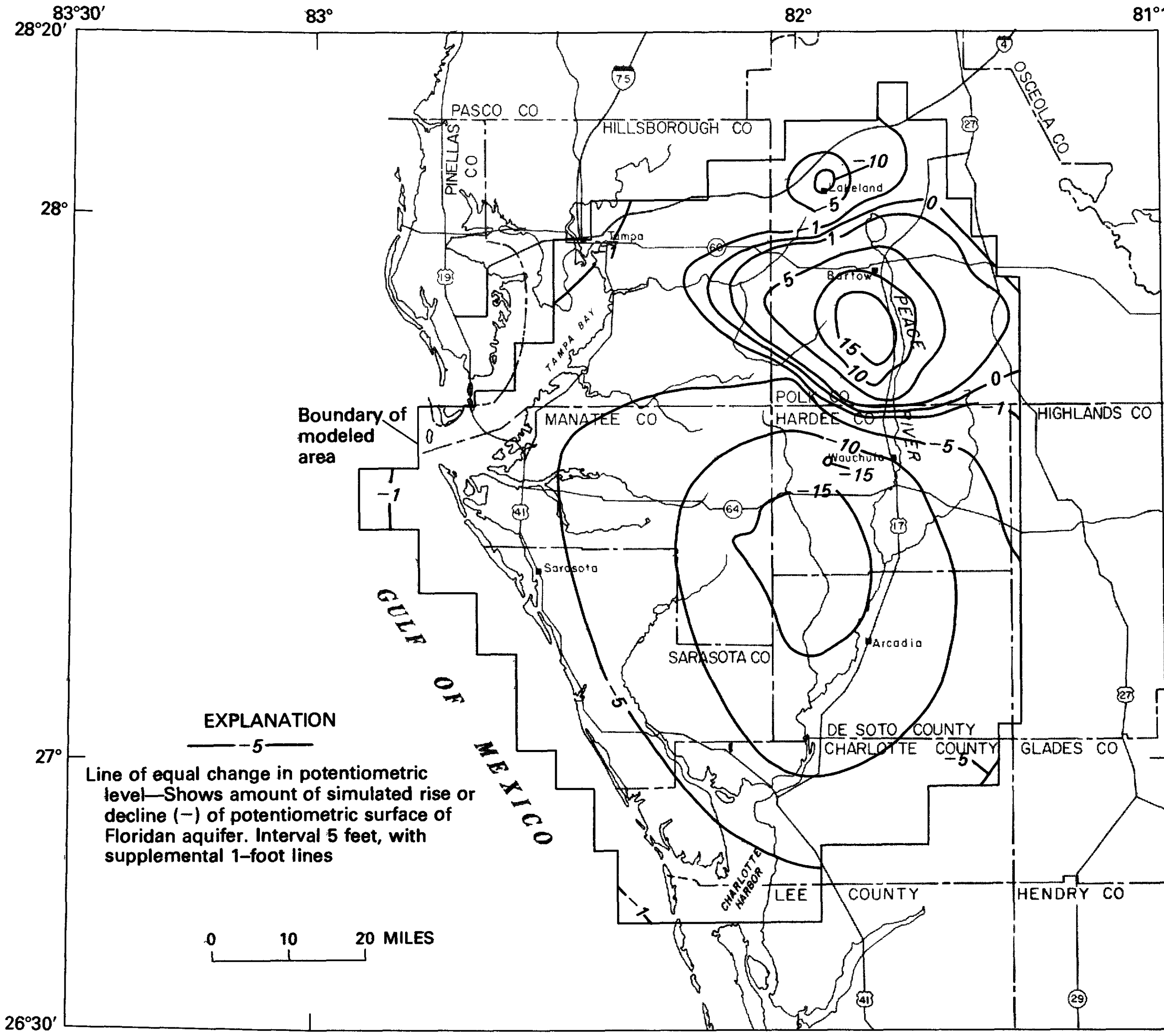

FIGURE 33.–Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing phosphate mines (without proposed phosphate mines), May 1976 to May 2000.

In the simulations using projected pumpage, the water table was held constant on the assumption that the surficial aquifer could be fully recharged each year. If, however, pumping from the Floridan aquifer were to result in a long-term or seasonal decline of the water table, leakage would be reduced. Additional drawdown of the potentiometric surface would then be required to sustain leakage at a rate sufficient to supply the water being discharged by pumping. This effect would, in turn, produce additional decline in the water table and, perhaps, additional expansion of the pumping effects.

Model results can be used to obtain a sense of the magnitude of changes in potentiometric levels that could be expected on a regional basis if the projected pumping schemes are carried out. Results also indicate the relative amounts of changes caused by pumping for irrigation, public supplies, and phosphate mining. Table 9 summarizes these changes. The values in table 9 show only the maximum range in simulated declines and rises, as indicated by contour lines; the areal extent and locations of these changes can be determined from the illustrations listed in table 9. The table shows that pum-

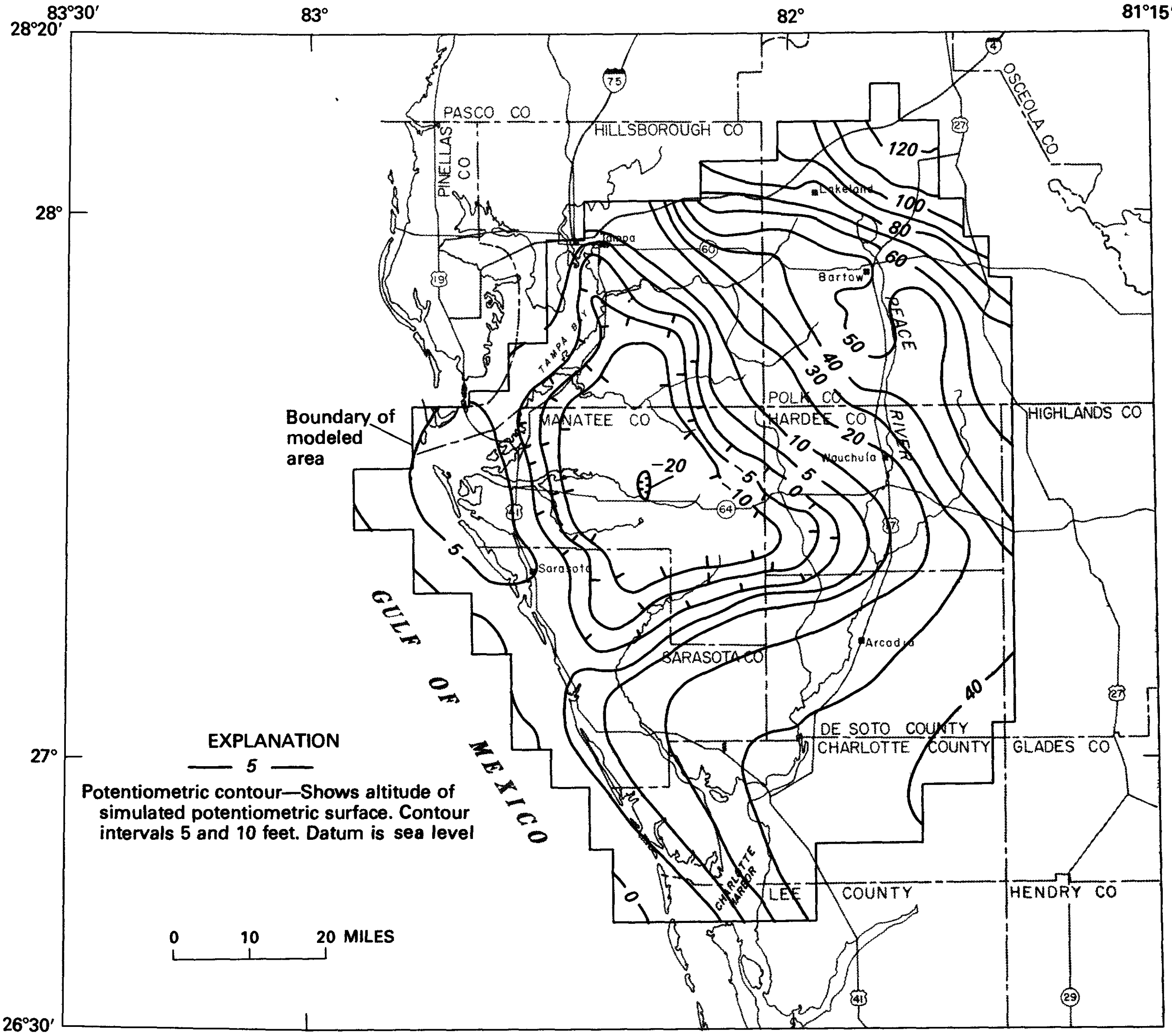

FIGURE 34.—Simulated potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing phosphate mines (without proposed phosphate mines), May 2000.

page for irrigation, public supplies, and existing and proposed phosphate mines would each contribute a maximum decline of about 15 ft by May 2000. Because of recovery during the nonirrigation season in 2000, maximum projected net decline by October 2000 due to irrigation pumpage alone was only about 3 ft.

Table 9 illustrates the role that the projected reduction in pumping for existing phosphate mines would have on the potentiometric surface. Projected pumping for existing phosphate mines alone resulted in a simulated rise of about 25 ft, and even when combined with all other types of pumping, including that for proposed mines, maximum net rise was still about 10 ft in some areas. Maximum net decline due to all pumping was projected to be about 35 ft in May 2000 and about 25 ft in October 2000.

These results suggest that the effects of projected combined pumping rates are on the order of several tens of feet, and not hundreds of feet or a few feet. The impact of these effects on the environmental system cannot be addressed by this model. However, predicted potentiometric changes can provide the basis for future impact analysis.

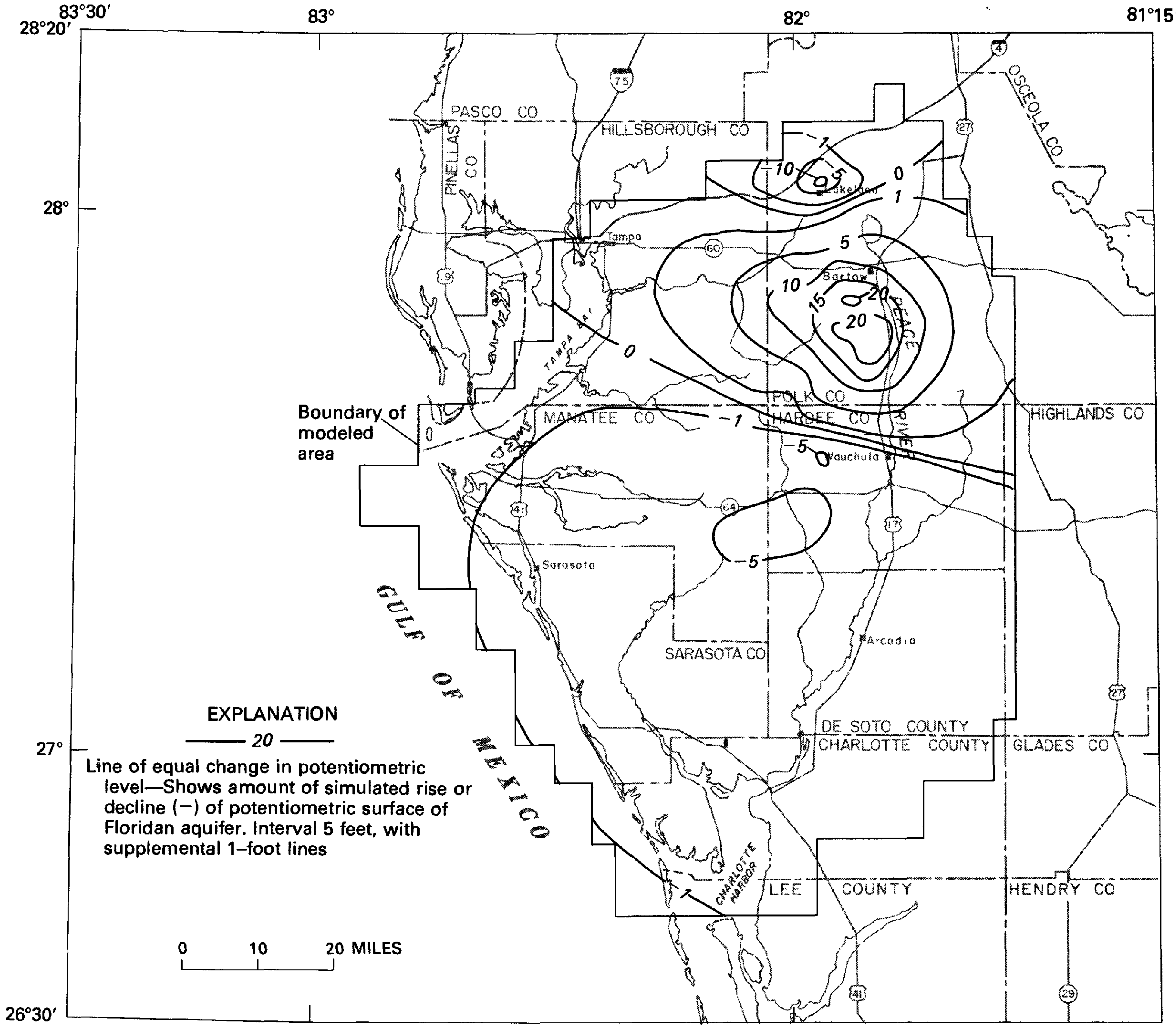

FIGURE 35. – Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing phosphate mines (without proposed phosphate mines), November 1976 to October 2000.

SUMMARY

An area of 5,938 mi² in west-central Florida was modeled to simulate changes from 1976 to 2000 in the potentiometric surface of the Floridan aquifer due to expected increases in ground-water withdrawals for irrigation and municipal supplies and due to anticipated shifts in the sites of pumping for phosphate mines.

Ground water occurs beneath the study area in two principal aquifers, the surficial aquifer and Floridan aquifer. The Floridan aquifer is overlain by an upper confining bed and underlain by a lower confining bed. The surficial aquifer is predominantly fine to very fine sand and clayey sand and is generally a few tens of feet thick. Ground water in the surficial aquifer is unconfined. The water table fluctuates seasonally about 2-5 ft.

The Floridan aquifer includes all or parts of the Avon Park Limestone, Ocala Limestone, Suwannee Limestone, and Tampa Limestone. The top of the Floridan aquifer is the horizon below which carbonate rocks persistently occur. The base is the first persistently occurring intergranular evaporites in the carbonate

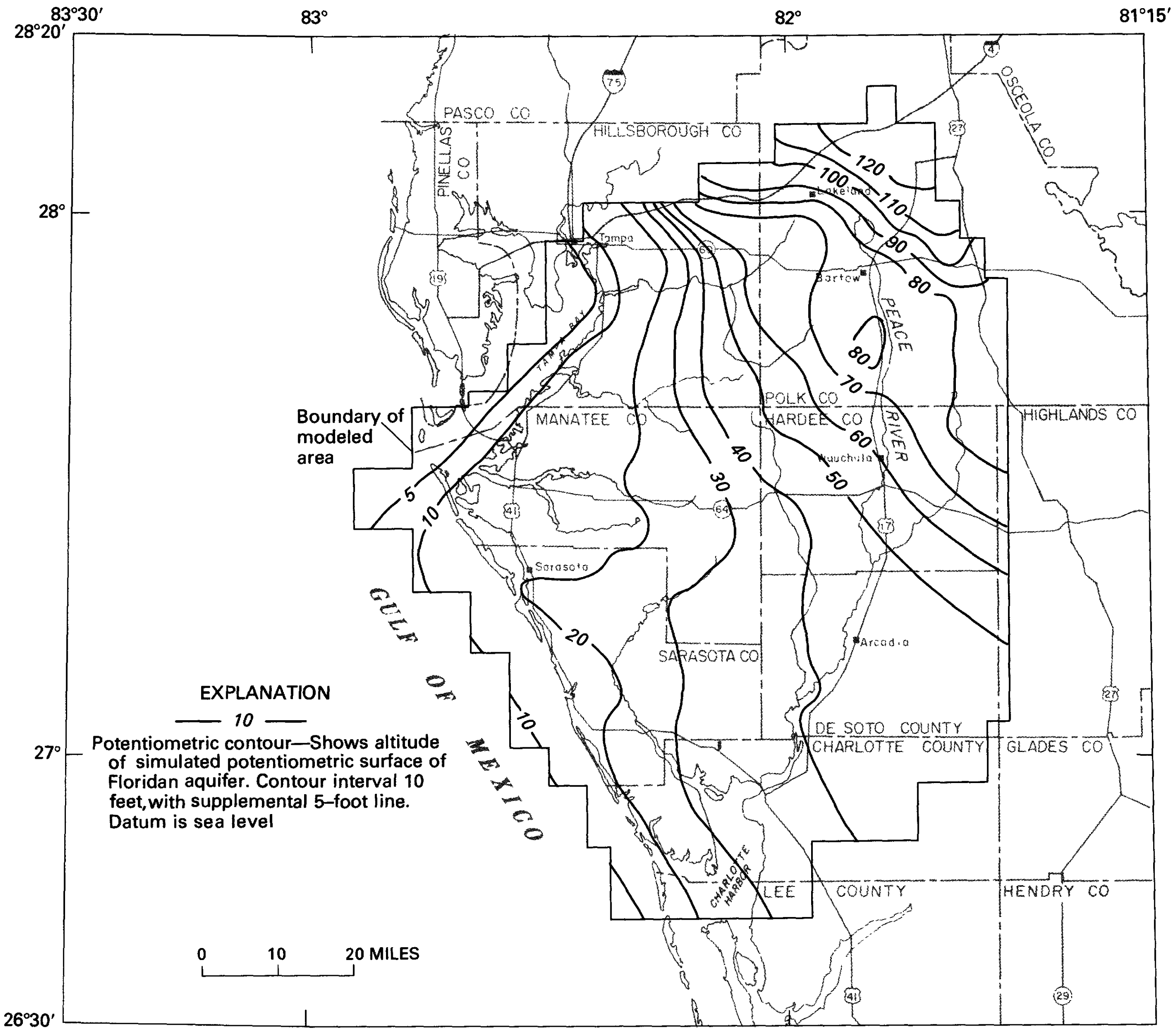

FIGURE 36.—Simulated potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing phosphate mines (without proposed phosphate mines), October 2000.

rocks, commonly coincident with the top of the Lake City Limestone. Aquifer thickness generally ranges from 900 to 1,900 ft. Transmissivity ranges from about 80,000 to 500,000 ft²/d. Storage coefficient ranges from about 8.8×10^{-4} to 1.9×10^{-3}.

The potentiometric surface fluctuates seasonally, with highest levels in September and lowest levels in May. In September 1975, altitudes ranged from about 5 ft near Tampa Bay to about 120 ft in the northeastern part of the area. In May 1976, altitudes ranged from about 10 ft below sea level to about 120 ft above. Well hydrographs indicate a general downward trend in annual peaks and an increase in range between seasonal lows and highs, especially since the early 1960's.

Ground-water flow is generally coastward. However, development of a depression and trough in the potentiometric surface in the dry season substantially alters the direction of ground-water flow. The freshwater flow system in the Floridan aquifer is bounded coastward by a saltwater-freshwater interface.

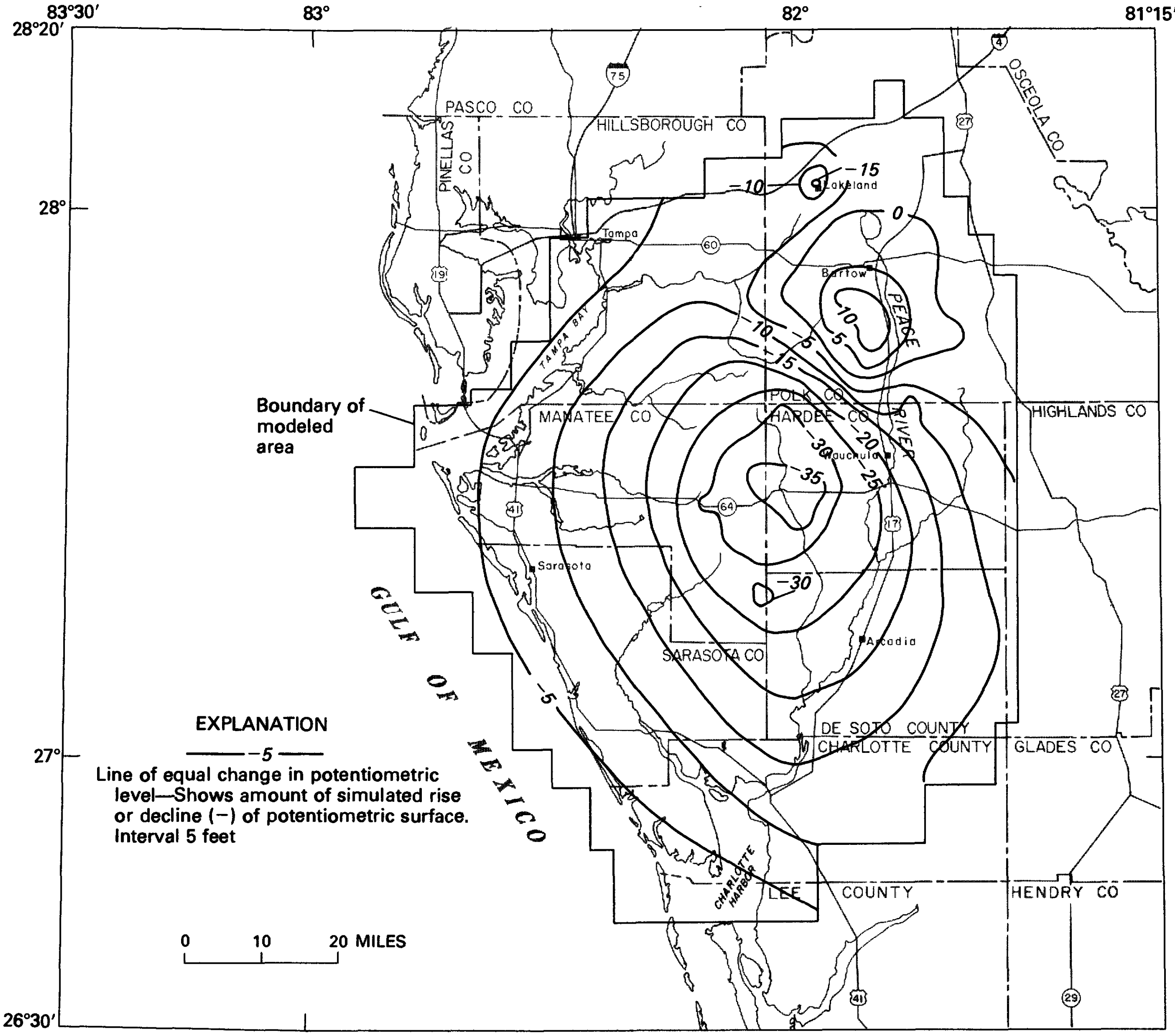

FIGURE 37.—Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines, May 1976 to May 2000.

The upper confining bed of the Floridan aquifer may include all or part of the Bone Valley Formation, Tamiami Formation, Hawthorn Formation, Tampa Limestone, and other undifferentiated predominantly clastic deposits of late Miocene to Pleistocene age. The rocks consist of clay, sand, marl, limestone, and dolomite. Thickness ranges from about 20 ft to about 780 ft. Vertical hydraulic conductivity ranges from about 8.6×10^{-4}ft/d to 2.6×10^{-2}ft/d, as determined principally by model calibration. Leakance coefficient ranges from about 1×10^{-5} [(gal/d)/ft²]/ft to more than 1×10^{-3} [(gal/d)/ft²]/ft. Storage coefficient ranges from about 2.0×10^{-4} to about 7.8×10^{-3}.

The lower confining bed of the Floridan aquifer includes the Lake City Limestone, Oldsmar Limestone, and Cedar Keys Limestone. For modeling purposes the lower confining bed was considered to be impermeable on the basis of a detailed test in Manatee County and on the extensive occurrence of intergranular and interbedded anhydrite and gypsum in the formations constituting the confining bed.

Downward leakage from the surficial aquifer to the

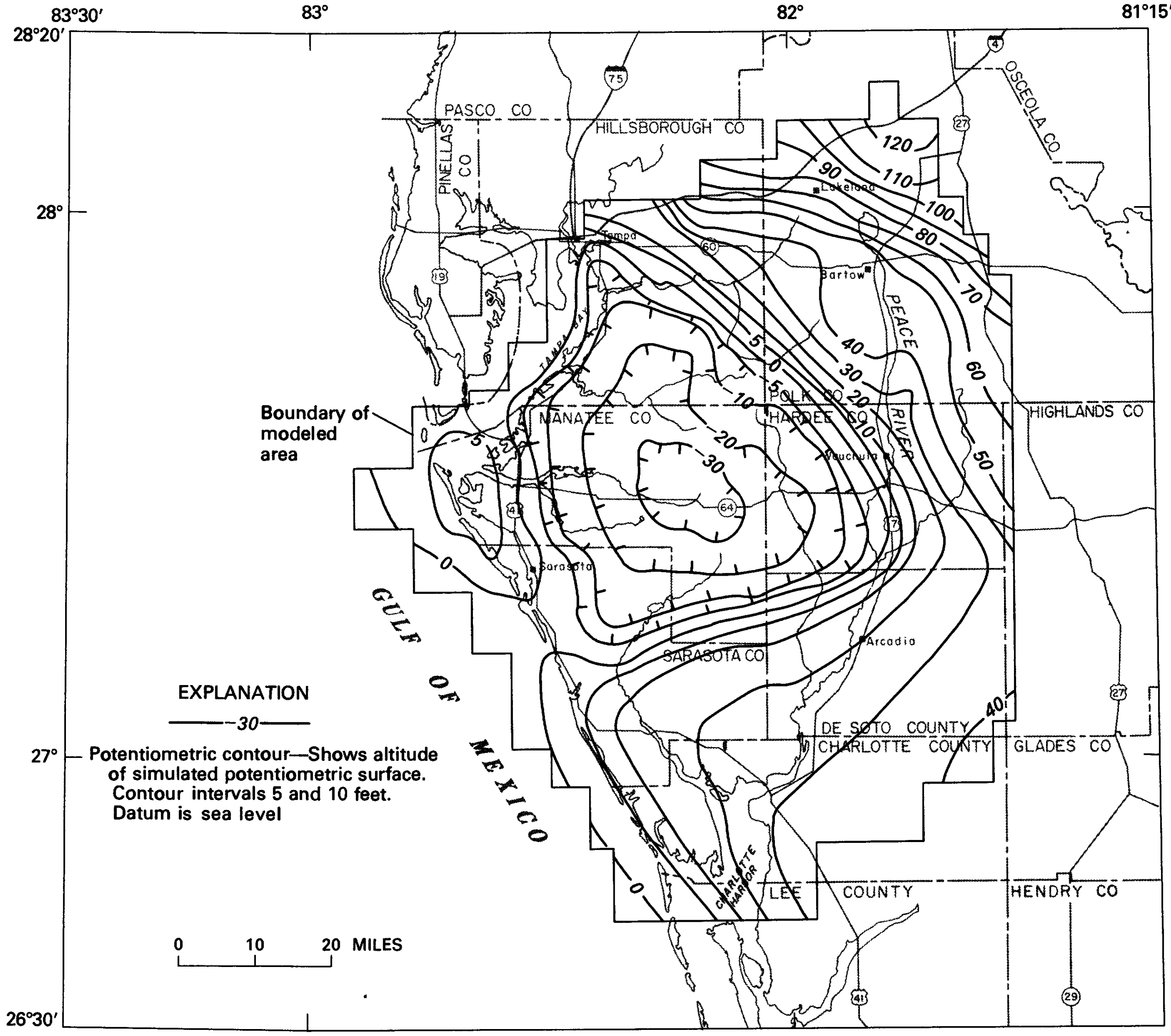

FIGURE 38. – Simulated potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines, May 2000.

Floridan aquifer, through the upper confining bed, occurs in most inland areas; upward leakage occurs along coastal areas and along incised valleys of major streams.

Water from the Floridan aquifer is the major source of water supply in the modeled area. In 1975, withdrawals averaged 649 Mgal/d, mostly for industrial, public-supply, and agricultural purposes.

In 1975, more than half (174 Mgal/d) of the industrial ground-water withdrawals were for phosphate mining, nearly all of which was in Polk County. Mines existing in Polk County in 1976 are expected to be phased out, and proposed mines are expected to begin operations in De Soto, Hardee, and Manatee Counties in the decades ahead. Projected withdrawal rates for phosphate mines were 217 Mgal/d in 1985 and 161 Mgal/d in 2000. Withdrawal rates for other self-supplied industries were expected to remain unchanged.

In 1975 about 50 Mgal/d was withdrawn for municipal supplies in the modeled area. Rates were projected to increase to about 108 Mgal/d in 1985 and to about 145

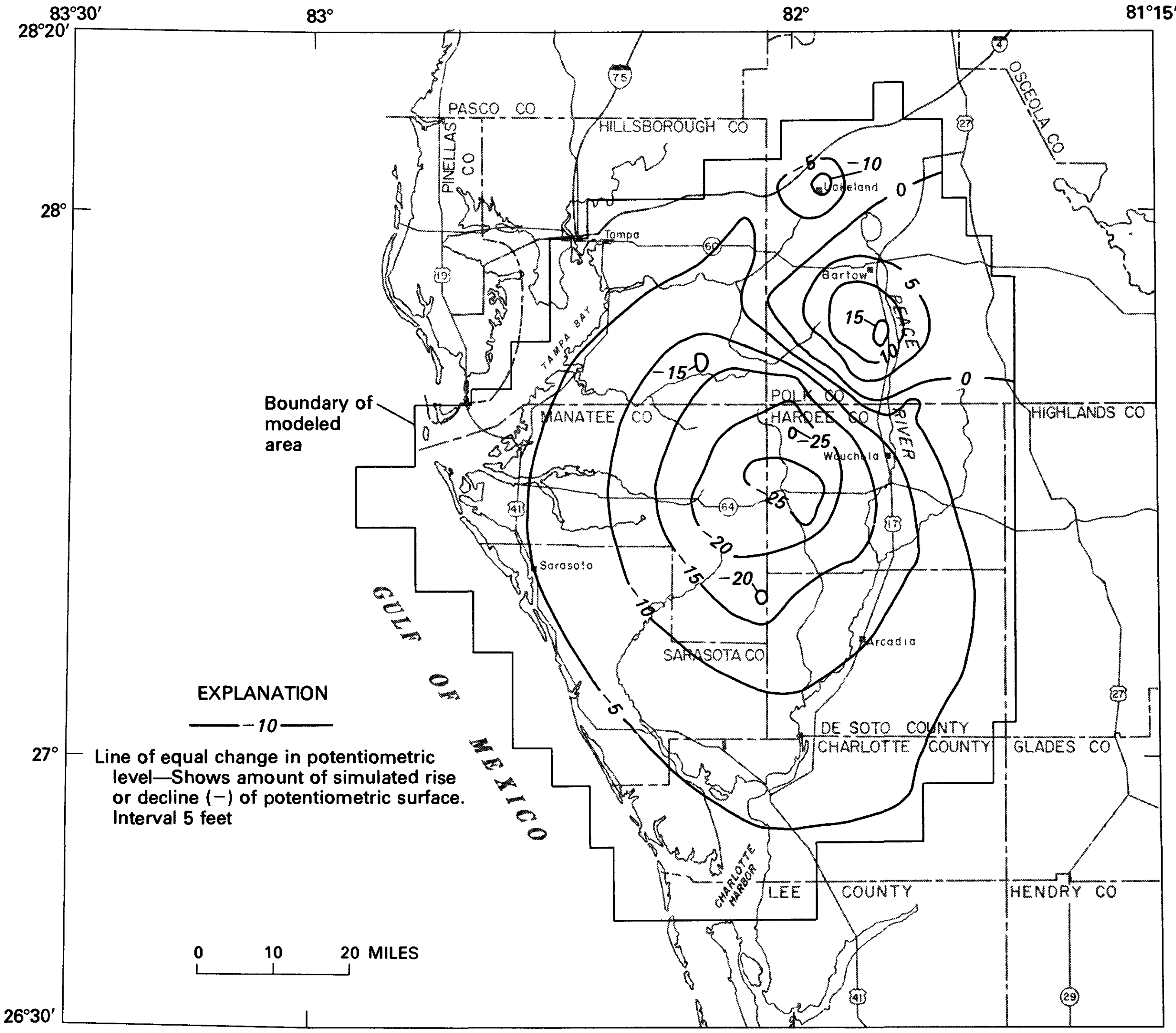

FIGURE 39.—Simulated changes in the potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines, November 1976 to October 2000.

Mgal/d in 2000 owing to the expansion of existing well fields and the establishment of new well fields.

A digital model of two-dimensional flow was used to compute hydraulic head changes in the Floridan aquifer in response to projected pumping rates. A head-controlled flux boundary condition was used for all model runs. The steady-state model was calibrated by comparing simulated potentiometric surfaces with the September 1975 and the 1949 surfaces; irrigation pumpage was assumed to be zero.

At most nodes, the difference between computed and observed heads was less than 10 ft. In most instances, the differences could be accounted for by reasonable ranges of errors in the input parameters.

The transient model was calibrated by comparing simulated potentiometric surfaces with observed May 1976 and September 1976 surfaces. Irrigation pumpage was simulated using the inventoried withdrawal rates for the 1975–76 fall and winter-spring seasons. The difference between computed and observed May 1976

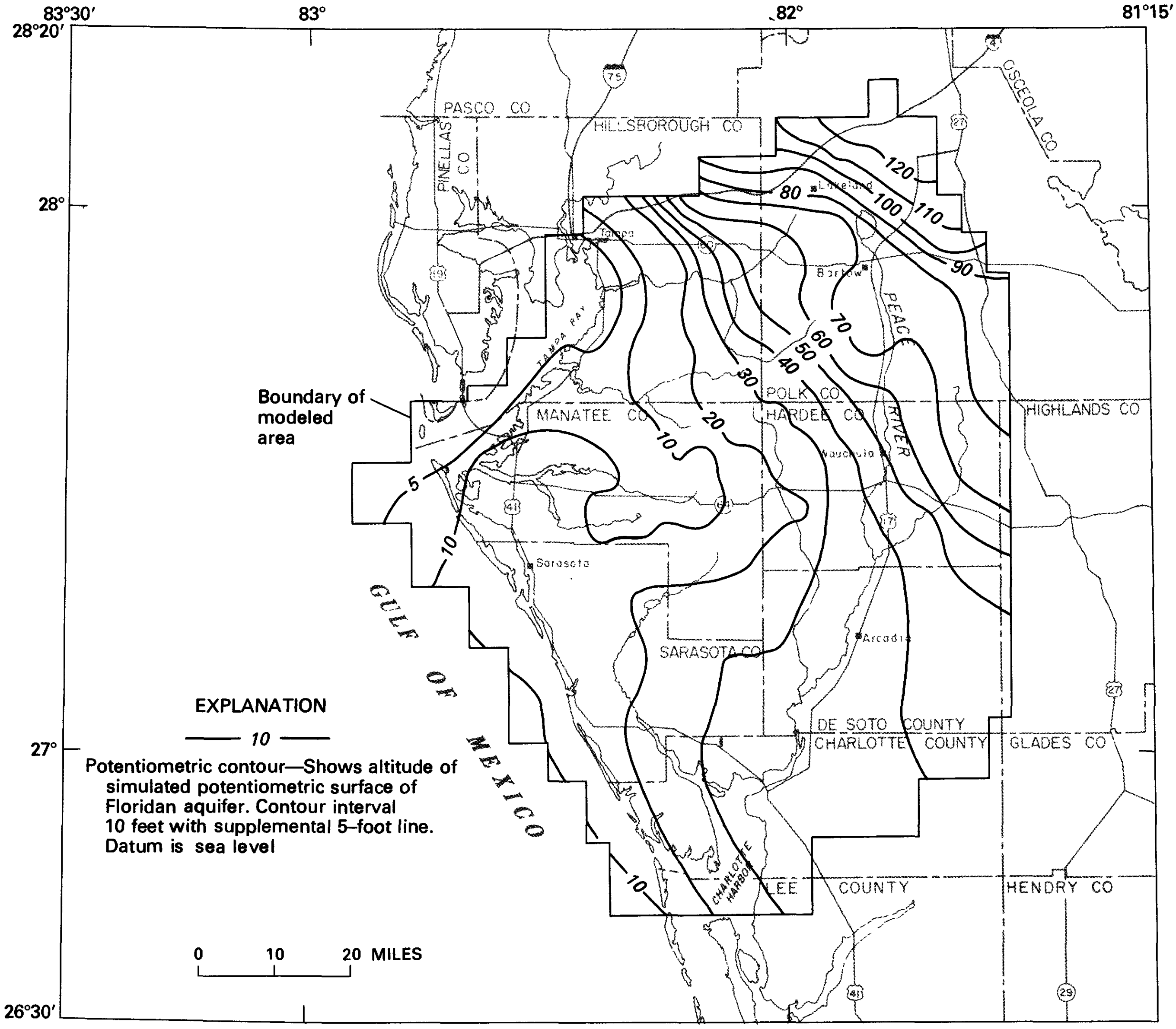

FIGURE 40.–Simulated potentiometric surface due to projected ground-water withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines, October 2000.

heads was less than 10 ft at 78 percent of the nodes; maximum difference was about 19 ft. Simulation of the closed depression in the potentiometric surface in May 1976 was poor, probably because of inaccurate irrigation withdrawal rates input to the model. In most instances, differences could be accounted for by reasonable ranges of errors in the input parameters.

Mass-balance computations for the 1975–76 calibration runs of the transient model show that, on the average, about 83 percent of ground-water discharge was pumpage. About 76 percent was derived from downward leakage and 13 percent from cross-boundary flow. Downward leakage was equivalent to 2.01 in./yr over the modeled area.

Transient-model analyses were used to simulate changes in the potentiometric surface during 1976–2000 resulting from projected ground-water withdrawals for irrigation, municipal supplies, and existing and proposed phosphate mines, separately and in combination.

Projected irrigation withdrawals alone were expected

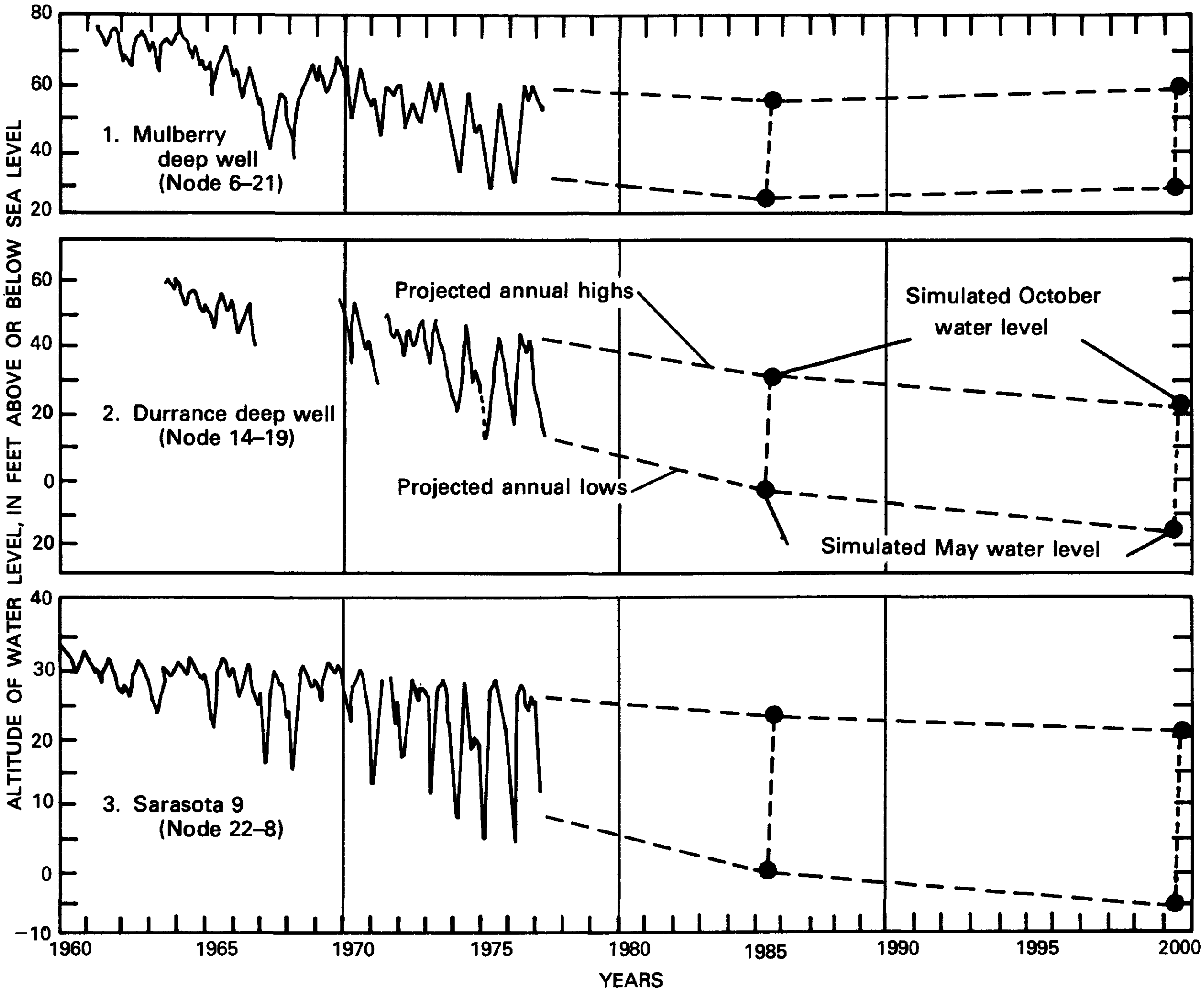

FIGURE 41. – Projected hydrographs of selected wells open to the Floridan aquifer.

to result in about 15 ft of decline of the potentiometric surface by May 2000 in a small area in De Soto County. Projected net decline in October 2000 was generally less than 3 ft.

Projected increases in withdrawals for municipal supplies were expected to result in several localized cones of depression, where declines were 10 ft or more. A decline of at least 1 ft was projected over almost all the modeled area.

Projected declines in withdrawal rates for existing phosphate mines were expected to result in a rise of about 25 ft in the potentiometric surface in southwestern Polk County. Withdrawals for proposed mines showed a maximum decline of about 20 ft in eastern Manatee and western Hardee Counties. When effects of existing and proposed mines were combined, maximum expected rise in Polk County was reduced to about 20 ft, and elsewhere as much as about 15 ft of decline occurred.

Combined effects of projected ground-water withdrawals for municipal supplies, irrigation, and phosphate mining (with and without proposed mines) were determined for May and October 2000. Under conditions of greatest projected stress on the aquifer (with proposed phosphate mines, in May 2000), about 10 ft of rise was expected to occur in Polk County, and about 35 ft of decline was expected to occur in parts of Manatee and Hardee Counties. In the map of the simulated May

TABLE 9.—*Summary of simulated maximum changes in potentiometric surface, in feet*[1], *1976–2000*

Cause[2]	May 1976 to May 2000			November 1976 to October 2000		
	Decline	Rise	*Shown* on figure	Decline	Rise	*Shown* on figure
Irrigation	−15	0	25	−3	0	26
Municipal supplies	−15	0	(3)	−15	0	27
Phosphate mines:						
Existing	0	25	(3)	0	25	29
Proposed	−20	0	(3)	−20	0	31
Existing and proposed	−15	20	(3)	−15	20	32
Combined uses:						
Irrigation, municipal supplies, and existing mines	−15	15	33	−5	20	35
Irrigation, municipal supplies, and existing and proposed mines	−35	10	37	−25	15	39

[1]As indicated by contour line with maximum value on figure listed.
[2]Ground-water withdrawals for use indicated.
[3]Not mapped, but values approximately the same as for November 1976 to October 2000.

2000 potentiometric surface, the lowest level was about 30 ft below sea level, and the zero potentiometric contour line extended eastward to the Peace River in Hardee County. Projected declines during November 1976 to October 2000 were generally 5–10 ft less than projected declines during May 1976 to May 2000.

The model represents an initial effort to determine, on a regional scale in west-central Florida, the net effects of combined withdrawals on the potentiometric surface of the Floridan aquifer. Results can be used in assessing the impacts of these effects.

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APPENDIX

APPENDIX

SUPPLEMENTARY DATA I—MODEL INPUT DATA

The following table lists by node the input values used in model calibrations. Included are potentiometric head; aquifer trasnmissivity (T) and storage coefficient (S); confining-bed storage coefficient (S′), vertical hydraulic conductivity (K′), and thickness (B′); water-table altitude; and pumping rate. Negative values of pumping rate indicate discharge rates; positive values indicate recharge rates.

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.-DEC.	WATER TABLE ALT. (FT) TRANSIENT CALIB. DEC.-MAY	WATER TABLE ALT. (FT) TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.-DEC.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. DEC.-MAY	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. MAY-OCT.
2	26	124.0	1.39	0.92E-03	0.40E-03	0.10E-06	40.0	130.0	129.0	127.0	130.0	-0.88	-1.15	-1.26	-0.88
2	27	125.0	1.39	0.91E-03	0.20E-03	0.10E-06	20.0	130.0	129.0	127.0	130.0	0.0	-1.01	-1.83	0.0
3	20	107.0	1.39	0.10E-02	0.60E-03	0.50E-07	60.0	150.0	149.0	147.0	150.0	0.0	-0.79	-1.43	0.0
3	21	110.0	1.39	0.10E-02	0.85E-03	0.50E-07	85.0	145.0	144.0	142.0	145.0	0.0	-0.60	-1.27	0.0
3	22	115.0	1.39	0.10E-02	0.75E-03	0.50E-07	75.0	135.0	134.0	132.0	135.0	0.0	-0.71	-1.58	0.0
3	23	119.0	1.39	0.10E-02	0.60E-03	0.10E-06	60.0	130.0	129.0	127.0	130.0	-7.51	-7.64	-6.44	-6.25
3	24	121.0	1.39	0.98E-03	0.60E-03	0.10E-06	60.0	132.0	131.0	129.0	132.0	-10.00	-10.07	-10.15	-9.96
3	25	122.0	1.39	0.96E-03	0.75E-03	0.10E-06	75.0	135.0	134.0	132.0	135.0	0.0	0.0	0.0	0.0
3	26	123.0	1.39	0.94E-03	0.85E-03	0.10E-06	85.0	140.0	139.0	137.0	140.0	0.0	-1.50	-2.09	0.0
3	27	124.0	1.39	0.93E-03	0.85E-03	0.10E-06	85.0	132.0	131.0	129.0	132.0	-0.40	-1.46	-1.88	-0.40
3	28	125.0	1.39	0.91E-03	0.35E-03	0.10E-06	35.0	133.0	132.0	130.0	133.0	0.0	-1.14	-1.60	0.0
3	29	126.0	1.39	0.88E-03	0.25E-03	0.10E-06	25.0	130.0	129.0	127.0	130.0	-0.57	-1.49	-1.86	-0.57
4	15	84.0	1.39	0.11E-02	0.65E-03	0.10E-07	65.0	95.0	94.0	92.0	95.0	-0.15	-0.45	-1.43	-0.15
4	16	88.0	1.39	0.11E-02	0.60E-03	0.10E-07	60.0	100.0	99.0	97.0	100.0	-0.57	-0.98	-1.52	-0.57
4	17	90.0	1.39	0.11E-02	0.55E-03	0.10E-07	55.0	105.0	104.0	102.0	105.0	-2.29	-2.85	-5.69	-2.29
4	18	90.0	1.39	0.11E-02	0.60E-03	0.10E-07	60.0	110.0	109.0	107.0	110.0	0.0	-1.31	-5.13	0.0
4	19	89.0	1.39	0.10E-02	0.75E-03	0.50E-07	75.0	122.0	121.0	119.0	122.0	-0.88	-1.05	-1.73	-0.88
4	20	87.0	1.39	0.10E-02	0.10E-02	0.50E-07	100.0	130.0	129.0	127.0	130.0	-3.09	-5.11	-5.26	-3.09
4	21	88.0	1.39	0.10E-02	0.20E-02	0.50E-07	200.0	170.0	169.0	167.0	170.0	-5.50	-5.71	-6.00	-5.50
4	22	91.0	1.39	0.10E-02	0.12E-02	0.50E-07	125.0	130.0	129.0	127.0	130.0	-5.30	-5.30	-5.30	-5.30
4	23	95.0	1.39	0.98E-03	0.90E-03	0.50E-07	90.0	128.0	127.0	125.0	128.0	-2.64	-2.64	-2.71	-2.64
4	24	100.0	1.39	0.97E-03	0.90E-03	0.50E-07	90.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
4	25	108.0	1.39	0.96E-03	0.12E-02	0.10E-06	125.0	110.0	109.0	107.0	110.0	0.0	-0.45	-0.86	0.0
4	26	113.0	1.39	0.94E-03	0.13E-02	0.10E-06	130.0	120.0	119.0	117.0	120.0	-9.09	-9.09	-9.09	-9.09
4	27	119.0	1.39	0.92E-03	0.13E-02	0.10E-06	130.0	135.0	134.0	132.0	135.0	-10.59	-10.91	-11.04	-10.59
4	28	121.0	1.39	0.91E-03	0.10E-02	0.10E-06	105.0	131.0	130.0	128.0	131.0	-1.84	-1.84	-1.84	-1.84
4	29	122.0	1.39	0.89E-03	0.75E-03	0.10E-06	75.0	128.0	127.0	125.0	128.0	-3.35	-3.35	-3.35	-3.35
5	9	12.0	1.39	0.12E-02	0.20E-03	0.10E-07	20.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
5	10	17.0	1.39	0.12E-02	0.30E-03	0.10E-07	30.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
5	11	22.0	1.39	0.11E-02	0.30E-03	0.10E-07	30.0	35.0	34.0	32.0	35.0	-0.05	-0.16	-0.18	-0.05
5	12	28.0	1.39	0.11E-02	0.50E-03	0.10E-07	50.0	45.0	44.0	42.0	45.0	-5.57	-6.01	-6.21	-5.57
5	13	45.0	1.39	0.11E-02	0.70E-03	0.10E-07	70.0	70.0	69.0	67.0	70.0	0.0	-1.64	-3.44	0.0
5	14	55.0	1.39	0.11E-02	0.50E-03	0.10E-07	50.0	75.0	74.0	72.0	75.0	0.0	-2.06	-4.35	0.0
5	15	61.0	1.39	0.11E-02	0.60E-03	0.10E-07	60.0	90.0	89.0	87.0	90.0	0.0	-0.47	-1.91	0.0
5	16	63.0	1.39	0.11E-02	0.90E-03	0.10E-07	90.0	100.0	99.0	97.0	100.0	0.0	-1.67	-2.44	0.0
5	17	63.0	1.39	0.11E-02	0.10E-02	0.10E-07	100.0	115.0	114.0	112.0	115.0	0.0	-0.18	-1.60	0.0
5	18	63.0	1.39	0.11E-02	0.90E-03	0.10E-07	90.0	120.0	119.0	117.0	120.0	-0.97	-1.74	-2.29	-0.97
5	19	62.0	1.39	0.10E-02	0.90E-03	0.50E-07	90.0	120.0	119.0	117.0	120.0	-1.76	-2.08	-4.46	-1.76
5	20	60.0	1.39	0.10E-02	0.11E-02	0.50E-07	110.0	120.0	119.0	117.0	120.0	-0.88	-0.88	-0.88	-0.88
5	21	59.0	1.39	0.10E-02	0.16E-02	0.50E-07	160.0	140.0	139.0	137.0	140.0	-2.64	-2.64	-2.64	-2.64
5	22	60.0	1.39	0.99E-03	0.16E-02	0.50E-07	160.0	160.0	159.0	157.0	160.0	-3.53	-3.57	-3.72	-3.53
5	23	69.0	1.39	0.98E-03	0.14E-02	0.50E-07	140.0	120.0	119.0	117.0	120.0	-1.76	-2.12	-2.67	-1.76
5	24	75.0	1.39	0.97E-03	0.10E-02	0.50E-07	100.0	108.0	107.0	105.0	108.0	-1.76	-2.30	-3.03	-1.76
5	25	80.0	1.39	0.96E-03	0.80E-03	0.50E-07	80.0	97.0	96.0	94.0	97.0	0.0	0.0	0.0	0.0
5	26	90.0	1.39	0.95E-03	0.10E-02	0.50E-07	100.0	100.0	99.0	97.0	100.0	0.0	-0.42	-1.18	0.0
5	27	96.0	1.39	0.94E-03	0.12E-02	0.10E-06	125.0	130.0	129.0	127.0	130.0	0.0	-0.17	-0.24	0.0
5	28	104.0	1.39	0.93E-03	0.11E-02	0.10E-06	110.0	135.0	134.0	132.0	135.0	-4.84	-5.18	-5.31	-4.84
5	29	110.0	1.39	0.92E-03	0.90E-03	0.10E-06	90.0	131.0	130.0	128.0	131.0	0.0	-0.77	-1.08	0.0
5	30	112.0	1.39	0.92E-03	0.80E-03	0.10E-06	80.0	130.0	129.0	127.0	130.0	0.0	-0.30	-0.42	0.0
6	8	5.0	1.39	0.12E-02	0.20E-03	0.10E-07	20.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
6	9	5.0	1.39	0.12E-02	0.20E-03	0.10E-07	20.0	10.0	9.0	7.0	10.0	-2.17	-2.17	-1.90	-1.90
6	10	10.0	1.39	0.12E-02	0.30E-03	0.10E-07	30.0	20.0	19.0	17.0	20.0	0.0	-0.05	-0.04	0.0
6	11	14.0	1.39	0.12E-02	0.30E-03	0.10E-07	30.0	30.0	29.0	27.0	30.0	0.0	-0.03	-0.02	0.0

NODE		POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT)				PUMPING RATE (CU.FT/SEC)			
								1975 STEADY STATE CALIB.	TRANSIENT CALIB.			1975 STEADY STATE CALIB.	TRANSIENT CALIB.		
ROW	COL.								NOV.- DEC.	DEC.- MAY	MAY- OCT.		NOV.- DEC.	DEC.- MAY	MAY- OCT.
6	12	17.0	1.39	0.12E-02	0.25E-03	0.10E-07	25.0	60.0	59.0	57.0	60.0	-0.62	-1.23	-1.46	-0.62
6	13	21.0	1.39	0.12E-02	0.30E-03	0.10E-07	30.0	60.0	59.0	57.0	60.0	0.0	-2.79	-3.82	0.0
6	14	32.0	1.39	0.11E-02	0.50E-03	0.10E-07	50.0	40.0	39.0	37.0	40.0	0.0	-0.17	-0.38	0.0
6	15	37.0	1.39	0.11E-02	0.85E-03	0.10E-07	85.0	45.0	44.0	42.0	45.0	0.0	-0.47	-0.66	0.0
6	16	42.0	1.39	0.11E-02	0.15E-02	0.10E-07	150.0	70.0	69.0	67.0	70.0	0.0	0.0	0.0	0.0
6	17	51.0	1.39	0.11E-02	0.13E-02	0.10E-07	135.0	100.0	99.0	97.0	100.0	0.0	-0.41	-2.09	0.0
6	18	52.0	1.39	0.11E-02	0.10E-02	0.10E-07	105.0	60.0	59.0	57.0	60.0	0.0	-0.15	-0.54	0.0
6	19	50.0	1.39	0.11E-02	0.75E-03	0.50E-07	75.0	80.0	79.0	77.0	80.0	-38.01	-38.01	-37.62	-37.62
6	20	49.5	1.39	0.10E-02	0.11E-02	0.50E-07	115.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
6	21	49.5	1.39	0.10E-02	0.17E-02	0.50E-07	170.0	120.0	119.0	117.0	120.0	-0.55	-0.55	-0.54	-0.54
6	22	50.0	1.39	0.99E-03	0.20E-02	0.50E-07	200.0	180.0	179.0	177.0	180.0	-5.42	-5.42	-5.00	-5.00
6	23	51.0	1.39	0.98E-03	0.18E-02	0.50E-07	185.0	185.0	184.0	182.0	185.0	-20.20	-20.20	-18.55	-18.55
6	24	55.0	1.39	0.97E-03	0.12E-02	0.50E-07	125.0	130.0	129.0	127.0	130.0	-14.25	-14.42	-6.26	-5.03
6	25	59.0	1.39	0.96E-03	0.13E-02	0.50E-07	135.0	100.0	99.0	97.0	100.0	-4.08	-4.16	-5.14	-4.08
6	26	63.0	1.39	0.96E-03	0.13E-02	0.50E-07	130.0	95.0	94.0	92.0	95.0	-7.51	-7.59	-7.63	-7.51
6	27	68.0	1.39	0.96E-03	0.13E-02	0.50E-07	130.0	105.0	104.0	102.0	105.0	0.0	-1.76	-3.03	0.0
6	28	72.0	1.39	0.96E-03	0.14E-02	0.50E-07	140.0	104.0	103.0	101.0	104.0	0.0	-1.07	-1.97	0.0
6	29	85.0	1.39	0.96E-03	0.15E-02	0.10E-06	150.0	110.0	109.0	107.0	110.0	0.0	-1.63	-2.28	0.0
6	30	98.5	1.39	0.96E-03	0.12E-02	0.10E-06	125.0	120.0	119.0	117.0	120.0	0.0	-0.52	-0.73	0.0
6	31	99.0	1.39	0.97E-03	0.80E-03	0.10E-06	80.0	120.0	119.0	117.0	120.0	-3.65	-4.32	-4.68	-3.65
7	8	3.0	1.39	0.12E-02	0.25E-03	0.10E-07	25.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
7	9	4.0	1.39	0.12E-02	0.35E-03	0.10E-07	35.0	5.0	4.0	2.0	5.0	-69.62	-70.83	-73.06	-69.62
7	10	7.0	1.39	0.12E-02	0.55E-03	0.10E-07	55.0	25.0	24.0	22.0	25.0	0.0	-2.08	-3.33	0.0
7	11	15.0	1.39	0.12E-02	0.60E-03	0.10E-07	60.0	70.0	69.0	67.0	70.0	-2.77	-3.86	-4.73	-2.77
7	12	20.0	1.39	0.12E-02	0.50E-03	0.10E-07	50.0	70.0	69.0	67.0	70.0	0.0	-0.15	-0.22	0.0
7	13	25.0	1.39	0.12E-02	0.65E-03	0.10E-07	65.0	60.0	59.0	57.0	60.0	0.0	-0.08	-0.05	0.0
7	14	31.0	1.39	0.12E-02	0.95E-03	0.10E-07	95.0	80.0	79.0	77.0	80.0	0.0	-0.86	-0.71	0.0
7	15	36.0	1.39	0.11E-02	0.13E-02	0.10E-07	130.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
7	16	40.0	1.39	0.11E-02	0.12E-02	0.10E-07	125.0	100.0	99.0	97.0	100.0	0.0	-0.17	-0.29	0.0
7	17	45.0	1.39	0.11E-02	0.10E-02	0.10E-07	100.0	65.0	64.0	62.0	65.0	0.0	-1.13	-2.17	0.0
7	18	51.0	1.39	0.11E-02	0.12E-02	0.10E-07	125.0	110.0	109.0	107.0	110.0	0.0	-0.77	-1.08	0.0
7	19	50.0	1.39	0.11E-02	0.15E-02	0.50E-07	150.0	140.0	139.0	137.0	140.0	-9.32	-9.32	-27.41	-27.41
7	20	50.0	1.39	0.11E-02	0.17E-02	0.50E-07	170.0	140.0	139.0	137.0	140.0	-9.24	-9.24	-4.38	-4.38
7	21	49.5	1.39	0.10E-02	0.20E-02	0.50E-07	205.0	135.0	134.0	132.0	135.0	-3.70	-3.70	-1.32	-4.19
7	22	49.0	1.39	0.10E-02	0.22E-02	0.50E-07	225.0	140.0	139.0	137.0	140.0	-22.15	-22.15	-21.93	-21.93
7	23	48.5	1.39	0.99E-03	0.24E-02	0.50E-07	240.0	165.0	164.0	162.0	165.0	-10.42	-10.42	-10.40	-10.40
7	24	48.5	1.39	0.99E-03	0.21E-02	0.50E-07	215.0	145.0	144.0	142.0	145.0	-23.36	-23.36	-20.43	-20.43
7	25	49.0	1.39	0.99E-03	0.20E-02	0.50E-07	200.0	120.0	119.0	117.0	120.0	-10.81	-10.81	-5.43	-5.43
7	26	50.0	1.39	0.99E-03	0.17E-02	0.50E-07	170.0	90.0	89.0	87.0	90.0	-11.94	-11.94	-8.29	-8.29
7	27	51.0	1.39	0.99E-03	0.14E-02	0.50E-07	145.0	115.0	114.0	112.0	115.0	0.0	-1.08	-5.26	0.0
7	28	54.0	1.39	0.99E-03	0.13E-02	0.50E-07	135.0	175.0	174.0	172.0	175.0	0.0	-1.76	-2.47	0.0
7	29	63.0	1.39	0.10E-02	0.15E-02	0.50E-07	155.0	135.0	134.0	132.0	135.0	0.0	-1.95	-2.96	0.0
7	30	75.0	1.39	0.10E-02	0.13E-02	0.50E-07	135.0	130.0	129.0	127.0	130.0	0.0	-0.61	-1.08	0.0
7	31	88.0	1.39	0.10E-02	0.10E-02	0.10E-06	100.0	120.0	119.0	117.0	120.0	-1.55	-2.21	-2.82	-1.55
7	32	89.0	1.39	0.10E-02	0.95E-03	0.10E-06	95.0	118.0	117.0	115.0	118.0	0.0	-1.76	-2.46	0.0
8	8	4.0	1.39	0.12E-02	0.45E-03	0.10E-07	45.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
8	9	5.0	1.39	0.12E-02	0.60E-03	0.10E-07	60.0	6.0	5.0	3.0	6.0	0.0	-0.08	-2.02	0.0
8	10	12.0	1.39	0.12E-02	0.90E-03	0.10E-07	90.0	35.0	34.0	32.0	35.0	0.0	-3.19	-5.61	0.0
8	11	19.0	1.39	0.12E-02	0.10E-02	0.10E-07	105.0	80.0	79.0	77.0	80.0	0.0	-0.80	-1.51	0.0
8	12	23.0	1.39	0.12E-02	0.10E-02	0.10E-07	100.0	120.0	119.0	117.0	120.0	0.0	-0.90	-4.16	0.0
8	13	27.0	1.39	0.12E-02	0.12E-02	0.10E-07	120.0	120.0	119.0	117.0	120.0	0.0	-1.58	-2.10	0.0
8	14	32.0	1.39	0.12E-02	0.17E-02	0.10E-07	175.0	115.0	114.0	112.0	115.0	0.0	-2.91	-5.24	0.0
8	15	37.0	1.39	0.12E-02	0.18E-02	0.10E-07	185.0	105.0	104.0	102.0	105.0	0.0	-1.24	-1.96	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.-DEC.	WATER TABLE ALT. (FT) TRANSIENT CALIB. DEC.-MAY	WATER TABLE ALT. (FT) TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.-DEC.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. DEC.-MAY	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. MAY-OCT.
8	16	40.0	1.39	0.12E-02	0.17E-02	0.10E-07	175.0	95.0	94.0	92.0	95.0	0.0	-0.09	-0.13	0.0
8	17	43.0	1.39	0.12E-02	0.17E-02	0.10E-07	170.0	90.0	89.0	87.0	90.0	0.0	-1.54	-2.09	0.06
8	18	45.0	1.39	0.12E-02	0.18E-02	0.10E-07	180.0	105.0	104.0	102.0	105.0	0.0	-1.28	-1.59	0.0
8	19	49.0	1.39	0.12E-02	0.19E-02	0.10E-07	195.0	115.0	114.0	112.0	115.0	0.0	0.0	0.0	0.0
8	20	50.0	1.39	0.11E-02	0.21E-02	0.50E-07	215.0	116.0	115.0	113.0	116.0	0.0	0.0	0.20	0.20
8	21	51.0	1.39	0.11E-02	0.24E-02	0.50E-07	245.0	120.0	119.0	117.0	120.0	0.0	0.0	0.0	0.0
8	22	50.5	1.39	0.10E-02	0.27E-02	0.50E-07	275.0	124.0	123.0	121.0	124.0	0.0	0.0	0.0	0.0
8	23	50.0	1.39	0.10E-02	0.26E-02	0.50E-07	260.0	128.0	127.0	125.0	128.0	-28.82	-28.82	-25.13	-25.13
8	24	49.0	1.39	0.10E-02	0.24E-02	0.50E-07	240.0	155.0	154.0	152.0	155.0	0.0	0.0	0.0	0.0
8	25	48.5	1.39	0.10E-02	0.22E-02	0.50E-07	225.0	140.0	139.0	137.0	140.0	0.0	0.0	0.0	0.0
8	26	48.5	1.39	0.10E-02	0.18E-02	0.50E-07	185.0	130.0	129.0	127.0	130.0	-29.97	-29.97	-23.97	-23.97
8	27	49.0	1.39	0.10E-02	0.16E-02	0.50E-07	165.0	84.0	83.0	81.0	84.0	0.0	-0.06	-0.08	0.0
8	28	49.5	1.39	0.10E-02	0.16E-02	0.50E-07	160.0	145.0	144.0	142.0	145.0	-0.31	-0.90	-1.13	-0.31
8	29	50.0	1.39	0.10E-02	0.19E-02	0.50E-07	190.0	140.0	139.0	137.0	140.0	0.0	-1.34	-2.12	0.0
8	30	64.0	1.39	0.10E-02	0.17E-02	0.50E-07	175.0	127.0	126.0	124.0	127.0	0.0	-0.92	-1.72	0.0
8	31	81.0	1.39	0.10E-02	0.14E-02	0.50E-07	140.0	130.0	129.0	127.0	130.0	-2.24	-2.37	-2.43	-2.24
8	32	86.0	1.39	0.10E-02	0.12E-02	0.10E-06	125.0	100.0	99.0	97.0	100.0	0.0	-1.71	-2.40	0.0
9	7	4.0	1.39	0.12E-02	0.11E-02	0.50E-07	110.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
9	8	9.0	1.39	0.12E-02	0.90E-03	0.10E-07	90.0	7.0	6.0	4.0	7.0	0.0	-2.47	-4.72	0.0
9	9	13.0	1.39	0.12E-02	0.90E-03	0.10E-07	90.0	35.0	34.0	32.0	35.0	0.0	-4.87	-15.10	0.0
9	10	17.0	1.39	0.12E-02	0.10E-02	0.10E-07	100.0	45.0	44.0	42.0	45.0	-1.29	-3.40	-4.14	-1.29
9	11	20.0	1.39	0.13E-02	0.11E-02	0.10E-07	110.0	75.0	74.0	72.0	75.0	0.0	-0.82	-7.97	0.0
9	12	26.0	1.39	0.13E-02	0.10E-02	0.10E-07	100.0	100.0	99.0	97.0	100.0	0.0	-2.70	-9.82	0.0
9	13	30.0	1.39	0.13E-02	0.14E-02	0.10E-07	140.0	105.0	104.0	102.0	105.0	0.0	-2.92	-3.06	0.0
9	14	35.0	1.39	0.13E-02	0.20E-02	0.10E-07	200.0	105.0	104.0	102.0	105.0	0.0	-1.78	-4.50	0.34
9	15	37.0	1.39	0.12E-02	0.20E-02	0.10E-07	200.0	100.0	99.0	97.0	100.0	0.0	-1.55	-3.22	0.82
9	16	40.0	1.39	0.12E-02	0.20E-02	0.10E-07	200.0	105.0	104.0	102.0	105.0	0.0	0.0	0.99	0.20
9	17	42.0	1.39	0.12E-02	0.21E-02	0.10E-07	210.0	100.0	99.0	97.0	100.0	0.0	0.0	1.19	0.40
9	18	43.0	1.39	0.12E-02	0.21E-02	0.10E-07	215.0	85.0	84.0	82.0	85.0	0.0	-0.07	-1.80	0.0
9	19	44.0	1.39	0.12E-02	0.23E-02	0.10E-07	230.0	105.0	104.0	102.0	105.0	0.0	-0.08	-0.12	0.0
9	20	45.0	1.39	0.11E-02	0.26E-02	0.10E-07	260.0	130.0	129.0	127.0	130.0	-11.38	-11.38	-6.34	-6.34
9	21	49.0	1.39	0.11E-02	0.28E-02	0.50E-07	285.0	140.0	139.0	137.0	140.0	-1.69	-1.69	-0.85	-0.85
9	22	51.0	1.39	0.11E-02	0.29E-02	0.50E-07	290.0	139.0	138.0	136.0	139.0	-2.20	-2.20	-2.20	-2.20
9	23	51.0	1.39	0.10E-02	0.28E-02	0.50E-07	280.0	130.0	129.0	127.0	130.0	0.0	0.0	0.0	0.0
9	24	50.0	1.39	0.10E-02	0.26E-02	0.50E-07	265.0	148.0	147.0	145.0	148.0	0.0	0.0	0.0	0.0
9	25	49.0	1.39	0.10E-02	0.24E-02	0.50E-07	240.0	120.0	119.0	117.0	120.0	-47.97	-47.97	-40.84	-40.81
9	26	49.0	1.39	0.10E-02	0.21E-02	0.50E-07	210.0	110.0	109.0	107.0	110.0	-16.55	-16.72	-17.10	-16.86
9	27	49.5	1.39	0.11E-02	0.18E-02	0.50E-07	185.0	76.0	75.0	73.0	76.0	-0.56	-0.56	-0.56	-0.56
9	28	50.0	1.39	0.11E-02	0.18E-02	0.50E-07	185.0	120.0	119.0	117.0	120.0	-0.22	-0.22	-1.17	-0.23
9	29	54.0	1.39	0.11E-02	0.20E-02	0.50E-07	205.0	140.0	139.0	137.0	140.0	0.0	-1.48	-2.65	0.0
9	30	65.0	1.39	0.11E-02	0.18E-02	0.50E-07	185.0	130.0	129.0	127.0	130.0	0.0	0.0	0.0	0.0
9	31	79.0	1.39	0.11E-02	0.17E-02	0.50E-07	170.0	140.0	139.0	137.0	140.0	0.0	-0.13	-0.19	0.0
9	32	84.0	1.39	0.10E-02	0.19E-02	0.20E-06	190.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
10	7	9.0	1.39	0.12E-02	0.15E-02	0.50E-07	150.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10	8	16.0	1.39	0.12E-02	0.14E-02	0.10E-07	140.0	20.0	19.0	17.0	20.0	0.0	-8.18	-11.73	0.0
10	9	18.0	1.39	0.12E-02	0.17E-02	0.10E-07	170.0	35.0	34.0	32.0	35.0	-4.70	-7.90	-10.84	-4.70
10	10	20.0	1.39	0.12E-02	0.15E-02	0.10E-07	150.0	50.0	49.0	47.0	50.0	-0.64	-1.40	-1.30	-0.64
10	11	24.0	1.39	0.12E-02	0.15E-02	0.10E-07	150.0	70.0	69.0	67.0	70.0	0.0	-4.89	-4.78	0.0
10	12	28.0	1.39	0.13E-02	0.14E-02	0.10E-07	140.0	75.0	74.0	72.0	75.0	0.0	-1.73	-2.28	0.0
10	13	30.0	1.39	0.13E-02	0.17E-02	0.10E-07	170.0	75.0	74.0	72.0	75.0	0.0	-0.50	-0.71	0.0
10	14	35.0	1.39	0.13E-02	0.20E-02	0.10E-07	200.0	65.0	64.0	62.0	65.0	0.0	-0.29	-0.10	0.31
10	15	37.0	1.39	0.13E-02	0.20E-02	0.10E-07	205.0	80.0	79.0	77.0	80.0	0.0	0.0	0.02	0.02
10	16	39.0	1.39	0.13E-02	0.22E-02	0.10E-07	220.0	95.0	94.0	92.0	95.0	0.0	-1.72	-3.20	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.-DEC.	WATER TABLE ALT. (FT) TRANSIENT CALIB. DEC.-MAY	WATER TABLE ALT. (FT) TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.-DEC.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. DEC.-MAY	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. MAY-OCT.
10	17	41.0	1.39	0.12E-02	0.24E-02	0.10E-07	245.0	100.0	99.0	97.0	100.0	0.0	-0.64	-1.23	0.46
10	18	42.0	1.74	0.12E-02	0.27E-02	0.10E-07	275.0	120.0	119.0	117.0	120.0	0.0	-0.25	-0.35	0.0
10	19	43.0	1.74	0.12E-02	0.30E-02	0.10E-07	300.0	135.0	134.0	132.0	135.0	0.0	-0.07	0.17	0.26
10	20	45.0	1.74	0.11E-02	0.32E-02	0.10E-07	320.0	133.0	132.0	130.0	133.0	0.0	0.0	1.24	1.24
10	21	47.0	1.74	0.11E-02	0.32E-02	0.10E-07	325.0	126.0	125.0	123.0	126.0	0.0	0.0	0.0	0.0
10	22	49.0	1.39	0.11E-02	0.33E-02	0.10E-07	330.0	130.0	129.0	127.0	130.0	-3.54	-3.54	-0.29	-0.29
10	23	51.0	1.39	0.11E-02	0.32E-02	0.50E-07	320.0	125.0	124.0	122.0	125.0	0.0	0.0	0.0	0.0
10	24	50.0	1.39	0.11E-02	0.30E-02	0.50E-07	305.0	124.0	123.0	121.0	124.0	0.0	0.0	0.0	0.0
10	25	49.5	1.39	0.11E-02	0.29E-02	0.50E-07	290.0	104.0	103.0	101.0	104.0	-18.78	-18.78	-18.90	-18.90
10	26	49.5	1.39	0.11E-02	0.25E-02	0.50E-07	250.0	67.0	66.0	64.0	67.0	0.0	-0.13	-0.19	0.0
10	27	50.0	1.39	0.11E-02	0.22E-02	0.50E-07	225.0	120.0	119.0	117.0	120.0	0.0	-0.08	-0.12	0.0
10	28	55.0	1.39	0.11E-02	0.21E-02	0.20E-06	215.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
10	29	63.0	1.39	0.11E-02	0.21E-02	0.20E-06	215.0	115.0	114.0	112.0	115.0	0.0	-0.24	-0.34	0.0
10	30	70.0	1.39	0.11E-02	0.20E-02	0.20E-06	200.0	135.0	134.0	132.0	135.0	0.0	-0.86	-1.43	0.0
10	31	79.0	1.39	0.11E-02	0.19E-02	0.20E-06	190.0	120.0	119.0	117.0	120.0	0.0	-1.26	-2.21	0.0
10	32	83.0	1.39	0.10E-02	0.22E-02	0.20E-06	220.0	100.0	99.0	97.0	100.0	0.0	-0.99	-1.39	0.0
11	6	5.0	1.39	0.11E-02	0.19E-02	0.50E-07	190.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
11	7	15.0	1.39	0.12E-02	0.18E-02	0.50E-07	180.0	2.0	1.0	0.0	2.0	0.0	-1.32	-1.26	0.0
11	8	17.0	1.39	0.12E-02	0.19E-02	0.10E-07	195.0	22.0	21.0	19.0	22.0	0.0	-4.99	-8.37	0.0
11	9	19.0	1.39	0.12E-02	0.21E-02	0.10E-07	215.0	18.0	17.0	15.0	18.0	0.0	-0.84	-2.28	0.0
11	10	22.0	1.39	0.12E-02	0.20E-02	0.10E-07	205.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
11	11	25.0	1.39	0.12E-02	0.19E-02	0.10E-07	190.0	45.0	44.0	42.0	45.0	0.0	-0.79	-1.70	0.0
11	12	28.0	1.39	0.13E-02	0.20E-02	0.10E-07	200.0	55.0	54.0	52.0	55.0	0.0	-4.48	-5.16	0.0
11	13	31.0	1.39	0.13E-02	0.21E-02	0.10E-07	210.0	90.0	89.0	87.0	90.0	0.0	-0.13	-5.82	0.0
11	14	35.0	1.39	0.13E-02	0.22E-02	0.10E-07	220.0	60.0	59.0	57.0	60.0	0.0	-1.82	-1.57	0.0
11	15	37.0	1.39	0.13E-02	0.24E-02	0.10E-07	240.0	80.0	79.0	77.0	80.0	0.0	0.0	0.0	0.0
11	16	38.0	1.39	0.13E-02	0.26E-02	0.10E-07	265.0	120.0	119.0	117.0	120.0	0.0	0.0	0.0	0.0
11	17	40.0	1.74	0.13E-02	0.29E-02	0.10E-07	290.0	130.0	129.0	127.0	130.0	0.0	-0.11	-0.16	0.0
11	18	42.0	1.74	0.12E-02	0.32E-02	0.10E-07	320.0	130.0	129.0	127.0	130.0	0.0	0.0	0.0	0.0
11	19	43.0	1.74	0.12E-02	0.34E-02	0.10E-07	340.0	134.0	133.0	131.0	134.0	0.0	0.0	0.0	0.0
11	20	45.0	1.74	0.11E-02	0.36E-02	0.10E-07	360.0	130.0	129.0	127.0	130.0	0.0	0.0	0.0	-11.69
11	21	47.0	1.74	0.11E-02	0.37E-02	0.10E-07	370.0	130.0	129.0	127.0	130.0	0.0	0.0	0.0	0.0
11	22	48.0	1.74	0.11E-02	0.36E-02	0.10E-07	360.0	130.0	129.0	127.0	130.0	-8.87	-8.87	-8.18	-8.18
11	23	50.0	1.39	0.11E-02	0.35E-02	0.10E-07	350.0	120.0	119.0	117.0	120.0	0.0	0.0	0.0	0.0
11	24	51.0	1.39	0.11E-02	0.33E-02	0.50E-07	330.0	115.0	114.0	112.0	115.0	0.0	-0.20	-0.28	0.0
11	25	50.0	1.39	0.11E-02	0.31E-02	0.50E-07	310.0	120.0	119.0	117.0	120.0	0.0	-0.05	-0.07	0.0
11	26	50.0	1.39	0.11E-02	0.29E-02	0.20E-06	290.0	62.0	61.0	59.0	62.0	0.0	-0.17	-0.24	0.0
11	27	54.0	1.39	0.11E-02	0.26E-02	0.20E-06	265.0	115.0	114.0	112.0	115.0	0.0	-0.18	-0.26	0.0
11	28	60.0	1.39	0.11E-02	0.24E-02	0.20E-06	240.0	125.0	124.0	122.0	125.0	0.0	0.0	0.0	0.0
11	29	65.0	1.39	0.11E-02	0.22E-02	0.20E-06	220.0	127.0	126.0	124.0	127.0	0.0	0.0	0.0	0.0
11	30	73.0	1.39	0.11E-02	0.20E-02	0.20E-06	205.0	125.0	124.0	122.0	125.0	0.0	0.0	0.0	0.0
11	31	80.0	1.39	0.11E-02	0.20E-02	0.20E-06	200.0	115.0	114.0	112.0	115.0	0.0	-0.76	-1.19	0.0
11	32	82.0	1.39	0.10E-02	0.22E-02	0.20E-06	225.0	105.0	104.0	102.0	105.0	0.0	-0.76	-1.06	0.0
12	5	3.0	1.39	0.11E-02	0.21E-02	0.50E-07	210.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	6	10.0	1.39	0.11E-02	0.21E-02	0.50E-07	215.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
12	7	17.0	1.39	0.11E-02	0.19E-02	0.50E-07	195.0	5.0	4.0	2.0	5.0	0.0	-0.74	-1.03	0.0
12	8	19.0	1.39	0.12E-02	0.22E-02	0.50E-07	220.0	20.0	19.0	17.0	20.0	0.0	-1.08	-1.88	0.0
12	9	20.0	1.39	0.12E-02	0.25E-02	0.10E-07	255.0	22.0	21.0	19.0	22.0	0.0	-0.57	-1.32	0.0
12	10	23.0	1.39	0.12E-02	0.22E-02	0.10E-07	220.0	30.0	29.0	27.0	30.0	0.0	-0.38	-0.94	0.0
12	11	26.0	1.39	0.12E-02	0.23E-02	0.10E-07	235.0	55.0	54.0	52.0	55.0	0.0	-0.55	-1.50	0.0
12	12	28.0	1.39	0.12E-02	0.24E-02	.10E-07	245.0	75.0	74.0	72.0	75.0	0.0	-0.55	-1.41	0.0
12	13	30.0	1.39	0.13E-02	0.25E-02	0.10E-07	250.0	90.0	89.0	87.0	90.0	0.0	-0.50	-1.08	0.0
12	14	34.0	1.39	0.13E-02	0.26E-02	0.10E-07	260.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.- DEC.	DEC.- MAY	MAY- OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.- DEC.	DEC.- MAY	MAY- OCT.
12	15	37.0	1.39	0.13E-02	0.27E-02	0.10E-07	275.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
12	16	38.0	1.39	0.13E-02	0.29E-02	0.10E-07	290.0	110.0	109.0	107.0	110.0	0.0	-0.44	-0.61	0.0
12	17	40.0	1.74	0.13E-02	0.33E-02	0.10E-07	330.0	125.0	124.0	122.0	125.0	0.0	0.0	0.0	0.0
12	18	42.0	1.74	0.12E-02	0.37E-02	0.10E-07	375.0	125.0	124.0	122.0	125.0	0.0	0.0	0.0	0.0
12	19	43.0	1.74	0.12E-02	0.39E-02	0.10E-07	390.0	126.0	125.0	123.0	126.0	0.0	0.0	0.0	0.0
12	20	45.0	1.74	0.11E-02	0.41E-02	0.10E-07	410.0	124.0	123.0	121.0	124.0	0.0	0.0	0.0	0.0
12	21	47.0	1.74	0.11E-02	0.42E-02	0.10E-07	425.0	113.0	112.0	110.0	113.0	0.0	0.0	0.0	0.0
12	22	48.0	1.74	0.11E-02	0.40E-02	0.10E-07	400.0	114.0	113.0	111.0	114.0	0.0	0.0	0.0	0.0
12	23	49.0	1.74	0.11E-02	0.36E-02	0.10E-07	360.0	117.0	116.0	114.0	117.0	0.0	0.0	0.0	0.0
12	24	51.0	1.39	0.11E-02	0.34E-02	0.10E-07	340.0	117.0	116.0	114.0	117.0	0.0	0.0	0.0	0.0
12	25	52.0	1.39	0.11E-02	0.32E-02	0.20E-06	325.0	84.0	83.0	81.0	84.0	0.0	0.0	0.0	0.0
12	26	52.0	1.39	0.11E-02	0.31E-02	0.20E-06	310.0	56.0	55.0	53.0	56.0	0.0	-0.47	-0.66	0.0
12	27	55.0	1.39	0.11E-02	0.28E-02	0.20E-06	285.0	100.0	99.0	97.0	100.0	0.0	-1.31	-1.83	0.0
12	28	63.0	1.39	0.11E-02	0.26E-02	0.20E-06	260.0	105.0	104.0	102.0	105.0	0.0	-0.07	-0.09	0.0
12	29	67.0	1.39	0.11E-02	0.23E-02	0.20E-06	230.0	108.0	107.0	105.0	108.0	0.0	-2.49	-6.30	0.0
12	30	74.0	1.39	0.11E-02	0.22E-02	0.20E-06	220.0	90.0	89.0	87.0	90.0	0.0	-1.61	-3.57	0.0
12	31	80.5	1.39	0.11E-02	0.22E-02	0.20E-06	225.0	86.0	85.0	83.0	86.0	0.0	-9.83	-8.46	0.0
12	32	81.0	1.39	0.11E-02	0.22E-02	0.20E-06	225.0	115.0	114.0	112.0	115.0	0.0	0.0	0.0	0.0
13	5	4.0	1.39	0.11E-02	0.21E-02	0.50E-07	215.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	6	15.0	1.39	0.11E-02	0.22E-02	0.50E-07	225.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
13	7	18.0	1.39	0.11E-02	0.21E-02	0.50E-07	215.0	6.0	5.0	3.0	6.0	0.0	-1.76	-2.47	0.0
13	8	19.0	1.39	0.12E-02	0.24E-02	0.50E-07	240.0	25.0	24.0	22.0	25.0	0.0	-1.94	-3.85	0.0
13	9	20.0	1.39	0.12E-02	0.23E-02	0.10E-07	230.0	20.0	19.0	17.0	20.0	0.0	-0.94	-3.20	0.0
13	10	23.0	1.39	0.12E-02	0.22E-02	0.10E-07	220.0	35.0	34.0	32.0	35.0	0.0	-0.38	-1.32	0.0
13	11	26.0	1.39	0.12E-02	0.25E-02	0.10E-07	250.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
13	12	27.0	1.39	0.13E-02	0.28E-02	0.10E-07	280.0	100.0	99.0	97.0	100.0	0.0	-0.38	-0.94	0.0
13	13	29.0	1.39	0.13E-02	0.30E-02	0.10E-07	305.0	80.0	79.0	77.0	80.0	0.0	-0.44	-1.13	0.0
13	14	32.0	1.39	0.13E-02	0.31E-02	0.10E-07	315.0	95.0	94.0	92.0	95.0	0.0	-0.50	-1.22	0.0
13	15	35.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
13	16	38.0	1.39	0.13E-02	0.32E-02	0.10E-07	320.0	110.0	109.0	107.0	110.0	0.0	-0.55	-1.50	0.0
13	17	40.0	1.74	0.13E-02	0.34E-02	0.10E-07	340.0	120.0	119.0	117.0	120.0	0.0	-0.17	-0.24	0.0
13	18	42.0	1.74	0.12E-02	0.40E-02	0.10E-07	400.0	125.0	124.0	122.0	125.0	0.0	-0.50	-0.71	0.0
13	19	43.0	1.74	0.12E-02	0.43E-02	0.10E-07	430.0	122.0	121.0	119.0	122.0	0.0	0.0	0.0	0.0
13	20	44.0	1.74	0.12E-02	0.45E-02	0.10E-07	455.0	120.0	119.0	117.0	120.0	0.0	0.0	0.0	0.0
13	21	46.0	1.74	0.11E-02	0.45E-02	0.10E-07	455.0	114.0	113.0	111.0	114.0	0.0	-0.01	-0.32	0.0
13	22	47.0	1.74	0.11E-02	0.40E-02	0.10E-07	405.0	105.0	104.0	102.0	105.0	0.0	-0.10	-0.14	0.0
13	23	48.0	1.74	0.11E-02	0.38E-02	0.10E-07	385.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
13	24	51.0	1.39	0.11E-02	0.37E-02	0.10E-07	370.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
13	25	53.0	1.39	0.11E-02	0.35E-02	0.20E-06	350.0	113.0	112.0	110.0	113.0	0.0	0.0	0.0	0.0
13	26	54.0	1.39	0.11E-02	0.33E-02	0.20E-06	335.0	53.0	52.0	50.0	53.0	0.0	-0.55	-0.78	0.0
13	27	57.0	1.39	0.11E-02	0.29E-02	0.20E-06	290.0	85.0	84.0	82.0	85.0	0.0	-1.36	-1.90	0.0
13	28	63.0	1.39	0.12E-02	0.26E-02	0.20E-06	265.0	104.0	103.0	101.0	104.0	0.0	-0.27	-0.38	0.0
13	29	68.0	1.39	0.12E-02	0.24E-02	0.20E-06	245.0	108.0	107.0	105.0	108.0	0.0	-2.15	-3.01	0.0
13	30	75.0	1.39	0.12E-02	0.23E-02	0.20E-06	235.0	75.0	74.0	72.0	75.0	0.0	0.0	0.0	0.0
13	31	80.0	1.39	0.11E-02	0.22E-02	0.20E-06	225.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
13	32	80.5	1.39	0.11E-02	0.22E-02	0.20E-06	225.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
14	5	7.0	1.39	0.11E-02	0.22E-02	0.50E-07	225.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	6	17.0	1.39	0.11E-02	0.23E-02	0.50E-07	235.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
14	7	20.0	1.39	0.11E-02	0.24E-02	0.50E-07	240.0	20.0	19.0	17.0	20.0	0.0	-0.07	-0.09	0.0
14	8	21.0	1.39	0.12E-02	0.27E-02	0.50E-07	275.0	30.0	29.0	27.0	30.0	0.0	-0.87	-1.62	0.0
14	9	21.0	1.39	0.12E-02	0.25E-02	0.10E-07	250.0	15.0	14.0	12.0	15.0	0.0	-0.07	-0.09	0.0
14	10	23.0	1.39	0.12E-02	0.26E-02	0.10E-07	265.0	40.0	39.0	37.0	40.0	0.0	-2.52	-2.82	0.0
14	11	26.0	1.39	0.12E-02	0.27E-02	0.10E-07	275.0	65.0	64.0	62.0	65.0	0.0	-0.98	-2.54	0.0

NODE		POT. HEAD	T	S	S'	K'	B'	WATER TABLE ALT. (FT)				PUMPING RATE (CU.FT/SEC)			
								1975 STEADY	TRANSIENT CALIB.			1975 STEADY	TRANSIENT CALIB.		
ROW	COL.	(FT)	(SQ.FT /SEC)			(FT/SEC)	(FT)	STATE CALIB.	NOV.-DEC.	DEC.-MAY	MAY-OCT.	STATE CALIB.	NOV.-DEC.	DEC.-MAY	MAY-OCT.
14	12	27.0	1.39	0.13E-02	0.28E-02	0.10E-07	285.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
14	13	29.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	115.0	114.0	112.0	115.0	0.0	0.0	0.0	0.0
14	14	30.0	1.39	0.13E-02	0.32E-02	0.10E-07	325.0	110.0	109.0	107.0	110.0	0.0	-0.34	-0.47	0.0
14	15	34.0	1.39	0.13E-02	0.33E-02	0.10E-07	330.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
14	16	36.0	1.39	0.13E-02	0.33E-02	0.10E-07	335.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
14	17	39.0	1.39	0.13E-02	0.35E-02	0.10E-07	350.0	115.0	114.0	112.0	115.0	0.0	-0.17	-0.24	0.0
14	18	42.0	1.74	0.13E-02	0.39E-02	0.10E-07	395.0	117.0	116.0	114.0	117.0	0.0	-0.50	-0.71	0.0
14	19	43.0	1.74	0.12E-02	0.43E-02	0.10E-07	435.0	115.0	114.0	112.0	115.0	0.0	0.0	0.0	0.0
14	20	44.0	1.74	0.12E-02	0.45E-02	0.10E-07	450.0	116.0	115.0	113.0	116.0	0.0	0.0	0.0	0.0
14	21	46.0	1.74	0.12E-02	0.46E-02	0.10E-07	460.0	116.0	115.0	113.0	116.0	0.0	0.0	0.0	0.0
14	22	47.0	1.74	0.11E-02	0.45E-02	0.10E-07	450.0	107.0	106.0	104.0	107.0	0.0	0.0	0.0	0.0
14	23	48.0	1.74	0.11E-02	0.42E-02	0.10E-07	425.0	97.0	96.0	94.0	97.0	0.0	0.0	0.0	0.0
14	24	50.0	1.74	0.11E-02	0.40E-02	0.10E-07	400.0	106.0	105.0	103.0	106.0	0.0	0.0	0.0	0.0
14	25	52.0	1.39	0.11E-02	0.38E-02	0.10E-07	380.0	114.0	113.0	111.0	114.0	-1.98	-1.98	-1.98	-1.98
14	26	54.0	1.39	0.11E-02	0.36E-02	0.20E-06	360.0	49.0	48.0	46.0	49.0	0.0	-1.45	-2.48	0.0
14	27	58.0	1.39	0.12E-02	0.32E-02	0.20E-06	325.0	65.0	64.0	62.0	65.0	0.0	-0.71	-0.99	0.0
14	28	63.0	1.39	0.12E-02	0.28E-02	0.20E-06	280.0	103.0	102.0	100.0	103.0	0.0	-1.01	-1.41	0.0
14	29	68.0	1.39	0.12E-02	0.26E-02	0.20E-06	260.0	118.0	117.0	115.0	118.0	0.0	-1.75	-2.44	0.0
14	30	75.0	1.39	0.12E-02	0.25E-02	0.20E-06	250.0	70.0	69.0	67.0	70.0	0.0	-0.84	-1.36	0.0
14	31	79.5	1.39	0.12E-02	0.25E-02	0.20E-06	250.0	80.0	79.0	77.0	80.0	0.0	-2.52	-5.99	0.0
14	32	80.0	1.39	0.11E-02	0.23E-02	0.20E-06	235.0	83.0	82.0	80.0	83.0	0.0	0.0	0.0	0.0
15	5	10.0	1.39	0.11E-02	0.25E-02	0.50E-07	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	6	18.0	1.39	0.11E-02	0.25E-02	0.50E-07	250.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
15	7	21.0	1.39	0.11E-02	0.26E-02	0.50E-07	260.0	15.0	14.0	12.0	15.0	0.0	-0.96	-1.53	0.0
15	8	22.0	1.39	0.12E-02	0.29E-02	0.50E-07	295.0	10.0	9.0	7.0	10.0	0.0	-0.65	-1.32	0.0
15	9	23.0	1.39	0.12E-02	0.28E-02	0.10E-07	285.0	9.0	8.0	6.0	9.0	0.0	-0.71	-1.69	0.0
15	10	24.0	1.39	0.12E-02	0.28E-02	0.10E-07	285.0	55.0	54.0	52.0	55.0	0.0	-0.27	-2.26	0.0
15	11	26.0	1.39	0.12E-02	0.28E-02	0.10E-07	285.0	70.0	69.0	67.0	70.0	0.0	0.0	-4.51	0.0
15	12	27.0	1.39	0.13E-02	0.29E-02	0.10E-07	295.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
15	13	28.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
15	14	29.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	115.0	114.0	112.0	115.0	0.0	0.0	0.0	0.0
15	15	32.0	1.39	0.13E-02	0.32E-02	0.10E-07	325.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
15	16	36.0	1.39	0.13E-02	0.33E-02	0.10E-07	335.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
15	17	39.0	1.39	0.13E-02	0.35E-02	0.10E-07	350.0	105.0	104.0	102.0	105.0	0.0	-0.17	-0.24	0.0
15	18	42.0	1.74	0.13E-02	0.39E-02	0.10E-07	390.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
15	19	43.0	1.74	0.13E-02	0.40E-02	0.10E-07	400.0	113.0	112.0	110.0	113.0	0.0	0.0	0.0	0.0
15	20	44.0	1.74	0.12E-02	0.41E-02	0.10E-07	415.0	111.0	110.0	108.0	111.0	0.0	0.0	0.0	0.0
15	21	45.0	1.74	0.12E-02	0.43E-02	0.10E-07	430.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
15	22	47.0	1.74	0.12E-02	0.44E-02	0.10E-07	445.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
15	23	48.0	1.74	0.12E-02	0.42E-02	0.10E-07	420.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
15	24	50.0	1.74	0.12E-02	0.41E-02	0.10E-07	410.0	97.0	96.0	94.0	97.0	0.0	-1.09	-0.94	0.0
15	25	52.0	1.39	0.12E-02	0.40E-02	0.10E-07	400.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
15	26	54.0	1.39	0.12E-02	0.38E-02	0.20E-06	380.0	75.0	74.0	72.0	75.0	-1.41	-1.41	-1.41	-1.41
15	27	57.0	1.39	0.12E-02	0.33E-02	0.20E-06	330.0	47.0	46.0	44.0	47.0	0.0	0.0	0.0	0.0
15	28	61.0	1.39	0.12E-02	0.28E-02	0.20E-06	285.0	101.0	100.0	98.0	101.0	0.0	-1.13	-1.57	0.0
15	29	67.0	1.39	0.12E-02	0.27E-02	0.20E-06	275.0	104.0	103.0	101.0	104.0	0.0	-2.03	-3.41	0.0
15	30	73.0	1.39	0.12E-02	0.27E-02	0.20E-06	275.0	65.0	64.0	62.0	65.0	0.0	-1.65	-2.30	0.0
15	31	76.5	1.39	0.12E-02	0.27E-02	0.20E-06	270.0	75.0	74.0	72.0	75.0	0.0	-1.68	-2.35	0.0
15	32	77.0	1.39	0.11E-02	0.26E-02	0.20E-06	260.0	80.0	79.0	77.0	80.0	0.0	0.0	0.0	0.0
16	4	2.0	1.39	0.11E-02	0.27E-02	0.50E-07	275.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	5	13.0	1.39	0.11E-02	0.27E-02	0.50E-07	275.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
16	6	19.0	1.39	0.11E-02	0.27E-02	0.50E-07	275.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
16	7	21.0	1.39	0.11E-02	0.27E-02	0.50E-07	270.0	2.0	1.0	0.0	2.0	0.0	-0.11	-0.38	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.-DEC.	WATER TABLE ALT. (FT) TRANSIENT CALIB. DEC.-MAY	WATER TABLE ALT. (FT) TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.-DEC.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. DEC.-MAY	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. MAY-OCT.
16	8	22.0	1.39	0.12E-02	0.29E-02	0.50E-07	295.0	8.0	7.0	5.0	8.0	0.0	-0.13	-0.19	0.0
16	9	23.0	1.39	0.12E-02	0.29E-02	0.10E-07	290.0	15.0	14.0	12.0	15.0	0.0	-0.82	-1.83	0.0
16	10	24.0	1.39	0.12E-02	0.29E-02	0.10E-07	290.0	50.0	49.0	47.0	50.0	0.0	-0.41	-3.62	0.0
16	11	26.0	1.39	0.12E-02	0.30E-02	0.10E-07	300.0	65.0	64.0	62.0	65.0	0.0	0.0	-9.68	0.0
16	12	27.0	1.39	0.13E-02	0.30E-02	0.10E-07	305.0	70.0	69.0	67.0	70.0	0.0	-0.27	-0.85	0.0
16	13	28.0	1.39	0.13E-02	0.30E-02	0.10E-07	305.0	100.0	99.0	97.0	100.0	0.0	0.0	0.0	0.0
16	14	29.0	1.39	0.13E-02	0.30E-02	0.10E-07	300.0	95.0	94.0	92.0	95.0	0.0	0.0	0.0	0.0
16	15	31.0	1.39	0.14E-02	0.30E-02	0.10E-07	300.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
16	16	35.0	1.39	0.14E-02	0.33E-02	0.10E-07	330.0	85.0	84.0	82.0	85.0	0.0	0.0	-0.47	0.0
16	17	38.0	1.39	0.14E-02	0.35E-02	0.10E-07	350.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
16	18	41.0	1.74	0.13E-02	0.36E-02	0.10E-07	365.0	110.0	109.0	107.0	110.0	0.0	0.0	0.0	0.0
16	19	42.0	1.74	0.13E-02	0.37E-02	0.10E-07	375.0	105.0	104.0	102.0	105.0	0.0	-2.17	-6.06	0.0
16	20	43.0	1.74	0.13E-02	0.37E-02	0.10E-07	370.0	100.0	99.0	97.0	100.0	0.0	-1.95	-5.45	0.0
16	21	44.0	1.74	0.13E-02	0.38E-02	0.10E-07	380.0	87.0	86.0	84.0	87.0	0.0	0.0	0.0	0.0
16	22	46.0	1.74	0.12E-02	0.43E-02	0.10E-07	430.0	92.0	91.0	89.0	92.0	0.0	-0.15	-0.21	0.0
16	23	48.0	1.74	0.12E-02	0.42E-02	0.10E-07	420.0	103.0	102.0	100.0	103.0	0.0	0.0	0.0	0.0
16	24	49.0	1.74	0.12E-02	0.39E-02	0.10E-07	390.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
16	25	51.0	1.39	0.12E-02	0.39E-02	0.10E-07	390.0	105.0	104.0	102.0	105.0	0.0	0.0	0.0	0.0
16	26	53.0	1.39	0.12E-02	0.36E-02	0.50E-07	365.0	45.0	44.0	42.0	45.0	0.0	0.0	0.0	0.0
16	27	55.0	1.39	0.12E-02	0.33E-02	0.20E-06	330.0	76.0	75.0	73.0	76.0	0.0	-0.86	-1.20	0.0
16	28	59.0	1.39	0.12E-02	0.30E-02	0.20E-06	300.0	93.0	92.0	90.0	93.0	0.0	-1.16	-1.62	0.0
16	29	65.0	1.39	0.12E-02	0.30E-02	0.20E-06	305.0	78.0	77.0	75.0	78.0	0.0	-0.40	-0.56	0.0
16	30	71.0	1.39	0.12E-02	0.29E-02	0.20E-06	295.0	55.0	54.0	52.0	55.0	0.0	-0.40	-1.13	0.0
16	31	73.5	1.39	0.12E-02	0.28E-02	0.20E-06	285.0	65.0	64.0	62.0	65.0	0.0	-0.40	-1.13	0.0
16	32	74.0	1.39	0.12E-02	0.29E-02	0.20E-06	290.0	78.0	77.0	75.0	78.0	0.0	0.0	0.0	0.0
17	4	4.0	1.39	0.11E-02	0.29E-02	0.50E-07	295.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	5	14.0	1.39	0.11E-02	0.29E-02	0.50E-07	295.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
17	6	18.0	1.39	0.11E-02	0.29E-02	0.50E-07	295.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
17	7	19.0	1.39	0.11E-02	0.27E-02	0.50E-07	275.0	10.0	9.0	7.0	10.0	0.0	-0.42	-0.59	0.0
17	8	21.0	1.39	0.12E-02	0.29E-02	0.50E-07	290.0	15.0	14.0	12.0	15.0	0.0	-0.60	-1.26	0.0
17	9	23.0	1.39	0.12E-02	0.30E-02	0.10E-07	300.0	20.0	19.0	17.0	20.0	0.0	-1.20	-3.01	0.0
17	10	24.0	1.39	0.12E-02	0.30E-02	0.10E-07	300.0	30.0	29.0	27.0	30.0	0.0	-0.55	-1.41	0.0
17	11	26.0	1.39	0.13E-02	0.30E-02	0.10E-07	305.0	40.0	39.0	37.0	40.0	0.0	-1.04	-1.46	0.0
17	12	27.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
17	13	28.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	90.0	89.0	87.0	90.0	0.0	0.0	0.0	0.0
17	14	29.0	1.39	0.13E-02	0.30E-02	0.10E-07	300.0	70.0	69.0	67.0	70.0	0.0	0.0	0.0	0.0
17	15	31.0	1.39	0.14E-02	0.30E-02	0.10E-07	300.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
17	16	35.0	1.39	0.14E-02	0.33E-02	0.10E-07	330.0	90.0	89.0	87.0	90.0	0.0	-0.50	-2.12	0.0
17	17	37.0	1.39	0.14E-02	0.34E-02	0.10E-07	345.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
17	18	40.0	1.74	0.14E-02	0.33E-02	0.10E-07	335.0	95.0	94.0	92.0	95.0	0.0	0.0	0.0	0.0
17	19	42.0	1.74	0.14E-02	0.32E-02	0.10E-07	320.0	88.0	87.0	85.0	88.0	0.0	-1.82	-5.08	0.0
17	20	43.0	1.74	0.14E-02	0.32E-02	0.10E-07	320.0	85.0	84.0	82.0	85.0	0.0	-1.26	-3.15	0.0
17	21	44.0	1.74	0.13E-02	0.34E-02	0.10E-07	340.0	81.0	80.0	78.0	81.0	0.0	-0.57	-0.80	0.0
17	22	45.0	1.74	0.13E-02	0.39E-02	0.10E-07	390.0	76.0	75.0	73.0	76.0	0.0	-0.59	-1.65	0.0
17	23	47.0	1.74	0.13E-02	0.40E-02	0.10E-07	405.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
17	24	48.0	1.74	0.12E-02	0.38E-02	0.10E-07	385.0	80.0	79.0	77.0	80.0	0.0	-0.50	-0.71	0.0
17	25	50.0	5.79	0.12E-02	0.36E-02	0.10E-07	360.0	40.0	39.0	37.0	40.0	0.0	-0.15	-0.21	0.0
17	26	52.0	1.39	0.12E-02	0.34E-02	0.50E-07	340.0	44.0	43.0	41.0	44.0	-0.05	-0.05	-0.05	-0.05
17	27	54.0	1.39	0.12E-02	0.32E-02	0.20E-06	320.0	55.0	54.0	52.0	55.0	0.0	0.0	0.0	0.0
17	28	58.0	1.39	0.13E-02	0.30E-02	0.20E-06	300.0	68.0	67.0	65.0	68.0	0.0	-0.44	-0.61	0.0
17	29	63.0	1.39	0.13E-02	0.32E-02	0.20E-06	325.0	73.0	72.0	70.0	73.0	0.0	-2.77	-7.76	0.0
17	30	68.0	1.39	0.13E-02	0.32E-02	0.20E-06	320.0	65.0	64.0	62.0	65.0	0.0	-0.29	-0.80	0.0
17	31	71.0	1.39	0.12E-02	0.30E-02	0.20E-06	300.0	73.0	72.0	70.0	73.0	0.0	-2.34	-6.09	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. (FT) TRANSIENT CALIB. NOV.-DEC.	WATER TABLE ALT. (FT) TRANSIENT CALIB. DEC.-MAY	WATER TABLE ALT. (FT) TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. NOV.-DEC.	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. DEC.-MAY	PUMPING RATE (CU.FT/SEC) TRANSIENT CALIB. MAY-OCT.
17	32	72.0	1.39	0.12E-02	0.31E-02	0.20E-06	315.0	81.0	80.0	78.0	81.0	0.0	0.0	0.0	0.0
18	4	5.0	1.39	0.11E-02	0.30E-02	0.50E-07	300.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	5	13.0	1.39	0.11E-02	0.30E-02	0.50E-07	300.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
18	6	17.0	1.39	0.11E-02	0.30E-02	0.50E-07	300.0	15.0	14.0	12.0	15.0	0.0	-1.31	-2.59	0.0
18	7	19.0	1.39	0.11E-02	0.31E-02	0.50E-07	310.0	20.0	19.0	17.0	20.0	0.0	-0.87	-1.25	0.0
18	8	21.0	1.39	0.12E-02	0.31E-02	0.50E-07	315.0	25.0	24.0	22.0	25.0	0.0	-0.66	-1.69	0.0
18	9	23.0	1.39	0.12E-02	0.33E-02	0.10E-07	330.0	40.0	39.0	37.0	40.0	0.0	-0.76	-1.95	0.0
18	10	24.0	1.39	0.12E-02	0.32E-02	0.10E-07	325.0	60.0	59.0	57.0	60.0	0.0	-1.09	-2.82	0.0
18	11	26.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	75.0	74.0	72.0	75.0	0.0	-1.09	-2.73	0.0
18	12	27.0	1.39	0.13E-02	0.31E-02	0.10E-07	310.0	75.0	74.0	72.0	75.0	0.0	0.0	0.0	0.0
18	13	28.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
18	14	29.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	75.0	74.0	72.0	75.0	0.0	0.0	0.0	0.0
18	15	33.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	80.0	79.0	77.0	80.0	0.0	-1.69	-4.51	0.0
18	16	35.0	1.39	0.14E-02	0.33E-02	0.10E-07	330.0	70.0	69.0	67.0	70.0	0.0	-0.50	-1.22	0.0
18	17	37.0	1.39	0.14E-02	0.32E-02	0.10E-07	325.0	70.0	69.0	67.0	70.0	0.0	0.0	0.0	0.0
18	18	39.0	1.74	0.14E-02	0.30E-02	0.10E-07	300.0	80.0	79.0	77.0	80.0	0.0	0.0	0.0	0.0
18	19	41.0	1.74	0.14E-02	0.27E-02	0.10E-07	270.0	76.0	75.0	73.0	76.0	0.0	0.0	0.0	0.0
18	20	42.0	1.74	0.14E-02	0.26E-02	0.10E-07	260.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
18	21	43.0	1.74	0.14E-02	0.28E-02	0.10E-07	280.0	76.0	75.0	73.0	76.0	0.0	-1.61	-3.57	0.0
18	22	44.0	1.74	0.14E-02	0.34E-02	0.10E-07	340.0	73.0	72.0	70.0	73.0	0.0	0.0	0.0	0.0
18	23	46.0	1.74	0.13E-02	0.38E-02	0.10E-07	380.0	74.0	73.0	71.0	74.0	0.0	-0.59	-1.65	0.0
18	24	47.0	5.79	0.13E-02	0.37E-02	0.10E-07	375.0	68.0	67.0	65.0	68.0	0.0	-0.66	-0.92	0.0
18	25	48.0	5.79	0.13E-02	0.35E-02	0.10E-07	350.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
18	26	50.0	1.39	0.13E-02	0.33E-02	0.50E-07	330.0	64.0	63.0	61.0	64.0	0.0	-0.24	-0.61	0.0
18	27	53.0	1.39	0.13E-02	0.30E-02	0.20E-06	300.0	66.0	65.0	63.0	66.0	0.0	-1.04	-1.69	0.0
18	28	56.0	1.39	0.13E-02	0.30E-02	0.20E-06	300.0	65.0	64.0	62.0	65.0	0.0	-1.21	-2.26	0.0
18	29	60.0	1.39	0.13E-02	0.34E-02	0.20E-06	340.0	55.0	54.0	52.0	55.0	0.0	-1.48	-2.40	0.0
18	30	67.0	1.39	0.13E-02	0.35E-02	0.20E-06	350.0	60.0	59.0	57.0	60.0	0.0	-0.30	-0.85	0.0
18	31	68.5	1.39	0.12E-02	0.31E-02	0.20E-06	315.0	86.0	85.0	83.0	86.0	0.0	0.0	0.0	0.0
18	32	69.0	1.39	0.12E-02	0.33E-02	0.20E-06	335.0	88.0	87.0	85.0	88.0	0.0	0.0	0.0	0.0
19	4	5.0	1.39	0.11E-02	0.30E-02	0.50E-07	305.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	5	12.0	1.39	0.11E-02	0.30E-02	0.50E-07	305.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	6	17.0	1.39	0.11E-02	0.30E-02	0.50E-07	305.0	10.0	9.0	7.0	10.0	-1.00	-2.21	-2.30	-1.00
19	7	19.0	1.39	0.11E-02	0.32E-02	0.50E-07	325.0	20.0	19.0	17.0	20.0	0.0	-0.54	-0.82	0.0
19	8	22.0	1.39	0.12E-02	0.34E-02	0.50E-07	340.0	15.0	14.0	12.0	15.0	0.0	-0.38	-0.94	0.0
19	9	23.0	1.39	0.12E-02	0.35E-02	0.50E-07	355.0	30.0	29.0	27.0	30.0	0.0	-0.89	-2.16	0.0
19	10	25.0	1.39	0.13E-02	0.34E-02	0.10E-07	340.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
19	11	27.0	1.39	0.13E-02	0.32E-02	0.10E-07	320.0	75.0	74.0	72.0	75.0	0.0	-0.44	-2.26	0.0
19	12	28.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
19	13	29.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	80.0	79.0	77.0	80.0	0.0	0.0	0.0	0.0
19	14	30.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	65.0	64.0	62.0	65.0	0.0	0.0	0.0	0.0
19	15	32.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	75.0	74.0	72.0	75.0	0.0	0.0	0.0	0.0
19	16	35.0	1.39	0.14E-02	0.30E-02	0.10E-07	305.0	55.0	54.0	52.0	55.0	0.0	0.0	0.0	0.0
19	17	37.0	1.39	0.14E-02	0.29E-02	0.10E-07	295.0	60.0	59.0	57.0	60.0	0.0	-0.27	-0.75	0.0
19	18	39.0	1.74	0.15E-02	0.28E-02	0.10E-07	280.0	75.0	74.0	72.0	75.0	0.0	-0.17	-0.35	0.0
19	19	41.0	1.74	0.15E-02	0.26E-02	0.10E-07	260.0	75.0	74.0	72.0	75.0	0.0	0.0	0.0	0.0
19	20	42.0	1.74	0.15E-02	0.25E-02	0.10E-07	250.0	64.0	63.0	61.0	64.0	0.0	-0.20	-0.28	0.0
19	21	43.0	1.74	0.15E-02	0.25E-02	0.10E-07	250.0	70.0	69.0	67.0	70.0	0.0	-0.67	-0.94	0.0
19	22	44.0	1.74	0.14E-02	0.33E-02	0.10E-07	330.0	82.0	81.0	79.0	82.0	0.0	0.0	0.0	0.0
19	23	46.0	5.79	0.14E-02	0.36E-02	0.10E-07	360.0	74.0	73.0	71.0	74.0	0.0	-1.21	-1.69	0.0
19	24	47.0	5.79	0.14E-02	0.36E-02	0.10E-07	360.0	50.0	49.0	47.0	50.0	0.0	-0.54	-0.75	0.0
19	25	48.0	5.79	0.13E-02	0.35E-02	0.50E-07	355.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
19	26	49.0	5.79	0.13E-02	0.32E-02	0.50E-07	325.0	65.0	64.0	62.0	65.0	0.0	-0.13	-0.19	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.-DEC.	TRANSIENT CALIB. DEC.-MAY	TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.-DEC.	TRANSIENT CALIB. DEC.-MAY	TRANSIENT CALIB. MAY-OCT.
19	27	51.0	1.39	0.13E-02	0.32E-02	0.50E-07	325.0	67.0	66.0	64.0	67.0	0.0	-0.71	-0.99	0.0
19	28	55.0	1.39	0.13E-02	0.33E-02	0.20E-06	330.0	64.0	63.0	61.0	64.0	0.0	-0.74	-1.79	0.0
19	29	60.0	1.39	0.13E-02	0.37E-02	0.20E-06	370.0	50.0	49.0	47.0	50.0	0.0	-1.11	-1.55	0.0
19	30	65.0	1.39	0.13E-02	0.38E-02	0.20E-06	380.0	75.0	74.0	72.0	75.0	0.0	-2.46	-6.89	0.0
19	31	67.0	1.39	0.12E-02	0.34E-02	0.20E-06	340.0	85.0	84.0	82.0	85.0	0.0	-2.19	-5.64	0.0
19	32	67.5	1.39	0.12E-02	0.36E-02	0.20E-06	360.0	88.0	87.0	85.0	88.0	0.0	0.0	0.0	0.0
20	5	12.0	1.39	0.11E-02	0.31E-02	0.50E-07	310.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	6	17.0	1.39	0.11E-02	0.31E-02	0.50E-07	310.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
20	7	20.0	1.39	0.11E-02	0.35E-02	0.50E-07	350.0	15.0	14.0	12.0	15.0	0.0	-0.22	-0.56	0.0
20	8	23.0	1.39	0.12E-02	0.36E-02	0.50E-07	360.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
20	9	25.0	1.39	0.12E-02	0.36E-02	0.50E-07	360.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
20	10	26.0	1.39	0.13E-02	0.33E-02	0.10E-07	335.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
20	11	27.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	65.0	64.0	62.0	65.0	0.0	0.0	0.0	0.0
20	12	29.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	80.0	79.0	77.0	80.0	0.0	0.0	0.0	0.0
20	13	30.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	65.0	64.0	62.0	65.0	0.0	0.0	0.0	0.0
20	14	31.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	55.0	54.0	52.0	55.0	0.0	-0.44	-1.13	0.0
20	15	33.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	45.0	44.0	42.0	45.0	0.0	0.0	0.0	0.0
20	16	36.0	1.39	0.15E-02	0.30E-02	0.10E-07	305.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
20	17	38.0	1.39	0.15E-02	0.29E-02	0.10E-07	295.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
20	18	40.0	1.74	0.15E-02	0.28E-02	0.10E-07	280.0	70.0	69.0	67.0	70.0	0.0	-0.16	-0.38	0.0
20	19	41.0	1.74	0.15E-02	0.26E-02	0.10E-07	260.0	77.0	76.0	74.0	77.0	0.0	-0.15	-0.21	0.0
20	20	42.0	1.74	0.15E-02	0.26E-02	0.10E-07	260.0	75.0	74.0	72.0	75.0	0.0	-0.57	-0.80	0.0
20	21	43.0	1.74	0.15E-02	0.27E-02	0.10E-07	270.0	63.0	62.0	60.0	63.0	0.0	-0.54	-0.75	0.0
20	22	44.0	1.74	0.15E-02	0.32E-02	0.10E-07	325.0	82.0	81.0	79.0	82.0	0.0	-0.20	-0.28	0.0
20	23	46.0	5.79	0.15E-02	0.35E-02	0.10E-07	350.0	67.0	66.0	64.0	67.0	0.0	-1.56	-2.19	0.0
20	24	47.0	5.79	0.14E-02	0.33E-02	0.10E-07	330.0	45.0	44.0	42.0	45.0	0.0	0.0	0.0	0.0
20	25	47.8	5.79	0.14E-02	0.32E-02	0.50E-07	320.0	27.0	26.0	24.0	27.0	0.0	0.0	0.0	0.0
20	26	49.0	5.79	0.14E-02	0.32E-02	0.50E-07	325.0	47.0	46.0	44.0	47.0	0.0	-0.32	-0.82	0.0
20	27	50.0	1.39	0.13E-02	0.36E-02	0.50E-07	360.0	50.0	49.0	47.0	50.0	0.0	-0.35	-0.49	0.0
20	28	54.0	1.39	0.13E-02	0.38E-02	0.20E-06	380.0	48.0	47.0	45.0	48.0	0.0	-0.20	-0.28	0.0
20	29	58.0	1.39	0.13E-02	0.41E-02	0.20E-06	415.0	70.0	69.0	67.0	70.0	0.0	-0.31	-0.43	0.0
20	30	62.0	1.39	0.13E-02	0.41E-02	0.20E-06	410.0	77.0	76.0	74.0	77.0	0.0	-1.08	-2.54	0.0
20	31	65.0	1.39	0.13E-02	0.36E-02	0.20E-06	360.0	78.0	77.0	75.0	78.0	0.0	-3.21	-7.90	0.0
20	32	65.5	1.39	0.13E-02	0.37E-02	0.20E-06	370.0	88.0	87.0	85.0	88.0	0.0	0.0	0.0	0.0
21	5	10.0	1.39	0.11E-02	0.31E-02	0.50E-07	315.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	6	17.0	1.39	0.11E-02	0.31E-02	0.50E-07	315.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
21	7	22.0	1.39	0.12E-02	0.35E-02	0.50E-07	350.0	8.0	7.0	5.0	8.0	0.0	-0.76	-0.82	0.0
21	8	23.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	28.0	27.0	25.0	28.0	0.0	0.0	0.0	0.0
21	9	25.0	1.39	0.12E-02	0.35E-02	0.50E-07	350.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
21	10	27.0	1.39	0.13E-02	0.31E-02	0.10E-07	315.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
21	11	30.0	1.39	0.14E-02	0.30E-02	0.10E-07	305.0	60.0	59.0	57.0	60.0	-4.68	-4.68	-7.12	-4.68
21	12	31.0	1.39	0.14E-02	0.30E-02	0.10E-07	305.0	65.0	64.0	62.0	65.0	-6.32	-6.32	-6.32	-6.32
21	13	32.0	1.39	0.14E-02	0.31E-02	0.10E-07	315.0	65.0	64.0	62.0	65.0	0.0	-1.31	-3.57	0.0
21	14	33.0	1.39	0.14E-02	0.32E-02	0.10E-07	320.0	40.0	39.0	37.0	40.0	0.0	-0.27	-0.75	0.0
21	15	35.0	1.39	0.15E-02	0.32E-02	0.10E-07	320.0	35.0	34.0	32.0	35.0	0.0	-0.07	-0.09	0.0
21	16	37.0	1.39	0.15E-02	0.32E-02	0.10E-07	320.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
21	17	38.0	1.39	0.15E-02	0.31E-02	0.10E-07	310.0	55.0	54.0	52.0	55.0	0.0	0.0	0.0	0.0
21	18	40.0	1.74	0.15E-02	0.29E-02	0.10E-07	295.0	76.0	75.0	73.0	76.0	0.0	0.0	0.0	0.0
21	19	41.5	1.74	0.15E-02	0.27E-02	0.10E-07	275.0	76.0	75.0	73.0	76.0	0.0	0.0	0.0	0.0
21	20	42.5	1.74	0.15E-02	0.26E-02	0.10E-07	265.0	80.0	79.0	77.0	80.0	0.0	-0.20	-0.28	0.0
21	21	43.5	1.74	0.15E-02	0.27E-02	0.10E-07	275.0	60.0	59.0	57.0	60.0	0.0	-1.18	-1.72	0.0
21	22	45.1	5.79	0.15E-02	0.31E-02	0.10E-07	310.0	70.0	69.0	67.0	70.0	0.0	-0.52	-0.73	0.0
21	23	46.2	5.79	0.15E-02	0.31E-02	0.10E-07	310.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	WATER TABLE ALT. TRANSIENT CALIB. NOV.- DEC.	DEC.- MAY	MAY- OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	PUMPING RATE TRANSIENT CALIB. NOV.- DEC.	DEC.- MAY	MAY- OCT.
21	24	47.3	5.79	0.15E-02	0.31E-02	0.50E-07	315.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
21	25	47.9	5.79	0.14E-02	0.33E-02	0.50E-07	330.0	26.0	25.0	23.0	26.0	0.0	0.0	0.0	0.0
21	26	48.8	5.79	0.14E-02	0.37E-02	0.50E-07	370.0	30.0	29.0	27.0	30.0	0.0	-0.30	-0.85	0.0
21	27	49.9	5.79	0.14E-02	0.39E-02	0.50E-07	395.0	62.0	61.0	59.0	62.0	0.0	-6.55	-5.64	0.0
21	28	53.0	1.39	0.13E-02	0.42E-02	0.20E-06	420.0	70.0	69.0	67.0	70.0	0.0	0.0	0.0	0.0
21	29	56.0	1.39	0.13E-02	0.44E-02	0.20E-06	445.0	75.0	74.0	72.0	75.0	0.0	-1.18	-2.35	0.0
21	30	60.0	1.39	0.13E-02	0.42E-02	0.20E-06	425.0	91.0	90.0	88.0	91.0	0.0	-3.16	-8.84	0.0
21	31	61.0	1.39	0.13E-02	0.36E-02	0.20E-06	365.0	84.0	83.0	81.0	84.0	0.0	-16.65	-15.89	0.0
21	32	62.0	1.39	0.13E-02	0.38E-02	0.20E-06	385.0	87.0	86.0	84.0	87.0	0.0	0.0	0.0	0.0
22	5	10.0	1.39	0.11E-02	0.32E-02	0.50E-07	320.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	6	17.0	1.39	0.11E-02	0.32E-02	0.50E-07	320.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
22	7	22.0	1.39	0.12E-02	0.36E-02	0.50E-07	360.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
22	8	24.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	15.0	14.0	12.0	15.0	0.0	-0.76	-0.82	0.0
22	9	26.0	1.39	0.13E-02	0.34E-02	0.50E-07	340.0	25.0	24.0	22.0	25.0	0.0	0.0	-0.35	0.0
22	10	27.0	1.39	0.13E-02	0.31E-02	0.50E-07	310.0	35.0	34.0	32.0	35.0	0.0	-0.30	-4.67	0.0
22	11	30.0	1.39	0.14E-02	0.27E-02	0.10E-07	270.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
22	12	32.0	1.39	0.14E-02	0.31E-02	0.10E-07	310.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
22	13	33.0	1.39	0.15E-02	0.33E-02	0.10E-07	330.0	16.0	15.0	13.0	16.0	0.0	-0.37	-0.52	0.0
22	14	35.0	1.39	0.15E-02	0.33E-02	0.10E-07	335.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
22	15	36.0	1.39	0.15E-02	0.34E-02	0.10E-07	340.0	40.0	39.0	37.0	40.0	0.0	-0.12	-0.16	0.0
22	16	38.0	1.39	0.15E-02	0.34E-02	0.10E-07	340.0	60.0	59.0	57.0	60.0	0.0	-0.20	-0.56	0.0
22	17	40.0	1.39	0.15E-02	0.30E-02	0.10E-07	300.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
22	18	41.0	1.74	0.15E-02	0.31E-02	0.10E-07	310.0	71.0	70.0	68.0	71.0	0.0	0.0	0.0	0.0
22	19	42.0	1.74	0.15E-02	0.30E-02	0.10E-07	305.0	71.0	70.0	68.0	71.0	0.0	0.0	-0.47	0.0
22	20	43.0	1.74	0.16E-02	0.29E-02	0.10E-07	295.0	70.0	69.0	67.0	70.0	0.0	-0.66	-1.65	0.0
22	21	44.0	1.74	0.15E-02	0.29E-02	0.10E-07	295.0	68.0	67.0	65.0	68.0	0.0	-0.07	-0.09	0.0
22	22	45.3	5.79	0.15E-02	0.31E-02	0.10E-07	310.0	58.0	57.0	55.0	58.0	0.0	-0.54	-1.50	0.0
22	23	46.5	5.79	0.15E-02	0.32E-02	0.50E-07	325.0	63.0	62.0	60.0	63.0	0.0	-2.71	-4.42	0.0
22	24	47.5	5.79	0.15E-02	0.33E-02	0.50E-07	330.0	62.0	61.0	59.0	62.0	0.0	-1.41	-2.54	0.0
22	25	48.2	5.79	0.14E-02	0.34E-02	0.50E-07	340.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
22	26	49.0	5.79	0.14E-02	0.38E-02	0.50E-07	385.0	50.0	49.0	47.0	50.0	0.0	-0.20	-0.28	0.0
22	27	49.7	5.79	0.14E-02	0.42E-02	0.50E-07	420.0	77.0	76.0	74.0	77.0	0.0	0.0	0.0	0.0
22	28	51.0	1.39	0.14E-02	0.45E-02	0.20E-06	450.0	78.0	77.0	75.0	78.0	0.0	0.0	0.0	0.0
22	29	54.0	1.39	0.13E-02	0.46E-02	0.20E-06	460.0	77.0	76.0	74.0	77.0	0.0	-0.61	-1.69	0.0
22	30	56.0	1.39	0.13E-02	0.43E-02	0.20E-06	430.0	91.0	90.0	88.0	91.0	0.0	-0.34	-0.94	0.0
22	31	59.0	1.39	0.13E-02	0.38E-02	0.30E-06	385.0	85.0	84.0	82.0	85.0	0.0	-0.50	-1.41	0.0
22	32	59.5	1.39	0.13E-02	0.40E-02	0.30E-06	405.0	85.0	84.0	82.0	85.0	0.0	0.0	0.0	0.0
23	5	9.0	1.39	0.11E-02	0.33E-02	0.50E-07	330.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	6	17.0	1.39	0.11E-02	0.33E-02	0.50E-07	330.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
23	7	22.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	3.0	2.0	0.0	3.0	0.0	0.0	-0.11	0.0
23	8	24.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	20.0	19.0	17.0	20.0	0.0	-0.32	-0.41	0.0
23	9	27.0	1.39	0.13E-02	0.37E-02	0.50E-07	370.0	25.0	24.0	22.0	25.0	0.0	-2.48	-2.13	0.0
23	10	28.0	1.39	0.14E-02	0.33E-02	0.50E-07	335.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
23	11	31.0	1.39	0.14E-02	0.31E-02	0.50E-07	310.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
23	12	33.0	1.39	0.15E-02	0.31E-02	0.10E-07	315.0	15.0	14.0	12.0	15.0	0.0	0.0	0.0	0.0
23	13	34.0	1.39	0.15E-02	0.32E-02	0.10E-07	325.0	18.0	17.0	15.0	18.0	0.0	0.0	0.0	0.0
23	14	36.0	1.39	0.15E-02	0.33E-02	0.10E-07	330.0	40.0	39.0	37.0	40.0	0.0	-0.17	-0.47	0.0
23	15	38.0	1.39	0.15E-02	0.33E-02	0.10E-07	330.0	50.0	49.0	47.0	50.0	0.0	-0.50	-1.41	0.0
23	16	40.0	1.39	0.15E-02	0.33E-02	0.10E-07	330.0	55.0	54.0	52.0	55.0	0.0	-0.25	-0.71	0.0
23	17	41.0	1.74	0.16E-02	0.30E-02	0.10E-07	305.0	65.0	64.0	62.0	65.0	0.0	0.0	0.0	0.0
23	18	42.0	1.74	0.16E-02	0.31E-02	0.10E-07	310.0	72.0	71.0	69.0	72.0	0.0	0.0	0.0	0.0
23	19	43.0	1.74	0.16E-02	0.33E-02	0.10E-07	330.0	72.0	71.0	69.0	72.0	0.0	0.0	-7.15	0.0
23	20	44.0	1.74	0.16E-02	0.33E-02	0.10E-07	330.0	67.0	66.0	64.0	67.0	0.0	-1.78	-15.04	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.-DEC.	TRANSIENT CALIB. DEC.-MAY	TRANSIENT CALIB. MAY-OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.-DEC.	TRANSIENT CALIB. DEC.-MAY	TRANSIENT CALIB. MAY-OCT.
23	21	45.0	5.79	0.16E-02	0.32E-02	0.50E-07	325.0	62.0	61.0	59.0	62.0	0.0	0.0	0.0	0.0
23	22	46.0	5.79	0.15E-02	0.32E-02	0.50E-07	325.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
23	23	47.0	5.79	0.15E-02	0.35E-02	0.50E-07	350.0	66.0	65.0	63.0	66.0	0.0	-0.71	-1.97	0.0
23	24	48.2	5.79	0.15E-02	0.36E-02	0.50E-07	365.0	60.0	59.0	57.0	60.0	0.0	-0.97	-1.46	0.0
23	25	49.0	5.79	0.14E-02	0.41E-02	0.50E-07	410.0	24.0	23.0	21.0	24.0	0.0	-0.60	-1.10	0.0
23	26	49.3	5.79	0.14E-02	0.44E-02	0.50E-07	445.0	55.0	54.0	52.0	55.0	0.0	-0.27	-0.38	0.0
23	27	49.6	5.79	0.14E-02	0.46E-02	0.50E-07	465.0	77.0	76.0	74.0	77.0	0.0	0.0	0.0	0.0
23	28	49.8	5.79	0.14E-02	0.47E-02	0.50E-07	470.0	83.0	82.0	80.0	83.0	0.0	0.0	0.0	0.0
23	29	51.0	1.39	0.13E-02	0.47E-02	0.30E-06	470.0	82.0	81.0	79.0	82.0	0.0	0.0	0.0	0.0
23	30	53.0	1.39	0.13E-02	0.44E-02	0.30E-06	440.0	89.0	88.0	86.0	89.0	0.0	-0.67	-1.88	0.0
23	31	55.0	1.39	0.13E-02	0.37E-02	0.30E-06	370.0	87.0	86.0	84.0	87.0	0.0	0.0	0.0	0.0
23	32	56.0	1.39	0.13E-02	0.43E-02	0.30E-06	435.0	88.0	87.0	85.0	88.0	0.0	0.0	0.0	0.0
24	6	15.0	1.39	0.12E-02	0.35E-02	0.50E-07	350.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
24	7	22.0	1.39	0.12E-02	0.40E-02	0.50E-07	400.0	9.0	8.0	6.0	9.0	0.0	0.0	0.0	0.0
24	8	24.0	1.39	0.12E-02	0.39E-02	0.50E-07	395.0	25.0	24.0	22.0	25.0	0.0	0.0	-0.57	0.0
24	9	27.0	1.39	0.13E-02	0.38E-02	0.50E-07	380.0	28.0	27.0	25.0	28.0	0.0	0.0	-0.06	0.0
24	10	28.0	1.39	0.14E-02	0.35E-02	0.50E-07	350.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
24	11	32.0	1.39	0.15E-02	0.32E-02	0.50E-07	320.0	15.0	14.0	12.0	15.0	0.0	0.0	0.0	0.0
24	12	33.0	1.39	0.15E-02	0.30E-02	0.50E-07	305.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
24	13	35.0	1.39	0.15E-02	0.30E-02	0.10E-07	305.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
24	14	37.0	1.39	0.15E-02	0.30E-02	0.10E-07	300.0	35.0	34.0	32.0	35.0	0.0	-0.34	-0.94	0.0
24	15	39.0	1.39	0.16E-02	0.30E-02	0.10E-07	300.0	45.0	44.0	42.0	45.0	0.0	-0.20	-0.56	0.0
24	16	41.0	1.74	0.16E-02	0.28E-02	0.10E-07	285.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
24	17	42.0	1.74	0.16E-02	0.28E-02	0.10E-07	280.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
24	18	43.0	1.74	0.16E-02	0.28E-02	0.10E-07	280.0	60.0	59.0	57.0	60.0	0.0	-0.44	-0.38	0.0
24	19	44.0	1.74	0.16E-02	0.30E-02	0.50E-07	300.0	60.0	59.0	57.0	60.0	0.0	0.0	0.0	0.0
24	20	45.0	5.79	0.16E-02	0.33E-02	0.50E-07	330.0	60.0	59.0	57.0	60.0	0.0	-0.10	-0.14	0.0
24	21	45.8	5.79	0.16E-02	0.35E-02	0.50E-07	350.0	52.0	51.0	49.0	52.0	0.0	-0.30	-0.42	0.0
24	22	46.8	5.79	0.16E-02	0.36E-02	0.50E-07	360.0	55.0	54.0	52.0	55.0	0.0	-0.54	-1.22	0.0
24	23	47.8	5.79	0.15E-02	0.37E-02	0.50E-07	375.0	58.0	57.0	55.0	58.0	0.0	-0.59	-1.29	0.0
24	24	48.9	5.79	0.15E-02	0.39E-02	0.50E-07	395.0	18.0	17.0	15.0	18.0	0.0	-1.32	-1.85	0.0
24	25	49.8	5.79	0.14E-02	0.45E-02	0.50E-07	450.0	23.0	22.0	20.0	23.0	0.0	-1.53	-2.99	0.0
24	26	50.0	5.79	0.14E-02	0.51E-02	0.50E-07	510.0	70.0	69.0	67.0	70.0	0.0	-0.89	-2.23	0.0
24	27	50.0	5.79	0.14E-02	0.52E-02	0.50E-07	520.0	76.0	75.0	73.0	76.0	0.0	-6.18	-8.84	0.0
24	28	49.4	5.79	0.14E-02	0.51E-02	0.50E-07	510.0	78.0	77.0	75.0	78.0	0.0	-4.84	-4.94	0.0
24	29	49.5	5.79	0.14E-02	0.48E-02	0.30E-06	485.0	81.0	80.0	78.0	81.0	0.0	-7.31	-7.46	0.0
24	30	50.0	5.79	0.14E-02	0.43E-02	0.30E-06	430.0	86.0	85.0	83.0	86.0	0.0	-7.19	-7.33	0.0
24	31	52.0	1.39	0.14E-02	0.38E-02	0.30E-06	385.0	88.0	87.0	85.0	88.0	0.0	-7.07	-7.21	0.0
24	32	53.0	1.39	0.13E-02	0.42E-02	0.30E-06	425.0	89.0	88.0	86.0	89.0	0.0	0.0	0.0	0.0
25	6	14.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
25	7	21.0	1.39	0.12E-02	0.40E-02	0.50E-07	400.0	1.0	0.0	0.0	1.0	0.0	-0.30	-0.33	0.0
25	8	24.0	1.39	0.13E-02	0.40E-02	0.50E-07	405.0	18.0	17.0	15.0	18.0	0.0	-1.01	-1.66	0.0
25	9	27.0	1.39	0.14E-02	0.37E-02	0.50E-07	375.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
25	10	28.0	1.39	0.14E-02	0.34E-02	0.50E-07	345.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
25	11	32.0	1.39	0.15E-02	0.31E-02	0.50E-07	315.0	14.0	13.0	11.0	14.0	0.0	0.0	0.0	0.0
25	12	34.0	1.39	0.16E-02	0.29E-02	0.50E-07	290.0	29.0	28.0	26.0	29.0	0.0	0.0	0.0	0.0
25	13	36.0	1.39	0.16E-02	0.28E-02	0.50E-07	280.0	32.0	31.0	29.0	32.0	0.0	0.0	0.0	0.0
25	14	38.0	1.39	0.16E-02	0.27E-02	0.50E-07	275.0	38.0	37.0	35.0	38.0	0.0	0.0	0.0	0.0
25	15	40.0	1.39	0.16E-02	0.27E-02	0.50E-07	270.0	40.0	39.0	37.0	40.0	0.0	0.0	0.0	0.0
25	16	41.0	1.74	0.17E-02	0.26E-02	0.50E-07	260.0	40.0	39.0	37.0	40.0	0.0	-0.07	-0.09	0.0
25	17	42.0	1.74	0.17E-02	0.25E-02	0.50E-07	250.0	41.0	40.0	38.0	41.0	0.0	0.0	0.0	0.0
25	18	43.0	1.74	0.17E-02	0.26E-02	0.50E-07	260.0	45.0	44.0	42.0	45.0	0.0	0.0	0.0	0.0
25	19	44.9	1.74	0.16E-02	0.27E-02	0.50E-07	275.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0

NODE		POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT)				PUMPING RATE (CU.FT/SEC)			
								1975 STEADY STATE CALIB.	TRANSIENT CALIB.			1975 STEADY STATE CALIB.	TRANSIENT CALIB.		
ROW	COL.								NOV.- DEC.	DEC.- MAY	MAY- OCT.		NOV.- DEC.	DEC.- MAY	MAY- OCT.
25	20	45.6	5.79	0.16E-02	0.31E-02	0.50E-07	310.0	48.0	47.0	45.0	48.0	0.0	-0.30	-0.42	0.0
25	21	46.3	5.79	0.16E-02	0.34E-02	0.50E-07	340.0	35.0	34.0	32.0	35.0	0.0	-0.27	-0.38	0.0
25	22	47.1	5.79	0.16E-02	0.37E-02	0.50E-07	370.0	51.0	50.0	48.0	51.0	0.0	0.0	0.0	0.0
25	23	48.2	5.79	0.15E-02	0.39E-02	0.50E-07	390.0	51.0	50.0	48.0	51.0	0.0	-1.11	-1.55	0.0
25	24	49.5	5.79	0.15E-02	0.42E-02	0.50E-07	425.0	17.0	16.0	14.0	17.0	0.0	-0.21	-0.29	0.0
25	25	50.0	5.79	0.14E-02	0.49E-02	0.50E-07	490.0	56.0	55.0	53.0	56.0	0.0	-1.17	-1.95	0.0
25	26	50.1	5.79	0.14E-02	0.55E-02	0.50E-07	550.0	66.0	65.0	63.0	66.0	0.0	-1.80	-5.03	0.0
25	27	50.1	5.79	0.14E-02	0.55E-02	0.50E-07	550.0	69.0	68.0	66.0	69.0	0.0	-2.29	-6.39	0.0
25	28	50.0	5.79	0.14E-02	0.52E-02	0.50E-07	525.0	73.0	72.0	70.0	73.0	0.0	-1.26	-3.53	0.0
25	29	49.9	5.79	0.14E-02	0.49E-02	0.30E-06	490.0	76.0	75.0	73.0	76.0	0.0	-2.24	-6.90	0.0
25	30	49.9	5.79	0.14E-02	0.43E-02	0.30E-06	430.0	80.0	79.0	77.0	80.0	0.0	-7.64	-7.79	0.0
25	31	49.8	5.79	0.14E-02	0.42E-02	0.30E-06	425.0	87.0	86.0	84.0	87.0	0.0	-7.39	-7.53	0.0
25	32	50.0	5.79	0.14E-02	0.44E-02	0.30E-06	440.0	87.0	86.0	84.0	87.0	0.0	0.0	0.0	0.0
26	6	13.0	1.39	0.12E-02	0.38E-02	0.50E-07	380.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	7	19.0	1.39	0.12E-02	0.37E-02	0.50E-07	375.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
26	8	23.0	1.39	0.13E-02	0.40E-02	0.50E-07	400.0	16.0	15.0	13.0	16.0	0.0	0.0	0.0	0.0
26	9	26.0	1.39	0.14E-02	0.37E-02	0.50E-07	370.0	18.0	17.0	15.0	18.0	0.0	0.0	0.0	0.0
26	10	28.0	1.39	0.15E-02	0.34E-02	0.50E-07	340.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
26	11	30.0	1.39	0.15E-02	0.31E-02	0.50E-07	310.0	21.0	20.0	18.0	21.0	0.0	0.0	0.0	0.0
26	12	33.0	1.39	0.16E-02	0.28E-02	0.50E-07	280.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
26	13	37.0	1.39	0.16E-02	0.26E-02	0.50E-07	265.0	31.0	30.0	28.0	31.0	0.0	0.0	0.0	0.0
26	14	39.0	1.39	0.17E-02	0.25E-02	0.50E-07	250.0	34.0	33.0	31.0	34.0	0.0	0.0	0.0	0.0
26	15	41.0	1.39	0.17E-02	0.24E-02	0.50E-07	240.0	38.0	37.0	35.0	38.0	0.0	0.0	0.0	0.0
26	16	42.0	1.74	0.17E-02	0.23E-02	0.50E-07	230.0	39.0	38.0	36.0	39.0	0.0	-0.13	-0.38	0.0
26	17	43.0	1.74	0.17E-02	0.23E-02	0.50E-07	230.0	37.0	36.0	34.0	37.0	0.0	-0.20	-0.56	0.0
26	18	44.0	1.74	0.17E-02	0.26E-02	0.50E-07	265.0	41.0	40.0	38.0	41.0	0.0	0.0	0.0	0.0
26	19	45.1	5.79	0.17E-02	0.28E-02	0.50E-07	280.0	47.0	46.0	44.0	47.0	0.0	0.0	0.0	0.0
26	20	46.0	5.79	0.17E-02	0.30E-02	0.50E-07	300.0	32.0	31.0	29.0	32.0	0.0	-0.13	-0.19	0.0
26	21	46.8	5.79	0.16E-02	0.33E-02	0.50E-07	335.0	38.0	37.0	35.0	38.0	0.0	-0.55	-0.78	0.0
26	22	47.8	5.79	0.16E-02	0.37E-02	0.50E-07	370.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
26	23	48.9	5.79	0.16E-02	0.40E-02	0.50E-07	400.0	46.0	45.0	43.0	46.0	-0.36	-1.13	-1.44	-0.36
26	24	49.8	5.79	0.15E-02	0.46E-02	0.50E-07	465.0	14.0	13.0	11.0	14.0	0.0	-0.13	-0.19	0.0
26	25	50.1	5.79	0.14E-02	0.53E-02	0.50E-07	530.0	62.0	61.0	59.0	62.0	-1.17	-1.17	-1.17	-1.17
26	26	50.5	5.79	0.14E-02	0.57E-02	0.50E-07	570.0	60.0	59.0	57.0	60.0	0.0	-1.36	-3.67	0.0
26	27	51.0	5.79	0.14E-02	0.56E-02	0.50E-07	560.0	62.0	61.0	59.0	62.0	0.0	-0.87	-2.44	0.0
26	28	50.5	5.79	0.14E-02	0.53E-02	0.50E-07	530.0	61.0	60.0	58.0	61.0	0.0	-2.18	-5.17	0.0
26	29	50.0	5.79	0.14E-02	0.49E-02	0.30E-06	490.0	70.0	69.0	67.0	70.0	0.0	-1.92	-5.36	0.0
26	30	49.8	5.79	0.14E-02	0.44E-02	0.30E-06	440.0	75.0	74.0	72.0	75.0	0.0	-4.34	-4.43	0.0
26	31	49.7	5.79	0.14E-02	0.49E-02	0.30E-06	490.0	80.0	79.0	77.0	80.0	0.0	-4.35	-19.48	0.0
26	32	49.9	5.79	0.14E-02	0.50E-02	0.30E-06	505.0	81.0	80.0	78.0	81.0	0.0	0.0	0.0	0.0
27	6	12.0	0.93	0.12E-02	0.36E-02	0.50E-07	365.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	7	16.0	0.93	0.12E-02	0.36E-02	0.50E-07	365.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
27	8	20.0	0.93	0.14E-02	0.38E-02	0.50E-07	380.0	14.0	13.0	11.0	14.0	0.0	0.0	0.0	0.0
27	9	23.0	0.93	0.14E-02	0.36E-02	0.50E-07	360.0	15.0	14.0	12.0	15.0	0.0	0.0	0.0	0.0
27	10	25.0	0.93	0.15E-02	0.32E-02	0.50E-07	325.0	13.0	12.0	10.0	13.0	0.0	0.0	0.0	0.0
27	11	29.0	0.93	0.16E-02	0.30E-02	0.50E-07	305.0	27.0	26.0	24.0	27.0	0.0	0.0	0.0	0.0
27	12	33.0	0.93	0.16E-02	0.27E-02	0.50E-07	270.0	29.0	28.0	26.0	29.0	0.0	0.0	0.0	0.0
27	13	35.0	0.93	0.17E-02	0.26E-02	0.50E-07	260.0	29.0	28.0	26.0	29.0	0.0	0.0	0.0	0.0
27	14	39.0	0.93	0.17E-02	0.23E-02	0.50E-07	235.0	29.0	28.0	26.0	29.0	0.0	0.0	0.0	0.0
27	15	41.0	1.74	0.17E-02	0.22E-02	0.50E-07	220.0	33.0	32.0	30.0	33.0	0.0	0.0	0.0	0.0
27	16	42.0	1.74	0.17E-02	0.21E-02	0.50E-07	215.0	35.0	34.0	32.0	35.0	0.0	-1.01	-0.74	0.0
27	17	43.0	1.74	0.17E-02	0.24E-02	0.50E-07	240.0	37.0	36.0	34.0	37.0	0.0	0.0	0.0	0.0
27	18	44.0	1.74	0.17E-02	0.30E-02	0.50E-07	300.0	38.0	37.0	35.0	38.0	0.0	0.0	0.0	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.- DEC.	TRANSIENT CALIB. DEC.- MAY	TRANSIENT CALIB. MAY- OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.- DEC.	TRANSIENT CALIB. DEC.- MAY	TRANSIENT CALIB. MAY- OCT.
27	19	45.4	5.79	0.17E-02	0.30E-02	0.50E-07	305.0	38.0	37.0	35.0	38.0	0.0	-1.01	-4.23	0.0
27	20	46.2	5.79	0.17E-02	0.31E-02	0.50E-07	315.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
27	21	46.9	5.79	0.17E-02	0.33E-02	0.50E-07	335.0	25.0	24.0	22.0	25.0	0.0	-0.34	-0.47	0.0
27	22	48.0	5.79	0.16E-02	0.37E-02	0.50E-07	370.0	45.0	44.0	42.0	45.0	0.0	-0.38	-0.53	0.0
27	23	49.1	5.79	0.16E-02	0.40E-02	0.50E-07	400.0	30.0	29.0	27.0	30.0	0.0	-1.04	-1.45	0.0
27	24	50.1	5.79	0.15E-02	0.47E-02	0.50E-07	475.0	13.0	12.0	10.0	13.0	0.0	0.0	0.0	0.0
27	25	50.5	5.79	0.14E-02	0.54E-02	0.50E-07	540.0	52.0	51.0	49.0	52.0	0.0	-0.25	-0.45	0.0
27	26	51.0	5.79	0.14E-02	0.58E-02	0.50E-07	580.0	48.0	47.0	45.0	48.0	0.0	-0.97	-1.36	0.0
27	27	51.5	5.79	0.14E-02	0.57E-02	0.50E-07	570.0	54.0	53.0	51.0	54.0	0.0	-0.89	-1.25	0.0
27	28	51.0	5.79	0.14E-02	0.53E-02	0.50E-07	535.0	60.0	59.0	57.0	60.0	0.0	-0.44	-0.61	0.0
27	29	50.5	5.79	0.14E-02	0.49E-02	0.30E-06	490.0	64.0	63.0	61.0	64.0	0.0	0.0	0.0	0.0
27	30	49.7	5.79	0.14E-02	0.47E-02	0.30E-06	475.0	68.0	67.0	65.0	68.0	-0.15	-2.33	-2.03	-0.15
27	31	49.6	5.79	0.14E-02	0.53E-02	0.30E-06	530.0	77.0	76.0	74.0	77.0	0.0	-0.54	-1.50	0.0
27	32	49.8	5.79	0.14E-02	0.55E-02	0.30E-06	550.0	77.0	76.0	74.0	77.0	0.0	0.0	0.0	0.0
28	7	14.0	0.93	0.13E-02	0.35E-02	0.50E-07	355.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
28	8	17.0	0.93	0.14E-02	0.35E-02	0.50E-07	350.0	12.0	11.0	9.0	12.0	0.0	0.0	-0.71	0.0
28	9	20.0	0.93	0.15E-02	0.33E-02	0.50E-07	335.0	14.0	13.0	11.0	14.0	0.0	0.0	0.0	0.0
28	10	23.0	0.93	0.16E-02	0.32E-02	0.50E-07	320.0	15.0	14.0	12.0	15.0	0.0	0.0	0.0	0.0
28	11	27.0	0.93	0.16E-02	0.29E-02	0.50E-07	295.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
28	12	30.0	0.93	0.17E-02	0.26E-02	0.50E-07	265.0	27.0	26.0	24.0	27.0	0.0	0.0	0.0	0.0
28	13	34.0	0.93	0.17E-02	0.25E-02	0.50E-07	250.0	28.0	27.0	25.0	28.0	0.0	0.0	0.0	0.0
28	14	37.0	0.93	0.17E-02	0.23E-02	0.50E-07	230.0	28.0	27.0	25.0	28.0	0.0	0.0	0.0	0.0
28	15	40.0	1.74	0.17E-02	0.22E-02	0.50E-07	220.0	28.0	27.0	25.0	28.0	0.0	0.0	0.0	0.0
28	16	42.0	1.74	0.17E-02	0.22E-02	0.50E-07	225.0	31.0	30.0	28.0	31.0	0.0	0.0	0.0	0.0
28	17	43.0	1.74	0.17E-02	0.26E-02	0.50E-07	265.0	33.0	32.0	30.0	33.0	0.0	0.0	0.0	0.0
28	18	44.0	1.74	0.17E-02	0.30E-02	0.50E-07	300.0	34.0	33.0	31.0	34.0	0.0	0.0	0.0	0.0
28	19	45.5	5.79	0.17E-02	0.31E-02	0.50E-07	310.0	35.0	34.0	32.0	35.0	0.0	-0.42	-1.18	0.0
28	20	46.3	5.79	0.17E-02	0.32E-02	0.50E-07	320.0	34.0	33.0	31.0	34.0	0.0	-0.67	-1.88	0.0
28	21	47.1	5.79	0.17E-02	0.33E-02	0.50E-07	330.0	20.0	19.0	17.0	20.0	0.0	-0.39	-0.42	0.0
28	22	48.4	5.79	0.16E-02	0.36E-02	0.50E-07	360.0	30.0	29.0	27.0	30.0	0.0	-0.24	-0.33	0.0
28	23	49.5	5.79	0.16E-02	0.44E-02	0.50E-07	440.0	10.0	9.0	7.0	10.0	0.0	-0.44	-0.61	0.0
28	24	50.3	5.79	0.15E-02	0.50E-02	0.50E-07	500.0	12.0	11.0	9.0	12.0	0.0	-0.97	-1.36	0.0
28	25	51.0	5.79	0.14E-02	0.54E-02	0.50E-07	540.0	34.0	33.0	31.0	34.0	0.0	-1.50	-2.99	0.0
28	26	51.8	5.79	0.14E-02	0.58E-02	0.50E-07	580.0	53.0	52.0	50.0	53.0	0.0	-0.57	-0.80	0.0
28	27	52.0	5.79	0.14E-02	0.56E-02	0.50E-07	565.0	57.0	56.0	54.0	57.0	0.0	-0.67	-2.82	0.0
28	28	51.8	5.79	0.14E-02	0.53E-02	0.50E-07	530.0	63.0	62.0	60.0	63.0	0.0	0.0	0.0	0.0
28	29	51.0	5.79	0.14E-02	0.52E-02	0.30E-06	525.0	58.0	57.0	55.0	58.0	0.0	0.0	0.0	0.0
28	30	49.8	5.79	0.14E-02	0.52E-02	0.30E-06	525.0	65.0	64.0	62.0	65.0	0.0	0.0	0.0	0.0
28	31	49.5	5.79	0.14E-02	0.57E-02	0.30E-06	575.0	72.0	71.0	69.0	72.0	0.0	0.0	0.0	0.0
28	32	49.7	5.79	0.13E-02	0.58E-02	0.30E-06	585.0	74.0	73.0	71.0	74.0	0.0	0.0	0.0	0.0
29	7	12.0	0.93	0.14E-02	0.34E-02	0.50E-07	340.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
29	8	16.0	0.93	0.14E-02	0.34E-02	0.50E-07	340.0	4.0	3.0	1.0	4.0	0.0	0.0	0.0	0.0
29	9	19.0	0.93	0.15E-02	0.33E-02	0.50E-07	330.0	12.0	11.0	9.0	12.0	0.0	0.0	0.0	0.0
29	10	23.0	0.93	0.16E-02	0.31E-02	0.50E-07	310.0	13.0	12.0	10.0	13.0	0.0	0.0	0.0	0.0
29	11	26.0	0.93	0.16E-02	0.29E-02	0.50E-07	290.0	22.0	21.0	19.0	22.0	0.0	0.0	0.0	0.0
29	12	29.0	0.93	0.17E-02	0.26E-02	0.50E-07	265.0	26.0	25.0	23.0	26.0	0.0	0.0	0.0	0.0
29	13	32.0	0.93	0.17E-02	0.25E-02	0.50E-07	250.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
29	14	35.0	0.93	0.17E-02	0.24E-02	0.50E-07	240.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
29	15	38.0	1.74	0.18E-02	0.25E-02	0.50E-07	250.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
29	16	41.0	1.74	0.18E-02	0.26E-02	0.50E-07	260.0	27.0	26.0	24.0	27.0	0.0	0.0	0.0	0.0
29	17	43.0	1.74	0.18E-02	0.28E-02	0.50E-07	280.0	31.0	30.0	28.0	31.0	0.0	0.0	0.0	0.0
29	18	44.0	1.74	0.18E-02	0.31E-02	0.50E-07	310.0	31.0	30.0	28.0	31.0	0.0	0.0	0.0	0.0
29	19	45.3	5.79	0.17E-02	0.33E-02	0.50E-07	330.0	34.0	33.0	31.0	34.0	0.0	0.0	0.0	0.0

NODE		POT. HEAD	T	S	S'	K'	B'	WATER TABLE ALT. (FT)				PUMPING RATE (CU.FT/SEC)			
								1975 STEADY	TRANSIENT CALIB.			1975 STEADY	TRANSIENT CALIB.		
ROW	COL.	(FT)	(SQ.FT /SEC)			(FT/SEC)	(FT)	STATE CALIB.	NOV.- DEC.	DEC.- MAY	MAY- OCT.	STATE CALIB.	NOV.- DEC.	DEC.- MAY	MAY- OCT.
29	20	46.4	5.79	0.17E-02	0.33E-02	0.50E-07	335.0	33.0	32.0	30.0	33.0	0.0	-0.76	-1.69	0.0
29	21	47.3	5.79	0.17E-02	0.34E-02	0.50E-07	345.0	18.0	17.0	15.0	18.0	0.0	0.0	0.0	0.0
29	22	48.5	5.79	0.17E-02	0.37E-02	0.50E-07	370.0	8.0	7.0	5.0	8.0	0.0	-0.47	-0.66	0.0
29	23	49.9	5.79	0.16E-02	0.41E-02	0.50E-07	410.0	30.0	29.0	27.0	30.0	0.0	-0.71	-0.99	0.0
29	24	50.5	5.79	0.15E-02	0.50E-02	0.50E-07	505.0	43.0	42.0	40.0	43.0	0.0	-0.20	-0.28	0.0
29	25	51.3	5.79	0.15E-02	0.53E-02	0.50E-07	535.0	36.0	35.0	33.0	36.0	0.0	-0.67	-0.93	0.0
29	26	51.7	5.79	0.15E-02	0.55E-02	0.50E-07	555.0	46.0	45.0	43.0	46.0	-0.23	-0.55	-0.68	-0.23
29	27	52.5	5.79	0.15E-02	0.52E-02	0.50E-07	525.0	55.0	54.0	52.0	55.0	0.0	-2.89	-7.15	0.0
29	28	51.5	5.79	0.15E-02	0.52E-02	0.50E-07	525.0	56.0	55.0	53.0	56.0	0.0	-4.57	-6.02	0.0
29	29	51.0	5.79	0.14E-02	0.54E-02	0.30E-06	540.0	57.0	56.0	54.0	57.0	0.0	0.0	0.0	0.0
29	30	49.9	5.79	0.14E-02	0.56E-02	0.30E-06	560.0	63.0	62.0	60.0	63.0	0.0	0.0	0.0	0.0
29	31	49.4	5.79	0.13E-02	0.61E-02	0.30E-06	615.0	69.0	68.0	66.0	69.0	0.0	0.0	0.0	0.0
29	32	49.6	5.79	0.13E-02	0.63E-02	0.30E-06	635.0	73.0	72.0	70.0	73.0	0.0	0.0	0.0	0.0
30	7	11.0	0.93	0.14E-02	0.33E-02	0.50E-07	330.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
30	8	15.0	0.93	0.14E-02	0.32E-02	0.50E-07	325.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
30	9	19.0	0.93	0.15E-02	0.33E-02	0.50E-07	330.0	12.0	11.0	9.0	12.0	0.0	0.0	0.0	0.0
30	10	23.0	0.93	0.16E-02	0.30E-02	0.50E-07	305.0	8.0	7.0	5.0	8.0	0.0	0.0	0.0	0.0
30	11	26.0	0.93	0.16E-02	0.28E-02	0.50E-07	285.0	15.0	14.0	12.0	15.0	0.0	0.0	0.0	0.0
30	12	28.0	0.93	0.17E-02	0.27E-02	0.50E-07	270.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
30	13	32.0	0.93	0.17E-02	0.26E-02	0.50E-07	265.0	23.0	22.0	20.0	23.0	0.0	0.0	0.0	0.0
30	14	35.0	0.93	0.17E-02	0.27E-02	0.50E-07	270.0	22.0	21.0	19.0	22.0	0.0	0.0	0.0	0.0
30	15	37.0	1.74	0.18E-02	0.28E-02	0.50E-07	280.0	24.0	23.0	21.0	24.0	0.0	0.0	0.0	0.0
30	16	39.0	1.74	0.18E-02	0.29E-02	0.50E-07	290.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
30	17	42.0	1.74	0.18E-02	0.31E-02	0.50E-07	310.0	26.0	25.0	23.0	26.0	0.0	0.0	0.0	0.0
30	18	44.0	1.74	0.18E-02	0.32E-02	0.50E-07	320.0	27.0	26.0	24.0	27.0	0.0	0.0	0.0	0.0
30	19	45.2	5.79	0.17E-02	0.33E-02	0.50E-07	335.0	33.0	32.0	30.0	33.0	0.0	0.0	0.0	0.0
30	20	46.5	5.79	0.17E-02	0.34E-02	0.50E-07	345.0	30.0	29.0	27.0	30.0	0.0	-0.34	-0.47	0.0
30	21	47.4	5.79	0.17E-02	0.36E-02	0.50E-07	360.0	5.0	4.0	2.0	5.0	0.0	-0.39	-0.54	0.0
30	22	48.5	5.79	0.17E-02	0.38E-02	0.50E-07	380.0	34.0	33.0	31.0	34.0	0.0	-1.38	-2.07	0.0
30	23	50.0	5.79	0.16E-02	0.41E-02	0.50E-07	410.0	38.0	37.0	35.0	38.0	0.0	-1.87	-4.91	0.0
30	24	51.0	5.79	0.16E-02	0.46E-02	0.50E-07	465.0	38.0	37.0	35.0	38.0	0.0	-5.02	-4.32	0.0
30	25	51.8	5.79	0.15E-02	0.50E-02	0.50E-07	500.0	34.0	33.0	31.0	34.0	0.0	-0.74	-1.03	0.0
30	26	52.0	5.79	0.15E-02	0.51E-02	0.50E-07	515.0	45.0	44.0	42.0	45.0	0.0	-0.34	-0.47	0.0
30	27	53.0	5.79	0.15E-02	0.52E-02	0.50E-07	525.0	51.0	50.0	48.0	51.0	0.0	-3.29	-2.26	0.0
30	28	51.0	5.79	0.15E-02	0.54E-02	0.50E-07	540.0	53.0	52.0	50.0	53.0	0.0	0.0	0.0	0.0
30	29	50.5	5.79	0.14E-02	0.56E-02	0.30E-06	565.0	55.0	54.0	52.0	55.0	0.0	0.0	-7.52	0.0
30	30	49.6	5.79	0.14E-02	0.59E-02	0.30E-06	590.0	62.0	61.0	59.0	62.0	0.0	0.0	0.0	0.0
30	31	49.3	5.79	0.13E-02	0.66E-02	0.30E-06	660.0	66.0	65.0	63.0	66.0	0.0	0.0	0.0	0.0
30	32	49.5	5.79	0.13E-02	0.68E-02	0.30E-06	680.0	73.0	72.0	70.0	73.0	0.0	0.0	0.0	0.0
31	7	9.0	0.93	0.14E-02	0.33E-02	0.50E-07	330.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
31	8	14.0	0.93	0.15E-02	0.33E-02	0.50E-07	330.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
31	9	20.0	0.93	0.15E-02	0.32E-02	0.50E-07	320.0	11.0	10.0	8.0	11.0	0.0	0.0	0.0	0.0
31	10	23.0	0.93	0.16E-02	0.30E-02	0.50E-07	300.0	7.0	6.0	4.0	7.0	0.0	0.0	0.0	0.0
31	11	27.0	0.93	0.17E-02	0.29E-02	0.50E-07	290.0	4.0	3.0	1.0	4.0	0.0	0.0	0.0	0.0
31	12	29.0	0.93	0.17E-02	0.30E-02	0.50E-07	300.0	12.0	11.0	9.0	12.0	0.0	0.0	0.0	0.0
31	13	32.0	0.93	0.17E-02	0.31E-02	0.50E-07	310.0	13.0	12.0	10.0	13.0	0.0	0.0	0.0	0.0
31	14	35.0	0.93	0.18E-02	0.32E-02	0.50E-07	320.0	16.0	15.0	13.0	16.0	0.0	0.0	0.0	0.0
31	15	37.0	0.93	0.18E-02	0.33E-02	0.50E-07	330.0	17.0	16.0	14.0	17.0	0.0	0.0	0.0	0.0
31	16	39.0	1.74	0.18E-02	0.33E-02	0.50E-07	335.0	19.0	18.0	16.0	19.0	0.0	0.0	0.0	0.0
31	17	42.0	1.74	0.18E-02	0.33E-02	0.50E-07	335.0	22.0	21.0	19.0	22.0	0.0	0.0	0.0	0.0
31	18	43.0	1.74	0.18E-02	0.33E-02	0.50E-07	335.0	24.0	23.0	21.0	24.0	0.0	0.0	0.0	0.0
31	19	45.1	5.79	0.18E-02	0.34E-02	0.50E-07	340.0	28.0	27.0	25.0	28.0	0.0	0.0	-2.82	0.0
31	20	46.4	5.79	0.17E-02	0.34E-02	0.50E-07	345.0	5.0	4.0	2.0	5.0	0.0	-0.55	-0.47	0.0

NODE ROW	NODE COL.	POT. HEAD (FT)	T (SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	WATER TABLE ALT. (FT) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.- DEC.	TRANSIENT CALIB. DEC.- MAY	TRANSIENT CALIB. MAY- OCT.	PUMPING RATE (CU.FT/SEC) 1975 STEADY STATE CALIB.	TRANSIENT CALIB. NOV.- DEC.	TRANSIENT CALIB. DEC.- MAY	TRANSIENT CALIB. MAY- OCT.
31	21	47.5	5.79	0.17E-02	0.36E-02	0.50E-07	360.0	19.0	18.0	16.0	19.0	0.0	-1.08	-1.25	0.0
31	22	48.5	5.79	0.17E-02	0.38E-02	0.50E-07	380.0	29.0	28.0	26.0	29.0	0.0	-1.01	-1.41	0.0
31	23	50.0	5.79	0.17E-02	0.40E-02	0.50E-07	400.0	36.0	35.0	33.0	36.0	0.0	0.0	0.0	0.0
31	24	50.7	5.79	0.16E-02	0.44E-02	0.50E-07	445.0	38.0	37.0	35.0	38.0	0.0	-0.27	-3.01	0.0
31	25	51.4	5.79	0.16E-02	0.49E-02	0.50E-07	490.0	38.0	37.0	35.0	38.0	0.0	-1.18	-1.79	0.0
31	26	51.6	5.79	0.16E-02	0.53E-02	0.50E-07	530.0	39.0	38.0	36.0	39.0	0.0	-0.74	-1.03	0.0
31	27	51.0	5.79	0.15E-02	0.55E-02	0.50E-07	550.0	42.0	41.0	39.0	42.0	0.0	-2.02	-3.29	0.0
31	28	50.5	5.79	0.15E-02	0.57E-02	0.50E-07	570.0	48.0	47.0	45.0	48.0	0.0	-0.54	-0.75	0.0
31	29	50.0	5.79	0.15E-02	0.59E-02	0.30E-06	595.0	46.0	45.0	43.0	46.0	0.0	0.0	0.0	0.0
31	30	49.2	5.79	0.14E-02	0.65E-02	0.30E-06	650.0	55.0	54.0	52.0	55.0	0.0	0.0	0.0	0.0
31	31	49.2	5.79	0.14E-02	0.72E-02	0.30E-06	720.0	59.0	58.0	56.0	59.0	0.0	0.0	0.0	0.0
31	32	49.4	5.79	0.13E-02	0.73E-02	0.30E-06	735.0	70.0	69.0	67.0	70.0	0.0	0.0	0.0	0.0
32	7	8.0	0.93	0.14E-02	0.33E-02	0.50E-07	330.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
32	8	13.0	0.93	0.15E-02	0.33E-02	0.50E-07	330.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
32	9	21.0	0.93	0.15E-02	0.33E-02	0.50E-07	330.0	10.0	9.0	7.0	10.0	0.0	0.0	0.0	0.0
32	10	24.0	0.93	0.16E-02	0.33E-02	0.50E-07	330.0	10.0	9.0	7.0	10.0	0.0	0.0	0.0	0.0
32	11	27.0	0.93	0.17E-02	0.34E-02	0.50E-07	340.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
32	12	31.0	0.93	0.17E-02	0.35E-02	0.50E-07	355.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
32	13	33.0	0.93	0.18E-02	0.36E-02	0.50E-07	365.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
32	14	36.0	0.93	0.18E-02	0.37E-02	0.50E-07	370.0	7.0	6.0	4.0	7.0	0.0	0.0	0.0	0.0
32	15	38.0	0.93	0.18E-02	0.38E-02	0.50E-07	380.0	8.0	7.0	5.0	8.0	0.0	0.0	0.0	0.0
32	16	41.0	1.74	0.18E-02	0.38E-02	0.50E-07	385.0	10.0	9.0	7.0	10.0	0.0	0.0	0.0	0.0
32	17	43.0	1.74	0.18E-02	0.37E-02	0.50E-07	370.0	14.0	13.0	11.0	14.0	0.0	0.0	0.0	0.0
32	18	44.0	1.74	0.18E-02	0.35E-02	0.50E-07	355.0	20.0	19.0	17.0	20.0	0.0	0.0	0.0	0.0
32	19	45.4	5.79	0.18E-02	0.34E-02	0.50E-07	340.0	23.0	22.0	20.0	23.0	0.0	0.0	0.0	0.0
32	20	46.3	5.79	0.18E-02	0.34E-02	0.50E-07	340.0	4.0	3.0	1.0	4.0	0.0	0.0	0.0	0.0
32	21	47.1	5.79	0.18E-02	0.35E-02	0.50E-07	350.0	8.0	7.0	5.0	8.0	0.0	-0.27	-0.38	0.0
32	22	48.0	5.79	0.17E-02	0.37E-02	0.50E-07	370.0	24.0	23.0	21.0	24.0	0.0	-0.40	-1.69	0.0
32	23	48.9	5.79	0.17E-02	0.39E-02	0.50E-07	390.0	28.0	27.0	25.0	28.0	0.0	0.0	0.0	0.0
32	24	49.5	5.79	0.17E-02	0.42E-02	0.50E-07	425.0	26.0	25.0	23.0	26.0	0.0	-0.34	-4.23	0.0
32	25	49.9	5.79	0.16E-02	0.47E-02	0.50E-07	475.0	33.0	32.0	30.0	33.0	0.0	-1.75	-3.85	0.0
32	26	49.8	5.79	0.16E-02	0.53E-02	0.50E-07	530.0	37.0	36.0	34.0	37.0	0.0	-6.62	-13.43	0.0
32	27	49.6	5.79	0.16E-02	0.57E-02	0.50E-07	570.0	38.0	37.0	35.0	38.0	0.0	-3.28	-8.46	0.0
32	28	49.4	5.79	0.15E-02	0.59E-02	0.50E-07	590.0	39.0	38.0	36.0	39.0	0.0	0.0	0.0	0.0
32	29	49.1	5.79	0.15E-02	0.63E-02	0.30E-06	635.0	41.0	40.0	38.0	41.0	0.0	0.0	0.0	0.0
32	30	49.0	5.79	0.14E-02	0.73E-02	0.30E-06	730.0	50.0	49.0	47.0	50.0	0.0	0.0	0.0	0.0
32	31	49.0	5.79	0.14E-02	0.78E-02	0.30E-06	780.0	53.0	52.0	50.0	53.0	0.0	0.0	0.0	0.0
33	8	11.0	0.93	0.15E-02	0.34E-02	0.50E-07	345.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
33	9	20.0	0.93	0.16E-02	0.34E-02	0.50E-07	345.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
33	10	24.0	0.93	0.16E-02	0.36E-02	0.50E-07	360.0	7.0	6.0	4.0	7.0	0.0	0.0	0.0	0.0
33	11	28.0	0.93	0.17E-02	0.37E-02	0.50E-07	370.0	8.0	7.0	5.0	8.0	0.0	0.0	0.0	0.0
33	12	31.0	0.93	0.18E-02	0.38E-02	0.50E-07	380.0	5.0	4.0	2.0	5.0	0.0	0.0	-0.02	0.0
33	13	33.0	0.93	0.18E-02	0.39E-02	0.50E-07	395.0	2.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0
33	14	35.0	0.93	0.18E-02	0.41E-02	0.50E-07	410.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
33	15	38.0	0.93	0.18E-02	0.42E-02	0.50E-07	425.0	2.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0
33	16	42.0	1.74	0.18E-02	0.42E-02	0.50E-07	420.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
33	17	43.0	1.74	0.18E-02	0.41E-02	0.50E-07	410.0	2.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0
33	18	44.0	1.74	0.18E-02	0.40E-02	0.50E-07	400.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
33	19	45.1	1.74	0.18E-02	0.37E-02	0.50E-07	370.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
33	20	45.7	5.79	0.18E-02	0.35E-02	0.50E-07	350.0	2.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0
33	21	46.3	5.79	0.18E-02	0.36E-02	0.50E-07	360.0	12.0	11.0	9.0	12.0	0.0	0.0	0.0	0.0
33	22	46.9	5.79	0.18E-02	0.37E-02	0.50E-07	375.0	17.0	16.0	14.0	17.0	0.0	0.0	0.0	0.0
33	23	47.0	5.79	0.17E-02	0.40E-02	0.50E-07	400.0	19.0	18.0	16.0	19.0	0.0	0.0	0.0	0.0

NODE		POT.	T					WATER TABLE ALT. (FT)				PUMPING RATE (CU.FT/SEC)			
								1975 STEADY	TRANSIENT CALIB.			1975 STEADY	TRANSIENT CALIB.		
ROW	COL.	HEAD (FT)	(SQ.FT /SEC)	S	S'	K' (FT/SEC)	B' (FT)	STATE CALIB.	NOV.- DEC.	DEC.- MAY	MAY- OCT.	STATE CALIB.	NOV.- DEC.	DEC.- MAY	MAY- OCT.
33	24	47.5	5.79	0.17E-02	0.46E-02	0.50E-07	460.0	24.0	23.0	21.0	24.0	0.0	0.0	0.0	0.0
33	25	47.7	5.79	0.17E-02	0.51E-02	0.50E-07	510.0	26.0	25.0	23.0	26.0	0.0	-6.99	-6.02	0.0
33	26	47.8	5.79	0.16E-02	0.55E-02	0.50E-07	550.0	35.0	34.0	32.0	35.0	0.0	-4.64	-4.00	0.0
33	27	47.8	5.79	0.16E-02	0.58E-02	0.50E-07	585.0	36.0	35.0	33.0	36.0	0.0	0.0	0.0	0.0
33	28	47.9	5.79	0.15E-02	0.64E-02	0.50E-07	640.0	38.0	37.0	35.0	38.0	0.0	0.0	0.0	0.0
33	29	48.0	5.79	0.15E-02	0.68E-02	0.30E-06	680.0	42.0	41.0	39.0	42.0	0.0	0.0	0.0	0.0
33	30	48.2	5.79	0.14E-02	0.75E-02	0.30E-06	750.0	57.0	56.0	54.0	57.0	0.0	0.0	0.0	0.0
33	31	48.5	5.79	0.14E-02	0.77E-02	0.30E-06	775.0	58.0	57.0	55.0	58.0	0.0	0.0	0.0	0.0
34	9	13.0	0.93	0.17E-02	0.39E-02	0.50E-07	390.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	10	19.0	0.93	0.18E-02	0.41E-02	0.50E-07	410.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	11	24.0	0.93	0.18E-02	0.42E-02	0.50E-07	425.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
34	12	27.0	0.93	0.19E-02	0.43E-02	0.50E-07	430.0	4.0	3.0	1.0	4.0	0.0	0.0	0.0	0.0
34	13	30.0	0.93	0.19E-02	0.44E-02	0.50E-07	440.0	3.0	2.0	0.0	3.0	0.0	0.0	0.0	0.0
34	14	32.0	0.93	0.19E-02	0.46E-02	0.50E-07	460.0	2.0	1.0	0.0	2.0	0.0	0.0	0.0	0.0
34	15	34.0	0.93	0.19E-02	0.47E-02	0.50E-07	470.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	16	37.0	0.93	0.19E-02	0.47E-02	0.50E-07	470.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	17	40.0	0.93	0.19E-02	0.47E-02	0.50E-07	470.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	18	42.0	1.74	0.19E-02	0.45E-02	0.50E-07	450.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
34	19	43.0	1.74	0.19E-02	0.44E-02	0.50E-07	440.0	5.0	4.0	2.0	5.0	0.0	0.0	0.0	0.0
34	20	44.0	1.74	0.19E-02	0.42E-02	0.50E-07	425.0	15.0	14.0	12.0	15.0	0.0	-0.70	-0.98	0.0
34	21	45.1	1.74	0.18E-02	0.42E-02	0.50E-07	420.0	17.0	16.0	14.0	17.0	0.0	0.0	0.0	0.0
34	22	45.3	5.79	0.18E-02	0.44E-02	0.50E-07	440.0	22.0	21.0	19.0	22.0	0.0	0.0	0.0	0.0
34	23	45.6	5.79	0.18E-02	0.48E-02	0.50E-07	480.0	25.0	24.0	22.0	25.0	0.0	0.0	0.0	0.0
34	24	45.8	5.79	0.18E-02	0.50E-02	0.50E-07	500.0	26.0	25.0	23.0	26.0	0.0	0.0	0.0	0.0
34	25	46.1	5.79	0.17E-02	0.53E-02	0.50E-07	530.0	30.0	29.0	27.0	30.0	0.0	0.0	0.0	0.0
34	26	46.3	5.79	0.17E-02	0.57E-02	0.50E-07	570.0	33.0	32.0	30.0	33.0	0.0	0.0	0.0	0.0
34	27	46.5	5.79	0.16E-02	0.61E-02	0.50E-07	610.0	35.0	34.0	32.0	35.0	0.0	0.0	0.0	0.0
34	28	46.8	5.79	0.16E-02	0.66E-02	0.30E-06	665.0	36.0	35.0	33.0	36.0	0.0	0.0	0.0	0.0
35	10	9.0	0.93	0.18E-02	0.47E-02	0.50E-07	475.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	11	14.0	0.93	0.19E-02	0.48E-02	0.50E-07	480.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	12	19.0	0.93	0.19E-02	0.51E-02	0.50E-07	510.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	13	22.0	0.93	0.19E-02	0.52E-02	0.50E-07	525.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	14	24.0	0.93	0.19E-02	0.53E-02	0.50E-07	530.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	15	26.0	0.93	0.19E-02	0.53E-02	0.50E-07	530.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	16	29.0	0.93	0.19E-02	0.53E-02	0.50E-07	535.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	17	31.0	0.93	0.19E-02	0.54E-02	0.50E-07	540.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
35	18	33.0	0.93	0.19E-02	0.53E-02	0.50E-07	535.0	1.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0
35	19	36.0	0.93	0.19E-02	0.53E-02	0.50E-07	530.0	6.0	5.0	3.0	6.0	0.0	0.0	0.0	0.0
35	20	38.0	0.93	0.19E-02	0.53E-02	0.50E-07	530.0	16.0	15.0	13.0	16.0	0.0	0.0	0.0	0.0
35	21	40.0	1.74	0.19E-02	0.52E-02	0.50E-07	525.0	19.0	18.0	16.0	19.0	0.0	0.0	0.0	0.0

SUPPLEMENTARY DATA II—MODEL PROGRAM MODIFICATIONS

The following program modifications were made to the two-dimensional model source deck of Trescott and others (1976) in order to incorporate the head-controlled flux boundary condition.

1. ADD THESE STATEMENTS, REPLACING THE STATEMENTS WITH THE SAME IDENTIFYING NUMBERS IN THE ORIGINAL PROGRAM

```
      DIMENSION Y(70000), L(38), IFMT1(9), IFMT2(9), IFMT3(9), IFMT5(9),MAN 200
     1NAME(108),YY(1)                                                    MAN 210
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50MAN 240
     80,4HN     ,3*4H     ,4H ARE,4HAL R,4HECHA,4HRGE ,4HRATE,2*4H     ,4H  MAN 460
   20 READ(R,320) DIML,DIMW,NW,ITMAX,IHCF,LPRINT                         MAN 620
     3L(34)),Y(L(35)),Y(L(38)))                                          MAN1580
  325 FORMAT(8I5)                                                        MAN2690
     1M,SY,RATE,RIVER,M,TOP,GRND,DELX,DELY,WR,NWR,DIST)                  DAT  20
     4,NWR(IH,2), A(IZ,JZ), IN(9), IFMT(9), DIST(IZ,JZ)                  DAT 170
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50DAT 190
  265 JNO1=DIMW-1                                                        DAT1640
  370 IF(NWEL.EQ.0) GO TO 404                                            DAT2260
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50STP 180
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50SIP 200
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50D4  130
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50ADI 200
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50COF 170
     1TOM,SY,RATE,RIVER,M,TOP,GRND,DELX,DELY,DIST)                       CHK  20
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50CHK 180
  258 RETURN                                                             CHK1600
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50PRN 150
      COMMON /SARRAY/ VF4(11),CHK(15),VF5(7),XLAB(6),VF6(7),XRATEX(50,50BLD  80
```

2. ADD THESE STATEMENTS IN THE SEQUENCE INDICATED BY THE IDENTIFYING NUMBERS

```
     1),XRIVX(50,50)                                                     MAN 245
     1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                         MAN 255
      COMMON /XLT/ BFINT,BFOUTT,XNINT,XNOUTT                             MAN 305
      DATA IFMT5/4H('0',4H,I2,,4H2X,1,4H0F12,4H.4,3,4H(/5X,4H,10F,4H12.4MAN 372
     1,4H))  /                                                           MAN 374
     9 ,4HDIST,4HANCF,4H BEY,4HOND ,4HBOUN,4HDARY,2*4H                   MAN 465
      READ(R,325) IUL,JUL,ILL,JLL,ILR,JLR,IUR,JUR                        MAN 635
      L(38)=ISUM                                                         MAN1512
      ISUM=ISUM+ISIZ                                                     MAN1514
     3Y(L(38)))                                                          MAN1835
      BFINT=0.                                                           MAN1903
      BFOUTT=0.                                                          MAN1904
      XNINT=0.                                                           MAN1905
      XNOUTT=0.                                                          MAN1906
      IF(IHCF.EQ.1.OR.IHCF.EQ.2) CALL ARRAY(Y(L(38)),IFMT5,NAME(100),13)MAN2035
  320 FORMAT(4I10,I20,I2)                                                MAN2685
     1),XRIVX(50,50)                                                     DAT 195
     1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                         DAT 295
     1),XRIVX(50,50)                                                     STP 185
     1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                         STP 255
     1),XRIVX(50,50)                                                     SIP 205
```

```
      1),XRIVX(50,50)                                                   D4   135
      1),XRIVX(50,50)                                                   ADI  205
      1),XRIVX(50,50)                                                   COF  175
       DIMENSION XXLEAK(50,50),XBFLUX(50,50),XNFLUX(50,50)              CHK  165
       DIMENSION DIST(IZ,JZ)                                            CHK  168
      1),XRIVX(50,50)                                                   CHK  185
      1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                       CHK  255
       COMMON /XLT/ BFINT,BFOUTT,XNINT,XNOUTT                           CHK  257
       XXXX=0.                                                          CHK  411
       YYYY=0.                                                          CHK  412
       ZZZZ=0.                                                          CHK  413
       WWWW=0.                                                          CHK  414
       DO 1 I=1,DIML                                                    CHK  415
       DO 1 I=1,DIMW                                                    CHK  416
       XXLEAK(I,J)=0.                                                   CHK  417
       XBFLUX(I,J)=0.                                                   CHK  418
     1 XNFLUX(I,J)=0.                                                   CHK  419
       XXLEAK(I,J)=XNET/AREA                                            CHK1245
       BFIN=XXXX*DELT                                                   CHK1461
       BFOUT=YYYY*DELT                                                  CHK1462
       XNIN=ZZZZ*DELT                                                   CHK1463
       XNOUT=WWWW*DELT                                                  CHK1464
       BFINT=BFINT+BFIN                                                 CHK1465
       BFOUTT=BFOUTT+BFOUT                                              CHK1466
       XNINT=XNINT+XNIN                                                 CHK1467
       XNOUTT=XNOUTT+XNOUT                                              CHK1468
      1),XRIVX(50,50)                                                   PRN  155
      1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                       PRN  245
      1),XRIVX(50,50)                                                   BLD   85
      1HCF,LPRINT,IUL,JUL,ILL,JLL,IUR,JUR,ILR,JLR                       BLD  175
```

3. ADD THESE STATEMENTS BETWEEN STATEMENTS DAT1610 AND DAT1620

```
C
C     ---CHECK TO SEE IF HCF OPTION IS TO BE USED---
C
      IF(IHCF.NE.1.AND.IHCF.NE.2) GO TO 265
C
C     ---DEFINITION OF VARIABLES---
C
C     COFNL   =  COEFFICIENT OF LEAKAGE OCCURRING IN BOUNDARY NODE
C                     (FT**2/SEC)
C     COFHCF  =  COEFFICIENT OF HORIZONTAL FLOW OCCURRING BETWEEN
C                     BOUNDARY NODE AND POINT BEYOND BOUNDARY (FT**2/SEC)
C     COFTOT  =  SUM OF 2 COEFFICIENTS (FT**2/SEC)
C     QB1     =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                     NODE ABOVE IT AT START OF STEADY-STATE SIMULATION
C                     (FT**3/SEC)
C     QB2     =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                     NODE TO LEFT OF IT AT START OF STEADY-STATE
C                     SIMULATION (FT**3/SEC)
C     QB3     =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                     NODE BENEATH IT AT START OF STEADY-STATE SIMULATION
C                     (FT**3/SEC)
```

```
C      QR4      =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                       NODE TO RIGHT OF IT AT START OF STEADY-STATE
C                       SIMULATION (FT**3/SEC)
C      QBINIT   =  HORIZONTAL FLOW OCCURRING ACROSS OUTER EDGE(EDGES) OF
C                       BOUNDARY NODE AT START OF STEADY-STATE SIMULATION
C                       (FT**3/SEC)
C      HQ1      =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                       NODE ABOVE IT AT START OF TRANSIENT SIMULATION
C                       (FT**3/SEC)
C      HQ2      =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                       NODE TO LEFT OF IT AT START OF TRANSIENT SIMULATION
C                       (FT**3/SEC)
C      HQ3      =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                       NODE BENEATH IT AT START OF TRANSIENT SIMULATION
C                       (FT**3/SEC)
C      HQ4      =  HORIZONTAL FLOW OCCURRING BETWEEN BOUNDARY NODE AND
C                       NODE TO RIGHT OF IT AT START OF TRANSIENT
C                       SIMULATION (FT**3/SEC)
C      HQTOT    =  SUM OF 4 HORIZONTAL FLOW COMPONENTS (FT**3/SEC)
C      XRATEX   =  ORIGINAL VERTICAL HYDRAULIC CONDUCTIVITY (FT/SEC)
C      XRIVX    =  ORIGINAL ELEVATION OF WATER TABLE (FT)
C      RATE     =  ADJUSTED VERTICAL HYDRAULIC CONDUCTIVITY (FT/SEC)
C      RIVER    =  ADJUSTED ELEVATION OF WATER TABLE (FT)
C      STRT     =  STARTING HEAD (FT)
C      T        =  TRANSMISSIVITY (FT**2/SEC)
C      S        =  STORAGE COEFFICIENT
C      M        =  THICKNESS OF CONFINING BED (FT)
C      DELX     =  GRID-SPACING IN X-DIRECTION (FT)
C      DELY     =  GRID-SPACING IN Y-DIRECTION (FT)
C      TR       =  INTERNODAL TRANSMISSIVITY ALONG ROWS (FT/SEC)
C      TC       =  INTERNODAL TRANSMISSIVITY ALONG COLUMNS (FT/SEC)
C      DIST     =  DISTANCE BETWEEN BOUNDARY NODE AND POINT BEYOND MODEL
C                       AREA WHERE HEAD IS CONSTANT (FT)
C      IUL,JUL  =  ROW,COLUMN LOCATION OF UPPER LEFT CORNER BOUNDARY NODE
C      ILL,JLL  =  ROW,COLUMN LOCATION OF LOWER LEFT CORNER BOUNDARY NODE
C      ILR,JLR  =  ROW,COLUMN LOCATION OF LOWER RIGHT CORNER BOUNDARY NODE
C      IUR,JUR  =  ROW,COLUMN LOCATION OF UPPER RIGHT CORNER BOUNDARY NODE
C
C      ---SAVE RATE , RIVER---
C
       DO 690 I=1,DIML
       DO 690 J=1,DIMW
       XRATEX(I,J)=RATE(I,J)
  690  XRIVX(I,J)=RIVER(I,J)
C
C      ---WRITE HEADING FOR TABLE OF CALCULATED VALUES---
C
       IF(IHCF.EQ.1) WRITE(P,692)
       IF(IHCF.EQ.2) WRITE(P,694)
  692  FORMAT('1',3X,'I',3X,'J',5X,'COFNL',6X,'COFHCF',5X,'RATE',6X,'RIVE
      1R',4X,'XRATEX',5X,'XRIVX',4X,'QBINIT')
  694  FORMAT('1',3X,'I',3X,'J',5X,'COFNL',6X,'COFHCF',4X,'HQ1',8X,'HQ2',
      18X,'HQ3',8X,'HQ4',9X,'RATE',6X,'XRATEX')
C
C      ---SET UP LOOP TO DO CALCULATIONS AT EACH BOUNDARY NODE---
C
       III=DIML-1
       JJJ=DIMW-1
       DO 860 I=2,III
```

```
      DO 860 J=2,JJJ
      IF(DIST(I,J).EQ.0.) GO TO 860
C
C     ---INITIALIZE VARIABLES---
C
      COFNL=0.
      COFHCF=0.
      COFTOT=0.
      HQ1=0.
      HQ2=0.
      HQ3=0.
      HQ4=0.
      HQTOT=0.
      AAA=0.
      BBB=0.
      QB1=0.
      QB2=0.
      QB3=0.
      QB4=0.
      QBINIT=0.
C
C     ---CALCULATE INITIAL BOUNDARY FLOWS FOR STEADY-STATE CASE---
C
      IF(IHCF.NE.1) GO TO 698
      QB1=2.*T(I,J)*(STRT(I-1,J)-STRT(I,J))*DELX(J)/(DELY(I-1)+DELY(I))
      QB2=2.*T(I,J)*(STRT(I,J-1)-STRT(I,J))*DELY(I)/(DELX(J-1)+DELX(J))
      QB3=2.*T(I,J)*(STRT(I+1,J)-STRT(I,J))*DELX(J)/(DELY(I+1)+DELY(I))
      QB4=2.*T(I,J)*(STRT(I,J+1)-STRT(I,J))*DELY(I)/(DELX(J+1)+DELX(J))
C
C     ---CALCULATE COEFFICIENTS---
C
  698 COFNL=XRATEX(I,J)*DELX(J)*DELY(I)/M(I,J)
      AAA=SQRT(T(I,J)*XRATEX(I,J)/M(I,J))
      BBB=EXP((-2.)*SQRT(XRATEX(I,J)*(DIST(I,J)**2)/M(I,J)*T(I,J)))
      IF(I.EQ.IUL.AND.J.EQ.JUL) GO TO 700
      IF(I.EQ.IUR.AND.J.EQ.JUR) GO TO 700
      IF(I.EQ.ILL.AND.J.EQ.JLL) GO TO 700
      IF(I.EQ.ILR.AND.J.EQ.JLR) GO TO 700
      GO TO 710
  700 COFHCF=AAA*(1.+BBB)*(DELX(J)+DELY(I))/(1.-BBB)
      IF(IHCF.NE.1) GO TO 790
      IF(I.EQ.IUL.AND.J.EQ.JUL) QBINIT=QB1+QB2
      IF(I.EQ.IUR.AND.J.EQ.JUR) QBINIT=QB1+QB4
      IF(I.EQ.ILL.AND.J.EQ.JLL) QBINIT=QB2+QB3
      IF(I.EQ.ILR.AND.J.EQ.JLR) QBINIT=QB3+QB4
      GO TO 790
  710 IF(I.LE.MAX0(IUL,IUR).AND.J.GT.JUL.AND.J.LT.JUR.AND.T(I-1,J).EQ.0.
     1) GO TO 720
      GO TO 730
  720 COFHCF=AAA*(1.+BBB)*DELX(J)/(1.-BBB)
      IF(IHCF.EQ.1) QBINIT=QB1
      GO TO 790
  730 IF(J.LE.MAX0(JUL,JLL).AND.I.GT.IUL.AND.I.LT.ILL.AND.T(I,J-1).EQ.0.
     1) GO TO 740
      GO TO 750
  740 COFHCF=AAA*(1.+BBB)*DELY(I)/(1.-BBB)
      IF(IHCF.EQ.1) QBINIT=QB2
      GO TO 790
  750 IF(I.GE.MIN0(ILL,ILR).AND.J.GT.JLL.AND.J.LT.JLR.AND.T(I+1,J).EQ.0.
```

```
     1) GO TO 760
      GO TO 770
  760 COFHCF=AAA*(1.+BBB)*DELX(J)/(1.-BBB)
      IF(IHCF.EQ.1) QBINIT=QB3
      GO TO 790
  770 IF(J.GE.MINO(JUR,JLP).AND.I.GT.IUR.AND.I.LT.ILR.AND.T(I,J+1).EQ.0.
     1) GO TO 780
      GO TO 860
  780 COFHCF=AAA*(1.+BBB)*DELY(I)/(1.-BBB)
      IF(IHCF.EQ.1) QBINIT=QB4
C
C     ---CALCULATE NEW VERTICAL HYDRAULIC CONDUCTIVITY---
C
  790 COFTOT=COFNL+COFHCF
      RATE(I,J)=COFTOT*XRATEX(I,J)/COFNL
C
C     ---CHECK IF STEADY-STATE OR TRANSIENT CASE---
C
      IF(IHCF.EQ.2) GO TO 795
C
C     ---CALCULATE NEW WATER-TABLE HEAD FOR STEADY-STATE CASE---
C
      RIVER(I,J)=STRT(I,J)+XRATEX(I,J)*(XRIVX(I,J)-STRT(I,J))/RATE(I,J)+
     1M(I,J)*QBINIT/(RATE(I,J)*DELX(J)*DELY(I))
      WRITE(P,792) I,J,COFNL,COFHCF,RATE(I,J),RIVER(I,J),XRATEX(I,J),XRI
     1VX(I,J),QBINIT
  792 FORMAT(' ',2X,I2,2X,I2,1X,2F11.6,E11.3,F9.3,E11.3,F9.3,F9.3)
      GO TO 860
C
C     ---WATER-TABLE HEAD , TRANSIENT CASE---
C
C
C     ---CALCULATE HORIZONTAL FLOW COMPONENTS---
C
  795 IF(T(I-1,J).EQ.0..OR.S(I-1,J).LT.0.) GO TO 800
      TC(I-1,J)=(2.*T(I-1,J)*T(I,J))/(DELY(I)*T(I-1,J)+DELY(I-1)*T(I,J))
     1*FACTY
      HQ1=(STRT(I-1,J)-STRT(I,J))*TC(I-1,J)*DELX(J)
  800 IF(T(I,J-1).EQ.0..OR.S(I,J-1).LT.0.) GO TO 810
      TR(I,J-1)=(2.*T(I,J-1)*T(I,J))/(DELX(J)*T(I,J-1)+DELX(J-1)*T(I,J))
     1*FACTX
      HQ2=(STRT(I,J-1)-STRT(I,J))*TR(I,J-1)*DELY(I)
  810 IF(T(I+1,J).EQ.0..OR.S(I+1,J).LT.0.) GO TO 820
      TC(I,J)=(2.*T(I,J)*T(I+1,J))/(DELY(I)*T(I+1,J)+DELY(I+1)*T(I,J))*F
     1ACTY
      HQ3=(STRT(I+1,J)-STRT(I,J))*TC(I,J)*DELX(J)
  820 IF(T(I,J+1).EQ.0..OR.S(I,J+1).LT.0.) GO TO 830
      TR(I,J)=(2.*T(I,J)*T(I,J+1))/(DELX(J)*T(I,J+1)+DELX(J+1)*T(I,J))*F
     1ACTX
      HQ4=(STRT(I,J+1)-STRT(I,J))*TR(I,J)*DELY(I)
C
C     ---CALCULATE NET HORIZONTAL FLOW---
C
  830 HQTOT=HQ1+HQ2+HQ3+HQ4
C
C     ---CALCULATE NEW WATER-TABLE HEAD FOR TRANSIENT CASE---
C
      RIVER(I,J)=STRT(I,J)-M(I,J)*HQTOT/(RATE(I,J)*DELX(J)*DELY(I))
      WRITE(P,840) I,J,COFNL,COFHCF,HQ1,HQ2,HQ3,HQ4,RATE(I,J),XRATEX(I,J
```

```
     1)
 840 FORMAT(' ',2X,I2,2X,I2,1X,6F11.6,F11.3,1X,F11.3)
 860 CONTINUE
C
C     ---RE-INITIALIZE INTERNODAL TRANSMISSIVITIES---
C
      DO 870 I=1,DIML
      DO 870 J=1,DIMW
      TR(I,J)=0.
 870  TC(I,J)=0.
```

4. ADD THESE STATEMENTS BETWEEN STATEMENTS DAT2420 AND DAT2430

```
C
C     ---CHECK IF TRANSIENT CASE---
C
      IF(IHCF.NE.2) GO TO 410
C
C     ---RE-CALCULATE AND WRITE WATER-TABLE HEAD FOR TRANSIENT CASE
C                   IF WELL LOCATED IN BOUNDARY NODE---
C
      IF(KP.NE.1) GO TO 410
      WRITE(P,406)
      DO 403 I=1,DIML
      DO 403 J=1,DIMW
      IF(DIST(I,J).LE.0.) GO TO 403
      IF(WELL(I,J).EQ.0.) GO TO 402
      RIVER(I,J)=RIVER(I,J)-M(I,J)*WELL(I,J)/RATE(I,J)
      SL(I,J)=RATE(I,J)/M(I,J)*(RIVER(I,J)-STRT(I,J))
 402  WELCFS=WELL(I,J)*DELX(J)*DELY(I)
      WRITE(P,407) I,J,RIVER(I,J),XRIVX(I,J),WELCFS
 403  CONTINUE
      GO TO 410
 404  IF(IHCF.NE.2) GO TO 410
C
C     ---WRITE WATER-TABLE HEAD FOR TRANSIENT CASE IF NO WELL LOCATED
C                   IN BOUNDARY NODE---
C
      IF(KP.NE.1) GO TO 410
      WRITE(P,408)
      DO 405 I=1,DIML
      DO 405 J=1,DIMW
      IF(DIST(I,J).LE.0.) GO TO 405
      WRITE(P,409) I,J,RIVER(I,J),XRIVX(I,J)
 405  CONTINUE
 406  FORMAT('1',7X,'ROW',2X,'COL',5X,'RIVER',7X,'XRIVX',6X,'WELCFS')
 407  FORMAT(' ',8X,I2,3X,I2,3X,F9.3,3X,F9.3,3X,F7.2)
 408  FORMAT('1',7X,'ROW',2X,'COL',5X,'RIVER',7X,'XRIVX')
 409  FORMAT(' ',8X,I2,3X,I2,3X,F9.3,3X,F9.3)
```

5. ADD THESE STATEMENTS BETWEEN STATEMENTS CHK1260 AND CHK1270

```
C
C     ---CHECK IF HCF OPTION IS IN USE---
C
      IF(IHCF.NE.1.AND.IHCF.NE.2) GO TO 240
      IF(DIST(I,J).LE.0.) GO TO 240
C
C     ---CALCULATE ACTUAL LEAKAGE RATE---
C
      XNFLUX(I,J)=XRATEX(I,J)*(XRIVX(I,J)-HED2)/M(I,J)
C
C     ---BOUNDARY FLOW RATE , STEADY-STATE RUN---
C
      QB11=0.
      QB22=0.
      QB33=0.
      QB44=0.
      QTOT=0.
      QVL=0.
      QBDY=0.
      IF(IHCF.EQ.2) GO TO 232
      QB11=2.*T(I,J)*(STRT(I-1,J)-STRT(I,J))*DELX(J)/(DELY(I-1)+DELY(I))
      QB22=2.*T(I,J)*(STRT(I,J-1)-STRT(I,J))*DELY(I)/(DELX(J-1)+DELX(J))
      QB33=2.*T(I,J)*(STRT(I+1,J)-STRT(I,J))*DELX(J)/(DELY(I+1)+DELY(I))
      QB44=2.*T(I,J)*(STRT(I,J+1)-STRT(I,J))*DELY(I)/(DELX(J+1)+DELX(J))
      IF(I.EQ.IUL.AND.J.EQ.JUL) QBDY=QB11+QB22
      IF(I.EQ.IUR.AND.J.EQ.JUR) QBDY=QB11+QB44
      IF(I.EQ.ILL.AND.J.EQ.JLL) QBDY=QB22+QB33
      IF(I.EQ.ILR.AND.J.EQ.JLR) QBDY=QB33+QB44
      IF(QBDY.NE.0.) GO TO 234
      IF(I.LE.MAX0(IUL,IUR).AND.J.GT.JUL.AND.J.LT.JUR.AND.T(I-1,J).EQ.0.
     1) QBDY=QB11
      IF(J.LE.MAX0(JUL,JLL).AND.I.GT.IUL.AND.I.LT.ILL.AND.T(I,J-1).EQ.0.
     1) QBDY=QB22
      IF(I.GE.MIN0(ILL,ILR).AND.J.GT.JLL.AND.J.LT.JLR.AND.T(I+1,J).EQ.0.
     1) QBDY=QB33
      IF(J.GE.MIN0(JUR,JLR).AND.I.GT.IUR.AND.I.LT.ILR.AND.T(I,J+1).EQ.0.
     1) QBDY=QB44
      GO TO 234
C
C     ---BOUNDARY FLOW RATE , TRANSIENT RUN---
C
  232 QTOT=RATE(I,J)*DELX(J)*DELY(I)*(RIVER(I,J)-STRT(I,J))/M(I,J)
      QVL=XRATEX(I,J)*DELX(J)*DELY(I)*(XRIVX(I,J)-STRT(I,J))/M(I,J)
      QBDY=QTOT-QVL
C
C     ---CALCULATE BOUNDARY FLOW RATE---
C
  234 XBFLUX(I,J)=(RATE(I,J)-XRATEX(I,J))*(HED1-HED2)/M(I,J)+QBDY/AREA
C
C     ---SUM UP ACTUAL LEAKAGE AND BOUNDARY FLOW RATES---
C
      IF(XBFLUX(I,J).LT.0.) YYYY=YYYY+XBFLUX(I,J)*AREA
      IF(XBFLUX(I,J).GE.0.) XXXX=XXXX+XBFLUX(I,J)*AREA
      IF(XNFLUX(I,J).LT.0.) WWWW=WWWW+XNFLUX(I,J)*AREA
      IF(XNFLUX(I,J).GE.0.) ZZZZ=ZZZZ+XNFLUX(I,J)*AREA
```

```
 6. ADD THESE STATEMENTS BETWEEN STATEMENTS CHK1590 AND CHK1600
    ----------------------------------------------------------
```

```
C
C     ---CHECK IF HCF OPTION IS IN USE---
C
  254 IF(IHCF.NE.1.AND.IHCF.NE.2) GO TO 258
C
C     ---WRITE ACTUAL LEAKAGE AND BOUNDARY FLOW RATES IN EACH BOUNDARY
C                     NODE---
C
      IF(LPRINT.NE.1) GO TO 256
      WRITE(P,282)
      WRITE(P,283)
      DO 255 I=1,DIML
      DO 255 J=1,DIMW
      IF(DIST(I,J).LE.0.) GO TO 255
      WRITE(P,284) I,J,XBFLUX(I,J),XNFLUX(I,J)
  255 CONTINUE
C
C     ---WRITE SUMS OF ACTUAL LEAKAGE AND BOUNDARY FLOW RATES---
C
  256 WRITE(P,285)
      WRITE(P,286)
      WRITE(P,287) XXXX,YYYY
      WRITE(P,288) ZZZZ,WWWW
C
C     ---WRITE SUMS OF ACTUAL LEAKAGE AND BOUNDARY FLOW VOLUMES---
C
      WRITE(P,289)
      WRITE(P,290)
      WRITE(P,291) BFIN,BFOUT
      WRITE(P,292) XNIN,XNOUT
C
C     ---WRITE CUMULATIVE VOLUMES OF ACTUAL LEAKAGE AND BOUNDARY FLOW---
C
      IF(IHCF.EQ.1) GO TO 258
      WRITE(P,293)
      WRITE(P,294)
      WRITE(P,295) BFINT,BFOUTT
      WRITE(P,296) XNINT,XNOUTT
```

7. ADD THESE STATEMENTS BETWEEN STATEMENTS CHK1790 AND CHK1800

```
  282 FORMAT('1',15X,'BREAKDOWN OF HCF BOUNDARY NODE LEAKAGE RATES IN TH
     1IS TIME STEP, FT**3/SEC/FT**2, (-) - FLOW OUT')
  283 FORMAT('0',3X,'ROW',3X,'COL',3X,'LEAKAGE DUE TO BOUNDARY',3X,'LEAK
     1AGE DUE TO NODE')
  284 FORMAT(' ',4X,I2,4X,I2,8X,E12.3,12X,E12.3)
  285 FORMAT('1')
  286 FORMAT('0',15X,'TOTAL BOUNDARY AND NODAL LEAKAGE RATES IN ALL HCF
     1BOUNDARY NODES IN THIS TIME STEP, FT**3/SEC')
  287 FORMAT('0',5X,'BOUNDARY RATE IN = ',F15.3,5X,'BOUNDARY RATE OUT =
     1',F15.3)
  288 FORMAT('0',5X,'NODAL RATE IN = ',F18.3,5X,'NODAL RATE OUT = ',F18.
     13)
  289 FORMAT('0')
```

```
290 FORMAT('0',15X,'BOUNDARY AND NODAL LEAKAGE IN ALL HCF BOUNDARY NOD
   1ES IN THIS TIME STEP, FT**3')
291 FORMAT('0',5X,'BOUNDARY IN = ',F20.2,5X,'BOUNDARY OUT = ',F20.2)
292 FORMAT('0',5X,'NODAL IN = ',F23.2,5X,'NODAL OUT = ',F23.2)
293 FORMAT('0')
294 FORMAT('0',15X,'CUMULATIVE BOUNDARY AND NODAL LEAKAGE IN ALL HCF B
   1OUNDARY NODES DURING THIS RUN, FT**3')
295 FORMAT('0',5X,'BOUNDARY IN = ',F20.2,5X,'BOUNDARY OUT = ',F20.2)
296 FORMAT('0',5X,'NODAL IN = ',F23.2,5X,'NODAL OUT = ',F23.2)
```

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