Ground-Water Contamination Potential and Quality in Polk County, Florida

By G.L. Barr

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U.S. DEPARTMENT OF THE INTERIOR
BRUCE BABBITT, Secretary

U.S. GEOLOGICAL SURVEY
Dallas L. Peck, Director

For additional information write to:

District Chief
U.S. Geological Survey
Suite 3015
227 N. Bronough Street
Tallahassee, FL 32301

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Multiply	By	To obtain
inch (in.)	25.4	millimeter
inch per year (in/yr)	2.54	centimeter per year
foot (ft)	0.3084	meter
foot per day (ft/d)	0.3084	meter per day
mile (mi)	1.609	kilometer
foot squared per day (ft^2/d)	0.09290	square meter per day
square mile (mi^2)	2.590	square kilometer
cubic foot per second (ft^3/s)	0.02832	cubic meter per second
gallon per minute (gal/min)	0.00006309	cubic meter per second
million gallons per day (Mgal/d)	0.04381	cubic meter per second
foot per day per foot [(ft/d)/ft]	1.000	meter per day per meter

Temperature in degrees Fahrenheit (°F) may be converted to degrees Celsius (°C) as follows: °C = (°F-32)/1.8.

Sea level: In this report, "sea level" refers to the National Geodetic Vertical Datum of 1929 (NGVD of 1929)—a geodetic datum derived from a general adjustment of the first-order level nets of the United States and Canada, formerly called Sea Level Datum of 1929.

Abbreviated water-quality units:

col/100 mL	colonies per 100 milliliters
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter at 25 degrees Celsius
mg/L	milligrams per liter
pCi/L	picocuries per liter

Acronyms:

EDB	ethylene dibromide
FDER	Florida Department of Environmental Regulation
FDOA	Florida Department of Agriculture

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ABSTRACT

A potential for contamination of ground water in Polk County, Florida, exists as a result of anthropogenic (man-induced) and hydrogeologic factors. Anthropogenic factors are associated with land use in urban developed areas and industrial activities in the county. They include waste-disposal practices, the use of agricultural chemicals on citrus and other crops, and phosphate mining and related chemical processing. Hydrogeologic factors that affect the potential for ground-water contamination include hydraulic properties of aquifers and confining units that control movement of water through the ground-water system. Hydrogeologic features that control the movement of ground water include karst features and subsurface fractures. Ground-water quality data from this and previous studies are described by aquifer system and land-use type. Land-use types included in this study are undeveloped areas, areas of intense citrus farming, areas near point-source waste discharges, phosphate mining and reclamation areas, and areas near phosphate chemical-processing plants.

Three hydrogeologic units comprise the ground-water system in the county: the surficial aquifer system, composed mainly of fine sand; the intermediate aquifer system and intermediate confining units, composed of a moderately permeable sandy carbonate aquifer bounded above and below by clay; and the Upper Floridan aquifer, composed of highly permeable limestone and dolomite.

The surficial aquifer system was estimated to have the greatest potential for contamination because it is in direct contact with sources of surface contamination. Upland areas were designated as having a high potential for contamination; wetland areas were designated as having a low potential for contamination because little water infiltrates these areas. The underlying intermediate aquifer system is estimated to have a high potential for contamination in the sinkhole-prone midcounty area, a moderate potential in the western part of the county, and a low potential in the eastern part where artesian flow occurs. The Upper Floridan aquifer is estimated to have a moderate potential for contamination in the central part of the county and low to very low potential in the remainder of the county where artesian conditions prevail.

Ground-water quality in localized areas has been affected as a result of specific land-use activities. Water-quality data for 39 of the 95 wells that were sampled during this study had either chemical concentrations that exceeded Florida Department of Environmental Regulation standards for public water supply, or had detectable amounts of pesticides or volatile organic compounds. Of those 39 samples, 32 were from wells open to the intermediate aquifer system or to both the intermediate and the Upper Floridan aquifers. Areas of intense citrus farming were the only areas in which land use had discernible effects on water quality of the Upper Floridan aquifer.

Ground-water quality varies between aquifer systems and land-use types. Water in the surficial aquifer system is relatively fresh and slightly acidic, with concentrations of major ions commonly less than 250 milligrams per liter. Water in the intermediate aquifer system is an alkaline calcium bicarbonate type with concentrations of major ions generally less than 250 milligrams per liter. Water in the Upper Floridan aquifer is an alkaline calcium bicarbonate type. Water from undeveloped and developed areas is similar in chemical composition. Although water from the Upper Floridan aquifer has detectable concentrations of organic compounds and pesticides in some areas, these contaminants were detected in fewer samples from the Upper Floridan aquifer than in samples from the surficial and intermediate aquifer systems. Ground-water contamination documented during this investigation was most common in areas near citrus farming, point-source waste discharges, and phosphate chemical-processing plants.

INTRODUCTION

Polk County, in central Florida (fig. 1), relies heavily on ground water for public supply. Ground-water use for public supply averaged 55 Mgal/d in 1985 and is projected to average about 88 Mgal/d by the year 2020 (Marella, 1992). The principal source of ground water in Polk County is the Upper Floridan aquifer, which consists of carbonate rocks that have actively developing sinkholes. Because of these sinkholes and the highly permeable nature of the sediments overlying the Upper Floridan aquifer, ground water in the area is vulnerable to contamination. Four examples of ground-water contamination related to sinkhole activity and waste discharges are described in the following paragraphs.

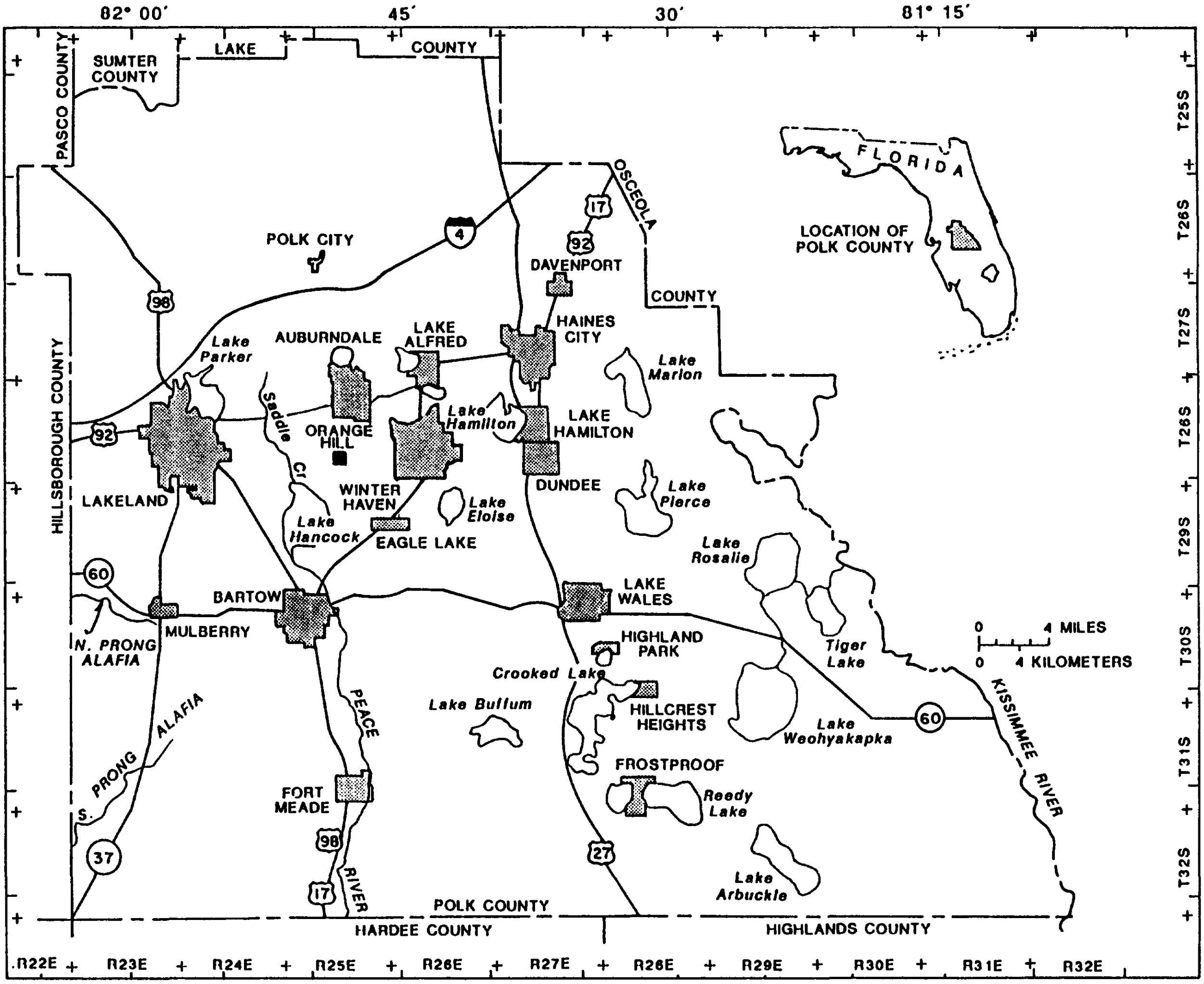

Figure 1. Location of study area.

In May 1974, water pumped from several wells near Bartow became cloudy. It was suspected that a sinkhole had developed in the bed of a nearby slime pond that contained clay waste from a phosphate processing plant. The source of the clay and its movement were not verified; however, it is feasible for such material to have been transported through highly developed solution cavities into the aquifer that is tapped by the contaminated wells.

In April 1975, a sinkhole about 75 ft in diameter collapsed beneath a gypsum stack near Mulberry. Gypsum stacks are repositories for phosphate process water that is known to be highly acidic and contains dissolved solids, ions, and radioisotopes that are higher in concentration than ground water of central Florida (Miller and Sutcliffe, 1984). Water was observed flowing from the stack into the underlying limestone at about 100 to 150 gal/min. Although no wells were reportedly contaminated, the introduction of contaminated water into the underlying aquifer system presented a potential health hazard to nearby and possibly distant consumers of water.

In April 1981, flow in the Peace River about 3 mi south of Bartow was totally captured by two sinkholes that opened in the riverbed. The mean discharge estimated from the U.S. Geological Survey gage at Bartow was 17 ft^3/s. Flow into the sinkholes consisted almost entirely of treated wastewater from various Polk County cities, phosphate operations, and other industries. The sinkholes functioned as a source of contamination to the ground water because natural filtration through overlying sands was bypassed. Eventually, the sinkholes became clogged with sand and the river stage returned to normal.

In early 1982, several residents of the Orange Hill residential community (fig. 1) suffered an unknown illness. The Polk County Water Resources Department indicated that either septic-tank effluent or citrus-processing wastes had contaminated the community's water supply. Although water-quality tests failed to verify the cause of the illness, it is possible that a slug of contaminated water could have moved through the Upper Floridan limestone aquifer to the Orange Hill supply well.

Public concern about the vulnerability of ground water to contamination in some areas and the heavy reliance on ground water led the U.S. Geological Survey, in cooperation with Polk County and the Southwest Florida Water Management District, to conduct a study to assess the contamination potential and to evaluate ground-water quality in Polk County. This study was conducted between 1985 and 1988. Results of the study, presented in this report, will aid county and district water managers in managing and developing the ground-water resources of the area while minimizing the possibility of ground-water contamination.

Purpose and Scope

The objectives of this report are (1) to describe the potential for ground-water contamination in the surficial aquifer system, the intermediate aquifer, and the Upper Floridan aquifer; and (2) to summarize ground-water quality in Polk County. This report presents the results of a 3-year investigation to assess the contamination potential and to evaluate the quality of ground water in Polk County. Contamination potential was estimated and related to various land uses and hydrogeologic factors that can affect ground-water quality.

Land uses examined in analyzing the available water-quality data include urban development, industrial operations, waste storage and disposal, and phosphate-ore mining and processing. Hydrogeologic factors discussed include aquifer hydraulic properties, sinkhole development, lineaments, and subsurface fractures. Water-quality data used in the analyses included data collected during previous studies and data collected at 95 sites in the study area during the 1985-88 study period. Much of the data collected during this study was collected in the densely populated and industrial area south of Polk City and generally west of Lake Wales. Data used to portray geologic conditions and subsurface fractures were concentrated more in this area because of a lack of information for the eastern and southeastern parts of the county. Data were grouped and analyzed according to aquifer and selected land-use types, including undeveloped areas, citrus farming areas, areas near point-source waste discharges, phosphate mining and reclamation areas, and areas near phosphate chemical-processing plants.

Acknowledgments

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Previous Investigations

Many investigators have described the geology and ground-water quality of Polk County. Discussions on Florida geology with reference to Polk County are included in reports by Cooke (1945), Vernon (1951), Parker and others (1955), Ketner and McGreevy (1959), Stringfield (1966), and Miller (1986). Miller (1986) redefined the terminology of the Floridan aquifer system. Stewart (1966) presented comprehensive information about the hydrogeology and ground-water resources of Polk County. Pride and others (1966) and Grubb and Rutledge (1979) studied the hydrology of the Green Swamp area, Robertson (1971) discussed the hydrology of the Lakeland Ridge, and Hutchinson (1978) appraised the surficial and intermediate aquifers of the upper Peace River and eastern Alafia River basins. Many of these investigators have reported on the ground-water quality in the various aquifers in Polk County and are listed in table 1. The distribution of wells sampled by each investigator is shown in figure 2. Stewart (1966) presented a broad reconnaissance of ground-water quality (fig. 2, frame A). Robertson (1971) described ground-water quality in the Lakeland area (fig. 2, frame B). Irwin and Hutchinson (1976) described the radiochemistry of ground water in the phosphate region (fig. 2, frame C). Hutchinson (1978) conducted a reconnaissance of water quality of the surficial and intermediate aquifer systems (fig. 2, frame D). Miller and Sutcliffe (1982) and Rutledge (1987) described the quality of water in the surficial aquifer system in part of the phosphate region (fig, 2, frame E). Shaw and Trost (1984) and Moore and others (1986) listed ambient ground-water data for the South Florida Water Management District and the Southwest Florida Water Management District, respectively (fig. 2, frame F).

Description of the Area

Polk County, in the center of the Florida Peninsula (fig. 1), is the State's fourth largest county with an area of 1,823 mi^2 (University of Florida, 1985). Population growth (321,000 in 1980) of this landlocked county has lagged behind that of the State's coastal counties. However, the county is a world leader in production of phosphate ore and related products and is also a center for the State's citrus industry. The county is experiencing problems with contamination of its vital ground-water resources.

The principal geomorphic features of the Polk County area, as defined by White (1970), are shown in figure 3. The county lies in the central highlands in midpeninsular Florida and includes a large part of the Polk Upland that stands above the surrounding plains and lowlands at 100 to 130 ft above sea level. A predominant karst feature is the intraridge valley, which bisects the Lake Wales Ridge. The valley was formed by the slow dissolution of the limestone bedrock. Within the Polk Upland, there are five major north-northwest to south-

Table 1. Selected studies reporting ground-water quality in Polk County, Florida
[IAS, intermediate aquifer system; UFA, Upper Floridan aquifer; --, no data]

Source	Study period	Aquifer unit and number of wells sampled: Surficial aquifer system	Intermediate aquifer system	Upper Floridan aquifer	IAS-UFA[1]	Water use	Major land-use type represented by data
Stewart (1966)	1954-80	8	28	58	17	municipal, industrial, domestic, citrus irrigation, observation	Countywide
Robertson (1971)	1967-71	--	8	12	--	municipal, industrial, domestic, observation	Urban
Irwin and Hutchinson (1976)	1974-78	25	9	--	--	industrial, domestic, observation	Phosphate-mining and reclamation areas
Hutchinson (1978)	1974-76	4	9	--	--	municipal, industrial, domestic, citrus irrigation, observation	Phosphate-mining and reclamation areas
Miller and Sutcliffe (1982)	1979-80	37	20	--	1	observation	Phosphate-processing plants
Shaw and Trost (1984)	1962-82	--	1	8	7	domestic, citrus irrigation, observation	Urban
Rutledge (1987)	1984-85	23	--	--	--	observation	Phosphate-processing plants[2]
Moore and others (1986)	1985-86	10	7	18	5	municipal, industrial domestic, citrus irrigation, observation	Countywide

[1]IAS-UFA, well open to both the intermediate aquifer system and the Upper Floridan aquifer.
[2]Clay-waste storage and sand-tailing site related to phosphate-processing plants.

southeast trending ridges (the Lakeland, Winter Haven, Lake Henry, Lake Wales, and Bombing Range Ridges) and several intervening valleys. The ridges are composed of depositional sands and sandy clays that generally range in altitude from 150 to 250 ft above sea level, but some ridge crests along the Lake Wales Ridge have altitudes of more than 300 ft.

The Peace River is the largest river in the county and drains the area between the Lakeland Ridge to the west and the Winter Haven and Lake Henry ridges to the east. Numerous lakes, sinks, and internally drained basins are distributed throughout the ridge and valley areas, and surface-water drainage is poorly developed in much of Polk County (Stewart, 1966).

Methods of Investigation

The hydrogeology of Polk County was described by using published data from previous investigations and unpublished data from well-completion reports in the files of the Southwest Florida Water Management District. Karst development and lineament analyses were described by using data available from the U.S. Geological Survey and Southwest Florida Water Management District files. Hydraulic properties of the three aquifer systems in Polk County were compiled from selected U.S. Geological Survey and Florida Geological Survey publications.

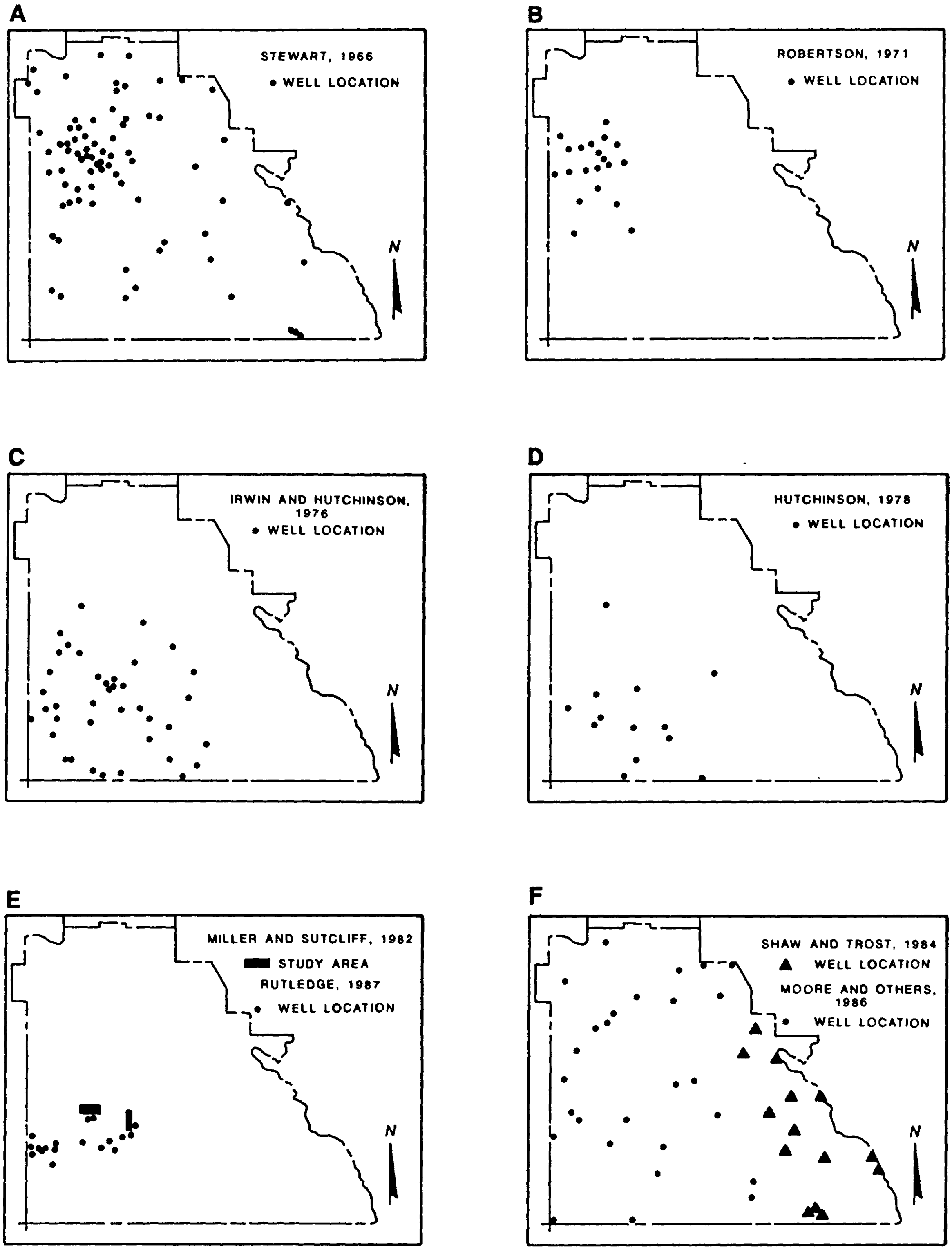


Figure 2. Water-quality data-collection sites for selected previous investigations.

A network of monitoring wells was established to sample ground water near suspected or potential sources of contamination. In addition, wells were sampled in undeveloped areas where ground-water quality generally is considered to be unaffected by humans. Water samples were collected from 5 wells in the surficial aquifer system, 41 wells in the intermediate aquifer system, 20 wells in the Upper Floridan aquifer, and 29 wells open to both the intermediate aquifer system and the Upper Floridan aquifer. All sampled wells are used for municipal, industrial, or domestic supply (fig. 4). The wells were either in undeveloped areas, in areas of dense industry, in areas of active agriculture, near phosphate mining and processing operations, or in urbanized areas. Well locations are shown in figure 4 and are listed in table 2. The potential for contamination and direction of ground-water flow were considered when selecting sampling sites. Well-construction information, such as depth and casing length, also was considered. The sites selected were either downgradient from a possible contamination source or located on or near a photolinear feature, sinkhole, or the interior of a closed depression. The wells were open to a known aquifer unit in most instances, but in some, the casing or total depths were unknown and aquifer units were estimated based on available information.

Water samples were collected over a 2-year period from 1986 through 1987 and were analyzed for a wide variety of constituents: major ions, trace metals, nutrients, dissolved solids, bacteria (surficial aquifer system wells only), selected volatile organic compounds (except surficial aquifer system wells), total organic carbon, and radiochemicals. Measurements of temperature, specific conductance, pH, and alkalinity were made onsite. Some wells were sampled again in 1988 to verify the presence of contaminants or abnormal constituent concentrations.

Water samples were collected from the surficial aquifer by driving a stainless-steel, hollow-tube, drive-point sampler through the unconsolidated material to just below the water table. A peristaltic pump was used to lift the water samples to the surface through the drive-point sampler. To ensure that a sample represented water from the aquifer, sampling was begun after water extracted from the well casing, or tube, equaled a minimum of two or more times the casing or tube volume. Also, samples were not collected until temperature and specific conductance of the pumped water had stabilized.

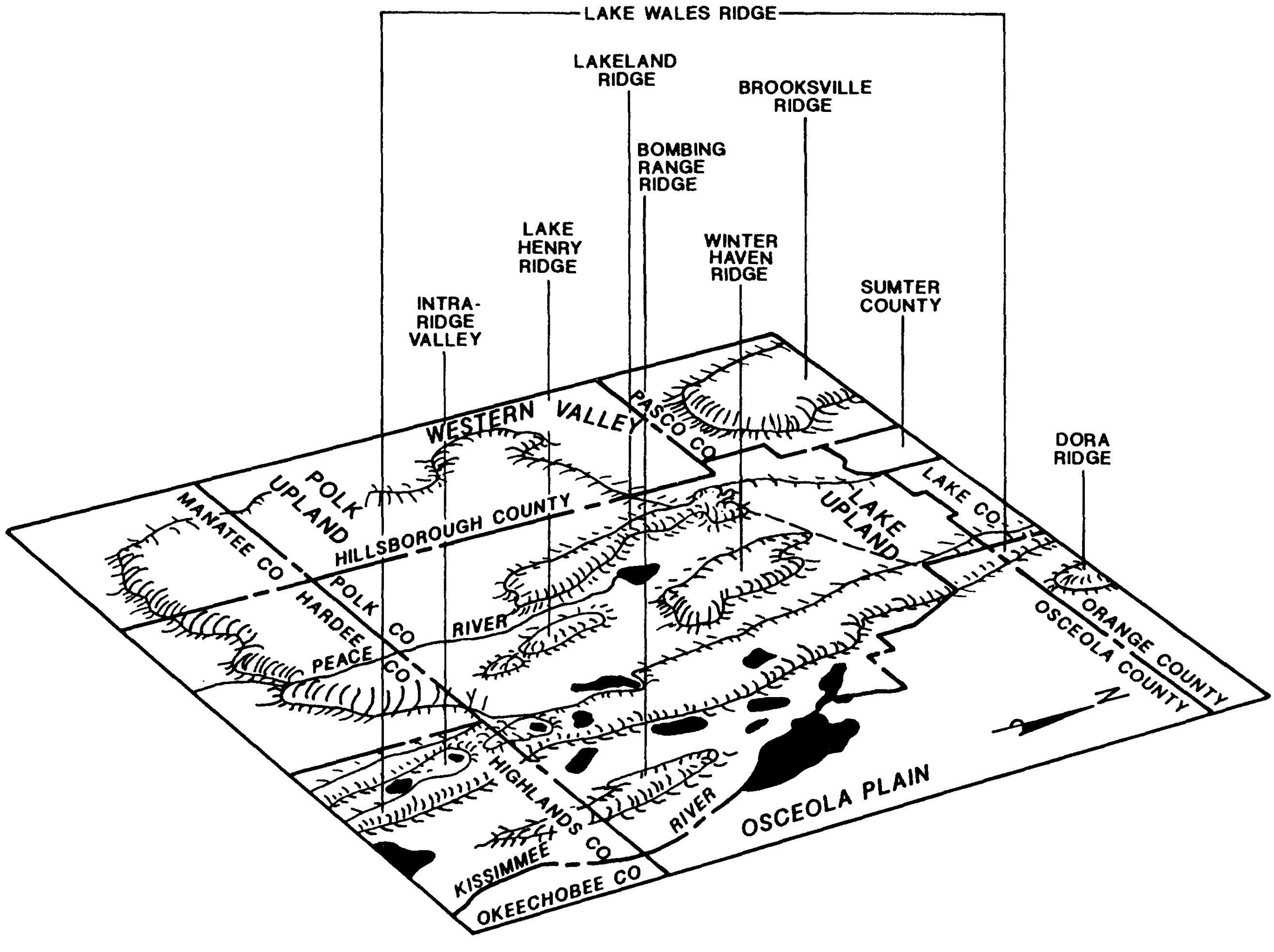


Figure 3. Principal geomorphic features of the Polk County area. (Modified from White, 1970.)

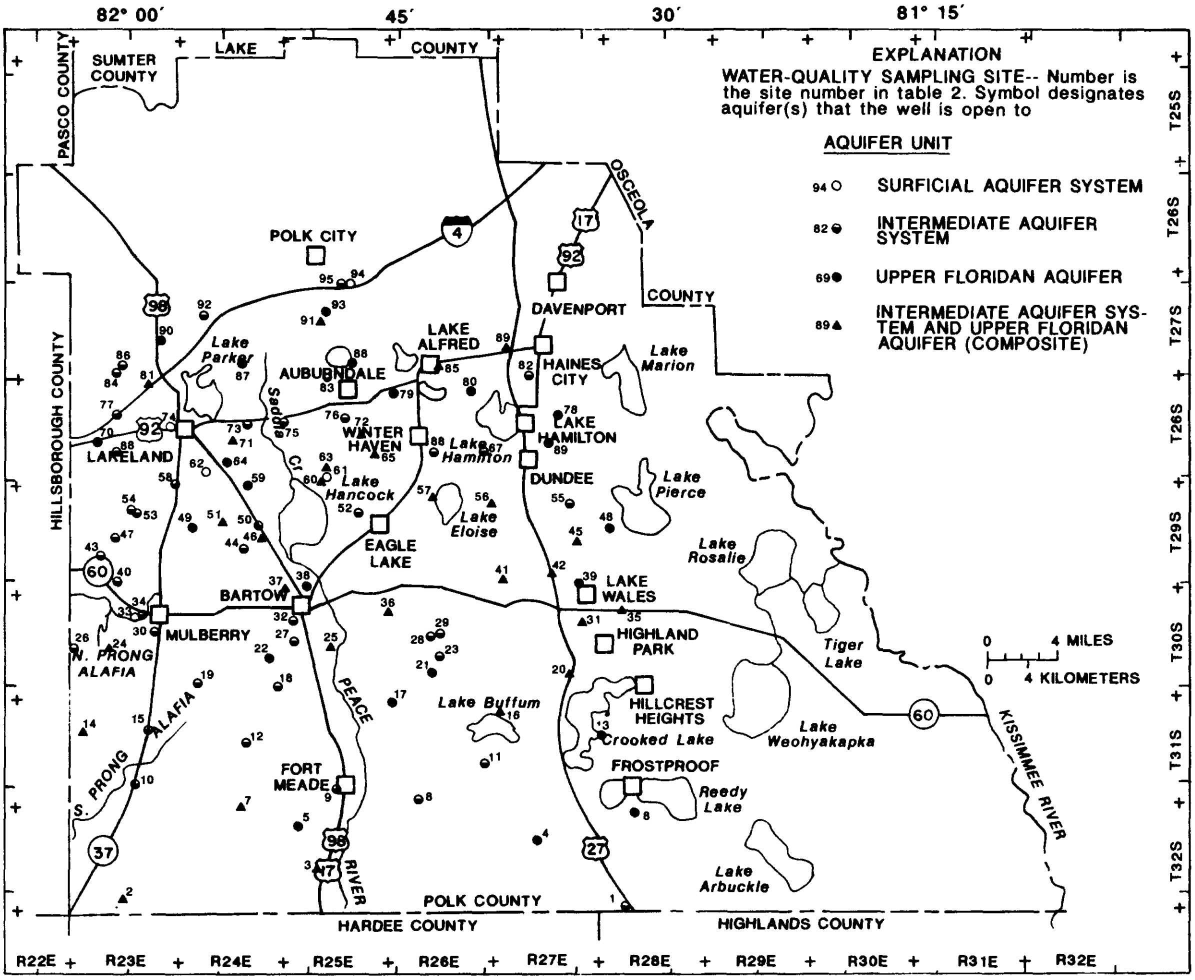


Figure 4. Locations of wells used for water-quality sampling during this study.

Water samples were obtained from existing, privately owned wells open to the intermediate aquifer system or the Upper Floridan aquifer or both using existing in-place centrifugal, submersible, or turbine pumps (table 2). The samples were collected at a near-surface discharge outlet. Field measurements were made, and water samples were collected and analyzed for chemical constituents and volatile organic compounds. Some loss of volatile organic compounds occurred at a number of sites due to the agitation effects of the existing pumps. When many large bubbles were observed in the samples, it was assumed that too much degassing had occurred and the samples were not analyzed for volatile organic compounds. If no pump was in place, water samples were obtained by using a portable centrifugal pump, a submersible pump, or a bailer apparatus. Water samples for organic analyses were collected from these wells by using either a Teflon[1] or a stainless-steel bailer to avoid the loss of volatile organic compounds.

HYDROGEOLOGIC FRAMEWORK

The hydrogeologic units that underlie the study area consist of the surficial aquifer system; the intermediate aquifer system or intermediate confining unit; and the Floridan aquifer system, which includes the Upper Floridan aquifer, the middle confining unit, and the Lower Floridan aquifer (Miller, 1986). This report focuses on the units overlying the middle confining unit (table 3). The stratigraphic units are an assemblage of sands, clays, and calcareous rocks that range in age from Holocene to Eocene. The location of five hydrogeologic sections traversing the county are shown in figure 5. The sections in figures 6 through 10 show the thickness and depth of the surficial and intermediate aquifer systems and the upper part of the Floridan aquifer system.

[1]Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the U.S. Government.

Table 2. Description of wells sampled during this study

[--, no data

Aquifer unit: SA, water sample from the surficial aquifer system; IAS, well open to the intermediate aquifer system; UFA, well open to the Upper Floridan aquifer; IAS-UFA, well open to both the intermediate and the Upper Floridan aquifers; ?, aquifer unit is estimated

Pump type: A, airlift; B, bailer; C, centrifugal pump; S, submersible pump; T, turbine pump; ts, thief sampler; dp, drive-point sampler;

Land-use type: bk, undeveloped areas; ci, citrus farming areas; mr, phosphate mining and reclamation areas; ps, areas near point-source waste discharges]

Site number (fig. 4)	Well identification number	Land net location	Casing depth	Well depth (feet)	Aquifer unit (feet)	Date of collection	Altitude of land surface (feet)	Pump type	Primary land-use type
1	273903081322701	T32 R28 S32	--	300	IAS	7/23/86	128	C	ci
2	273930082002301	T32 R23 S33	372	620	IAS-UFA	8/04/87	130	S	mr
3	274058081493501	T32 R25 S20	165	719	IAS-UFA	7/09/87	100	S	mr
4	274220081371801	T32 R27 S16	300	1,100	UFA	7/23/86	175	T	ci
5	274304081503801	T31 R25 S32	179	420	UFA	4/24/86	126	S	mr
6	274342081315401	T32 R28 S05	256	1,047	UFA	8/05/86	112	S	ci
7	274401081534901	T31 R24 S34	168	--	IAS-UFA?	6/22/87	146	S	mr
8	274421081435601	T31 R26 S32	105	172	IAS	4/24/86	134	S	ci
9	274452081482901	T31 R25 S34	105	190	IAS	7/30/87	139	S	mr
10	274507081594201	T31 R23 S27	103	165	IAS	6/22/87 1/19/88	140	S	mr
11	274607081401601	T31 R26 S24	--	180	IAS	5/07/86	142	C	ci
12	274712081533301	T31 R24 S15	99	115	IAS	8/10/87	165	C	mr
13	274730081333801	T31 R28 S18	210	250	UFA	7/14/87	123	S,ts	ci
14	274740082023601	T31 R23 S07	--	200	IAS-UFA?	4/29/86	160	S	mr
15	274749081590001	T31 R23 S11	105	230	IAS	4/28/86	138	S	mr
16	274843081392201	T31 R27 S06	94	650	IAS-UFA	7/30/87	150	S	ci
17	274910081452201	T31 R26 S06	316	817	UFA	4/10/86	230	T	ci
18	274958081514601	T30 R24 S36	126	300	IAS	8/04/87	143	S	mr
19	275010081561301	T30 R24 S32	84	185	IAS	7/23/87	160	S	mr
20	275032081353201	T30 R27 S26	150	400	IAS-UFA	7/29/87	137	S	ci
21	275036081431201	T30 R26 S28	231	583	UFA	5/05/86	158	S	ci
22	275123081521601	T30 R24 S24	252	740	UFA	7/23/87	130	T	mr
23	275130081424601	T30 R26 S21	83	195	IAS	7/21/87	145	S	ci
24	275150082011001	T30 R23 S21	126	200	IAS-UFA	4/28/86	115	S	mr
25	275156081485101	T30 R25 S16	188	260	IAS-UFA	5/07/86	112	S	ps
26	275156082031101	T30 R23 S18	102	179	IAS	7/23/87	110	S	mr
27	275213081505401	T30 R25 S18	123	180	IAS	6/24/87	125	S	mr
28	275230081431301	T30 R26 S16	89	239	IAS	4/10/86	125	S	ci
29	275236081424301	T30 R26 S16	126	250	IAS	7/21/87 1/20/88	160	S	ci
30	275243081584001	T30 R23 S14	74	175	IAS	6/22/87 1/19/88	129	S	mr
31	275304081344701	T30 R27 S12	--	600	IAS-UFA	7/23/86	152	T	ci
32	275310081505501	T30 R25 S07	77	128	IAS	6/24/87	121	S	bk
33	275327081595301	T30 R23 S10	--	7	SA	8/18/87	112	dp	ps
34	275332081592701	T30 R23 S10	48	70	IAS	6/22/87	110	C	ci
35	275337081323301	T30 R28 S08	147	270	IAS-UFA	7/29/87 1/20/88	120	S	ci
36	275339081453901	T30 R26 S06	112	270	IAS-UFA	5/05/86	124	S	ci
37	275449081512101	T29 R25 S31	88	475	IAS-UFA	4/28/86	122	S	ci
38	275450081501001	T29 R25 S32	200	250	UFA	6/24/87	200	S	ci
39	275456081345501	T29 R27 S35	705	1,050	UFA	7/30/87	200	T	ci
40	275511082004401	T29 R23 S33	65	88	IAS	6/23/87	80	C	bk
41	275514081391401	T29 R27 S31	--	480	IAS-UFA	4/30/86	131	S	ci
42	275530081362901	T29 R27 S27	112	360	IAS-UFA	7/29/87	125	S	ci
43	275627082014101	T29 R23 S20	--	60	IAS	6/24/86	120	C	bk
44	275646081534201	T29 R24 S22	142	240	IAS	4/14/86	139	S	ci
45	275702081350701	T29 R27 S23	108	700	IAS-UFA	7/22/86	185	T	ci

Table 2. Description of wells sampled during this study—Continued

Site number (fig. 4)	Well identification number	Land net location	Casing depth	Well depth (feet)	Aquifer unit (feet)	Date of collection	Altitude of land surface (feet)	Pump type	Primary land-use type
46	275714081523801	T29 R24 S14	--	700	IAS?-UFA	6/26/86	138	S	ci
47	275718082004901	T29 R23 S16	110	115	IAS	6/24/86	121	S	bk
48	275743081331501	T29 R28 S18	151	300	UFA	7/29/87	125	S	ci
49	275748081563601	T29 R24 S18	225	300	UFA	7/13/87	230	S	ci
50	275752081525301	T29 R24 S14	88	112	IAS	6/26/86	123	S	ci
51	275806081545101	T29 R24 S09	100	255	IAS-UFA	8/04/87	160	S	ci
52	275829081471601	T29 R25 S11	--	180	IAS	6/26/86	132	T	bk
53	275832081594201	T29 R23 S10	45	110	IAS	6/25/86	110	S	bk
54	275838081595601	T29 R23 S10	--	50	IAS	6/25/86	120	C	bk
55	275858081353001	T29 R27 S02	--	100	IAS	7/22/86	185	C	ci
56	275859081395301	T29 R26 S01	--	250	IAS-UFA	7/22/86	150	C	ci
57	275918081425501	T29 R26 S04	96	240	IAS-UFA	7/20/87 1/20/88	147	S	ci
58	275953081532701	T28 R24 S35	--	164	IAS	7/07/87 1/20/88	140	C	ps
59	275956081572801	T28 R23 S36	207	320	UFA	7/13/87 1/19/88	180	S	ps
60	280005081492201	T28 R25 S33	120	500	IAS-UFA	7/01/86	116	T	ci
61	280016081490301	T28 R25 S33	--	8	SA	8/20/87	114	dp	ps
62	280039081555601	T28 R23 S32	--	15	SA	8/18/87	120	dp	ps
63	280044081490801	T28 R25 S28	63	192	IAS-UFA	4/30/86	125	C	ci
64	280101081543601	T28 R24 S33	--	--	UFA?	4/14/86	131	S	ci
65	280123081462301	T28 R25 S25	85	210	IAS-UFA	7/09/87	154	S	ps
66	280130082004901	T28 R23 S28	70	80	IAS	7/07/87	140	S	bk
67	280131081401601	T28 R26 S25	65	200	IAS	7/20/87	133	S	ci
68	280133081430501	T28 R26 S21	116	150	IAS	7/21/87 1/20/88	145	S	ps
69	280154081364101	T28 R27 S22	250	--	UFA	7/22/86	150	S	ci
70	280200082014901	T28 R23 S20	--	80	IAS	6/24/86	121	S	bk
71	280203081541701	T28 R24 S22	63	260	IAS-UFA	7/07/87 1/19/88	140	S	ps
72	280220081470701	T28 R25 S23	135	390	IAS-UFA	7/09/87	142	S	ps
73	280245081533101	T28 R24 S15	50	90	IAS	7/07/87	125	S	ps
74	280246081574501	T28 R23 S01	29	49	SA	8/19/87	200	dp	ps
75	280253081512901	T28 R25 S18	--	87	IAS	7/01/86	115	C	ci
76	280315081480101	T28 R25 S15	77	105	IAS	7/09/87	140	C	ps
77	280320082004601	T28 R23 S09	50	--	IAS	6/23/86	120	C	ci
78	280323081360901	T28 R27 S10	--	--	UFA	7/21/86	155	S	ci
79	280424081452001	T28 R26 S06	147	190	UFA	7/08/87	140	C	ci
80	280437081410207	T28 R26 S02	135	155	UFA	8/28/87	133	A,B	ci
81	280452081585701	T28 R23 S02	69	150	IAS-UFA	7/07/87	240	S	ci
82	280516081374701	T27 R27 S32	120	167	IAS	7/21/86	170	S	ci
83	280520081485601	T27 R25 S33	96	--	IAS	7/21/86	143	S	ci
84	280529082004601	T27 R23 S33	90	120	IAS	6/23/86	113	C	ps
85	280548081424801	T27 R26 S33	--	160	IAS-UFA	5/06/86	136	S	ps
86	280554082002701	T27 R23 S33	60	105	IAS	6/23/86	125	S	ps
87	280600081534901	T27 R24 S27	94	130	IAS	6/25/87	135	S	mr
88	280601081473701	T27 R25 S27	135	220	UFA	7/08/87	160	S	ci
89	280642081385301	T27 R27 S30	--	427	IAS?-UFA	7/02/86	143	C	ci
90	280703081582201	T27 R23 S24	90	180	UFA	7/08/87	160	S	ci
91	280805081492301	T27 R25 S17	120	220	IAS-UFA	5/05/86	163	S	ci
92	280819081555701	T27 R24 S17	62	84	IAS	7/08/87	160	S	ci
93	280836081490401	T27 R25 S09	85	200	UFA	7/20/87 1/20/88	175	S	ci
94	280950081480001	T27 R25 S03	--	8	SA	8/20/87	145	dp	ci
95	280950081480501	T27 R25 S03	--	600	IAS?-UFA	7/02/86	148	T	ci

Table 3. Stratigraphy and hydrogeology
[Modified from Ryder, 1985]

System	Series	Stratigraphic unit		General lithology unit	Major lithologic	Hydrogeologic unit[1]	
Quaternary	Holocene and Pleistocene	Surficial sand, terrace sand, and phosphorite.		Fine to medium sand, interbedded silts, clays and phosphorites; organic sediments and peat in lower parts in some areas.	Sand	Surficial aquifer system	
Tertiary	Pliocene						
		Undifferentiated deposits		Clay, sandy clays, calcareous clays, and phosphorites.	Clastic	Uppermost confining bed	Intermediate aquifer system or confining unit where aquifer(s) is absent
	Miocene	Hawthorn Group[2]	Peace River Formation	Limestone, dolomite, sand, clay, and phosphorites.	Carbonate and clastic	Aquifer(s)	
			Arcadia Formation; Tampa Member	Limestone, dolomite; fossiliferous sands, clays, and phosphorites, with sand and clay in lower part in some areas.		Lowermost confining bed	
	Oligocene	Suwannee Limestone		Limestone, slightly sandy, fossiliferous; some clay and dolomite.	Carbonate	Upper Floridan aquifer	Floridan aquifer system
	Eocene	Ocala Limestone		Limestone; chalky, foraminiferal, dolomitic near bottom.			
		Avon Park Formation		Limestone and hard brown dolomite; intergranular evaporite in lower part in some areas.	Carbonate with evaporites	Middle confining unit	

[1]Based on nomenclature of Southeastern Geological Society (1986).
[2]Based on nomenclature of Scott (1988).

Surficial Aquifer System

The surficial aquifer system is unconfined and consists of unconsolidated clastic deposits that range in age from Pliocene to Holocene (Southeastern Geological Society, 1986). The system is composed primarily of quartz sands that are fine to medium grained near the surface and that grade with depth to silty and clayey sands with increasing amounts of phosphate grains and pebbles. Organic sediments and peat occur near the bottom of the unit in some areas. Some clay layers are present above the base of the unit, but they are not laterally extensive.

More than 1,200 lithologic descriptions from the files of the Florida Geological Survey, the Southwest Florida Water Management District, and the U.S. Geological Survey were evaluated to estimate an average aquifer thickness within each 36-mi^2 area defined by the township and range grid in the county. These data indicate that thickness of the surficial aquifer system ranges from less than 1 ft to more than 200 ft (figs. 6-11). The surficial aquifer system is thickest along the center of the major ridges where the average thickness is in excess of 200 ft. Near Frostproof, the thickness is nearly 250 ft (fig. 7). The surficial aquifer is less than 25 ft thick in the areas on either side of the Lakeland Ridge and some scattered

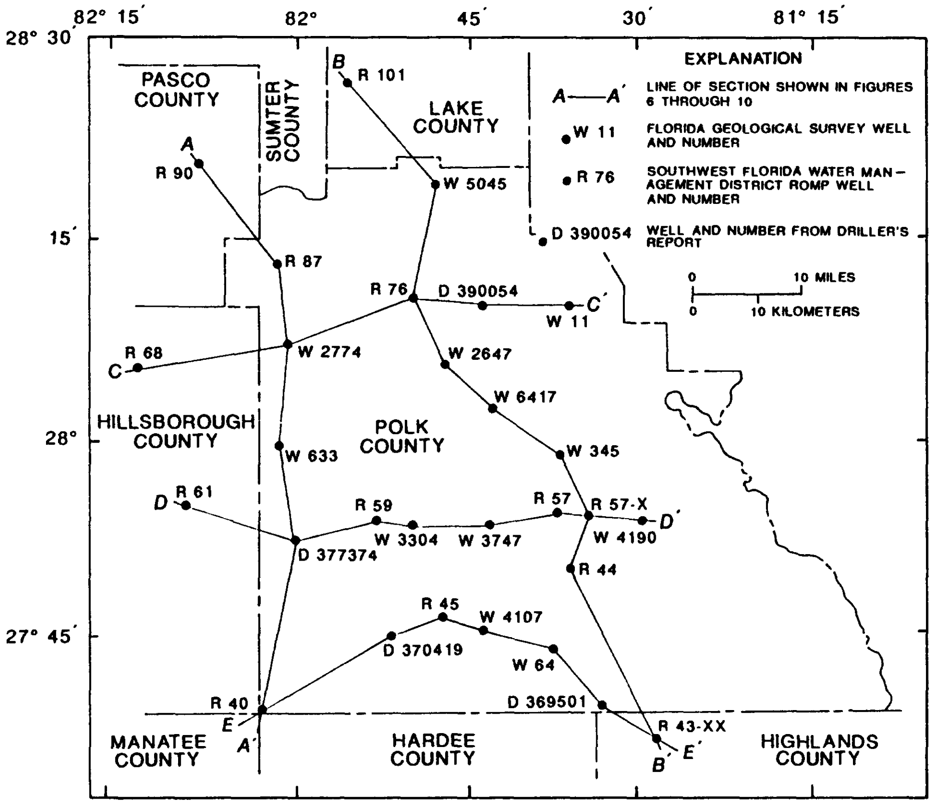


Figure 5. Locations of generalized hydrogeologic sections *A-A′* through *E-E′*.

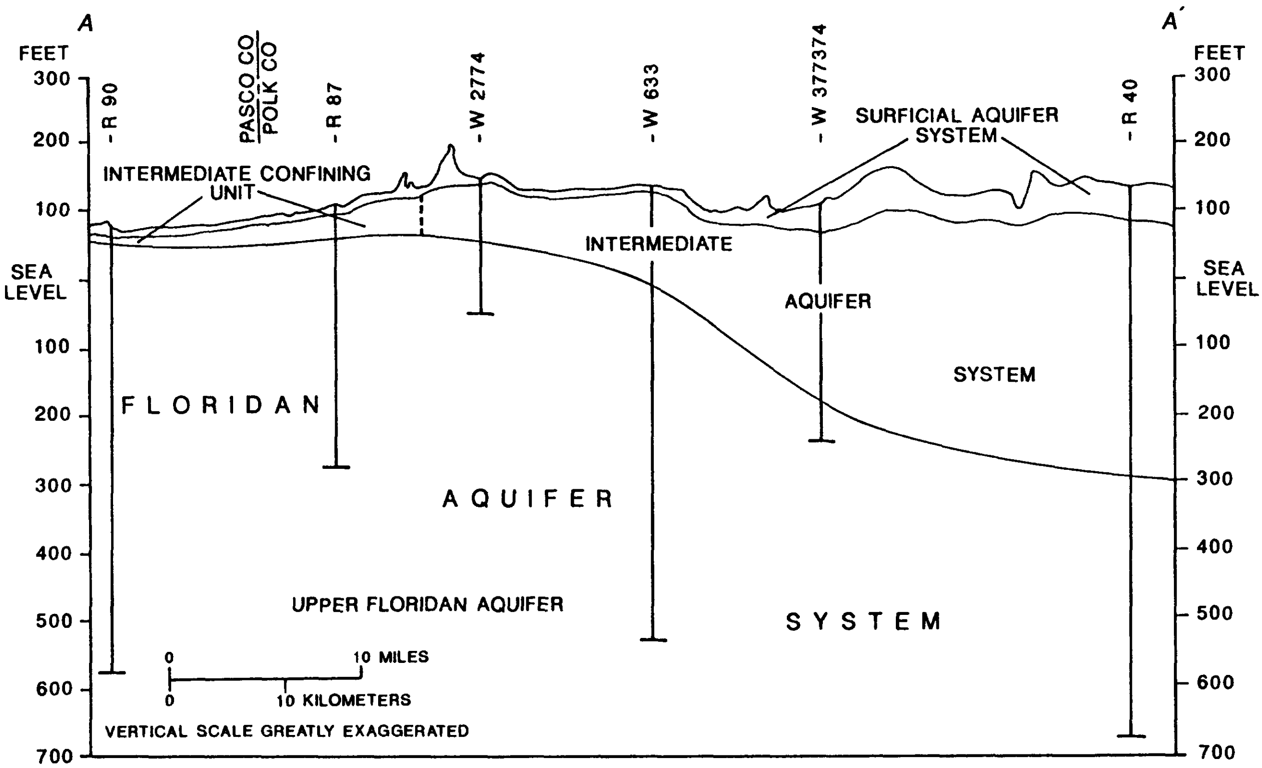


Figure 6. Generalized hydrogeologic section *A-A′*.

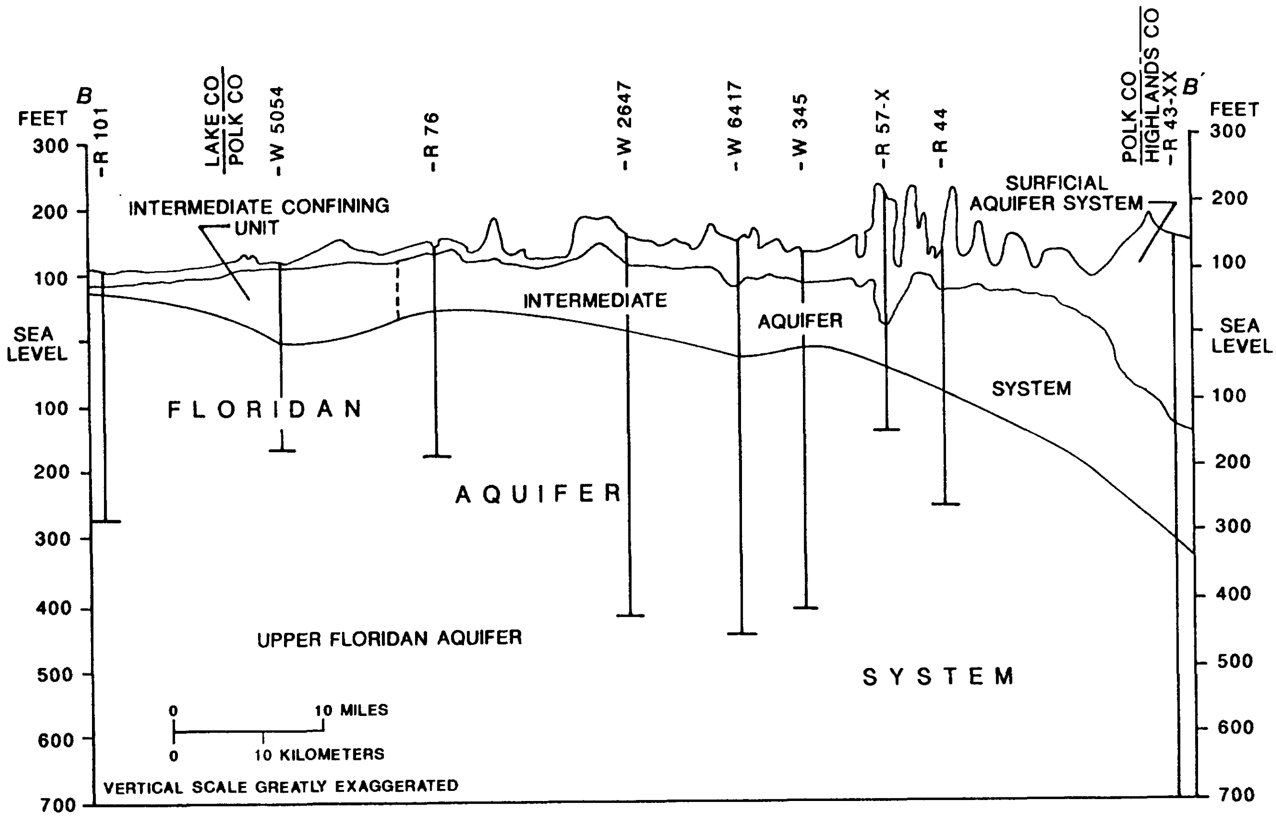


Figure 7. Generalized hydrogeologic section *B-B′*.

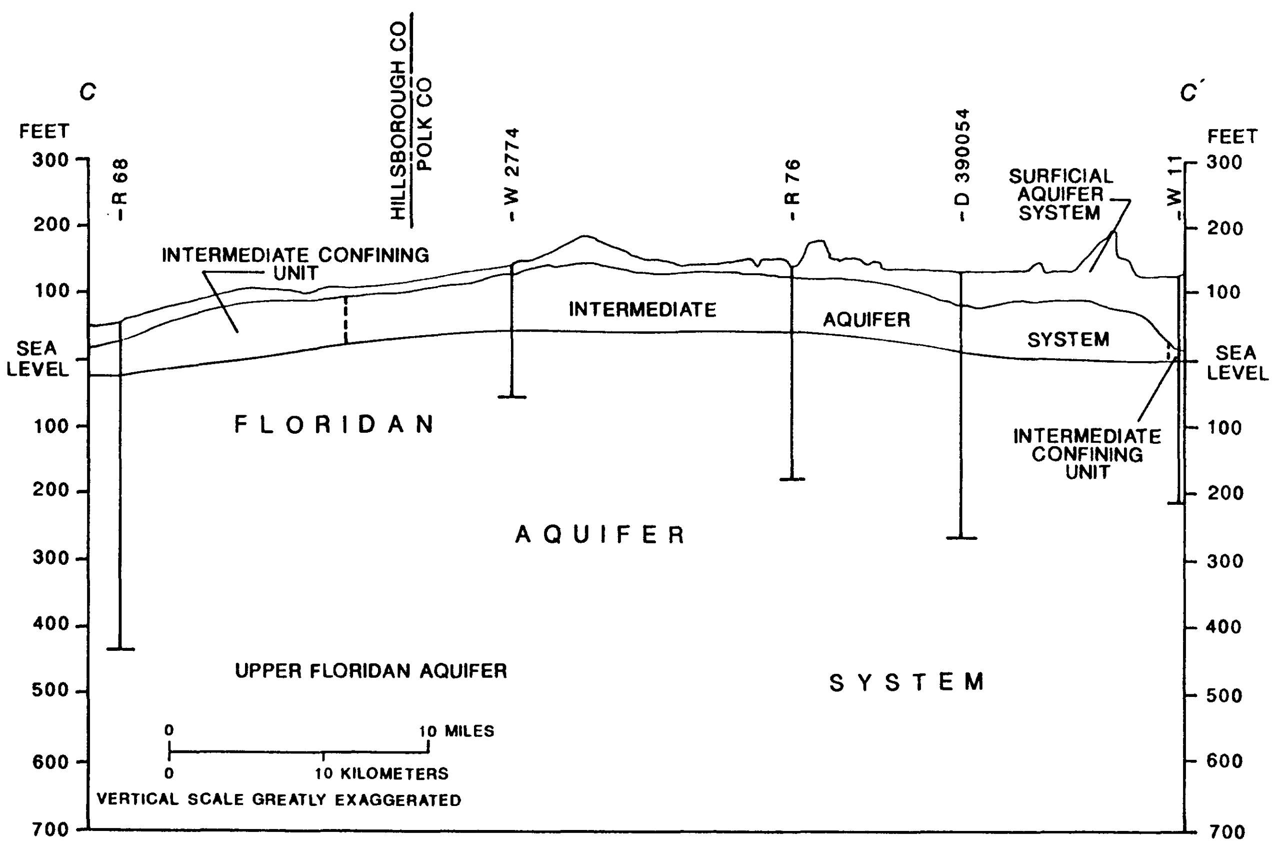


Figure 8. Generalized hydrogeologic section *C-C′*.

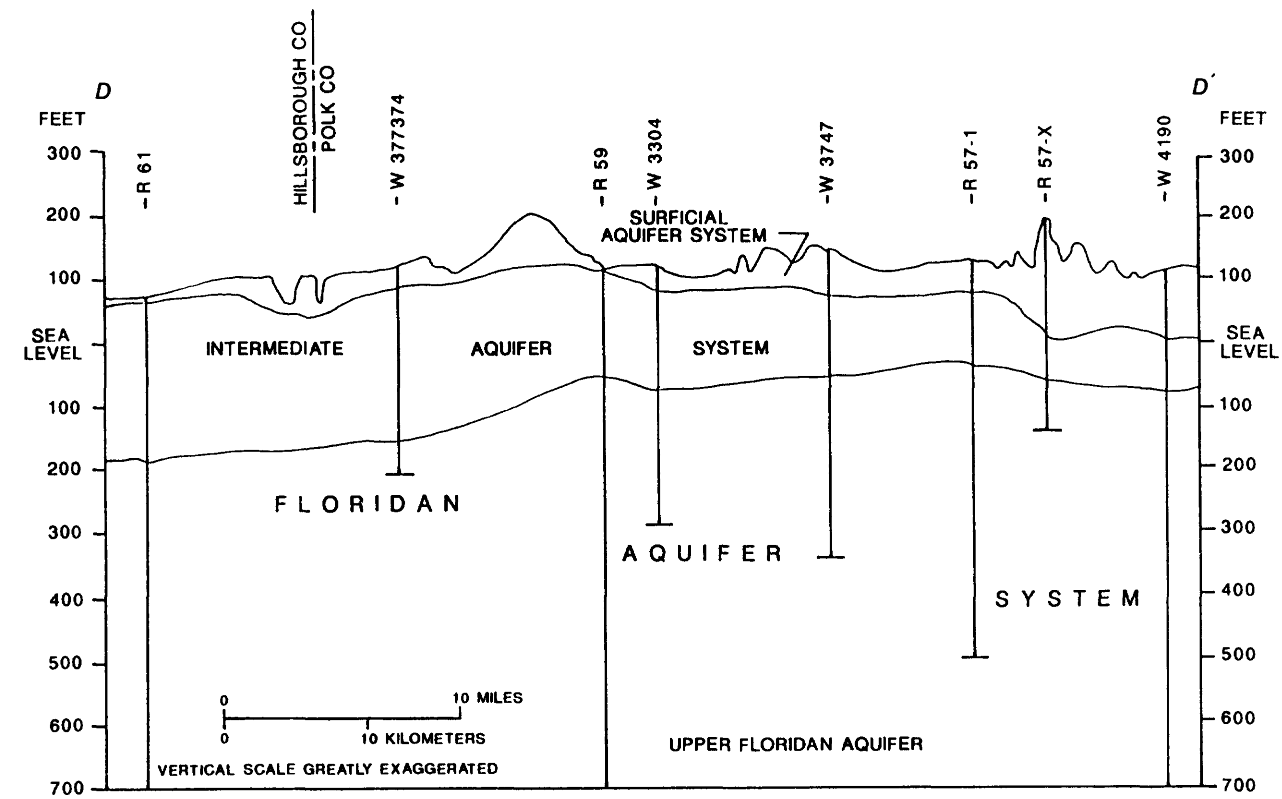


Figure 9. Generalized hydrogeologic section *D-D′*.

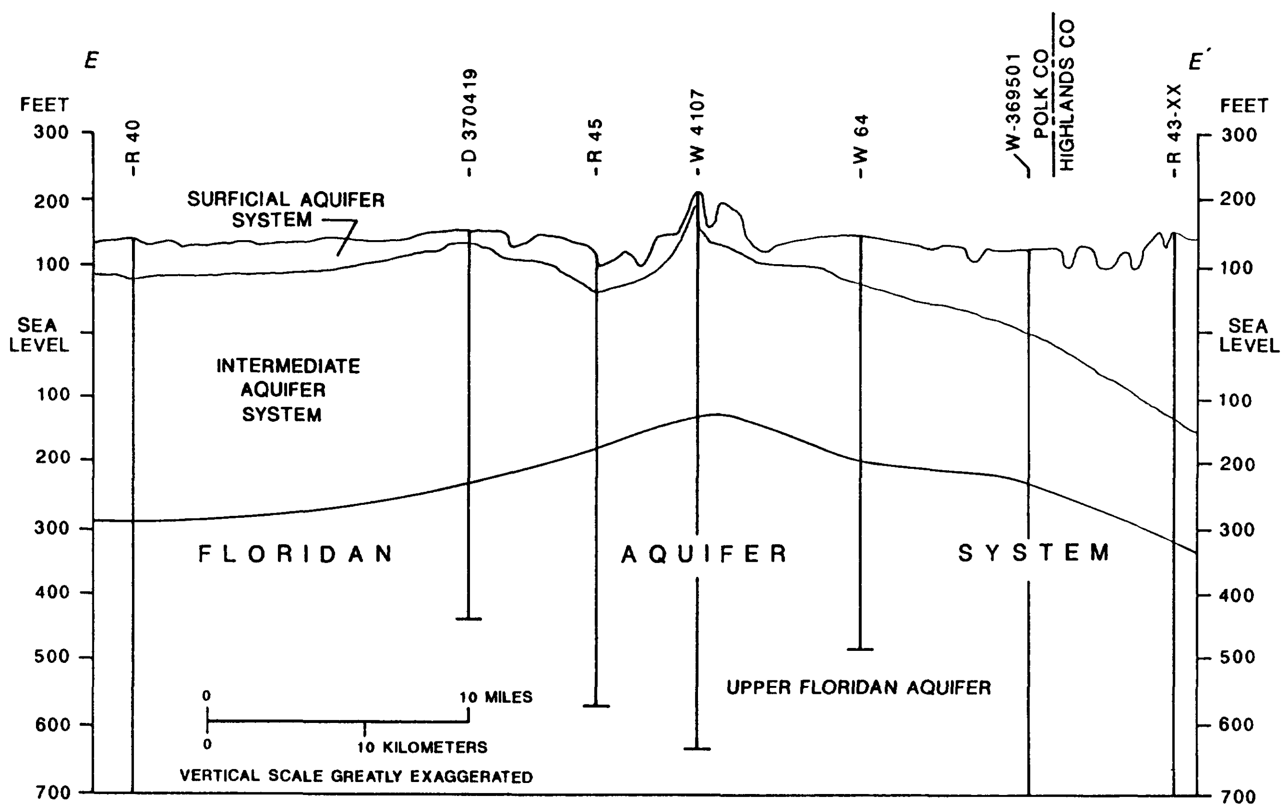


Figure 10. Generalized hydrogeologic section *E-E′*.

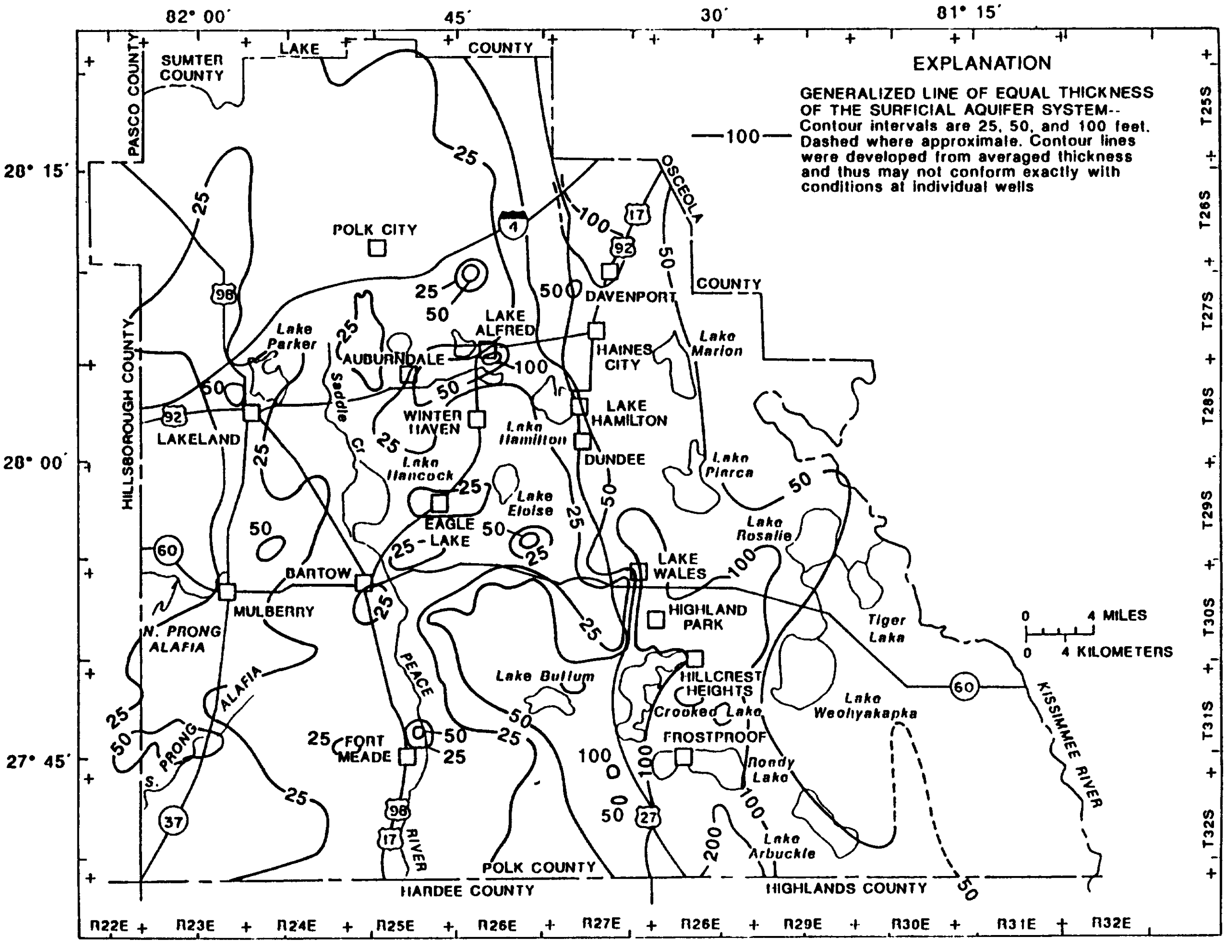


Figure 11. Generalized thickness of the surficial aquifer system in Polk County.

areas throughout the county. The thickness map (fig. 11) was developed from geologists' and drillers' descriptions of well cuttings and from well-completion reports.

Different depositional conditions have resulted in a range of values for the hydraulic characteristics of the surficial aquifer system. Previously reported values for transmissivity, specific yield, and hydraulic conductivity of the surficial aquifer system are presented in table 4. Transmissivity ranges from 240 to 2,200 ft^2/d and specific yield, or storage coefficient, is about 0.25 (average of values given in table 4).

Table 4. Hydraulic properties of the surficial aquifer system
[ft^2/d, foot squared per day; ft/d, foot per day; --, no data]

Source	Transmissivity (ft^2/d)	Specific yield (percent)	Hydraulic conductivity (ft/d)
Stewart (1963)	--	31 – 43.9	--
Pride and others (1966)	--	12.5 – 43.9	2.7 – 24.1
Stewart (1966)	--	22.2	--
Hutchinson (1978)	2,200	29	55
Wolansky and Corral (1985)	240 – 600	0.4 – 20	--

The surficial aquifer system is not widely used as a source of water; however, it is used in places for domestic supply and lawn irrigation. Well-completion reports and conversations with well owners indicate that pumping rates from wells tapping the surficial aquifer system are less than 100 gal/min and that most wells yield from 10 to 50 gal/min.

Kimrey and Fayard (1984, p. 52) indicated that, in 1980, there were 101 connector wells in use by the phosphate mining industry to dewater the surficial aquifer system by gravity drainage into deeper aquifers. Connector wells are constructed to allow several aquifer systems to be open to the well. Most of the connector wells are west of the Peace River and south of Bartow. Other discharges from the surficial aquifer system include evapotranspiration, spring flow, seepage to surface-water bodies, leakage to underlying units, and pumpage from wells.

The water surface in the saturated sediments of the unconfined surficial aquifer system is called the water table. The configuration of the water table in the surficial aquifer system is shown in figure 12. The water table generally is a subdued reflection of the land surface, with "highs" along ridges and "lows" in river valleys. Along the ridges, depth to the water table is more than 200 ft below land surface (Southwest

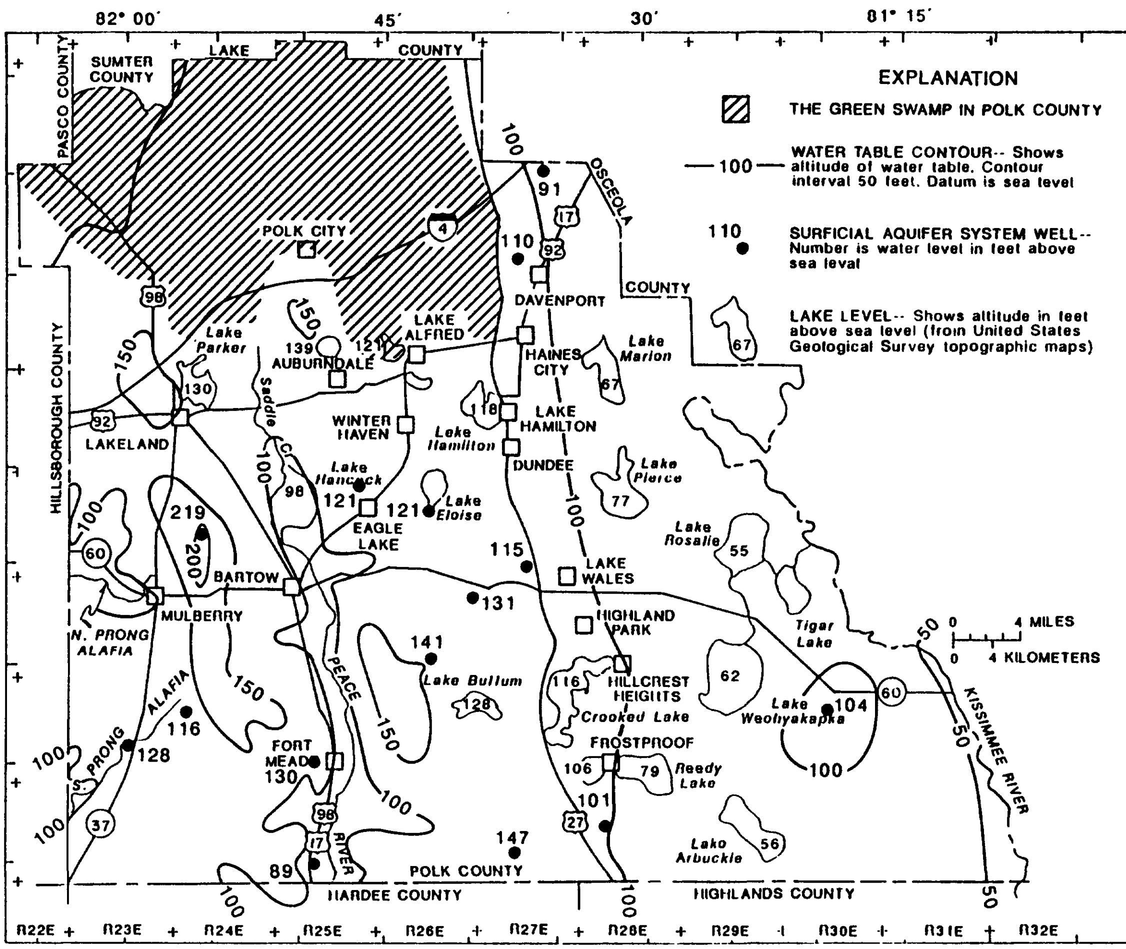


Figure 12. Generalized water table in the surficial aquifer system, 1975. (Modified from Hutchinson, 1978, using data from Grubb and Rutledge, 1979; U.S. Geological Survey, 1976a; 1976b.)

Florida Water Management District, written commun., 1989), whereas in valley areas or near streams, the water table may be at or near land surface. The water table generally is at land surface in a large area in the northern part of the county known as the Green Swamp.

Fluctuations of the water table result from recharge to or discharge from the surficial aquifer system. The main source of recharge is rainfall. Other sources of recharge include seepage from surface-water bodies and infiltration of agricultural and domestic irrigation water, and industrial discharges. Water levels are lowest at the end of the dry season, generally late May, and highest in September or October at the end of the rainy season. The water table is above the potentiometric surfaces of the intermediate aquifer system and the Upper Floridan aquifer in the western part of the county. The surficial aquifer system acts as a recharge source to the underlying aquifers in this area. In the Kissimmee River Valley in the eastern part of the county, the potentiometric surfaces are above the water table and indicate a potential for discharge from the deep aquifers to the surficial aquifer system.

Intermediate Aquifer System or Intermediate Confining Unit

The intermediate aquifer system and the intermediate confining unit are composed of sedimentary units that are Miocene or Pliocene age. They lie below the surficial aquifer system and above the highly permeable carbonates of the Upper Floridan aquifer (Southeastern Geological Society, 1986). The deposits have varying degrees of permeability because strata may consist of permeable sands, limestones, or dolomites, or relatively impermeable layers of clay, sandy clays, or clayey carbonates.

The intermediate aquifer system is present throughout Polk County, except in the extreme northern part (figs. 6-10 and 13). The criteria used to define the extent of the intermediate aquifer system is the occurrence of carbonate beds more than 5 ft thick that are confined above and below by clays. In places where permeable strata are 5 ft or less in thickness, the term "intermediate confining unit" applies. The intermediate aquifer system is about 390 ft thick in the southwestern part of the county; the permeable units become thin and discontinuous in the northern part. East of the Lake Wales Ridge, the Tampa Member pinches out, and the intermediate aquifer system is not an important source of water.

The generalized thicknesses of the uppermost and the lowermost confining units of the intermediate aquifer system and the intermediate confining unit are shown in figures 14 and 15. The generalized thickness of the uppermost confining unit ranges from less than 25 ft to more than 200 ft (fig. 14) and is less than 25 ft in the northern, southeastern, and some central parts of the county. The lowermost confining unit ranges from less than 25 ft to more than 100 ft in thickness (fig. 15) and is less than 25 ft thick in some areas of the northern, southern, and central parts of the county.

Hydraulic properties of units within the intermediate aquifer system, derived from field tests and computer model calibration, are listed in table 5. Transmissivity ranges from 1,600 ft^2/d at the Peace River about 4 mi north of the Polk-Hardee County line to 13,300 ft^2/d at an aquifer-test site about 1 mi northeast of Fort Meade (Hutchinson, 1978). Leakance coefficients of confining units, derived from model simulations by Ryder (1985) and Tibbals (1990), are shown in figure 16. The leakance coefficient for the uppermost confining unit of the intermediate aquifer system was lowest in southwestern parts of the county and highest in the northwestern part of the county.

The intermediate aquifer system receives recharge as downward leakage from the surficial aquifer system, inflow through breaches in the confining units where surface-mining operations have exposed permeable rocks, through recharge wells designed to drain water from the surficial aquifer system prior to mining, and from numerous solution pipes and sinkholes that breach the confining units. Discharge from the intermediate aquifer system occurs as spring flow, upward leakage to rivers, pumpage, and downward leakage to the Upper Floridan aquifer. The intermediate aquifer system generally is used as a source of water west of the Lake Wales Ridge and south of Lakeland because it has sufficient thickness and permeability. Duerr and others (1988) reported that, in 1985, 11.5 Mgal/d of water was withdrawn from the intermediate aquifer system for rural, industrial, and irrigation uses in that part of the county. Some of the large-diameter, multiaquifer supply wells in the area

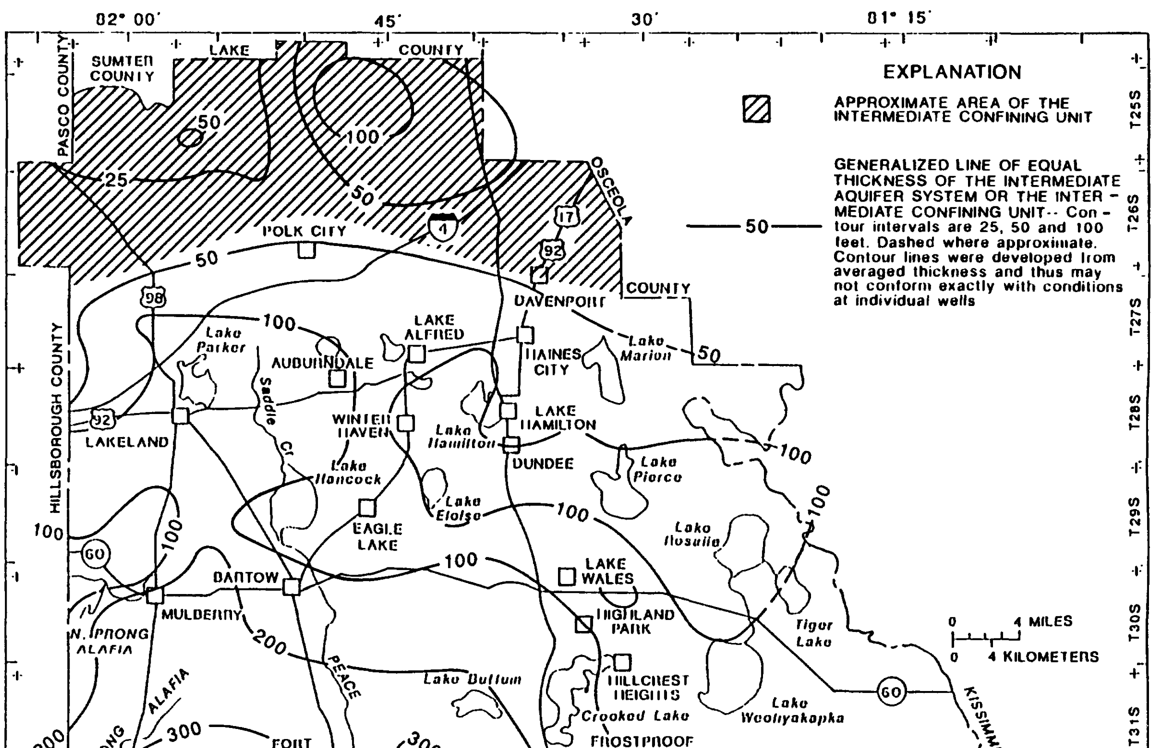


Figure 13. Generalized thickness of the intermediate aquifer system and the intermediate confining unit in Polk County.

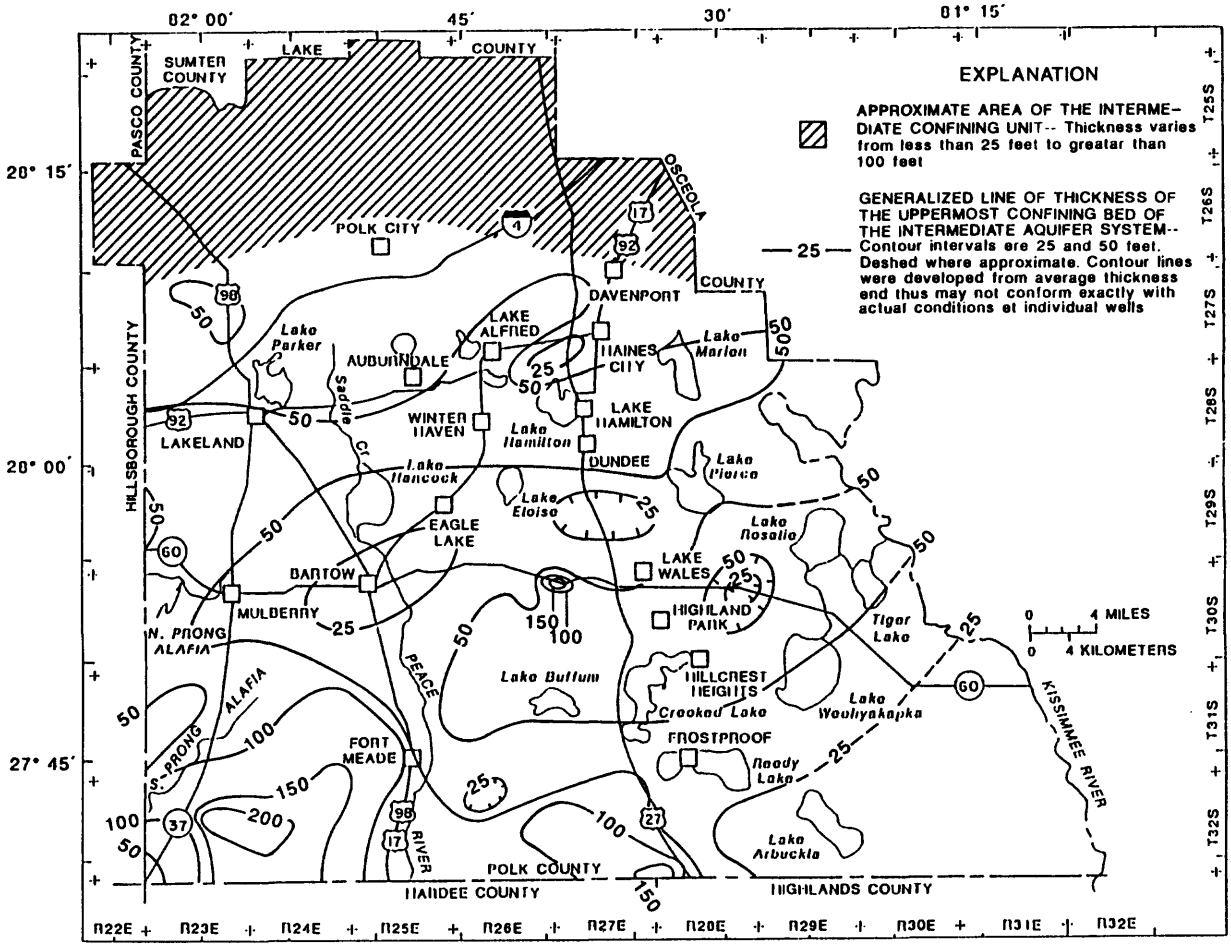


Figure 14. Generalized thickness of the uppermost intermediate confining bed and area of occurrence of the the intermediate confining unit in Polk County.

yield as much as 1,500 gal/min. A percentage of the total pumpage from multiaquifer wells was included in the estimate of water withdrawn from the intermediate aquifer system.

The potentiometric surface of the intermediate aquifer system, shown in figure 17, represents water-level conditions in Polk County during a high water-level period in September 1986 (Lewelling, 1987b) and a low water-level period in May 1987 (Lewelling, 1987a). The altitude of the potentiometric surface ranged from less than 50 ft during the low water-level period to more than 120 ft above sea level during the high water-level period (fig. 17). The flow system has two potentiometric surface highs in Polk County, one in the central part of the county, and another in the southwestern part. The flow paths shown in figure 17 are the general directions that water traveled through the aquifer under these water-level conditions. The depression in the potentiometric surface along the Peace River indicates that the aquifer is discharging to the river.

Over most of Polk County there is a positive head difference between the water table in the surficial aquifer system and the potentiometric surface of the intermediate aquifer system. The potentiometric surface coincides with or is higher than the water table only in the southern part of the Peace River and Kissimmee River Valleys. Stewart (1966) indicated that water levels in these areas rise rapidly toward high ground along the valley walls, and the area of artesian flow may be less than 100 ft wide in some places. The head difference is estimated to be as much as 100 ft in the area between Bartow and Lakeland, as calculated from figures 12 and 17.

Upper Floridan Aquifer

The Upper Floridan aquifer is the most permeable hydrogeologic unit in the study area. The aquifer underlies all of Polk County and is a continuous sequence of carbonate rocks that range in age from Eocene through Oligocene (table 3). Depth to the top of the aquifer ranges from less than 50 ft in the northwestern part of the county to more than 400 ft in the southwestern corner of the county (fig. 18). The aquifer thickness ranges from less than 900 ft in northern Polk County to more than 1,200 ft in southern and southwestern parts of the county (Ryder, 1985).

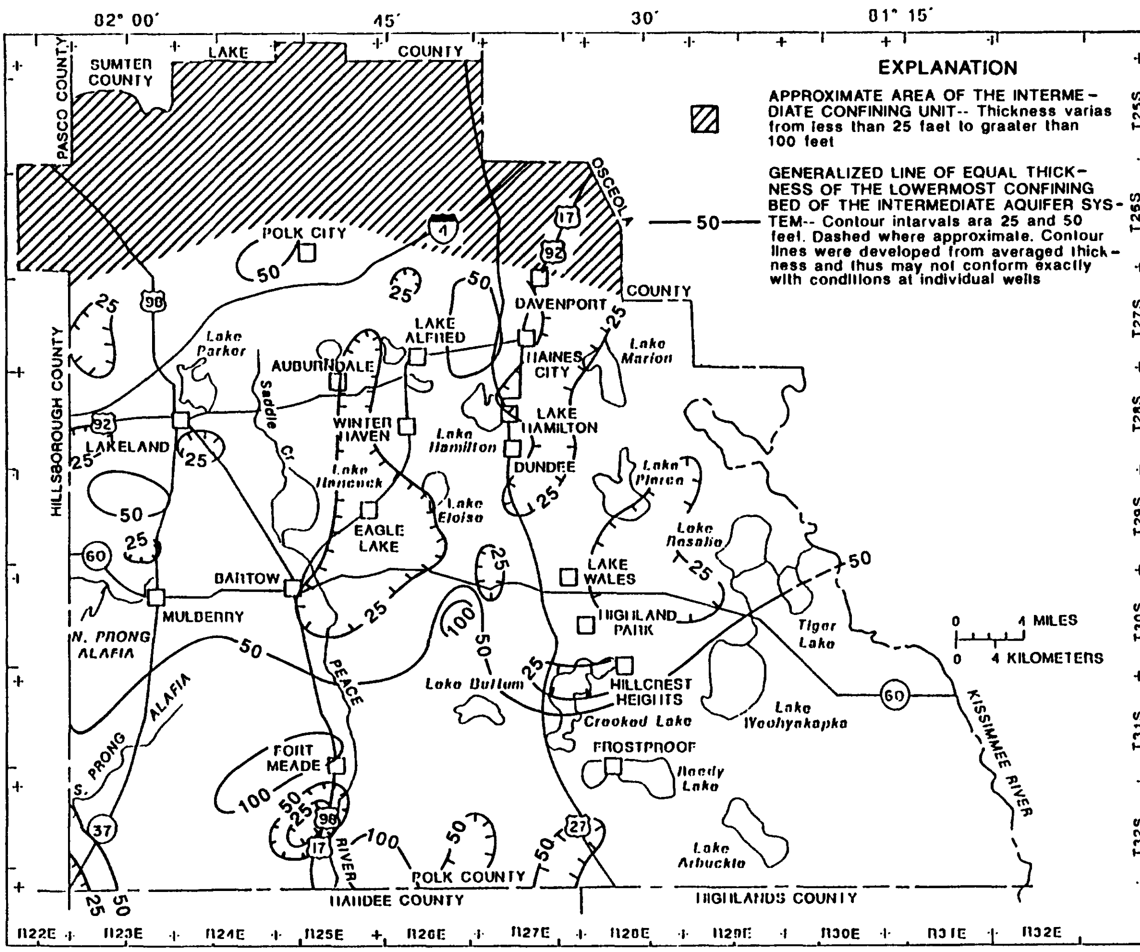


Figure 15. Generalized thickness of the lowermost intermediate confining bed and area of occurrence of the the intermediate confining unit in Polk County.

Transmissivities and storage coefficients for the Upper Floridan aquifer, determined during previous studies, are given in table 6. Values were derived from field tests or computer models. A transmissivity range of 10,000 to 1,000,000 ft²/d for this aquifer was reported by Miller (1986).

Table 5. Hydraulic properties of the intermediate aquifer system

[ft²/d, foot squared per day; (ft/d)/ft, foot per day per foot; --, no data]

Source	Transmissivity (ft/d)	Storage coefficient (dimensionless)	Leakance coefficient [(ft/d)/ft]
Hutchinson (1978)	1,600 – 13,300	0.0001 – 0.00021	0.00025
Ryder (1985)[1]	0.0001 – 3,300	--	[2]0.00001 – 0.0003 [3]0.000007 – 0.0001

[1]Model-derived values.
[2]Uppermost confining bed.
[3]Lowermost confining bed.

Transmissivity is lowest in the Green Swamp area in the north and highest in the southern part of the county. The Upper Floridan aquifer in Polk County is a layered hydrogeologic unit with zones of high and low hydraulic conductivity that respond as a single unit to pumping stresses.

Variations of recharge to and discharge from the Upper Floridan aquifer in Polk County (Aucott, 1988) are shown in figure 19. Recharge occurs in much of the county and exceeds 10 in/yr in areas surrounding Winter Haven; discharge occurs in the eastern part of the county. Stewart (1980) discussed recharge to the Upper Floridan aquifer and showed that the lowest recharge occurs where confining beds are 25 ft or more in thickness and are unbreached; more recharge occurs in the ridge areas that are characterized by poorly developed stream drainage and closed sinkhole basins.

The Upper Floridan aquifer is the major source of ground water in the county. Estimates of withdrawals for public supply, rural, industrial, and irrigation use for 1985 are about 295 Mgal/d in that part of Polk County within the Southwest Florida Water Management District (Southwest Florida Water Management District, 1986).

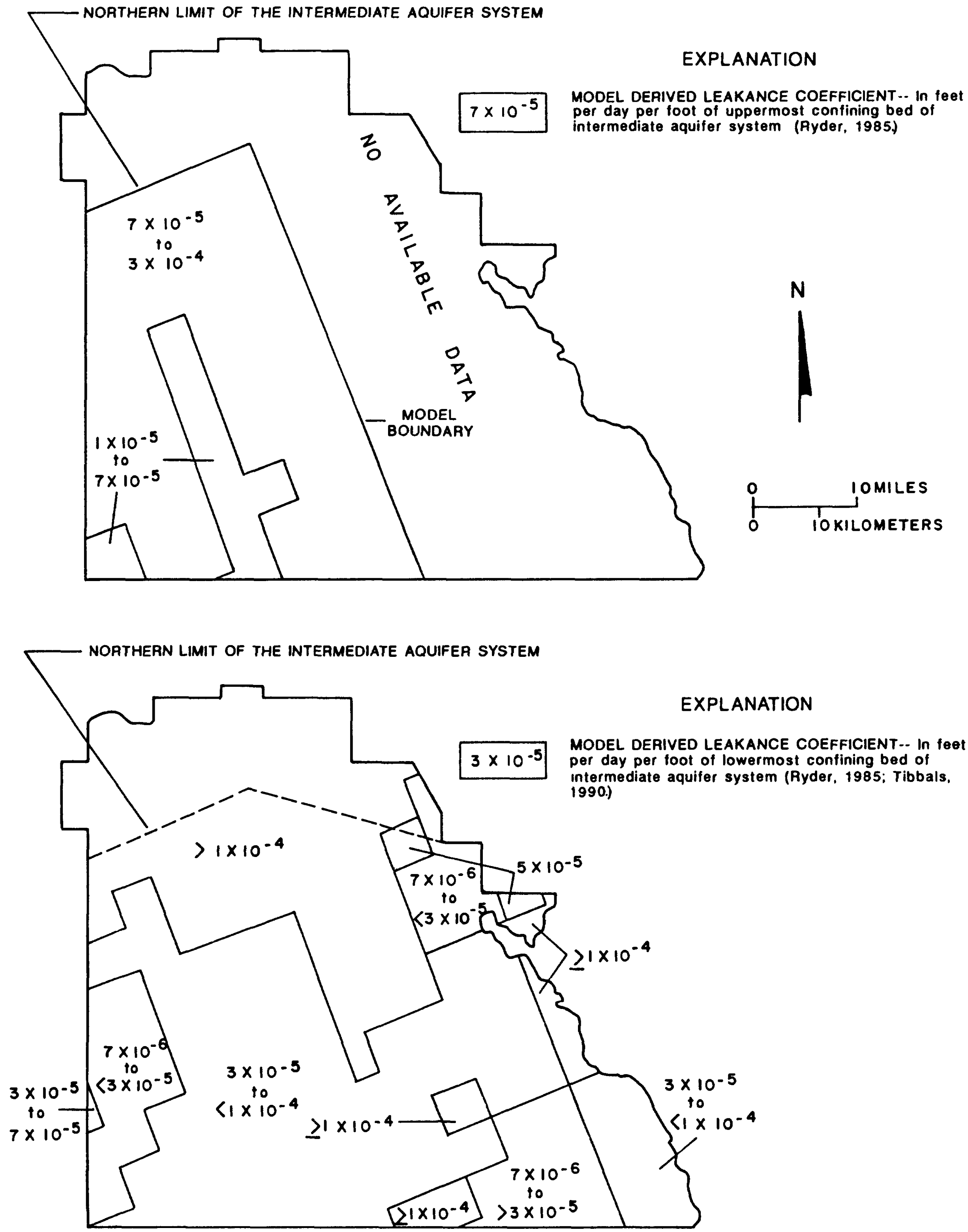


Figure 16. Model-derived values for leakance of the uppermost and lowermost confining beds of the intermediate aquifer system.

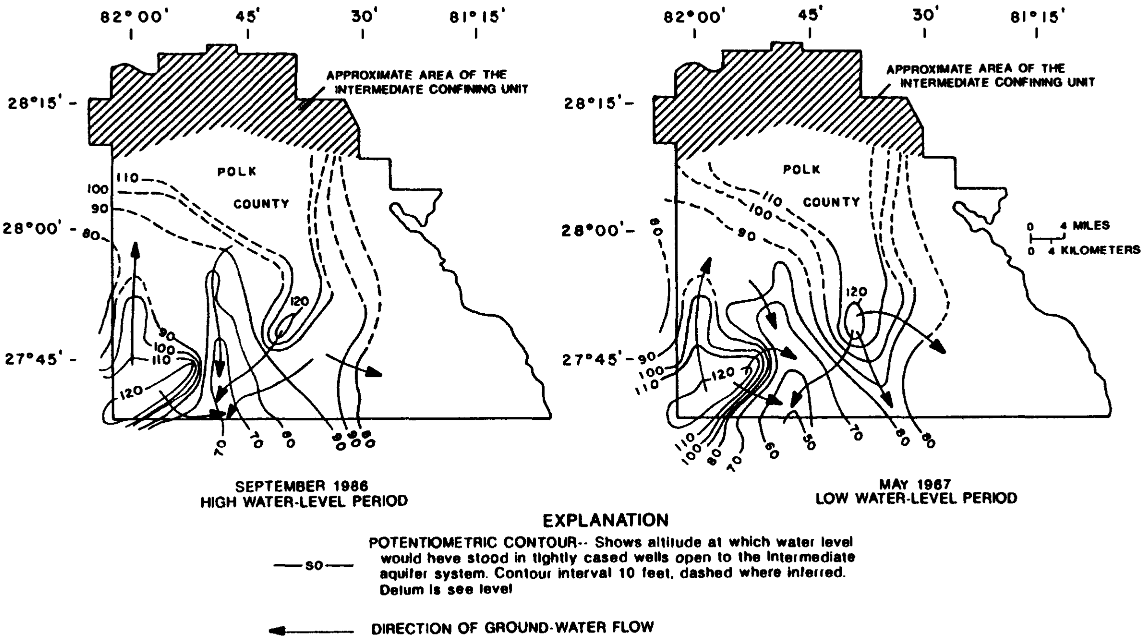


Figure 17. Potentiometric surface of the intermediate aquifer system in September 1986 and May 1987 during high and low water-level periods. (Modified from Lewelling, 1987a; 1987b.)

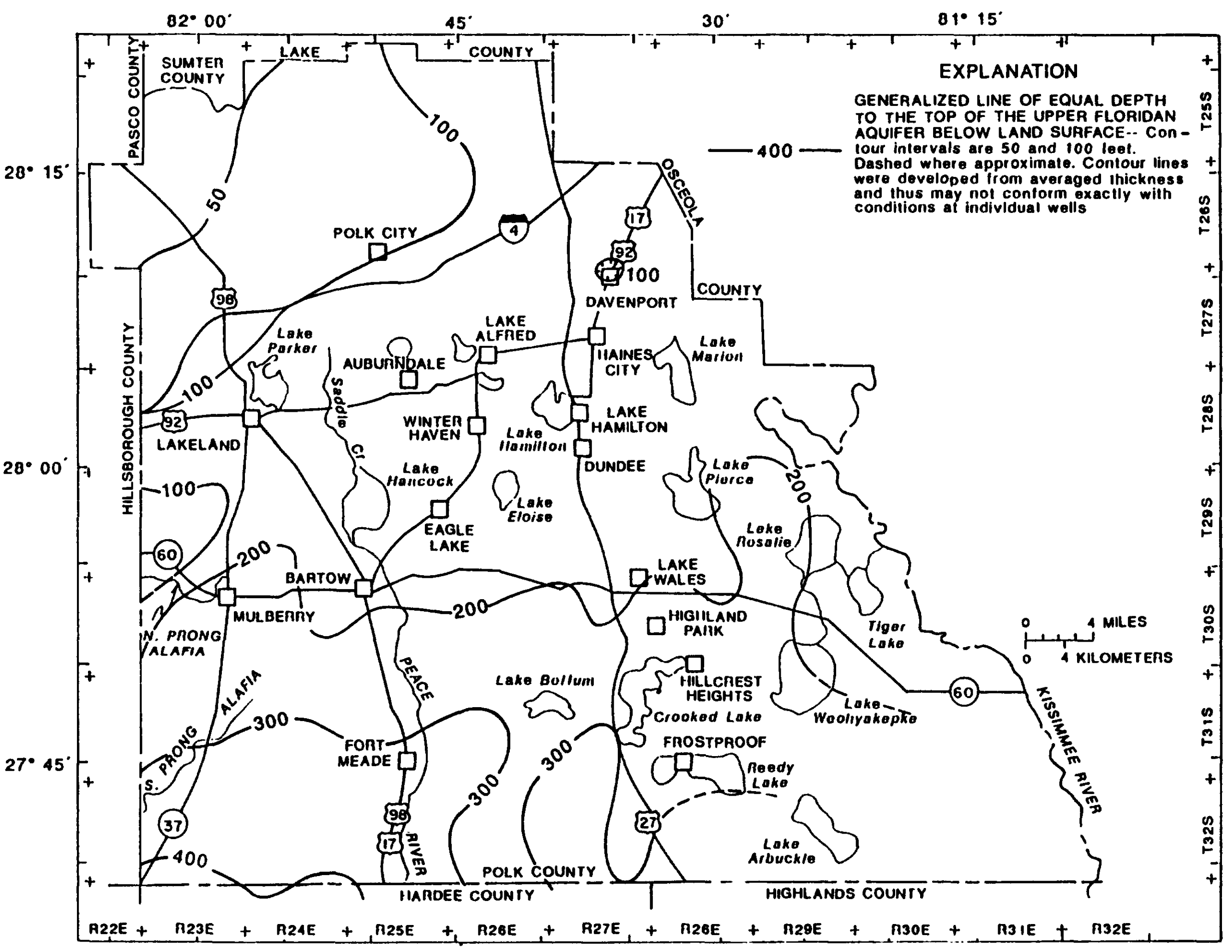


Figure 18. Generalized depth to the top of the Upper Floridan aquifer.

Table 6. Hydraulic properties of the Upper Floridan aquifer
[ft²/d, foot squared per day; --, no data; <, less than; >, greater than]

Source	Transmissivity (ft²/d)	Storage coefficient (dimensionless)
Pride and others (1966)	3,880 – 96,260	--
Stewart (1966)	110,000 – 1,150,000	0.003 – 0.0057
Wilson and Gerhart (1982)	96,300 – 174,000	--
Tibbals (1990)	10,000 – 100,000	--
Ryder (1985)[1]	50,000 – 400,000	0.0005 – 0.0018
Miller (1986)	10,000 – 1,000,000	--
Bush and Johnston (1988)	<10,000 – >1,000,000	--

[1]Model-derived values. Other values are derived from field tests.

The configuration of the potentiometric surface of the Upper Floridan aquifer and ground-water flow pathlines are shown in figure 20 for high water-level conditions in September 1986 and low water-level conditions in May 1987 in Polk County and adjacent areas. The altitude of the potentiometric surface ranged from more than 125 ft to less than 60 ft above sea level during the high water-level period in September 1986 and from more than 120 ft to less than 40 ft above sea level during the low water-level period in May 1987. Water moves radially through the aquifer from the potentiometric surface high in the northern part of the county. An extension of the potentiometric-surface high along the Lake Wales Ridge indicates that the ridge is a recharge area. Pathlines of ground-water flow are not altered in the area of the Peace River, which indicates that the river does not receive a significant amount of ground water from the Upper Floridan aquifer.

The head difference between the potentiometric surfaces of the intermediate aquifer system and the Upper Floridan aquifer is shown in figure 21. The head difference is less than 10 ft over approximately 80 percent of the county. The largest head differences are more than 40 ft and occur at intermediate aquifer system potentiometric-surface highs northwest of Lake Buffum and in the southwestern corner of the county.

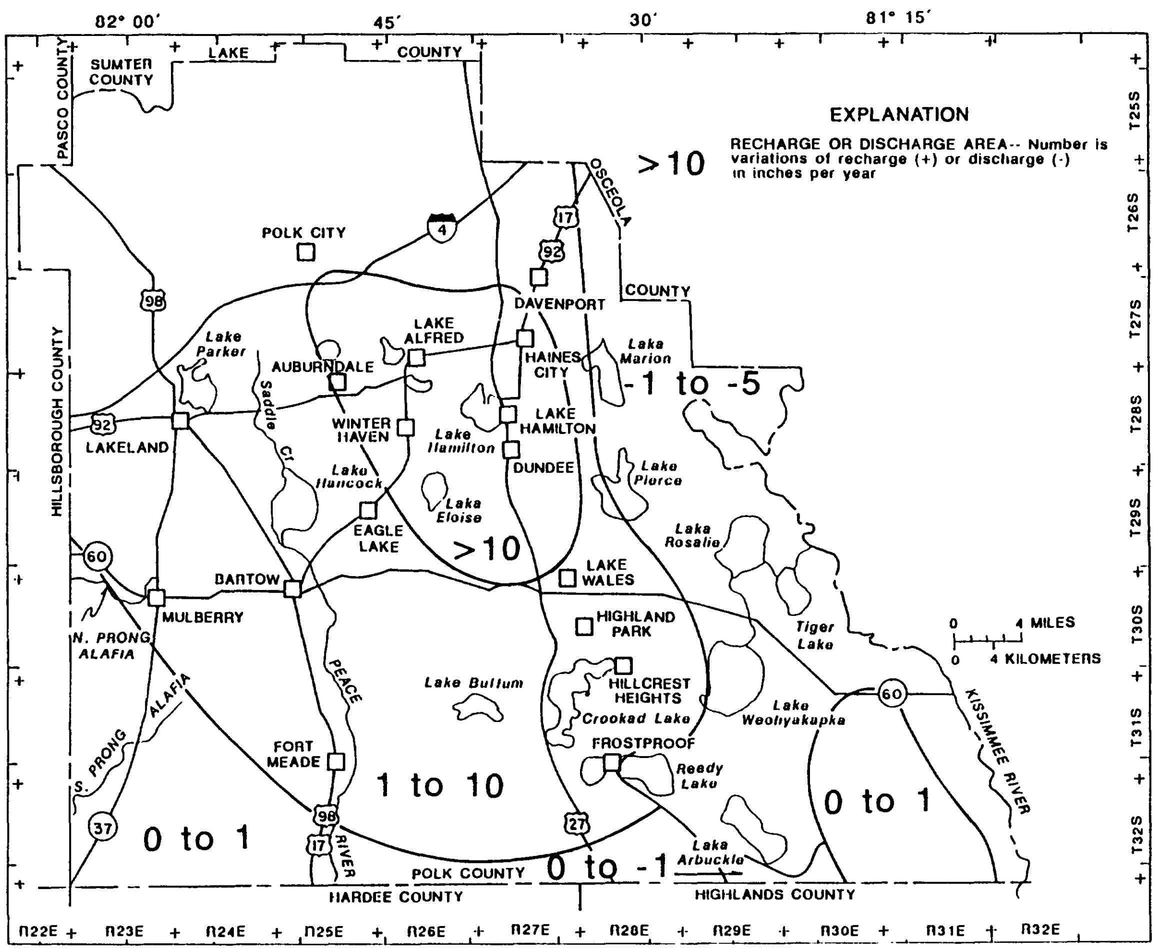


Figure 19. Variation of recharge to or discharge from the Upper Floridan aquifer. (Modified from Aucott, 1988.)

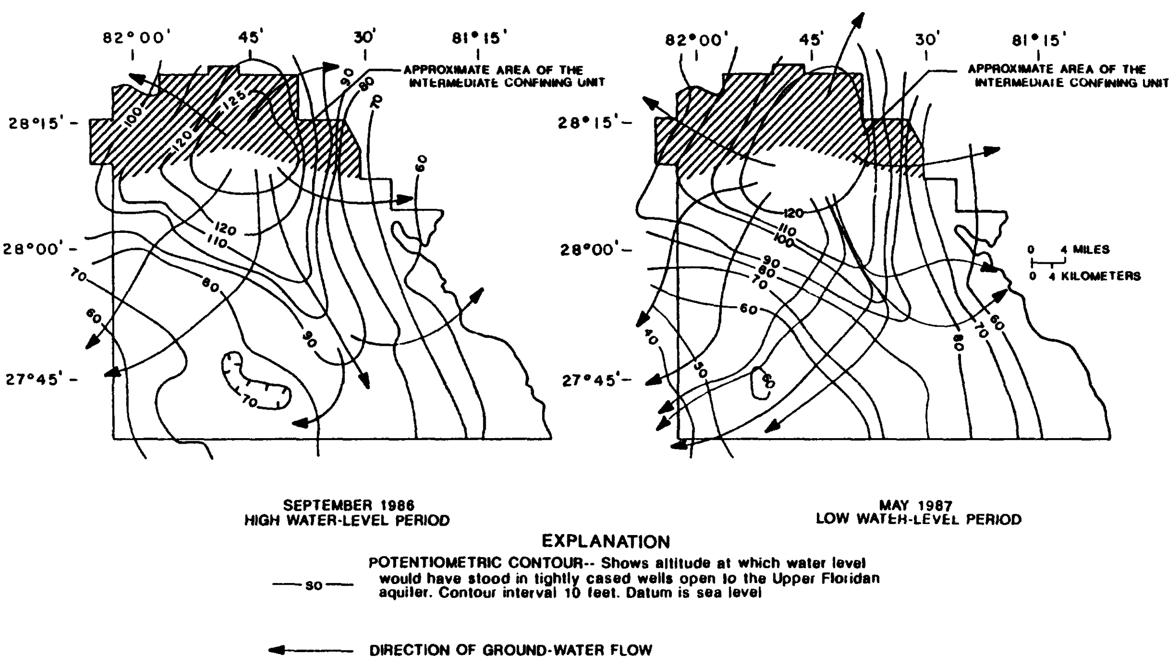


Figure 20. Potentiometric surface of the Upper Floridan aquifer in September 1986 and May 1987 during high and low water-level periods. (Modified from Lewelling and Belles, 1986; Lewelling, 1987c.)

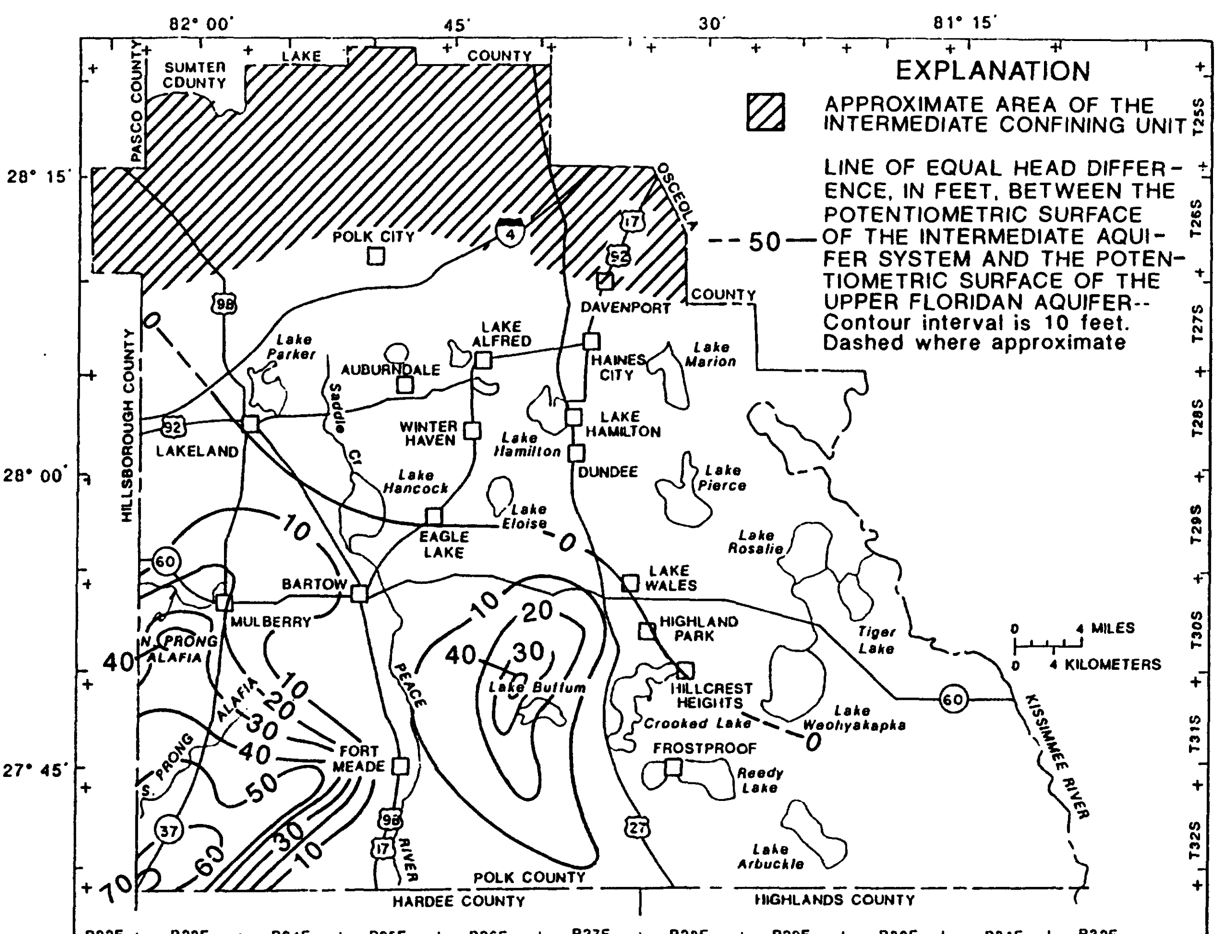


Figure 21. Head difference between the potentiometric surfaces of the intermediate aquifer system and the Upper Floridan aquifer, September 1986.

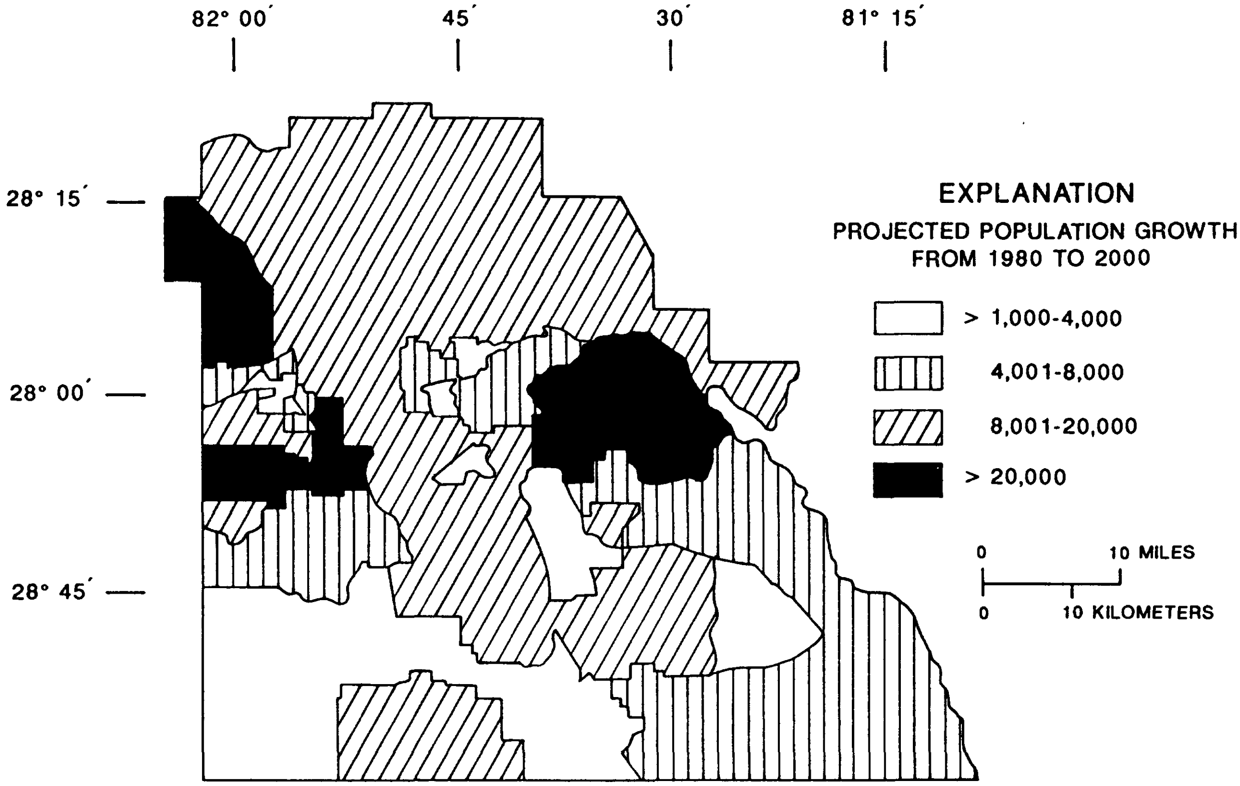


Figure 22. Projected population growth for census tracts in Polk County from 1980 to 2000. (Polk County Department of Community and Economic Development, 1986. Trend is based upon 1980 population.)

FACTORS THAT AFFECT THE POTENTIAL FOR GROUND-WATER CONTAMINATION

Anthropogenic and hydrogeologic factors are the principal elements that affect, either alone or in combination, the potential for contamination of the ground water in Polk County. For an aquifer to have a high potential for contamination, there must be a contaminant source and a pathway into the aquifer. The contaminant source results primarily from human activities, but also may be occurring naturally. The pathway is controlled by the depositional processes that formed the rock units and the subsequent weathering.

Anthropogenic Factors

Anthropogenic factors, such as land-use and waste-disposal practices, can result in ground-water contamination. Directly or indirectly, human activities provide the contaminant sources and the means for areal distribution of contaminants. Increases in human activity result in more waste products and contaminant sources and, thus, greater possibilities for ground-water contamination. Areas most susceptible to ground-water contamination in the county are the densely populated urban areas, citrus farming areas, and phosphate-mining areas.

Polk County is the eighth most populous of 67 counties in the State. In 1980, the county's population was more than 321,000, and the projected annual increase in population was 1.4 percent. The projected population in the year 2000 is more than 400,000 (University of Florida, 1985). The projected population growth of different census tracts in Polk County for 1980 to 2000 is shown in figure 22. Generally, the largest increases in population are projected for the areas around Lakeland, Winter Haven, and Bartow. Areas in the southern and southwestern parts of the county are expected to have the least population growth.

More than 1 million tourists visited Polk County in 1984. The principal resort areas are in the Lakeland-Winter Haven area, the Lake Wales Ridge area, and along the Peace River south of Bartow (figs. 1 and 3). Pressure on the environment generated by the growing population centers and the tourist industry include increased waste and increased demand for water for public supply and industrial uses. The increased demand for water is expected to result in increased ground-water withdrawals from the intermediate aquifer system and the Upper Floridan aquifer (Marella, 1988).

Polk County is a leader in industrial development in the State, having more than 400 manufacturing companies and 2,375 farms (ranks first in the State). It ranks first in phosphate production in the State, fourth in cattle production, fifth in sand production (Polk County Department of Community and Economic Development, 1986), and sixth in poultry production.

About 95 percent of the county's agricultural activity is devoted to the citrus industry (Duerr and Trommer, 1981). The county produces 22 percent of Florida's citrus (ranks first in the State) and 15 percent of the Nation's citrus; more than 25 percent of the State's citrus-processing plants are in Polk County. The general areas within Polk County where owners have reported water use for citrus farming (Moore and others, 1986) and citrus acreage inventory by township for 1986 (Whittaker, 1986) are shown in figure 23. Most townships in the county have some citrus farming, but the highest density of citrus groves is along the ridges and in the central part of the county.

Phosphate companies own or control 20 percent of the land within Polk County (Polk County Department of Community and Economic Development, 1986). Locations of phosphate chemical-processing plants in Polk County are shown in figure 24. The plants are all in the western third of the county. In 1986, there were 21 phosphate chemical-processing plants that separate phosphate minerals from a sand slurry piped from the mine. There were 13 chemical-processing plants that convert the ore to diammonium phosphate, which is used to manufacture fertilizer (International Minerals and Chemicals, Inc., written commun., 1985).

The Florida Department of Environmental Regulation (FDER) maintains information on municipal or industrial facility sites that have been or could be a source of contamination as part of their Ground-Water Pollution Source Management System (Florida Department of Environmental Regulation, written commun., 1985). Locations of facility site types within Polk County are shown in figure 25. The FDER has indicated that the sites have either past or present ground-water degradation problems or there is a potential for ground-water degradation at the site. The sites shown are grouped into seven types: (1) domestic, including sewage-treatment plants and wastewater-treatment activities; (2) industrial, including factories, service industries, and agricultural processing operations; (3) solid waste, including domestic trash and sewage-sludge operations; (4) dredge-and-fill, including sand excavations and sediment removal in surface-water bodies; (5) injection, including injection wells and drainage wells that allow water or waste fluids to flow or be pumped into nonpotable aquifer zones; (6) hazardous, including industrial activities with known ground-water degradation, drum storage of hazardous materials, and retention ponds with ground-water degradation potential; and (7) nonpoint source, including runoff from urban areas, crops, feedlots, and other agricultural activities. The concentration of sites is greatest in the western half of the county (fig. 25). The lowest concentration of sites is east of U.S. Highway 27 and in the Green Swamp north of Interstate Highway 4.

Hydrogeologic Factors

Hydrogeologic factors that affect the potential for ground-water contamination include sinkholes and other types of karst features, subsurface fractures, and hydraulic properties of hydrogeologic units. Hydrogeologic factors affect the rate, direction, and mode of ground-water movement, which, in turn, can affect the chemical quality of the water as it moves through the ground. Karst features, such as sinkholes, and subsurface fractures are two prominent factors that can affect ground-water quality in Polk County.

Karst Features

Polk County is composed of numerous basins and ridges formed by selective dissolution of the limestone bedrock. Within the major river basins of the county are many internally drained basins, such as lakes and sinkholes (fig. 26). Internally drained basins generally are small areas within river basins that do not have surface-water outflow, except during extreme floods. There are many small basins that drain to sinkhole lakes in the Winter Haven area. Eventually, runoff to the lakes or closed basins either evaporates or leaks downward into the underlying aquifers. The degree of ground-water degradation within an internally drained basin depends on the nature and quantity of contaminants in the surface runoff or water leaching through the sediments. The filtering and sorbing capacity of the surficial deposits, the degree of connection between sinkhole lakes and the underlying aquifers through fractures and piping, and the hydraulic and sorbing properties of the aquifer systems also affects ground-water degradation.

The development of a karst terrain, like that in Polk County, is the long-term result of chemical dissolution and erosional processes. Monroe (1970) described karst as the development of topography and surface features by dissolution of underlying carbonate rocks, characterized by karren, closed depressions, subterranean drainage, and caves. Water percolating through upper soil layers combines with carbon dioxide, forming a slightly acidic solution. This water passes through insoluble sediments until it reaches the underlying limestone of the intermediate aquifer system. Carbonates in Polk County may be fractured, jointed, and have many voids and cavities that provide conduits and circuitous paths for water flow. Acidic water passing through these openings dissolves and carries away carbonate material, thus creating larger cavities and voids. Sinkhole development begins with the solution and removal of carbonate rock over long periods of time and the winnowing away and the loss of support for overlying sands and clays (Sinclair and others, 1985). During

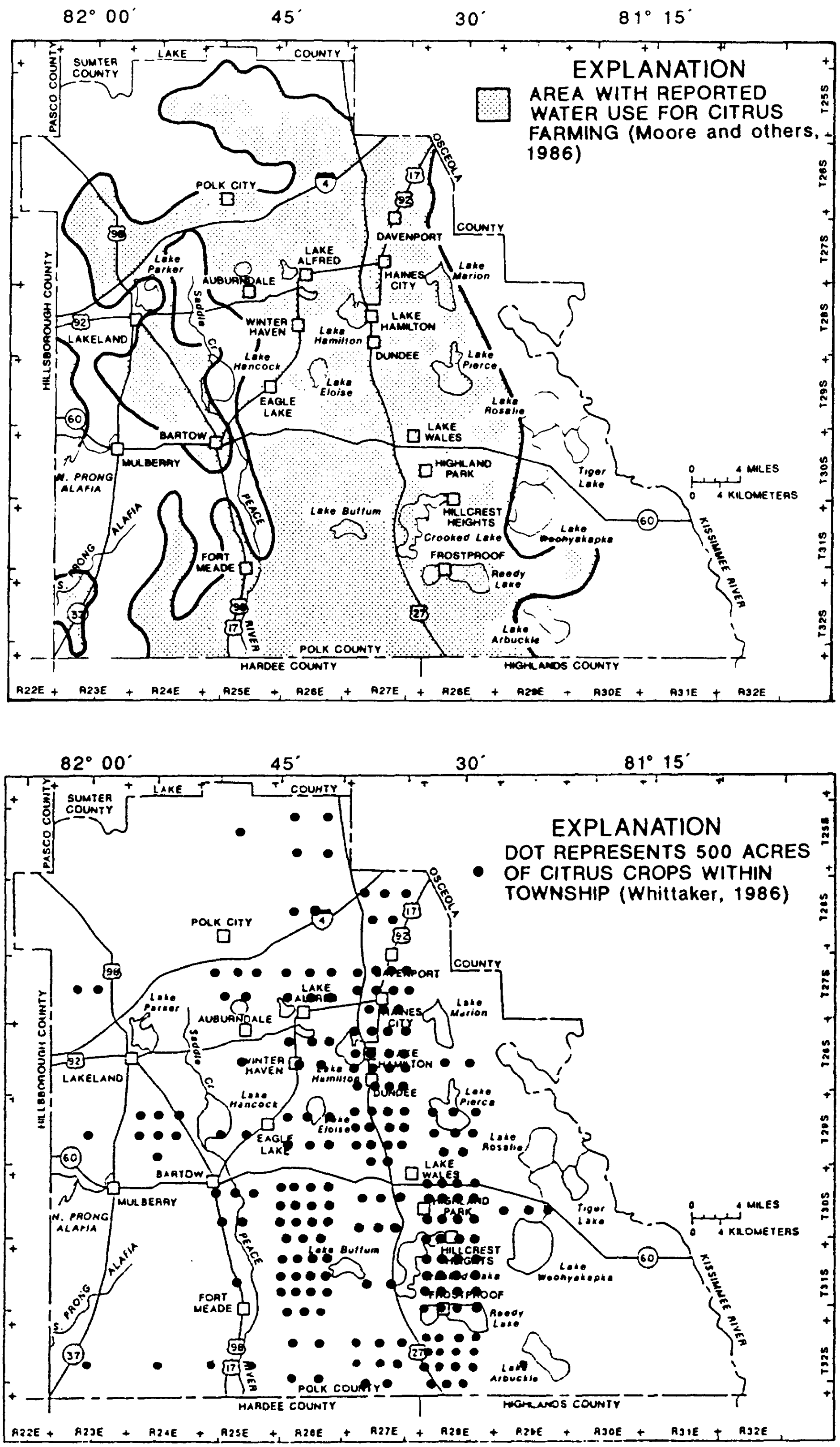


Figure 23. Areas with reported water use for citrus farming and generalized locations of citrus farming areas.

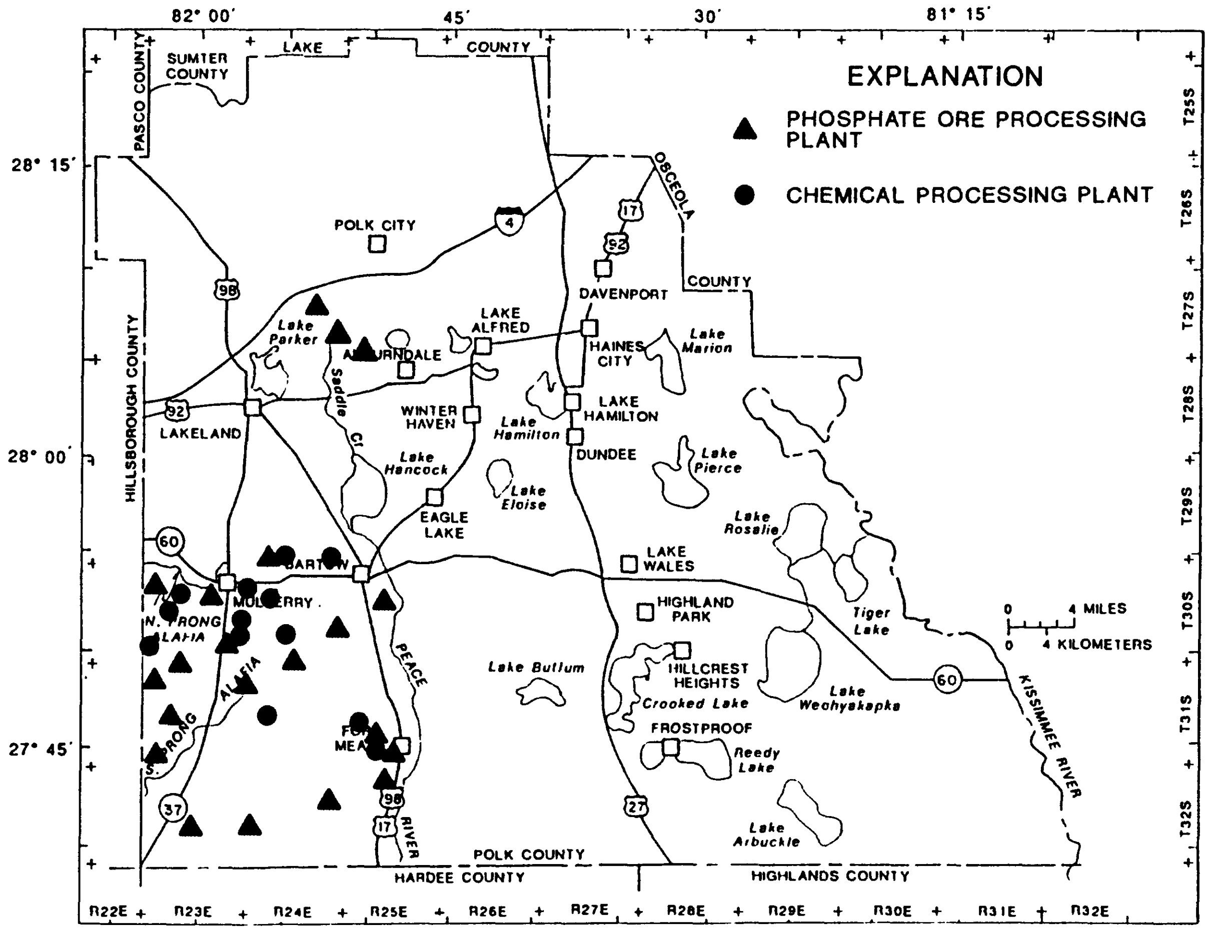


Figure 24. Location of phosphate chemical-processing plants.

the early stages of karst development, carbonate dissolution affects only the intermediate aquifer system or the Upper Floridan aquifer, or both, in the study area. During later stages, karst development results in sinkhole activity that affects the surficial aquifer system by causing deformation of unconsolidated sediments, breaching of confining clay beds, and introduction of ground-water flow paths from the surface, through the surficial aquifer system, and into lower aquifer units. Sinkholes, oval depressions at land surface, and subsidence and collapse features also are, in part, the surface manifestations created by these karst processes.

Closed depressions are indicative of karst and sinkhole activity. Closed depressions and sinkholes have steeper sloping perimeters and usually are much smaller than internally drained basins that act as large surface-water retention areas. These features, which range from about 50 ft to several hundred feet in diameter, were delineated for most of the county from U.S. Geological Survey topographic maps and are shown in figure 27. Many large lakes may be relict sinkholes or subsidence features. The depressions east of U.S. Highway 27, in the intraridge valley of the Lake Wales Ridge, appear to have formed in swales between ancient dunes (White, 1970).

The Florida Sinkhole Research Institute recorded more than 140 sinkhole occurrences in Polk County from 1954 to 1987 (B.F. Beck, Florida Sinkhole Research Institute, oral commun., 1987). Sinkholes may provide direct paths for surface water to move into the underlying aquifer systems, thus potentially affecting ground-water quality.

Photographs of a limestone solution sinkhole that provides direct access of surface water and contaminants to the underlying aquifer are shown in figure 28. Photographs A and B show the Peace River and a swallow hole southeast of Bartow (T30 R25 S10) during a low-flow period (April 1985). About 5 ft^3/s is flowing down the river course and into the swallow hole or solution cavity. Photograph C shows a 5-ft diameter segment of the cavity that is several feet below the riverbed. Many sinkholes also were observed in the riverbed and nearby flood plain along other parts of the river in April 1985. It was estimated that between 0.02 and 0.05 ft^3/s of effluent from the Bartow wastewater-treatment plant was being discharged into the Peace River upstream from the sinkhole during this low-flow period. During low-flow periods, river flow consists largely of wastewater discharge and any contaminants are only slightly diluted. During high-flow periods, flow in the river dilutes the contaminants that are present and results in a reduction of contaminants in recharge water. Suspended solids, large debris, and sand transported by the river as bedload during high flows may fill cavities and reduce recharge.

Crooked Lake, an example of a karst lake, was examined by Snyder and others (1989) and is illustrated in figure 29. Sinkholes represented as sediment-filled solution shafts at the lake's edge are clearly evident in the aerial photograph, as are similar features represented by vegetation patches west of the lake. Sediment-filled solution shafts, along the shoreline of Pond D and in a wetland vegetation area to the west (fig. 29), indicate that some connection exists between the surficial aquifer system and the intermediate aquifer system. The solution shafts were interpreted from low altitude aerial photographs by Snyder and others (1989). The solution shafts breach the upper confining unit of the intermediate aquifer system and terminate in the underlying carbonate layer. It is feasible that thousands of such sediment-filled shafts could significantly increase leakage from the surficial aquifer system to the intermediate aquifer system.

Subsurface Fractures

Subsurface fractures can provide avenues for the flow of water between surface-water and ground-water sources (fig. 30). In the study area, fractures can result in ground-water flow between the surficial aquifer system and the underlying intermediate aquifer system or Upper Floridan aquifer. Surface manifestations of these fractures can be seen as photolinear features, such as lineaments and fracture traces, on high-altitude photography. Photolinear features are linear trends of topographic features, soil tone, and vegetation. Lattman (1958, p. 569) defines a lineament as a photolinear feature at least 1 mi in length on aerial photographs. Lineaments may be continuous or discontinuous for many miles. Lattman defines a fracture trace as a photolinear feature that is continuous for less than a mile.

In karst terrain, lineaments and fracture traces are related to slumping, piping, sinkholes, and solution cavities in sediments that overlie joints, bedding planes, fractures, and faults in the carbonate rocks (fig. 28). Remote-sensing

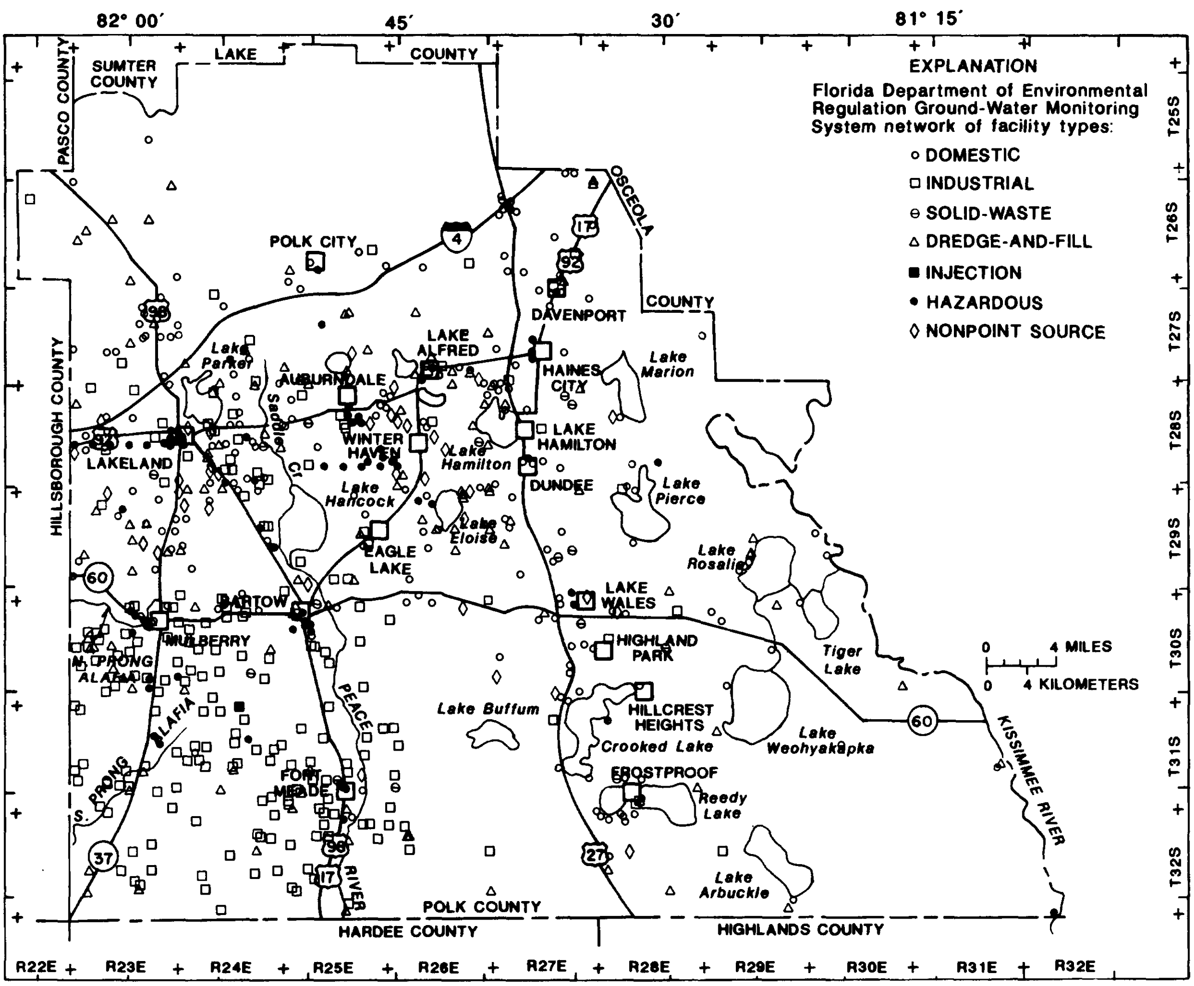


Figure 25. Location of Florida Department of Environmental Regulation facility sites where there is a potential for ground-water contamination. (Florida Department of Environmental Regulation, written commun., 1985.)

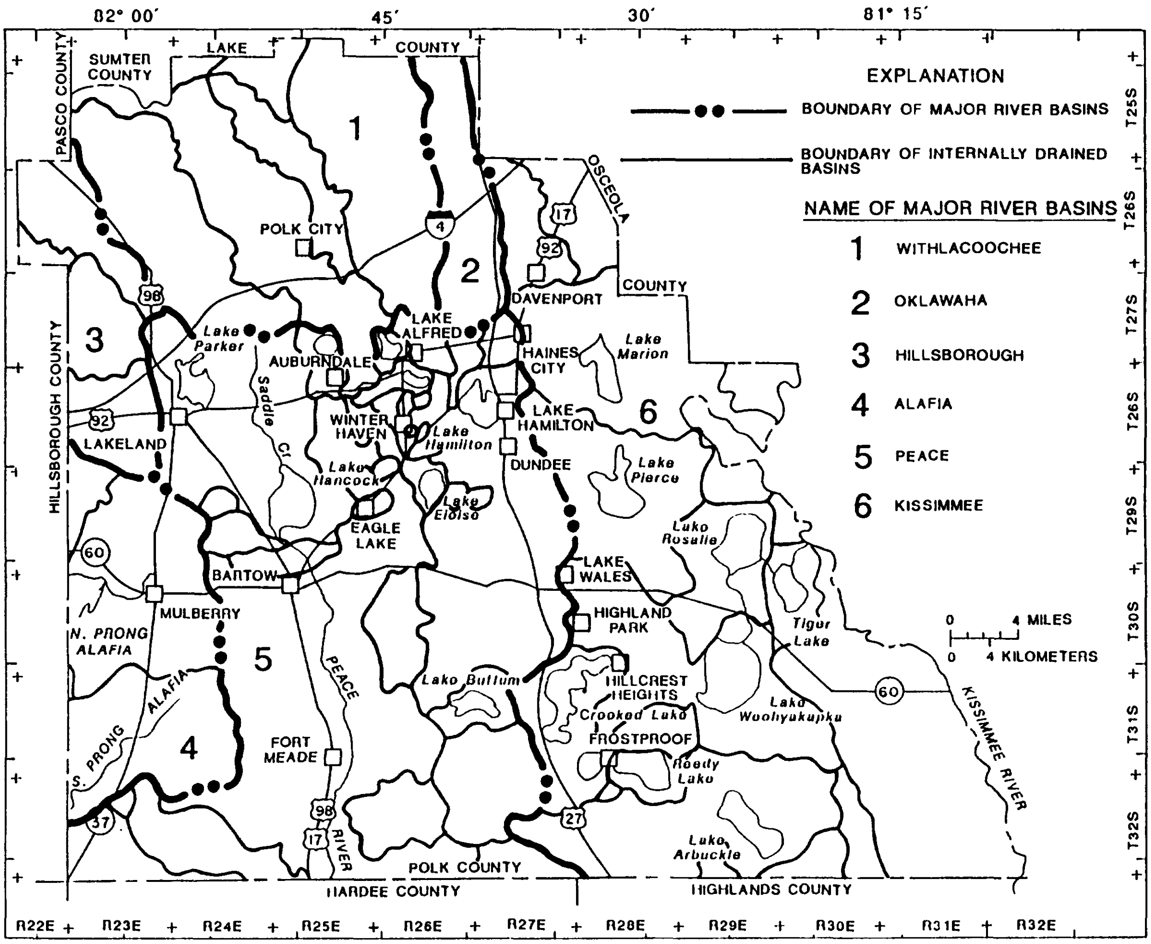


Figure 26. Contributing basins and internally drained basins within the major river basins in Polk County.

techniques that can be applied to satellite imagery and high- and low-altitude aerial photography may enhance the linear features. The technique, called "fracture trace analysis," may be used to detect vertical fractures or faults. These features may provide flow paths through subsurface carbonate rock units. Flow-through fractures and faults results in dissolution of carbonate rocks, thus enhancing the development of karst features (Lattman and Parizek, 1964). Where fracture traces cross, the probability for carbonate dissolution and sinkhole activity is increased (Parizek, 1976). Sinclair and others (1985) reported alignment of sinkholes along northeast-southwest and northwest-southeast directions across part of Polk County. Interpretations by other investigators have identified lineaments and fracture traces across the entire county. The general alignment of fracture traces is supported by a compilation by M.A. Culbreth (University of South Florida, oral commun., 1984) of lineament features and fracture traces in a 50-mi^2 area. This interpretation has been updated by R.P. Evans (Southwest Florida Water Management District, written commun., 1986) and is shown in figure 31. Lineament features identified by the Florida Department of Transportation (written commun., 1986) also are shown for the entire county in figure 31. Many north-south lineaments have been mapped by the Florida Department of Transportation at the smaller scale. These north-south lineaments differ from those mapped by Sinclair and others (1985) or by Culbreth. The density and distribution of lineaments, fracture traces, and sinkholes indicate a widespread occurrence of fractures.

The potential for contamination of ground water probably is greater in areas at or near fractures. Fractures tend to increase the potential for ground-water degradation because water may move rapidly from the surface through these conduits rather than through primary rock pore spaces, thus decreasing filtration and absorption of potential contaminants.

ESTIMATED POTENTIAL FOR CONTAMINATION

The potential for contamination of an individual aquifer is affected by the physical and hydraulic characteristics of adjacent hydrologic units and by the hydrogeologic characteristics of the aquifer. Contaminants would tend to move more rapidly through zones of high hydraulic conductivity than through zones of low hydraulic conductivity. All recharge areas are vulnerable to contamination; however, the degree of vulnerability may vary widely. For the assessment of potential for contamination described in this section, the potential for contamination was assumed to be closely related to the rate of recharge and the degree of confinement of the aquifer system.

Surficial Aquifer System

The surficial aquifer system is particularly vulnerable to contamination because it is exposed at land surface. It would be the first hydrogeologic unit to be contaminated in the event of a surface spill; thus, the surficial aquifer system is designated as having a high potential for contamination in upland areas. Wetlands are excluded and are designated as having a low potential for contamination because they generally constitute discharge areas or areas where infiltration is low. Depth to the water table was not considered in the analysis of contamination potential because the water table may be as deep as 150 ft. Depth to the water table, however, could be an important consideration in site-specific assessments of the vulnerability of the surficial aquifer system to contamination.

The wetlands and uplands of Polk County, as defined by the U.S. Fish and Wildlife Service (1985), are shown in figure 32. Wetlands and uplands each occupy about 50 percent of the surface area. The wetlands, which generally are vegetated, include swamps, flood plains, and water bodies, such as lakes, mined phosphate pits, and settling ponds. State regulations restrict alteration of wetlands by development.

Intermediate Aquifer System

The potential for contamination of the intermediate aquifer system is greatest where the upper confining unit is thin or breached and where there is downward leakage from the surficial aquifer system. Areas of estimated moderate to high contamination potential are the Lake Wales and Winter Haven Ridges where the potentiometric surface of the intermediate aquifer system is high (fig. 17). Contamination potential is estimated to be low in the extreme southwestern corner of the county where the upper confining unit is greater than 50 ft thick and along the Peace River south of Bartow where the potentiometric-surface low indicates discharge from the aquifer system.

Several factors complicate categorizing the contamination potential of the intermediate aquifer system based on recharge and degree of confinement. First, if the surficial aquifer system has a low potential for contamination in wetland areas, it may be assumed that the potential for contamination of the underlying intermediate aquifer system also should be low. Second, the occurrence of features like the swallow hole in the bed of the Peace River south of Bartow is evidence of recharge and potential for contamination in a discharge area. Third, over much of Polk County, the

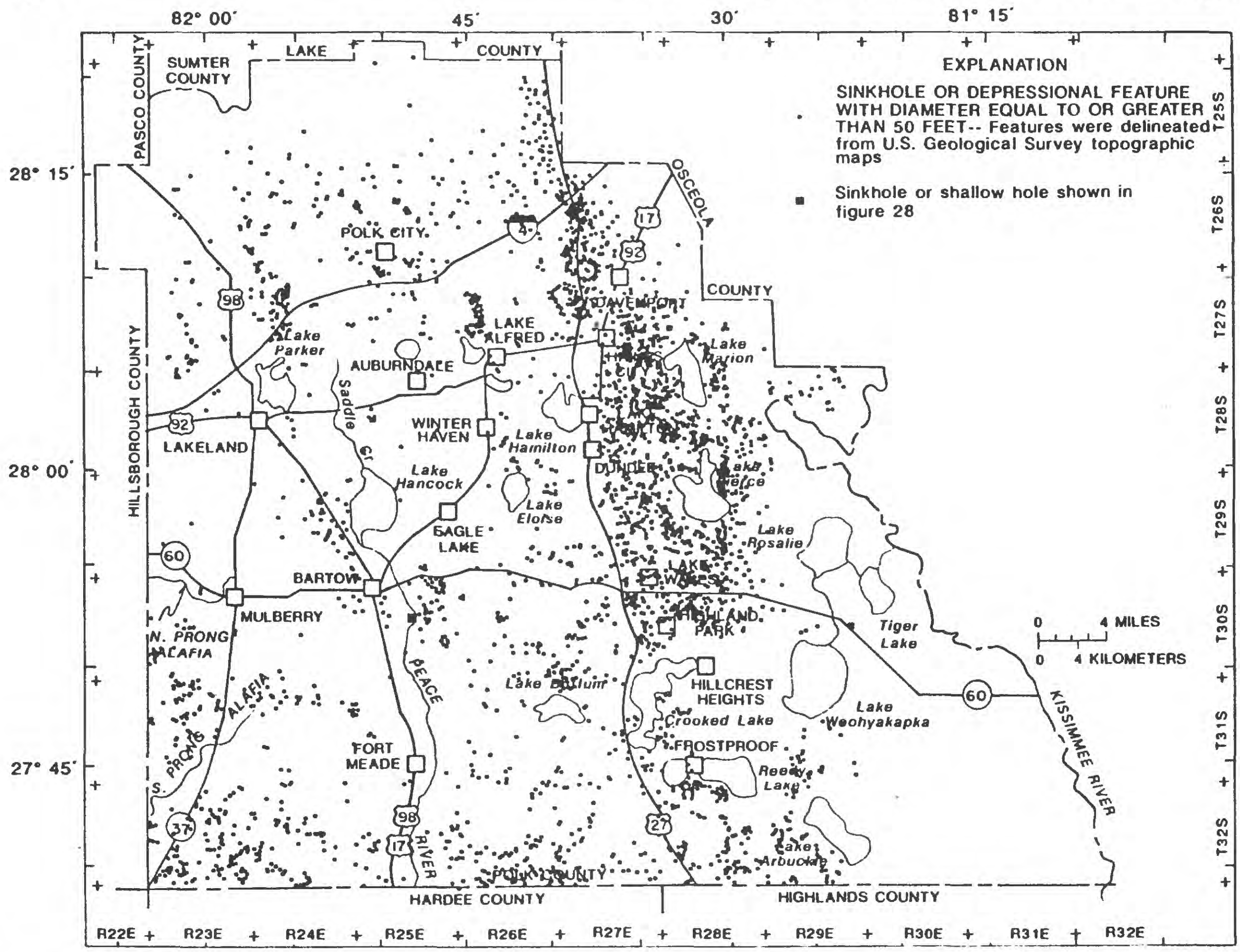


Figure 27. Location of sinkholes and depressions in Polk County.

A.

B.

C.

Figure 28. Peace River bed during a low-flow period and a swallow hole and connecting cavity near Bartow, April 1985.

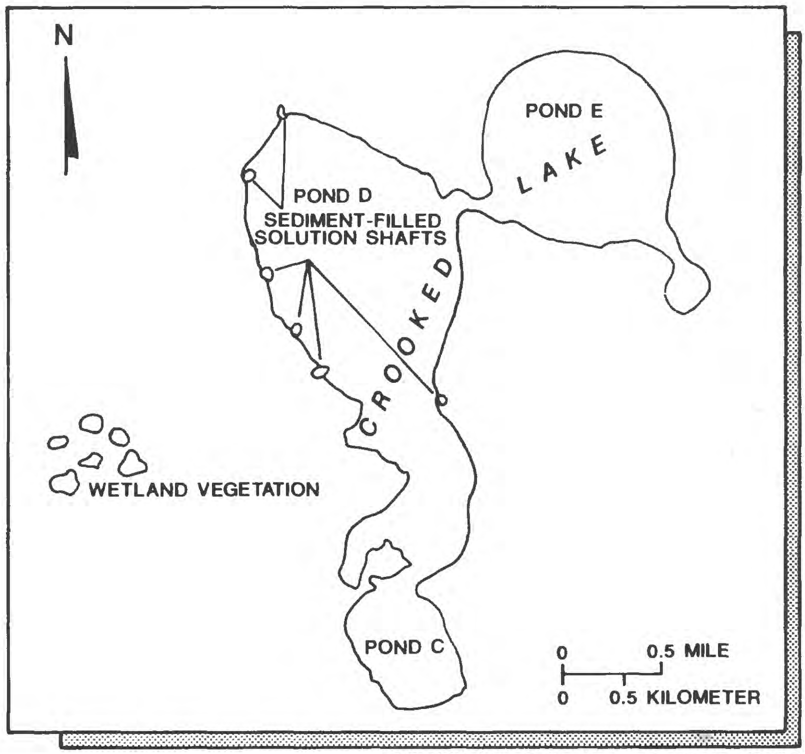
A. Partially exposed bed.
B. Swallow hole in the riverbed.
C. Solution cavity below the riverbed connected to the swallow hole shown in B.

upper confining unit is perforated by sinkholes, thereby allowing leakage between the surficial and intermediate aquifer systems.

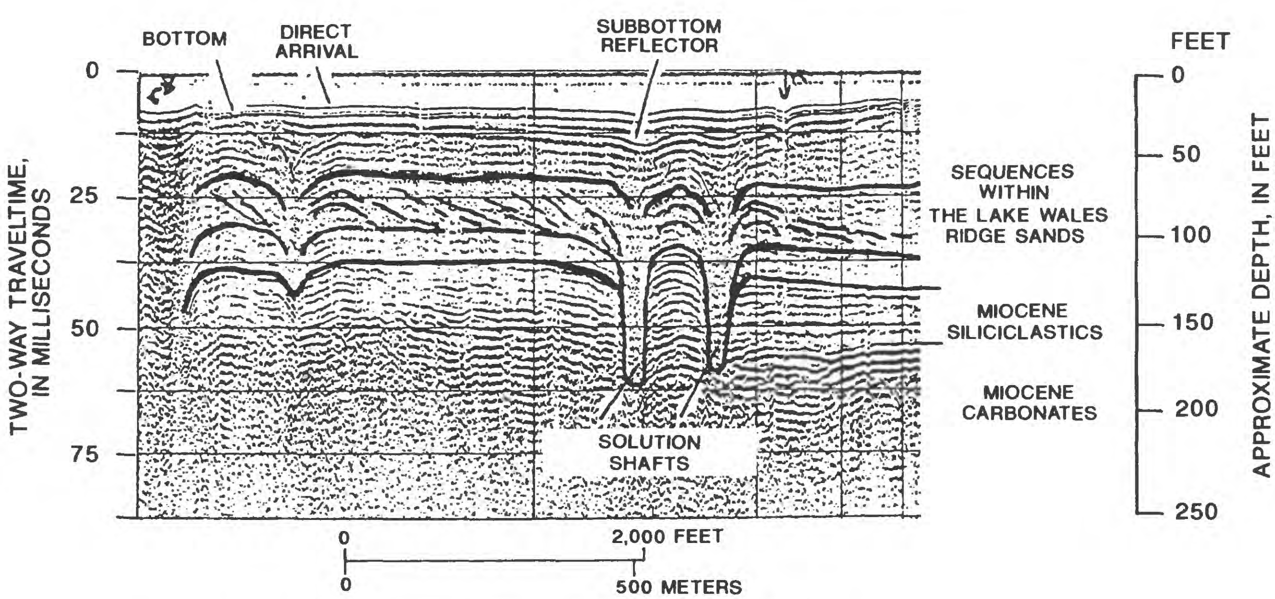
The estimated potential for contamination of the intermediate aquifer system, based on hydrogeologic characteristics, is shown in figure 33. The county is delineated into areas of high, moderate, and low potential for contamination. The intermediate aquifer system in the central area, encompassing the Winter Haven and Lake Wales Ridges, is estimated to have a high potential for contamination because the region is characterized by a thin cover of surficial aquifer system material, moderate to high recharge, and many sinkhole lakes and depressions that indicate a high degree of interconnection between the surficial and intermediate aquifer systems. In the western area, encompassing the Lakeland Ridge and the Peace River lowlands, the aquifer system is estimated to have a moderate potential for contamination because of thick overburden, low to moderate recharge rates, and numerous sinkholes and connector wells. In the eastern area in the Kissimmee River basin, the aquifer system is estimated to have a low potential for contamination because the overburden material is thick, there are few sinkholes, and artesian flow inhibits recharge.

Upper Floridan Aquifer

The potential for contamination of the Upper Floridan aquifer was estimated by comparing recharge, degree of confinement, transmissivity, and sinkhole activity. The area of highest estimated potential for contamination has relatively high recharge, thin overburden, high transmissivity, and much sinkhole activity. Ground-water age estimates, made by using the tritium concentration in water from the upper part of the aquifer, did not always support this assessment. Swancar and Hutchinson (1992) reported that a tritium



(Modified from Snyder and others, 1989.)



UNIBOOM seismic reflection profile illustrating several solution shafts from Pond E. These features are totally infilled with sediment and show no relief in the lake floor.

Figure 29. Surface and subsurface karst features at Crooked Lake near Hillcrest Heights. (From Snyder and others, 1989.)

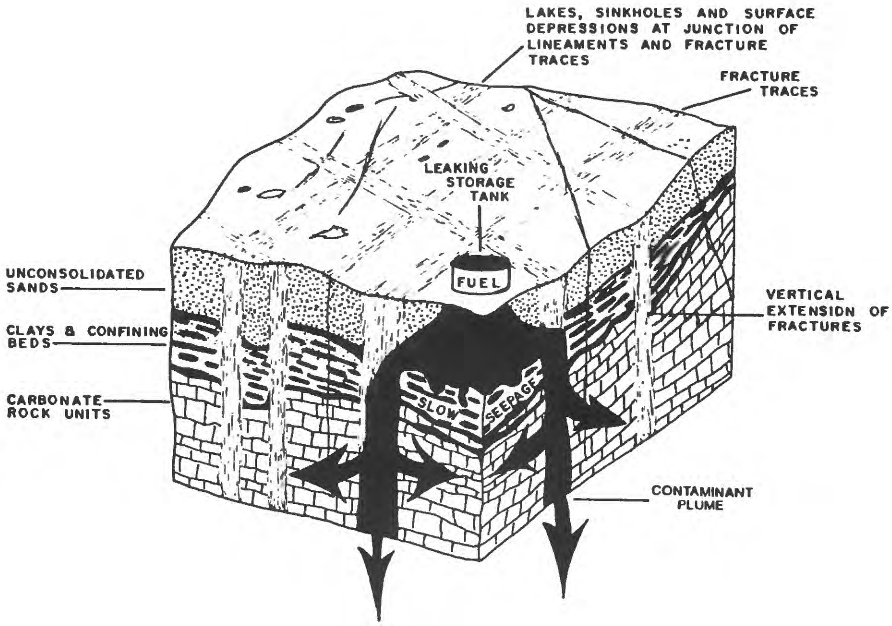


Figure 30. Vertical fractures in subsurface strata with photolinear surface expressions, karst features, and flow path of contaminant.

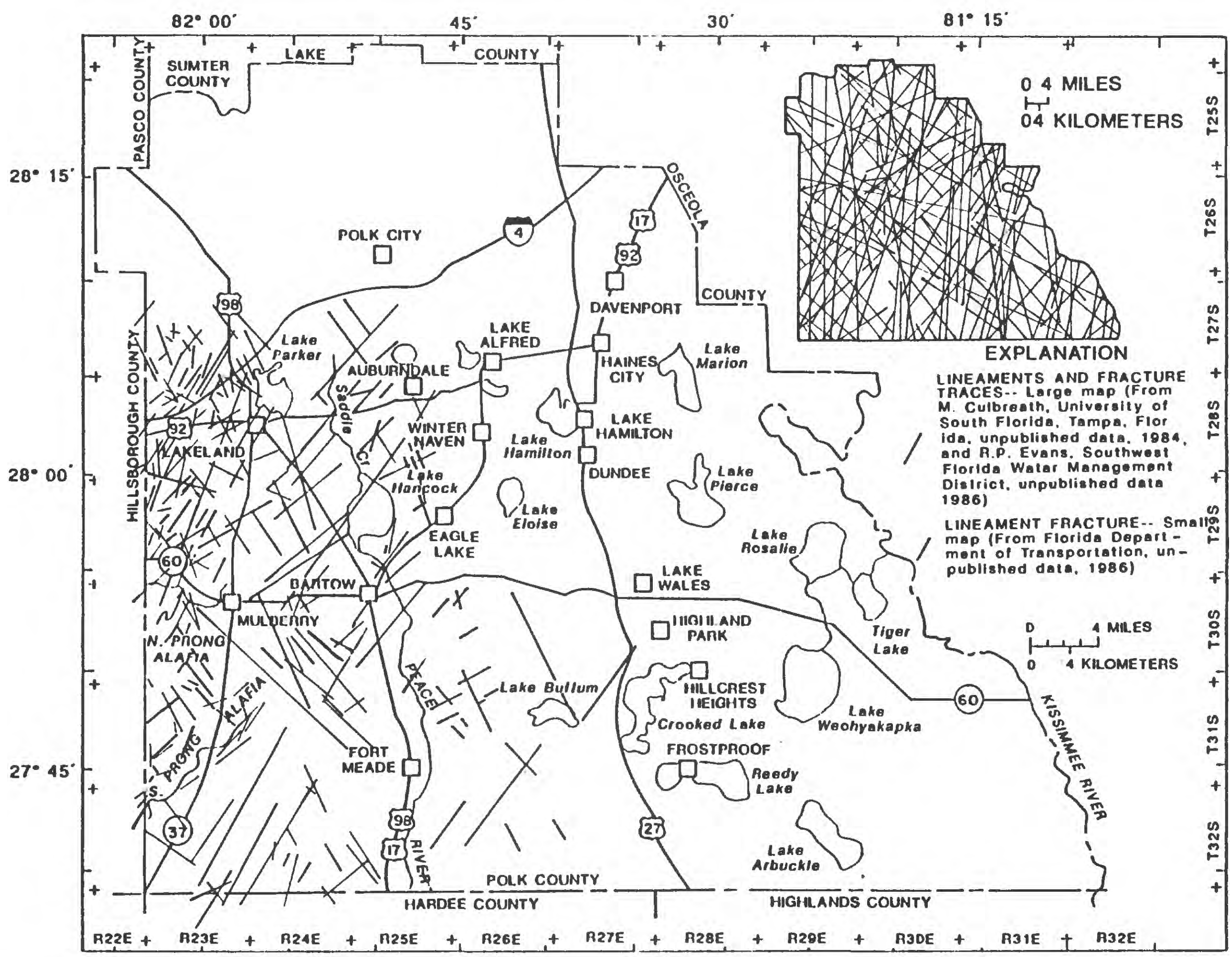


Figure 31. Location of photolinear features in selected areas of Polk County.

concentration less than 1 tritium unit per liter indicates that the water is more than 35 years old. An aquifer containing water with a low tritium concentration is assumed to have little recharge and a low potential for contamination. Where the water contains more than 1 tritium unit per liter, some recent recharge is indicated. These areas of the aquifer are estimated to have a low to moderate potential for contamination.

The estimated potential for contamination of the Upper Floridan aquifer is shown as very low, low, and moderate in figure 34. An area of very low potential is in the eastern quarter of the county where potentiometric-surface levels generally are above land surface and the overburden is fairly thick (more than 100 ft). Areas of low potential occur in the northern part of the county in the area of the Green Swamp where low transmissivity inhibits infiltration (Aucott, 1988) and in the southwestern part of the county where recharge is less than 10 in/yr, overburden is 200 to 400 ft thick, and water from the upper part of the aquifer contains less than 1 tritium unit per liter of sample (Swancar and Hutchinson, 1992). An area of estimated moderate potential for contamination occurs in the western and central parts of the county where recharge may be more than 10 in/yr, overburden is 50 to 200 ft thick, many sinkholes apparently breach the intermediate aquifer system, and the tritium concentration of water from the upper part of the aquifer generally is between 1 and 5 tritium units per liter. Although sediments overlying the Upper Floridan aquifer are 50 ft or less in thickness in the northwestern part of the county, the contamination potential is not estimated to be high because of low tritium concentration in water from the aquifer (Swancar and Hutchinson, 1992).

GROUND-WATER QUALITY

There are many chemical compounds associated with industrial and agricultural activities that are potential contaminants to ground water. The Florida Department of Environmental Regulation (FDER) lists 129 priority pollutants: 13 are metals and cations; 113 are organic compounds; and 3 are in a general category that includes fibrous asbestos, cyanides, and phenols (Florida Department of Environmental Regulation, 1989).

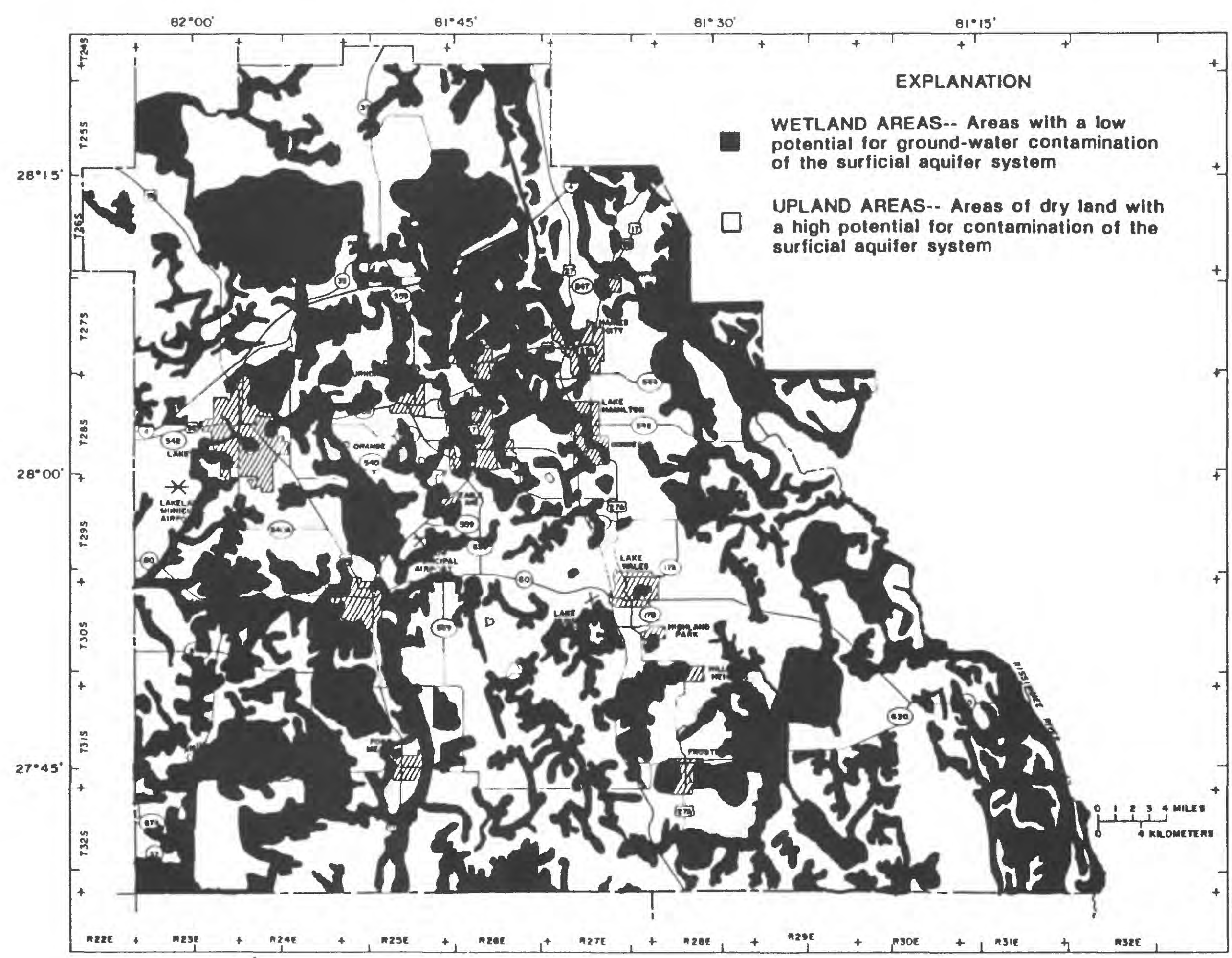


Figure 32. Wetlands and uplands of Polk County and estimated potential for contamination of the surficial aquifer system. (From the U.S. Fish and Wildlife Service, 1985.)

Many synthetic organic compounds have been used extensively in citrus groves and other croplands in Polk County to control insects, nematodes, and undesirable vegetation. These compounds include insecticides, herbicides, miticides, fungicides, nematicides, and plant-growth regulators. Some pesticides presently being used in Polk County citrus groves include Alachor, Aldicarb, Atrazine, Bromacil, Chlorpyrifor, Ethoprop, Fenamiphos, Metalaxyl, Metam-Sodium, methyl bromide, Oxzmyl, and Simazine (Florida Department of Agricultural and Consumer Services, written commun., 1986)

The Florida Department of Agriculture (FDOA) initiated a pesticides application program in the mid-1950's to aid Florida's citrus industry in the control of nematodes, which are harmful to citrus trees. About 1960, the FDOA began the application of ethylene dibromide (EDB) in Polk County in and adjacent to private citrus groves and continued to do so until August 1983 when the use of EDB was banned. EDB was applied to the upper few inches of soil, generally in sandy, dry areas and remains in the soil and surficial aquifer system in many Polk County citrus areas. Exposure to EDB may result in health disorders, and EDB has been placed on the U.S. Environmental Protection Agency list of priority pollutants (Keith and Telliard, 1979).

As a result of EDB application in Polk County, in 1983, the FDER started a ground-water sampling program in or adjacent to the application areas. Detectable concentrations of EDB were found in water from wells completed in all three aquifer systems. Selected wells with detectable quantities of EDB are shown in figure 35.

The Florida Legislature's Ground-Water Quality Assurance Act of 1983 states that the FDER is to work with the five Florida water management districts to establish a statewide ambient ground-water quality monitoring network. The primary purpose of the Southwest Florida Water Management District network is to determine the ambient ground-water quality of water in the surficial aquifer system, the intermediate aquifer system, and the Upper Floridan aquifer in areas in west-central Florida that are relatively unaffected by human activities (Moore and others, 1986). Subsequent samplings may be used to determine how ground-water quality is changing with time.

Polk County lies at the intersections of the Southwest Florida Water Management District, South Florida Water Management District, and St. Johns River Water Management District. All three districts collect and compile ambient ground-water data in the county.

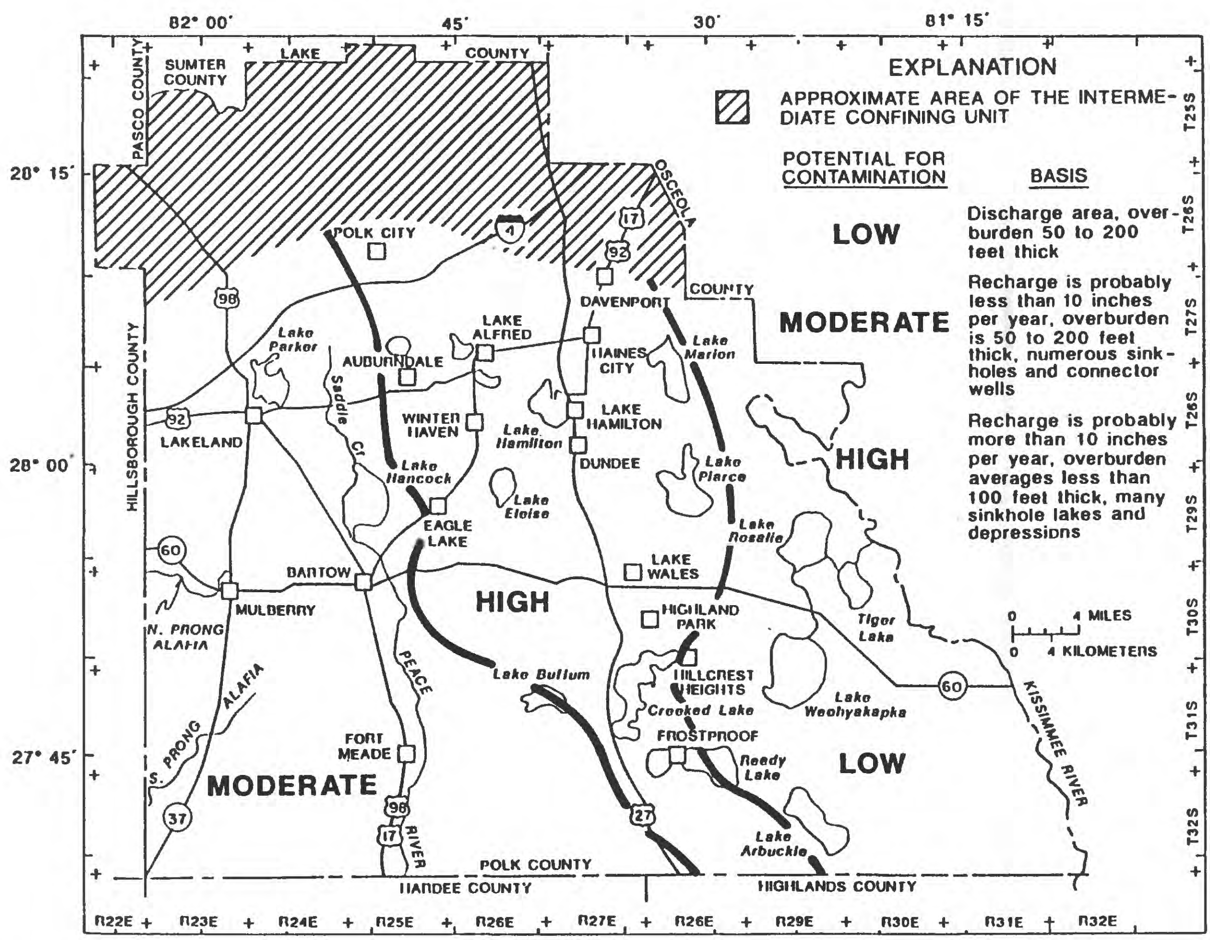


Figure 33. Estimated potential for contamination of the intermediate aquifer system.

As part of this investigation, water-quality data collected by the Water Management Districts were examined and additional water samples were collected at 95 sites in Polk County. These water samples were analyzed by several laboratories. U.S. Geological Survey laboratories analyzed the water samples for arsenic, lead, mercury, selenium, silica, strontium, and selected synthetic organic compounds by using standard methods described by Fishman and Friedman (1985) and Wershaw and others (1983). Radiochemical constituents were analyzed by a private laboratory using analytical techniques described by Fishman and Friedman (1985). The Polk County Water Resources Department laboratory performed all remaining analyses, which included major ions, trace metals, nutrients, total organic carbon, dissolved solids, and laboratory specific conductances, pH, and alkalinity, using methods recommended by the U.S. Environmental Protection Agency or those described by the American Public Health Association and others (1985).

Analytical results for ground-water samples from the 95 sites are presented in tables 7 through 13 at the back of this report. Water samples were collected from 44 wells in 1986 and from 51 wells in 1987. Analyses of samples from one well, collected by U.S. Geological Survey personnel in 1984 and 1985, also are included in table 7. Laboratory analyses for volatile organic compounds were not done on samples collected during 1987; instead, gas chromatography was used to test samples for the presence of selected volatile organic compounds, but detected substances were not identified or quantified. The 10 sites at which volatile organic compounds were detected using gas chromatography were resampled in 1988, and the samples were analyzed to identify the organic compounds that were present.

Water-quality data collected as part of this study and during previous studies in Polk County were analyzed by aquifer system and by individual land uses within each aquifer system. The five major land-use types used in these analyses were: (1) undeveloped areas, (2) citrus farming areas, (3) areas near point-source waste discharges, (4) phosphate-mining and reclamation areas, and (5) areas near phosphate chemical-processing plants. Selected water-quality data from this and previous studies are summarized in tables 14 through 18 at the back of this report. Water samples were collected and analyzed more than once from some wells, which sometimes resulted in more analyses than the number of wells reported. Water-quality samples were not collected at areas near phosphate chemical-processing plants during the

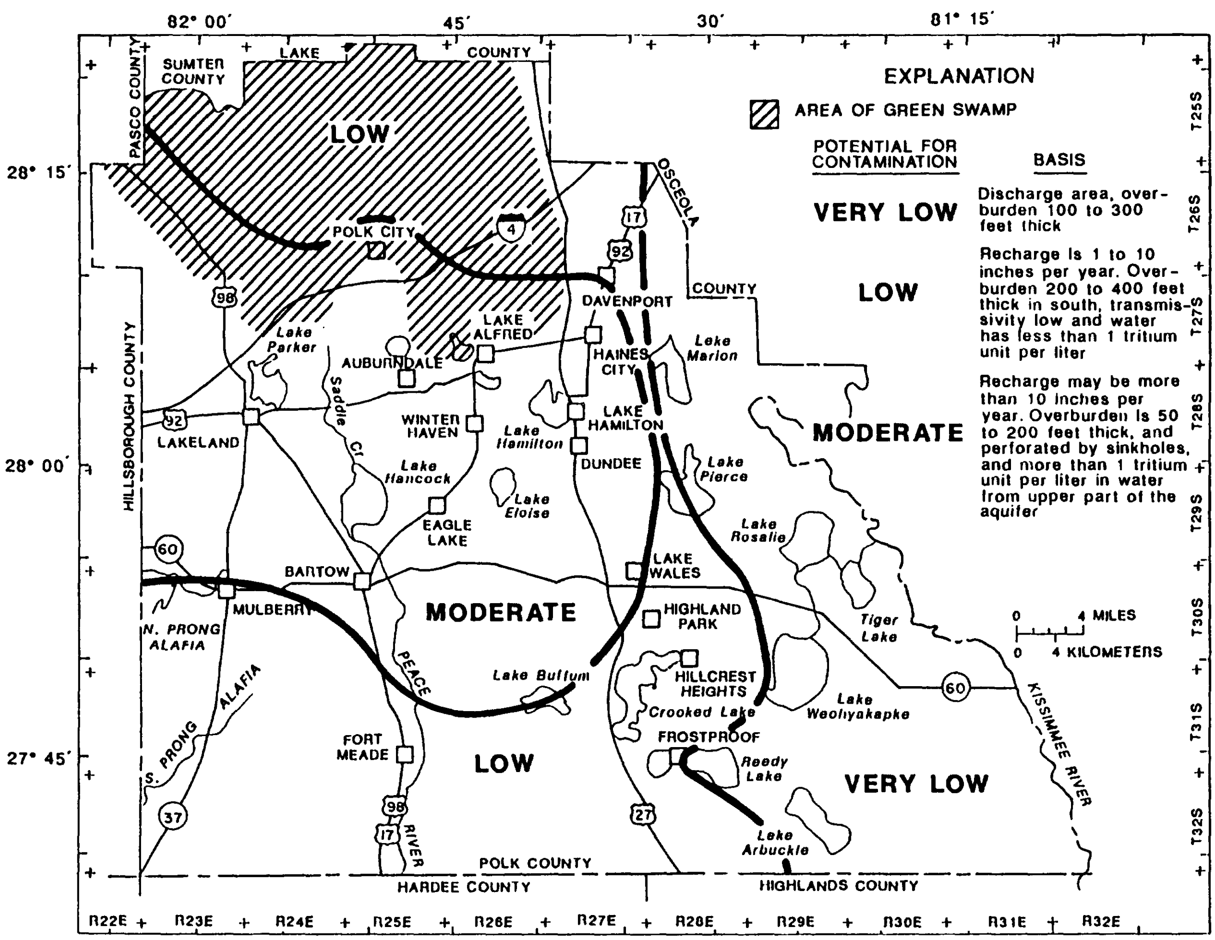


Figure 34. Estimated potential for contamination of the Upper Floridan aquifer.

current study, but analyses reported by previous investigators are presented in tables 14 through 17. The data in table 18 indicate that, during this study, water samples from 39 of the 95 wells sampled either had chemical concentrations that exceeded Florida Department of Environmental Regulation (1989) public-supply standards for certain constituents or had detectable amounts of organic compounds. Analytical results that were at or below laboratory detection limits are not included in the tables.

Surficial Aquifer System

Meteoric and surface sources provide the water that enters the surficial aquifer system. Because of these origins and the percolation through the soil zone, water in the surficial aquifer system can be mildly to highly acidic. Although the water within this system is fresh, with concentrations of major ions usually less than 250 mg/L, it does tend to have higher iron concentrations than water from deeper aquifer systems.

Undeveloped Areas

Water samples were not collected from the surficial aquifer system in undeveloped areas. Because of the high potential for contamination of the surficial aquifer system by surface contaminants, no areas were considered to have pristine ground water that would be representative of an undeveloped area.

Areas Near Point-Source Waste Discharges

Water samples were collected from wells open to the surficial aquifer system near several point-source waste discharge areas: a leaking gasoline tank (fig. 4, site 62), at a waste-spreading operation (fig. 4, site 61), and at two waste-disposal ponds (fig. 4, sites 33 and 74). The sites, all in upland areas, have a high potential for contamination. FDER standards for public supply generally were not exceeded in the wells sampled near the point-source sites, but FDER maximum contaminant levels for pH, fluoride, iron, dissolved solids, and gross alpha radiation were exceeded at

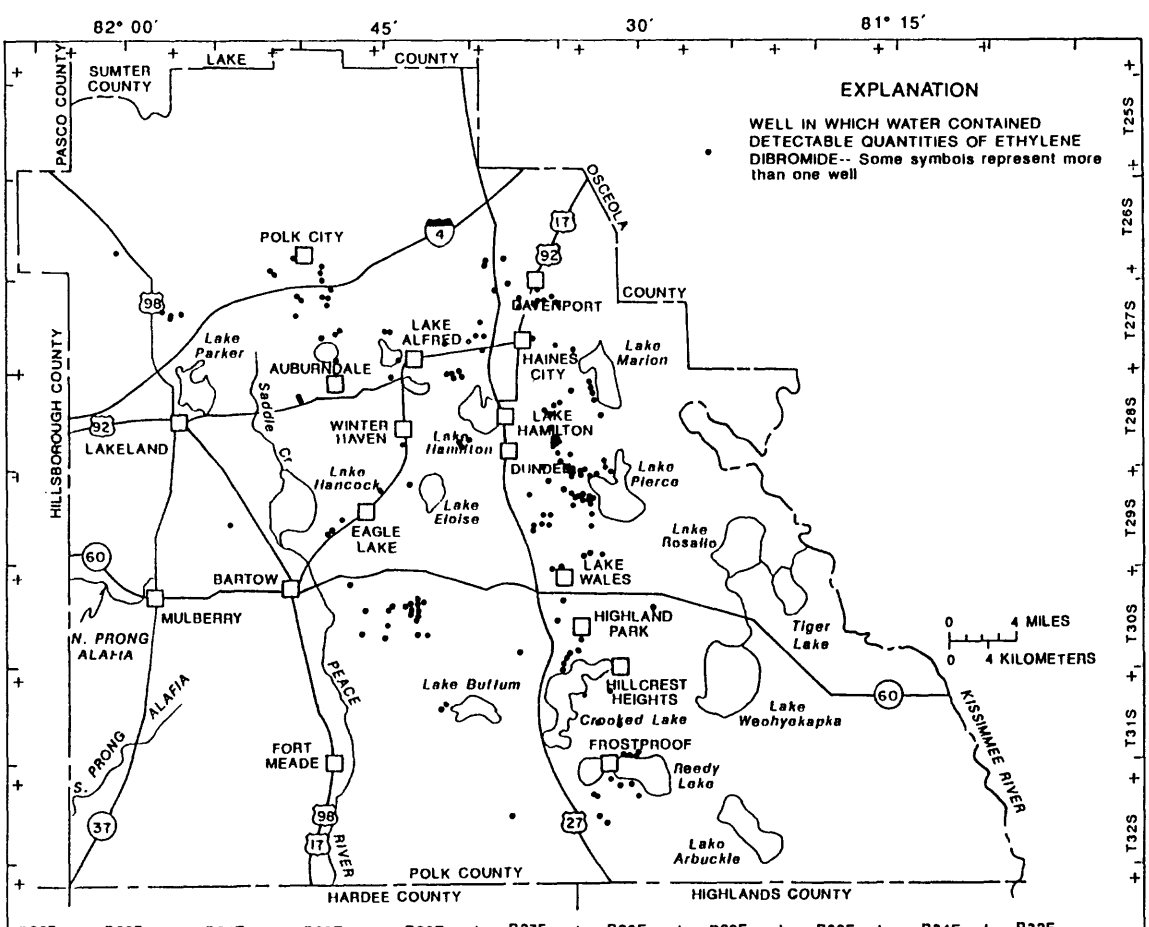


Figure 35. Locations of selected wells that contained water with detectable quantities of ethylene dibromide. (Florida Department of Environmental Regulation, written commun., 1985.)

one or more of these sites (table 14). Listed below are the water-quality property or constituent and concentration in water samples from four wells that indicate the possibility of contamination.

Site	Water-quality property or constituent and concentration	
33	pH (units)	3.7
	fluoride (mg/L)	22
	gross alpha (µg/L)	50
61	pH (units)	5.0
	dissolved solids (mg/L)	501
	iron (µg/L)	520
	gross alpha (µg/L)	31
62	pH (units)	6.3
74	pH (units)	6.3
	iron (µg/L)	4,400

Phosphate-Mining and Reclamation Areas

Water in the surficial aquifer system at phosphate-mining and reclamation areas in southwestern Polk County generally is a calcium bicarbonate type, but it does contain relatively high percentages of sodium and sulfate (Hutchinson, 1978). Dissolved-solids concentrations generally are less than 250 mg/L (table 14). The water typically is acidic and has pH values that range from 4.3 to 6.6 (table 14). A separate set of samples analyzed in the ambient water-quality program (Moore and others, 1986) indicated that the FDER maximum contamination level (table 14) was exceeded for some metals, including aluminum, arsenic, cadmium, chromium, copper, iron, manganese, mercury, and zinc and radium-226 at some sites; however, average concentrations were relatively low.

Areas Near Phosphate Chemical-Processing Plants

The most extreme ranges of concentrations for the majority of constituents in water from the surficial aquifer system were from sites at or near phosphate chemical-processing plants (Miller and Sutcliffe, 1982; Rutledge, 1987). At these sites, ground water is usually acidic, but may be alkaline; table 14 lists a pH range of 2.2 to 7.8. According to Miller and Sutcliffe (1982), concentrations of most solutes and trace elements in the surficial and intermediate aquifer systems decreased with distance from phosphate chemical-processing plants. Water from the surficial aquifer system at areas near phosphate chemical-processing plants is characterized by a higher maximum and a higher mean concentration for most solutes and trace metals when compared with water from other aquifer units in all other land-use areas. The FDER maximum contamination levels for nitrate, sodium, chloride, sulfate, fluoride, iron, dissolved solids, and radium-226 were exceeded in water samples from some wells.

Intermediate Aquifer System

Water in the intermediate aquifer system for all land-use types noted by this study is predominantly a calcium bicarbonate type and is usually alkaline. Dissolved-solids concentration in water from most wells is less than 250 mg/L; however, dissolved solids in water from some wells at areas near phosphate chemical-processing plants exceeded this concentration. Concentrations of most constituents in water from the intermediate aquifer are lower than those in water from the surficial aquifer system. Data for this study include analyses from 9 wells in undeveloped areas, 16 wells in citrus farming areas, 6 wells near areas of point-source waste discharges, and 10 wells in phosphate-mining and reclamation areas (tables 2 and 15).

Undeveloped Areas

Data collected during this study indicate that the specific conductance of water in the intermediate aquifer system averaged 314 µS/cm, dissolved solids averaged 200 mg/L, and pH ranged from 7.0 to 7.8 (table 15). Stewart (1963) reported small quantities of hydrogen sulfide gas. Magnesium concentrations in water samples collected from the intermediate aquifer system during this study averaged 17 mg/L, which is slightly higher than in water samples from other hydrogeologic units. The elevated magnesium concentration probably results from ion exchange with clay minerals, which are abundant in the intermediate aquifer system. Water samples from two wells that are open to the intermediate aquifer system in undeveloped areas had concentrations of iron (table 8, site 43) and selenium (table 8, site 53) that exceeded FDER standards (table 15).

Citrus Farming Areas

Citrus groves generally are in regions estimated to be of moderate to high potential for contamination of the intermediate aquifer system (figs. 23 and 33). Water samples collected from wells in citrus farming areas during this study had an average specific conductance of 326 µS/cm, an average dissolved-solids concentration of 199 mg/L, and a range in pH of 6.6 to 7.9 (table 15). Constituent concentrations in water from six intermediate aquifer system wells (fig. 4, sites 11, 23, 29, 34, 67, and 77) exceeded at least one of the Florida Department of Environmental Regulation (1989) drinking water standards for iron, manganese, nitrate, or gross alpha (table 18). Concentrations of most trace elements and organic compounds were below analytical detection limits. Table 18 includes analytical results of water samples from four wells in citrus farming areas (fig. 4, sites 29, 50, 60, and 89) that had measurable or detectable concentrations of volatile organic compounds (chloroform; tetrachloroethylene; 1,2, dichloropropane; trichloroethene; 1,1,3,3 teramethoxypropane; or pesticides).

The FDER indicated that many wells in or adjacent to EDB application areas have detectable concentrations of the compound (Florida Department of Environmental Regulation, written commun., 1985) (fig. 35). The wells are in citrus farming areas at or adjacent to the Winter Haven, Lake Henry, and Lake Wales Ridges where EDB was applied most frequently.

Areas Near Point-Source Waste Discharges

Water samples were collected from wells open to the intermediate aquifer near sinkholes (fig. 4, sites 68 and 84), industrial sites (fig. 4, sites 58, 73, and 76), or hazardous waste sites (fig. 4, site 86) during this study. Hardness (as calcium carbonate) averaged 147 mg/L, dissolved-solids concentrations averaged 206 mg/L, and pH ranged from 6.8 to 8.1 (table 15). Water samples from these wells had lower concentrations of phosphorus, total organic carbon, sodium, potassium, sulfate, fluoride, and gross alpha and beta than did samples from the surficial aquifer system wells (table 14). Most samples met the standards of the Florida Department of Environmental Regulation (1989) for public water supplies. Water samples from one well (fig. 4, site 73) exceeded the standard for iron (table 18). The only indicator of contamination appears to be in a sample from a well near a sinkhole lake (fig. 4, site 68) where 1,1,3,3 teramethoxypropane was tentatively identified (table 18).

Phosphate-Mining and Reclamation Areas

Data collected during this study and during previous studies indicate that mean concentrations of most chemical constituents and gross alpha radiation tend to be higher in these areas than in undeveloped areas (table 15). During this and previous studies, specific conductance averaged 406 and 371 μS/cm, dissolved-solids concentrations averaged 265 and 195 mg/L, and pH ranged from 7.0 to 7.8 and from 5.9 to 10.3. Two wells sampled during this study had water that exceeded the Florida Department of Environmental Regulation (1989) standards for public supply for iron (fig. 4 and table 18, sites 10 and 87), and one well had water that exceeded the standard for gross alpha radiation (fig. 4 and table 18, site 27). Water from two wells sampled during this study also had measurable concentrations of organic compounds (fig. 4 and table 18, sites 10 and 30). Of the wells sampled during previous studies, one had water that exceeded FDER maximum contaminant levels for iron and another had water that exceeded maximum contaminant levels for radium-226.

Concentrations of chemical constituents generally were higher in water from the intermediate aquifer system at phosphate-mining and reclamation areas than in water from the surficial aquifer system (table 15). Although the phosphate mining area is an area estimated to have a moderate potential for contamination of the intermediate aquifer system, analytical results do not conclusively demonstrate the presence of contamination in the aquifer. There were relatively few samples with elevated constituent concentrations (table 18).

Areas Near Phosphate Chemical-Processing Plants

Mean concentrations for most water-quality constituents in water from the intermediate aquifer system were higher at wells in areas near phosphate chemical-processing plants than at wells in other land-use areas (table 15) (Miller and Sutcliffe, 1982). Water from some intermediate aquifer system wells exceeded Florida Department of Environmental Regulation (1989) maximum contaminant levels for pH, sodium, sulfate, fluoride, iron, dissolved solids, radium-226, arsenic, and manganese (table 15). Specific conductance averaged 975 μS/cm, dissolved-solids concentrations averaged 759 mg/L, and pH ranged from 6.3 to 8.2 (table 15). Miller and Sutcliffe (1982) and Rutledge (1987) reported that the ranges in constituent concentrations in water samples from the intermediate aquifer system near these plants were less than those in water samples from the surficial aquifer system. Water samples from the intermediate aquifer system near phosphate chemical-processing plants had higher mean values for alkalinity and hardness (table 15) than did water in the surficial aquifer system.

Upper Floridan Aquifer

Data collected during this study include analyses of water samples from the Upper Floridan aquifer at 20 wells in citrus farming areas, at 2 wells in phosphate-mining and reclamation areas, and at 1 well near a point-source waste discharge (tables 2 and 16). The wells are in areas of low to moderate potential for contamination of the Upper Floridan aquifer (fig. 4).

Undeveloped Areas

Water in the Upper Floridan aquifer in undeveloped areas generally is an alkaline calcium bicarbonate type and has lower mean concentrations of dissolved solids, nitrate, chloride, and iron than water from the intermediate aquifer system (tables 15 and 16). Stewart (1966) concluded that mineralization increased with depth, but found no single constituent concentration that increased consistently with depth. Table 16 lists a mean specific conductance of 249 μS/cm, a mean dissolved-solids concentration of 155 mg/L, and a range in pH of 7.4 to 8.3 for water from the Upper Floridan aquifer. None of the water samples that were analyzed had constituent concentrations that exceeded FDER maximum contaminant levels.

Citrus Farming Areas

Citrus farming areas were the only land-use type that had discernible effects on the water quality of the Upper Floridan aquifer. Citrus groves generally are in regions of low and moderate potential for contamination of the Upper Floridan aquifer (figs. 23 and 34). Results of the water-quality analyses of samples collected during this study tend to support this conclusion because there was little evidence of contamination. During this study and previous studies, respectively, specific conductance averaged 300 and 250 µS/cm, dissolved-solids concentrations averaged 195 and 148, and pH ranged from 6.8 to 8.5 and 6.8 to 9.1 (table 16). Of 20 water samples collected from the Upper Floridan aquifer in citrus farming areas during this study, 7 contained concentrations of chemical constituents that exceeded Florida Department of Environmental Regulation (1989) standards for public water supply or had detectable concentrations of pesticides or volatile organic compounds (table 18). Standards for iron were exceeded in samples from two wells (fig. 4, sites 64 and 79), for gross alpha radiation in samples from three wells (fig. 4, sites 13, 21, and 38), and for organic compounds in samples from two wells (fig. 4, sites 39 and 93). Elevated concentrations of iron and gross alpha radiation may be the result of natural conditions, whereas elevated concentrations of many organic compounds indicate human-induced contamination. Volatile organic compounds were detected in water samples from wells 13 and 80 (table 10), but this may have been the result of contamination by collection procedures or solvents used on plastic casings (C.B. Hutchinson, U.S. Geological Survey, oral commun., 1988). EDB has been detected in water samples from Upper Floridan aquifer wells in Polk County (Florida Department of Environmental Regulation, written commun., 1985). Most of the water samples that contained EDB were collected in or near citrus groves within the region of moderate potential for contamination of the Upper Floridan aquifer (figs. 34 and 35).

Phosphate-Mining and Reclamation Areas

Concentrations of chemical constituents in water samples collected from the Upper Floridan aquifer at phosphate-mining and reclamation areas are similar to those in samples collected from undeveloped areas. Analytical results of 13 water samples collected from phosphate-mining and reclamation areas were used in this study; 2 of the samples were collected during this study and 11 were collected during previous studies. During this study and previous studies, respectively, specific conductance averaged 427 and 325 µS/cm, dissolved-solids concentrations averaged 246 and 185, and pH ranged from 7.3 to 7.4 and 7.6 to 8.3 (table 16). None of the 13 water samples exceeded Florida Department of Environmental Regulation (1989) maximum contaminant levels. Measurable concentrations of volatile organic compounds (tables 10 and 11) were not detected in the two water samples collected from the Upper Floridan aquifer at phosphate-mining and reclamation areas during this study.

Intermediate Aquifer System-Upper Floridan Aquifer

Many wells in Polk County are open to both the intermediate aquifer system and the Upper Floridan aquifer and, thus, are multiaquifer wells. A typical irrigation well or industrial supply well is cased through the surficial aquifer system and has an open hole in the deep carbonate intervals. Previous investigators have considered these multiaquifer wells to be Upper Floridan aquifer wells because the Upper Floridan aquifer generally yields the most water to the open borehole. Because there are so many multiaquifer wells in the county, the quality of the composite water produced by these wells is discussed separately in this section. Multiaquifer wells sampled during this study include 19 wells in citrus farming areas, 5 wells near areas of point-source waste discharge, and 5 wells in phosphate-mining and reclamation areas (tables 17 and 18).

Water from multiaquifer wells in the study area is a calcium bicarbonate type. Multiaquifer wells short circuit the lower confining unit of the intermediate aquifer system, thereby providing for direct interflow between aquifers and the potential for significant changes in the water quality of a particular aquifer. Water from multiaquifer wells seems to be a blend of intermediate aquifer system and Upper Floridan aquifer waters, both of which are calcium bicarbonate type water. Numerous borehole flow logs from previous investigations have identified water contributions from both aquifers. Twelve wells where composite water samples were collected during this study had water with concentrations of iron, nitrates, or gross alpha or radium-226 that exceeded Florida Department of Environmental Regulation (1989) maximum contaminant levels (table 18). Three wells also had water with measurable or trace concentrations of volatile organic compounds. In citrus farming areas, water samples from multiaquifer wells had higher concentrations of sodium and iron but lower concentrations of nitrate than did water from wells open only to the intermediate aquifer system (tables 15-17).

SUMMARY AND CONCLUSIONS

Land use and hydrogeologic factors that affect water-quality were used to estimate and delineate the potential for contamination to the surficial aquifer system, intermediate aquifer system, and Upper Floridan aquifer in Polk County. The surficial aquifer system, intermediate aquifer system, and Upper Floridan aquifer provide 80 percent of Polk County's total freshwater use. The surficial aquifer system, consisting of as much as 200 to 250 ft of unconsolidated sands and clays, yields about 10 gal/min to most wells, but yields as much as 50 gal/min to some wells. The underlying intermediate aquifer system, where present, consists of interbedded clastics and carbonate rocks that yield moderate quantities of water for rural, irrigation, and industrial uses. The Upper Floridan aquifer, below the intermediate aquifer system, lies from about 50 to 400 ft below land surface. The Upper Floridan aquifer is composed of limestone and dolomite and provides an estimated 295 Mgal/d of water to large-diameter wells in the Southwest Florida Water Management District. A typical irrigation well or industrial supply well is cased through the surficial aquifer system, has an open hole in the carbonate intervals of the intermediate and Upper Floridan aquifers, and yields up to 1,500 gal/min.

The potential for ground-water contamination was estimated and related to various land uses and hydrogeologic factors. Land uses examined in analyzing the available water-quality data include undeveloped areas, citrus farming areas, areas near point-source waste discharges, phosphate-mining and reclamation areas, and areas near phosphate chemical-processing plants. The potential for contamination is greatest in citrus farming areas along sandy ridges, in areas near point-source waste discharges, and in phosphate industry areas in the western third of the county. Hydrogeologic factors that affect the potential for ground-water contamination include the hydraulic properties of the aquifers and confining units that control the direction and rate of ground-water movement, sinkhole development, and lineaments and subsurface features.

The surficial aquifer system has a high potential for contamination throughout the county in upland areas because it has a high recharge rate, is exposed at land surface, and is the repository of wastes in many upland areas. Wetlands are areas of ground-water discharge from the surficial aquifer system, or are areas of low recharge. These areas are unlikely to be developed; therefore, both land use and hydrogeologic factors indicate a low potential for contamination in wetlands. Because the surficial aquifer system is the source of recharge to underlying aquifer systems, it has significant influence on potable ground-water resources.

The intermediate aquifer system has a high potential for contamination in the central part of the county, which encompasses the Winter Haven and Lake Wales Ridges. The region is characterized by thin overburden, moderate to high recharge, and many sinkhole lakes and depressions that indicate a high degree of interconnection between the surficial and intermediate aquifer systems. The western area, encompassing the Lakeland Ridge and the Peace River lowlands, has a moderate potential for contamination because of thick overburden, low to moderate recharge, and numerous sinkholes and connector wells. The eastern area in the Kissimmee River basin has a low potential for contamination because the overburden is thick, there are few sinkholes, and artesian flow inhibits the downward movement of contaminants.

The Upper Floridan aquifer had no areas designated as having high potential for contamination because of the degree to which it is confined by overlying materials. An area of estimated very low potential exists in the eastern quarter of the county where water levels in the aquifer generally are above land surface and the overburden generally is greater than 100 ft thick. Areas of estimated low potential occur to the north in the Green Swamp where low transmissivity inhibits infiltration and to the southwest where recharge is less than 10 in/yr. An area of western and central Polk County was estimated to have a moderate potential for contamination based on recharge of more than 10 in/yr, overburden thickness of 50 to 200 ft, and many sinkholes breaching the intermediate aquifer system.

Water quality varies among the surficial aquifer system, the intermediate aquifer system, and the Upper Floridan aquifer. Water in the surficial aquifer system is slightly acidic and contains relatively low concentrations of dissolved solids. Generally, concentrations of major ions are less than 250 mg/L. Water in the intermediate aquifer system is an alkaline calcium bicarbonate type with concentrations of major ions also generally less than 250 mg/L, but contains low concentrations of hydrogen sulfide gas and slightly elevated concentrations of magnesium in some areas. Water in the Upper Floridan aquifer also is an alkaline calcium bicarbonate type.

Ground-water contamination in Polk County is more common in the surficial and intermediate aquifer systems, whereas the Upper Floridan aquifer has experienced little degradation of ground-water quality. In some areas, concentrations of some trace elements, nitrate, and radiochemicals in water from the intermediate aquifer system exceeded Florida Department of Environmental Regulation standards for public water supplies. Only water samples collected from the intermediate aquifer system, the Upper Floridan aquifer, or multiaquifer wells were analyzed for volatile organic compounds. Most of the volatile organic compounds that were detected were in samples from the intermediate aquifer system or multiaquifer wells.

Water-quality has been affected by land use in some areas of the county. In phosphate mining and reclamation areas, the mean concentrations of most constituents in water from the intermediate aquifer system were higher than the mean concentrations in water from the surficial aquifer system. Near areas of point-source waste discharges and phosphate chemical-processing plants, the mean concentrations of most constituents in water from the intermediate aquifer system were lower than the mean concentrations in water from the surficial aquifer system. Most constituents in water samples from the intermediate aquifer system had concentrations that were similar to those in samples from the Upper Floridan aquifer or from wells open to both the intermediate aquifer system and the Upper Floridan aquifer. However, a number of exceptions, along with general quality-of-water comparisons, are presented below:

1. In undeveloped areas, concentrations of iron generally were greater in the intermediate aquifer system than in the Upper Floridan aquifer.
2. In some citrus farming areas, water samples from the intermediate aquifer system had concentrations of nitrate that were greater than those in samples from the Upper Floridan aquifer and in samples from multiaquifer wells.
3. In areas near point-source waste discharges, water samples from the intermediate aquifer system had concentrations of phosphorus, total organic carbon, sodium, potassium, sulfate, fluoride, and gross alpha and beta that were lower than concentrations in samples from the surficial aquifer system.
4. In phosphate-mining and reclamation areas, nitrate, phosphate, potassium, and sulfate concentrations generally were highest in water samples from the surficial aquifer system, lower in samples from the Upper Floridan aquifer, and lowest in samples from the intermediate aquifer system.
5. In areas near phosphate chemical-processing plants, water samples from the intermediate aquifer system had mean concentrations of alkalinity, magnesium, and hardness that were greater than those in samples from the surficial aquifer system.
6. Concentrations of trace elements, nutrients, radiochemicals, and volatile organic compounds in water samples from the surficial and intermediate aquifer systems generally were higher than in water samples from the Upper Floridan aquifer near citrus farming areas, in areas near point-source waste discharges, at phosphate-mining and reclamation areas, and in areas near phosphate chemical-processing plants.

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Table 7

Table 7. Physical and chemical characteristics of ground water in Polk County, Florida

[Analyses by U.S. Geological Survey and Polk County Water Resources Division laboratories. °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; mg/L, milligrams per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Alkalinity, total field (mg/L as $CaCO_3$)	Alkalinity, lab (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
1	273903081322701	7-23-86	25.0	240	7.46	88	79	120	35	8.4
2	273930082002301	8-04-87	25.5	362	7.80	125	120	170	44	14
3	274058081493501	8-17-87	25.5	255	7.30	204	196	190	38	23
4	274220081371801	7-23-86	28.5	365	7.62	192	173	170	39	17
5	274304081503801	4-24-86	24.5	508	7.26	237	226	220	43	26
6	274342081315401	8-05-86	25.0	252	7.32	122	84	110	26	11
7	274401081534901	6-22-87	25.5	180	7.70	184	178	160	40	14
8	274421081435601	4-24-86	24.0	345	7.62	162	156	170	34	20
9	274452081482901	7-30-87	25.0	326	7.69	176	171	170	37	18
10	274507081594201	6-22-87	25.5	297	7.30	146	138	140	30	17
		1-19-88	25.0	303	--	--	--	--	--	--
11	274607081401601	5-07-86	25.5	318	7.92	161	156	150	32	16
12	274712081533301	8-10-87	26.5	765	7.30	284	274	320	68	37
13	274730081333801	6-23-87	24.5	275	7.80	132	127	120	36	8.0
		7-14-87	25.0	285	--	--	130	120	36	7.9
14	274740082023601	4-29-86	23.5	351	7.96	--	172	140	32	15
15	274749081590001	4-28-86	24.5	422	7.55	187	194	180	41	19
16	274843081392201	7-30-87	25.0	425	7.33	219	217	210	50	22
17	274910081452201	2-03-86	25.5	--	--	159	--	140	37	12
		4-10-86	25.0	340	7.30	--	125	150	39	12
18	274958081514601	8-04-87	24.5	384	7.60	191	182	190	40	22
19	275010081561301	7-23-87	24.5	255	7.81	123	117	110	24	13
20	275032081353201	7-29-87	24.5	330	7.41	169	162	150	40	11
21	275036081431201	5-05-86	24.0	290	7.86	150	146	140	31	15
22	275123081521601	7-23-87	25.0	346	7.44	121	118	160	40	15
23	275130081424601	7-21-87	25.0	456	6.60	104	112	200	49	20
24	275150082011001	4-28-86	24.0	279	7.95	135	129	120	27	13
25	275156081435101	5-07-86	24.0	790	7.67	306	296	390	92	38
26	275156082031101	7-23-87	24.5	273	7.83	132	128	120	28	13
27	275213081505401	6-24-87	24.5	418	7.30	176	171	180	41	19
28	275230081431301	4-10-86	24.5	317	6.70	55	52	120	29	12
29	275236081424301	7-21-87	25.0	297	7.50	48	44	110	26	9.7
		1-20-88	24.5	307	--	--	--	--	--	--
30	275243081584001	6-23-87	24.5	372	7.00	187	183	170	37	18
		1-19-88	24.0	385	--	--	--	--	--	--
31	275304081344701	7-23-86	25.5	143	7.15	63	57	61	19	3.0
32	275310081505501	6-24-87	24.5	360	7.70	160	154	170	38	18
33	275327081595301	8-18-87	27.0	325	3.70	--	<1.0	89	33	1.8
34	275332081592701	6-23-87	24.5	452	7.30	154	153	210	46	22
35	275337081323301	7-29-87	25.5	184	8.26	35	34	70	22	3.5
		1-20-88	25.0	182	--	--	--	--	--	--
36	275339081453901	5-05-86	24.0	360	7.35	181	167	180	51	12
37	275449081512101	4-28-86	23.0	467	7.70	161	154	--	--	15
38	275450081501001	6-24-87	24.0	750	7.30	274	263	350	81	36
39	275456081345501	7-30-87	25.5	303	7.71	--	91	130	40	8.2
40	275511082004401	6-23-87	24.5	372	7.20	--	173	180	39	20
41	275514081391401	4-30-86	25.0	300	7.40	114	111	130	38	8.6
42	275530081362901	7-29-87	24.0	245	7.85	114	109	110	33	7.7
43	275627082014101	6-24-86	23.5	286	7.13	141	137	150	32	17
44	275646081534201	4-14-86	24.0	305	7.80	237	142	140	39	9.5
45	275702081350701	7-22-86	26.0	310	7.47	98	92	130	36	9.0
46	275714081523801	6-26-86	25.5	350	--	--	142	160	48	10
47	275718082004901	6-24-86	23.5	322	6.96	138	133	150	33	16
48	275743081331501	7-29-87	25.5	197	7.88	35	35	73	20	5.4
49	275748081563601	7-13-87	25.0	316	7.50	--	155	--	< .10	< .10
50	275752081525301	6-26-86	25.0	372	--	--	135	170	55	8.9

Table 7. Physical and chemical characteristics of ground water in Polk County, Florida–Continued

Site number (fig. 4)	Well identification number	Date	Water temperature (°C)	Specific conductance (µS/cm)	pH (standard units)	Alkalinity, total field (mg/L as $CaCO_3$)	Alkalinity, lab (mg/L as $CaCO_3$)	Hardness (mg/L as $CaCO_3$)	Calcium, dissolved (mg/L as Ca)	Magnesium, dissolved (mg/L as Mg)
51	275806081545101	8-04-87	24.0	388	7.70	84	81	150	37	14
52	275829081471601	6-26-86	25.0	315	--	--	165	160	39	16
53	275832081594201	6-25-86	24.0	272	7.56	136	132	140	29	16
54	275838081595601	6-25-86	24.5	250	7.84	129	124	130	27	15
55	275858081353001	7-22-86	25.5	316	7.15	149	143	140	40	9.4
56	275859081395301	7-22-86	24.0	198	7.45	103	81	92	23	8.4
57	275918081425501	7-20-87	24.5	330	6.60	29	28	110	25	11
		1-20-88	24.5	319	--	--	--	--	--	--
58	275953081532701	7-07-87	25.5	285	7.80	--	141	140	34	12
		1-19-88	23.5	282	--	--	--	--	--	--
59	275956081572801	7-13-87	25.0	282	7.60	138	133	130	34	12
		1-19-88	25.5	280	--	--	--	--	--	--
60	280005081492201	7-01-86	25.0	319	7.75	151	147	140	37	11
61	280016081490301	8-20-87	31.0	450	5.00	--	45	16	2.7	2.2
62	280039081505201	8-18-87	28.0	145	6.30	52	50	63	15	6.2
63	280044081490801	4-30-86	26.5	310	8.10	145	139	150	35	14
64	280101081543601	4-14-86	25.0	366	7.51	266	169	170	44	15
65	280123081462301	7-09-87	25.5	286	7.70	150	144	130	31	12
66	280130082004901	7-07-87	24.0	278	7.90	--	131	130	28	14
67	280131081401601	7-20-87	24.5	445	7.30	209	206	220	69	12
68	280133081430501	7-21-87	24.5	286	6.90	122	128	130	30	13
		1-20-88	24.5	277	--	--	--	--	--	--
69	280154081364101	7-22-86	25.5	284	6.81	--	108	120	37	7.5
70	280200082014901	6-24-86	25.0	368	7.35	193	187	180	40	20
71	280203081541701	7-07-87	24.5	365	--	--	184	180	48	14
		1-19-88	24.5	360	--	--	--	--	--	--
72	280220081470701	7-09-87	--	318	7.60	163	150	140	36	12
73	280245081533101	7-07-87	23.5	571	--	--	205	260	58	27
74	280246081574501	8-19-87	--	190	6.30	69	70	66	24	1.6
75	280253081512901	7-01-86	25.0	463	7.87	--	225	220	63	16
76	280315081480101	7-09-87	25.5	255	8.10	87	86	100	23	11
77	280320082004601	6-23-86	25.0	157	6.51	71	69	70	21	4.0
78	280323081360901	7-21-86	26.0	239	7.15	89	83	100	30	6.7
79	280424081452001	7-08-87	24.0	456	7.30	--	213	200	53	17
80	280437081410207	10-25-84	--	--	--	--	47	50	13	4.2
		12-17-85	--	172	8.50	71	68	70	20	4.5
		8-28-87	24.5	190	8.30	--	--	--	--	--
81	280452081585701	7-07-87	23.5	307	--	--	75	120	26	13
82	280516081374701	7-21-86	25.0	302	7.53	--	111	120	40	5.7
83	280520081485601	7-21-86	24.0	240	7.62	116	112	110	25	12
84	280529082004601	6-23-86	24.0	273	7.84	136	134	140	46	5.9
85	280548081424801	5-06-86	24.5	308	7.94	134	131	140	34	13
86	280554082002701	6-23-86	24.0	228	6.80	116	110	110	34	7.0
87	280600081534901	6-25-87	23.5	572	7.20	274	261	260	78	16
88	280601081473701	7-08-87	25.0	182	8.10	69	67	74	19	6.1
89	280642081385301	7-02-86	25.5	230	7.70	90	86	99	32	4.6
90	280703081582201	7-08-87	23.5	284	7.40	134	136	130	30	15
91	280805081492301	5-06-86	24.5	217	8.04	105	98	97	25	8.3
92	280819081555701	7-08-87	24.5	208	7.70	71	71	84	18	9.3
93	280836081490401	7-20-87	23.5	218	7.90	112	109	99	23	9.8
		1-20-88	23.0	228	--	--	--	--	--	--
94	280950081480001	8-20-87	28.0	169	5.60	51	48	21	3.3	3.2
95	280950081480501	7-02-86	25.0	259	7.76	107	107	120	40	4.5

Table 7. Physical and chemical characteristics of ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Sodium, dissolved (mg/L as Na)	Sodium, adsorption ratio	Percent sodium	Potassium dissolved (mg/L as K)	Chloride, dissolved (mg/L as Cl)	Sulfate, dissolved (mg/L as SO_4)	Fluoride dissolved (mg/L as F)	Silica, dissolved (mg/L as SiO_2)	Solids residue at 180 °C, dissolved (mg/L)	Bicarbonate, (mg/L as HOC_3)	Hardness, noncarbonate (mg/L as $CaCO_3$)	Carbon, organic total (mg/L as C)
1	7-23-86	6.0	0.2	10	0.89	15	26	0.11	8.8	165	78	34	0.4
2	8-04-87	6.5	.2	8	.87	10	44	.56	17	240	120	43	.7
3	8-17-87	17	.5	16	1.0	19	10	2.5	45	278	200	0	2.1
4	7-23-86	8.3	.3	10	1.8	.20	5.5	.49	22	220	170	0	1.7
5	4-24-86	20	.6	17	.81	17	9.7	1.0	38	282	230	0	2.1
6	8-05-86	5.2	.2	9	1.0	.50	5.0	.13	18	139	83	0	1.7
7	6-22-87	19	.7	21	1.0	12	7.0	1.1	47	276	180	0	1.0
8	4-24-86	3.6	.1	4	.37	15	<5.0	.09	17	180	150	2	.9
9	7-30-87	13	.4	14	.68	12	7.0	1.1	42	248	170	0	1.0
10	6-22-87	5.0	.2	7	.48	9.0	9.0	1.6	25	211	140	0	1.9
	1-19-88	--	--	--	--	--	--	--	--	--	--	--	--
11	5-07-86	5.6	.2	7	3.2	5.1	<5.0	.29	39	184	150	0	.7
12	8-10-87	32	.8	18	.83	75	8.0	.84	42	461	270	36	2.1
13	6-23-87	7.0	.3	11	2.8	8.8	.2	.20	32	180	--	0	--
	7-14-87	7.1	.3	11	2.6	8.0	7.0	.19	--	192	130	0	2.9
14	4-29-86	18	.7	21	1.0	7.1	5.3	.81	39	197	170	0	1.3
15	4-28-86	15	.5	15	.60	22	11	.55	36	229	190	0	2.3
16	7-30-87	4.4	.1	4	3.0	8.0	<6.0	.38	46	282	220	0	2.5
17	2-03-86	6.6	.2	9	1.5	8.3	16	.30	21	175	--	0	.1
	4-10-86	6.3	.2	--	--	3.5	23	.29	18	181	120	4	1.8
18	8-04-87	6.5	.2	7	.32	10	7.0	.80	30	244	180	0	.4
19	7-23-87	8.0	.3	13	.73	8.0	6.0	.81	25	166	120	0	1.5
20	7-29-87	7.6	.3	10	2.7	4.0	<6.0	.21	45	232	160	0	2.2
21	5-05-86	5.8	.2	8	1.9	5.2	<5.0	.46	43	184	140	0	1.1
22	7-23-87	6.5	.2	8	.91	9.0	41	.48	15	210	120	39	.7
23	7-21-87	5.7	.2	6	3.2	18	71	.37	18	284	110	100	.7
24	4-28-86	9.5	.4	15	.71	8.1	5.1	.62	30	144	130	0	1.0
25	5-07-86	22	.5	11	1.5	19	120	.41	--	497	290	81	3.5
26	7-23-87	8.1	.3	12	.54	6.0	<6.0	.64	21	164	130	0	.9
27	6-24-87	15	.5	15	.67	9.0	25	.39	18	280	170	6	.9
28	4-10-86	7.0	.3	11	1.1	22	6.9	.16	11	197	52	66	.5
29	7-21-87	9.5	.4	16	1.2	23	6.0	.21	13	192	44	58	.4
	1-20-88	--	--	--	--	--	--	--	--	--	--	--	--
30	6-23-87	12	.4	14	.66	1.0	8.0	.57	37	266	180	0	1.6
	1-19-88	--	--	--	--	--	--	--	--	--	--	--	--
31	7-23-86	3.3	.2	10	.50	5.3	<5.0	.11	12	91	56	0	< .3
32	6-24-87	7.8	.3	9	.35	9.0	13	.23	18	246	150	7	.4
33	8-18-87	6.4	.3	13	5.5	3.0	41	22	94	363	<1	0	26
34	6-23-87	6.9	.2	7	.62	22	7.0	.34	35	320	150	52	< .3
35	7-29-87	4.6	.2	12	.77	9.0	11	< .05	11	140	34	35	< .3
	1-20-88	--	--	--	--	--	--	--	--	--	--	--	--
36	5-05-86	2.8	.1	3	1.2	5.9	7.0	.31	18	194	170	0	2.1
37	4-28-86	8.2	--	--	.76	13	61	.31	16	259	150	--	2.2
38	6-24-87	21	.5	11	1.4	27	90	.33	20	506	260	79	1.9
39	7-30-87	6.4	.3	9	2.3	13	31	.13	10	204	90	43	.7
40	6-23-87	7.0	.2	8	.54	12	7.0	.36	21	256	170	5	.6
41	4-30-86	6.6	.3	10	3.6	13	19	.22	16	150	110	17	1.3
42	7-29-87	3.7	.2	6	1.5	6.0	7.0	.22	14	160	110	0	1.3
43	6-24-86	2.5	.1	4	.41	9.6	7.2	.43	29	183	140	6	2.4
44	4-14-86	5.1	.2	7	.64	10	<5.0	.22	16	161	140	0	1.7
45	7-22-86	7.5	.3	11	3.3	12	22	.11	10	180	91	27	.9
46	6-26-86	10	.4	12	.82	5.4	18	.27	14	210	140	21	1.5
47	6-24-86	9.2	.3	12	.21	22	5.4	.31	17	196	130	12	1.1
48	7-29-87	4.7	.2	12	2.1	10	14	.08	10	128	35	38	< .3
49	7-13-87	--	--	--	.05	7.0	7.0	.37	22	227	150	--	2.0
50	6-26-86	8.4	.3	9	.63	14	27	.17	12	229	130	40	.3

Table 7. Physical and chemical characteristics of ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Sodium, dis-solved (mg/L as Na)	Sodium, adsorp-tion ratio	Percent sodium	Potas-sium dis-solved (mg/L as K)	Chlo-ride, dis-solved (mg/L as Cl)	Sul-fate, dis-solved (mg/L as SO_4)	Fluo-ride dis-solved (mg/L as F)	Silica, dis-solved (mg/L as SiO_2)	Solids residue at 180 °C, dis-solved (mg/L)	Bicar-bonate, (mg/L as HOC_3)	Hard-ness, noncar-bonate (mg/L as $CaCO_3$)	Carbon, organic total (mg/L as C)
51	8-04-87	13	0.5	16	0.46	31	9.0	0.31	12	277	80	67	<0.3
52	6-26-86	5.2	.2	6	1.5	5.3	<5.0	.28	23	186	160	0	1.8
53	6-25-86	4.7	.2	7	.20	8.5	<5.0	.39	21	160	130	2	< .3
54	6-25-86	4.5	.2	7	.16	7.6	5.1	.35	22	150	120	0	< .3
55	7-22-86	9.2	.4	12	1.3	10	5.1	.12	14	167	140	0	2.7
56	7-22-86	3.0	.1	6	1.9	2.5	<5.0	.23	24	110	80	0	.3
57	7-20-87	13	.6	21	2.9	30	9.0	.26	16	226	28	77	.6
	1-20-88	--	--	--	--	--	--	--	--	--	--	--	--
58	7-07-87	4.4	.2	6	.57	3.0	7.0	.42	26	208	140	0	2.1
	1-19-88	--	--	--	--	--	--	--	--	--	--	--	--
59	7-13-87	4.5	.2	7	.50	5.0	7.0	.28	21	176	130	0	.3
	1-19-88	--	--	--	--	--	--	--	--	--	--	--	--
60	7-01-86	8.3	.3	11	1.2	9.2	<5.0	.23	19	177	150	0	1.9
61	8-20-87	26	3	31	86	44	37	< .05	15	510	45	0	140
62	8-18-87	3.8	.2	11	.74	11	8.0	.09	5.4	108	50	11	5.0
63	4-30-86	5.7	.2	8	.96	9.3	6.4	.35	14	152	140	0	1.5
64	4-14-86	5.1	.2	6	.56	14	5.1	.18	27	218	170	0	2.8
65	7-09-87	6.9	.3	10	2.6	2.0	7.0	.53	39	208	140	0	.9
66	7-07-87	5.1	.2	8	.64	5.0	7.0	.49	26	185	130	0	1.2
67	7-20-87	4.4	.1	4	2.3	8.0	15	.16	22	252	210	11	2.6
68	7-21-87	6.1	.2	9	2.0	8.0	6.0	.48	34	174	130	6	1.0
	1-20-88	--	--	--	--	--	--	--	--	--	--	--	--
69	7-22-86	6.9	.3	11	1.4	12	15	.18	12	158	110	10	1.8
70	6-24-86	11	.4	12	.59	11	<5.0	.43	50	234	190	0	1.0
71	7-07-87	5.0	.2	6	.67	3.0	7.0	.36	3.1	240	180	0	3.0
	1-19-88	--	--	--	--	--	--	--	--	--	--	--	--
72	7-09-87	6.2	.2	9	1.7	5.0	8.0	.29	26	202	150	0	1.8
73	7-07-87	12	.3	9	.50	50	11	.34	27	360	200	52	2.4
74	8-19-87	11	.6	26	.31	10	11	.06	2.1	136	70	0	6.4
75	7-01-86	12	.4	10	1.3	15	<5.0	.25	19	263	220	0	2.3
76	7-09-87	7.5	.3	14	1.9	22	8.0	.50	23	168	85	14	< .3
77	6-23-86	5.1	.3	14	.90	6.0	5.2	1.1	56	145	69	0	1.2
78	7-21-86	7.1	.3	13	1.2	9.9	9.8	.12	11	126	82	12	.8
79	7-08-87	11	.3	10	2.7	12	7.0	.40	37	301	210	0	4.2
80	10-25-84	6.7	.4	22	1.2	7.9	6.4	.27	15	--	--	3	--
	12-17-85	6.0	.3	15	2.5	9.5	6.0	.20	11	99	--	0	--
	8-82-87	--	--	--	--	--	--	--	--	--	--	--	--
81	7-07-87	12	.5	19	.24	14	9.0	.23	11	212	75	42	< .3
82	7-21-86	10	.4	15	1.7	14	5.8	.15	15	163	110	3	26
83	7-21-86	4.8	.2	8	.72	7.6	5.6	.53	21	130	110	0	.5
84	6-23-86	4.7	.2	7	.61	7.6	<5.0	.24	25	177	130	3	.7
85	5-06-86	6.5	.2	9	1.7	10	6.3	.19	19	169	130	3	< .3
86	6-23-86	4.7	.2	8	.39	5.5	<5.0	.35	25	151	110	0	1.1
87	6-25-87	15	.4	11	.38	10	8.0	.31	24	378	260	0	1.9
88	7-08-87	5.4	.3	13	1.4	6.0	12	.35	15	140	66	5	< .3
89	7-02-86	5.7	.3	11	.67	9.8	5.4	.13	12	131	85	8	< .3
90	7-08-87	4.2	.2	6	.35	4.0	7.0	.50	3.4	186	130	0	1.2
91	5-06-86	5.8	.3	11	.86	4.0	5.8	.57	41	147	97	0	< .3
92	7-08-87	5.6	.3	13	.13	14	7.0	.32	12	148	70	13	< .3
93	7-20-87	7.5	.3	14	1.3	2.0	9.0	.64	34	146	110	0	.4
	1-20-88	--	--	--	--	--	--	--	--	--	--	--	--
94	8-20-87	2.7	.3	13	13	6.0	10	< .05	19	180	48	0	54
95	7-02-86	5.4	.2	9	.71	11	6.9	.17	12	149	110	11	.4

Table 8

Table 8. Trace elements in ground water in Polk County, Florida

[Analyses by U.S. Geological Survey and Polk County Water Resources Division laboratories. µg/L, micrograms per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
1	273903081322701	7-23-86	<1	<100	<2	<20	<20	<40	<5
2	273930082002301	8-04-87	<1	<100	<2	<20	<20	430	<5
3	274058081493501	8-17-87	<1	<100	<2	<20	<20	2,500	<5
4	274220081371801	7-23-86	<1	<100	<2	<20	<20	<40	<5
5	274304081503801	4-24-86	2	<100	3	<20	<20	<40	<1
6	274342081315401	8-05-86	<1	<100	<2	<20	<20	<40	<5
7	274401081534901	6-22-87	<1	<100	<2	<20	<20	<40	<5
8	274421081435601	4-24-86	24	<100	2	<20	<20	82	<1
9	274452081482901	7-30-87	1	<100	2	<20	<20	<40	<5
10	274507081594201	6-22-87	3	<100	<2	<20	<20	1,900	<5
		1-19-88	--	--	--	--	--	--	--
11	274607081401601	5-07-86	<1	<100	<3	<20	<20	220	<5
12	274712081533301	8-10-87	6	<100	<2	<20	<20	<40	<5
13	274730081333801	6-23-87	--	--	--	--	--	--	--
		7-14-87	--	<100	<2	<20	<20	220	--
14	274740082023601	4-29-86	3	<100	2	<20	<20	300	4
15	274749081590001	4-28-86	<1	<100	2	<20	<20	60	<1
16	274843081392201	7-30-87	<1	<100	2	<20	<20	290	<5
17	274910081452201	2-03-86	--	34	--	--	--	14	--
		4-10-88	<1	<100	2	<20	<20	<40	<1
18	274958081514601	8-04-87	28	<100	<2	<20	<20	<40	<5
19	275010081561301	7-23-87	<1	<100	<2	<20	<20	<40	<5
20	275032081353201	7-29-87	<1	<100	2	<20	<20	580	<5
21	275036081431201	5-05-86	<1	<100	<2	<20	<20	70	<5
22	275123081521601	7-23-87	9	<100	2	<20	<20	160	<5
23	275130081424601	7-21-87	1	<100	2	<20	<20	140	<5
24	275150082011001	4-28-86	<1	<100	2	<20	<20	410	2
25	275156081485101	5-07-86	--	<100	3	<20	<20	46	--
26	275156082031101	7-23-87	<1	<100	<2	<20	<20	<40	<5
27	275213081505401	6-24-87	15	<100	<2	<20	<20	76	<5
28	275230081431301	4-10-86	<1	<100	2	<20	<20	<40	<1
29	275236081424301	7-21-87	<1	<100	<2	<20	<20	<40	<5
		1-20-88	--	--	--	--	--	--	--
30	275243081584001	6-23-87	<1	<100	<2	<20	<20	<40	<5
		1-19-88	--	--	--	--	--	--	--
31	275304081344701	7-23-86	<1	<100	<2	<20	<20	<40	<5
32	275310081505501	6-24-87	4	<100	<2	<20	<20	<40	<5
33	275327081595301	8-18-87	12	<100	<2	<20	25	94	<5
34	275332081592701	6-23-87	<1	<100	3	<20	<20	<40	<5
35	275337081323301	7-29-87	<1	<100	<2	<20	<20	<40	<5
		1-20-88	--	--	--	--	--	--	--
36	275339081453901	5-05-86	<1	<100	2	<20	<20	1,400	<5
37	275449081512101	4-28-86	<1	<100	3	<20	<20	<40	1
38	275450081501001	6-24-87	4	<100	3	<20	<20	<40	<5
39	275456081345501	7-30-87	<1	<100	2	<20	<20	<40	<5
40	275511082004401	6-23-87	3	<100	<2	<20	<20	<40	<5
41	275514081391401	4-30-86	<1	<100	<2	<20	<20	710	<1
42	275530081362901	7-29-87	<1	<100	<2	<20	<20	<40	<5
43	275627082014101	6-24-86	<1	<100	<2	<20	<20	1,600	<5
44	275646081534201	4-14-86	<1	<100	2	<20	<20	54	<1
45	275702081350701	7-22-86	<1	<100	<2	<20	<20	<40	<5
46	275714081523801	6-26-86	<1	<100	<2	<20	<20	61	<5
47	275718082004901	6-24-86	<1	<100	<2	<20	<20	260	<1
48	275743081331501	7-29-87	<1	<100	<2	<20	<20	<40	<5
49	275748081563601	7-13-87	<1	<100	2	<20	<20	<40	<5
50	275752081525301	6-26-86	<1	<100	2	<20	<20	<40	<5

Table 8. Trace elements in ground water in Polk County, Florida—Continued

Site number (fig. 4)	Well identification number	Date	Arsenic, dissolved (µg/L as As)	Barium, dissolved (µg/L as Ba)	Cadmium, dissolved (µg/L as Cd)	Chromium, dissolved (µg/L as Cr)	Copper, dissolved (µg/L as Cu)	Iron, dissolved (µg/L as Fe)	Lead, dissolved (µg/L as Pb)
51	275806081545101	8-04-87	2	<100	<2	<20	<20	<40	<5
52	275829081471601	6-26-86	<1	<100	<2	<20	<20	<40	<5
53	275832081594201	6-25-86	3	<100	<20	<20	<20	<40	<5
54	275838081595601	6-25-86	<1	<100	<2	<20	<20	<40	<5
55	275858081353001	7-22-86	<1	<100	<2	<20	<20	110	<5
56	275859081395301	7-22-86	2	<100	<2	<20	<20	71	<5
57	275918081425501	7-20-87	<1	<100	<2	<20	<20	<40	<5
		1-20-88	--	--	--	--	--	--	--
58	275953081532701	7-07-87	<1	<100	2	<20	<20	230	<5
		1-19-88	--	--	--	--	--	--	--
59	275956081572801	7-13-87	<1	<100	<2	<20	<20	<40	<5
		1-19-88	--	--	--	--	--	--	--
60	280005081492201	7-01-86	<1	<100	<2	<20	<20	<40	<5
61	280016081490301	8-20-87	<1	<100	<2	<20	340	520	<5
62	280039081505201	8-18-87	3	<100	2	<20	<20	290	<5
63	280044081490801	4-30-86	<1	<100	<2	<20	<20	<40	<1
64	280101081543601	4-14-86	1	<100	2	<20	<20	1,200	<1
65	280123081462301	7-09-87	<1	<100	2	<20	<20	<40	<5
66	280130082004901	7-07-87	<1	<100	2	<20	<20	280	<5
67	280131081401601	7-20-87	<1	<100	3	<20	<20	240	<5
68	280133081430501	7-21-87	<1	<100	<2	<20	<20	<40	<5
		1-20-88	--	--	--	--	--	--	--
69	280154081364101	7-22-86	1	<100	<2	<20	<20	160	<5
70	280200082014901	6-24-86	3	<100	<2	<20	<20	53	<5
71	280203081541701	7-07-87	<1	<100	3	<20	<20	68	<5
		1-19-88	--	--	--	--	--	--	--
72	280220081470701	7-09-87	<1	<100	2	<20	21	<40	<5
73	280245081533101	7-07-87	2	<100	3	<20	<20	1,200	<5
74	280246081574501	8-19-87	<1	<100	<2	<20	<20	4,400	<5
75	280253081512901	7-01-86	<1	<100	<2	<20	<20	<40	<5
76	280315081480101	7-09-87	<1	<100	<2	<20	<20	<40	<5
77	280320082004601	6-23-86	<1	<100	<2	<20	<20	930	<5
78	280323081360901	7-21-86	<1	<100	<2	<20	<20	<40	<5
79	280424081452001	7-08-87	<1	<100	3	<20	<20	1,200	<5
80	280437081410207	10-25-84	--	--	--	--	--	27	--
		12-17-85	--	--	--	--	--	13	--
		8-28-87	--	--	--	--	--	--	--
81	280452081585701	7-07-87	<1	<100	<3	<20	<20	<40	<5
82	280516081374701	7-21-86	<1	<100	<2	<20	<20	<40	<5
83	280520081485601	7-21-86	<1	<100	<2	<20	<20	280	<5
84	280529082004601	6-23-86	1	<100	<2	<20	<20	<40	<5
85	280548081424801	5-06-86	<1	<100	<2	<20	<20	<40	<5
86	280554082002701	6-23-86	1	<100	<2	<20	<20	<40	<5
87	280600081534901	6-25-87	<1	<100	<2	<20	<20	970	<5
88	280601081473701	7-08-87	10	<100	<2	<20	<20	<40	<5
89	280642081385301	7-02-86	<1	<100	<2	<20	<20	<40	<5
90	280703081582201	7-08-87	<1	<100	2	<20	<20	180	<5
91	280805081492301	5-06-86	3	<100	<2	<20	<20	<40	<5
92	280819081555701	7-08-87	2	<100	<2	<20	<20	<40	<5
93	280836081490401	7-20-87	<1	<100	<2	<20	<20	<40	<5
		1-20-88	--	--	--	--	--	--	--
94	280950081480001	8-20-87	<1	<100	<2	<20	99	430	<5
95	280950081480501	7-02-86	2	<100	<2	<20	<20	170	<5

Table 8. Trace elements in ground water in Polk County, Florida—Continued

Site number (fig. 4)	Date	Manganese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Mg)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Zinc, dissolved (µg/L as Zn)
1	7-23-86	<20	<0.1	1	<5	70	0
2	8-04-87	<20	< .1	<1	<20	1,900	<10
3	8-17-87	34	< .1	<1	<20	510	<10
4	7-23-86	<20	< .1	<1	<5	5,300	0
5	4-24-86	<20	.7	<1	<5	110	0
6	8-05-86	<20	< .1	<1	<5	2,500	0
7	6-22-87	<20	< .1	<1	<20	120	<10
8	4-24-86	<20	.3	<1	<5	100	0
9	7-30-87	<20	< .1	<1	<20	160	<10
10	6-22-87	39	< .1	<1	<20	20	17
	1-19-88	--	--	--	--	--	--
11	5-07-86	<41	< .1	<1	<5	70	0
12	8-10-87	<20	< .1	<1	<20	170	<10
13	6-23-87	--	--	--	--	220	--
	7-14-87	<20	--	--	<20	--	<10
14	4-29-86	<20	.4	<1	<5	150	0
15	4-28-86	<35	< .1	<1	<5	50	0
16	7-30-87	<20	< .1	<1	<20	110	<10
17	2-03-86	<1	--	--	--	2,000	--
	4-10-86	<20	.3	<1	<5	2,400	0
18	8-04-87	<20	< .1	<1	<20	90	<10
19	7-23-87	<20	< .1	<1	<20	20	0
20	7-29-87	31	< .1	<1	<20	190	71
21	5-05-86	<20	< .1	<1	<5	90	0
22	7-23-87	<20	< .1	<1	<20	920	<10
23	7-21-87	<20	< .1	1	<20	190	0
24	4-28-86	<20	.6	<1	<5	1,200	0
25	5-07-86	<20	--	--	<5	--	0
26	7-23-87	<20	< .1	<1	<20	120	<10
27	6-24-87	<20	< .1	<1	<20	240	66
28	4-10-86	<20	< .1	2	<5	110	0
29	7-21-87	<20	< .1	1	<20	130	65
	1-20-88	--	--	--	--	--	--
30	6-23-87	<20	< .1	<1	<20	150	<10
	1-19-88	--	--	--	--	--	--
31	7-23-86	<20	< .1	<1	<5	60	0
32	6-24-87	<20	< .1	<1	<20	190	<10
33	8-18-87	36	< .1	<1	<20	120	18
34	6-23-87	77	< .1	<1	<20	100	95
35	7-29-87	<20	< .1	<1	<20	150	<10
	1-20-88	--	--	--	--	--	--
36	5-05-86	25	< .1	<1	<5	70	0
37	4-28-86	<20	.2	<1	<5	120	0
38	6-24-87	<20	< .1	5	<20	850	200
39	7-30-87	<20	< .1	1	<20	260	<10
40	6-23-87	<20	< .1	<1	<20	70	46
41	4-30-86	22	.4	<1	<5	2,400	0
42	7-29-87	<20	< .1	<1	<20	80	<10
43	6-24-86	44	< .1	<1	<5	60	0
44	4-14-86	<20	.5	<1	<5	320	0
45	7-22-86	<20	< .1	1	<5	180	0
46	6-26-86	<20	< .1	<1	<5	550	0
47	6-24-86	46	< .1	<1	<5	30	0
48	7-29-87	<20	< .1	<1	<20	220	<10
49	7-13-87	<20	< .1	<1	<20	10	<10
50	6-26-86	<20	< .1	3	<5	110	0

Table 8. Trace elements in ground water in Polk County, Florida—Continued

Site number (fig. 4)	Date	Manganese, dissolved (µg/L as Mn)	Mercury, dissolved (µg/L as Mg)	Selenium, dissolved (µg/L as Se)	Silver, dissolved (µg/L as Ag)	Strontium, dissolved (µg/L as Sr)	Zinc, dissolved (µg/L as Zn)
51	8-04-87	<20	<0.1	1	<20	100	28
52	6-26-86	<20	< .1	<1	<5	100	0
53	6-25-86	<20	< .1	11	<5	50	0
54	6-25-86	<20	< .1	2	<5	50	0
55	7-22-86	<20	< .1	<1	<5	150	0
56	7-22-86	<20	< .1	<1	<5	60	0
57	7-20-87	<20	< .1	5	<20	150	19
	1-20-88	--	--	--	--	--	--
58	7-07-87	<20	< .1	<1	<20	70	21
	1-19-88	--	--	--	--	--	--
59	7-13-87	<20	< .1	<1	<20	90	<10
	1-19-88	--	--	--	--	--	--
60	7-01-86	<20	< .1	<1	<5	100	0
61	8-20-87	<20	< .1	<1	<20	20	1,000
62	8-18-87	20	< .1	<1	<20	60	<10
63	4-30-86	<20	.3	<1	<5	150	0
64	4-14-86	21	.3	<1	<5	110	0
65	7-09-87	<20	< .1	<1	<20	120	<10
66	7-07-87	<20	< .1	<1	<20	50	19
67	7-21-87	<20	< .1	<1	<20	110	<10
68	7-21-87	<20	< .1	<1	<20	150	<10
	1-20-88	--	--	--	--	--	--
69	7-22-86	<20	< .1	<1	<5	110	0
70	6-24-86	<20	< .1	<1	<5	70	0
71	7-07-87	<20	< .1	<1	<20	90	<10
	1-19-88	--	--	--	--	--	--
72	7-09-87	<20	< .1	<1	<20	130	280
73	7-07-87	23	< .1	<1	<20	90	26
74	8-19-87	<20	< .1	<1	<20	90	<10
75	7-01-86	<20	< .1	<1	<5	130	0
76	7-09-87	<20	< .1	<1	<20	70	<10
77	6-23-86	<20	< .1	<1	<5	40	0
78	7-21-86	<20	< .1	1	<5	200	0
79	7-08-87	35	< .1	<1	<20	120	250
80	10-25-84	<1	--	--	--	--	--
	12-17-85	4	--	--	--	1,100	--
	8-28-87	--	--	--	--	--	--
81	7-07-87	<20	< .1	<1	<20	40	<10
82	7-21-86	<20	< .1	1	<5	110	0
83	7-21-86	<20	< .1	<1	<5	50	0
84	6-23-86	34	< .1	<1	<5	80	0
85	5-06-86	<20	< .1	2	<5	90	0
86	6-23-86	<20	< .1	2	<5	80	0
87	6-25-87	<20	< .1	<1	<20	100	39
88	7-08-87	<20	< .1	<1	<20	60	<10
89	7-02-86	<20	< .1	1	<5	100	0
90	7-08-87	<20	< .1	<1	<20	50	22
91	5-06-86	<20	< .1	<1	<5	60	0
92	7-08-87	<20	< .1	<1	<20	40	21
93	7-20-87	<20	< .1	<1	<20	130	<10
	1-20-88	--	--	--	--	--	--
94	8-20-87	<20	< .1	<1	<20	30	25
95	7-02-86	<20	< .1	<1	<5	120	0

Table 9

Table 9. Biological constituents in ground water in Polk County, Florida

[Analyses by U.S. Geological Survey laboratories. col/100 mL, colonies per 100 milliliters; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Coliform, total, immediate (col/100 mL)	Coliform, fecal, 0.7 um-mf (col/100 mL)	Streptococci, fecal, kf agar (col/100 mL)
33	275327081595301	8-18-87	<1	<3	<3
61	280016081490301	8-20-87	14	<3	<3
62	280039081505201	8-18-87	6	3	<3
74	280246081574501	8-19-87	8	0	0
94	280950081480001	8-20-87	2	<3	<3

Table 10

Table 10. Volatile organic compounds in ground water in Polk County, Florida

[Analyses by U.S. Geological Survey laboratories. µg/L, micrograms per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Dichloro-bromo-methane total (µg/L)	Carbon-tetra-chlor-ide, total (µg/L)	1,2-di-chloro-ethane, total (µg/L)	Bromo-form, total (µg/L)	Chloro-dibromo-methane, total (µg/L)	Chloro-form, total (µg/L)	Toulene, total (µg/L)	Benzene, total (µg/L)	Chloro-benzen total (µg/L)
1	273903081322701	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2	273930082002301	8-04-87	--	--	--	--	--	--	--	--	--
3	274058081493501	8-17-87	--	--	--	--	--	--	--	--	--
4	274220081371801	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
5	274304081503801	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
6	274342081315401	8-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
7	274401081534901	6-22-87	--	--	--	--	--	--	--	--	--
8	274421081435601	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
9	274452081482901	7-30-87	--	--	--	--	--	--	--	--	--
10	274507081594201	6-22-87	--	--	--	--	--	--	--	--	--
		1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
11	274607081401601	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
12	274712081533301	8-10-87	--	--	--	--	--	--	--	--	--
13	274730081333801	6-23-87	< .20	< .20	< .20	< .20	< .20	< .20	1.3	.70	< .20
		7-14-87	< .20	< .20	< .20	< .20	< .20	< .20	1.2	< .20	< .20
14	274740082023601	4-29-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15	274749081590001	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
16	274843081392201	7-30-87	--	--	--	--	--	--	--	--	--
17	274910081452201	2-03-86	--	--	--	--	--	--	--	--	--
		4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
18	274958081514601	8-04-87	--	--	--	--	--	--	--	--	--
19	275010081561301	7-23-87	--	--	--	--	--	--	--	--	--
20	275032081353201	7-29-87	--	--	--	--	--	--	--	--	--
21	275036081431201	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
22	275123081521601	7-23-87	--	--	--	--	--	--	--	--	--
23	275130081424601	7-21-87	--	--	--	--	--	--	--	--	--
24	275150082011001	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
25	275156081485101	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
26	275156082031101	7-23-87	--	--	--	--	--	--	--	--	--
27	275213081505401	6-24-87	--	--	--	--	--	--	--	--	--
28	275230081431301	4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
29	275236081424301	7-21-87	--	--	--	--	--	--	--	--	--
		1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
30	275243081584001	6-23-87	--	--	--	--	--	--	--	--	--
		1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
31	275304081344701	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	4.1	<3.0	<3.0	<3.0
32	275310081505501	6-24-87	--	--	--	--	--	--	--	--	--
33	275327081595301	8-18-87	--	--	--	--	--	--	--	--	--
34	275332081592701	6-23-87	--	--	--	--	--	--	--	--	--
35	275337081323301	7-29-87	--	--	--	--	--	--	--	--	--
		1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
36	275339081453901	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
37	275449081512101	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
38	275450081501001	6-24-87	--	--	--	--	--	--	--	--	--
39	275456081345501	7-30-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
40	275511082004401	6-23-87	--	--	--	--	--	--	--	--	--
41	275514081391401	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
42	275530081362901	7-29-87	--	--	--	--	--	--	--	--	--
43	275627082014101	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
44	275646081534201	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
45	275702081350701	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
46	275714081523801	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
47	275718082004901	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
48	275743081331501	7-29-87	--	--	--	--	--	--	--	--	--
49	275748081563601	7-13-87	--	--	--	--	--	--	--	--	--
50	275752081525301	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 10. Volatile organic compounds in ground water in Polk County, Florida

Site number (fig. 4)	Well identification number	Date	Dichloro-bromo-methane total (µg/L)	Carbon-tetra-chlor-ide, total (µg/L)	1,2-di-chloro-ethane, total (µg/L)	Bromo-form, total (µg/L)	Chloro-dibromo-methane, total (µg/L)	Chloro-form, total (µg/L)	Toulene, total (µg/L)	Benzene, total (µg/L)	Chloro-benzen total (µg/L)
51	275806081545101	8-04-87	--	--	--	--	--	--	--	--	--
52	275829081471601	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
53	275832081594201	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
54	275838081595601	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
55	275858081353001	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
56	275859081395301	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
57	275918081425501	7-20-87	--	--	--	--	--	--	--	--	--
		1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
58	275953081532701	7-07-87	--	--	--	--	--	--	--	--	--
		1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
59	275956081572801	7-13-87	--	--	--	--	--	--	--	--	--
		1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
60	280005081492201	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
61	280016081490301	8-20-87	--	--	--	--	--	--	--	--	--
62	280039081505201	8-18-87	--	--	--	--	--	--	--	--	--
63	280044081490801	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
64	280101081543601	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
65	280123081462301	7-09-87	--	--	--	--	--	--	--	--	--
66	280130082004901	7-07-87	--	--	--	--	--	--	--	--	--
67	280131081401601	7-20-87	--	--	--	--	--	--	--	--	--
68	280133081430501	7-21-87	--	--	--	--	--	--	--	--	--
		1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
69	280154081364101	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
70	280200082014901	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
71	280203081541701	7-07-87	--	--	--	--	--	--	--	--	--
		1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
72	280220081470701	7-09-87	--	--	--	--	--	--	--	--	--
73	280245081533101	7-07-87	--	--	--	--	--	--	--	--	--
74	280246081574501	8-19-87	--	--	--	--	--	--	--	--	--
75	280253081512901	7-01-87	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
76	280315081480101	7-09-87	--	--	--	--	--	--	--	--	--
77	280320082004601	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
78	280323081360901	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
79	280424081452001	7-08-87	--	--	--	--	--	--	--	--	--
80	280437081410207	10-25-84	--	--	--	--	--	--	--	--	--
		12-17-85	--	--	--	--	--	--	--	--	--
		8-28-87	< .20	< .20	< .20	< .20	< .20	3.8	1.2	< .20	< .20
81	280452081585701	7-07-87	--	--	--	--	--	--	--	--	--
82	280516081374701	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
83	280520081485601	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
84	280529082004601	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
85	280548081424801	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
86	280554082002701	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
87	280600081534901	6-25-87	--	--	--	--	--	--	--	--	--
88	280601081473701	7-08-87	--	--	--	--	--	--	--	--	--
89	280642081385301	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
90	280703081582201	7-08-87	--	--	--	--	--	--	--	--	--
91	280805081492301	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
92	280819081555701	7-08-87	--	--	--	--	--	--	--	--	--
93	280836081490401	7-20-87	--	--	--	--	--	--	--	--	--
		1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
94	280950081480001	8-20-87	--	--	--	--	--	--	--	--	--
95	280950081480501	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 10. Volatile organic compounds in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Chloro-ethane, total (µg/L)	Ethyl-benzene, total (µg/L)	Methyl-bromide, total (µg/L)	Methyl-chloride, total (µg/L)	Methylene chloride, total (µg/L)	Tetra-chloro-ethylene, total (µg/L)	Trichoro-fluoro-methane, total (µg/L)	1,1-di-chloro-ethane, total (µg/L)	1,1-di-chloro-ethylene, total (µg/L)
1	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2	8-04-87	--	--	--	--	--	--	--	--	--
3	8-17-87	--	--	--	--	--	--	--	--	--
4	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
5	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
6	8-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
7	6-22-87	--	--	--	--	--	--	--	--	--
8	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
9	7-30-87	--	--	--	--	--	--	--	--	--
10	6-22-87	--	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
11	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
12	8-10-87	--	--	--	--	--	--	--	--	--
13	6-23-87	< .20	1.7	< .20	< .20	< .20	< .20	< .20	< .20	< .20
	7-14-87	--	--	--	--	--	--	--	--	--
14	4-29-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
16	7-30-87	--	--	--	--	--	--	--	--	--
17	2-03-86	--	--	--	--	--	--	--	--	--
	4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
18	8-04-87	--	--	--	--	--	--	--	--	--
19	7-23-87	--	--	--	--	--	--	--	--	--
20	7-29-87	--	--	--	--	--	--	--	--	--
21	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
22	7-23-87	--	--	--	--	--	--	--	--	--
23	7-21-87	--	--	--	--	--	--	--	--	--
24	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
25	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
26	7-23-87	--	--	--	--	--	--	--	--	--
27	6-24-87	--	--	--	--	--	--	--	--	--
28	4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
29	7-21-87	--	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
30	6-23-87	--	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
31	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
32	6-24-87	--	--	--	--	--	--	--	--	--
33	8-18-87	--	--	--	--	--	--	--	--	--
34	6-23-87	--	--	--	--	--	--	--	--	--
35	7-29-87	--	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
36	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
37	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
38	6-24-87	--	--	--	--	--	--	--	--	--
39	7-30-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
40	6-23-87	--	--	--	--	--	--	--	--	--
41	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
42	7-29-87	--	--	--	--	--	--	--	--	--
43	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
44	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
45	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
46	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
47	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
48	7-29-87	--	--	--	--	--	--	--	--	--
49	7-13-87	--	--	--	--	--	--	--	--	--
50	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 10. Volatile organic compounds in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Chloro-ethane, total (µg/L)	Ethyl-benzene, total (µg/L)	Methyl-bromide, total (µg/L)	Methyl-chloride, total (µg/L)	Methylene chloride, total (µg/L)	Tetra-chloro-ethylene, total (µg/L)	Trichoro-fluoro-methane, total (µg/L)	1,1-di-chloro-ethane, total (µg/L)	1,1-di-chloro-ethylene, total (µg/L)
51	8-04-87	--	--	--	--	--	--	--	--	--
52	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
53	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
54	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
55	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
56	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
57	7-20-87	--	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
58	7-07-87	--	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
59	7-13-87	--	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
60	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
61	8-20-87	--	--	--	--	--	--	--	--	--
62	8-18-87	--	--	--	--	--	--	--	--	--
63	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
64	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
65	7-09-87	--	--	--	--	--	--	--	--	--
66	7-07-87	--	--	--	--	--	--	--	--	--
67	7-20-87	--	--	--	--	--	--	--	--	--
68	7-21-87	--	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
69	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
70	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
71	7-07-87	--	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
72	7-09-87	--	--	--	--	--	--	--	--	--
73	7-07-87	--	--	--	--	--	--	--	--	--
74	8-19-87	--	--	--	--	--	--	--	--	--
75	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
76	7-09-87	--	--	--	--	--	--	--	--	--
77	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
78	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
79	7-08-87	--	--	--	--	--	--	--	--	--
80	10-25-84	--	--	--	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--	--	--	--
	8-28-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
81	7-07-87	--	--	--	--	--	--	--	--	--
82	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
83	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
84	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
85	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
86	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
87	6-25-87	--	--	--	--	--	--	--	--	--
88	7-08-87	--	--	--	--	--	--	--	--	--
89	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
90	7-08-87	--	--	--	--	--	--	--	--	--
91	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
92	7-08-87	--	--	--	--	--	--	--	--	--
93	7-20-87	--	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
94	8-20-87	--	--	--	--	--	--	--	--	--
95	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 10. Volatile organic compounds in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	1,1,1-tri-chloro-ethane, total (µg/L)	1,1,2-tri-chloro-ethane, total (µg/L)	1,1,2,2-tetra-chloro-ethane, total (µg/L)	1,2-di-chloro-benzene, total (µg/L)	1,2-di-chloro-propane, total (µg/L)	Transdi chloro-ethylene, total (µg/L	1,3-dichloro-propane, total (µg/L)	1,3-dichloro-benzene, total (µg/L)
1	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2	8-04-87	--	--	--	--	--	--	--	--
3	8-17-87	--	--	--	--	--	--	--	--
4	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
5	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
6	8-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
7	6-22-87	--	--	--	--	--	--	--	--
8	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0
9	7-30-87	--	--	--	--	--	--	--	--
10	6-22-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
11	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0
12	8-10-87	--	--	--	--	--	--	--	--
13	6-23-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
	7-14-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
14	4-29-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
16	7-30-87	--	--	--	--	--	--	--	--
17	2-03-86	--	--	--	--	--	--	--	--
	4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0
18	8-04-87	--	--	--	--	--	--	--	--
19	7-23-87	--	--	--	--	--	--	--	--
20	7-29-87	--	--	--	--	--	--	--	--
21	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
22	7-23-87	--	--	--	--	--	--	--	--
23	7-21-87	--	--	--	--	--	--	--	--
24	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
25	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
26	7-23-87	--	--	--	--	--	--	--	--
27	6-24-87	--	--	--	--	--	--	--	--
28	4-10-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	0.0
29	7-21-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	1.2	< .20	< .20	< .20
30	6-23-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
31	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
32	6-24-87	--	--	--	--	--	--	--	--
33	8-18-87	--	--	--	--	--	--	--	--
34	6-23-87	--	--	--	--	--	--	--	--
35	7-29-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
36	5-05-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
37	4-28-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
38	6-24-87	--	--	--	--	--	--	--	--
39	7-30-87	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
40	6-23-87	--	--	--	--	--	--	--	--
41	4-30-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
42	7-29-87	--	--	--	--	--	--	--	--
43	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
44	4-14-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
45	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
46	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
47	6-24-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
48	7-29-87	--	--	--	--	--	--	--	--
49	7-13-87	--	--	--	--	--	--	--	--
50	6-26-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0

Site number (fig. 4)	Date	1,1,1-tri-chloro-ethane, total (µg/L)	1,1,2-tri-chloro-ethane, total (µg/L)	1,1,2,2-tetra-chloro-ethane, total (µg/L)	1,2-di-chloro-benzene, total (µg/L)	1,2-di-chloro-propane, total (µg/L)	Transdi chloro-ethylene, total (µg/L	1,3-dichloro-propane, total (µg/L)	1,3-dichloro-benzene, total (µg/L)
51	8-04-87	--	--	--	--	--	--	--	--
52	6-26-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
53	6-25-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
54	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
55	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
56	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
57	7-20-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	1.6	< .20	< .20	< .20
58	7-07-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
59	7-23-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
60	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
61	8-20-87	--	--	--	--	--	--	--	--
62	8-18-87	--	--	--	--	--	--	--	--
63	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
64	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
65	7-09-87	--	--	--	--	--	--	--	--
66	7-07-87	--	--	--	--	--	--	--	--
67	7-20-87	--	--	--	--	--	--	--	--
68	7-21-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
69	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
70	6-24-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
71	7-07-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
72	7-09-87	--	--	--	--	--	--	--	--
73	7-07-87	--	--	--	--	--	--	--	--
74	8-19-87	--	--	--	--	--	--	--	--
75	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
76	7-09-87	--	--	--	--	--	--	--	--
77	6-23-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
78	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
79	7-08-87	--	--	--	--	--	--	--	--
80	10-25-84	--	--	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--	--	--
	8-28-87	.80	< .20	< .20	< .20	2.0	< .20	< .20	< .20
81	7-07-87	--	--	--	--	--	--	--	--
82	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
83	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
84	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
85	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
86	6-23-86	<3.0	<3.0	<3.0	0.0	<3.0	<3.0	<3.0	0.0
87	6-25-87	--	--	--	--	--	--	--	--
88	7-08-87	--	--	--	--	--	--	--	--
89	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
90	7-08-87	--	--	--	--	--	--	--	--
91	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
92	7-08-87	--	--	--	--	--	--	--	--
93	7-20-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .20	< .20
94	8-20-87	--	--	--	--	--	--	--	--
95	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 10. Volatile organic compounds in ground water in Polk County, Florida–Coninued

Site number (fig. 4)	Date	1,4-di-chloro-benzene, total (µg/L)	Chloroethyl-vinylether, total (µg/L)	Chloro-difluoro-methane, total (µg/L)	Trans-1,3-dichloro-propene, total (µg/L)	Cis-1,3-dichloro-propene, total (µg/L)	Vinyl-chloride, total (µg/L)	Trichloro-ethylene, total (µg/L)	Styrene, total (µg/L)
1	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
2	8-04-87	--	--	--	--	--	--	--	--
3	8-17-87	--	--	--	--	--	--	--	--
4	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
5	4-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
6	8-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
7	6-22-87	--	--	--	--	--	--	--	--
8	4-24-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
9	7-30-87	--	--	--	--	--	--	--	--
10	6-22-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
11	5-07-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
12	8-10-87	--	--	--	--	--	--	--	--
13	6-23-87	< .20	< .20	< .20	< .20	.20	< .20	12.0	< .2
	7-14-87	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
14	4-29-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
15	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
16	7-30-87	--	--	--	--	--	--	--	--
17	2-03-86	--	--	--	--	--	--	--	--
	4-10-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
18	8-04-87	--	--	--	--	--	--	--	--
19	7-23-87	--	--	--	--	--	--	--	--
20	7-29-87	--	--	--	--	--	--	--	--
21	5-05-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
22	7-23-87	--	--	--	--	--	--	--	--
23	7-21-87	--	--	--	--	--	--	--	--
24	4-28-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
25	5-07-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
26	7-23-87	--	--	--	--	--	--	--	--
27	6-24-87	--	--	--	--	--	--	--	--
28	4-10-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
29	7-21-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
30	6-23-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
31	7-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
32	6-24-87	--	--	--	--	--	--	--	--
33	8-18-87	--	--	--	--	--	--	--	--
34	6-23-87	--	--	--	--	--	--	--	--
35	7-29-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
36	5-05-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
37	4-28-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
38	6-24-87	--	--	--	--	--	--	--	--
39	7-30-87	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
40	6-23-87	--	--	--	--	--	--	--	--
41	4-30-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
42	7-29-87	--	--	--	--	--	--	--	--
43	6-24-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
44	4-14-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
45	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
46	6-26-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
47	6-24-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
48	7-29-87	--	--	--	--	--	--	--	--
49	7-13-87	--	--	--	--	--	--	--	--
50	6-26-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0

Table 10. Volatile organic compounds in ground water in Polk County, Florida–Coninued

Site number (fig. 4)	Date	1,4-dichloro-benzene, total (µg/L)	Chloroethyl-vinylether, total (µg/L)	Chloro-difluoro-methane, total (µg/L)	Trans-1,3-dichloro-propene, total (µg/L)	Cis-1,3-dichloro-propene, total (µg/L)	Vinyl-chloride, total (µg/L)	Trichloro-ethylene, total (µg/L)	Styrene, total (µg/L)
51	8-04-87	--	--	--	--	--	--	--	--
52	6-26-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
53	6-25-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	0
54	6-25-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
55	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
56	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
57	7-20-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
58	7-07-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
59	7-13-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
60	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
61	8-20-87	--	--	--	--	--	--	--	--
62	8-18-87	--	--	--	--	--	--	--	--
63	4-30-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
64	4-14-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
65	7-09-87	--	--	--	--	--	--	--	--
66	7-07-87	--	--	--	--	--	--	--	--
67	7-20-87	--	--	--	--	--	--	--	--
68	7-21-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
69	7-22-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
70	6-24-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	<0
71	7-07-87	--	--	--	--	--	--	--	--
	1-19-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
72	7-09-87	--	--	--	--	--	--	--	--
73	7-07-87	--	--	--	--	--	--	--	--
74	8-19-87	--	--	--	--	--	--	--	--
75	7-01-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
76	7-09-87	--	--	--	--	--	--	--	--
77	6-23-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	<0
78	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
79	7-08-87	--	--	--	--	--	--	--	--
80	10-25-84	--	--	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--	--	--
	8-28-87	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
81	7-07-87	--	--	--	--	--	--	--	--
82	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
83	7-21-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
84	6-23-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
85	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
86	6-23-86	0.0	<3.0	<3.0	0.0	0.0	<3.0	<3.0	<0
87	6-25-87	--	--	--	--	--	--	--	--
88	7-08-87	--	--	--	--	--	--	--	--
89	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
90	7-08-87	--	--	--	--	--	--	--	--
91	5-06-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
92	7-08-87	--	--	--	--	--	--	--	--
93	7-20-87	--	--	--	--	--	--	--	--
	1-20-88	< .20	< .20	< .20	< .20	< .20	< .20	< .2	< .2
94	8-20-87	--	--	--	--	--	--	--	--
95	7-02-86	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0

Table 11

Table 11. Pesticides in ground water in Polk County, Florida

[Analyses by U.S. Geological Survey laboratories. µg/L, micrograms per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Perthane, total (µg/L)	1,2-dibromoethylene, total (µg/L)	Naphthalenes, polychlor total (µg/L)	Aldrin, total (µg/L)	Lindane, total (µg/L	Chlordane, total (µg/L)	DDD, total (µg/L)	DDE, total (µg/L)	DDT total (µg/L)	Dieldrin, total (µg/L)
1	273903081322701	7-23-86	<0.1	<3.0	<0.10	<0.010	<0.010	<0.1	<0.010	<0.010	<0.010	<0.010
2	273930082002301	8-04-87	--	--	--	--	--	--	--	--	--	--
3	274058081493501	8-17-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
4	274220081371801	7-23-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
5	274304081503801	4-24-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
6	274342081315401	8-05-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
7	274401081534901	6-22-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
8	274221081435601	4-24-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
9	274452081482901	7-30-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
10	274507081594201	6-22-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-19-88	--	< .2	--	--	--	--	--	--	--	--
11	274607081401601	5-07-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
12	274712081533301	8-10-87	--	--	--	--	--	--	--	--	--	--
13	274730081333801	6-23-87	--	< .2	--	--	--	--	--	--	--	--
		7-14-87	< .1	< .2	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
14	274740082023601	4-29-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
15	274749081590001	4-28-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
16	274843081392201	7-30-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
17	274910081452201	2-03-86	--	--	--	--	--	--	--	--	--	--
		4-10-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
18	274956081514601	8-04-87	--	--	--	--	--	--	--	--	--	--
19	275010081561301	7-23-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
20	275032081353201	7-29-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
21	275036081431201	5-05-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
22	275123081521601	7-23-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
23	275130081424601	7-21-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
24	275150082011001	4-28-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
25	275156081485101	5-07-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
26	275156082031101	7-23-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
27	275213081505401	6-24-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
28	275230081431301	4-10-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
29	275236081424301	7-21-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-20-88	--	< .2	--	--	--	--	--	--	--	--
30	275243081584001	6-23-87	< .1	--	< .10	--	--	< .1	< .010	< .010	< .010	< .010
		1-19-88	--	< .2	--	--	--	--	--	--	--	--
31	275304081344701	7-23-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
32	275310081505501	6-24-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
33	275327081595301	8-18-87	--	--	--	--	--	--	--	--	--	--
34	275332081592701	6-23-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
35	275337081323301	7-29-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-20-88	--	< .2	--	--	--	--	--	--	--	--
36	275339081453901	5-05-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
37	275449081512101	4-28-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
38	275450081501001	6-24-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
39	275456081345501	7-30-87	< .1	.4	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
40	275511082004401	6-23-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
41	275514081391401	4-30-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
42	275530081362901	7-29-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
43	275627082014101	6-24-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
44	275646081534201	4-14-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
45	275702081350701	7-22-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
46	275714081523801	6-26-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
47	275718082004901	6-24-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
48	275743081331501	7-29-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
49	275748081563601	7-13-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
50	275752081525301	6-26-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010

Site number (fig. 4)	Well identification number	Date	Perthane, total (µg/L)	1,2-dibromoethylene, total (µg/L)	Naphthalenes, polychlor total (µg/L)	Aldrin, total (µg/L)	Lindane, total (µg/L)	Chlordane, total (µg/L)	DDD, total (µg/L)	DDE, total (µg/L)	DDT total (µg/L)	Dieldrin, total (µg/L)
51	275806081545101	8-04-87	<0.1	--	<0.10	<0.010	<0.010	<0.1	<0.010	<0.010	<0.010	<0.010
52	275829081471601	6-26-86	.1<+.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010	
53	275832081594201	6-25-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
54	275838081595601	6-25-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
55	275858081353001	7-22-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
56	275859081395301	7-22-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
57	275918081425501	7-20-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-20-99	--	.2	--	--	--	--	--	--	--	--
58	275953081532701	7-07-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-19-88	--	.2	--	--	--	--	--	--	--	--
59	275956081572801	7-13-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-19-88	--	.2	--	--	--	--	--	--	--	--
60	280005081492201	7-01-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
61	280016081490301	8-20-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
62	280039081505201	8-18-87	--	--	--	--	--	--	--	--	--	--
63	280044081490801	4-30-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
64	280101081543601	4-14-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
65	280123081462301	7-09-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
66	280130082004901	7-07-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
67	280131081401601	7-20-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
68	280133081430501	7-21-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-20-88	--	.2	--	--	--	--	--	--	--	--
69	280154081364101	7-22-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
70	280200082014901	6-24-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
71	280203081541701	7-07-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-19-88	--	.2	--	--	--	--	--	--	--	--
72	280220081470701	7-09-87	< .1	--	< .10	--	--	< .1	< .010	< .010	< .010	< .010
73	280245081533101	7-07-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
74	280246081574501	8-19-87	--	--	--	--	--	--	--	--	--	--
75	280253081512901	7-01-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
76	280315081480101	7-09-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
77	280320082004601	6-23-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
78	280323081360901	7-21-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
79	280424081452001	7-08-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
80	280437081410201	10-25-84	--	--	--	--	--	--	--	--	--	--
		12-17-85	--	--	--	--	--	--	--	--	--	--
		8-28-87	--	.2	--	--	--	--	--	--	--	--
81	280452081585701	7-07-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
82	280516081374701	7-21-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
83	280520081485601	7-21-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
84	280529082004601	6-23-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
85	280548081424801	5-06-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
86	280554082002701	6-23-86	< .1	.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
87	280600081534901	6-25-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
88	280601081473701	7-08-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
89	280642081385301	7-02-86	< .1	5.8	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
90	280703081582201	7-08-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
91	280805081493201	5-06-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
92	280819081555701	7-08-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
93	280836081490401	7-20-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
		1-20-88	--	.2	--	--	--	--	--	--	--	--
94	280950081480001	8-20-87	< .1	--	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010
95	280950081480501	7-02-86	< .1	<3.0	< .10	< .010	< .010	< .1	< .010	< .010	< .010	< .010

Table 11. Pesticides in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Endo-sulfan, total (μg/L)	Endrin, total (μg/L)	Ethion, total (μg/L)	Toxa-aphene, total (μg/L)	Hepta-chlor, total (μg/L)	Hepta-chlor epoxide, total (μg/L)	Meth-oxy-chlor, total (μg/L)	PCB, total (μg/L)	Mala-thion, total (μg/L)	Para-thion, total (μg/L)
1	7-23-86	<0.010	<0.010	<0.01	<1	<0.010	<0.010	<0.01	<0.1	<0.01	<0.01
2	8-04-87	--	--	--	--	--	--	--	--	--	--
3	8-17-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
4	7-23-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
5	4-24-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
6	8-05-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
7	6-22-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
8	4-24-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
9	7-30-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
10	6-22-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--	--
11	5-07-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
12	8-10-87	--	--	--	--	--	--	--	--	--	--
13	6-23-87	--	--	--	--	--	--	--	--	--	--
	7-14-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
14	4-29-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
15	4-28-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
16	7-30-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
17	2-03-86	--	--	--	--	--	--	--	--	--	--
	4-10-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
18	8-04-87	--	--	--	--	--	--	--	--	--	--
19	7-23-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
20	7-29-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
21	5-05-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
22	7-23-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
23	7-21-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
24	4-28-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
25	5-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
26	7-23-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
27	6-24-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
28	4-10-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
29	7-21-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--	--
30	6-23-87	< .010	< .010	< .01	<1	--	--	< .01	< .1	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--	--
31	7-23-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
32	6-24-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
33	8-18-87	--	--	--	--	--	--	--	--	--	--
34	6-23-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
35	7-29-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--	--
36	5-05-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
37	4-28-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
38	6-24-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
39	7-30-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
40	6-23-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
41	4-30-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
42	7-29-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
43	6-24-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
44	4-14-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
45	7-22-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
46	6-26-84	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
47	6-24-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
48	7-29-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
49	7-13-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
50	6-26-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01

Table 11. Pesticides in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Endo-sulfan, total (μg/L)	Endrin, total (μg/L)	Ethion, total (μg/L)	Toxa-aphene, total (μg/L)	Hepta-chlor, total (μg/L)	Hepta-chlor epoxide, total (μg/L)	Meth-oxy-chlor, total (μg/L)	PCB, total (μg/L)	Mala-thion, total (μg/L)	Para-thion, total (μg/L)
51	8-04-87	<0.010	<0.010	<0.01	<1	<0.010	<0.01	<0.01	<0.1	<0.01	<0.01
52	6-26-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
53	6-25-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
54	6-25-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
55	7-22-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
56	7-22-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
57	7-20-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--	--
58	7-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--	--
59	7-13-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--	--
60	7-01-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
61	8-20-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
62	8-18-87	--	--	--	--	--	--	--	--	--	--
63	4-30-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
64	4-14-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
65	7-09-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
66	7-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
67	7-20-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
68	7-21-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--	--
69	7-22-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
70	6-24-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
71	7-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--	--
72	7-09-87	< .010	< .010	< .01	<1	--	--	< .01	< .1	< .01	< .01
73	7-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
74	8-19-87	--	--	--	--	--	--	--	--	--	--
75	7-01-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
76	7-09-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
77	6-23-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
78	7-21-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
79	7-08-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
80	10-25-84	--	--	--	--	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--	--	--	--	--
	8-28-87	--	--	--	--	--	--	--	--	--	--
81	7-07-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
82	7-21-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
83	7-21-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
84	6-23-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
85	5-06-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
86	6-23-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
87	6-25-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
88	7-08-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
89	7-02-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
90	7-08-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
91	5-06-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
92	7-08-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
93	7-20-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--	--
94	8-20-87	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01
95	7-02-86	< .010	< .010	< .01	<1	< .010	< .01	< .01	< .1	< .01	< .01

Table 11. Pesticides in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Diazinon, total (µg/L)	Methyl-parathion, total (µg/L)	2,4-D, total (µg/L)	2,4,5-T, total (µg/L)	Mirex, total (µg/L)	Silvex, total (µg/L)	Trithion, total (µg/L)	Methyl trithion, total (µg/L)	2,4-DP, total (µg/L)
1	7-23-86	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
2	8-04-87	--	--	--	--	--	--	--	--	--
3	8-17-87	--	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
4	7-23-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
5	4-24-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
6	8-05-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
7	6-22-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
8	4-24-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
9	7-30-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
10	6-22-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--
11	5-07-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
12	8-10-87	--	--	--	--	--	--	--	--	--
13	6-23-87	--	--	--	--	--	--	--	--	--
	7-14-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
14	4-29-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
15	4-28-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
16	7-30-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
17	2-03-86	--	--	--	--	--	--	--	--	--
	4-10-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
18	8-04-87	--	--	--	--	--	--	--	--	--
19	7-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
20	7-29-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
21	5-05-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
22	7-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
23	7-21-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
24	4-28-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
25	5-07-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
26	7-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
27	6-24-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
28	4-10-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
29	7-21-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--
30	6-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--
31	7-23-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
32	6-24-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
33	8-18-87	--	--	--	--	--	--	--	--	--
34	6-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
35	7-29-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--
36	5-05-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
37	4-28-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
38	6-24-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
39	7-30-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
40	6-23-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
41	4-30-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
42	7-29-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
43	6-24-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
44	4-14-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
45	7-22-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
46	6-26-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
47	6-24-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
48	7-29-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
49	7-13-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
50	6-26-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01

Table 11. Pesticides in ground water in Polk County, Florida–Continued

Site number (fig. 4)	Date	Diazinon, total (µg/L)	Methyl-parathion, total (µg/L)	2,4-D, total (µg/L)	2,4,5-T, total (µg/L)	Mirex, total (µg/L)	Silvex, total (µg/L)	Trithion, total (µg/)	Methyl trithion, total (µg/L)	2,4-DP, total (µg/L)
51	8-04-87	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
52	6-26-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
53	6-25-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
54	6-25-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
55	7-22-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
56	7-22-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
57	7-20-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--
58	7-07-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--
59	7-13-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--
60	7-01-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
61	8-20-87	--	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
62	8-18-87	--	--	--	--	--	--	--	--	--
63	4-30-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
64	4-14-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
65	7-09-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
66	7-07-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
67	7-20-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
68	7-21-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--
69	7-22-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
70	6-24-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
71	7-07-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-19-88	--	--	--	--	--	--	--	--	--
72	7-09-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
73	7-07-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
74	8-19-87	--	--	--	--	--	--	--	--	--
75	7-01-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
76	7-09-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
77	6-23-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
78	7-21-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
79	7-08-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
80	10-25-84	--	--	--	--	--	--	--	--	--
	12-17-85	--	--	--	--	--	--	--	--	--
	8-28-87	--	--	--	--	--	--	--	--	--
81	7-07-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
82	7-21-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
83	7-21-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
84	6-23-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
85	5-06-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
86	6-23-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
87	6-25-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
88	7-08-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
89	7-02-86	< .01	< .01	--	--	< .01	--	< .01	< .01	--
90	7-08-87	< .01	< .01	--	--	< .01	--	< .01	< .01	--
91	5-06-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
92	7-08-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
93	7-20-87	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
	1-20-88	--	--	--	--	--	--	--	--	--
94	8-20-87	.01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01
95	7-02-86	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01	< .01

Table 12

Table 12. Nutrients in ground water in Polk County, Florida

[Analyses by U.S. Geological Survey and Polk County Water Resources Division laboratories. mg/L, milligrams per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Nitrogen, nitrate, dissolved (mg/L as N)	Phosphorus, ortho, dissolved (mg/L as P)
1	273903081322701	7-23-86	6.21	<0.020
2	273930082002301	8-04-87	< .010	< .020
3	274058081493501	8-17-87	< .010	< .020
4	274220081371801	7-23-86	.038	.027
5	274304081503801	4-24-86	< .005	.040
6	274342081315401	8-05-86	< .005	.045
7	274401081534901	6-22-87	< .010	< .020
8	274221081435601	4-24-86	.084	.021
9	274452081482901	7-30-87	.010	< .020
10	274507081594201	6-22-87	< .010	.028
		1-19-88	--	--
11	274607081401601	5-07-86	.010	< .020
12	274712081533301	8-10-87	< .010	< .020
13	274730081333801	6-23-87	--	--
		7-14-87	.043	.086
14	274740082023601	4-29-86	< .005	.026
15	274749081590001	4-28-86	< .005	.024
16	274843081392201	7-30-87	< .010	.209
17	274910081452201	2-03-86	--	.020
		4-10-86	--	.045
18	274958081514601	8-04-87	< .010	< .020
19	275010081561301	7-23-87	.033	< .020
20	275032081353201	7-29-87	< .010	.135
21	275036081431201	5-05-86	< .005	< .020
22	275123081521601	7-23-87	< .010	< .020
23	275130081424601	7-21-87	1.32	.042
24	275150082011001	4-28-86	.005	.032
25	275156081485101	5-07-86	.041	.057
26	275156082031101	7-23-87	.101	< .020
27	275156082031101	7-23-87	.055	< .020
28	275230081431301	4-10-86	--	.057
29	275236081424301	7-21-87	13.7	.118
		1-20-88	--	--
30	275243081584001	6-23-87	< .010	< .020
		1-19-88	--	--
31	275304081344701	7-23-86	1.06	.029
32	275310081505501	6-24-87	.772	< .020
33	275327081595301	8-18-87	.971	26.9
34	275332081592701	6-23-87	10.4	< .020
35	275337081323301	7-29-87	7.10	< .020
		1-20-88	--	--
36	275339081453901	5-05-86	.006	.174
37	275449081512101	4-28-86	< .005	.061
38	275450081501001	6-24-87	2.08	.025
39	275456081345501	7-30-87	.135	.026
40	275511082004401	6-23-87	< .010	< .020
41	275514081391401	4-30-86	.015	.447
42	275530081362901	7-29-87	< .010	.067
43	275627082014101	6-24-86	.008	.590
44	275646081534201	4-14-86	.005	.025
45	275702081350701	7-22-86	3.76	21.9
46	275714081523801	6-26-86	.385	.052
47	275718082004901	6-24-86	.361	.774
48	275743081331501	7-29-87	5.94	.021
49	275748081563601	7-13-87	< .010	.123
50	275752081525301	6-26-86	3.13	.041
51	275806081545101	8-04-87	2.49	.034
52	275829081471601	6-26-86	.010	.025
53	275832081594201	6-25-86	.454	.021
54	275838081595601	6-25-86	.299	.023
55	275858081353001	7-22-86	< .005	.052
56	275859081395301	7-22-86	<0.005	0.032
57	275918081425501	7-20-87	< .010	.547
		1-20-88	--	--
58	275953081532701	7-07-87	.092	< .020
		1-19-88	--	--
59	275956081572801	7-13-87	< .010	.040
		1-19-88	--	--
60	280005081492201	7-01-86	.013	.065
61	280016081490301	8-20-87	< .010	< .020
62	280039081505201	8-18-87	< .010	.298
63	280044081490801	4-30-86	.141	< .020
64	280101081543601	4-14-86	< .005	.200
65	280123081462301	7-09-87	.010	< .020
66	280130082004901	7-07-87	.010	.049
67	280131081401601	7-20-87	< .010	.114
68	280133081430501	7-21-87	.011	< .020
		1-20-88	--	--
69	280154081364101	7-22-86	.017	.065
70	280200082014901	6-24-86	< .005	.030
71	280203081541701	7-07-87	< .010	.029
		1-19-88	--	--
72	280220081470701	7-09-87	< .010	< .020
73	280245081533101	7-07-87	< .010	.023
74	280246081574501	8-19-87	.080	.038
75	280253081512901	7-01-86	.009	.047
76	280315081480101	7-09-87	< .010	< .020
77	280320082004601	6-23-86	< .005	.839
78	280323081360901	7-21-86	2.66	.048
79	280424081452001	7-08-87	< .010	.140
80	280437081410201	10-25-84	.010	.034
		12-17-85	--	< .010
		8-28-87	--	--
81	280452081585701	7-07-87	11.8	.446
82	280516081374701	7-21-86	2.81	.071
83	280520081485601	7-21-86	< .005	.029
84	280529082004601	6-23-86	< .005	.043
85	280548081424801	5-06-86	1.10	.020
86	280554082002701	6-23-86	.146	.027
87	280600081534901	6-25-87	< .010	.059
88	280601081473701	7-08-87	.079	< .020
89	280642081385301	7-02-86	2.62	.029
90	280703081582201	7-08-87	.010	.067
91	280805081492301	5-06-86	.300	< .020
92	280819081555701	7-08-87	.924	.113
93	280836081490401	7-20-87	< .010	< .020
		1-20-88	--	--
94	280950081480001	8-20-87	< .010	< .020
95	280950081480501	7-02-86	1.71	.052

Table 13

Table 13. Radiochemicals in ground water in Polk County, Florida

[Analyses by private laboratories. µg/L, micrograms per liter; pCi/L, picocuries per liter; <, less than; --, no data]

Site number (fig. 4)	Well identification number	Date	Gross alpha, dissolved (µg/L as U-nat)	Gross alpha, suspended total (µg/L (as U-nat)	Gross beta, dissolved (pCi/L as CS-137)	Gross beta, suspended total (pCi/L as CS-137)
1	273903081322701	7-23-86	7.0	<0.4	5.6	<0.4
2	273930082002301	8-04-87	1.8	< .4	1.3	< .4
3	274058081493501	8-17-87	56	< .4	18	7.7
4	274220081371801	7-23-86	6.7	< .4	9.8	< .4
5	274304081503801	4-24-86	2.2	1.1	1.8	< .7
6	274342081315401	8-05-86	--	--	1.6	< .9
7	274401081534901	6-22-87	41	.8	3.4	< .4
8	274221081435601	4-24-86	6.0	6.9	8.6	1.2
9	274452081482901	7-30-87	4.2	< .4	2.1	< .4
10	274507081594201	6-22-87	1.7	.8	.7	.5
		1-19-88	--	--	--	--
11	274607081401601	5-07-86	47	< .8	29	< .6
12	274712081533301	8-10-87	8.7	2.4	2.4	1.0
13	274730081333801	6-23-87	--	--	--	--
		7-14-87	17	.7	4.0	.7
14	274740082023601	4-29-86	7.8	1.0	1.5	.5
15	274749081590001	4-28-86	3.3	1.8	1.3	.6
16	274843081392201	7-30-87	18	< .4	5.6	< .4
17	274910081452201	2-03-86	--	--	--	--
		4-10-86	1.6	--	2.2	--
18	274958081514601	8-04-87	4.6	< .4	< .4	.6
19	275010081561301	7-23-87	5.7	5.2	1.4	5.0
20	275032081353201	7-29-87	3.5	< .4	4.6	< .4
21	275036081431201	5-05-86	17	< .8	12	< .4
22	275123081521601	7-23-87	2.1	< .4	1.3	.9
23	275130081424601	7-21-87	17	.6	6.0	.8
24	275150082011001	4-28-86	2.5	2.7	1.6	< .6
25	275156081485101	5-07-86	14	1.4	15	.8
26	275156082031101	7-23-87	4.5	< .4	.7	.8
27	275213081505401	6-24-87	21	< .4	1.1	< .4
28	275230081431301	4-10-86	1.2	--	2.5	--
29	275236081424301	7-21-87	2.2	< .4	2.2	< .4
		1-20-88	--	--	--	--
30	275243081584001	6-23-87	8.3	< .4	.8	< .4
		1-19-88	--	--	--	--
31	275304081344701	7-23-86	.8	< .4	.7	< .4
32	275310081505501	6-24-87	5.2	1.4	1.4	< .4
33	275327081595301	8-18-87	50	8.7	22	5.5
34	275332081592701	6-23-87	3.1	.5	3.4	2.2
35	275337081323301	7-29-87	.9	< .4	1.0	< .4
		1-20-88	--	--	--	--
36	275339081453901	5-05-86	1.5	1.7	1.5	1.0
37	275449081512101	4-28-86	4.1	4.3	1.5	< .6
38	275450081501001	6-24-87	41	< .4	4.9	.5
39	275456081345501	7-30-87	8.1	< .4	3.9	< .4
40	275511082004401	6-23-87	2.0	< .4	1.1	.5
41	275514081391401	4-30-86	4.7	5.4	5.1	1.0
42	275530081362901	7-29-87	2.4	< .4	1.6	< .4
43	275627082014101	6-24-86	< .4	1.8	.6	1.3
44	275646081534201	4-14-86	1.4	--	1.2	--
45	275702081350701	7-22-86	8.3	< .4	9.7	< .4
46	275714081523801	6-26-86	4.8	< .6	2.4	< .5
47	275718082004901	6-24-86	<1.6	1.0	.8	1.2
48	275743081331501	7-29-87	.5	.5	2.6	< .4
49	275748081563601	7-13-87	< .4	< .4	< .4	.7
50	275752081525301	6-26-86	4.7	<1.1	1.9	< .6

Table 13. Radiochemicals in ground water in Polk County, Florida

Site number (fig. 4)	Well identification number	Date	Gross alpha, dissolved (µg/L as U-nat)	Gross alpha, suspended total (µg/L (as U-nat)	Gross beta, dissolved (pCi/L as CS-137)	Gross beta, suspended total (pCi/L as CS-137)
51	275806081545101	8-04-87	2.2	< .4	1.1	< .4
52	275829081471601	6-26-86	7.9	< .7	6.0	< .6
53	275832081594201	6-25-86	4.9	< .5	2.7	.4
54	275838081595601	6-25-86	6.3	< .8	6.4	< .6
55	275858081353001	7-22-86	4.6	--	6.1	< .4
56	275859081395301	7-22-86	9.5	<0.4	10	<0.4
57	275918081425501	7-20-87	3.7	1.1	4.8	1.1
		1-20-88	--	--	--	--
58	275953081532701	7-07-87	3.7	< .4	.6	.8
		1-19-88	--	--	--	--
59	275956081572801	7-13-87	< .4	< .4	.7	.5
		1-19-88	--	--	--	--
60	280005081492201	7-01-86	5.7	< .7	2.6	< .6
61	280016081490301	8-20-87	31	16	120	3.8
62	280039081505201	8-18-87	1.0	< .4	1.2	< .4
63	280044081490801	4-30-86	6.4	3.0	1.6	< .7
64	280101081543601	4-14-86	2.6	--	.9	--
65	280123081462301	7-09-87	17	.7	3.6	1.4
66	280130082004901	7-07-87	1.6	1.0	1.1	.8
67	280131081401601	7-20-87	18	< .4	4.5	.7
68	280133081430501	7-21-87	12	< .4	4.7	.4
		1-20-88	--	--	--	--
69	280154081364101	7-22-86	4.3	< .4	2.0	< .4
70	280200082014901	6-24-86	<2.2	< .6	1.5	< .6
71	280203081541701	7-07-87	2.4	< .4	< .4	.5
		1-19-88	--	--	--	--
72	280220081470701	7-09-87	21	< .4	3.0	< .4
73	280245081533101	7-07-87	5.0	1.2	1.1	< .4
74	280246081574501	8-19-87	2.1	2.2	8.4	.8
75	280253081512901	7-01-86	6.9	< .6	3.5	< .6
76	280315081480101	7-09-87	10	< .4	3.5	< .4
77	280320082004601	6-23-86	< .6	< .9	1.0	.6
78	280323081360901	7-21-86	1.2	< .4	2.7	< .4
79	280424081452001	7-08-87	7.6	.6	5.0	< .4
80	280437081410207	10-25-84	--	--	--	--
		12-17-85	--	--	--	--
		8-28-87	--	--	--	--
81	280452081585701	7-07-87	.7	8.1	1.1	< .4
82	280516081374701	7-21-86	6.4	< .4	2.2	< .4
83	280520081485601	7-21-86	3.4	.9	1.5	.6
84	280529082004601	6-23-86	2.7	< .7	1.4	< .6
85	280548081424801	5-06-86	7.7	< .7	6.1	< .6
86	280554082002701	6-23-86	1.4	< .9	.9	.5
87	280600081534901	6-25-87	13	.5	1.3	< .4
88	280601082473701	7-08-87	8.0	6.1	2.7	4.2
89	280642081385301	7-02-86	--	--	--	--
90	280703081582201	7-08-87	7.6	1.6	.6	.8
91	280805081492301	5-06-86	7.2	< .7	5.6	.4
92	280819081555701	7-08-87	< .4	< .4	< .4	< .4
93	280836081490401	7-20-87	5.4	< .4	2.0	< .4
		1-20-88	--	--	--	--
94	280950081480001	8-20-87	1.2	< .4	14	< .4
95	280950081480501	7-02-86	3.8	< .9	2.1	.5

Table 14

Table 14. Water quality in the surficial aquifer system for selected land-use types in Polk County, Florida

[Minimum (min), maximum (max), and mean concentrations shown with number (no.) of analyses. Concentrations are in milligrams per liter, except as noted. FDER, Florida Department of Environmental Regulation; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; pCi/L, picocuries per liter; --, no data]

Water-quality property or constituent [FDER maximum contaminant level][1]	Areas near point-source waste discharges[2]		Phosphate-mining and reclamation areas[3]		Areas near phosphate-chemical processing plants[4]	
	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	27-31	29/3	26	26/2	21-29.5	25/5
Specific conductance (µS/cm)	145-450	278/4	109-478	228/6	88-20,100	3,020/29
pH (units) [6.5-8.5]	3.7-6.3	--/4	4.3-6.6	--/6	2.2-7.8	--/28
Alkalinity (as $CaCO_3$)	52-69	61/2	30-135	83/2	3.3-510	128/21
Nitrate (as N) [10]	0.08-0.97	0.53/2	0.001-7.4	3.7/2	0.01-43	4/11
Phosphorus (as P)	0.04-26.9	9.1/3	0.74-1.4	0.51/6	0.01-9,300	1,247/14
Total organic carbon (as C)	5-140	44/4	6.2-13	10/2	1.9-370	71/14
Hardness (as $CaCO_3$)	16-89	59/4	42-180	84/4	53-1,600	438/15
Calcium	2.7-33	19/4	4.6-41	20/6	0.7-400	79/29
Magnesium	1.6-6.2	3/4	2.9-20	9/6	0.5-240	42/24
Sodium [160]	3.8-26	12/4	5.5-18	9/5	4.5-1,200	186/29
Potassium	0.31-86	23/4	0.3-2.1	1.66/6	0.2-240	24/29
Chloride [250]	3-44	17/4	8.7-18	13/5	3.7-520	42/27
Sulfate [250]	8-41	24/4	1-77	29/6	0.2-7,400	811/27
Fluoride [2]	0.06-22	7/3	0.09-0.5	0.33/7	0.1-1,600	68/27
Silica	2.1-94	29/4	3.5-14	8/4	6.4-1,600	274/15
Iron (µg/L) [300]	94-4,400	1,326/4	140-5,000	55/5	40-720,000	37,000/40
Bicarbonate (as HCO_3)	45-70	55/3	19-135	55/5	--	
Dissolved solids [500]	108-510	279/4	41-206	127/6	101-33,400	7,788/15
Total alpha (pCi/L)	--		--		0.3-2,027	[5]222/14
Total beta (pCi/L)	--		--		0.2-2,985	[5]325/12
Gross alpha (as U, pCi/L) [15]	1-50	21/4	--		--	
Gross beta (as Cs-137, pCi/L)	1.2-120	38/4	--		--	
Radium-226 (pCi/L) [5]	--		0.1-100	0.55/20	0.1-54	[5]4/15
Aluminum (µg/L)	--		100-150,000	[4]17,435/17	--	
Antimony (µg/L)	--		16-98	[4]163/3	--	
Arsenic (µg/L) [50]	--		1-1,100	[4]194/30	--	
Berylium (µg/L)	--		10-150	[4]145/8	--	
Cadmium (µg/L) [10]	--		1-2,100	[4]176/19	--	
Chromium (µg/L) [50]	--		1-3,200	[4]183/20	--	
Copper (µg/L) [100]	--		1-130	[4]17/35	--	
Iodine (µg/L)	--		0.05-7	[4]1.9/12	--	
Lead (µg/L) [50]	--		1-13	[4]14/20	--	
Manganese (µg/L) [50]	--		10-13,000	[4]1,275/38	--	
Mercury (µg/L) [2]	--		0.1-8	[4]0.7/22	--	
Molybdenum (µg/L)	--		1-130	[4]13/22	--	
Nickel (µg/L)	--		1-630	[4]102/28	--	
Strontium (µg/L)	--		10-15,000	[4]853/29	--	
Zinc (µg/L) [5,000]	--		10-7,300	[4]974/15	--	

[1]Florida Department of Environmental Regulation maximum contaminant level under the Florida Administrative Code for drinking water standards.
[2]Data from this study.
[3]Data from Hutchinson (1978) and Moore and others (1986).
[4]Data from Miller and Sutcliffe (1982) and Rutledge (1987).
[5]Data from Miller and Sutcliffe (1982).

Table 15

Table 15. Water quality in the intermediate aquifer system for selected land-use types in Polk County, Florida

[Minimum (min), maximum (max), and mean concentrations shown with number (no.) of analyses. Concentrations are in milligrams per liter, except as noted. FDER, Florida Department of Environmental Regulation; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; pCi/L, picocuries per liter; --, no data]

Water-quality property or constituent [FDER maximum contaminant level][1]	Undeveloped areas[2]		Citrus farming areas[2]		Areas near point-source waste discharges[2]	
	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	23-25	24/9	25.5-24	26.4/18	23.5-25.5	24.2/7
Specific conductance (µS/cm)	250-372	314/9	157-463	326/16	228-571	316/6
pH (units) [6.5-8.5]	7.0-7.8	--/7	6.6-7.9	--/15	6.8-8.1	--/5
Alkalinity (as $CaCO_3$)	129-193	152/9	48-237	131/16	87-205	135/5
Nitrate (as N) [10]	0.008-0.77	0.27/7	0.005-13.7	3.5/11	0.011-0.146	0.08/3
Phosphorus (as P)	0.02-0.77	0.22/7	0.021-0.12	0.12/13	0.023-0.043	0.03/3
Total organic carbon (as C)	0.04-1.2	0.96/6	0.3-26	3/14	0.7-2.4	1.5/5
Hardness (as $CaCO_3$)	130-180	154/9	70-220	147/16	100-260	147/6
Calcium	27-40	34/9	18-69	39/16	23-58	38/6
Magnesium	14-20	17/9	4-22	12/16	5.9-27	13/6
Sodium [160]	2.5-11	6/9	3.6-12	7/16	4.4-12	7/6
Potassium	0.16-1.5	0.5/9	0.13-3.2	1.3/16	0.39-2	1/6
Chloride [250]	5-22	10/9	5.1-23	14/16	3-50	16/6
Sulfate [250]	5.1-13	7/6	5.1-71	17/13	6-11	8/4
Fluoride [2]	0.23-0.49	0.4/9	0.09-1.1	0.3/16	0.24-0.5	0.4/6
Silica	17-50	25/10	8.8-56	21/16	23-34	27/6
Iron (µg/L) [300]	53-1,600	548/4	54-930	288/6	220-1,200	720/2
Bicarbonate (as HCO_3)	120-190	147/9	44-220	121/16	85-200	133/6
Dissolved solids [500]	150-256	200/9	130-320	199/16	115-360	206/6
Total alpha (pCi/L)	---		---		---	
Total beta (pCi/L)	---		---		---	
Gross alpha (as U, pCi/L) [15]	1.6-7.9	4.7/6	1.2-47	9.2/14	1.4-12	6/6
Gross beta (as Cs-137, pCi/L)	0.6-6.4	2.4/9	1.0-29	5.1/16	0.6-4.7	2.0/6
Radium-226 (pCi/L) [5]	---		---		---	
Aluminum (µg/L)	---		---		---	
Antimony (µg/L)	---		---		---	
Arsenic (µg/L) [50]	---		---		---	
Berylium (µg/L)	---		---		---	
Cadmium (µg/L) [10]	---		---		---	
Chromium (µg/L) [50]	---		---		---	
Copper (µg/L) [100]	---		---		---	
Iodine (µg/L)	---		---		---	
Lead (µg/L) [50]	---		---		---	
Manganese (µg/L) [50]	---		---		---	
Mercury (µg/L) [2]	---		---		---	
Molybdenum (µg/L)	---		---		---	
Nickel (µg/L)	---		---		---	
Strontium (µg/L)	---		---		---	
Zinc (µg/L) [5,000]	---		---		---	

Table 15. Water quality in the intermediate aquifer system for selected land-use types in Polk County, Florida–Continued

Water-quality property or constituent [FDER maximum contaminant level][1]	Phosphate-mining and reclamation areas[2]		Phosphate-mining and reclamation areas[3]		Areas near phosphate- chemical processing plants[4]	
	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	23.5-26.5	24.7/11	22.2-27	25/3	22.5-25	24/13
Specific conductance (μS/cm)	255-765	406/11	174-800	371/6	318-3,200	975/13
pH (units) [6.5-8.5]	7.0-7.8	--/10	5.9-10.3	--/6	6.3-8.2	--/13
Alkalinity (as $CaCO_3$)	123-284	188/10	109-204	138/4	54-822	389/13
Nitrate (as N) [10]	0.01-0.10	0.05/4	0.22-0.5	0.4/2	--	
Phosphorus (as P)	0.024-0.059	0.04/3	0.11-0.12	0.1/2	0.01-100	11/12
Total organic carbon (as C)	0.4-2.3	1.5/10	9.8-15.6	13/2	2.7-28	14/13
Hardness (as $CaCO_3$)	110-260	169/9	70-160	110/3	189-1,600	487/13
Calcium	24-78	42/10	2.3-38.4	25/6	34-170	73/13
Magnesium	13-37	19/10	5.4-24.8	13/5	13-280	74/13
Sodium [160]	5-32	13/10	4.6-45	19/4	0.2-190	44/13
Potassium	0.32-0.83	0.6/10	0.66-22.4	5/5	0.5-6.1	1.5/13
Chloride [250]	1-75	16/10	4.8-64.1	21/6	3.9-23	11/13
Sulfate [250]	6-25	10/9	2.2-30	9/6	2-1,500	265/13
Fluoride [2]	0.31-1.6	0.8/10	0.35-0.7	0.6/4	0.3-2.8	1/12
Silica	18-42	30/10	20-46	33/3	17-290	82/13
Iron (μg/L) [300]	60-1,900	752/4	0.01-1,000	0.1/5	20-1,800	396/13
Bicarbonate (as HCO_3)	120-270	181/10	25.5-249	120/6	--	
Dissolved solids [500]	164-461	265/10	119-301	195/6	189-2,730	759/13
Total alpha (pCi/L)	--		--		0.6-22	6/13
Total beta (pCi/L)	--		--		0.3-31	4/11
Gross alpha (as U, pCi/L) [15]	1.7-21	7.5/10	--		--	
Gross beta (as Cs-137, pCi/L)	0.7-2.4	1.3/9	--		--	
Radium-226 (pCi/L) [5]	--		0.5-14	1.5/4	0.11-16	4/13
Aluminum (μg/L)	--		--		10-500	128/13
Antimony (μg/L)	--		--		--	
Arsenic (μg/L) [50]	--		--		5-160	23/13
Berylium (μg/L)	--		--		10-20	17/10
Cadmium (μg/L) [10]	--		--		1	1/3
Chromium (μg/L) [50]	--		--		3-50	11/13
Copper (μg/L) [100]	--		--		1-24	8/6
Iodine (μg/L)	--		--		0.03-4.4	0.8/11
Lead (μg/L) [50]	--		--		1-3	1.7/6
Manganese (μg/L) [50]	--		--		10-940	123/12
Mercury (μg/L) [2]	--		--		0.1-0.8	0.3/12
Molybdenum (μg/L)	--		--		1-900	137/9
Nickel (μg/L)	--		--		1-110	18/12
Strontium (μg/L)	--		--		60-230	212/13
Zinc (μg/L) [5,000]	--		--		10-40	16/13

[1]Florida Department of Environmental Regulation maximum contaminant level under the Florida Administrative Code for drinking water standards.
[2]Data from this study.
[3]Data from Steward (1963), Hutchinson (1978), and Moore and others (1986).
[4]Data from Miller and Sutcliffe (1982).

Table 16

Table 16. Water quality in the Upper Floridan aquifer for selected land-use types in Polk County, Florida

[Minimum (min), maximum (max), and mean concentrations shown with number (no.) of analyses. Concentrations are in milligrams per liter, except as noted. FDER, Florida Department of Environmental Regulation; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; pCi/L, picocuries per liter; --, no data]

Water-quality property or constituent [FDER maximum contaminant level][1]	Undeveloped areas[2]		Citrus farming areas[2]		Citrus farming areas[2]	
	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	21.7-25.5	24/25	23.3-27.2	24.8/26	23-28.5	24.9/20
Specific conductance (µS/cm)	135-599	249/26	105-396	250/26	172-750	300/20
pH (units) [6.5-8.5]	7.4-8.3	--/22	6.8-9.1	--/25	6.8-8.5	--/18
Alkalinity (as $CaCO_3$)	65-100	78/13	60-150	125/12	35-274	134/18
Nitrate (as N) [10]	0.0025-1.0	0.25/8	0.005-1.5	0.6/7	0.01-5.94	1.1/10
Phosphorus (as P)	--		--		0.02-0.14	0.06/13
Total organic carbon (as C)	--		--		0.1-4.2	1.7/15
Hardness (as $CaCO_3$)	98-284	164/7	40-180	110/11	50-350	132/19
Calcium	15-110	35/23	15-56	39/25	13-81	34/19
Magnesium	2.5-10	7/24	0.6-12	4.5/25	4.2-36	12/19
Sodium [160]	3-20	6/24	3-5	5/24	4.2-21	7/19
Potassium	0.5-1.7	1/24	0.4-2	1/14	0.05-2.8	1.6/19
Chloride [250]	5-33	10/27	4-24	8/25	0.2-27	8/20
Sulfate [250]	0.1-40	10/24	0.4-28	8/22	0.2-90	16/17
Fluoride [2]	0.1-0.5	0.2/7	0.1-0.4	0.2/7	0.08-0.64	0.3/19
Silica	6-22.5	15/6	1.1-27	18/8	3.4-43	20/19
Iron (µg/L) [300]	0.03-200	36/8	0.01-10	1/11	13-1,200	343/9
Bicarbonate (as HCO_3)	110-355	201/8	32-192	130/9	35-260	114/16
Dissolved solids [500]	80-350	155/25	62-224	148/27	99-506	195/19
Gross alpha (as U, pCi/L) [15]	--		--		0.5-41	9/14
Gross beta (as Cs-137, pCi/L)	--		--		0.6-12	4/15

Water-quality property or constituent [FDER maximum contaminant level][1]	Phosphate-mining and reclamation areas[3]		Phosphate-mining and reclamation areas[4]	
	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	24.5-25	25/2	24.5-27.2	26.11
Specific conductance (µS/cm)	346-508	427/2	294-373	325/11
pH (units) [6.5-8.5]	7.3-7.4	--/2	7.6-8.3	--/11
Alkalinity (as $CaCO_3$)	121-237	179/2	--	
Nitrate (as N) [10]	--		0.1-0.4	0.3/6
Phosphorus (as P)	0.04	--/1	--	
Total organic carbon (as C)	0.7-2.1	1.4/2	--	
Hardness (as $CaCO_3$)	160220	190/2	140-166	160/10
Calcium	40-43	42/2	25-55	40/11
Magnesium	15-26	21/2	7-16	10/11
Sodium [160]	6.5-20	13/2	4.5-32.6	11/8
Potassium	0.81-0.91	0.86/2	0.7-1.7	1/8
Chloride [250]	9-17	13/2	8-13	9/11
Sulfate [250]	9.7-41	25/2	10-85	14/10
Fluoride [2]	0.48-1	0.7/2	0.1-1.0	0.2/7
Silica	15-38	27/2	13-31	20/7
Iron (µg/L) [300]	160	--/1	0.01-0.05	0.03/3
Bicarbonate (as HCO_3)	120-230	175/2	125-220	180/11
Dissolved solids [500]	210-282	246/2	175-275	185/10
Gross alpha (as U, pCi/L) [15]	2.1-2.2	2.1/2	--	
Gross beta (as Cs-137, pCi/L)	1.3-1.8	1.6/2	--	

[1]Florida Department of Environmental Regulation maximum contaminant level under the Florida Administrative Code for drinking water standards.
[2]Data from Stewart (1963), Shaw and Trost (1984), and Moore and others (1966).
[3]Data from this study.
[4]Data from Stewart (1963) and Moore and others (1986).

Table 17

Table 17. Composite-water quality for samples collected from multiaquifer wells for selected land-use types in Polk County, Florida

[Minimum (min), maximum (max), and mean concentrations shown with number (no.) of analyses. Concentrations are in milligrams per liter, except as noted. FDER, Florida Department of Environmental Regulation; °C, degrees Celsius; µS/cm, microsiemens per centimeter at 25 degrees Celsius; µg/L, micrograms per liter; pCi/L, picocuries per liter; --, no data]

Water-quality property or constituent [FDER maximum contaminant level][1]	Citrus farming areas[3]		Citrus farming areas[2]		Areas near point-source waste discharges[2]		Phosphate-mining and reclamation areas[2]	
	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.	min-max	mean/no.
Temperature (°C)	23-26.5	24.8/21	22.5-25	23.8/7	24-25.5	24.6/5	23.5-25.5	24.8/5
Specific conductance (µS/cm)	143-467	294/21	155-296	218/9	286-798	406/6	255-380	325/5
pH (units) [6.5-8.5]	6.6-8.3	--/17	7.5-8.2	--/8	7.6-7.9	--/4	7.3-8.0	--/5
Alkalinity (as $CaCO_3$)	29-219	114/18	87-116	95/7	134-306	194/4	125-204	164/5
Nitrate (as N) [10]	0.006-11.8	2.4/13	--		0.01-1.1	0.4/3	0.005	--/1
Phosphorus (as P)	0.029-21.9	1.5/16	--		0.02-0.06	0.04/3	0.026-0.032	0.03/2
Total organic carbon (as C)	0.3-2.5	1.4/13	--		0.9-3.5	2.3/4	0.7-2.1	1.2/5
Hardness (as $CaCO_3$)	61-210	127/18	--		130-390	196/5	120-190	156/5
Calcium	19-51	34/18	18-27	24/9	31-92	48/5	27-44	36/5
Magnesium	3-22	10/19	6-15	9/10	12-38	18/5	13-23	16/5
Sodium [160]	2.8-13	7/19	3-9	5/9	5-22	9/5	6.5-19	14/5
Potassium	0.24-3.6	1.5/19	0.3-1.2	0.7/9	0.67-2.6	1.6/5	0.71-1.2	1/5
Chloride [250]	2.5-31	11/19	4-10	6/10	2-19	8/5	7.1-19	11/5
Sulfate [250]	5.4-61	14/14	1-30	11/8	6.3-120	30/5	5.1-44	14/5
Fluoride [2]	0.11-0.57	0.3/18	--		0.19-0.53	0.36/5	0.56-2.5	1/5
Silica	10-46	19/19	--		3.1-39	22/4	17-47	36/5
Iron (µg/L) [300]	61-1,400	469/7	--		46-68	57/2	300-2,500	910/4
Bicarbonate (as HCO_3)	28-220	110/19	--		130-290	178/5	120-200	160/5
Dissolved solids [500]	91-282	183/19	100-182	137/9	169-497	263/5	144-278	227/5
Gross alpha (as U, pCi/L) [15]	0.7-18	5/18	--		2.4-21	12/5	1.8-56	22/5
Gross beta (as Cs-137, pCi/L)	0.7-10	4/18	--		3.0-15	7/4	1.3-18	5/5

[1]Florida Department of Environmental Regulation maximum contaminant level under the Florida Administrative Code for drinking water standards.
[2]Data from this study.
[3]Data from Stewart (1963), Shaw and Trost (1984), and Moore and others (1986).

Table 18

Table 18. Wells that contained water with constituent concentrations exceeding Florida Department of Environmental Regulation maximum contaminant levels or with detectable concentrations of organic compounds in Polk County, Florida

[Site number from fig.4. FDER, Florida Department of Environmental Regulation; multiaquifer, water from well open to both the intermediate and the Upper Floridan aquifers; land-use type: ud, undeveloped areas; ci, citrus farming areas; ps, areas near point-source waste discharges; mr, phosphate-mining and reclamation areas; mg/L, milligrams per lter; µg/L, micrograms per liter; pCi/L, picocuries per liter]

Water-quality constituent [FDER maximum contaminant level][1]	Site numbers of wells for which concentration exceeded maximum contaminant level or samples contained organic compounds in indicated aquifer			Site numbers of wells for which concentration exceeded maximum contaminant level or samples contained organic compounds in indicated land-use type			
	Intermediate aquifer system	Upper Floridan aquifer	Multi-aquifer	ud	ci	ps	mr
Iron ..... [0.3 mg/L]	10,43,73, 77,87	64,79	2,3,14, 24,36, 41	43	20,34, 41,64, 77,79	73	2,3,10, 14,24, 87
Manganese ..... [50 mg/L]	34				34		
Selenium ..... [10 mg/L]	53			53			
Nitrate ..... [10 mg/L]	29,34		81		29,34, 81		
Gross alpha (includes Ra-226 but not radon and U) ..... [15 pCi/L]	11,23,27, 67	13,21,38	3,7,16, 65,72		11,13, 16,21, 23,38, 67	65,72	3,7,27
Volatile organic compounds							
Chloroform	[2]10, [2]29, 30		[2]35,71		29,35	71	10,30
Benzene ..... [1 mg/L]			[2]71			71	
Tetrachloroethylene ..... [0.2 mg/L]	50				50		
1,2 Dichloropropane	29		57		29,57		
Trichloroethene	[2]10,50		71		50	71	10
1,1,3,3 Teramethoxypropane[3]	10,29,68	93	57		29,57, 93	68	10
Pesticides							
Ethion	60				60		
Ethylene dibromide	89	39			38,89		

[1]Florida Department of Environmental Regulation maximum contaminant level under the Florida Administrative Code for drinking water standards.

[2]Trace concentrations detected.

*U.S. Government Printing Office: 1993 — 733-120/60022