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REGIONAL SIMULATION OF PROJECTED GROUNDWATER WITHDRAWALS FROM THE FLORIDAN AQUIFER SYSTEM IN WESTERN VOLUSIA COUNTY AND SOUTHEASTERN PUTNAM COUNTY, FLORIDA

by

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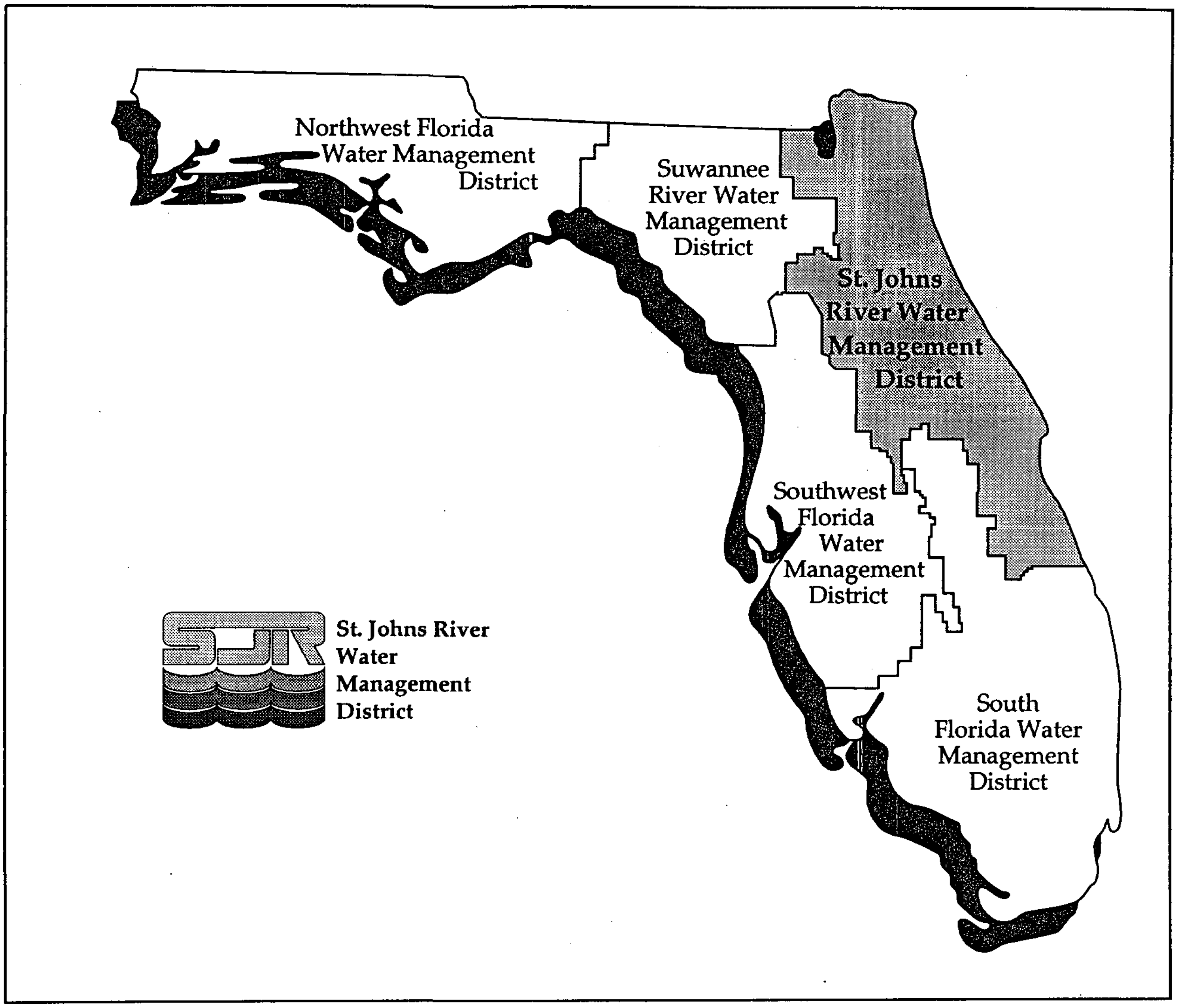

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EXECUTIVE SUMMARY

The St. Johns River Water Management District conducted a water resources evaluation of the Floridan aquifer system for the western Volusia-southeastern Putnam (WVSP) area in east-central Florida. The purpose of the study was to compare, on a regional basis, future water supply needs with the possible sources of fresh groundwater from the Floridan aquifer system. Specific objectives of the project were (1) to estimate the impacts upon the fresh groundwater resources of the Floridan aquifer system within the WVSP area under average steady-state conditions due to future changes in groundwater withdrawals and (2) to estimate the impacts upon the fresh groundwater resources of the Floridan aquifer system within and outside of the WVSP area during and after short-term (transient) periods of groundwater withdrawals associated with frost-and-freeze irrigation.

The study area included a region containing all of Volusia County except for the southeastern corner, all of Flagler County, and southeastern Putnam County. The primary area of focus consisted of the western one-half of Volusia County and that part of southeastern Putnam County located between the St. Johns River, Dunns Creek, and Crescent Lake.

The technical approach taken to accomplish the objectives consisted of compiling and analyzing available water use and hydrogeologic data and organizing these data into a conceptual hydrogeologic framework. The groundwater flow system beneath the study area consists of three aquifers that are separated by two semiconfining layers. The three aquifers are, in descending order, the surficial aquifer system, the Upper Floridan aquifer, and the Lower Floridan aquifer. The upper semiconfining unit (USCU) separates the surficial aquifer system from the Upper Floridan aquifer, and the middle semiconfining unit separates the Upper Floridan aquifer from the Lower Floridan aquifer. The USCU is considered a semiconfining unit (rather than a confining unit) because it is relatively thin in the study area compared to other areas within the St. Johns River Water Management District and because of the abundance of sinkhole depressions throughout the WVSP area in which confining sediments may not be present.

Groundwater flow is predominantly horizontal within the aquifer layers and predominantly vertical within the semiconfining units.

Most of the groundwater pumped within the study area is derived from the Upper Floridan aquifer and is used primarily for domestic use and agricultural irrigation. The amount of groundwater for domestic use obtained from public water supplies increased significantly between 1965 and 1990 in Putnam, Flagler, and Volusia counties and is projected to increase significantly between 1990 and 2010. In these counties, average daily agricultural groundwater use increased significantly between 1965 and 1990 but is not projected to increase significantly between 1990 and 2010.

Based on the hydrogeologic framework described above, a numerical groundwater flow model was developed that covers southeastern Putnam County, all of Flagler County, all of Volusia County except for the southeastern corner, and parts of adjacent counties. The model treats the surficial aquifer system as a constant-head layer that acts as a source-sink bed for the Upper Floridan aquifer. Once constructed, the model was calibrated so that it could simulate water levels within the Upper Floridan aquifer for both estimated predevelopment and observed 1988 average steady-state conditions. Model-simulated areal recharge rates to the Upper Floridan aquifer and spring discharge rates from the Upper Floridan aquifer for the steady-state calibrations were compared to estimated and observed areal recharge rates and spring discharges. The model also was calibrated to transient conditions during and after a period of frost-and-freeze irrigation in January 1991 by comparing simulated drawdown and recovery in the Upper Floridan aquifer to observed drawdown and recovery in the Upper Floridan aquifer and at a group of observation wells equipped with continuous water level recorders.

A series of analyses was conducted that determines the sensitivity of model-simulated water levels in the Upper Floridan aquifer to changes in aquifer parameters and boundary conditions. In the WVSP area, steady-state potentiometric levels for the Upper Floridan aquifer are most sensitive to changes in the constant-head values of the surficial aquifer system and the leakance of the USCU. Simulated drawdown values computed during transient frost-and-freeze simulations are most sensitive to changes in the specified transmissivity and storativity of the Upper Floridan aquifer.

Two predictive scenarios were evaluated using the calibrated model. For the first, a simulation was run using the same boundary conditions that were used for the 1988 steady-state calibration, except that the prescribed well withdrawals were updated to include 1994 withdrawals plus the increased public water supply pumping that is projected for the year 2010.

Impacts to the Floridan aquifer system due to the increase in average groundwater withdrawals between 1988 and 2010 are described in terms of changes in the potentiometric levels of the Upper Floridan aquifer, spring flows, and steady-state water budget flow rates. Simulated potentiometric and water budget flow rate changes are greater outside of the WVSP area than inside, except for southwestern Volusia County. The predicted average 2010 potentiometric surface in the Upper Floridan aquifer is more than 10 feet (ft) lower than the simulated 1988 surface in parts of eastern Volusia County, where the bulk of the increase in public supply withdrawals is projected to occur. It is more than 5 ft lower (relative to the simulated 1988 surface) throughout much of eastern Volusia County and part of eastern Flagler County. Within the WVSP area, differences range from 2 ft to greater than 5 ft throughout most of southwestern Volusia County. Differences are less than 2 ft everywhere else in the WVSP area, except near Pierson in northwestern Volusia County and just west of Crescent Lake in southeastern Putnam County. Changes in simulated water budget flow rates (except for spring flow) are greater when computed for the model as a whole rather than when computed for the WVSP area only. Most of the simulated change in steady-state springflow rates is predicted at the three springs (Blue, Gemini, and Green) located within southwestern Volusia County.

The second predictive scenario involved conducting a transient simulation with frost-and-freeze withdrawals superimposed upon simulated average 1988 steady-state conditions. Frost-and-freeze protection withdrawals for a hypothetical large-scale freeze similar to that which occurred during December 1989 were added to the 1988 average daily withdrawals. The simulation consisted of four stress periods representing a total of 1.5 days of frost-and-freeze protection withdrawals followed by a 14-day recovery period.

The simulated drawdown of the potentiometric surface of the Upper Floridan aquifer exceeds 1 ft throughout most of the WVSP area.

Maximum simulated drawdowns exceed 20 ft in southeastern Putnam County, 80 ft in northwestern Volusia County, and 30 ft in western Volusia County, north of De Land. The simulated potentiometric surface of the Upper Floridan aquifer recovers to near prefreeze levels by the end of the recovery period. Most of the water withdrawn for freeze protection is supplied by storage within the aquifer and adjacent confining units, an increase in recharge from the overlying surficial aquifer system, and decreases in discharge at springs located near areas of large withdrawals.

The errors that are inherent in the estimation of model inputs such as transmissivity, leakance, and hydraulic head in the surficial aquifer system, plus the errors inherent in measuring "known" quantities such as well and spring discharge rates, combine to produce uncertainty in all model predictions. This uncertainty can be lessened by conducting additional calibrations with new field data. Further calibration efforts would be significantly enhanced by the availability of additional hydrologic data. Specific suggestions are listed below.

- Construct more long-term monitoring sites with climatological instrumentation and observation wells completed within both the surficial aquifer system and the Lower Floridan aquifer

- Install continuous recorders on additional observation wells

- Collect additional data regarding agricultural water use rates

- Increase the frequency at which flow rates are estimated at large springs so that the relationships between changes in rainfall, springflow, and groundwater withdrawals can be understood better.

The groundwater flow model developed for this study can be considered useful for predicting heads in the Upper Floridan aquifer, spring discharges, and areal recharge rates for various steady-state conditions on a regional scale and for predicting drawdown and recovery in the Upper Floridan aquifer for periods of frost-and-freeze protection on a regional scale. This model should not be used to examine local-scale problems where parameter inhomogeneities and/or changes in water table elevations would affect simulation results.

Examples of such local-scale problems include (1) lowering of lake or wetland surface water levels due to increased groundwater withdrawals, (2) subsidence and/or sinkhole formation caused by pumping for frost-and-freeze protection, and (3) saline-water upconing or lateral intrusion that occurs in response to long-term drawdown in the Floridan aquifer system where the unit of freshwater is relatively thin. An examination of any of these problems can be better addressed using a local- or subregional-scale model that focuses upon specific areas where the problems are likely to occur. This model, however, can be used to provide lateral groundwater flow boundary conditions for local- or subregional-scale models that are constructed within the WVSP area.

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INTRODUCTION

BACKGROUND

Southeastern Putnam County and western Volusia County, like many areas in Florida, are experiencing increased development and population growth. This increased growth has led to competition among agricultural concerns, public water supply vendors, and domestic well owners for supplies of good quality water. The primary source of water for all users in southeastern Putnam County and western Volusia County is the Floridan aquifer system. The concern exists that increased demand for water from the Floridan aquifer system, particularly during periods of agricultural irrigation for freeze protection, will damage the supply of freshwater available to all users.

In 1987, the U.S. Environmental Protection Agency (EPA) designated the Floridan aquifer system within Volusia County as a sole-source aquifer (EPA 1987). This designation was made because the Floridan aquifer system in Volusia County, southeastern Putnam County, and parts of Flagler County is recharged solely by water derived from local rainfall that infiltrates through the overlying sediments. The actual physical boundaries of the aquifer system extend far beyond the political boundaries of the counties, but fresh groundwater (defined as having a chloride content of less than 250 milligrams per liter [mg/L]) exists within the aquifer system beneath and bordering the recharge areas that provide freshwater. The part of the aquifer system containing freshwater is surrounded and underlain by brackish water with chloride concentrations greater than 250 mg/L. Wherever more freshwater is withdrawn from the Floridan aquifer system than can be replaced by vertical recharge from above, the possibility exists for brackish water to travel laterally or vertically upward within the aquifer system toward the point of withdrawal.

PURPOSE AND SCOPE

In 1989, the Florida Legislature mandated that each water management district within the state prepare an assessment of regional water resource needs and sources for the next 20 years (Paragraph 373.0391(2)(e), *Florida Statutes*). The purpose of this study is to compare, on a regional scale, future water supply needs with the estimated fresh groundwater sources within the Floridan aquifer system for western Volusia and southeastern Putnam counties. Information gathered during the study will provide technical assistance to local governments and will be used in the development of the District Water Management Plan.

The general study area included southeastern Putnam County; all of Flagler County; all of Volusia County except for the southeastern corner; small parts of St. Johns, Marion, Lake, Seminole, and Orange counties; and part of the continental shelf offshore from southern St. Johns County to southern Volusia County (Figures 1 and 2). The primary area of focus, however, was western Volusia-southeastern Putnam (WVSP) counties. For the purposes of this study, the WVSP area includes the western one-half of Volusia County plus that part of southeastern Putnam County that is bounded by the St. Johns River on the west, Dunns Creek on the north and northeast, and Crescent Lake on the east.

The specific project objectives are as follows.

- To estimate the impacts upon the fresh groundwater resources of the Floridan aquifer system within the WVSP area under average steady-state conditions due to changes in groundwater withdrawal rates at the end of the 20-year planning period (2010)

- To estimate the impacts upon the fresh groundwater resources of the Floridan aquifer system within the WVSP area under short-term, transient conditions due to pumping for frost-and-freeze protection

This study does not attempt to quantify the long- or short-term degradation of water quality in the Floridan aquifer system. Inferences about particular areas that may be likely to experience water quality degradation can be made, however, based upon the estimated impacts upon the groundwater flow system. Project results also can be used as a regional framework for more localized water level or water quality impact studies.

There are many regional, countywide, and local-scale publications that include the WVSP area. Regional hydrogeologic reports that include

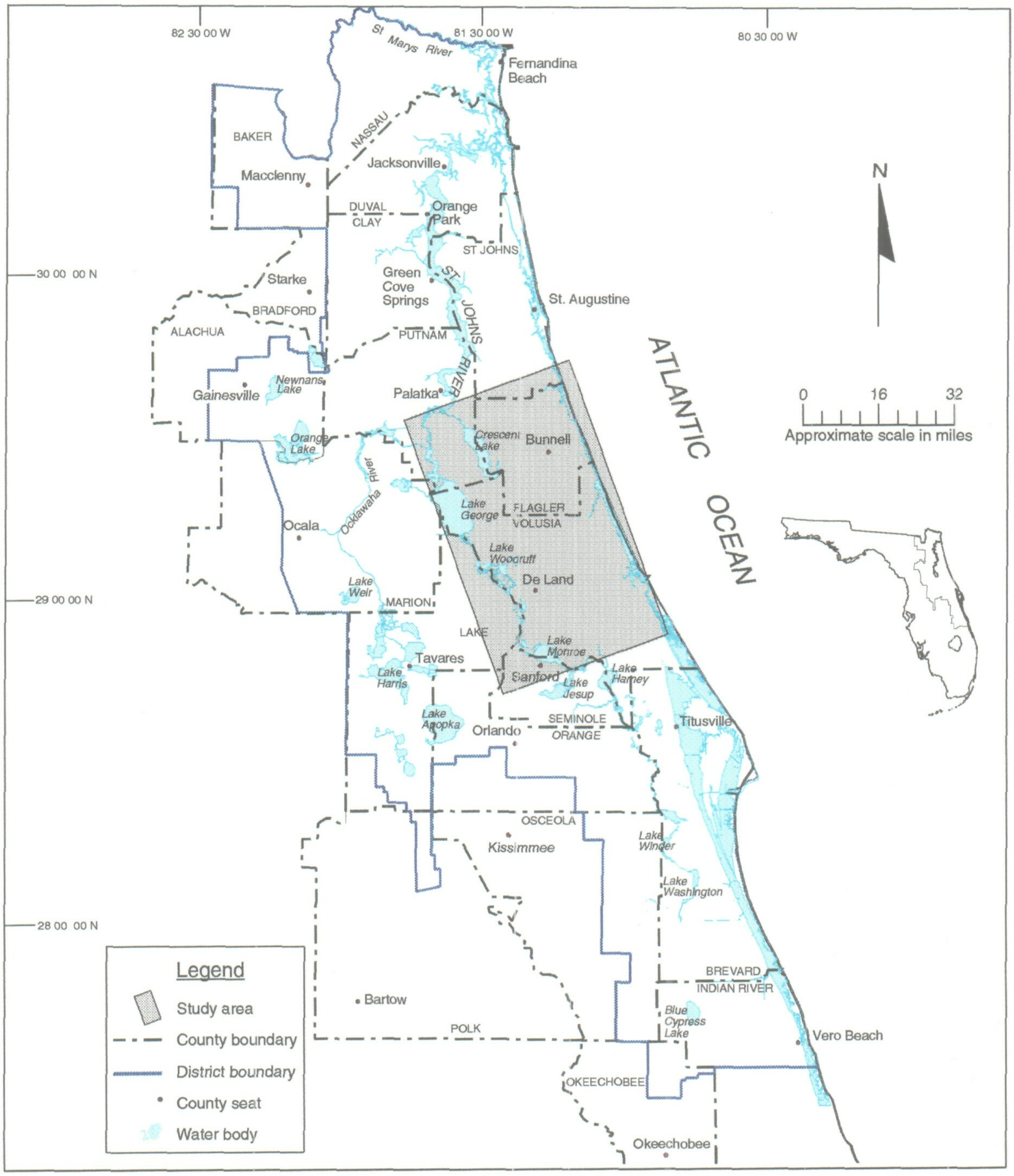


Figure 1. The St. Johns River Water Management District

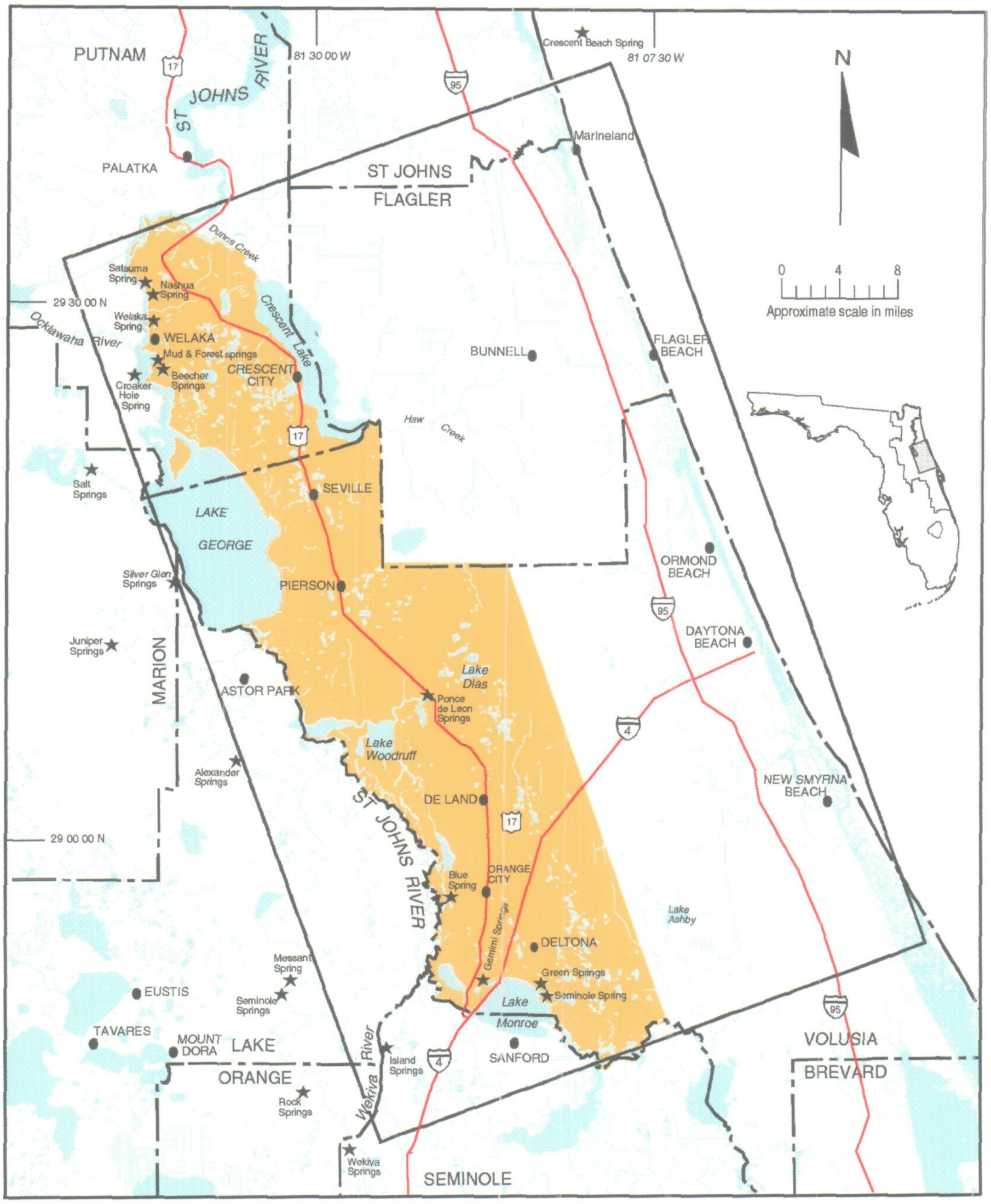


Figure 2. Study area, showing location of western Volusia-southeastern Putnam (WVSP) area

all or part of this area include Bentley (1977), Bermes et al. (1963a, 1963b), Causey and Leve (1976), Cooke (1945), Cooper et al. (1953), Faulkner (1973), Huff and McKenzie-Arenberg (1990), Johnson (1981), Johnston et al. (1980), Klein (1975), Lichtler (1972), Matson and Sanford (1913), McKenzie-Arenberg (1989), McKenzie-Arenberg and Szell (1990), Miller (1986), Munch et al. (1979), Phelps (1984), Rosenau et al. (1977), Sellards and Gunter (1913), Snell and Anderson (1970), Sprinkle (1989), Stewart (1980), Stringfield (1936, 1966), Szell (1993), Toth (1988) and White (1958, 1970). Countywide hydrogeologic reports include those by Knochenmus (1968), Knochenmus and Beard (1971), McGurk et al. (1989), Phelps (1990), Rutledge (1985a), Vecchioli et al. (1990), and Wyrick (1960, 1961) for Volusia County and Navoy and Bradner (1987) for Flagler County. Publications focusing on the hydrogeologic characteristics of specific areas within the WVSP region include Boniol et al. (1990), Brooks (1961), Hughes (1979), Kimrey (1990), Munch (1979), Ross and Munch (1980), Rutledge (1982, 1985b), Simonds et al. (1980), and Stringfield and Cooper (1951). Investigations reporting on computer simulations of groundwater flow and/or transport that include parts of the WVSP area were conducted by Blandford and Birdie (1992), Blandford et al. (1991), Bush (1978, 1982), GeoTrans (1992), Geraghty and Miller (1992), Mercer et al. (1984), Motz et al. (1995), Tibbals (1981, 1990), Ward and Thomas (1987), and Williams (1997).

The technical approach for this study consisted of compiling, organizing, and analyzing available hydrogeologic data and developing a conceptual model of the groundwater flow system. A numerical groundwater flow model (the WVSP regional model) was constructed, based upon the conceptual model. Hydrogeologic data reviewed included historic rainfall and groundwater level patterns, water use records and projections, lake and stream stage data, surface and groundwater quality with particular reference to chloride levels, springflow records, geologic and geophysical logs, and topographic maps. Isopach and structure contour maps of geologic and hydrologic layers published by Miller (1986) and Tibbals (1990) were examined. Similar maps prepared by St. Johns River Water Management District (SJRWMD) staff for the Prime Recharge Area Delineation Project were also used. In addition to these publications, consultant reports prepared in support of consumptive use or landfill operation permits were reviewed. Published and unpublished reports provided valuable information concerning estimates of aquifer parameters such as hydraulic conductivity, transmissivity, leakance, and storativity.

Although the project focuses upon the WVSP area, the conceptual model and the WVSP regional model encompass a much larger area. This is because Volusia County, southeastern Putnam County, and much of Flagler County together comprise a regional groundwater flow system wherein freshwater enters the Floridan aquifer system in recharge areas (located mainly in the WVSP area) and flows laterally to discharge areas in Flagler County, eastern Volusia County, and along the St. Johns River. Future groundwater withdrawals outside of the WVSP area (e.g., eastern Volusia County) could conceivably have an effect upon the water levels in the Floridan aquifer system within the WVSP area. Note that, in this study, southeastern Putnam County is considered a northern extension of the Volusia Groundwater Basin described by McKenzie-Arenberg (1989).

The study area is within the area modeled by Tibbals (1990) as part of the U.S. Geological Survey's (USGS) Regional Aquifer Simulation Analysis (RASA) program. Aquifer parameters derived from that larger-scale numerical model were thus available as a starting point from which to begin construction of a more detailed model.

Once constructed, the WVSP regional model was calibrated to simulate estimated or observed water levels in the Upper Floridan aquifer under average steady-state predevelopment and postdevelopment (1988) conditions and under transient conditions during and after a freeze event in January 1991. The calibrated model was used to predict average steady-state water levels in the Upper Floridan aquifer for the year 2010. It was also used to predict possible changes in water levels in the Upper Floridan aquifer that would result from a hypothetical freeze event.

This report is organized into the following seven chapters:

- Introduction
- Current water use and projections for future needs
- Hydrogeologic framework of the study area
- Construction and calibration of the regional groundwater flow model

- Subsequent predictive simulations
- Discussion of model results
- Conclusions and recommendations

WATER USE

Most of the water used within the WVSP area is obtained from the Floridan aquifer system. Groundwater is withdrawn primarily for domestic use and agricultural irrigation. Both public water systems and private wells supply water for domestic use. Smaller amounts are withdrawn for self-supplied industrial uses and for electric power generation. SJRWMD has compiled and published water use estimates annually since 1978 for each county within its jurisdiction. These annual water use surveys categorize water use estimates according to source (e.g., groundwater, surface water) and type of use. In 1990, groundwater sources provided 92% of total water use in Flagler County; 77% in Putnam County; and, excluding water used for electric power generation, 95% in Volusia County (Florence 1992). Most of the groundwater used is pumped from the Floridan aquifer system. Almost all of the water obtained from the surficial aquifer system is from self-supplied domestic (private) wells and a few public systems in eastern Flagler and Volusia counties. Reclaimed water provided a very small percentage of the total water use in each of these counties.

Groundwater use has increased significantly in Flagler, Putnam, and Volusia counties in the past three decades (Table 1). The increase in average withdrawals between 1965 and 1990 ranges from 9.5 million gallons per day (mgd) in Flagler County to 55.9 mgd in Volusia County. Separate estimates of water use in 1965 are not available for southeastern Putnam County. Ross and Munch (1980), however, estimated an average of 1.0 mgd in 1980 for domestic use (public supply plus domestic self-supply) in southeastern Putnam County. The large difference in water use for the industrial self-supply category for Putnam County is due to increased pumping at the Georgia-Pacific paper plant near Palatka, which is north of the project area. Given that exception, the largest increases between 1965 and 1990 were for public water supply and agricultural irrigation in Volusia County, where public water supply usage increased 3.4 times and agricultural irrigation usage increased 3.1 times (Table 1).

Water use estimates for individual agricultural crops are not available from 1965 to 1980; estimates for 1980 are available from Marella (1987). The major crops (in terms of irrigated acreage and average daily

Table 1. Average daily groundwater use (million gallons per day)

Type of Use	1965*	1990†	2010‡
Flagler County			
Public supply	0.2	3.8	15.3
Agricultural irrigation	3.5	7.3	6.8
Domestic self-supply	0.3	1.9	0.3
Industrial self-supply§	0.0	0.3	0.3
Recreational self-supply	NA	0.2	0.2
(Subtotal)	4.0	13.5	22.9
Putnam County			
Public supply	2.0	3.1	3.2
Agricultural irrigation	11.6	20.2	20.1
Domestic self-supply	1.1	5.9	7.5
Industrial self-supply§	3.0	35.3	34.4
Recreational self-supply	NA	0.3	0.4
(Subtotal)	17.7	64.8	65.6
Volusia County			
Public supply	13.0	44.6	93.8
Agricultural irrigation	6.2	19.3	22.0
Domestic self-supply	1.9	6.7	6.3
Industrial self-supply§	0.6	3.3	1.6
Recreational self-supply	NA	3.7	1.8
(Subtotal)	21.7	77.6	125.5
Total	43.4	155.9	214.0

Note: NA = not available

*Snell and Anderson 1970
†Vergara 1994
‡2010 estimates from several sources, primarily Vergara (1994); also municipal and county comprehensive plans, Lynne and Kiker (1992a, 1992b), Kimball-Lloyd (1991), and Williams (1997). Agricultural estimates include water used for frost-and-freeze protection
§Includes commercial, institutional, power generation, and miscellaneous uses

groundwater use) are potatoes and cabbage in Putnam and Flagler counties and ornamental ferns in Volusia and southeastern Putnam counties. In Volusia County, most ferns are grown in the sandy upland soils of the western and northwestern portions of the county. Most of the acreage devoted to potatoes and cabbage in Putnam County is located north of the study area, in northeastern Putnam County (Singleton 1990, 1996). The majority of agricultural water use in southeastern Putnam County is for irrigation of ornamental ferns. Irrigated fern acreage increased from 700 acres in 1980 to 1,100 acres in 1990. In Volusia County, the irrigated fern acreage increased from 3,715 acres in 1980 to 5,380 acres in 1990.

FROST-AND-FREEZE PROTECTION

A great deal of water is used by the fern industry for frost-and-freeze protection. Most ferneries produce leatherleaf fern, which is the predominant cut foliage crop in the world and the most valuable floricultural crop produced in Florida (Stamps and Haman 1991). Leatherleaf fern fronds are not cold-tolerant; they are susceptible to damage when the air temperature drops below freezing (32°F). Frost-and-freeze protection of leatherleaf fern crops is conducted by overhead spray irrigation systems. Water sprayed upon the fern fronds forms an ice coating, and the heat released from the water during ice formation sustains the plant. The water must be supplied more or less continuously to the entire crop during a freeze. Recommended water application rates range from 0.22 inches per hour (100 gallons per minute per acre [gpm/acre]) to 0.35 inches per hour (158 gpm/acre) (Stamps and Haman 1991). Rates near or greater than the high end of this range were traditionally applied until 1985, when SJRWMD recommended the use of water-conserving spray irrigation systems that provide approximately 100 gpm/acre to artificial shadehouse ferneries and approximately 120 gpm/acre to natural hammock ferneries.

WATER USE PROJECTIONS

The available water use estimates for the end of the 20-year planning period (2010) indicate that public supply water use will continue to increase, but agricultural water use will not increase significantly (Table 1). Average daily public supply groundwater use in Volusia

County is projected to increase from 57% of the county total in 1990 (44.6 mgd) to 75% in 2010 (93.8 mgd). Agricultural groundwater use in Volusia County, on the other hand, is expected to increase only slightly (from 19.3 mgd to 22.0 mgd), dropping from 25% of the 1990 countywide total to 18% by 2010. The projections for Flagler and Putnam counties are similar, where public supply groundwater use is expected to increase but agricultural groundwater use is expected to remain approximately the same as in 1990. As a result, agricultural water use in Flagler County is projected to drop from 54% of the countywide total in 1990 to 30% in 2010. In Putnam County, agricultural water use is projected to remain at 31% of the countywide total water use.

HYDROGEOLOGIC FRAMEWORK

The important climatic, topographic, and hydrogeologic characteristics of the Floridan aquifer system can be organized into a basic structure or hydrogeologic framework. The major components of this framework are discussed in this chapter.

CLIMATE

The study area climate is humid and subtropical, with warm, relatively wet summers and mild, relatively dry winters (Tibbals 1990). Most years have at least several days when the temperature drops below freezing, but minimum temperatures are rarely below 20°F and maximum temperatures are rarely above 100°F.

Rainfall is unevenly distributed throughout time and space. Approximately 60% of the annual rainfall occurs from June through October (Rao et al. 1989). Most of this rain results from local thunderstorms that cover a relatively small area, although large-scale tropical storms or hurricanes occasionally pass through the region. Normal annual rainfall amounts measured at six sites within or near the study area that have long-term data range from 46.71 inches per year (in/yr) at Marineland to 54.06 in/yr at De Land (Table 2). Extremes of annual rainfall totals at these stations range from 28.07 inches (in.) at Marineland to 84.03 in. at De Land. In addition to yearly fluctuations in rainfall amounts, long-term rainfall patterns vary. Tibbals (1990) discussed the evidence for a period of rainfall deficiency (compared to observed long-term averages at four stations) lasting from 1888 to approximately 1931.

TOPOGRAPHY AND SURFACE WATER FEATURES

Topographic relief and the nature of surface water features affect the distribution of recharge and discharge within a groundwater flow system. These features are briefly discussed below.

Land surface elevations range from sea level at the coast to slightly greater than 100 feet (ft) above the National Geodetic Vertical Datum of 1929 (NGVD, formerly called mean sea level) around De Land and

Table 2. Average, normal, and 1988 annual rainfall amounts at long-term stations in the study area (inches per year)

Station	Period of Record	Average (through 1984)*	Normal (average for 1951–80)*	Total for 1988†
Crescent City	1897–1998	52.44	53.58	47.49
Daytona Beach	1923–98	48.16	48.04	40.91
De Land	1909–98	54.81	54.06	60.74
Marineland	1942–98	47.73	46.71	NA
Palatka	1923–98	52.59	51.50	NA
Sanford	1913–98	51.47	51.14	52.93

Note: NA = data not available for entire year

*Rao et al. 1989
†From SJRWMD scientific database

Deltona. In general, the topography increases in elevation in a stepwise fashion westward from the coast to the highlands just east of the St. Johns River valley, then drops to just above mean sea level along the river (Figure 3).

These relatively level "steps" are terraces, which were the sea floor when sea level stood higher than at present (Wyrick 1960; Rutledge 1985a). The present-day remnants of the highest of these terraces are the Crescent City and De Land ridges. These ridges have well-developed karst topography, which is characterized by relatively high local relief, sinkhole lakes and ponds, dry depressions, and subsurface drainage. A review of the 1:24,000-scale topographic quadrangle maps that cover these ridges indicates abundant evidence of closed depressions and a lack of well-developed stream channels. The Orange City and De Land areas in western Volusia County (Figure 2) exhibit the greatest local relief within the study area. Land surface elevation contours in these areas change from less than 25 ft NGVD to greater than 75 ft NGVD over relatively short distances (Figure 3).

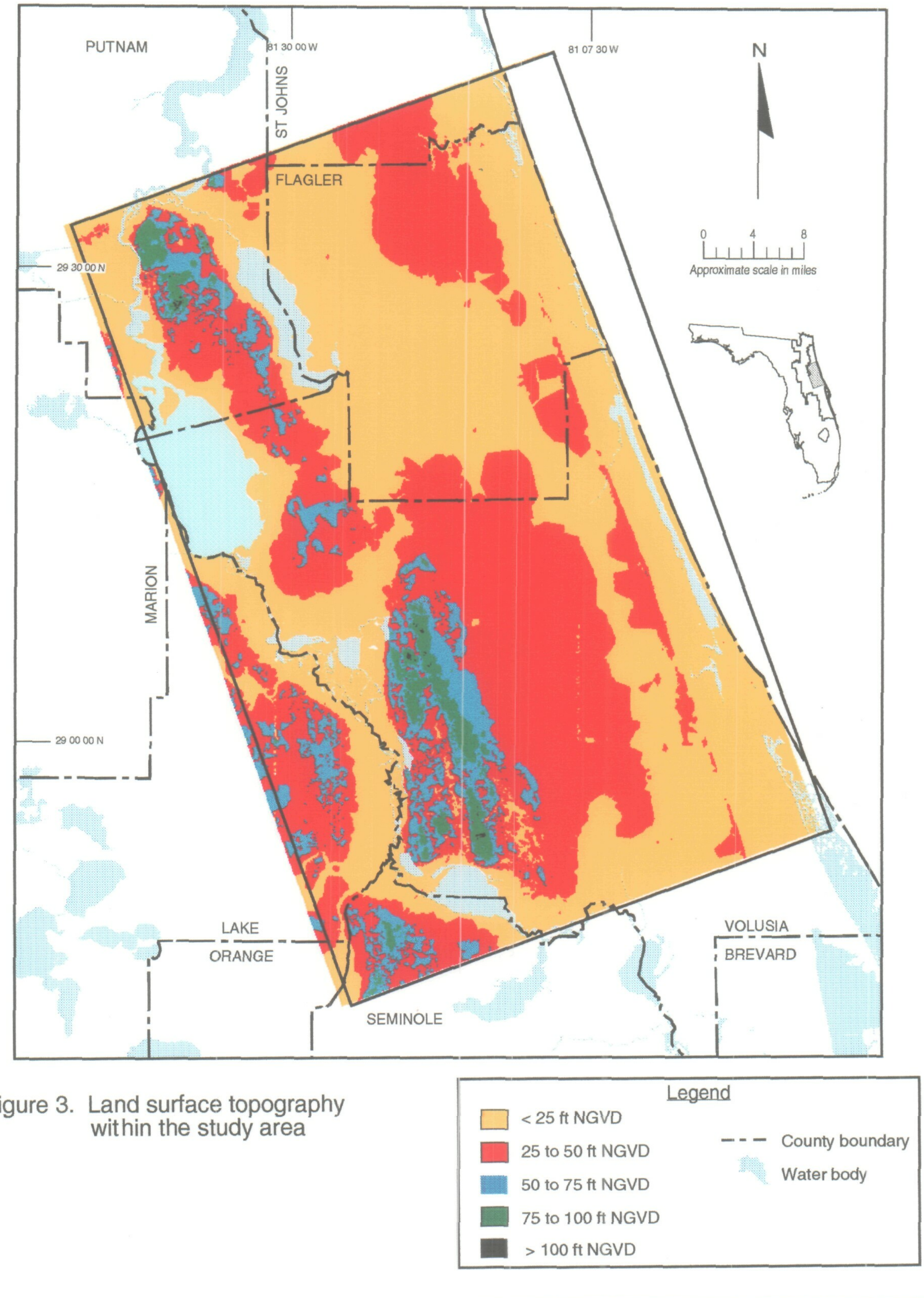


Figure 3. Land surface topography within the study area

Surface water bodies within the study area include rivers, freshwater marshes and swamps, small streams, canals, lakes, coastal lagoons, and the Atlantic Ocean. The St. Johns River flows northward through the region, forming the southwestern and western boundaries of Volusia County (Figure 2). Surface water flows to the St. Johns River from the western and southern parts of the study area. Major tributaries to the St. Johns River include the Wekiva River, the Ocklawaha River, and Haw Creek. Several large lakes are part of or are connected to the St. Johns River channel. These lakes include Monroe, Woodruff, George, and Crescent. Extensive marshes and swamps border the St. Johns River, especially along the Lake County-Volusia County boundary between Lake Monroe and Lake George. Small streams and man-made canals drain the flat terraces and coastal ridge areas of Flagler and Volusia counties, as well as those parts of southeastern Putnam and western Volusia counties not covered by karstic ridges. Depth contours in the Atlantic Ocean increase to about 30 ft below NGVD within approximately one-half mile from shore, then very gradually increase to about 60 ft below NGVD and level off for several miles.

Long-term flow measurement records made for the St. Johns River near De Land indicate that the mean flow rate is 3,041 cubic feet per second (cfs), or 1,965 mgd (USGS 1992). The total average measured flow for the smaller streams and canals that drain the interior parts of southeastern Putnam County, Flagler County, and Volusia County is approximately 356 cfs (230 mgd) (USGS 1992).

The study area contains many relatively small lakes. These lakes are most numerous in upland areas of northeastern Lake County, southeastern Putnam County, and western Volusia County (Bermes et al. 1963a; Knochenmus and Beard 1971; Knochenmus and Hughes 1976). They range in size from less than 1 acre to approximately 700 acres (Lake Dias, near Ponce de Leon Springs; Figure 2) and are often sinkhole depressions that have filled with water.

GEOLOGY

The geologic characteristics of major importance throughout the study area are the stratigraphy of the sedimentary deposits underlying the region and the structural controls on their thickness and distribution. These topics are briefly discussed in the following two sections.

Stratigraphy

Sand, silt, clay, and various carbonate and evaporite sediments ranging in age from the Cretaceous period to the Quaternary (Recent) period underlie the study area (Figure 4). Information concerning the character of these sediments comes primarily from subsurface data such as lithologic logs, geophysical logs, and seismic reflection techniques. Only the youngest sediments (post-Miocene) occur at the surface within the study area.

The following discussion of the characteristics of the various stratigraphic units is based upon the comprehensive descriptions and isopach maps prepared by Miller (1986) and Tibbals (1990) as part of the USGS RASA program.

Carbonate rocks of Eocene age make up the thickest sequence of sediments in the region and are represented by the Oldsmar Formation, the Avon Park Formation, and the Ocala Limestone. The Oldsmar and Avon Park Formations increase in thickness to the southeast across the study area. The Ocala Limestone, however, increases in thickness in a northeastward direction.

Middle Miocene Hawthorn Group sediments and undifferentiated late Miocene sediments lie unconformably upon the Eocene carbonate rocks. The Hawthorn Group contains a complexly interbedded sequence of phosphatic sand, silt, clay, and carbonate beds. The Hawthorn Group is not present in most of Volusia County and southern Flagler County, probably due to postdepositional erosion (Scott 1988). Phosphatic sediments have been tentatively identified as Hawthorn Group beds from well cuttings and geophysical logs in western Volusia County; the phosphate observed might result from redistribution and sedimentation of eroded Hawthorn Group sediments (Phelps 1990). Also overlying the Eocene rocks (and the Hawthorn Group, where present) are interbedded and interfingering deposits of sand, sandy clay, and shell of late Miocene and/or Pliocene age (Cooke 1945; Scott 1988; Huddlestun 1988). The overall thickness of the combined Miocene and Pliocene deposits varies within the study area between 20 and 70 ft (Bermes et al. 1963a; Phelps 1990; Rutledge 1982).

System	Series	Geologic Unit	Lithology	Study Area Hydrostratigraphic Unit (1)	Districtwide Hydrostratigraphic Unit (2)
Quaternary	Recent Pleistocene	Undifferentiated deposits Anastasia Formation	Sand, clayey sand, silt, and minor shell	Surficial aquifer system	Surficial aquifer system
Tertiary	Pliocene and/or late Miocene	Nashua Formation and/or undifferentiated deposits	Mixture of sand and shell, clay and shell, shell beds, and clay beds	Semiconfining unit (USCU)	
	Middle Miocene	Hawthorn Group	Phosphatic sand, silt, clay, and carbonates		Intermediate confining unit
	Late Eocene	Ocala Limestone	Limestone and dolomitic limestone	Upper Floridan aquifer	Floridan aquifer system
	Middle Eocene	Avon Park Formation	Dolomitic limestone, limestone, and dolomite	Middle semiconfining unit (MSCU)	
				Lower Floridan aquifer	
	Early Eocene	Oldsmar Formation	Limestone and interbedded dolomite		
	Paleocene	Cedar Keys Formation	Dolomite, limestone and interbedded evaporites	Lower confining unit	Sub-Floridan confining unit
Cretaceous		Undifferentiated sediments	Interbedded carbonates, dolomite, and evaporites		

Figure 4. Relation between geologic units and hydrologic units in the study area (modified from Tibbals 1990)

Pleistocene and Recent sand, clay, and shell layers blanket the former marine terraces and relict beach ridges, including the De Land and Crescent City ridges. Thickness of the Pleistocene and Recent sandy sediments generally ranges between 20 and 50 ft but can be greater than 100 ft locally. Greater thicknesses occur in the vicinity of sinkholes on the Crescent City and De Land ridges, where the more clayey Miocene and Pliocene deposits have been breached and the Pleistocene-Recent sediments directly overlie the Eocene carbonates.

Geologic Structure

Several regional-scale geologic structures exist on the Florida peninsula, which have influenced the thickness and distribution of the deposits laid down during the Tertiary period. As Scott (1988) pointed out, however, the nature of the deposits makes it difficult to determine whether the origin of some of these structural features is actually due to structural (tectonic) processes or to depositional and erosional processes.

One such feature that is important to this study is the Sanford High, named by Vernon (1951) for a positive feature in Seminole and Volusia counties, which he described as a "closed fold that has been faulted, the Sanford High being located on the upthrown side." Meisburger and Field (1976) documented the existence of this positive feature offshore from Volusia County using data from high-resolution seismic reflection profiles. The top of the Avon Park Formation, the entire Ocala limestone, and the Hawthorn Group have presumably been eroded from the crest of the Sanford High in western Volusia County. The Oldsmar Formation and the remainder of the Avon Park Formation dip gently away from the crest to the north, east, and south, as does the Ocala Limestone along the flanks of the Sanford High.

Faults along the St. Johns River have been mapped by Vernon (1951), Wyrick (1960), Barraclough (1962), Johnson (1981), and Miller (1986). These faults form the southern and western boundaries of the Sanford High and also delineate the western boundary of a structural high in the Eocene limestones beneath the Crescent City Ridge. The mode of origin of these faults is uncertain. Vernon (1951) and other authors suggest a tectonic origin related to the formation of the Ocala Platform. Miller (1986) notes that the faults can be mapped only for middle and late Eocene rocks (the Avon Park Formation and Ocala Group) and appear to be absent at greater depth. Snyder et al. (1989) suggest that the apparent displacement of Miocene and Eocene sediments along the St. Johns River is due to very long-term subsidence caused by paleokarst solution collapse within the Eocene carbonates.

HYDROSTRATIGRAPHIC UNITS

The clastic and carbonate sediments beneath the study area can be grouped into three aquifers bounded by three confining layers (Figure 4). These hydrostratigraphic units apply throughout the study area and can be considered subsets of the larger-scale hydrostratigraphic units that apply throughout SJRWMD. The characteristics of each of these six hydrostratigraphic units are described in the following sections.

Surficial Aquifer System

The uppermost unit is the surficial aquifer system, which consists of Pleistocene to Recent age sand, silt, clayey sand, and shell beds. It is equivalent to the surficial aquifer system described by Tibbals (1990) for the entire east-central Florida region. It is also equivalent to the upper permeable zone of the surficial aquifer system described in Volusia County by Phelps (1990), and the upper, unconfined part of the surficial aquifer system (Southeastern Geological Society 1986) that exists throughout SJRWMD. The thickness of the aquifer system ranges from less than 10 ft in places where a significant thickness of clay material is near the surface to greater than 100 ft where sands have filled sinkhole depressions in karstic areas. The top of the surficial aquifer system (the water table) is generally at or within a few feet of land surface in swampy lowlands and in the flatlands of central Flagler and central Volusia counties. In the karstic highlands, the water table can be found several tens of feet below land surface.

Few data are available that quantify the hydraulic parameters of the water table sediments. McGurk et al. (1989) reported values of horizontal hydraulic conductivity derived from slug tests at six sites in Volusia County that ranged from 0.07 to 12.8 feet per day (ft/day). Phelps (1990) reported hydraulic conductivities estimated from pump tests in northeastern Volusia County by Gomberg (1980, 1981) ranging from 4 to 110 ft/day.

The surficial aquifer system receives recharge from rainfall through the unsaturated zone. The largest rates of recharge occur where the unsaturated zone is relatively thick and consists of permeable sand. The Floridan aquifer system also supplies recharge to the surficial aquifer system in lowland areas where the potentiometric surface of the Floridan aquifer system is higher than the water table.

Upper Semiconfining Unit

The top of the upper semiconfining unit (USCU) occurs where poorly permeable beds are thick enough to separate the sands of the water table aquifer from deeper, more permeable sediments. The USCU contains unconsolidated sand, silt, clay, and shell and consolidated beds of shell, limestone, and dolomite of Miocene and Pliocene age. Pleistocene clay or silt beds may also be considered part of the USCU if they are relatively thick. Thin, discontinuous lenses of permeable sand, shell, and limestone form locally important secondary artesian aquifers within the USCU. Note that, in this report, the lower part of the surficial aquifer system defined by the Southeastern Geological Society (1986) and described in Volusia County by Phelps (1990) constitutes the upper part of the USCU. The total thickness of the USCU generally varies between 20 and 70 ft. Some sinkhole depressions may be totally filled with permeable sand, and the USCU is very thin or essentially absent in these locations. The designation upper semiconfining unit, rather than upper confining unit (as used in the RASA study), is appropriate for this study area because the USCU is relatively thin compared to other areas of SJRWMD and because of the abundance of sinkhole depressions throughout the WVSP area.

Estimates of hydraulic properties of the USCU consist of horizontal hydraulic conductivity derived from slug tests and pump tests and of vertical hydraulic conductivity derived from permeameter tests from core samples. Phelps (1990) reported a horizontal hydraulic conductivity of approximately 30 ft/day from a pump test conducted on a well open to a secondary artesian aquifer in southeastern Volusia County. Phelps (1990) also listed vertical conductivity estimates from cores collected in Volusia County ranging from 7.6×10^{-5} ft/day to 0.34 ft/day. No direct field estimates of vertical conductivity of the USCU are known to have been collected within the study area.

The USCU limits the transfer of groundwater between the water table aquifer and the Floridan aquifer system. The amount of water transferred between the two aquifers depends upon the head difference between the water table aquifer and the Floridan aquifer system and upon the leakance coefficient of the USCU. The leakance coefficient is the ratio of the vertical hydraulic conductivity of the USCU to its thickness. Leakance values have been estimated from the results of pump tests conducted on wells drilled into the Upper Floridan aquifer. Reported values vary between 4×10^{-5} day^{-1} and 1.5×10^{-2} day^{-1} (Szell 1993). These values, however, are sometimes higher than the actual leakance of the USCU, because the pump test results are affected by water derived from portions of the Floridan aquifer system that are deeper than the interval tested.

Floridan Aquifer System

In east-central Florida, the Floridan aquifer system (Figure 4) can be subdivided vertically into two productive units (the Upper and Lower Floridan aquifers) separated by a less productive unit (Tibbals 1990). The Upper Floridan aquifer (uppermost productive unit) provides the majority of groundwater used for municipal supplies, agricultural irrigation, industrial self-supply, and domestic supply. The geologic units included within the Upper Floridan aquifer are the Ocala Limestone (where present) and approximately the upper one-third of the Avon Park Formation (Figure 4). The thickness of the Upper Floridan aquifer is approximately 300 to 350 ft throughout Volusia County, but it increases across southeastern Putnam County and Flagler County to over 650 ft in northeastern Flagler County (Miller 1986, Plate 28). The top of the Upper Floridan aquifer is near land surface at major springs such as Blue Spring, Croaker Hole Spring, and Ponce de Leon Springs (Figure 2), but drops to as much as -175 ft NGVD near the coastal border of Flagler and St. Johns counties.

The Upper Floridan aquifer is separated from the Lower Floridan aquifer (lower productive unit) by a less permeable, soft, chalky limestone and hard dolomitic limestone sequence termed the middle semiconfining unit (MSCU) (Tibbals 1990) (Figure 4). The MSCU makes up approximately the middle one-third of the Avon Park Formation. Its thickness ranges from approximately 150 ft in southeastern Putnam County and northwestern Flagler County to greater than 500 ft in northeastern Volusia County. In western Volusia

County, the thickness of the MSCU is between 200 and 400 ft (Tibbals 1990, Figure 13).

The geologic units comprising the Lower Floridan aquifer are the lower part of the Avon Park Formation, the Oldsmar Formation, and the upper part of the Cedar Keys Formation. The Lower Floridan aquifer gradually increases in thickness from 1,100 ft in northern Flagler County to greater than 1,500 ft in southeastern Volusia County.

Lower Confining Unit

The lower confining unit is made up of a combination of anhydrite beds and gypsiferous and anhydritic carbonate beds. These beds have a very low permeability and serve as the hydraulic base of the Floridan aquifer system (Tibbals 1990). In the study area, the base of the Floridan aquifer system ranges from approximately 1,850 ft below NGVD in the northwest to approximately 2,300 ft below NGVD in the southeast.

Observed Water Levels and Groundwater Flow Patterns

The water level measured in a well that is cased to a particular depth within the Floridan aquifer system represents the potentiometric level, or hydraulic head, at that location averaged over the interval penetrated by the well. Hydrographs of water levels from wells completed within the Upper Floridan aquifer indicate that hydraulic heads fluctuate in response to annual rainfall patterns. Heads are usually highest in the late summer and early fall during the wet season, and lowest during late spring after several months of low rainfall. The average of the springtime low potentiometric level and the late summer high potentiometric level can be considered the average, quasi-steady-state (relatively unchanging) potentiometric level for that year. However, for the several years preceding 1992, 1988 was the most recent in which the normal pattern of springtime low rainfall and potentiometric levels, followed by late summer high rainfall and potentiometric levels, occurred within the study area (Figure 5).

USGS prepares potentiometric surface maps of water levels in the Upper Floridan aquifer as measured in May and September of each year. A contour map of the average 1988 potentiometric surface of the

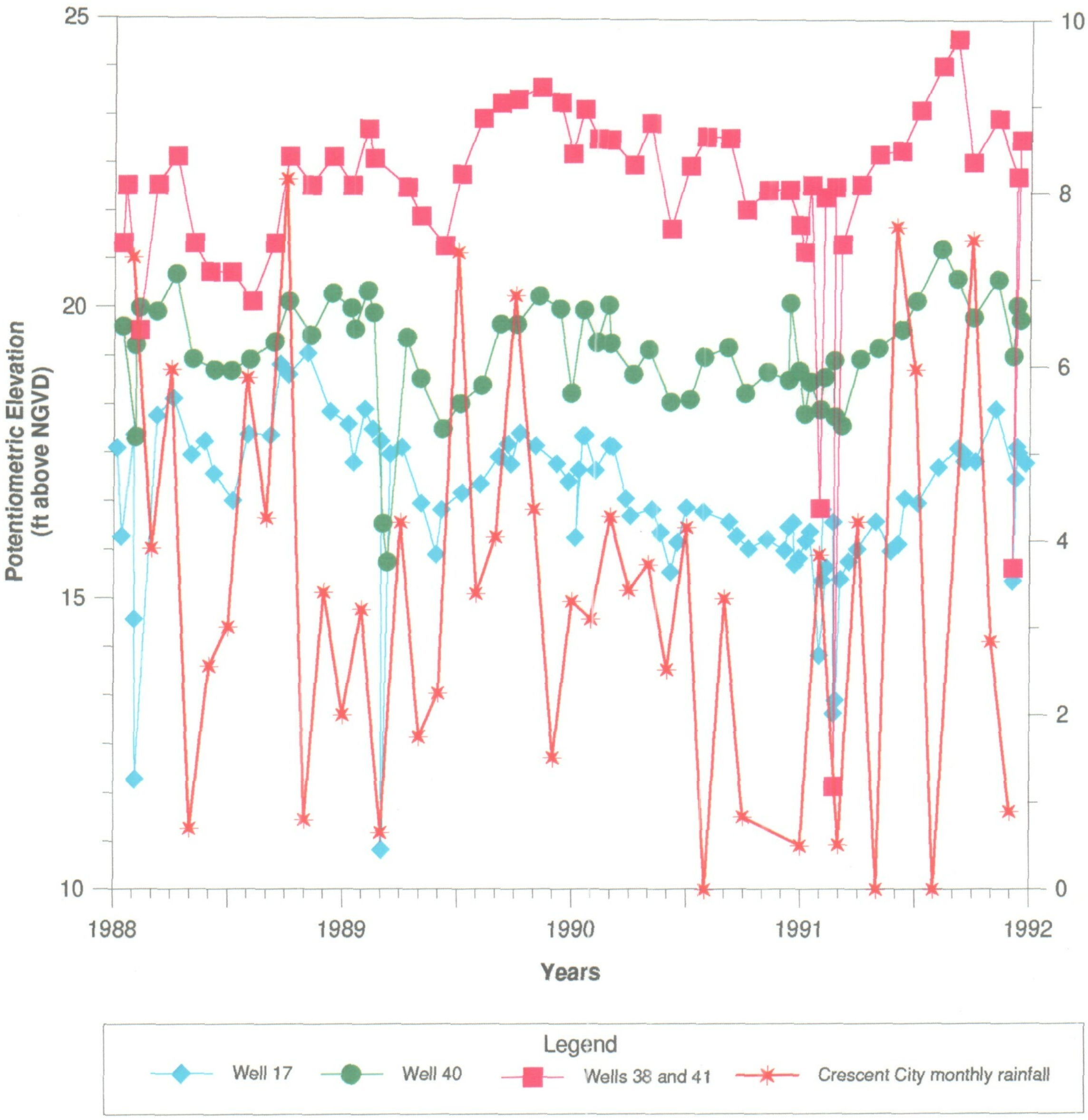


Figure 5. Potentiometric levels of the Upper Floridan aquifer and monthly rainfall patterns

Upper Floridan aquifer was derived by digitizing the May and September 1988 maps (Schiner 1988 and Rodis 1989, respectively) and averaging the digitized values throughout the study area (Figure 6). The elevation of this potentiometric surface ranges from approximately -5 ft NGVD at the coast in the Daytona Beach area to greater than 35 ft NGVD in central Volusia County, northeastern Lake County, and northwestern Seminole County. Within the WVSP area,

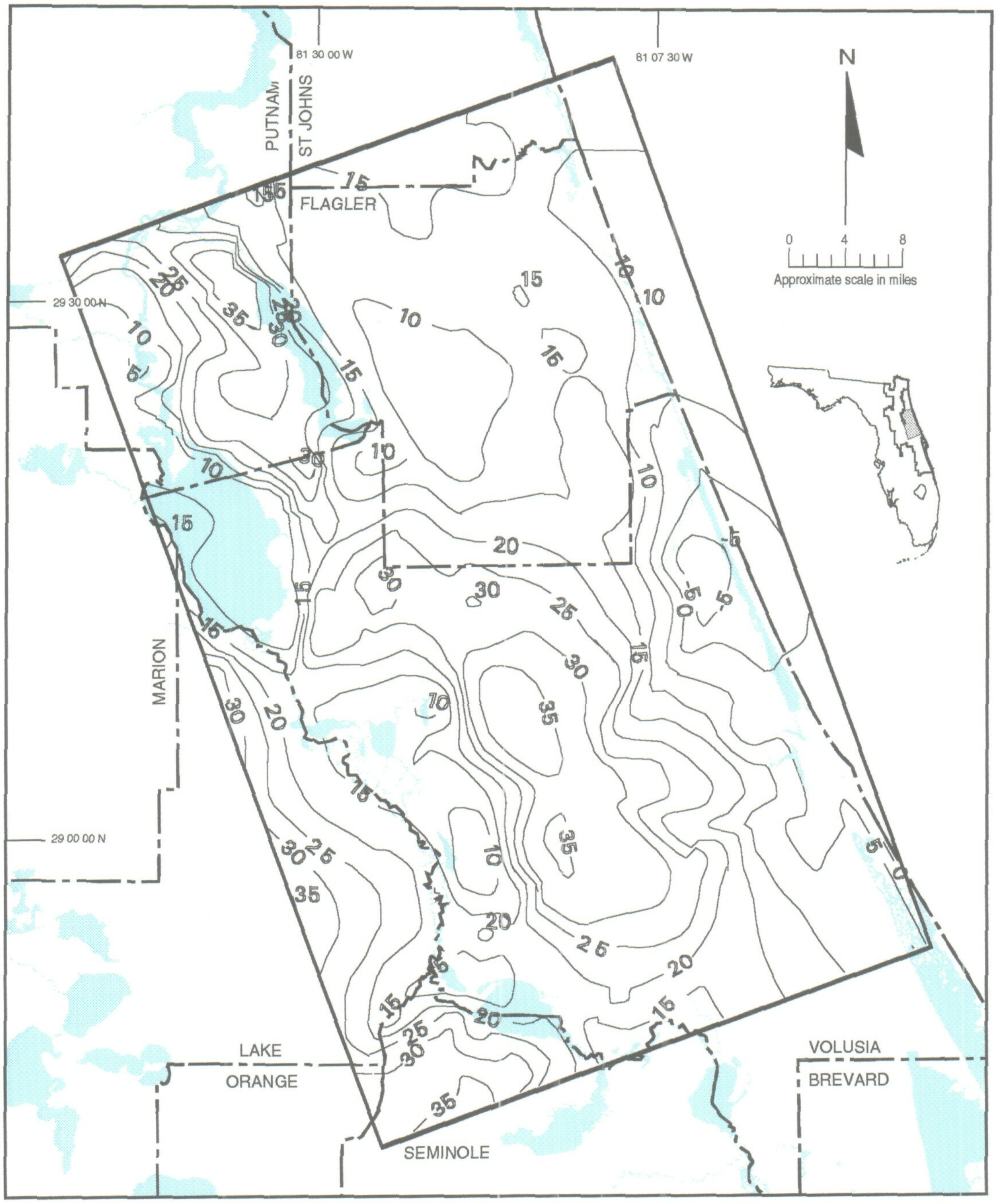


Figure 6. The average 1988 potentiometric surface of the Upper Floridan aquifer (Schiner 1988; Rodis 1989)

Legend

— —	County boundary
—20—	Elevation, ft NGVD
	Water body

high areas (greater than 25 ft NGVD) exist along the Crescent City Ridge in southeastern Putnam County and northwestern Volusia County and across central Volusia County. Groundwater within the Upper Floridan aquifer within the study area flows in all directions from these high areas to discharge along the coast and along the St. Johns River.

USGS also has published a map of the estimated potentiometric surface of the Upper Floridan aquifer prior to development (Johnston et al. 1980) or the commencement of major groundwater withdrawals (Figure 7). The average 1988 surface (Figure 6) is noticeably lower than the estimated predevelopment surface in much of the study area (Figure 7), particularly in eastern Volusia County and on the Crescent City Ridge north of Pierson. There is evidence that the elevation of the estimated predevelopment potentiometric surface (Figure 7), is possibly overestimated in northwestern Volusia County. The long-term hydrograph of data from wells 38 and 41 near Seville (Figures 2 and 8, part C; see Appendix A) shows water levels consistently around 25 to 26 ft NGVD as long ago as 1936, whereas on Figure 7, Seville is included within the area enclosed by the 30-ft contour. The 1988 cumulative average (the average computed for each value in a time series that includes all previous data values) of the potentiometric elevation at well 38 is approximately 2 ft lower than the 1936 cumulative average.

The concept of a potentiometric surface is rigorously valid only for horizontal flow in horizontal aquifers (Freeze and Cherry 1979). When water flows vertically, a well open to only the upper part of the Upper Floridan aquifer may have a different hydraulic head than a well at the same location that is open to only the bottom part of the Upper Floridan aquifer. Evidence of this is shown by hydrographs of four wells located in a cluster on the shore of Lake George in southeastern Putnam County (Figure 9). Observed head values in well 25 (Appendix A), which is open to the bottom of the zone of freshwater within the Upper Floridan aquifer (330 to 360 ft below land surface [bls]), are approximately 3 ft higher than those in well 26, which is open to the top 30 ft of the Upper Floridan aquifer. The average head of the Upper Floridan aquifer at this site for the time period shown is probably between 7 and 10 ft NGVD. In an area of relatively high recharge to the Upper Floridan aquifer, such as the Crescent City Ridge or De Land Ridge, the uppermost part of the Upper Floridan

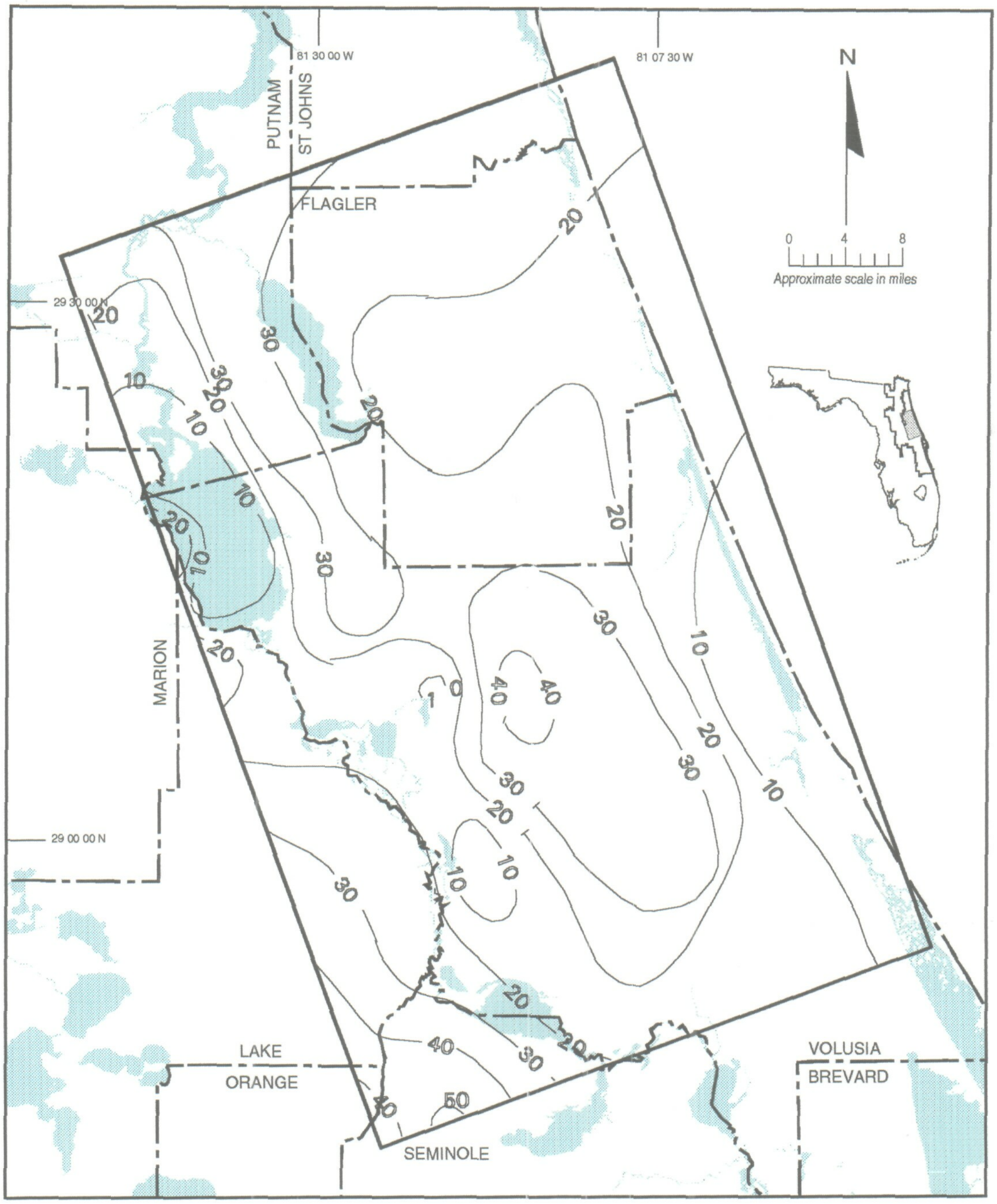


Figure 7. Estimated potentiometric surface of the Upper Floridan aquifer prior to development (Johnston et al. 1980)

Legend
- County boundary
- 20 Elevation, ft NGVD
- Water body

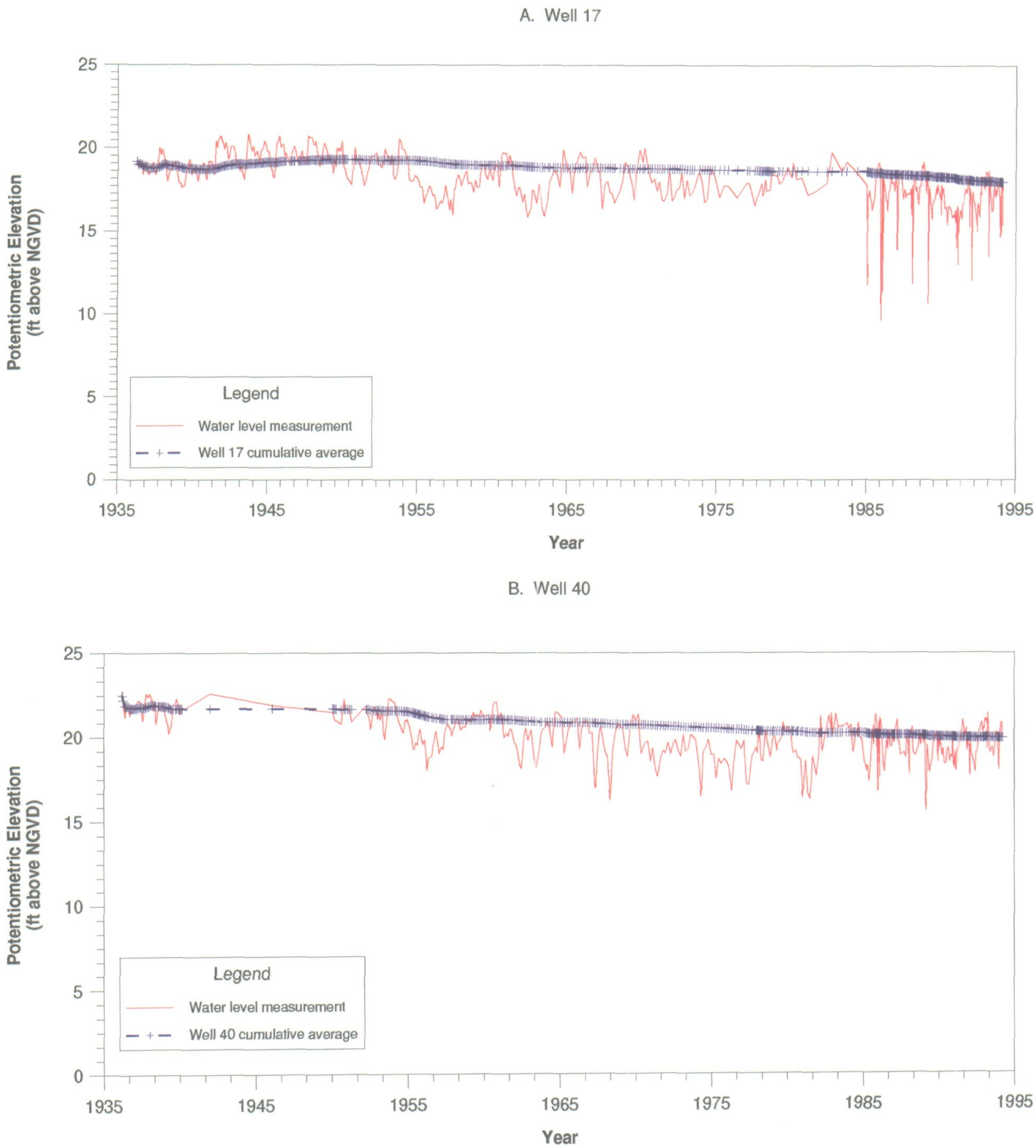


Figure 8. Long-term hydrographs of observation wells completed in the Upper Floridan aquifer

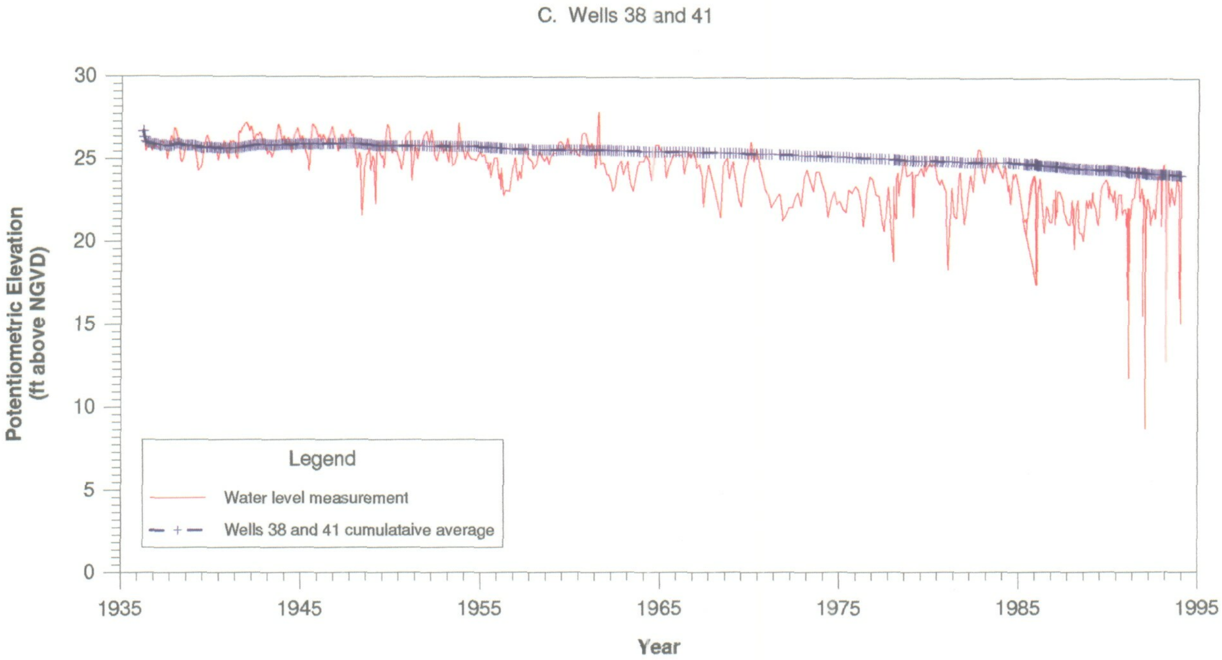


Figure 8—*Continued*

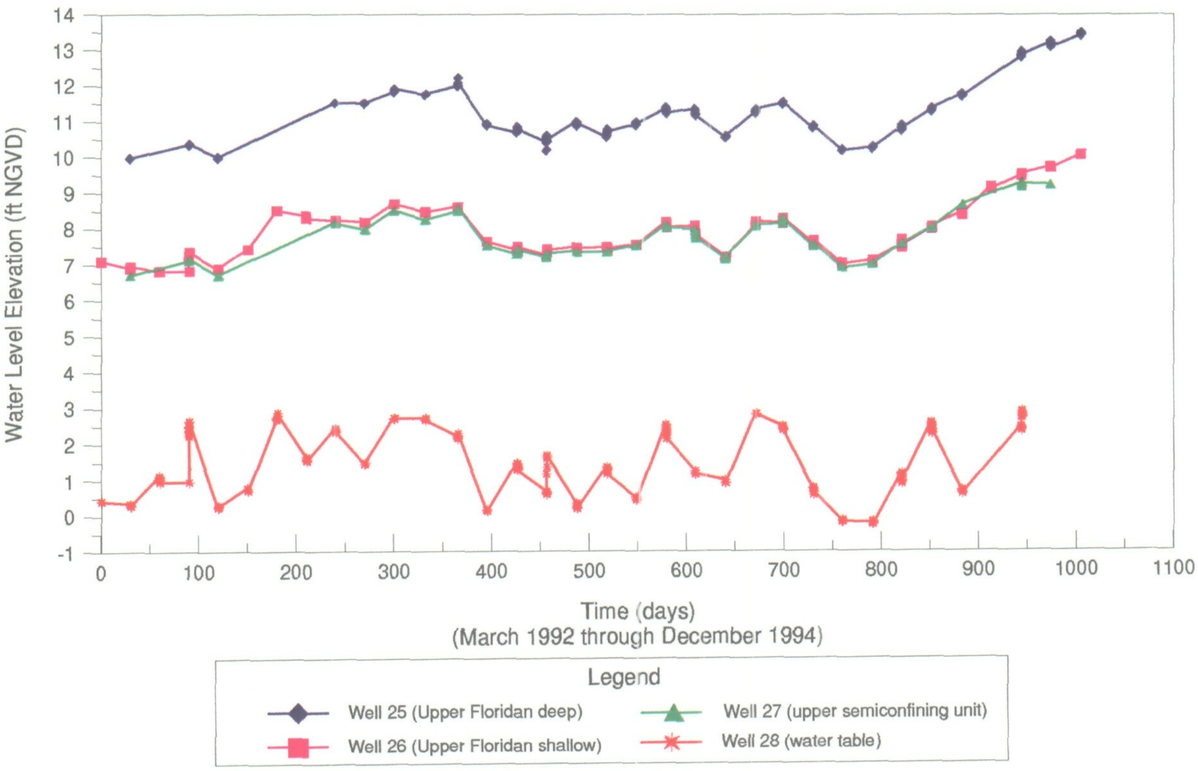


Figure 9. Hydrographs of a cluster of observation wells near Lake George

Few observation wells have been constructed that measure heads in the MSCU and the Lower Floridan aquifer. Hydrographs constructed using data from the few observation wells that exist suggest that hydraulic head in the Lower Floridan aquifer is lower than hydraulic head in the Upper Floridan aquifer in recharge areas and higher than hydraulic head in the Upper Floridan aquifer in discharge areas (e.g., Figure 72 in Tibbals 1990). Head values in the MSCU are apparently intermediate between those in the two more permeable units.

The sudden, short-term drops depicted on hydrographs of wells completed in the Upper Floridan aquifer and USCU wells (Figure 10) represent drawdown due to withdrawals from the Upper Floridan aquifer for frost-and-freeze protection. Drawdowns of more than 40 ft in wells open to the Upper Floridan aquifer have been recorded in the Pierson area when large-scale withdrawals occur during a freeze.

Hydraulic Characteristics

The hydraulic characteristics of the Floridan aquifer system are described by the transmissivity and storativity of the two aquifer layers (Upper and Lower Floridan aquifers) and by the leakance coefficient of the MSCU. Transmissivity and storativity values for the Upper Floridan aquifer have been listed in a compendium of aquifer test results by Szell (1993). The reported transmissivity values derived from tests conducted within the study area range from 3,743 square feet per day (ft^2/day) to 160,000 ft^2/day. There are no reported field values of transmissivity for the Lower Floridan aquifer within the study area.

Transmissivity estimates are also available from several regional groundwater flow models (Blandford and Birdie 1992; Bush 1978; Mercer et al. 1984; GeoTrans 1992; Tibbals 1990; Geraghty and Miller 1992). Values obtained from calibrations of these models for the Upper Floridan aquifer range from approximately 2,500 ft^2/day to approximately 900,000 ft^2/day. According to Tibbals (1990), model-derived transmissivity estimates are often greater than those derived from pump tests because the wells used in pump tests generally tap less than the full thickness of the aquifer, and the resulting transmissivity value is less than the actual value due to partial penetration effects. In addition, the highly heterogeneous and anisotropic nature of the Floridan aquifer system causes the

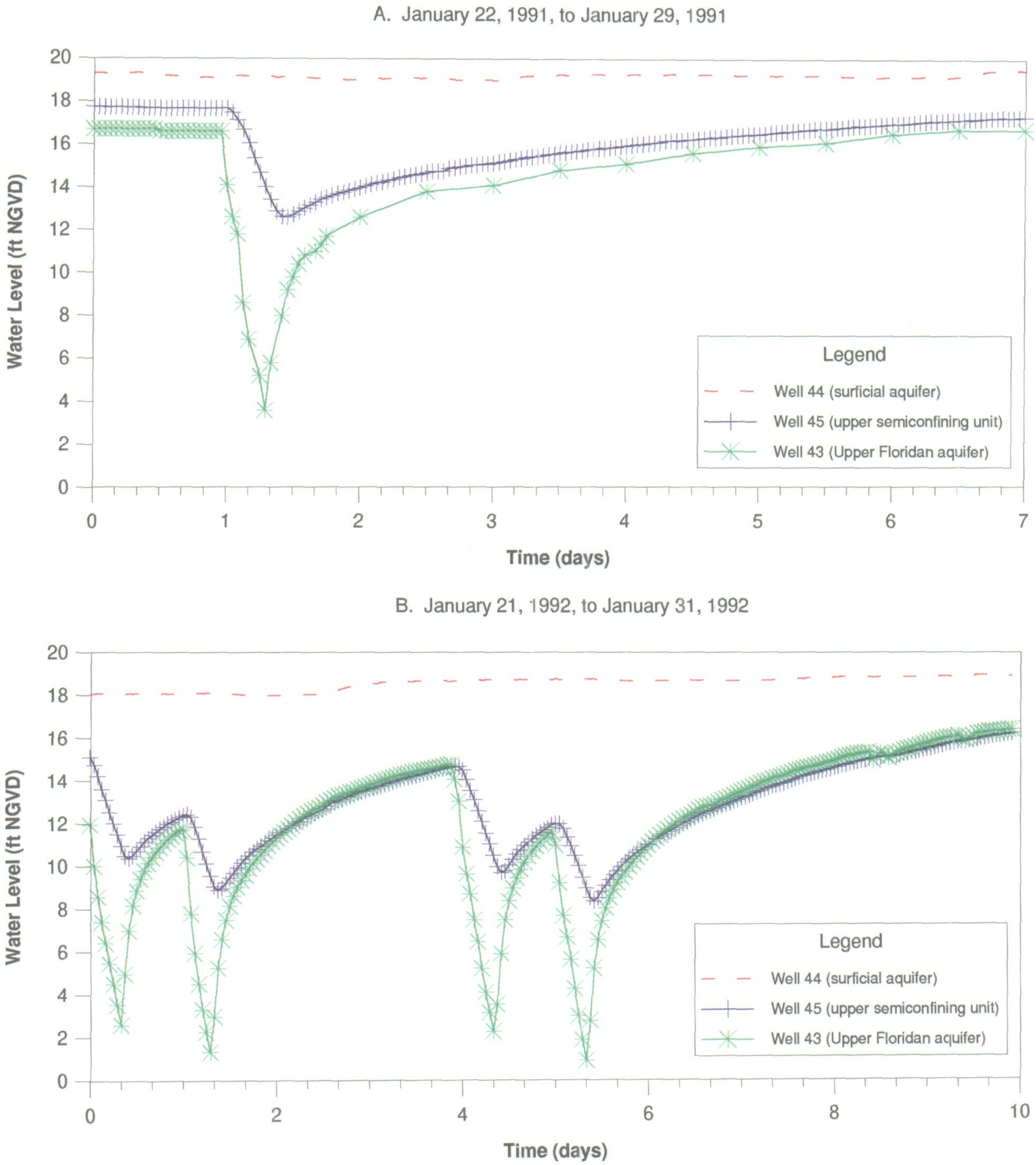


Figure 10. Recorded water level elevation differences between the surficial aquifer system, upper semiconfining unit, and Upper Floridan aquifer from an observation well cluster near Pierson, Volusia County

application of standard aquifer test methods to be uncertain. Within the WVSP area, both field-derived and model-derived transmissivity estimates are in agreement in a regional sense. The lowest values generally represent areas in central Volusia County and on parts of the Crescent City Ridge; the highest values generally represent karstic areas near springs.

Storativity values reported from tests of the Upper Floridan aquifer range from 1.65×10^{-5} to 5.0×10^{-3} (Szell 1993). Tibbals (1990) reported a uniform storativity of 1.0×10^{-3} for both the Upper and Lower Floridan aquifers from a transient calibration of the east-central Florida RASA model.

Data describing the leakance of the MSCU are very limited. Field-derived estimates of the leakance of the MSCU are not available. Laboratory estimates of vertical hydraulic conductivity from permeameter tests of core samples are available from two sites south of the study area. Navoy (1986) reported vertical hydraulic conductivities of 4×10^{-4} ft/day and 1.2×10^{-2} ft/day from a test hole site in the Green Swamp area of southern Lake County. Post, Buckley, Schuh, and Jernigan (1990) reported a core-derived estimate of 2.0×10^{-4} ft/day from an aquifer performance test site in eastern Osceola County. The latter report also lists a range of vertical hydraulic conductivity estimates derived from an analysis of drawdown data collected directly from piezometers installed within the MSCU. These values range from 5.0×10^{-3} ft/day to 1.24 ft/day.

A potential range of leakance can be computed by dividing the reported hydraulic conductivities from outside the study area by the estimated range of thickness of the MSCU within the study area (150–500 ft). The resulting minimum leakance is 4.0×10^{-7} day^{-1}, and the resulting maximum leakance is 8.0×10^{-3} day^{-1}. Tibbals (1990) used a uniform value of 5.0×10^{-5} day^{-1} in his flow model, except in the vicinity of Blue Spring in western Volusia County, where a value of approximately 0.05 day^{-1} was used.

Recharge and Discharge

Groundwater enters, or recharges, the Floridan aquifer system wherever the hydraulic head in the USCU is above the potentiometric surface of the Upper Floridan aquifer. Groundwater discharges from the Floridan aquifer system wherever the potentiometric surface of the Upper Floridan aquifer is higher than the hydraulic head in the USCU. The hydraulic head within the USCU is generally intermediate between that within the surficial aquifer system and the Upper Floridan aquifer so that groundwater is transferred through the USCU from one aquifer to the other. The rate at which groundwater can pass through the USCU depends upon the leakance (vertical hydraulic conductivity divided by thickness) of the USCU and the difference in hydraulic head between the two aquifers.

The major areas of recharge to the Floridan aquifer system within the study area are the Crescent City and De Land ridges and the rolling highlands in northeastern Lake County just west of the St. Johns River. In these areas, the elevation of the water table is often significantly above that of the potentiometric surface of the Upper Floridan aquifer. Leakance of the USCU is often greater in these areas than elsewhere because of the relative thinness of the USCU and because of the abundance of sinkholes that are at least partially infilled with permeable sand.

Average annual rates of recharge to the Upper Floridan aquifer on the Crescent City and De Land ridges have been estimated in several different ways. Rutledge (1982), using flow-net analysis, calculated average areal recharge rates in northwestern Volusia County of up to 13.4 in/yr. Boniol et al. (1990, 1993) used a geographic information system methodology to compare maps of USCU thickness, water table elevation, and the potentiometric surface of the Upper Floridan aquifer in the Crescent City Ridge area of southeastern Putnam County and throughout SJRWMD, respectively. These maps were used with a uniform vertical hydraulic conductivity value for the USCU to compute potential recharge rates of up to 18 in/yr. Vecchioli et al. (1990) used an approach similar to that of Rutledge (1982) to estimate recharge rates on the De Land Ridge in western Volusia County. They divided the long-term average discharge rates of Blue Spring and Ponce de Leon Springs by their respective contributing drainage areas (total drainage area minus area of artesian flow) to obtain estimates of minimum recharge rates. They also divided the same long-term average discharge rates by the respective estimated areas of internal drainage (no surface runoff) to obtain estimates of maximum recharge rates. The resulting estimates range from 5.8 to 18.4 in/yr. Tibbals

(1990) reports model-derived areal recharge rates in the Crescent City Ridge and De Land Ridge areas as high as 13 in/yr.

With the exception of the values reported by Boniol et al. (1990), the recharge rate estimates reported above are average rates for areas of at least 16 square miles (mi^2) (the grid cell size in Tibbals' regional model). Tibbals (1990) states that, locally, areal average recharge rates are probably as high as 20 in/yr. The estimates made by Boniol et al. (1990, 1993) are dependent upon a constant uniform vertical hydraulic conductivity throughout the areas mapped. Thus, localities with a different vertical conductivity could have a different annual average recharge rate than that estimated in those studies.

The maximum rate of recharge in the internally drained portions of southeastern Putnam and western Volusia counties depends upon the amount of rainfall and the rate of evapotranspiration. This dependency occurs because runoff does not leave the area and rain that falls upon the ground either must return to the air via evapotranspiration or it must infiltrate to the water table. According to Tibbals (1990), in east-central Florida the minimum rate of evapotranspiration, about 30 in/yr, occurs where the water table is greater than 13 ft bls. If the average annual rainfall in the WVSP area is assumed to be 52 in/yr, then in those parts of the karstic ridges where the water table is greater than 13 ft bls, 22 in/yr is available for recharge to the water table aquifer. Values higher than 22 in/yr also may be possible in closed sinkhole depressions that collect and concentrate runoff from the surrounding terrain (Tibbals, USGS, pers. com. 1991). In many closed-depression areas, all water recharged to the water table aquifer ultimately reaches the Upper Floridan aquifer.

Groundwater discharges from the Floridan aquifer system via diffuse upward leakage, pumping wells, abandoned artesian (free-flowing) wells, and springs. The major areas of diffuse upward leakage from the Floridan aquifer system include the St. Johns River valley, Crescent Lake and the lower reaches of the Haw Creek drainage area, and the Atlantic Ocean. The potentiometric surface of the Upper Floridan aquifer in these areas is at least several feet above land surface (or sea level, in the case of the Atlantic Ocean). High resolution seismic surveys conducted in the St. Johns River valley (Snyder et al. 1989) and offshore (Meisburger and Field 1976; Popenoe et al. 1984) revealed karstic features that apparently were infilled with sands, suggesting that the USCU may be very leaky in these areas. Examples of computer-derived rates of diffuse upward leakage are 15.9 in/yr (Mercer et al. 1984), 16 in/yr (Geraghty and Miller 1992), and 7 in/yr (Tibbals 1981, 1990). As with computer-derived recharge rates, however, these are average discharge rates for the areas included within the boundaries of grid cells in regional models. Discharge rates at specific locations conceivably could be greater.

Steele (1991) inventoried 86 abandoned artesian wells existing within the study area in 1990. Flow measurements are available from only 17 of these wells. The sum of these flow rates equals 2.1 mgd of water discharging from the Upper Floridan aquifer. Fifty-nine of the remaining 69 free-flowing wells are located within Seminole County.

Thirteen documented springs within the study area discharge groundwater from the Upper Floridan aquifer (Figure 2 and Table 3). Data concerning measured rates of flow at most of these springs are limited. The flow rate at Blue Spring has been measured on a bimonthly basis since 1932. Flow rate at Ponce de Leon Springs has been measured periodically since 1965; it had been measured on an infrequent basis several times before then. The total estimated predevelopment spring flow is approximately 296.0 cfs, or 191.1 mgd (Table 3). Total average measured spring flow equals 294.0 cfs, or 189.9 mgd.

Water Quality

The following brief description of water quality within the Floridan aquifer system is limited to a discussion of the areal distribution of fresh and saline groundwater. Fresh groundwater is that which has a total dissolved solids (TDS) concentration of less than 1,000 mg/L (Todd 1980; Tibbals 1990). Chloride ion concentration is a common indicator of saline water content. In terms of feasibility for drinking, fresh groundwater can be defined as that which has a chloride concentration of less than 250 mg/L (EPA Secondary Drinking Water Standard for chloride). Maps prepared by Sprinkle (1989) and Tibbals (1990) show that areas of low TDS and chloride concentrations correspond with good recharge areas (e.g., the Crescent City and De Land ridges), and areas of high TDS and chloride concentrations correspond with the major discharge areas. Average chloride concentration in water from the Upper Floridan aquifer along the

Table 3. Locations and flow rates of springs discharging from the Upper Floridan aquifer within the study area

Spring Name	Latitude	Longitude	Estimated Predevelopment Flow*		Average Measured Flow†		Date Measured/ Period of Record†
			cfs	mgd	cfs	mgd	
Beecher Springs	29 26 54	81 38 49	9.0	5.8	9.8	6.3	4/72, 1/85, 1995–98
Blue Spring	28 56 38	81 20 24	160.0	103.4	159.0	102.7	1932–98
Croaker Hole Spring	29 26 18	81 41 21	80.0	51.7	77.0	49.8	9/81, 9/91
Forest Springs	29 27 25	81 39 35	—	—	0.3	0.2	6/72, 1995–98
Gemini Springs	28 51 44	81 18 39	8.0	5.0	9.5	6.2	4/72, 1996–98
Green Springs	28 51 45	81 14 55	—	—	1.3	0.8	3/32 to 4/72**, 1996–98
Island Springs	28 49 22	81 25 03	6.0	3.9	6.1	3.9	5/82
Mud Spring	29 27 35	81 39 45	—	—	1.3	0.8	6/72, 1995–98
Nashua Spring	29 30 33	81 40 34	—	—	0.4	0.3	3/72
Ponce de Leon Springs	29 08 02	81 21 47	31.0	20.0	28.2	18.2	1929–98§
Satsuma Spring	29 30 45	81 40 32	2.0‡	1.3‡	1.1	0.7	3/72, 1993–98
Seminole Spring (Volusia County)	28 50 44	81 14 05	—	—	< 0.1	< 0.1	4/72
Welaka Spring	29 29 35	81 40 25	—	—	ND	ND	Not measured
Total			296.0	191.1	294.0	189.9	

Note: — = no predevelopment estimates
cfs = cubic feet per second
mgd = million gallons per day
ND = no data

*Tibbals 1981, 1990
†St. Johns River Water Management District database files
‡Includes Nashua Spring
§Occasional measurements before 1965, monthly or bimonthly since 1965
**Periodic measurements

St. Johns River from Lake Monroe downstream to near Satsuma Spring is generally greater than 1,000 mg/L. The same is true along the coast from southern St. Johns County south (Sprinkle 1989, Plate 6).

The Lower Floridan aquifer contains water with higher chloride and TDS concentrations than that in the Upper Floridan aquifer in both recharge and discharge areas (Sprinkle 1989; Tibbals 1990). A significant thickness of freshwater exists within the Lower Floridan aquifer beneath the potentiometric highs in central Volusia County and southeastern Putnam County. Two recent geophysical surveys conducted in central Volusia County by Blackhawk Geosciences (1992) indicated depths below land surface to the 250 mg/L isochlor of 1,087 ft at a location approximately 10 miles (mi) northeast of De Land and 909 ft at another location approximately 9 mi east of De Land. Chloride concentrations in 10 water samples collected from an observation well open to the top 200 ft of the Lower Floridan aquifer in Pierson (well 51, Appendix A) have averaged 20 mg/L.

The Floridan aquifer system within the study area has been described by Tibbals (1990) as a relatively vigorous, mostly freshwater, flow system (the Upper Floridan aquifer) overlying a more sluggish flow system (the Lower Floridan aquifer), which is in many places very brackish or saline. According to Tibbals (1990), most of the highly mineralized water in the Upper Floridan aquifer is probably a mixture of freshwater and relict seawater remaining from a previous period of higher sea level. Some of this water is in the process of being flushed from the groundwater flow system. In discharge areas such as the St. Johns River valley, some of the highly mineralized water is the result of upward flow from the more saline Lower Floridan aquifer, possibly along solution-enlarged fractures and/or faults.

REGIONAL GROUNDWATER FLOW MODEL

The hydrogeologic framework described in the previous chapter provides the structure upon which the formulation of the conceptual model (and the subsequent construction of the numerical model) is based. The purpose of formulating a conceptual model is to simplify the real system for analysis without disregarding the important characteristics of the system (Anderson and Woessner 1992).

CONCEPTUAL MODEL

The conceptual model consists of three aquifer layers separated from one another by two semipervious confining layers (Figure 11). The surficial aquifer system (layer 1) is assumed to act solely as a source or sink bed for layer 2, the Upper Floridan aquifer. This means that, in the numerical model, heads for the surficial aquifer system vary spatially but are held constant at all times.

Flow between the surficial aquifer system and the Upper Floridan aquifer is dependent upon the difference in head between layers 1 and 2, as well as the leakance of the USCU. Likewise, flow between the Upper Floridan aquifer and the Lower Floridan aquifer (layer 3) is dependent upon the difference in head between layers 2 and 3, plus the magnitude of the leakance of the MSCU. Using the surficial aquifer system as a constant-head boundary layer avoids the necessity of having to prescribe recharge and evapotranspiration rates as upper boundary conditions to the numerical model. The flow system is bounded at its base by an impermeable boundary representing the confining unit of the Lower Floridan aquifer.

The groundwater flow system is conceptualized as quasi-three-dimensional. That is, groundwater flow is strictly horizontal within the aquifer layers and strictly vertical through the semiconfining units. The semiconfining units are thought of as membranes, allowing water to pass vertically through them from one aquifer layer to another. The assumption of strictly vertical flow through the semiconfining layers is valid because of the large contrast in hydraulic conductivity between the aquifers and the semiconfining units. The assumption of strictly horizontal flow in the aquifers is valid over most of the study area but

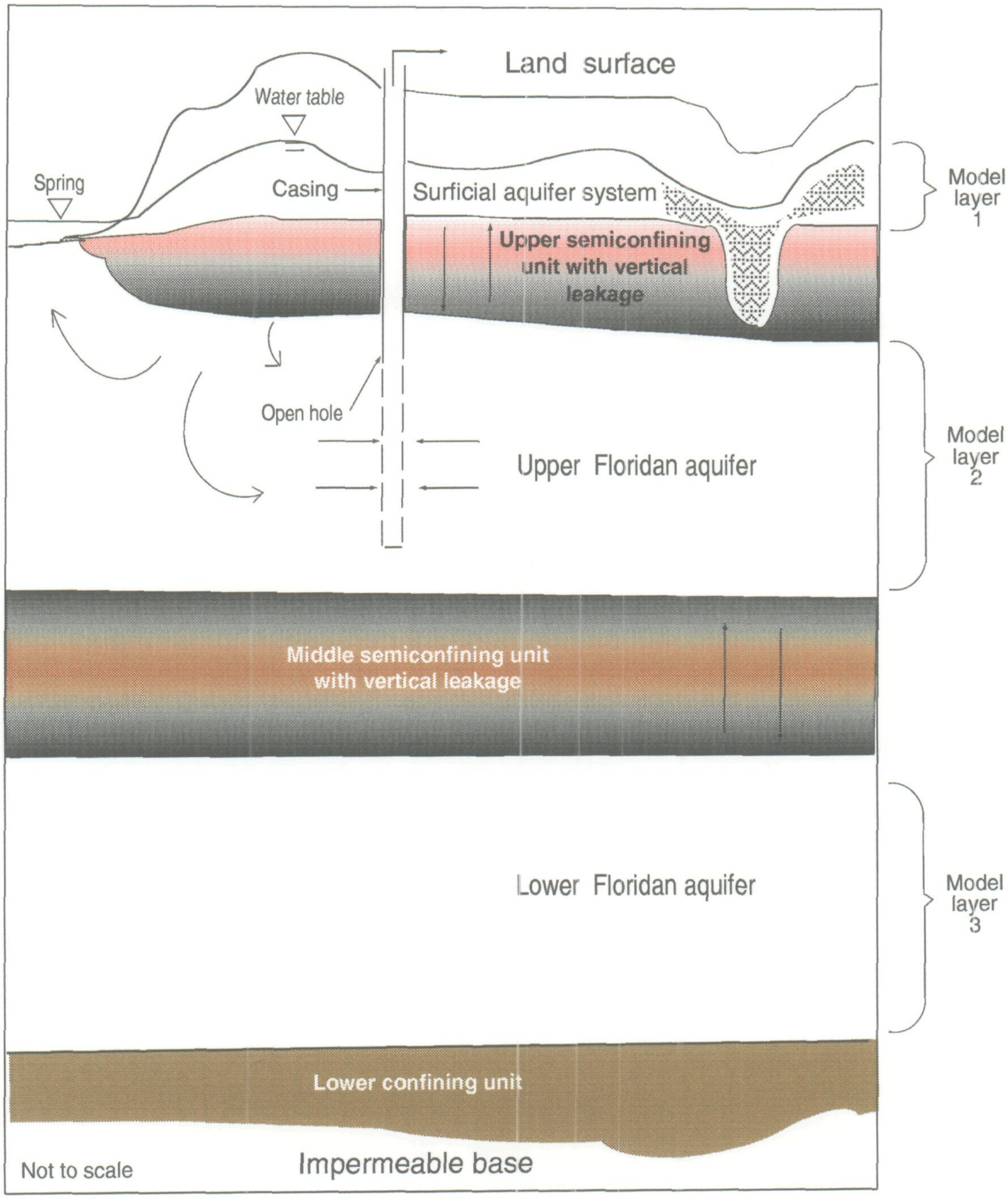


Figure 11. Conceptual model of the Floridan aquifer system in the western Volusia-southeastern Putnam area (adapted from Blandford and Birdie 1992)

may not be valid in areas with relatively high vertical gradients. Localized units of relatively high horizontal hydraulic conductivity within the semiconfining units are assumed to have no effect upon the vertical transfer of groundwater between aquifer layers.

The conceptual model portrayed by Figure 11 is similar to that used by GeoTrans (1992) to model groundwater flow in the Wekiva River Basin and by Tibbals (1981, 1990) to model regional groundwater flow throughout east-central Florida. It is also very similar to the approach taken by Blandford and Birdie (1992) to construct a regional groundwater flow model centered upon Orange and Seminole counties.

Numerical Model

The translation of the conceptual model into a numerical groundwater flow model, including computer code selection, grid design, assignment of boundary conditions, calibration, and sensitivity analysis, is discussed in the following sections.

Code Selection and General Assumptions

The computer code selected for use in this study is the MODFLOW code (McDonald and Harbaugh 1988). MODFLOW is a finite-difference code that employs block-centered discretization of the flow domain. MODFLOW is a public domain program that can incorporate a variety of boundary conditions; it is widely used and extensively documented.

The MODFLOW model contains several inherent assumptions concerning groundwater flow and boundary conditions. These assumptions (listed below) are consistent with the conceptual model described previously.

- Groundwater flow is laminar. Nonlaminar flow in individual fractures, faults, or solution cavities, for example, cannot be simulated.
- The effects of variable density and/or temperature are not considered. Therefore, in areas where the TDS concentration of the

groundwater is great enough to affect the pattern of groundwater flow, simulation results may be in error.

- Aquifer properties are assumed to be homogeneous within each grid cell. Hydraulic conductivity (or transmissivity) can be treated as anisotropic; however, if this is done, the finite-difference grid is assumed to be aligned with the principal directions of anisotropy.

- Pumping stresses are assumed to be distributed uniformly over each grid cell. If more than one pumping well is located within the boundaries of a grid cell, the program sums the individual withdrawals and computes a single head value for the cell.

Grid Design

The finite-difference grid is equal in size to the study area, encompassing Flagler County; southeastern Putnam County; most of Volusia County; and parts of Lake, St. Johns, and Seminole counties (Figure 12). The grid configuration is the same for all three layers (the surficial aquifer system and the Upper and Lower Floridan aquifers). Each layer consists of 90 rows and 45 columns, producing a total of 12,150 model grid cells. Fifteen grid cells along the eastern side of rows 89 and 90 (in the southeastern corner of the grid) are inactive in all three layers; thus, there are 12,105 active cells in the model. Note that model input values and simulation results are not shown for this portion of the grid on all subsequent map figures. Because layer 1 is a constant-head layer, head values are computed for the remaining 8,070 active grid cells that represent layers 2 and 3.

The grid was originally designed by hand on a 1:150,000-scale base map. The four grid corners were digitized, and the row and column spacings were used to print the grid on a new base map upon which final adjustments to the grid dimensions were made. Because the main regions of interest in this study are southeastern Putnam County and western Volusia County (the WVSP area), these regions were given the finest discretization. Within these areas, care was taken to align the boundaries of grid cells along topographic boundaries between regions of high elevation and regions of low elevation. This action was taken to minimize the number of grid cells that envelop areas of rapidly changing elevation, thus minimizing the number of cells that

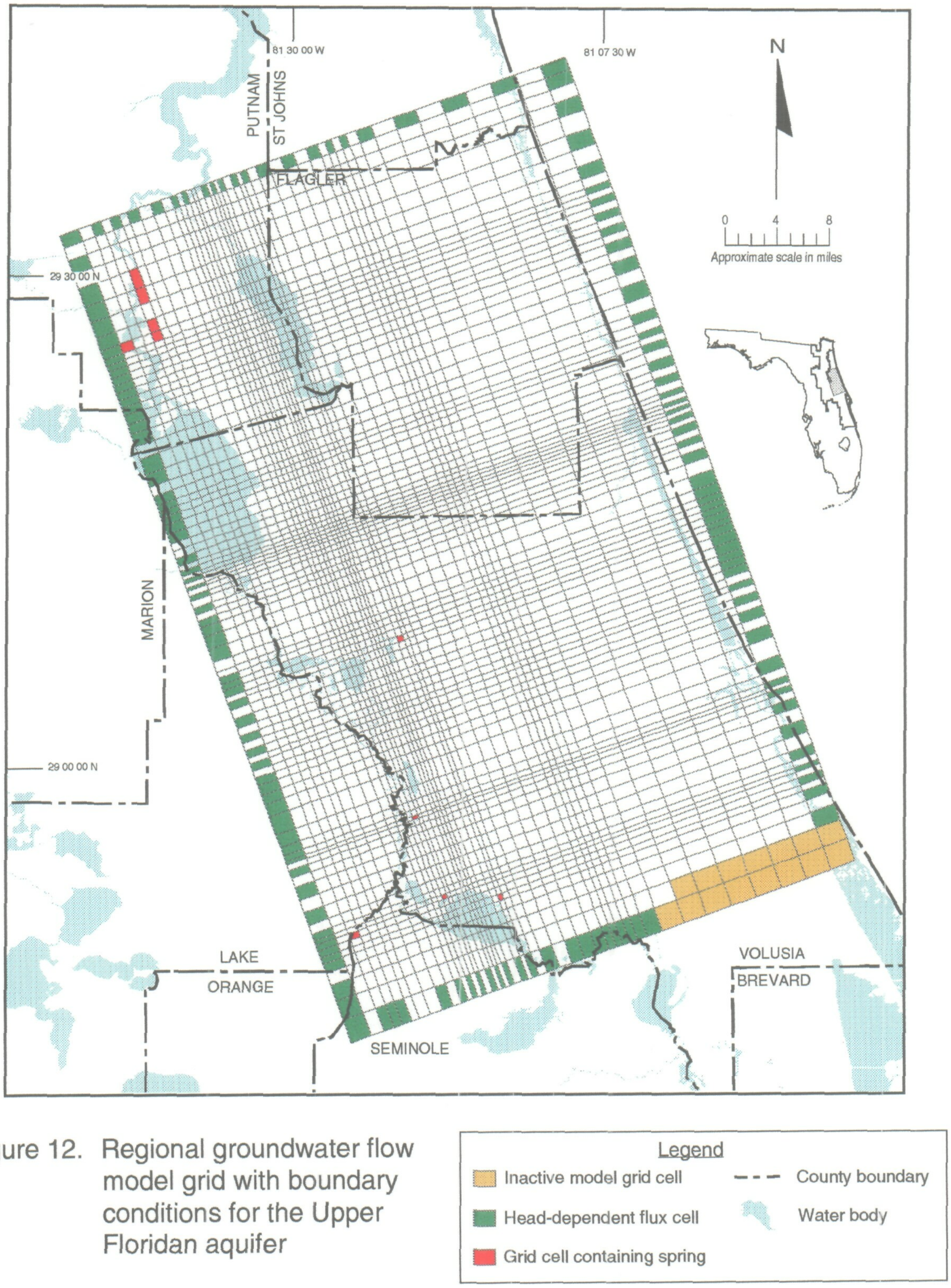


Figure 12. Regional groundwater flow model grid with boundary conditions for the Upper Floridan aquifer

include both recharge and discharge areas. The topographic boundaries are aligned along the edges of the Crescent City and De Land ridges, which trend roughly in a northwest-to-southeast direction. The model grid, therefore, is rotated 20 degrees west of north. The smallest row and column spacings are 1,500 ft; the largest are 10,000 ft. The row and column spacings and the coordinates of the grid corners are listed in Appendix B.

Initial Physical Parameters

An initial set of MODFLOW input files, representing a finite-difference grid with a uniform grid size of 1-minute latitude by 1-minute longitude (approximately 6,000 (5,500 ft) was available from the USGS regional office in Orlando. This data set was derived from the RASA-calibrated groundwater flow model of the entire east-central Florida region (Tibbals 1981, 1990). Physical parameters represented in the data set include head values for the surficial aquifer system and the Upper and Lower Floridan aquifers, leakance arrays for the USCU and the MSCU (identified in the MODFLOW input file as VCONT arrays), and transmissivity values for both the Upper and Lower Floridan aquifers.

Because of the different size of cells within the two finite-difference grids (several cells of the WVSP grid often fit within a single cell from the RASA grid), initial parameter and head values could not be transferred directly from one grid to the other. Instead, the data were transferred by overlaying both grids over a 1:150,000-scale base map. Units of parameter values from the RASA data set were drawn on the larger grid and extrapolated to the WVSP grid. The water table heads from the RASA model could not be extrapolated to the WVSP grid because of the disparity in grid cell sizes between the two models. Within much of the WVSP area the shape of the regional water table surface is highly variable. Applying the RASA values (which represent the average water table for 1-minute by 1-minute areas) to all of the corresponding cells in the WVSP grid that fit within a RASA cell would result in overestimation and/or underestimation of the water table elevation in many areas. Initial head estimates for the layers representing the Floridan aquifer system could be extrapolated, however, from one grid to the other because the MODFLOW solution scheme does not require a close initial estimate of the dependent variable.

Calibration Procedure

The model was calibrated using the following three stress conditions.

- Estimated steady-state predevelopment (unstressed) conditions
- Average steady-state 1988 conditions
- Transient conditions representing a freeze event that occurred during January 1991

The calibrations were conducted in a trial-and-error fashion by adjusting initial values of key hydrologic parameters, such as transmissivity, leakance, and storativity, until the computed head values in the layer for the Upper Floridan aquifer matched observed or estimated values. Estimated (predevelopment) and measured (postdevelopment) springflow rates also were used as calibration targets for the steady-state calibrations. In addition, simulated rates of recharge to and discharge from the Upper Floridan aquifer were compared to published estimates (Boniol et al. 1990, 1993; Rutledge 1982; Geraghty and Miller 1992; Tibbals 1990; Vecchioli et al. 1990).

The calibration simulations were conducted sequentially. The predevelopment calibration was begun first, then halted temporarily when a qualitative match was achieved to the estimated map of the predevelopment potentiometric surface of the Upper Floridan aquifer. The steady-state postdevelopment calibration was conducted by adding average groundwater withdrawals for 1988 to the predevelopment input files and adjusting boundary conditions to 1988 conditions. Calibration simulations were carried out until the computed results matched with the average measured head in 67 observation wells open to the Upper Floridan aquifer. Targets for the matching procedure were a mean error (observed head minus simulated head) of less than 1.0 ft and a mean absolute error (absolute value of observed minus simulated) of less than 3.0 ft. Finally, a transient calibration was conducted to simulate the water level changes observed during and after a freeze event on January 22 and 23, 1991, in wells completed in the Upper Floridan aquifer.

Because one of the main objectives of this study is to predict steady-state changes in the potentiometric surface of the Upper Floridan aquifer, the postdevelopment calibration was performed using the average 1988 potentiometric surface. The year 1988 was chosen because the groundwater flow system of the Upper Floridan aquifer was apparently in a quasi-steady-state condition during the period between 1987 and 1989. Rainfall was approximately near normal at most of the long-term stations in the study area (Table 2), and water level hydrographs of observation wells in the Upper Floridan aquifer show a typical seasonal low in May or June and a seasonal high in September (Figure 5). Blandford et al. (1991) showed this situation to be the case for the east-central Florida region, which included southern Volusia County.

The initial steady-state calibrations were performed by adjusting values for leakance of the USCU and the transmissivity of the Upper Floridan aquifer almost exclusively. Changes in these parameters were made based upon review of the following types of information.

- Thickness maps of both the USCU and the Upper Floridan aquifer

- Published and unpublished sources (e.g., consumptive use permit [CUP] files) of aquifer performance test results containing estimates of transmissivity of the Upper Floridan aquifer

- Published maps delineating areas and rates of recharge and discharge to the Upper Floridan aquifer

Comparisons of modeled recharge and discharge rates with published maps were conducted by periodically calculating the simulated recharge/discharge flux between the surficial aquifer system and the Upper Floridan aquifer for each model cell and plotting the resulting array. Simulated recharge values were reviewed for conformance with the conceptual model, which must incorporate the following criteria.

1. The highest recharge rates should be located in grid cells representing the karstic ridge areas.

2. Intermediate recharge rates should fringe the karstic areas and extend across central Volusia County.

3. The lowest recharge rates should fringe both of the former areas. Exceptions to this general model can be expected to occur where head differences between the surficial aquifer system and the Upper Floridan aquifer are locally increased or decreased by pumping or by abrupt changes in topography.

USCU leakance was adjusted so that the maximum simulated recharge rate was approximately 22 in/yr. Cells where the simulated recharge rate was allowed to approach this maximum are located in ridge areas with no surface runoff and where the water table can be expected to be at least 13 ft bls. Where these conditions are met, the recharge rate to the Upper Floridan aquifer is equal to the difference between average annual rainfall (approximately 52 in/yr) and the minimum rate of evapotranspiration (approximately 30 in/yr) (Tibbals 1990). The simulated recharge rate was allowed to exceed 22 in/yr at a small number of grid cells that, in addition to meeting the above conditions, contained dry sinkhole depressions throughout most of the area contained within the cell, indicating that the area represented would receive surface runoff from uplands within the adjacent model cells. The simulated recharge rate was also allowed to exceed 22 in/yr at some grid cells encompassing upland lakes in closed depressions. Although evapotranspiration is relatively high at these lakes, they receive discharge from the surficial aquifer system and runoff from surrounding uplands, thus allowing for relatively high rates of downward leakage as long as the lake-bottom sediments are leaky.

Input values for storativity of the layers for the Upper and Lower Floridan aquifers (layers 2 and 3) and the specific storage of the USCU and the MSCU were adjusted during the transient frost-freeze calibration. Aquifer performance tests conducted within the region indicate that the storativity of the Upper Floridan aquifer varies between approximately 1×10^{-4} and 2×10^{-3}. The available information, however, is not sufficient to indicate any particular areal distribution of storativity within either layer. The transient calibration simulations, therefore, were conducted by assigning uniform, modelwide values of storativity to the layers for the Upper and Lower Floridan aquifers from within the above range. Release of water from storage in the semiconfining units was accounted for by using the MODFLOW Transient Leakage Package (Leake et al. 1994). Without the use of this package, release of water from storage in the semiconfining units due to increases in groundwater withdrawals could only be evaluated by treating the USCU and MSCU as separate, low-permeability aquifer layers. However, site-specific values for specific storage of the semiconfining units are not available. Ranges of possible values can be estimated from published ranges of compressibility (Freeze and Cherry 1979). Estimates range from 3×10^{-6} ft^{-1} to 3×10^{-3} ft^{-1} for sand and clay and from 5×10^{-7} ft^{-1} to 3×10^{-5} ft^{-1} for jointed rock. Uniform, modelwide values for specific storage from the sand-clay range were thus used for the USCU. Likewise, uniform, modelwide values from the jointed rock range were used for the MSCU. The calibration was deemed adequate when plots of simulated drawdown and recovery matched reasonably well with plots of measured drawdown and recovery from 11 target observation wells with continuous recorder data (Appendix A).

The three calibrations were updated in an iterative fashion. That is, after the transient frost-freeze calibration runs produced initially satisfactory results, the predevelopment and 1988 steady-state input files were updated with the newest changes from the transient input files and rerun. This process was repeated until the data sets from all three calibrations produced satisfactory results with the same input arrays of physical parameters. Only the Upper Floridan aquifer can be considered calibrated. The Lower Floridan aquifer cannot be considered calibrated because not enough water level information exists from it with which to compare simulation results. The water table aquifer (layer 1) is a constant-head layer; thus, model results were not computed for it.

Boundary Conditions for Predevelopment and 1988 Steady-State Calibrations

The following section contains descriptions of the methodologies used to prescribe flow conditions along the top, bottom, and sides of the model domain. Prescribed conditions at internal sinks (wells and springs) are also described in this section.

Surficial Aquifer System (Layer 1)

Constant-head values for the water table aquifer (layer 1) were initially assigned for predevelopment conditions, then altered for the postdevelopment (1988) simulations. The process of assigning the water table values was begun by drawing the finite-difference grid on 7.5-minute topographic quadrangle maps. The average predevelopment hydraulic head for the surficial aquifer system for each grid cell was estimated by examining these maps and applying the following criteria.

- If the topographic map indicated that 50% or more of the grid cell lies within a marsh, wetland, or freshwater body, then the assigned value was assumed to be equal to the average land surface elevation or water body elevation of the map area included within the cell.

- If the topographic map indicated that 50% or more of the grid cell lies within the ocean, then the hydraulic head for the surficial aquifer system was computed using the following equation.

$$H_s = SL + [AOD] \times [\frac{\rho_{sw}}{\rho_{fw}} - 1] \qquad (1)$$

where

H_s = hydraulic head for the surficial aquifer system
SL = sea level
AOD = average ocean depth in feet
ρ_{sw} = density of sea water (1.025 mg/L)
ρ_{fw} = density of freshwater (0.999 mg/L)

- If the topographic map indicated that 50% or more of the grid cell lies within dry land or uplands, the average land surface elevation was first estimated by examining the topographic map. The hydraulic head for the surficial aquifer system was then estimated by comparing the average land surface elevation to nearby lake elevations from the topographic map and extrapolating the water table represented by the lake surface to the areas beneath uplands, assuming that the water table surface is a muted replica of the topographic surface.

A regression equation developed by SJRWMD staff (Boniol et al. 1993) for the Prime Recharge Area Delineation Project was used to check the estimated values. The equation relates land surface elevation to water table measurements from boreholes drilled during the spring and summer of 1990. Water table estimates from this equation were considered to be lower than the average predevelopment head for the surficial aquifer system because the spring and summer of 1990 was a period of less than average rainfall. The estimated predevelopment heads for the surficial aquifer system also were checked by comparing them to available hydrographs from observation wells completed within the water table aquifer.

Constant heads for the surficial aquifer system used for the predevelopment calibration were altered for the 1988 calibration at grid cell locations where water level data (from either observation wells or lake-stage monitoring points) indicate that the 1988 average hydraulic head of the surficial aquifer system differs from the estimated predevelopment hydraulic head of the aquifer system. For example, average 1988 stage elevations at nine upland lakes within the study area were lower than the elevations recorded on the topographic maps. The values for the hydraulic head of the surficial aquifer system at grid cells in the vicinity of these lakes were consequently adjusted to reflect average 1988 conditions. Comparisons also were made to the September 1988 water table map presented by Boniol et al. (1990). Adjustments were made mostly in the Crescent City Ridge area of southeastern Putnam County and northwestern Volusia County, where 1988 rainfall (as measured at Crescent City) was approximately 6 in. lower than the long-term average (Table 2).

Lateral and Bottom Boundaries

The lateral boundaries of the grid extend eastward to the Atlantic coast and across the St. Johns River into Lake and Seminole counties (Figure 12). Because actual aquifer boundaries do not exist for the Upper and Lower Floridan aquifers (layers 2 and 3) within or near the study area, lateral boundary conditions were estimated and prescribed along each side of the model.

No-flow boundaries were assigned around the outer edges of the model for the water table aquifer (layer 1). This procedure is in keeping with the regional conceptual model of the surficial aquifer system as a source-sink bed for the Upper Floridan aquifer, sending water to or receiving water from the Upper Floridan aquifer in a vertical direction only.

The lateral boundary conditions (layer 2) of the Upper Floridan aquifer consist of head-dependent flux cells alternating with no-flow boundary cells around much of the outside edge of the model where the contours of the estimated predevelopment potentiometric surface of the Upper Floridan aquifer meet the boundary at an angle (compare Figures 12 and 7). Where the contours on Figure 7 are roughly parallel to the model boundary, only head-dependent flux boundary cells are present. A strictly no-flow boundary exists in the southeastern corner of the model along the inactive cells in rows 89 and 90.

The head-dependent flux boundary cells (termed general-head boundary [GHB] cells in the MODFLOW model) allow flow into or out of the model, depending upon the head difference between the boundary cell and the assigned head at a certain point outside of the model, as well as on the estimated conductance of the aquifer between the boundary cell and the location of the assigned head. The assigned heads, or boundary heads, and the conductance are input parameters and are constant for each simulation. The conductance is calculated using the following equation:

$$CD = \frac{TW}{L} \tag{2}$$

where

CD = conductance
T = transmissivity of the aquifer between the boundary and the location of the assigned head
W = the width of the boundary cell along the model boundary
L = the distance between the location of the assigned constant head and the boundary cell

All these parameters can vary from grid cell to grid cell along the model boundary. The GHB condition assumes a linear change in head between the boundary head and the model side. Therefore, the boundary distance and boundary head values were estimated from the average 1988 and predevelopment potentiometric maps (Figures 6 and 7) so that this condition could be met. Boundary distances vary from a minimum of 2,500 ft where Silver Glen Springs and Alexander Springs (Figure 2) are located near (but outside of) the western boundary to 10,000 ft along much of the western and northern sides of the model. Potentiometric contours were extrapolated offshore to estimate boundary heads for the eastern side of the model for 1988 and predevelopment conditions, respectively (Figures 6 and 7).

Lateral boundary conditions for the Lower Floridan aquifer (layer 3) are the same as those shown on Figure 12 for the Upper Floridan aquifer, except for the coastal boundary (column 45), where no-flow conditions are imposed. Water quality maps (Sprinkle 1989; Tibbals 1990) indicate that the Lower Floridan aquifer is saline east of the coast. Thus, fresh groundwater would not be expected to flow across this boundary.

Boundary distances (*L* in Equation 2) for GHBs for the Lower Floridan aquifer are equal to those for the Upper Floridan aquifer. The boundary heads for the Lower Floridan aquifer, however, were assumed to be lower than boundary heads for the Upper Floridan aquifer in recharge areas and higher than boundary heads for the Upper Floridan aquifer in discharge areas.

The bottom of layer 3 is a no-flow boundary and is roughly equivalent to the bottom of the freshwater flow system within the Lower Floridan aquifer.

Springs

The discharge from the Floridan aquifer that occurs via springs was simulated using the MODFLOW drain package (McDonald and Harbaugh 1988). In the MODFLOW code, a drain is a type of head-dependent flux boundary that allows discharge to occur proportional to the difference between the head in the aquifer and the head at a fixed elevation. In this case, the fixed elevation is that of the spring pool, or the elevation of the surface of the water body created by the spring discharge. If the elevation of the head in the aquifer drops below that of the spring pool, the drain ceases to flow. The constant of proportionality, or drain conductance, depends upon the hydraulic characteristics of the convergent flow pattern in and around the immediate vicinity of the drain (McDonald and Harbaugh 1988). It can be considered analogous to the hydraulic conductivity of the aquifer in the vicinity of the spring. The spring conductance can be very high at large springs where solution cavities form conduits from which water is discharged from the aquifer.

Twelve of the 13 named springs that are located within the boundaries of the model domain are treated in the model as drains (Table 4 and Figure 2). Two pairs of relatively small springs (Satsuma/Nashua and Mud/Forest) were located within the same grid cell and were therefore treated as single drains. Seminole Spring in southern Volusia County was modeled as a free-flowing well rather than a drain because Rosenau et al. (1977) indicated that its discharge was very small (usually less than 1 cfs) and controlled by a man-made structure.

Well Withdrawals

Groundwater withdrawals from wells were input as prescribed fluxes for both the 1988 steady-state calibration and the 1991 transient freeze-event calibration. All well withdrawals were assumed to come from the Upper Floridan aquifer. Wells completed within the water table aquifer were not considered because the water table aquifer was modeled as a constant-head source-sink layer. A relatively small number of agricultural and public water supply wells have open-hole intervals that extend to depths that, according to the regional maps published by Miller (1986) and Tibbals (1990), represent the upper few dozen feet of the MSCU. Withdrawals from these wells were considered to come from the Upper Floridan aquifer. No withdrawal wells are known to be cased to a depth reaching the Lower Floridan aquifer. Because the Upper Floridan aquifer is represented by a single model layer within which only horizontal flow is assumed to occur, well withdrawals are assumed to be distributed throughout the full thickness of the Upper Floridan aquifer.

The quantity of groundwater withdrawn from the Upper Floridan aquifer is measured and reported for only a few public water supply wells. For most wells, the rates of withdrawal must be estimated based upon available data on water treatment plant flows and crop irrigation requirements.

The sources of the data that were used to estimate groundwater withdrawal rates are listed below.

- SJRWMD CUP database

Table 4. Spring model-grid locations, pool elevations, conductances, and comparisons between measured and simulated discharges for predevelopment and 1988 average steady-state conditions

Spring Name	Row	Column	Pool Elevation (ft msl)	Conductance (ft^2/day)	Measured Flow* (ft^3/day)	Simulated Flow (ft^3/day)	Percent Difference†
Predevelopment Steady-State Conditions							
Beecher Springs	9	5	5	3.2×10^5	777,600	760,366	2
Blue Spring	73	14	1	8.5×10^6	13,824,000	13,075,600	5
Croaker Hole Spring	9	2	1	6.9×10^6	6,912,000	6,719,696	3
Gemini Springs	82	14	1	5.8×10^4	691,200	827,797	-20
Green Springs	85	24	5	7.7×10^3	—	111,365	NA
Island Springs	83	3	7	4.0×10^4	518,400	758,429	-46
Mud/Forest springs	8	5	1	3.0×10^4	—	219,267	NA
Ponce de Leon Springs	54	23	2	4.5×10^5	2,678,400	2,399,830	10
Satsuma/Nashua springs	5	5	1	9.3×10^3	172,800	129,808	25
Welaka Spring	6	5	1	1.7×10^4	—	188,185	NA
1988 Steady-State Conditions							
Beecher Springs	9	5	5	3.2×10^5	717,120	676,461	6
Blue Spring	73	14	1	8.5×10^6	12,528,000	11,673,370	7
Croaker Hole Spring	9	2	1	6.9×10^6	6,575,040	6,482,491	1
Gemini Springs	82	14	1	5.8×10^4	734,400	706,072	4
Green Springs	85	23	5	7.7×10^3	77,760	88,710	-14
Island Springs	83	3	7	4.0×10^4	527,040	552,769	-5
Mud/Forest springs	8	5	1	3.0×10^4	221,184	206,822	6
Ponce de Leon Springs	54	23	2	4.5×10^5	2,358,720	2,209,531	6
Satsuma/Nashua springs	5	5	1	9.3×10^3	126,144	119,471	5
Welaka Spring	6	5	1	1.7×10^4	—	175,051	NA

Note: — = no measured flow rate
ft msl = feet above mean sea level
ft^3/day = cubic feet per day
NA = not applicable

*From Tibbals 1990, Table 1
† [(Measured flow rate - simulated flow rate)/(measured flow rate)] x 100

- Public water supply (water treatment plant) monthly operating reports that are reported to SJRWMD
- Annual water use survey (Florence 1990)
- SJRWMD Benchmark Farms Project data for 1988
- Telephone conversations with public, industrial, and institutional water suppliers

The SJRWMD CUP database served as the main source of water use data for this project. This computerized database contains information on the source, location, and purpose of each permitted withdrawal. It also contains information describing each permit, including estimated population for public supplies as well as type of crop, permitted acreage, and irrigation method for agricultural supplies. CUP data were obtained for those permits in the vicinity of the model area that were issued before July 1988 and that represented withdrawals from the Floridan aquifer system. Well locations were plotted using a geographic information system technology on a 1:150,000-scale base map with the model grid. For the 1988 steady-state calibration, average daily withdrawal rates were estimated for each well. Although withdrawal rates vary throughout the year, especially for irrigation of seasonal crops, this methodology assumes that the annual variation in pumping is reflected in the average elevation of head in the Upper Floridan aquifer.

The following subsections describe the methodology and assumptions used to allocate different types of withdrawals within the model domain.

Public, Industrial, Institutional, and Recreational Withdrawals. Estimates of 1988 average daily groundwater withdrawal rates for public water supplies were obtained from Florence (1990). The average monthly pumpage from each water treatment plant was computed from monthly totals obtained from monthly operating reports. This number was divided by the number of wells attributed to the facility in the CUP database. If particular wells listed in the database were not in use in 1988, they were assigned a withdrawal rate of zero. Average daily withdrawal rates were calculated by dividing monthly rates by 30.42, the average number of days per month. The withdrawal rates for public supplies in Volusia County and southern Flagler County were estimated using the same methodology as that of Geraghty and Miller (1992) and are, with a few minor exceptions, identical to the rates computed for that study. An inherent assumption with this methodology is that the reported water treatment plant pumpage is equal to the amount actually pumped from the wells during the same time period.

Withdrawal rates for industrial, institutional, and recreational uses were computed in a similar fashion to that of public supplies. Raw pumpage data were obtained from Florence (1990) or from SJRWMD, rather than from monthly operating reports. In a few cases, withdrawal rates were obtained verbally from the users or by dividing the permitted CUP allocation in million gallons per year by 365.

The greatest magnitude of withdrawals occurs in the eastern half of Volusia County (Figure 13). In western Volusia County, most of these types of withdrawals are located near, and south of, De Land (Figure 2).

Agricultural Withdrawals. Average daily agricultural withdrawals are dispersed throughout the WVSP area, as well as the farming areas in western and southern Flagler County (Figure 14). Average daily 1988 groundwater withdrawals for agricultural irrigation were estimated from water use data provided by Florence (1990). Florence presents total irrigated acres and water use by crop for each county for the 1988 calendar year. Average water use rates in cubic feet per day per acre were calculated for each county in the study area and for each crop listed (Table 5, part A). These average rates were computed by dividing the total water use listed for a crop in Florence (1990) by the total number of irrigated acres attributed to that crop. The only crop for which average water use was calculated differently was ferns. An average daily water use rate of 373.9 cubic feet per day per acre was computed for fern in all counties based upon an estimated average yearly irrigation rate of 37.6 in/yr/acre (Cynthia Moore, SJRWMD, pers. com. 1994). This value is within the range of average total water use for ferns recorded for 1990 through 1994 as part of SJRWMD's Benchmark Farms project (Singleton 1996). Assuming that each CUP

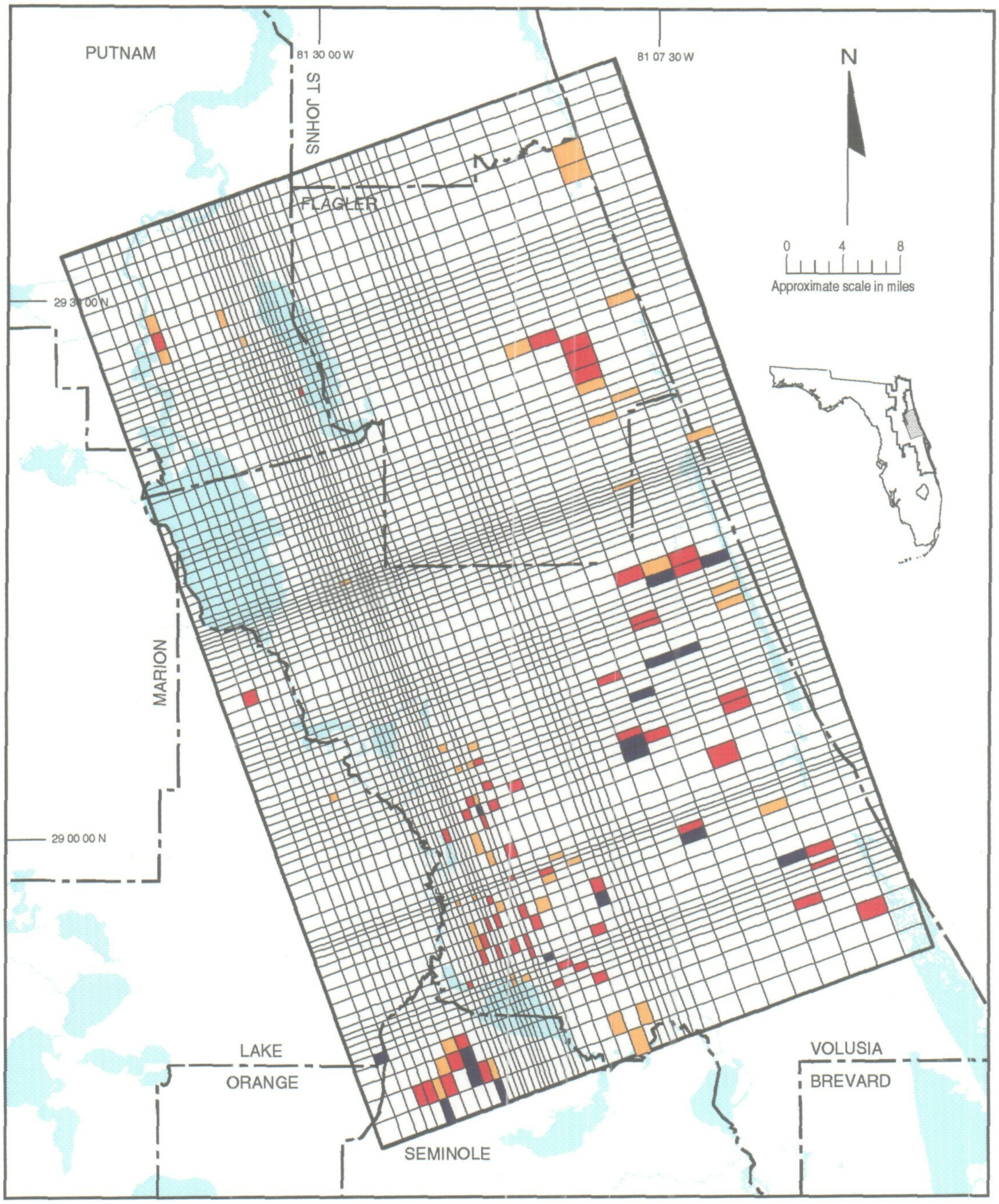


Figure 13. Location and pumping rate of average daily 1988 withdrawals for public, industrial, and institutional uses

Legend

- < 0.01 mgd
- 0.01 to 0.10 mgd
- 0.11 to 1.00 mgd
- > 1.00 mgd
- County boundary
- Water body

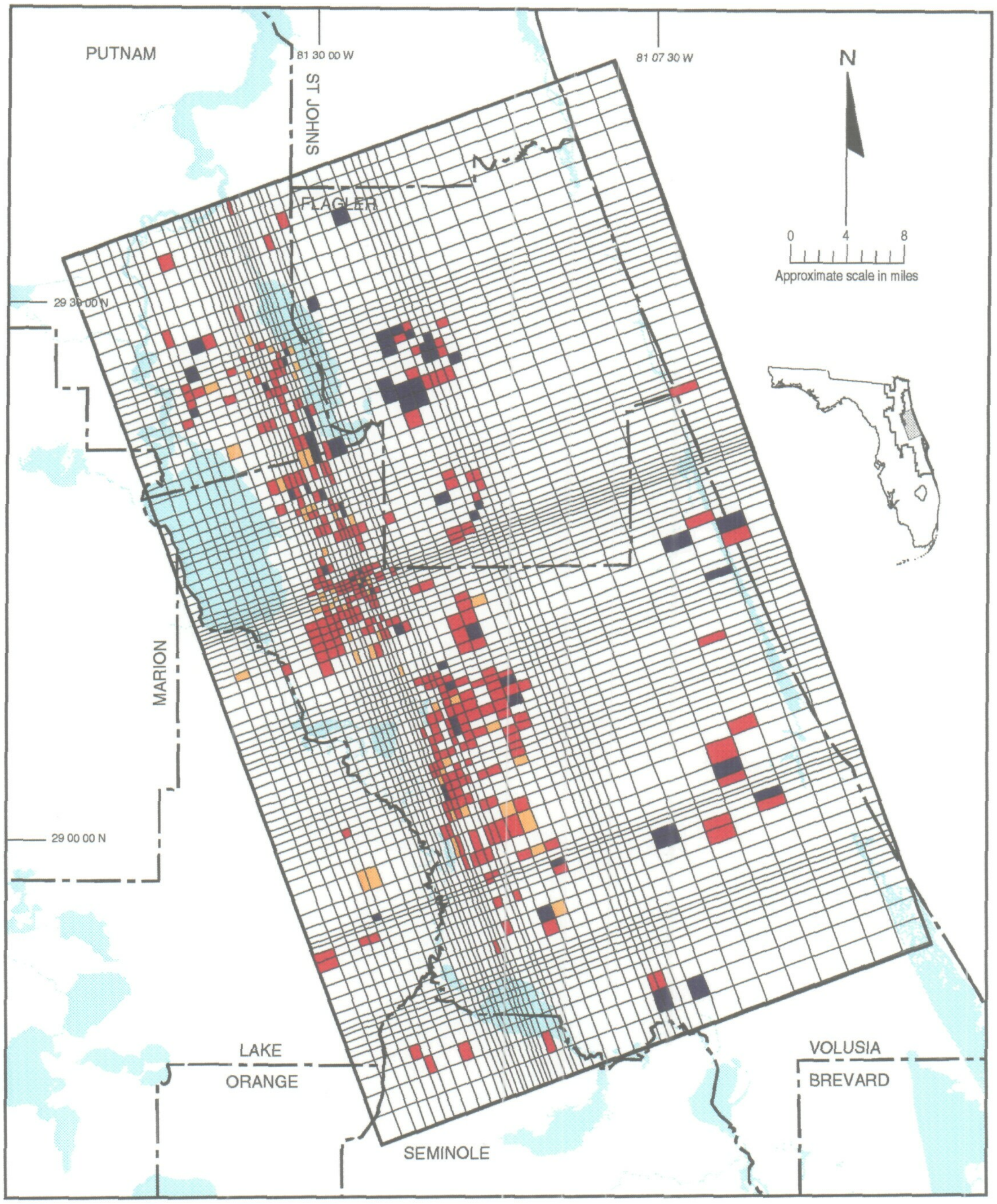


Figure 14. Location and pumping rate of average daily 1988 withdrawals for agricultural uses

Table 5. Agricultural water use rates for crops grown within the study area (cubic feet per day per acre)

A. Average rates computed using estimates of county totals in Florence (1990)

Crop Type	County				
	Flagler	Lake	Putnam	Seminole	Volusia
Cabbage	113.6	140.4	142.8	142.6	141.7
Citrus	—	158.1	145.3	160.6	157.9
Ferns	—	373.9	373.9	373.9	373.9
Field corn	193.8	208.5	192.5	200.5	—
Flowers and foliage	—	479.0	240.6	532.4	548.1
Improved pasture	157.7	109.2	109.5	109.1	109.6
Miscellaneous vegetables	116.3	100.3	153.7	54.3	120.3
Peaches	—	133.7	229.2	—	—
Potatoes	155.5	—	155.5	—	—
Sod	196.1	278.1	212.7	200.5	198.9
Turf grass (golf)	317.6	316.4	334.2	325.9	282.3
Turf grass (other)	293.0	300.8	267.4	275.2	300.1
Watermelon	80.2	90.9	86.9	100.3	86.9
Woody ornamentals	1,336.9	1,216.9	1,229.9	977.6	1,229.9

Note: — = no irrigated acreage listed in Florence (1990)

B. Observed 1988 rates from the St. Johns River Water Management District Benchmark Farms database

Crop	County	Range	Average Rate	Number of Sites
Cabbage	Flagler	22.8–86.3	49.9	3
	Putnam	157.1–184.5	170.8	2
Ferns	Lake	476.0–961.9	718.9	2
	Putnam	263.5–1,048.3	621.6	3
	Volusia	312.2–1,213.2	580.8	14
Potatoes	Flagler	98.5	98.5	1
	Putnam	42.8–247.1	130.2	9
Woody ornamentals	Seminole	1,181.2	1,181.2	1

project irrigates at the average water use rate, a daily groundwater withdrawal rate was estimated by multiplying the average water use rate times either the permitted acreage or the actual acreage. The estimates include irrigation for crop growth, chemigation, or fertigation only and do not include water used for frost-and-freeze protection.

SJRWMD conducted a field survey between February and August 1990 during which observations were made of actual irrigated acreage for approximately 550 fern-growing CUP projects in Lake, Putnam, and Volusia counties. Approximately 450 of these projects are located in western Volusia County, 88 are located in southeastern Putnam County, and 9 are located in northeastern Lake County. These actual acreages were used wherever possible instead of the listed permitted acreage.

If more than one crop was listed for a project in the CUP database and no actual acreage was available, the project acreage was assumed to be divided evenly among the different crops. The daily groundwater withdrawal rate was calculated using the mean of the average water use rates for each crop.

If more than one irrigation well was listed in the CUP database for a particular project, the daily groundwater withdrawal rate was divided by the number of wells listed to obtain an estimated withdrawal rate for each well. In a relatively few cases, the resulting withdrawal rate was greater than the listed pump capacity of the well(s), and the listed pump capacities were used instead. If no crop type was listed in the CUP database, the maximum annual permitted withdrawal was divided by 365 to compute the estimated average daily withdrawal.

For many CUPs, the permit specifies the use of both groundwater from the Floridan aquifer system and surface water. In this case, the daily groundwater withdrawal rate was divided by the total number of wells and surface water pumps listed for the project in the CUP database. The 1990 SJRWMD field survey also provided information regarding the number and pump capacities of wells and surface water pumps used for irrigation. The withdrawals attributable to surface water pumps were not included in the model.

For some crops, the sum of the permitted acreages listed in the CUP database for a particular county is significantly greater than the county total of irrigated acreage for that crop as listed in Florence (1990). Because the values in Florence were derived from several sources in addition to the CUP database, they may be more representative of the actual irrigated acreages. Therefore, for those crops for which the county total of permitted acreage (from the CUP database) was more than 10% greater than the corresponding irrigated acreage as listed in Florence (1990), permitted acreage used in calculating the daily groundwater withdrawal rates were reduced. This reduction was accomplished by multiplying the permitted acreage listed for each CUP by the ratio of the total estimated irrigated acreage (Florence 1990) to the CUP permitted acreage.

For example, the sum of the CUP permitted acreages attributed to citrus for Putnam County is 239 acres. The 1988 irrigated citrus acreage for Putnam County in Florence (1990) is 46 acres. The permitted acreage for Putnam County citrus CUPs in the model was subsequently multiplied by a factor of 46/239, or 0.19. The assumption underlying this reduction is that, for many agricultural CUPs, the actual acreage irrigated is less than the permitted acreage. The number and location of the CUPs that meet this assumption are unknown. Therefore, for those crops for which the withdrawal rate was reduced, the reduction was evenly distributed among all of the CUP projects within each county for which an estimate of the actual acreage was not available (from the 1990 SJRWMD field survey).

The estimated daily groundwater withdrawal rates were compared with measured groundwater withdrawals determined from metered wells as part of the SJRWMD Benchmark Farms Project (Table 5, part B). The estimated daily groundwater withdrawal rates are roughly similar to the available measured rates, with the exception of those for cabbage and potatoes in Flagler County and fern in Lake, Putnam, and Volusia counties. Measured rates for fern irrigation may be higher than the actual average daily irrigation rates because pumpage for frost-and-freeze protection was not differentiated in the metering process during 1988 (Vince Singleton, SJRWMD, pers. com. 1992).

Self-Supplied Domestic and Lawn Irrigation Withdrawals. Withdrawals from the Upper Floridan aquifer due to self-supplied domestic and lawn irrigation uses were included in the model for Volusia County, southeastern Putnam County, and part of western Flagler County (Figure 15). In Volusia County, they were incorporated into the model using a copy of the VOLDAT database. This database is maintained by the Volusia County Department of Environmental Management and includes information such as latitude, longitude, type of use, casing depth, and total depth for all wells with diameters of less than 6 in. Wells from the VOLDAT database were assigned row and column locations within the model grid in the same manner used for larger diameter wells. A withdrawal rate of 343 gallons per day (gpd) (45.9 cubic feet per day [ft^3/day]) was assigned to each self-supplied domestic well in VOLDAT. This rate equals the product of multiplying the Volusia County per capita use rate of 142 gpd from Florence (1990) times 2.416 persons per household (Geraghty and Miller 1992).

In southeastern Putnam County and western Flagler County, the locations of withdrawals for self-supplied domestic and lawn irrigation uses were estimated using aerial photography. First, the location and extent of the various public water supply service areas in southeastern Putnam County were identified using overlay maps prepared by Kimball-Lloyd (1991). The service areas were delineated on the same 7.5-minute topographic quadrangle maps that contained the model grid. Aerial photographs of the southeastern Putnam area taken during November 1989 and printed at a 1:24,000 scale were used to count the number of houses within each model grid block that were situated outside of public water supply service areas.

Each house located outside of a public water supply service area was assumed to have one well that supplies water from the Upper Floridan aquifer for domestic consumption at a rate of 407.2 gpd (54.4 ft^3/day) and for lawn irrigation at a rate of 514 gpd (68.75 ft^3/day). The value for domestic use was derived by multiplying the countywide per capita use rate of 161 gpd (Florence 1990) by 2.529 persons per household (value for the southeastern Putnam Planning District [Northeast Florida Regional Planning Council 1991]). The withdrawal rate for lawn irrigation is the same as that used for Volusia County by Geraghty and Miller (1992) and also was applied to Volusia County wells identified as lawn irrigation wells in VOLDAT.

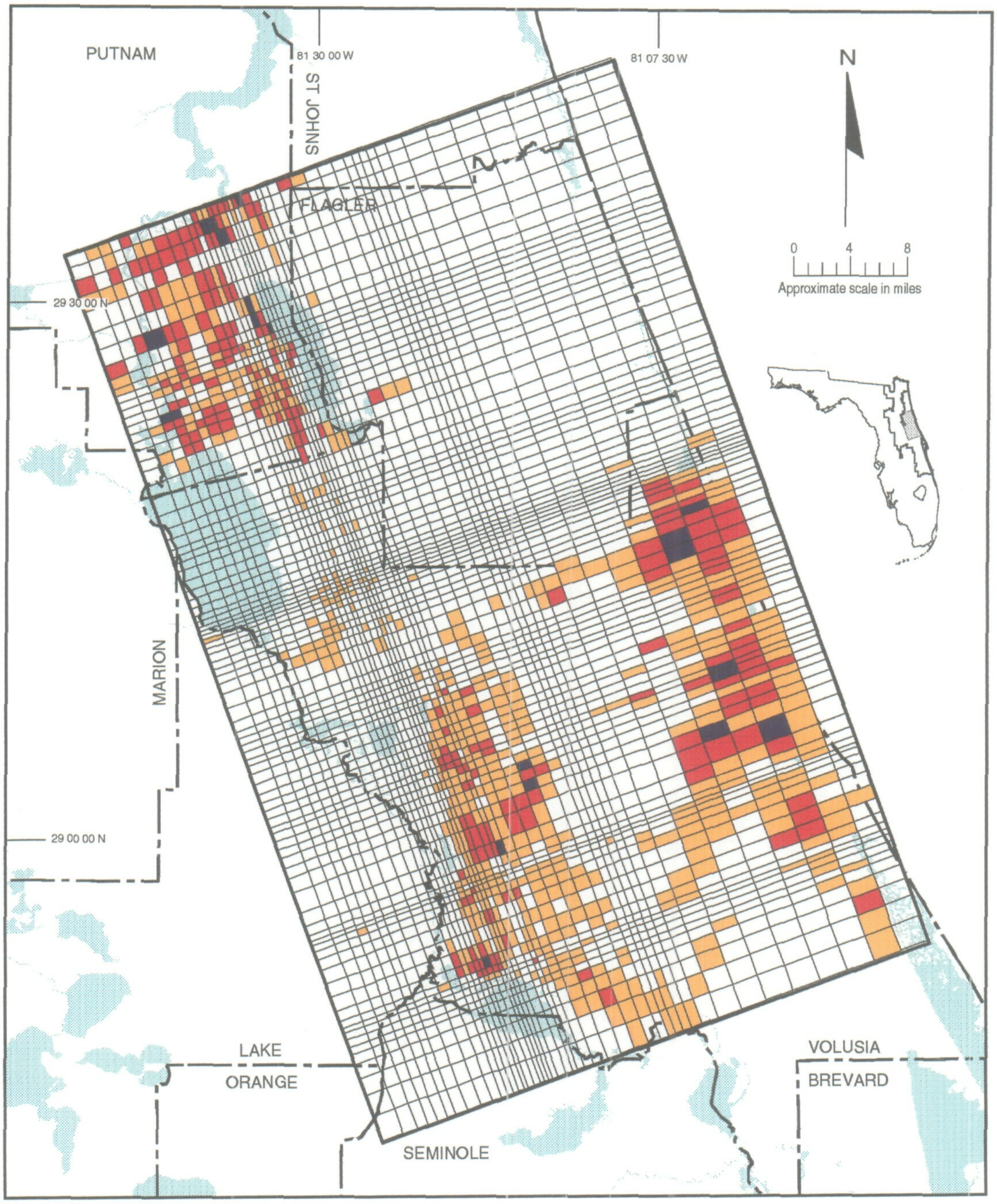


Figure 15. Location and pumping rate of average daily 1988 withdrawals for self-supplied, domestic, and lawn irrigation uses

Self-supplied domestic and lawn irrigation withdrawals from the Upper Floridan aquifer in the portions of Lake and Seminole counties that are within the model boundaries were assumed to be insignificant and were not modeled. The same assumption was made for central and eastern Flagler County; however, a few wells in the VOLDAT database are located within these areas and are included in the model.

Free-Flowing Wells. Discharge from the Upper Floridan aquifer from 17 free-flowing artesian wells also was included as input for the 1988 steady-state calibration. Most of the wells are located along the St. Johns River valley in southeastern Putnam County and western Volusia County. The free-flowing wells were located within the model grid in the same manner as all other wells, and the discharge rates reported in Steele (1991) were prescribed at their model locations. The majority of the inventoried free-flowing wells within the model area that do not have recorded discharges are located outside of the WVSP area, in Seminole County.

The locations and modeled discharge rates of all wells used for the 1988 steady-state calibration (excluding self-supplied domestic and free-flowing wells) are listed in Appendix C.

Initial and Boundary Conditions for the Transient Calibration

Calibration Period

The transient calibration represents a 9.5-day period from January 22 to February 1, 1991. Air temperature in Pierson dropped below 34°F at approximately 10:00 p.m. during the evening of January 22 and remained below that temperature until approximately 8:00 a.m. the next morning (Figure 16). The temperature dropped below freezing (32°F) for approximately 1 hour during the night; however, pumping for frost-and-freeze protection lasted for approximately 10 hours. Hydrographs of water level readings obtained from several wells completed in the Upper Floridan aquifer indicate that drawdown continued through the night until early the next morning, then recovered to approximately the prefreeze level after a few days (e.g., Figure 10, part A).

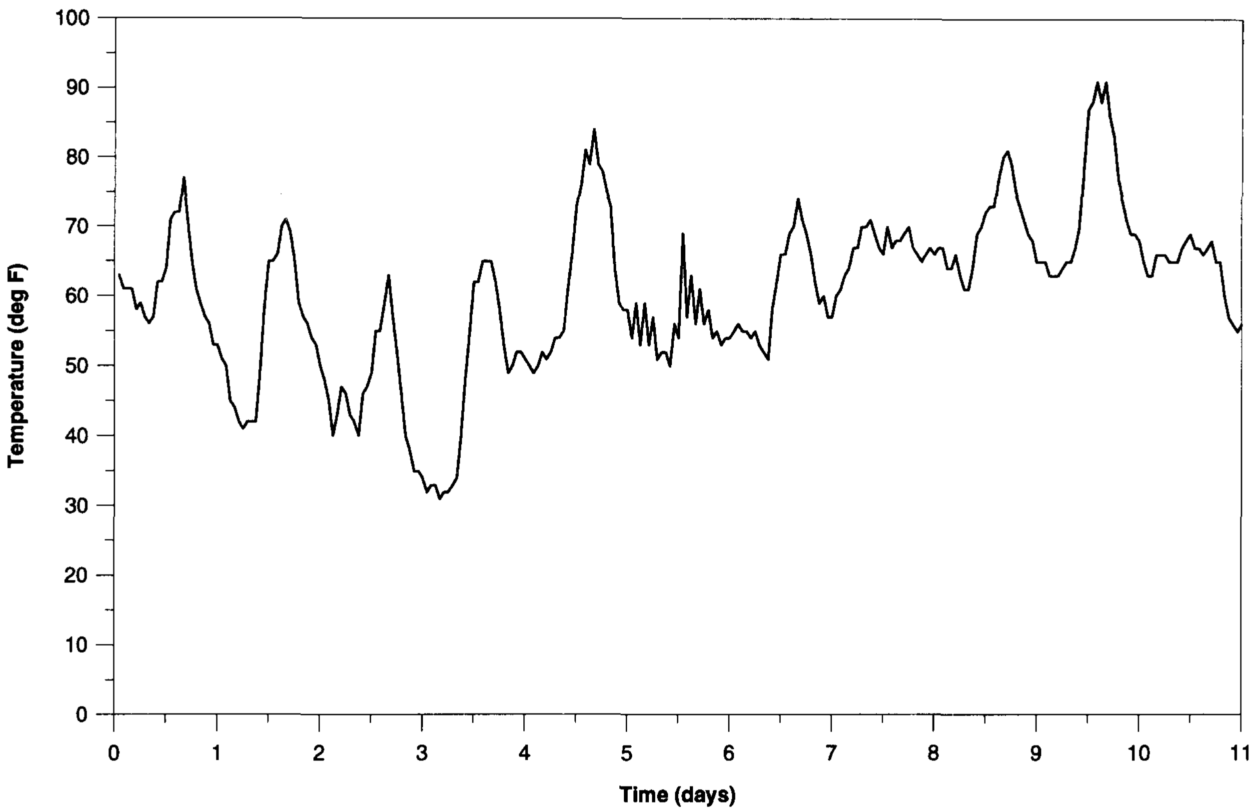


Figure 16. Hourly temperature readings at the West Pierson recording temperature gauge: January 20, 1991, through January 30, 1991

This particular time period was selected—as opposed to other, perhaps longer or colder frost-and-freeze events that occurred during recent years—because of the availability of continuous water level data. Continuous water level data collected during longer and/or colder freezes are very limited. This limitation exists partially because relatively few observation wells were equipped with continuous recorders, and also because the types of mechanical recorders in use were not able to record rapid changes in water levels. Continuous water level data are available for January 22 through February 1, 1991, at eight observation wells in the Upper Floridan aquifer located within and near the fern production areas and from three observation well sites that are located at some distance from the centers of agricultural frost-and-freeze protection pumping. Continuous records of actual water level changes (drawdown and recovery) with time are required for calibration at as many locations as possible so that the simulated response of the Floridan aquifer system to pumping for frost-and-freeze protection can be compared to the actual response.

Treatment of the surficial aquifer system as a constant-head layer in the transient calibration is considered a valid assumption, because the available data indicate that on a regional scale, the water levels in the surficial aquifer system do not respond quickly enough to pumping from the Floridan aquifer system to change significantly during a freeze of several hours duration. For example, drawdowns at a well cluster site just west of Pierson ranged from a few feet to more than 12 ft in the well open to the Upper Floridan aquifer during the freeze of 1991 (Figure 10, part A). Drawdowns also occurred to a lesser extent in a well completed within the USCU (Figure 10, part A). Drawdown within the well completed in the surficial aquifer system, however, did not occur.

Initial Conditions

The transient calibration was performed by adding prescribed fluxes representing frost-and-freeze protection pumping to the input files for the 1988 steady-state model. Initial conditions were represented by the simulated average steady-state water levels and the corresponding average steady-state withdrawals from the 1988 calibration. The same constant water table elevations assigned for the 1988 simulations also were assigned as constant heads for the transient simulations.

Two stress periods were used (Table 6). Stress period 1 represents a 10-hour freeze event with frost-and-freeze protection pumping superimposed upon the average steady-state groundwater flow system assumed to exist immediately prior to the freeze. The stress

Table 6. Stress periods used for the 1991 transient calibration

Stress Period	Duration	Type of Withdrawal
1	0.4 days (10 hours)	Average daily plus frost-and-freeze protection
2	9.0 days	Average daily only

period was discretized into five time-steps of 2 hours each. Stress period 2 represents the recovery period after frost-and-freeze protection pumping ceased; it was discretized into 12 time-steps of unequal duration. The time-step lengths were increased by a factor of 1.75 from an initial time-step length of 0.008 days (0.19 hours) to a final time-step length of 3.860 days (92.64 hours). This unequal time-stepping scheme was used so that the model could simulate the rapid recovery in water levels that is observed shortly after frost-and-freeze protection pumping has ceased.

The simulated average 1988 groundwater flow system was used to represent the January 1991 groundwater flow system because a regional sampling of January 1991 water levels in the surficial aquifer system or the Upper Floridan aquifer does not exist. The scattered water level measurements made in January 1991 in wells completed in the Upper Floridan aquifer compare reasonably well with simulated 1988 water levels from the same location in the model; therefore, this assumption is considered valid. The purpose of the transient calibration is to compare simulated changes in the potentiometric surface of the Upper Floridan aquifer with actual changes, rather than to compare the elevation of the potentiometric surfaces.

Frost-and-Freeze Withdrawal Locations and Rates

Withdrawals from the Upper Floridan aquifer due to frost-and-freeze protection were estimated in a manner similar to that for agricultural irrigation withdrawals for the 1988 steady-state calibration. The CUP database was used to identify and tabulate information for all CUPs with frost-and-freeze protection allocations that are located within the model domain and that were in existence in January 1991. Only those CUPs that use the Floridan aquifer system or a combination of the Floridan aquifer system and surface water as sources of water for freeze protection were considered. Permits with allocations to withdraw water for frost-and-freeze protection solely from surface water bodies or solely from the surficial aquifer system were not considered. As part of the 1990 field survey of fern CUP projects, SJRWMD estimated the number of fernery acres, by CUP, under natural hammock shade and the number of fernery acres, by CUP, under artificial (shadehouse) shade. Many of the fern CUP projects have a combination of hammock and shadehouse ferneries. For the CUPs tabulated, natural hammock acreage totaled approximately

2,456 acres and shadehouse acreage totaled approximately 3,670 acres. These acreage totals appear to conflict with the results of a recent survey of 167 fern growers reported by Boggess et al. (1991). The total hammock acreage reported from that survey (2,623 acres) is similar to the total CUP hammock acreage, but the total shadehouse acreage reported for that survey (1,460 acres) is much less than the 3,670 acres reported by SJRWMD. The Boggess et al. (1991) survey did not, however, include information on the spatial distribution of withdrawals. The SJRWMD estimated acreages were used because of the availability of well locations from CUP files.

The transient model was calibrated assuming that frost-and-freeze protection was carried out only at shadehouse ferneries. Ferns growing under natural hammock shade are better protected against frosts and radiating freezes than ferns growing under artificial shadecloth (Stamps et al. 1991). The loss of heat is greater from shadehouses than from hammocks with a natural foliage cover; the result is lower near-ground air temperatures in shadehouses than in hammocks. Because the measured air temperature was below freezing for only a short period during the early morning of January 23, growers probably did not pump water to protect natural hammock ferneries. Therefore, well withdrawals were estimated only for those wells located at ferneries with shadecloth (shadehouses).

The model locations of these wells were compared to shadecloth acreage maps constructed by SJRWMD for southeastern Putnam County, northeastern Lake County, and western Volusia County. These maps were made by digitizing the areas of shadehouses visible on 1:24,000-scale November 1989 aerial photographs. Polygons representing the shadehouses were then plotted on a base map with the model grid, along with their respective acreage amounts. The mapped shadehouse acreages were compared to the tabulated CUP acreages for each model grid containing shadehouses. The mapped shadehouse acreage compared quite well with permitted shadehouse acreage.

One of the reasons for preparing the maps was to locate possible shadehouse acreage that is irrigated by unpermitted, small-diameter wells (less than 4 in.). However, within the model domain, there were no grid cells containing shadehouse acreage that did not have any permitted wells located within the same cell. The relatively close match between the permitted acreages and the mapped acreages does not mean that ferneries irrigated by unpermitted wells do not exist. They may be relatively small and located within the areas where permitted ferneries are clustered. But, as of November 1989, there apparently were no significant acreages of unpermitted ferneries located in areas separated from the permitted ferneries.

The estimated frost-and-freeze irrigation requirement for each shadehouse fernery identified in the SJRWMD CUP database was calculated by multiplying the number of acres times an application rate of 100 gpm (0.144 mgd) per acre. This application rate is considered to be the delivery rate for sprinkler systems in shadehouse ferneries using current best management practices (Lynne and Kiker 1992b). In 1991, most shadehouse ferneries used sprinkler systems that were capable of delivering water at this rate. The fernery frost-and-freeze irrigation requirement was distributed equally among all permitted withdrawal points (wells completed in the Floridan aquifer system and surface water pumps); however, only withdrawals from wells completed in the Floridan aquifer system were input to the model.

The estimated frost-and-freeze protection withdrawal rate for each permitted shadehouse fernery was distributed among the associated wells using the following equation.

$$Q_{well} = \frac{Q_{permit}}{NWELLS + NPUMPS} \tag{3}$$

where

Q_{well} = withdrawal rate for frost-and-freeze protection for each well

Q_{permit} = withdrawal rate for frost-and-freeze protection for each permitted project or, if available, the estimated shadehouse acreage

$NWELLS$ = the number of irrigation wells completed in the Floridan aquifer system attributed to the permit in the CUP database

$NPUMPS$ = the number of surface water pumps attributed to the permit in the CUP database

The withdrawals from the Upper Floridan aquifer for frost-and-freeze protection are clustered around three areas: the Crescent City-Welaka area in southeastern Putnam County, the Seville and Pierson area in northwestern Volusia County, and the Ponce de Leon Springs area in western Volusia County (compare Figure 17 with Figure 2). The total of the modeled frost-and-freeze discharges equals 422.2 mgd.

Additional Assumptions Regarding Frost-and-Freeze Withdrawals

In addition to the major assumptions regarding the type of ferneries that pumped for frost-and-freeze protection during the calibration period and the rate at which they pumped, several other important assumptions were made during the frost-and-freeze withdrawal estimation process.

- The temperatures measured at the SJRWMD data collection site near Pierson are representative of the entire model area.
- One hundred percent of the permitted or estimated shadehouse acreage was frost-and-freeze protected during the calibration period.
- Fernery acreages estimated during the 1990 SJRWMD field survey and from the November 1989 aerial photographs did not change significantly by January 1991.
- A fernery not surveyed during 1990, or with no information about whether it was a hammock or shadehouse fernery provided by the 1990 survey, was assumed to be a hammock fernery (and thus not included in the calibration), unless the November 1989 maps indicated shadehouse acreage at the same model grid location with a very similar acreage to the permitted acreage.
- No pumping for frost-and-freeze protection occurred during the 9 days represented in the model by stress period 2.
- The CUP database does not identify the primary well or pump used for frost-and-freeze protection. The pumpage was distributed evenly among the irrigation wells and surface water pumps listed for the permit in the database, even though it is recognized that

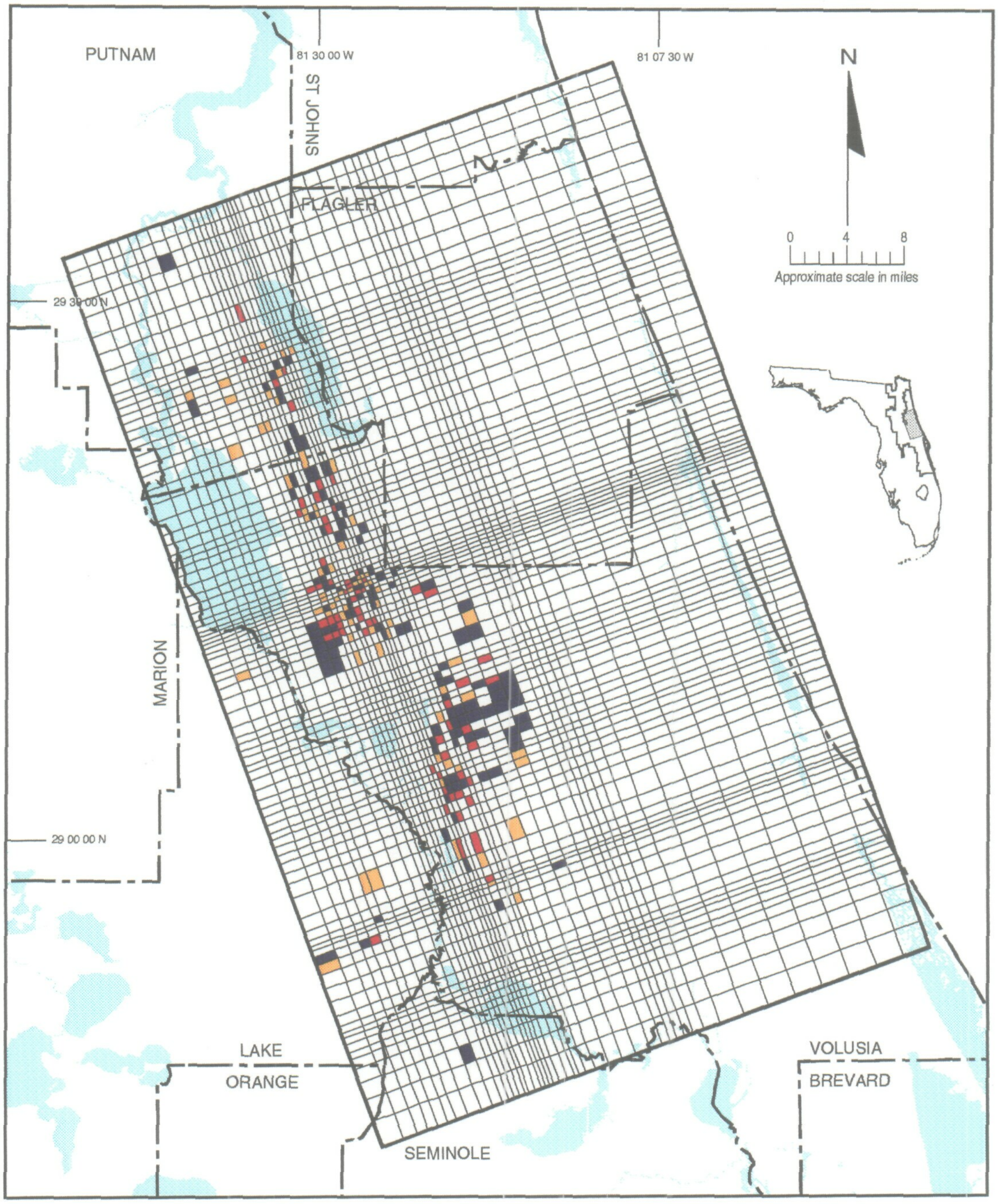


Figure 17. Location of and pumping rate of withdrawals for artificial shadecloth ferneries during frost-and-freeze protection

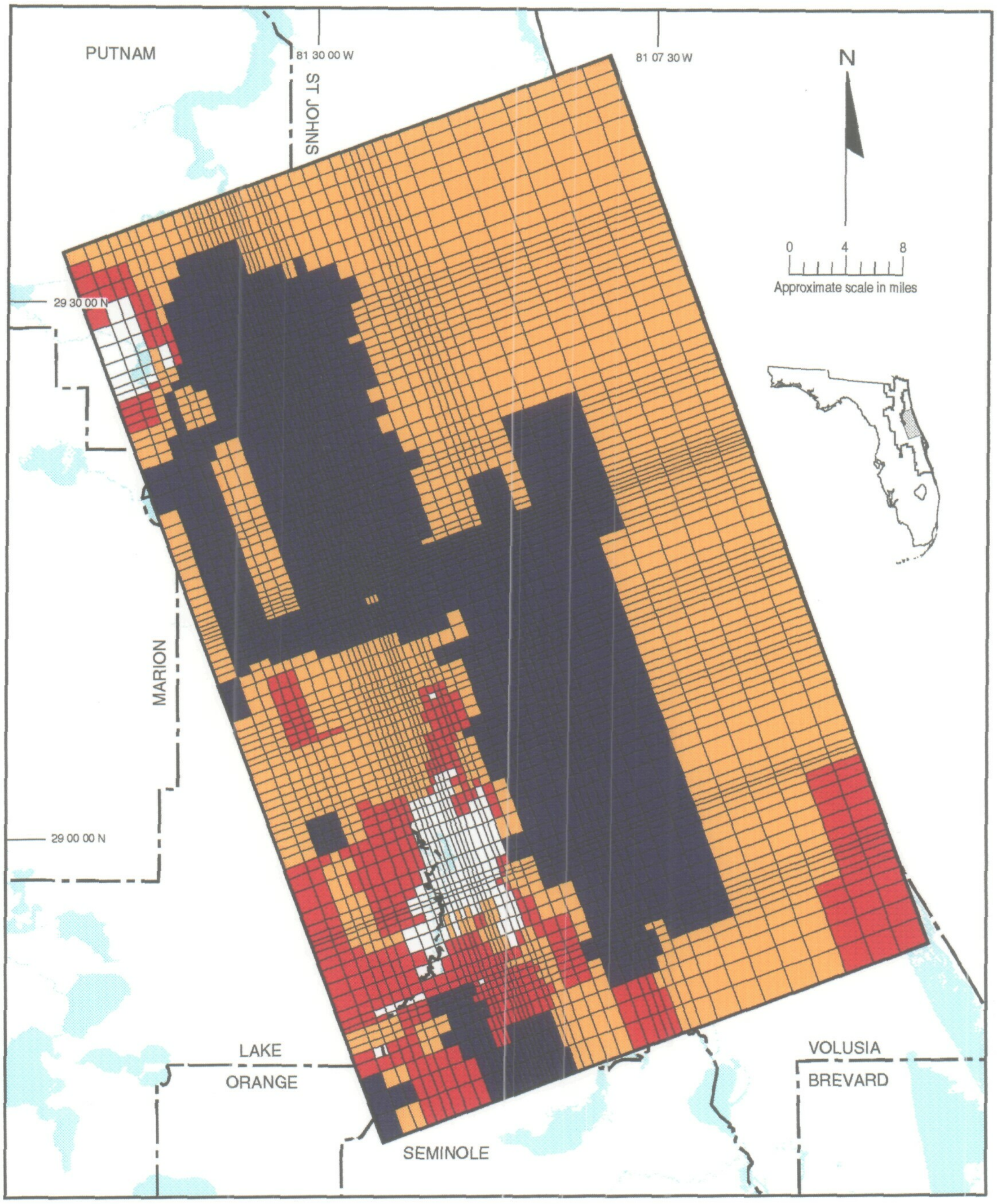
most, if not all, of the water for freeze protection could be supplied by the primary withdrawal point. (If the field report from the 1990 SJRWMD survey identified particular wells or pumps as backups, they were not used as withdrawal points in the calibration.)

In reality, all of the above assumptions were probably not valid to some extent during the time period represented by the calibration. The last assumption probably does not cause a significant error in the model because of its regional scale. Only 52 of the 569 CUPs with frost-and-freeze withdrawal allocations (including both hammock and shadehouse ferneries) in the model have wells located in different grid cells. Of these, all but five have wells located in adjacent cells. Thus, the error caused by distributing the pumpage probably does not affect the model's ability to simulate the regional effect of frost-and-freeze withdrawals.

CALIBRATION RESULTS

Input Parameters

The regional distribution of transmissivity values for the Upper Floridan aquifer for the calibrated model generally agrees with that of the USGS RASA model (compare Figure 18 with Figure 28 of Tibbals 1990). Areas of relatively low transmissivity correspond with potentiometric highs along the Crescent City Ridge and in central Volusia County. The lowest transmissivity values in the model (10,000 ft^2/day) occur in these areas. Transmissivity increases to approximately 90,000 ft^2/day to the north and northeast across Flagler County, due, in part, to the increase in thickness that occurs in the Upper Floridan aquifer in that direction. The highest values of transmissivity correspond to areas around major springs, where fractures and solution cavities are abundant. The highest transmissivity value in the model (2,000,000 ft^2/day) is at the grid cell representing Blue Spring. Large variations in transmissivity occur over relatively short horizontal distances in areas of the model where high horizontal gradients are indicated on maps of the potentiometric surface of the Upper Floridan aquifer (Figures 6 and 7). These areas include much of the WVSP area, plus northeastern Lake County.



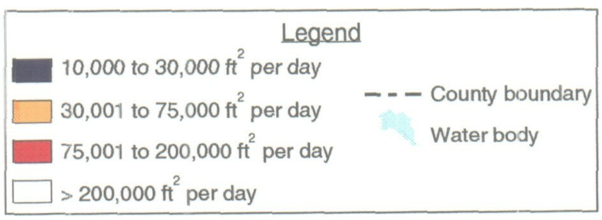


Figure 18. Model-derived transmissivity of the Upper Floridan aquifer

The model-derived values of transmissivity for the Lower Floridan aquifer are lower along the St. Johns River and along the coast (Figure 19) than the values initially derived from the USGS RASA model. Water quality data (Sprinkle 1989; Tibbals 1990) indicate that the thickness of the freshwater flow system within the Lower Floridan aquifer ranges from very thin to nonexistent in these areas.

Values of leakance of the USCU range between 2.5×10^{-6} day^{-1} and 7.5×10^{-4} day^{-1} (Figure 20). This range is similar to ranges reported by other groundwater modeling studies in east-central Florida. Generally, leakance of the USCU is greatest in the karstic ridge areas and along some portions of the St. Johns River valley and least in portions of eastern Flagler County and eastern Volusia County. Units of relatively high leakance are located offshore Flagler and Volusia counties. The leakance distribution within the WVSP area shows significant areal variation. This variation exists because the leakance values were determined by reviewing the model-calculated steady-state recharge rates and adjusting leakances in an iterative fashion until modeled recharge rates were calibrated in a general sense. That is, by adjusting leakance the modeled steady-state recharge rates were made (1) to agree in general with published maps (Boniol et al. 1990, 1993; Tibbals 1990; Vecchioli et al. 1990) and (2) to have (with a few exceptions) a maximum areal recharge rate of 22 in/yr.

The model-derived leakance distribution of the MSCU (Figure 21) is similar to that of the USGS RASA model. The initial value obtained from the RASA model (5×10^{-5} day^{-1}) was increased along parts of the St. Johns River valley to simulate increased hydraulic connection between the Upper and Lower Floridan aquifers along postulated fault or fracture zones. The highest values represent the apparent high degree of hydraulic connection between the Upper and Lower Floridan aquifers around Blue Spring (Figure 2) (Tibbals 1990). Leakance of the MSCU was reduced to approximately 1×10^{-5} day^{-1} over much of the southeastern half of the model to correspond with the increase in thickness in that direction (Tibbals 1990, Figure 13).

The modelwide value for storativity of the layers representing the Upper and Lower Floridan aquifers obtained during calibration is 2.5×10^{-4}. The modelwide values for specific storage of the USCU and MSCU are, respectively, 1×10^{-5} ft^{-1} and 1×10^{-6} ft^{-1}.

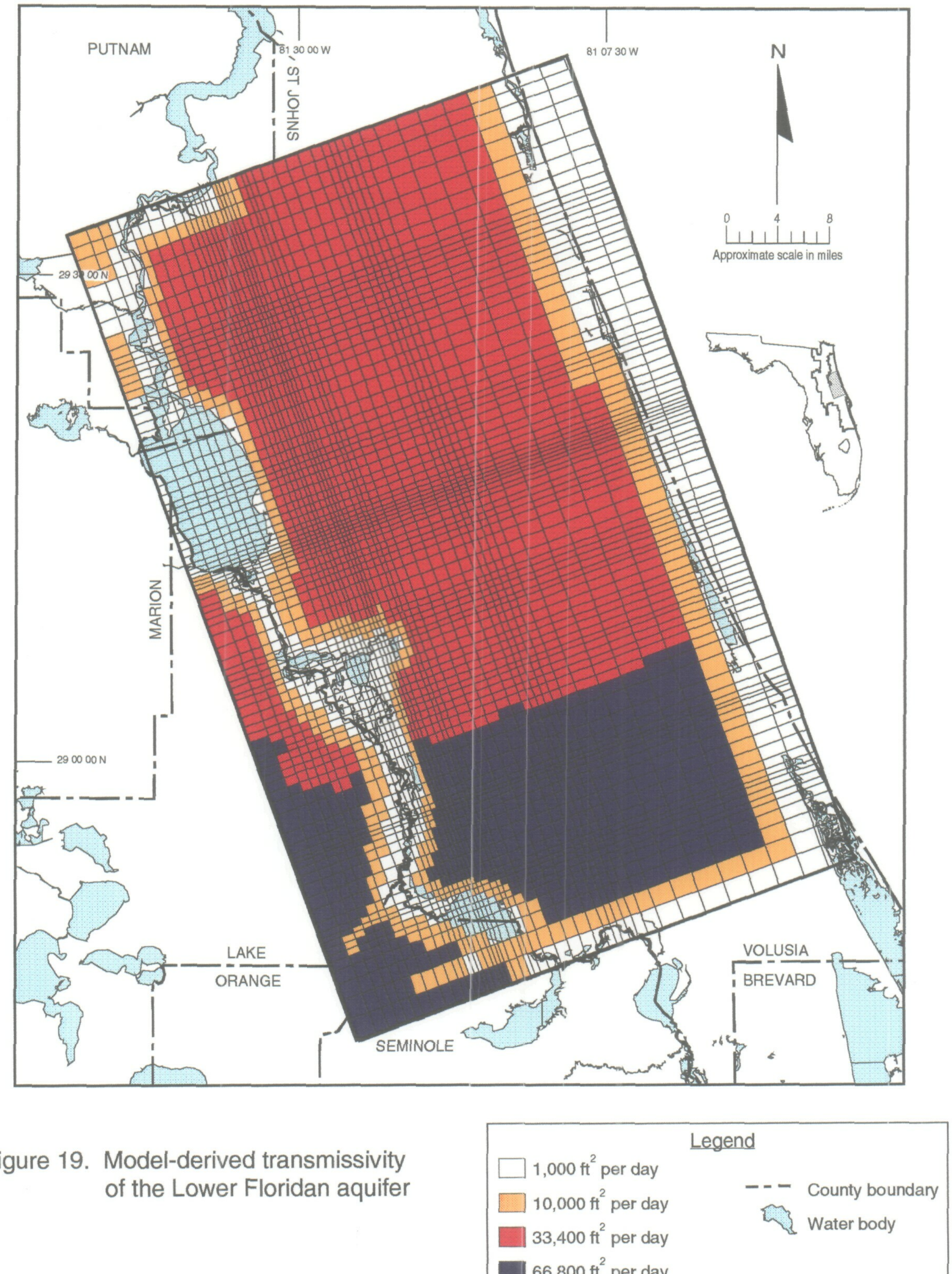


Figure 19. Model-derived transmissivity of the Lower Floridan aquifer

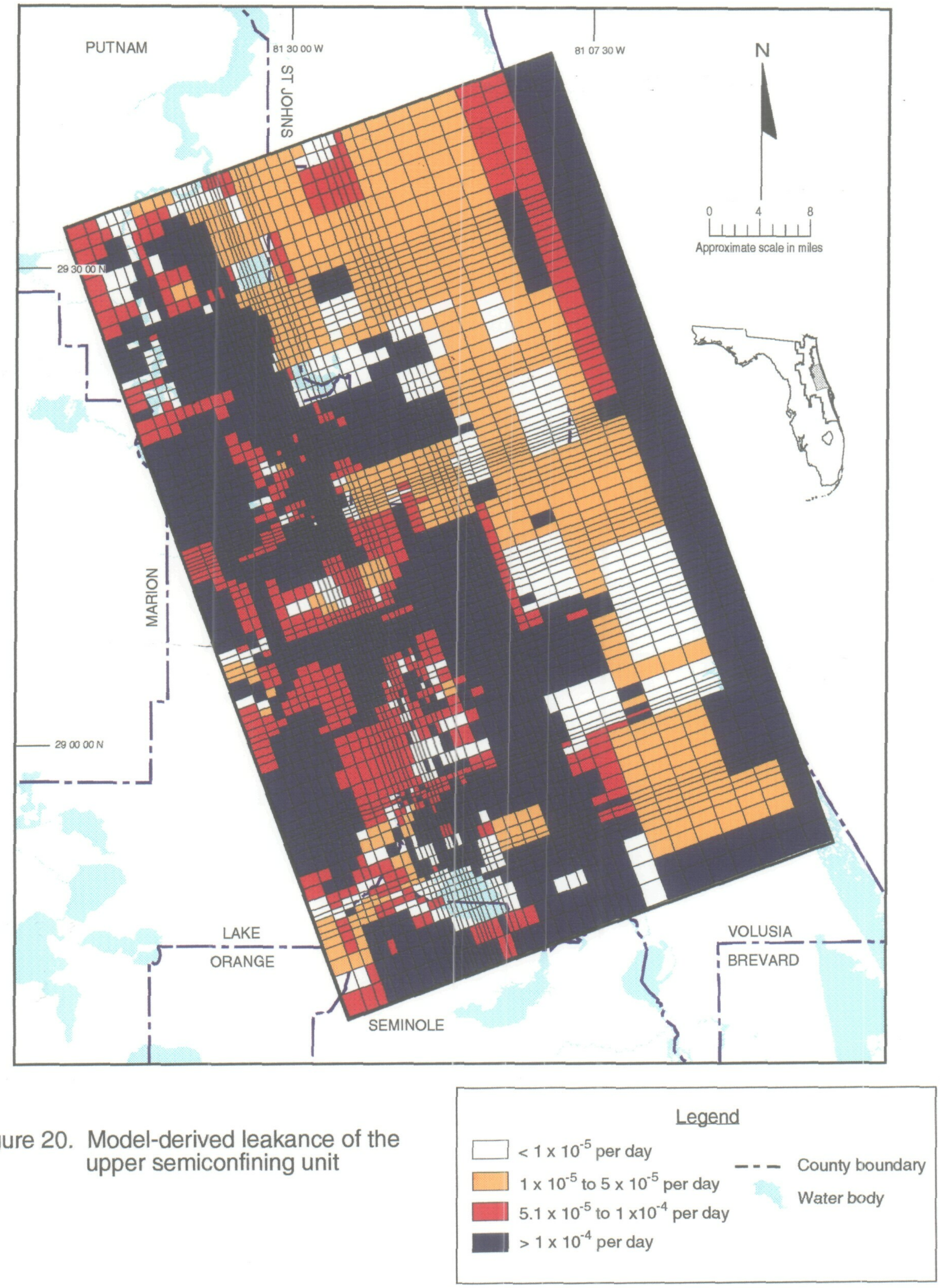


Figure 20. Model-derived leakance of the upper semiconfining unit

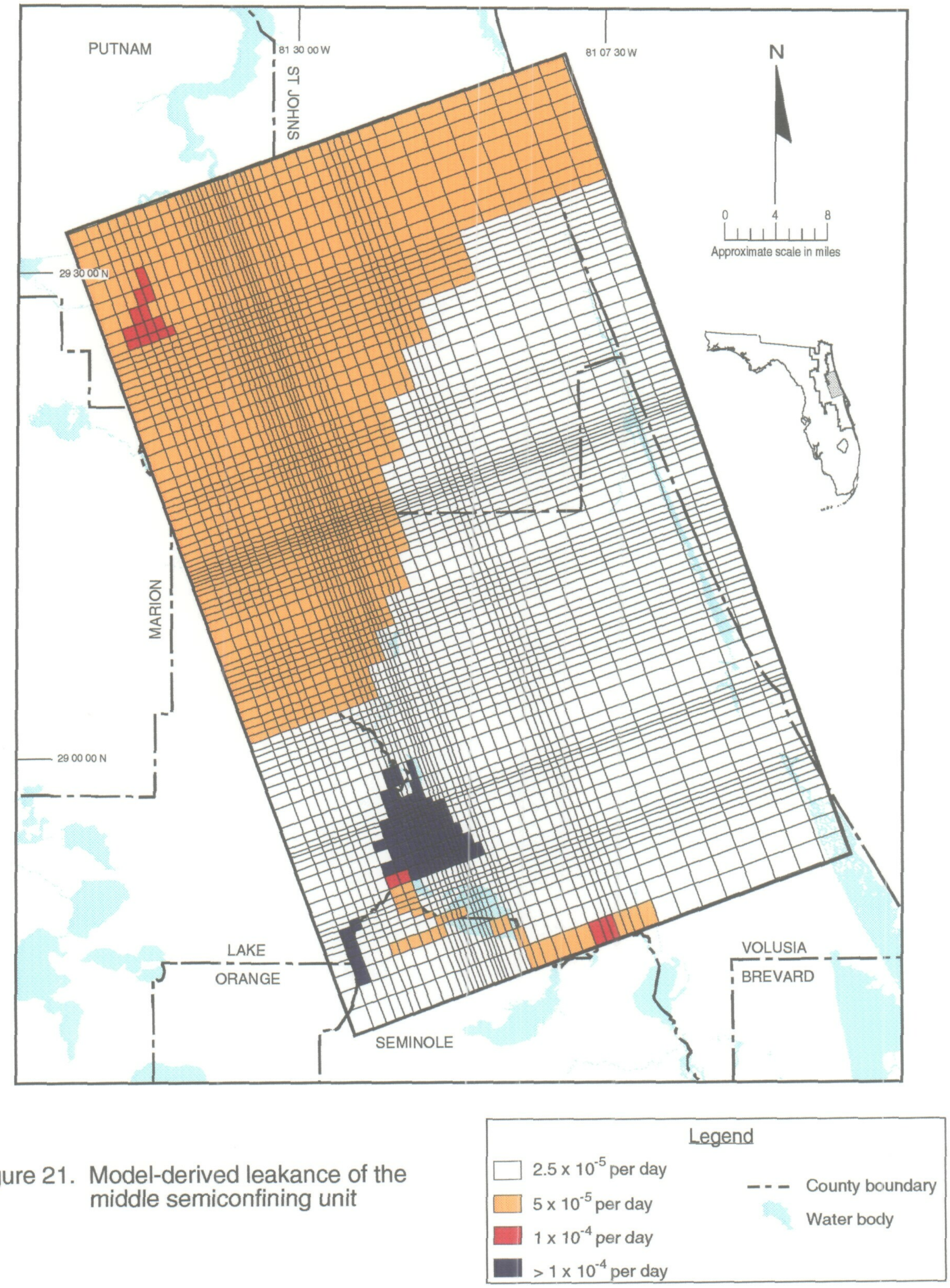


Figure 21. Model-derived leakance of the middle semiconfining unit

Average Predevelopment Calibration Results

The results of the steady-state predevelopment calibration are presented in the form of a potentiometric surface map of the Upper Floridan aquifer (Figure 22), a map of the areal distribution of simulated recharge to and discharge from the Upper Floridan aquifer for predevelopment conditions (Figure 23), and simulated predevelopment springflow rates (Table 4). A qualitative comparison of Figure 22 with Figure 7 reveals that the differences between the two maps are greatest along potentiometric highs and least in discharge areas along the St. Johns River and the Atlantic coast. The general pattern of predevelopment potentiometric contours (Figure 7), along with the groundwater flow directions that this pattern implies, is preserved reasonably well by the simulated contours (Figure 22).

As mentioned previously, the difference between real and simulated results along the Crescent City Ridge recharge area may be due to an overestimation of the extent of the 30-ft NGVD contour on the estimated predevelopment potentiometric surface map upon which Figure 7 was based. Examination of 7.5-minute topographic maps indicates that the area enclosed by the 30-ft NGVD contour on Figure 7 includes significant areas of low land surface elevation near Seville, south of Crescent City near Lake George, and north and east of Satsuma along the St. Johns River. These low regions historically would have been either discharge areas or low recharge areas with respect to the Floridan aquifer system because the water table would not have been significantly higher than the potentiometric surface of the Floridan aquifer system. Simulations conducted during the initial predevelopment calibration indicated that, for the model to simulate heads in the Upper Floridan aquifer high enough to match the 30-ft contour, average recharge rates within the existing high-elevation areas would have to attain unreasonable values (greater than 30 in/yr) over relatively large areas. This condition is inconsistent with the conceptual model that, given a long-term average annual rainfall of 52 in/yr, a maximum areal rate of 22 in/yr is available to recharge the Upper Floridan aquifer.

The simulated areal distribution of recharge and discharge to or from the Upper Floridan aquifer (Figure 23) agrees well with published maps by Tibbals (1981, 1990). Magnitudes of recharge and discharge

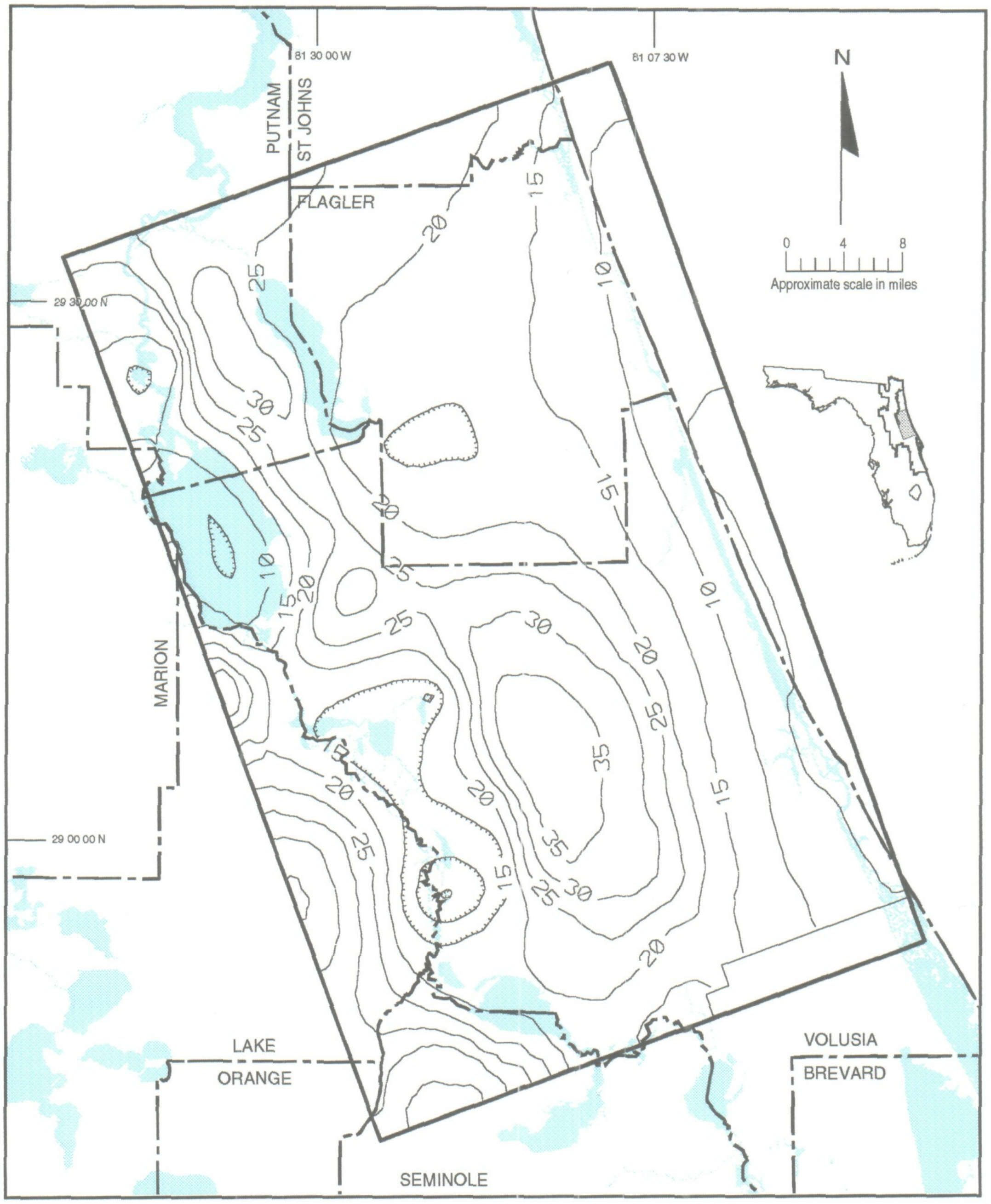


Figure 22. Simulated potentiometric surface of the Upper Floridan aquifer for predevelopment average conditions (contour interval = 5 ft)

Legend

- County boundary
- —25— Contour line of equal potentiometric head
- Water body

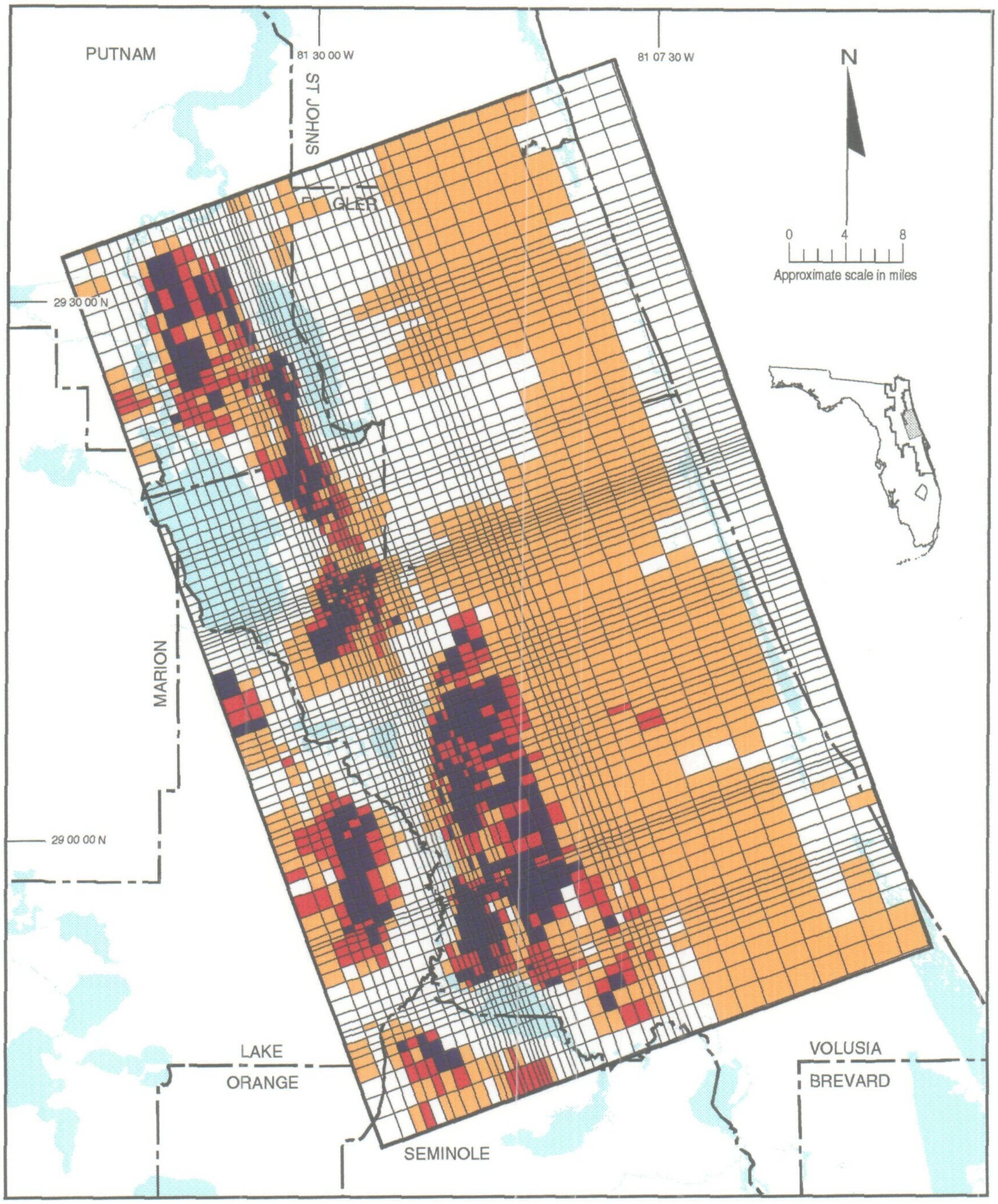
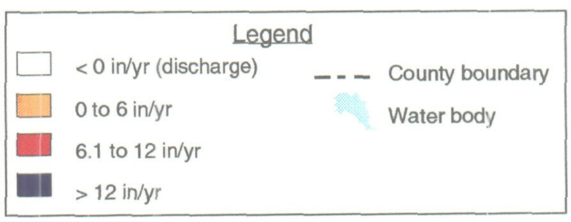


Figure 23. Simulated recharge/discharge for the Upper Floridan aquifer under average predevelopmen t conditions



rates are, in general, greater than those of Tibbals, which is possibly due to a finer grid discretization.

The percent difference between the simulated spring discharge and estimated actual spring discharge (Table 4) is less than or equal to 10% for the four largest springs (Croaker Hole, Ponce de Leon, Blue, and Beecher). The percent difference meets or exceeds ±20% at three of the springs (Satsuma/Nashua, Gemini, and Island) with relatively small flows.

Average Postdevelopment (1988) Conditions

The results of the average, steady-state 1988 calibration are documented by calibration statistics for target wells, maps of the simulated average 1988 potentiometric surface of the Upper Floridan aquifer (Figure 24) and simulated Upper Floridan recharge and discharge (Figure 25), plus simulated springflow rates (Table 4).

Calibration statistics calculated using the 67 target wells in the Upper Floridan aquifer (Figure 26 and Table 7) are within acceptable limits. The mean of the errors is 0.41 ft. The mean absolute error (MAE) is 2.74 ft, and the root mean squared error is 3.38 ft. The mean of errors and MAE values are less than the prescribed target values of 1.0 ft and 3.00 ft, respectively. The total head loss (the difference between the highest and lowest potentiometric elevations) within the Upper Floridan aquifer is approximately 40 ft (Figures 6 and 7). The ratio of root mean squared error to the total head loss is small (.08), indicating that the errors in head are a small part of the overall model response (Anderson and Woessner 1992).

The simulated potentiometric surface of the Upper Floridan aquifer for average 1988 conditions (Figure 24) mimics the regional features of the average 1988 potentiometric surface (Figure 6) quite well. Both surfaces range from less than 5 ft NGVD in eastern Volusia County and along the St. Johns River valley near Blue Spring and Lake George to greater than 35 ft NGVD in central Volusia County and along the western and southern model boundaries in Lake County and Seminole County.

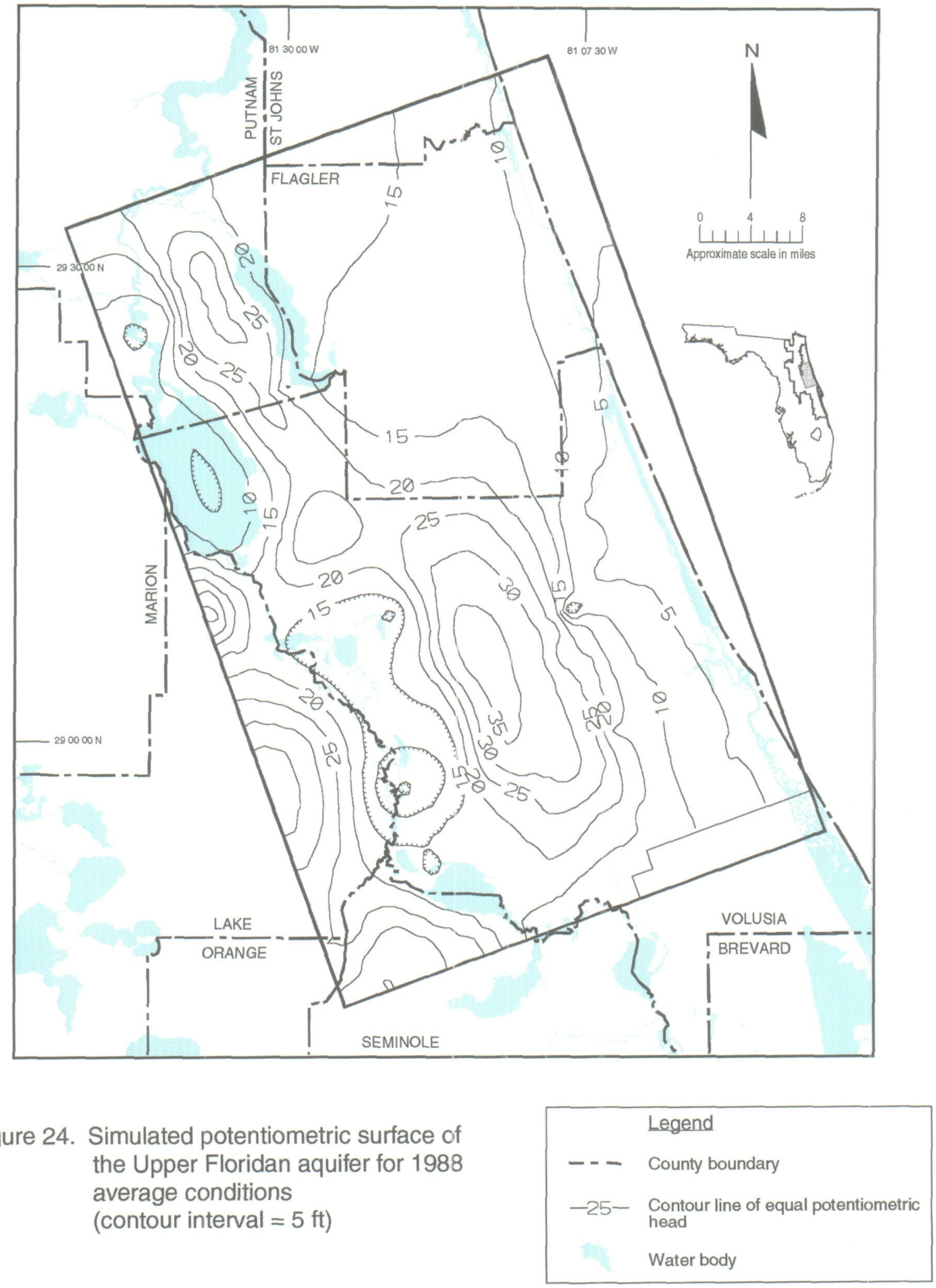


Figure 24. Simulated potentiometric surface of the Upper Floridan aquifer for 1988 average conditions (contour interval = 5 ft)

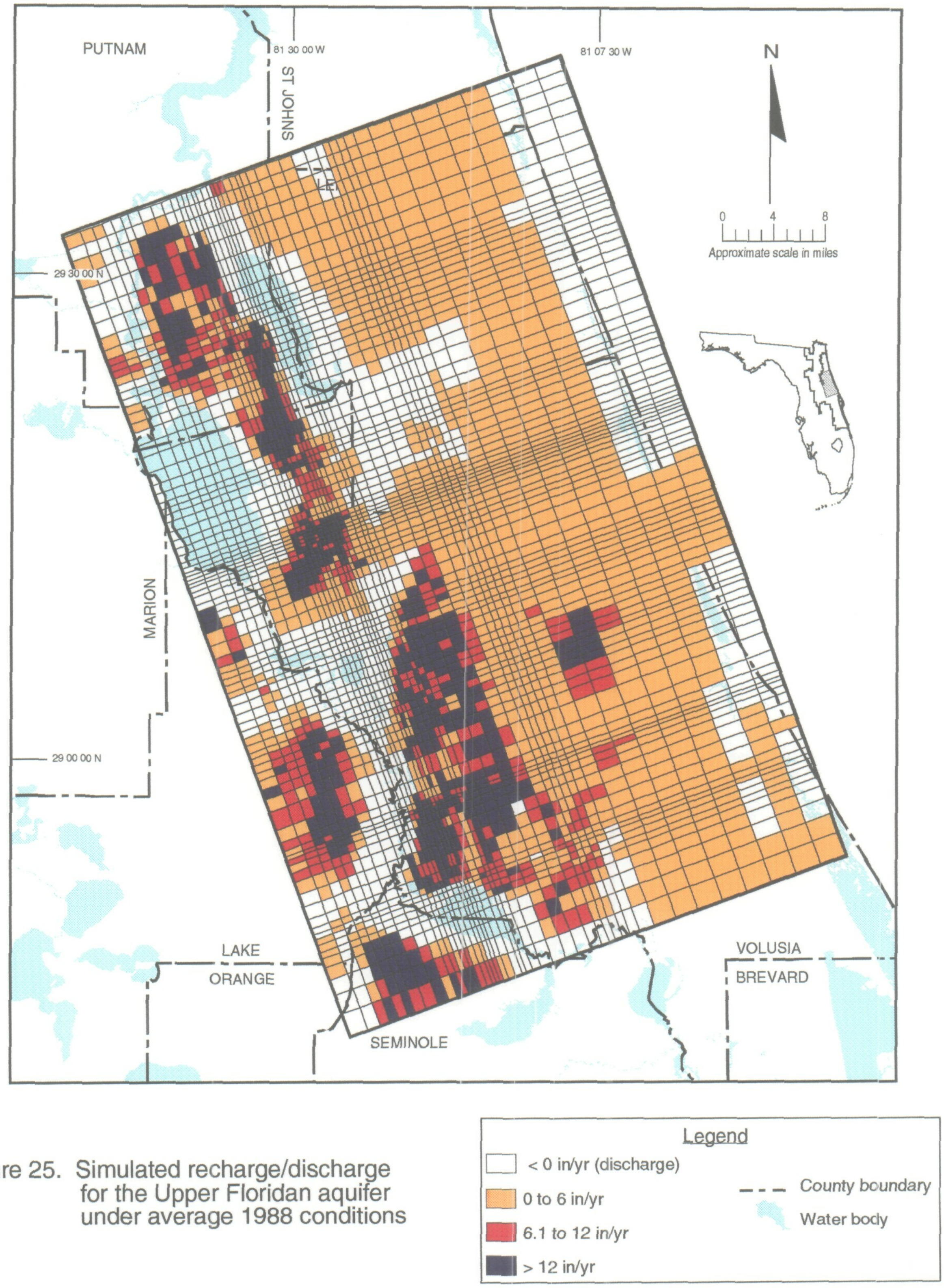


Figure 25. Simulated recharge/discharge for the Upper Floridan aquifer under average 1988 conditions

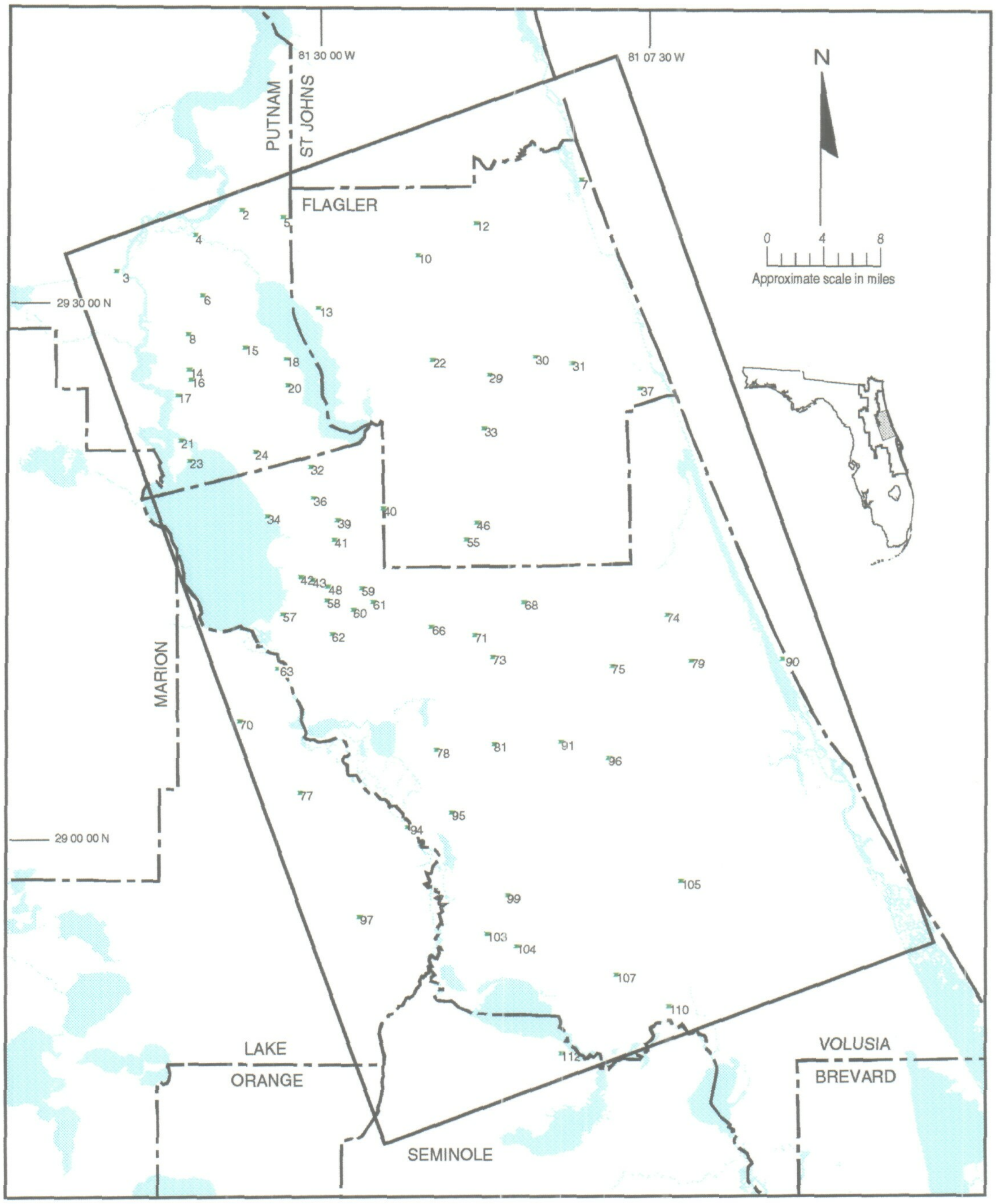


Figure 26. Location of observation wells completed in the Upper Floridan aquifer for the 1988 steady-state calibration

Legend

County boundary

110 Observation well site

Water body

Table 7. Comparison between observed and simulated water levels in target wells completed in the Upper Floridan aquifer, 1988 calibration

Well Number	Row	Column	Average Observed 1988 Water Level (mean sea level)	Simulated 1988 Water Level (mean sea level)	Observed Minus Simulated (feet)
2	1	21	16.23	19.73	-3.50
3	2	3	15.81	17.31	-1.50
4	2	11	24.90	21.93	2.97
5	3	26	14.91	18.39	-3.48
6	5	9	28.68	27.63	1.05
7	6	43	13.99	8.39	5.60
8	7	8	18.06	23.90	-5.84
10	7	36	14.75	15.24	-0.49
12	7	39	14.51	13.98	0.53
13	8	26	13.83	17.03	-3.20
14	9	7	21.23	17.40	3.83
15	9	13	32.43	30.09	2.34
16	11	7	22.32	20.11	2.21
17	12	5	18.36	11.37	6.99
18	13	19	23.62	24.50	-0.88
20	16	18	29.50	27.48	2.02
21	17	4	11.00	11.80	-0.80
22	18	34	10.35	12.73	-2.38
23	20	4	9.41	8.79	0.62
24	20	9	25.33	19.33	6.00
29	21	38	8.71	12.70	-3.99
30	21	39	13.28	12.51	0.77
31	22	41	15.41	10.67	4.74
32	23	17	31.39	24.62	6.77
33	24	36	8.40	12.93	-4.53
34	25	8	5.52	10.80	-5.28
36	25	15	26.42	24.59	1.83

Table 7—*Continued*

Well Number	Row	Column	Average Observed 1988 Water Level (mean sea level)	Simulated 1988 Water Level (mean sea level)	Observed Minus Simulated (feet)
37	26	43	8.29	6.06	2.23
39	29	18	23.62	23.33	0.29
40	29	26	19.50	18.40	1.10
41	30	15	22.20	21.41	0.79
42	33	9	13.31	14.42	-1.11
43	34	11	17.48	20.95	-3.47
46	34	32	16.64	17.04	-0.40
48	36	12	21.85	24.63	-2.78
55	36	31	19.03	18.14	0.89
57	38	7	6.51	12.31	-5.80
58	38	11	27.09	24.76	2.33
59	39	18	31.07	29.15	1.92
60	42	15	26.29	28.59	-2.30
61	42	19	31.08	28.16	2.92
62	44	11	29.05	25.99	3.06
63	46	5	13.40	17.42	-4.02
66	47	26	24.68	22.92	1.76
68	47	34	26.31	27.20	-0.89
70	48	1	37.41	32.87	4.54
71	48	29	25.41	29.06	-3.65
73	51	30	30.62	31.38	-0.76
74	54	41	7.38	5.36	2.02
75	57	38	25.38	23.31	2.07
77	58	3	15.77	23.16	-7.39
78	59	21	14.87	15.05	-0.18
79	59	41	-0.98	4.75	-5.73
81	61	28	34.53	32.69	1.84

Table 7—*Continued*

Well Number	Row	Column	Average Observed 1988 Water Level (mean sea level)	Simulated 1988 Water Level (mean sea level)	Observed Minus Simulated (feet)
90	61	44	2.37	2.75	-0.38
91	64	32	36.23	35.72	0.51
94	66	11	15.15	14.10	1.05
95	67	19	10.00	12.54	-2.54
96	67	37	35.23	29.67	5.56
97	71	4	35.74	30.18	5.56
99	76	23	12.08	12.69	-0.61
103	78	18	19.41	14.30	5.11
104	79	22	16.40	15.85	0.55
105	80	38	28.60	23.11	5.49
107	87	30	21.71	19.67	2.04
110	89	34	13.53	13.53	0.00
112	90	23	21.45	17.76	3.69

Mean error: 0.41 feet
Mean absolute error: 2.74 feet
Root mean squared error: 3.38 feet
Ratio of root mean squared error to total head loss: .08

The simulated potentiometric surface (Figure 24), however, is slightly lower than the actual 1988 potentiometric surface (Figure 6) in high regions (along the Crescent City Ridge and in central Volusia County), and it is slightly higher than the average surface in discharge areas. These differences are also evident by comparing plots of the head errors (residuals) (Table 7 and Figure 27). Positive errors indicate that the average observed head at a target well is greater than the simulated heads. Positive errors predominate along the Crescent City Ridge north of Pierson and in central and southwestern Volusia County. Negative errors indicate that the average observed head is less than the simulated head. Negative errors are more abundant than positive errors along the St. Johns River valley and in central Flagler County.

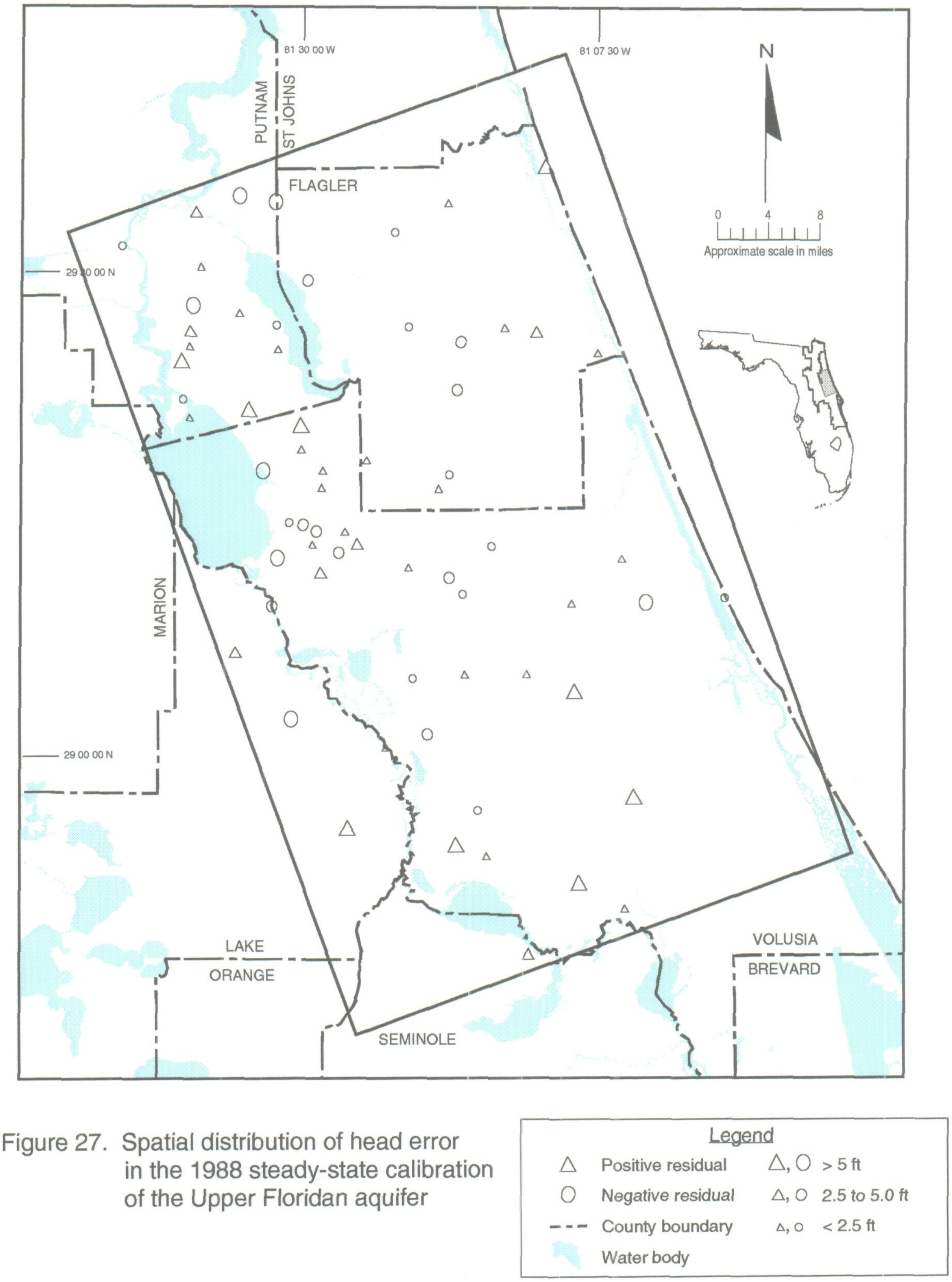


Figure 27. Spatial distribution of head error in the 1988 steady-state calibration of the Upper Floridan aquifer

The simulated areal recharge/discharge distribution for the Upper Floridan aquifer for average 1988 conditions (Figure 25) compares well with maps prepared by Boniol et al. (1990, 1993), Tibbals (1990), and Vecchioli et al. (1990). The highest rates of simulated recharge occur along the Crescent City and De Land ridges and in upland areas of Lake and Seminole counties. The highest rates of simulated discharge occur along the St. Johns River valley.

The magnitudes of the recharge and discharge rates simulated for some grid cells in the WVSP area are greater than those computed by the predevelopment RASA model (Tibbals 1990). However, individual grid cells in the RASA model cover much larger areas (4 mi^2 (4 mi^2) than in the WVSP area of the model. Therefore, some of the recharge and discharge rates computed by the RASA model represent net average rates for areas that may include both recharge and discharge areas.

Simulated average 1988 spring discharge rates (Table 4) are all within 10% of the observed discharge rate, except for Green Springs, where the simulated flow is 14% higher.

Transient Frost-and-Freeze Conditions

The transient frost-and-freeze model was calibrated by comparing observed drawdowns (referenced to the observed water level at the beginning of frost-and-freeze pumping) to simulated drawdowns for each of the 11 target wells with continuous recorder data for the calibration period (Figures 28–38). The model-grid locations of these wells are listed in Appendix A. The origin of the *x*-axis on each of these graphs corresponds to the beginning of frost-and-freeze pumping at approximately 10:00 p.m. on January 22, 1991. The relatively small observed drawdowns plotted several days later (Figures 29 and 31) are due to later pumping and are unrelated to the freeze of January 22–23, 1991.

The observed magnitudes of drawdown and recovery are matched well by the simulated drawdown and recovery at most locations. A comparison of Figure 26 with Figure 17 shows that wells 18, 43, and 61 (drawdowns plotted on Figures 31, 33, and 34, respectively) are located within areas of concentrated frost-and-freeze protection. These wells exhibit the greatest drawdowns and the most rapid recovery rates.

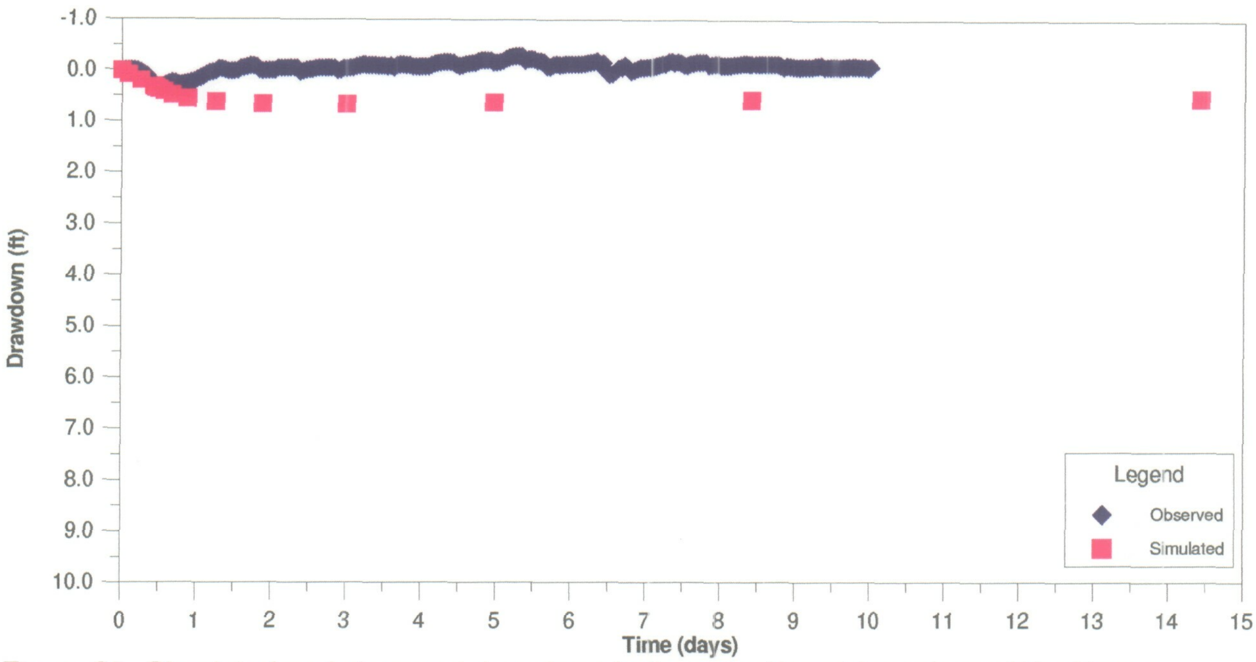


Figure 28. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 8

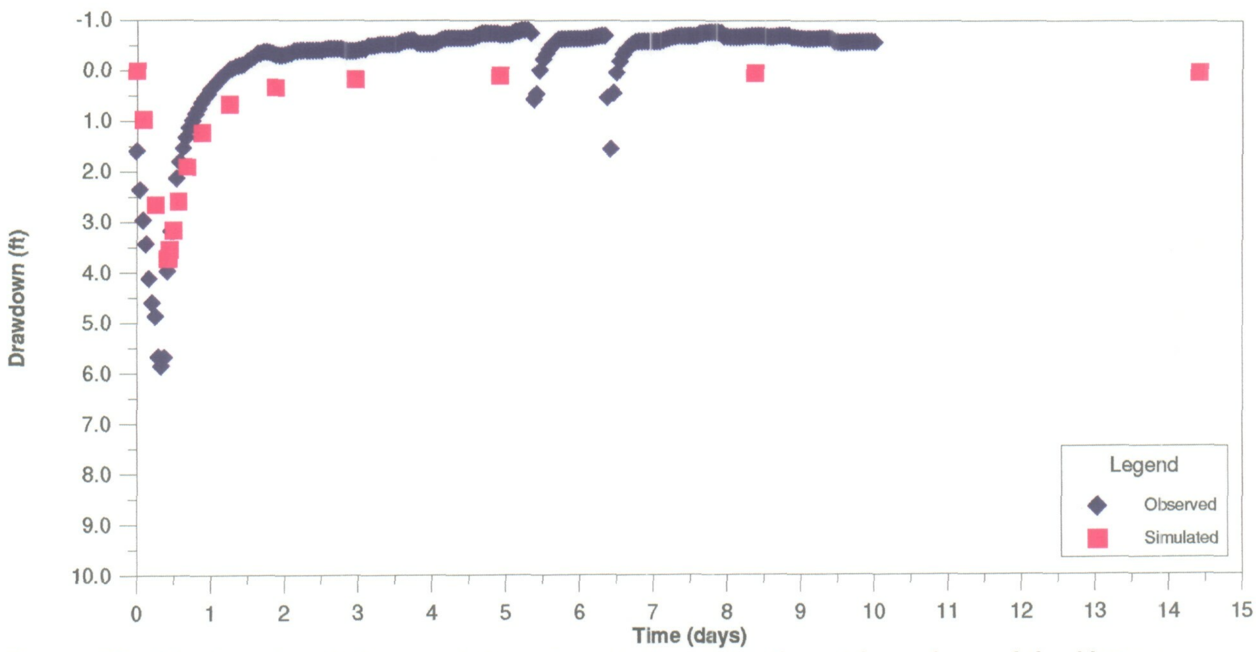


Figure 29. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 14

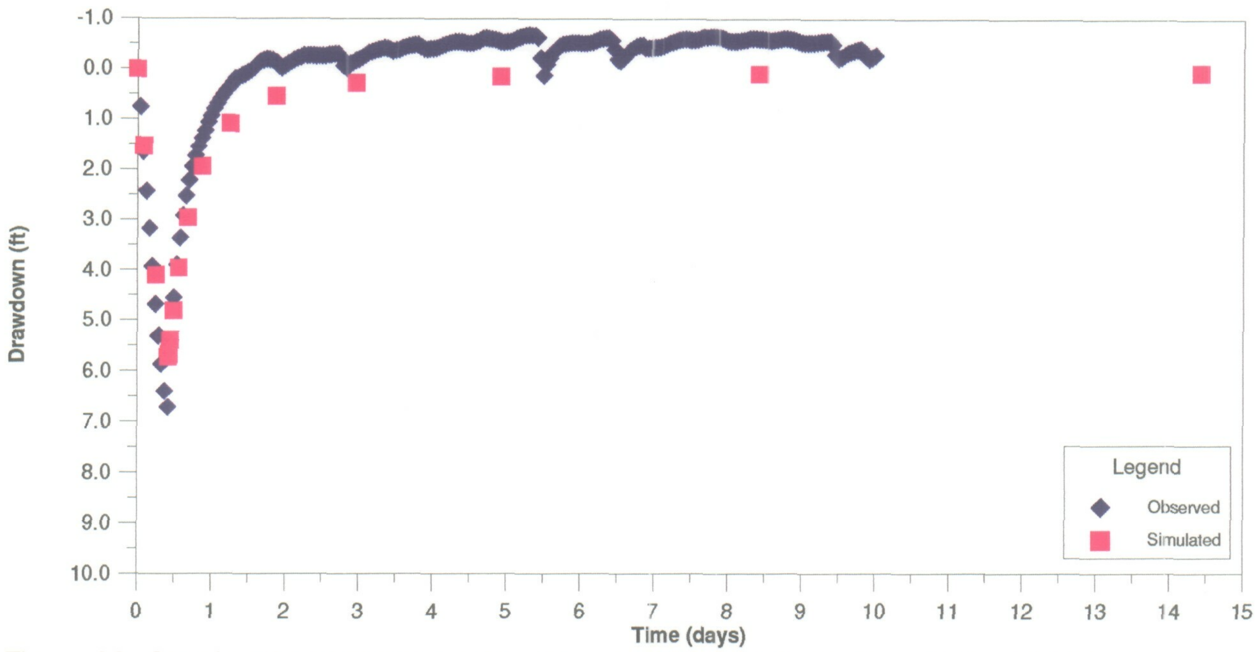


Figure 30. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 16

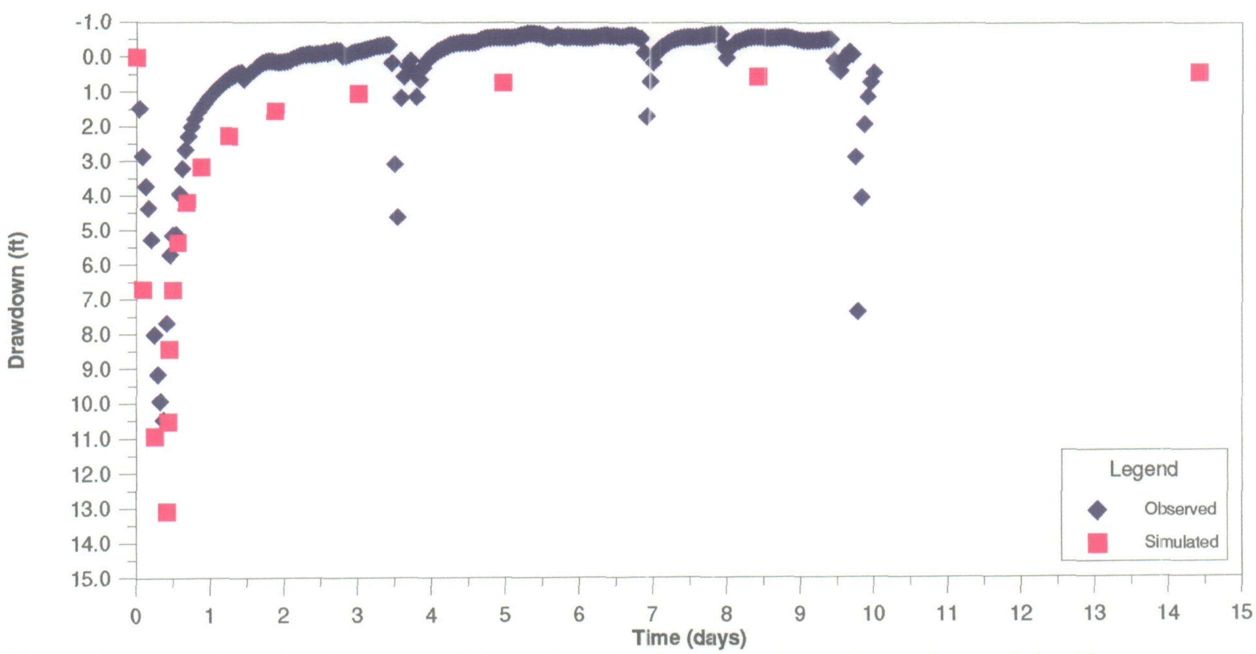


Figure 31. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 18

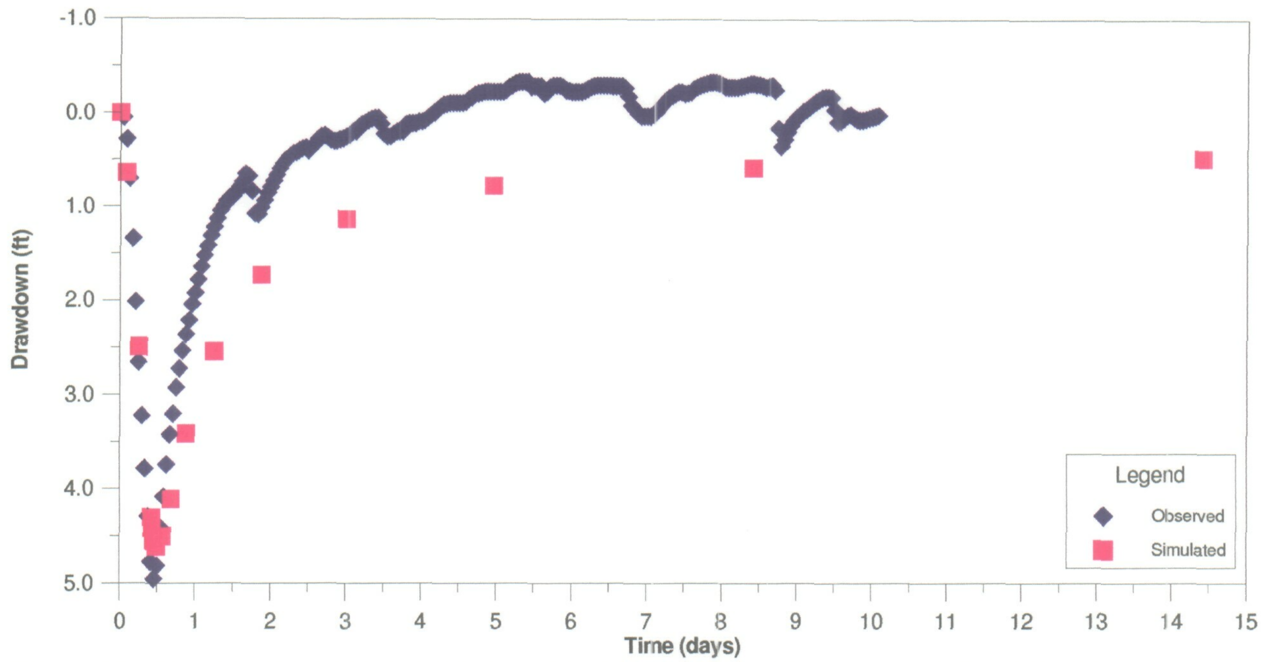


Figure 32. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 20

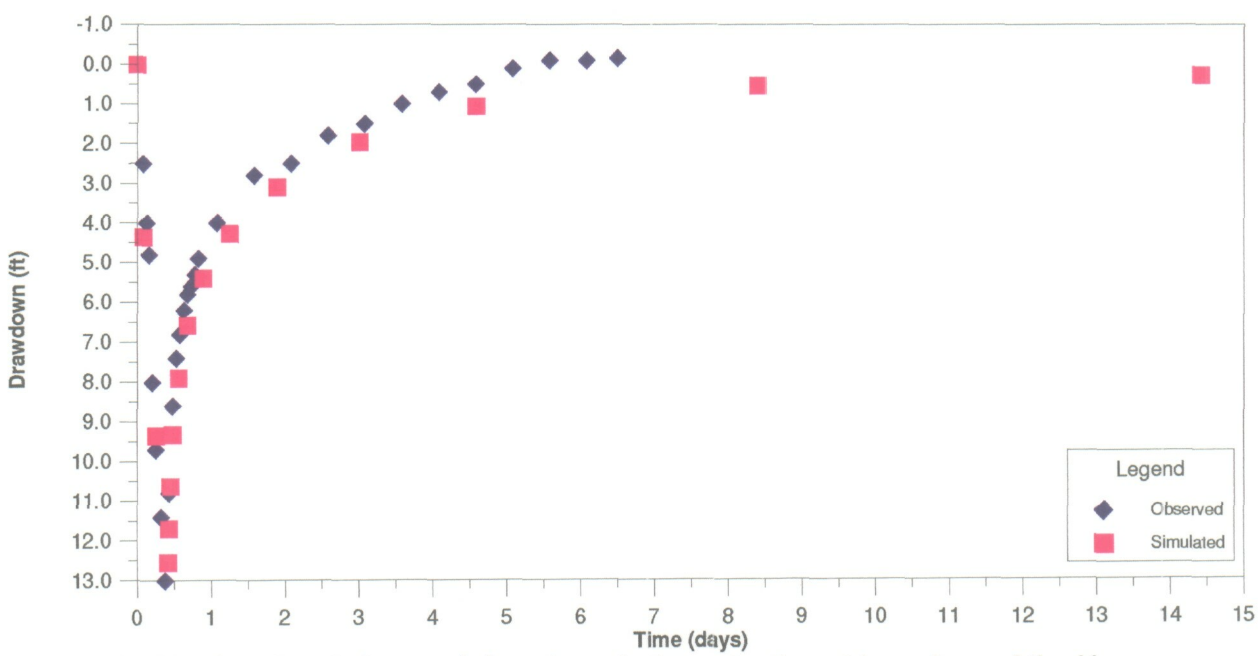


Figure 33. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 43

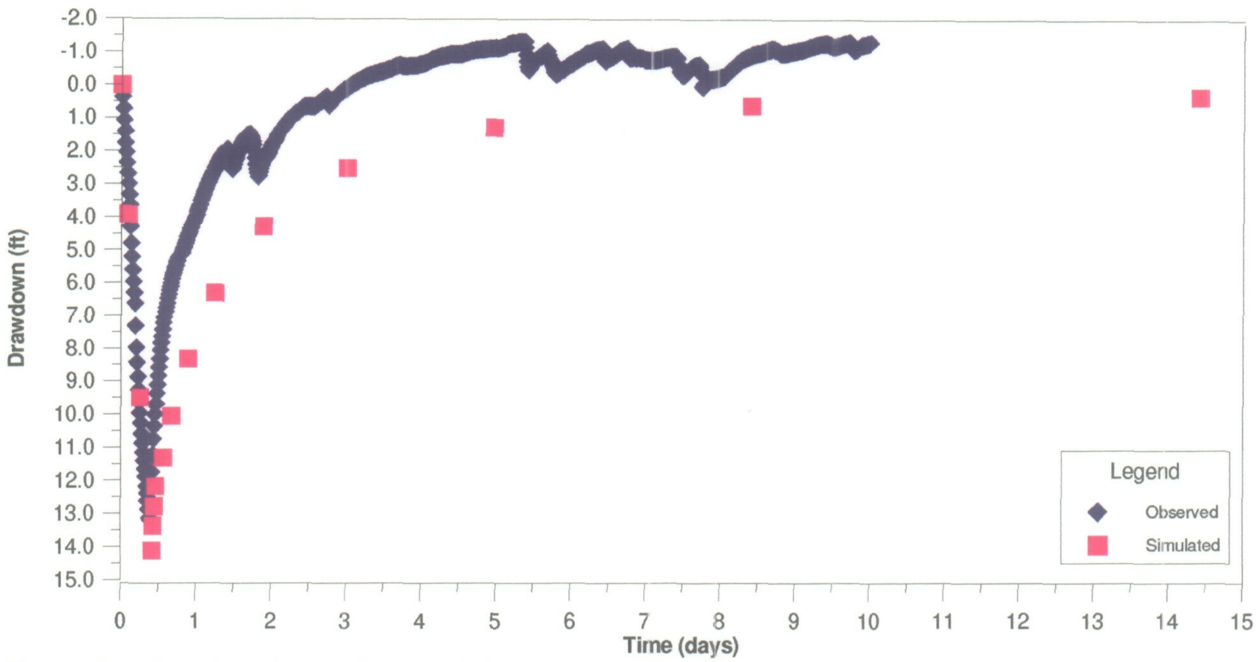


Figure 34. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 61

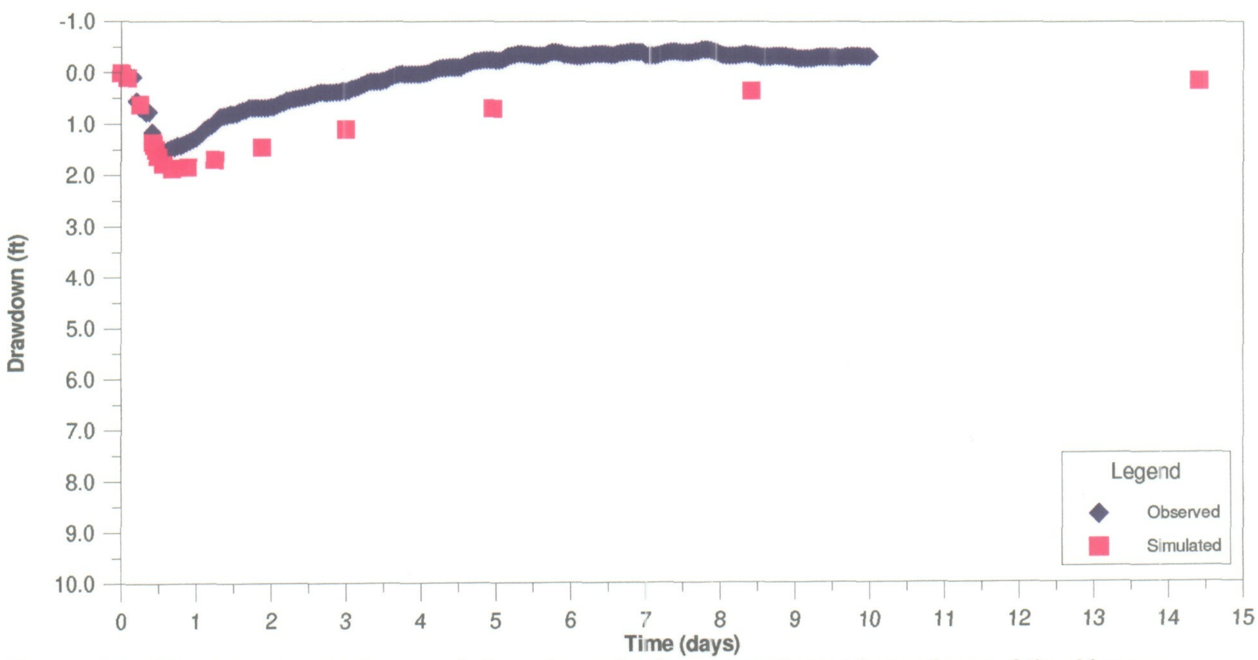


Figure 35. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 66

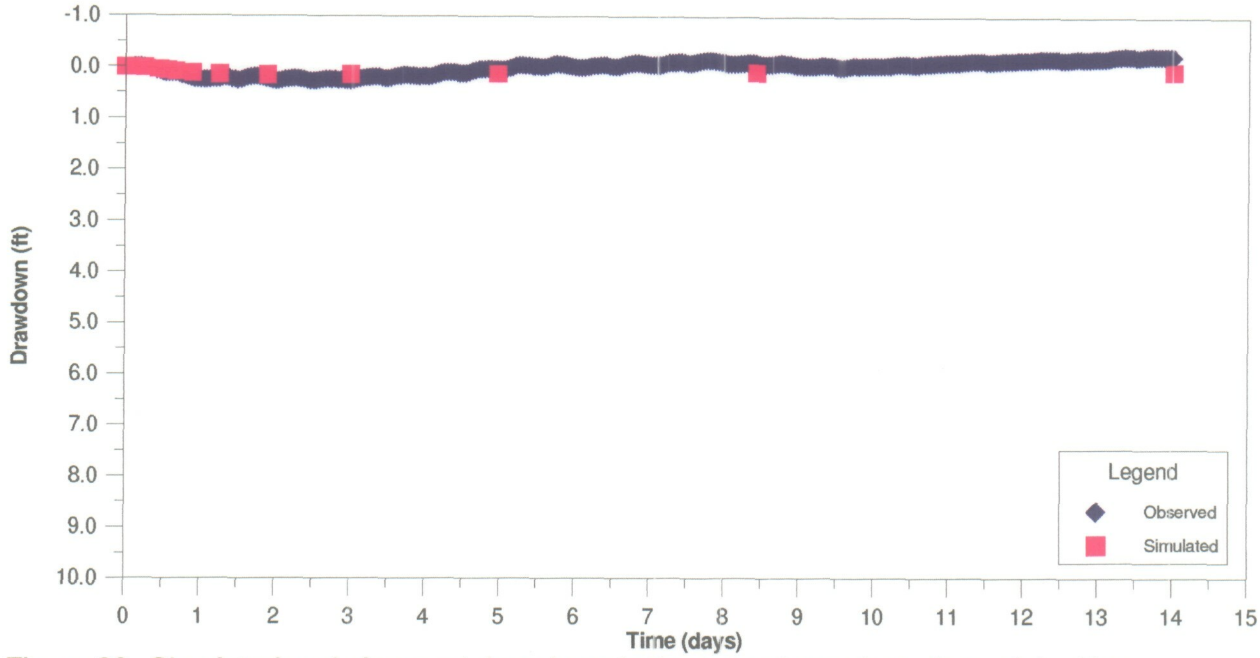


Figure 36. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 68

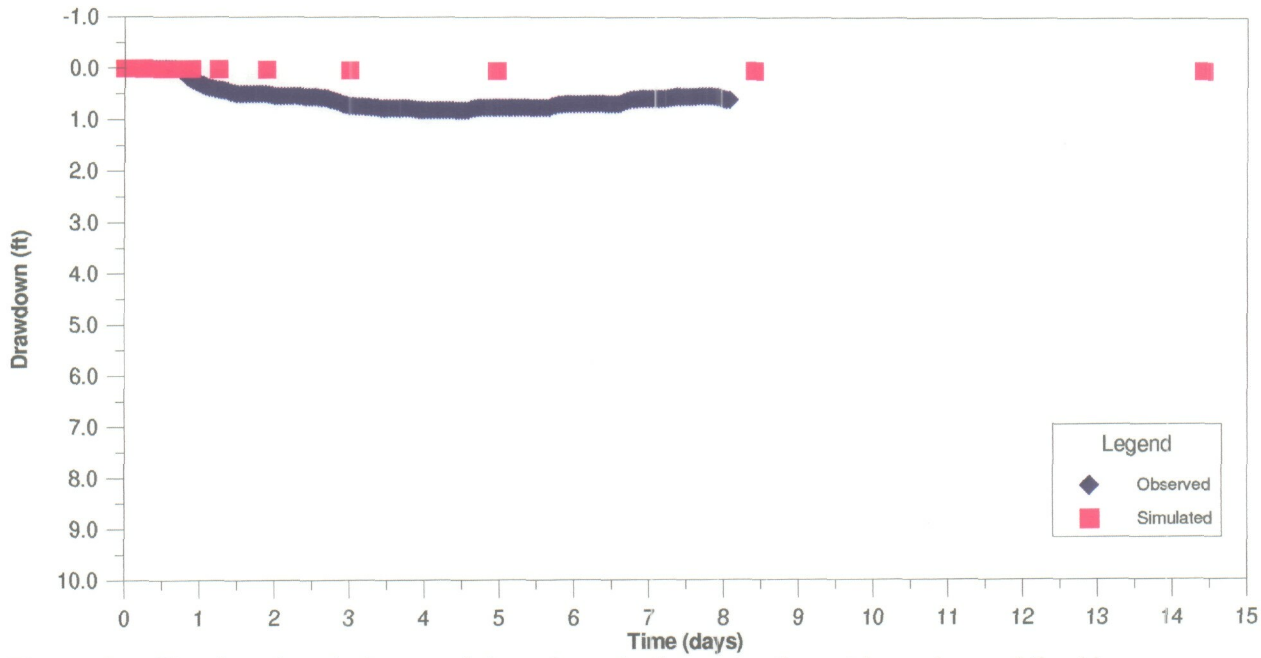


Figure 37. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 75

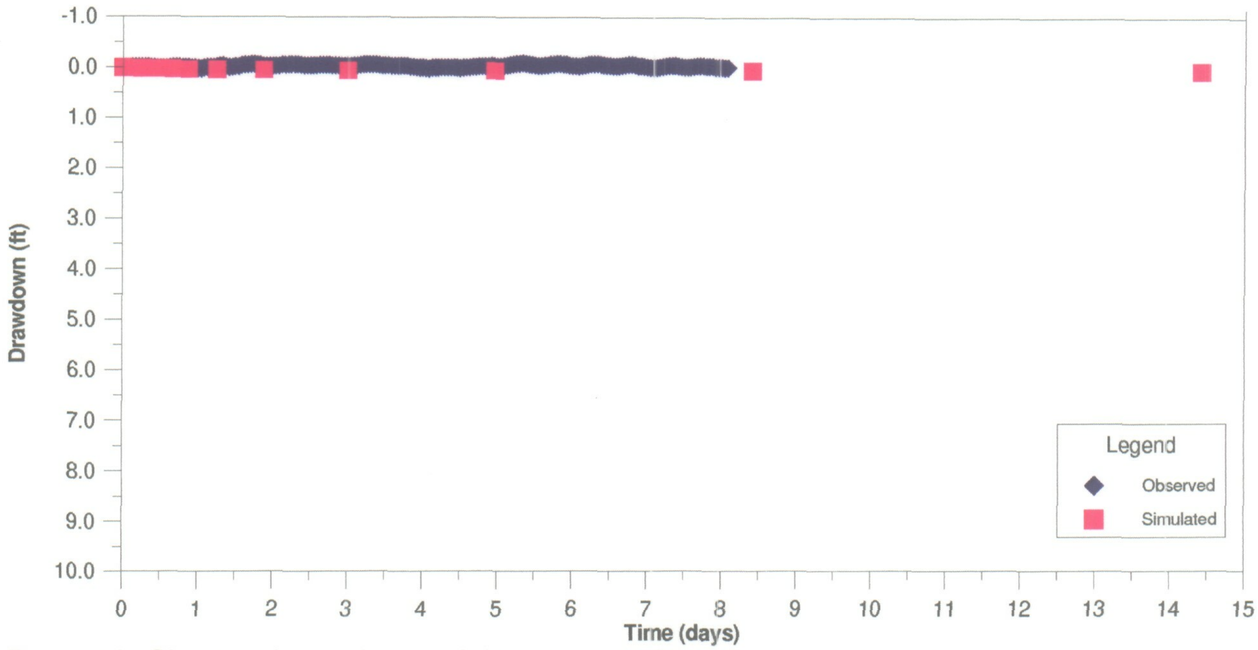


Figure 38. Simulated and observed drawdown in the potentiometric surface of the Upper Floridan aquifer at well 105

Wells 14, 16, and 20 (Figures 29, 30, and 32) are located adjacent to areas of frost-and-freeze protection, and wells 8, 66, 68, 75, and 105 (drawdowns plotted on Figures 28 and 35–38) are located relatively far from the centers of frost-and-freeze pumping. The change in drawdown with time is rapid both at the start and at the end of pumping for wells located within and near areas of concentrated withdrawals. At wells located away from the pumping centers, both drawdown and recovery are minimal in magnitude and are delayed from the start and end of pumping. No drawdown is apparent at well 105, which is located near Lake Ashby, more than 7 mi southeast of the nearest known frost-freeze withdrawals.

The hydrograph of well 75 (Figure 37) shows approximately 0.5 ft of drawdown occurring during the latter part of January 23, 1991 (nearly 1 day after the commencement of frost-and-freeze withdrawals). Repeated attempts during calibration to induce simulated drawdown at this location were unsuccessful, even using aquifer parameter values for central Volusia County that are significantly different than both reported values and the values required for steady-state calibrations. Well 75 is located less than 1 mi from the Daytona Beach wellfield.

Well 75 is located less than 1 mi from the Daytona Beach wellfield. Well 69 (Figure 36) incurred less drawdown and is closer to the centers of frost-and-freeze pumping than well 75. Given these facts, the drawdown observed in well 75 may not be due to frost-and-freeze protection pumping in western Volusia County, but rather to unaccounted-for frost-and-freeze protection irrigation in eastern Volusia County or, more likely, to an increase in public water supply pumping at the Daytona Beach wellfield on January 23, 1991.

A check on the transient calibration results was conducted by comparing simulated water levels with one-time water level measurements made during the morning and afternoon of January 23 at observation wells located throughout the WVSP area. The differences between observed and simulated water level elevations are less than ±2.0 ft at 9 of the 14 wells (Table 8).

Table 8. Comparison between observed and simulated water levels for wells completed in the Upper Floridan aquifer. *One-time-only water level measurements were made during the transient calibration period.*

Well Number*	Row	Column	Observed		Simulated		Observed Minus Simulated (ft NGVD)
			Water Level (ft NGVD)	Time	Water Level (ft NGVD)	Time	
3	2	3	16.56	1430	17.43	1419	-0.87
6	5	9	25.80	1123	27.05	1126	-1.25
36	25	15	19.39	0902	14.70	0847	4.69
40	29	26	18.27	0930	17.65	0945	0.62
42	33	9	8.37	1003	12.85	0945	-4.48
46	34	32	15.82	1031	17.06	0945	-1.24
55	36	31	17.88	1045	18.15	1126	-0.27
59	39	18	15.01	1125	7.58	1126	7.43
64	46	22	17.35	1120	18.17	1126	-0.82
72	50	22	15.65	1133	12.75	1126	2.90
19	15	13	24.56	0922	23.46	0945	1.10
38	29	15	16.57	0945	14.64	0945	1.93
54	36	17	9.46	1102	9.73	1126	-0.27
56	37	17	14.25	1116	8.56	1126	5.69

Note: ft NGVD = feet National Geodetic Vertical Datum

*See Appendix A

The simulated potentiometric surface of the Upper Floridan aquifer at the cessation of pumping for frost-and-freeze protection on January 23, 1991 contains lows of approximately 20 ft, 0 ft, and 10 ft near Crescent City, Pierson, and Ponce de Leon Springs, respectively (Figure 39).

Maximum drawdowns in the potentiometric surface in these same areas reach 10 ft, 20 ft, and 15 ft. Relatively large drawdowns are limited to the immediate areas of concentrated freeze protection. The area including simulated drawdown exceeding 0.5 ft does not extend beyond the WVSP area, except due to localized withdrawals in northeastern Lake County and in Seminole County (Figure 40).

SENSITIVITY ANALYSES

Two series of sensitivity analyses were conducted to demonstrate the sensitivity of simulated head values for the Upper Floridan aquifer to changes in the calibrated model parameters and boundary conditions. One series of sensitivity simulations was conducted in a steady-state mode using 1988 withdrawals and boundary conditions; the second series was conducted in a transient mode with well withdrawals and boundary conditions identical to the 1991 frost-and-freeze simulation. For each sensitivity run, the calibrated values of a particular aquifer parameter or head-dependent flux boundary head were raised and lowered by constant values modelwide.

Sensitivity analyses demonstrate that the steady-state model is most sensitive to changes in the values assigned as constant water table elevations and to the leakance of the USCU (Figure 41). Drawdowns computed by the transient model are most sensitive to aquifer storativity and the transmissivity of the Upper Floridan aquifer (Figure 42). The transient model is also moderately sensitive to the leakance and specific storage values assigned to the USCU.

Steady-State Sensitivity Analyses

The steady-state sensitivity analysis was conducted by running a series of simulations wherein the calibrated values of a particular input parameter were changed by the same percentage at each model cell location. Input value changes ranged from a 50% decrease to a 50% increase. The resulting simulated potentiometric elevation of the Upper Floridan aquifer at each of the 67 model cells corresponding to

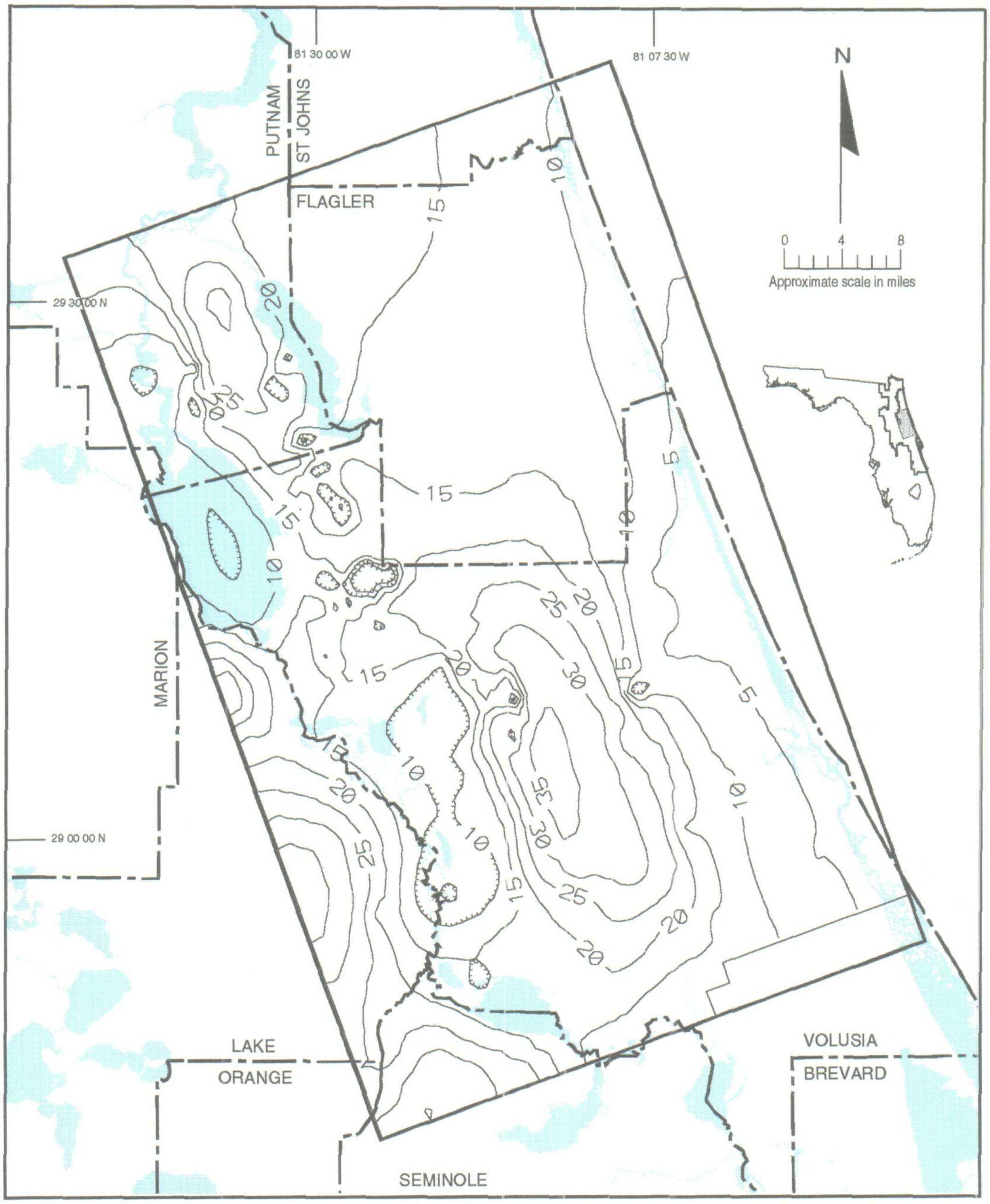
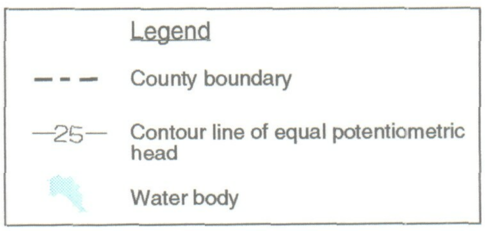


Figure 39. Simulated potentiometric surface of the Upper Floridan aquifer at the end of frost-and-freeze protection: January 23, 1991 (contour interval = 5 ft)



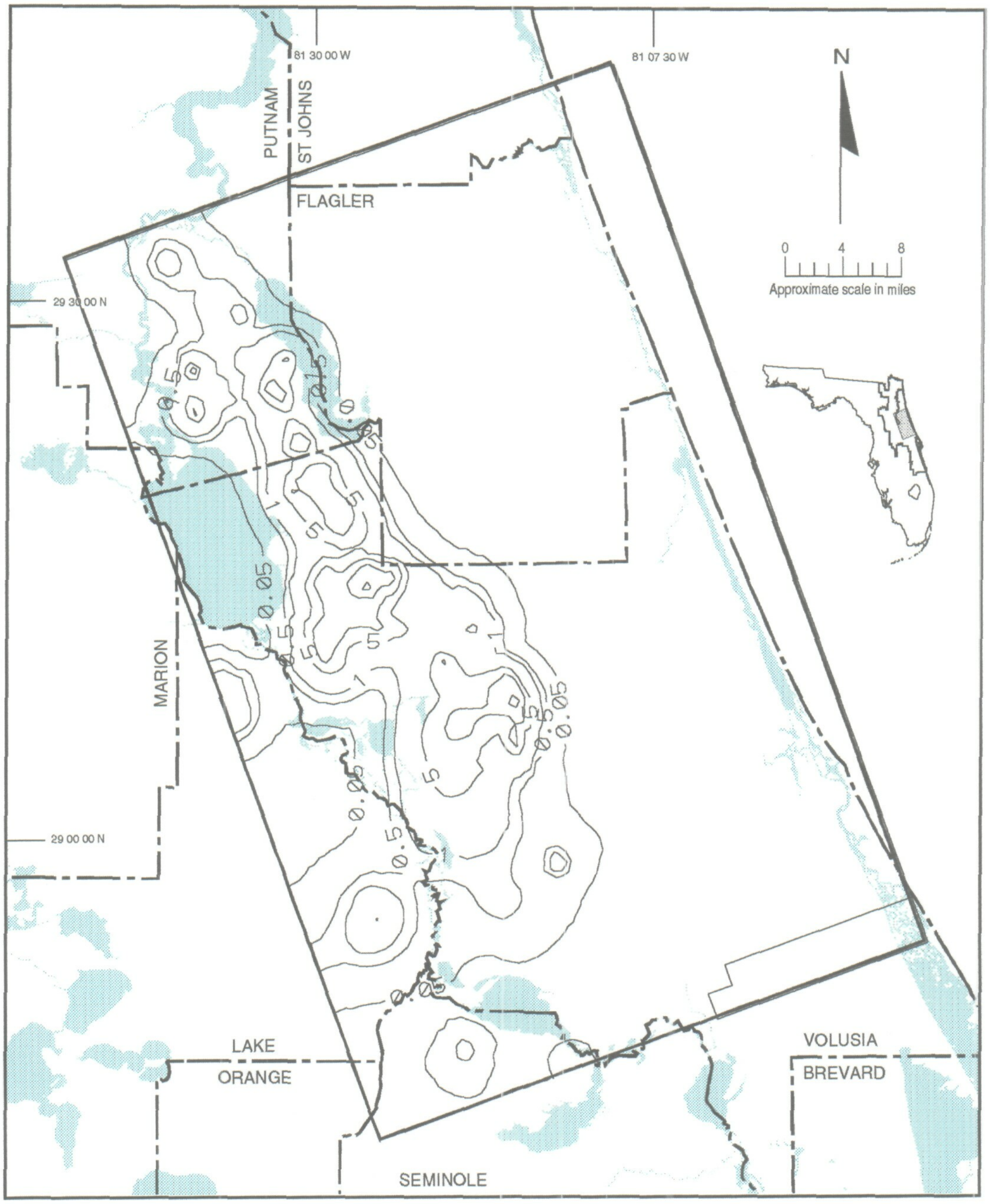


Figure 40. Simulated drawdown in the potentiometric surface of the Upper Floridan aquifer at the end of frost-and-freeze protection: January 23, 1991 (contour interval = 5 ft, except where marked)

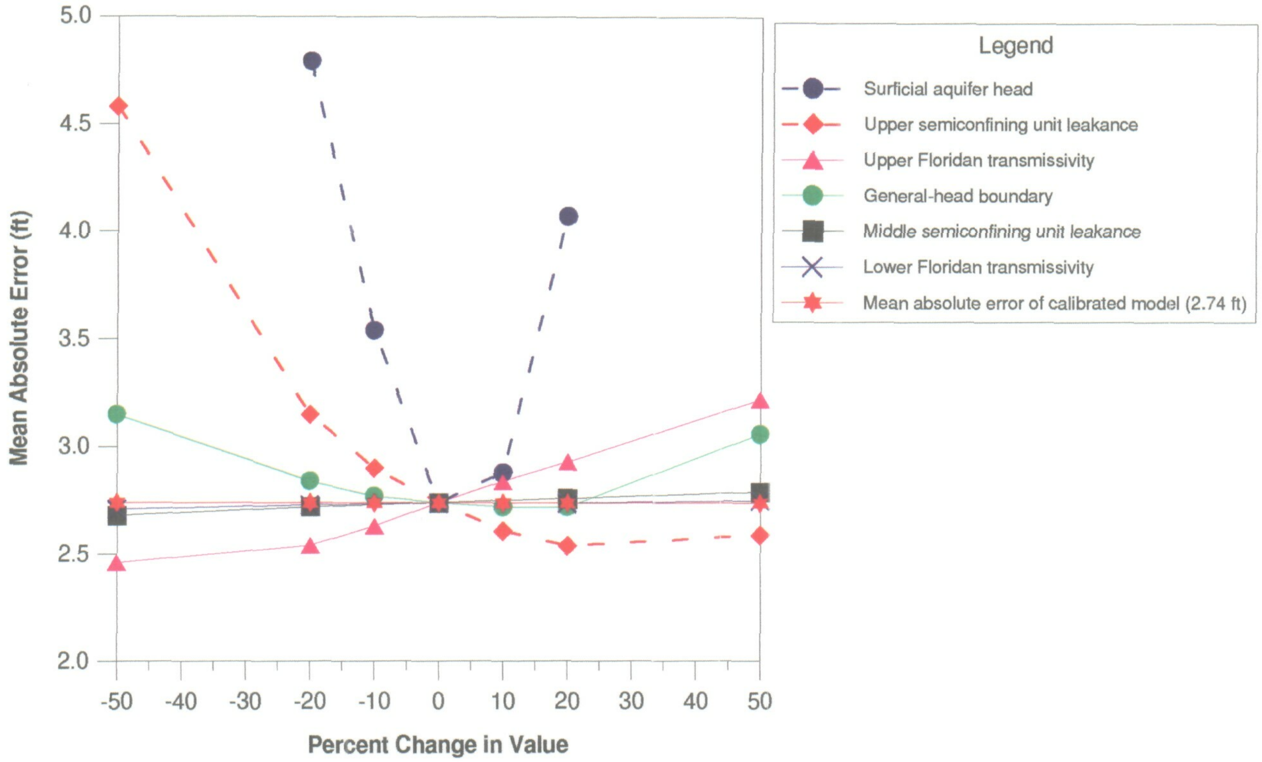


Figure 41. Sensitivity analysis of the 1988 steady-state model

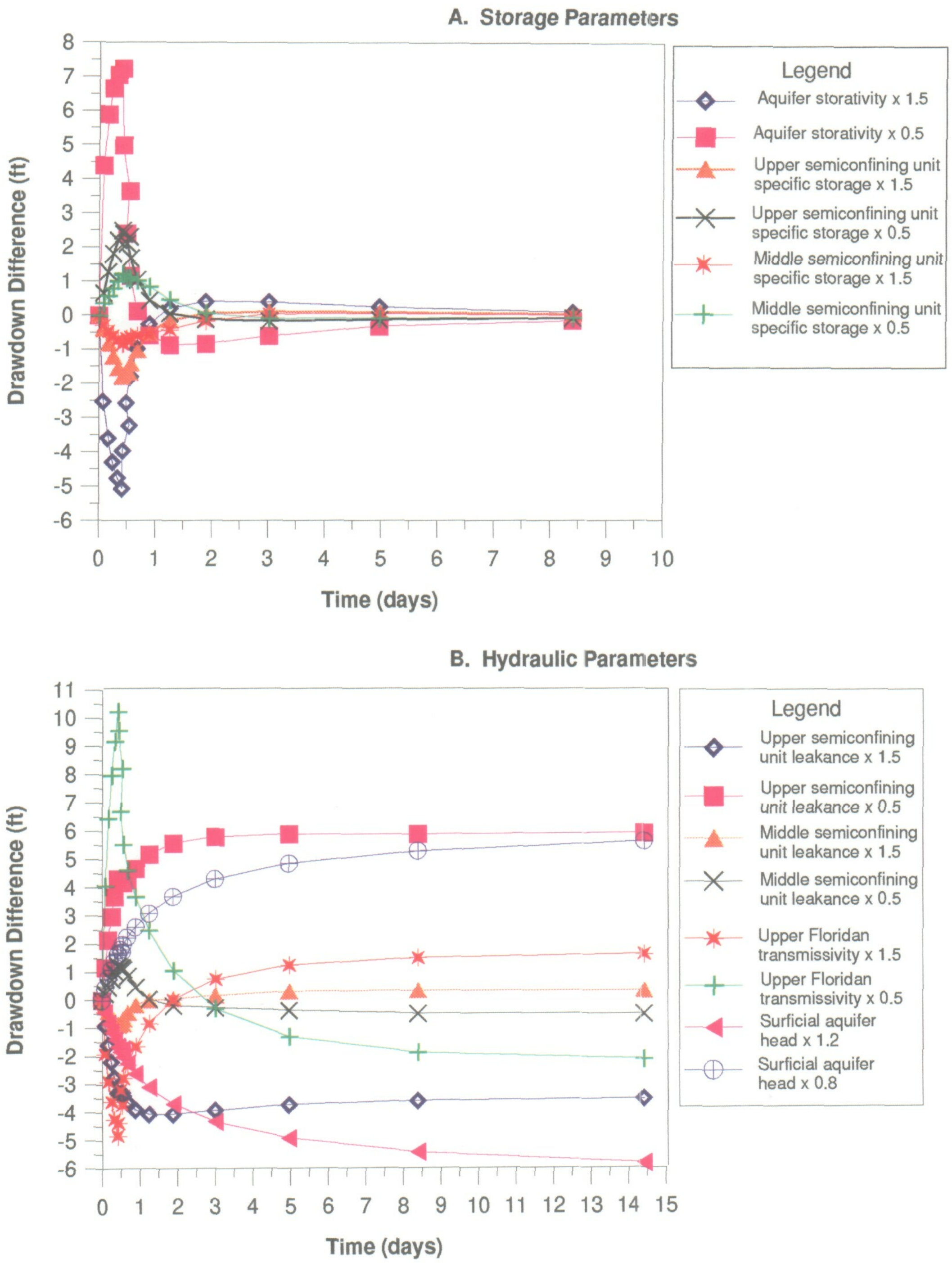


Figure 42. Difference in drawdown of the potentiometric surface of the upper Floridan aquifer between sensitivity simulations and 1991 frost-and-freeze calibration at model row 38, column 18 near Pierson

target observation well locations was compared to the average 1988 potentiometric elevations measured at the wells and an MAE was computed. System response to the various changes was examined by plotting MAE values versus percent change in the parameter value (Figure 41) and comparing the plots made for each input parameter with the MAE from the calibrated model.

MAE values resulting from changes in head of the surficial aquifer system and USCU leakance vary the most from the calibrated MAE value of 2.74 ft. The model is most sensitive to changes in head of the surficial aquifer system because, even though the head of the surficial aquifer system was changed less than the other parameters (±20%), the resulting MAE values are the most different from the calibrated MAE. The model is least sensitive to changes in transmissivity of the Lower Floridan aquifer and MSCU leakance. MAE values resulting from modelwide changes in these parameters are very close to the calibrated value.

Transient Sensitivity Analyses

The sensitivity of the model's response to changes in various input parameters during transient (frost-and-freeze) conditions was examined in a modelwide fashion similar to that conducted for steady-state conditions. Storativity of the Upper and Lower Floridan aquifers, confining unit specific storage, and leakance, transmissivity of the Upper Floridan aquifer, and lateral boundary GHB heads were alternately raised and lowered by 50% during successive simulations. Heads for the surficial aquifer system were raised and lowered by 20%. The resulting drawdown of the potentiometric surface of the Upper Floridan aquifer was compared to the drawdown computed during the 1991 transient frost-and-freeze calibration by subtracting the calibrated drawdown from the drawdown produced by the sensitivity run at various model cell locations within the WVSP area. Plots of drawdown difference versus time (Figure 42) at model row 38, column 18 near Pierson illustrate the effect of different parameter values upon simulated drawdown and recovery. (The Pierson area experiences the largest drawdowns during periods of pumping for frost-and-freeze protection: see Figures 17, 33, 34, and 40.)

Changes in the storativity of the Upper and Lower Floridan aquifers have greater effect upon the magnitude of drawdown values than changes in specific storage of the semiconfining units (Figure 42, part A). Multiplying the storativity by 1.5 causes approximately 5.5 ft less drawdown than the calibrated value at this location, while multiplying storativity by 0.5 causes approximately 7.5 ft more drawdown. Equivalent changes in specific storage cause drawdown differences ranging from approximately 2 ft less than the calibrated value to approximately 2.5 ft more than the calibrated value. Deviations from the calibrated drawdown values due to storage parameter changes begin to decline as soon as pumping ends, and they approach zero within a few days as the model gradually returns to the prefreeze steady-state flow condition.

Changes in hydraulic parameters such as leakance, transmissivity, and head of the surficial aquifer system affect not only the model's transient response to stress in terms of drawdown, they also cause a new steady-state equilibrium to be reached after frost-and-freeze pumping ceases. Raising and lowering the transmissivity of the Upper Floridan aquifer by 50% causes the largest drawdown differences (–5 ft to greater than 10 ft) while frost-and-freeze pumping is ongoing (Figure 42, part B). After freeze protection withdrawals end, the drawdown differences due to transmissivity changes stabilize at approximately –2 ft and approximately 1 ft, indicating a return to a steady-state potentiometric elevation of the Upper Floridan aquifer that is 1 to 2 ft different than that produced by the calibration simulation. Equivalent changes in USCU leakance and head of the surficial aquifer system have relatively lesser effects on drawdown during frost-and-freeze pumping, but they have successively larger effects upon the resulting new steady-state potentiometric elevation. Changes in leakance of the MSCU have a relatively small effect upon transient drawdown and an even smaller effect upon the new equilibrium that is reached. These results correspond to those produced by the steady-state sensitivity simulations, wherein successively larger changes in MAE were produced by similar changes in transmissivity, USCU leakance, and water table elevation.

Drawdown differences produced by changing the magnitude of GHB heads at the model's lateral boundaries were very small (less than 0.1 ft at row 38, column 18) and thus were not plotted on Figure 42, part B.

PREDICTIVE SIMULATIONS

Two steady-state predictive simulations were conducted using the calibrated steady-state model, and one transient predictive simulation was conducted using the calibrated transient model. Data input to the two steady-state predictive simulations is identical. The only difference between these two simulations is that, for the second simulation, output from the numerical model was coupled with an analytical model that estimates changes in the layer for the surficial aquifer system due to stresses in the Upper Floridan aquifer. The transient prediction simulates a hypothetical, long-term freeze event that is superimposed upon the 1988 steady-state calibrated model. Details of these simulations are discussed in the following sections.

STEADY-STATE SIMULATIONS FOR THE YEAR 2010

One of the objectives of this study is to assess the possible impacts of increased withdrawals upon the steady-state groundwater flow system of the Upper Floridan aquifer for the year 2010. These impacts were assessed quantitatively by conducting two predictive simulations with the calibrated steady-state model using the projected withdrawal rates from the Upper Floridan aquifer for 2010. The first prediction assumes constant heads in the surficial aquifer system; the second estimates declines in the surficial aquifer system and computes a resultant 2010 potentiometric surface for the Upper Floridan aquifer.

Well Fluxes

Withdrawal estimates for 2010 for the Floridan aquifer system were incorporated into the model in the same fashion as were those for 1988. The well locations for CUPs that were in existence in 1988 but have been modified since then were updated in the input files. The well data from new CUPs issued since July 1988 also were included.

Although withdrawal rates for public water supply, industrial, and institutional water use categories were changed from those used for the 1988 calibration, agricultural groundwater withdrawals were assumed to remain the same in 2010 as they were in 1988. There are two main reasons for this assumption.

- Total agricultural groundwater water use is not projected to change significantly on a countywide basis (Lynne and Kiker 1992a, 1992b; Vergara 1994).

- There are no available data on the spatial distribution of where possible changes in agricultural water use will occur.

Discharges due to abandoned, free-flowing artesian wells were not included in the 2010 simulation because of the assumption that all the abandoned, free-flowing wells currently on the SJRWMD inventory would be plugged by 2010. Because the total discharge due to these wells is such a small percentage of the total estimated withdrawals from the Upper Floridan aquifer, the effect of an error in this assumption is probably minimal.

The projected 2010 withdrawals for individual public water supply, industrial, and institutional water users (Figure 43) were distributed to the corresponding well locations in the CUP database in nearly the same manner as was done for the 1988 calibration. The sole exception to that procedure was that, if the comprehensive plan for a municipality identified locations of future production wells or wellfields that were not yet included in the CUP database as existing or proposed wells, these locations were incorporated into the well input file. Projected 2010 discharge rates were distributed evenly among wells or wellfields unless information was available from comprehensive plans or CUP files that indicated a more specific distribution. At those locations where the projected 2010 withdrawal rate is greater than the existing or proposed well capacity, additional withdrawal capacity was assumed to be available by 2010 at the locations of the existing or proposed wells.

Surficial Aquifer System and Lateral Boundaries

An important assumption made with reference to the 2010 steady-state predictive simulations is that, with the exception of prescribed withdrawals due to groundwater pumping, the same boundary conditions will exist in 2010 that existed in 1988. In other words, climatic conditions (e.g., rainfall patterns) in 2010 will be such that the hydraulic heads in the surficial aquifer system can be represented by the same layer 1 constant heads that were used for the 1988 calibration.

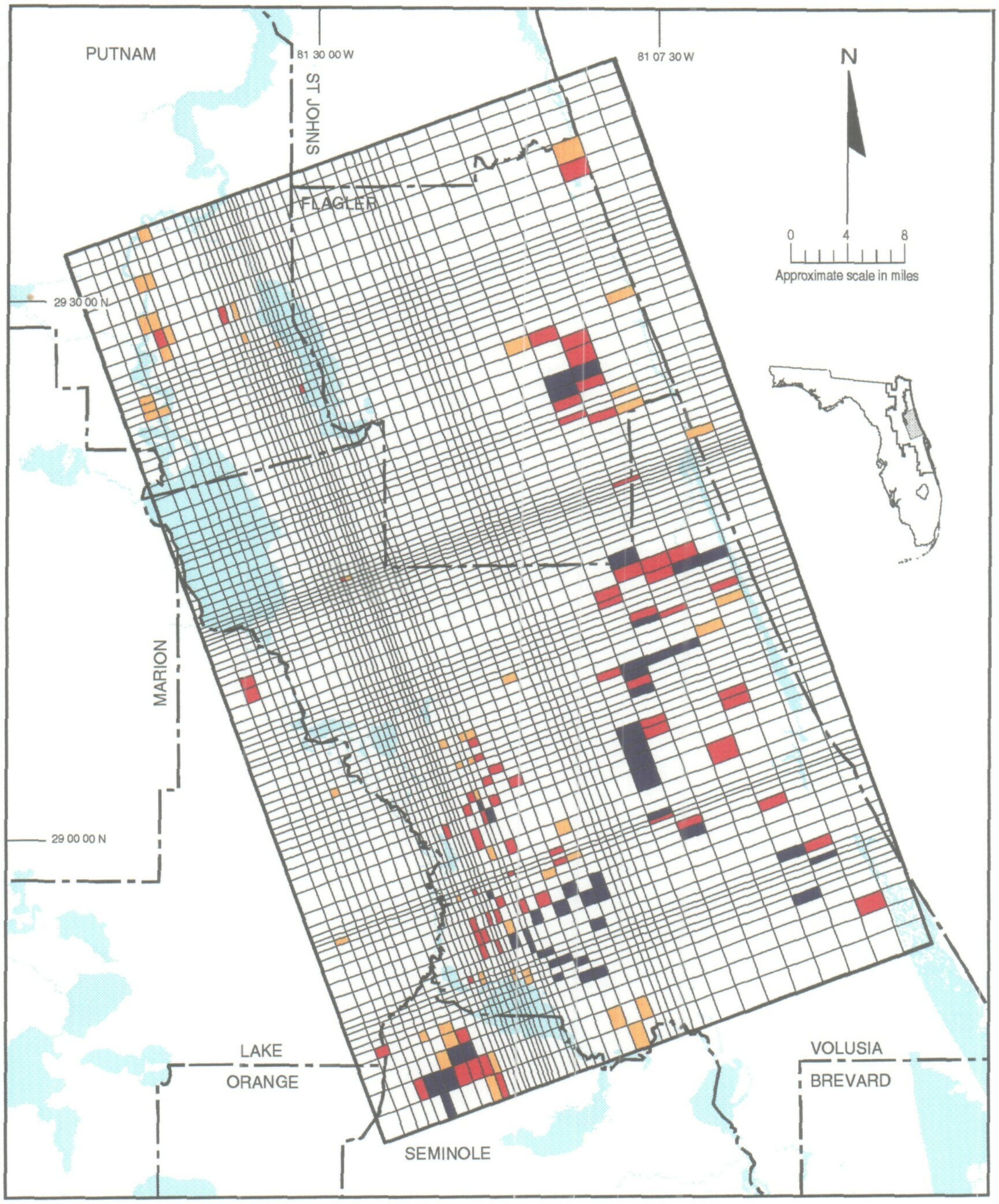
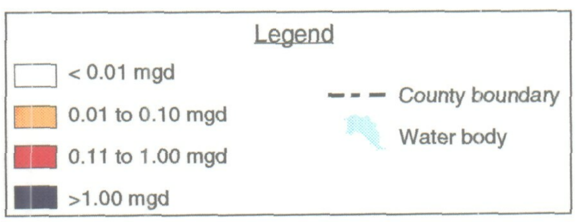


Figure 43. Location and pumping rate of projected average daily 2010 withdrawals for public, industrial, recreational, and institutional uses



Support for this assumption is provided by the observation that 1988 measured rainfall did not vary significantly from long-term averages (Table 2). The boundary heads assigned to points outside the model domain at GHB cells are also assumed to remain the same in 2010 as for 1988. With the exception of western Seminole County, relatively little change in public supply and industrial pumpage is expected that would alter the heads of the Upper Floridan aquifer near the model borders. Additionally, sensitivity analysis has shown that changes in assigned boundary heads of several feet have little effect upon simulated heads in the WVSP area.

Limitation on Simulated Recharge Rates

Recharge rates for the Floridan aquifer system calculated during the predictive simulations should not exceed the same maximum areal recharge rate assumed to exist for the 1988 calibration (22 in/yr) because the model represents average, steady-state conditions. Therefore, the model-calculated recharge rates were limited to a maximum of 22 in/yr in most cells. At those grid cells where the 1988 calibrated recharge rate was allowed to exceed 22 in/yr, the maximum 2010 recharge rate was limited to the 1988 calibrated rate. These limitations were accomplished by making use of a feature in the MODFLOW model that limits downward leakage from an upper layer to an aquifer below. The upper layer changes from confined to unconfined when pumping stresses cause its potentiometric level to drop below the top of the aquifer. The MODFLOW model computes the downward flux according to the following equation:

$$q = L(H_s - A) \tag{4}$$

where

q = the downward flux
L = the leakance of the confining bed
H_s = the head in the upper layer
A = the elevation of the aquifer top

The projected increases in pumping between 1988 and 2010 are probably not great enough to cause the Upper Floridan aquifer to become unconfined; however, assigning an artificial aquifer top for layer 2 to each grid cell allows the leakage to be limited to an amount proportional to the difference between the head in the upper layer (layer 1) and the artificial top of layer 2. The appropriate artificial aquifer top was determined for each grid cell location by rearranging Equation 4 and solving for A.

$$A = H_s - \left(\frac{q}{L}\right) \tag{5}$$

where

H_s = the hydraulic head of the surficial aquifer system from the 1988 calibration
q = 22 in/yr or, in a few cases, the calibrated 1988 recharge rate that exceeds 22 in/yr
L = the calibrated leakance value for the USCU

Steady-State Predictive Simulation 1: Fixed Surficial Aquifer Heads

As mentioned above, the first steady-state predictive simulation was conducted while holding the heads of the surficial aquifer system (layer 1) constant. The use of a fixed value for the head in the surficial aquifer system can be expected to cause some error in predicted head values for the Upper Floridan aquifer. This error is because, with a fixed head value for the surficial aquifer system, the effect of additional pumping from the Upper Floridan aquifer upon the surficial aquifer system is not taken into account. For the surficial aquifer system to replace the additional water supplied to the Floridan aquifer system due to increased pumping, the surficial aquifer system must be supplied with additional water by reductions in evapotranspiration and runoff. For that to occur, a reduction in water table elevation must take place, which causes a smaller vertical gradient between the water table and the Upper Floridan aquifer. This smaller vertical gradient, in turn, causes less water to be supplied to the Upper Floridan aquifer, causing more drawdown in the Upper Floridan aquifer relative to the condition before increased pumping. The use of a fixed H_s thus under-predicts the decline in the steady-state potentiometric surface.

Steady-State Predictive Simulation 2: Variable Surficial Aquifer Heads

The procedure for conducting the second steady-state prediction consisted of coupling MODFLOW results with an analytical model that estimates the decline in head in an upper aquifer due to pumping stresses that occur in an underlying aquifer (Motz 1978, 1981). This procedure was done by using the analytical model to calculate a drawdown in the surficial aquifer system at each model cell based upon the results of an initial MODFLOW predictive run, subtracting the amount of drawdown in the surficial aquifer system from the assigned layer 1 head, and using the subsequent adjusted hydraulic head value of the surficial aquifer system as input to a new MODFLOW run. This procedure was conducted in an iterative fashion until two successive runs produced maximum drawdowns in the surficial aquifer system that differed by less than 0.1 ft. This methodology, including the computer program (SURFDOWN) that couples the Motz analytical model with the MODFLOW model, is documented by Huang and Williams (1996). The SURFDOWN program requires as input three parameters for the surficial aquifer system

- Horizontal hydraulic conductivity
- Bottom elevation
- Evapotranspiration reduction rate

Constant, modelwide values of 10 ft/day and -50 ft NGVD were used for horizontal hydraulic conductivity and bottom elevation, respectively. Sensitivity analyses conducted with the SURFDOWN iterative procedure resulted in no significant differences in head for the surficial or Floridan aquifer systems when these parameters were varied within reasonable ranges. An evapotranspiration reduction rate (i.e., the rate at which evapotranspiration is reduced per unit of water-table drawdown) value of 2.7×10^{-4} was used. Although this number is lower than that used by Huang and Williams (1996), changes in the evapotranspiration reduction rate (for a given value of USCU leakance) do not significantly change the drawdown values in the Floridan aquifer system (Motz 1978).

Results of the Steady-State 2010 Predictive Simulations

The results of the two steady-state predictive simulations are presented as contour maps of the predicted potentiometric surface of the Upper Floridan aquifer, a map of the predicted recharge/discharge distribution of the Upper Floridan aquifer, and a table listing predicted spring flows. The steady-state 2010 potentiometric surface of the Upper Floridan aquifer predicted by the steady-state predictive simulation 1 (Figure 44) is slightly higher, but similar in appearance to the potentiometric surface predicted by the steady-state predictive simulation 2 (Figure 45). The difference between the two predicted surfaces (Figure 46) is greatest in those areas with the largest projected increases in withdrawals from the Upper Floridan aquifer. This difference reaches a maximum of 1.5 ft in central Volusia County, where the proposed Daytona Beach wellfield extension would be located and in Seminole County where relatively large increases in withdrawals are projected.

The difference between the simulated average 1988 potentiometric surface (Figure 24) and the average 2010 potentiometric surface predicted by simulation 2 is greatest where the largest increases in withdrawals are located (Figure 47). Drawdowns in heads of the Upper Floridan aquifer relative to 1988 exceed 10 ft in parts of eastern Volusia County. They exceed 5 ft throughout much of eastern Volusia County and part of eastern Flagler County. In the WVSP area, differences in the 2010 potentiometric surface of the Upper Floridan aquifer relative to 1988 range from 2 ft to greater than 5 ft throughout most of southwestern Volusia County. The difference is less than 2 ft elsewhere in the WVSP area, except for near Pierson and a small area just west of Crescent Lake in southeastern Putnam County.

The average 2010 recharge/discharge distribution predicted by steady-state simulation 2 (Figure 48) was subtracted from the simulated 1988 recharge/discharge pattern (Figure 25) to illustrate predicted changes in recharge/discharge patterns (Figure 49). Note that changes in simulated recharge/discharge between 1988 and 2010 are between −1 and +1 in/yr over most of the model area. Negative values on Figure 49 of less than −1.0 in/yr in the recharge areas of central Volusia County, Seminole County, and Flagler County near Bunnell mean that the simulated 2010 recharge in these areas is more than 1 in/yr greater than in 1988. This increase is in response to the increase

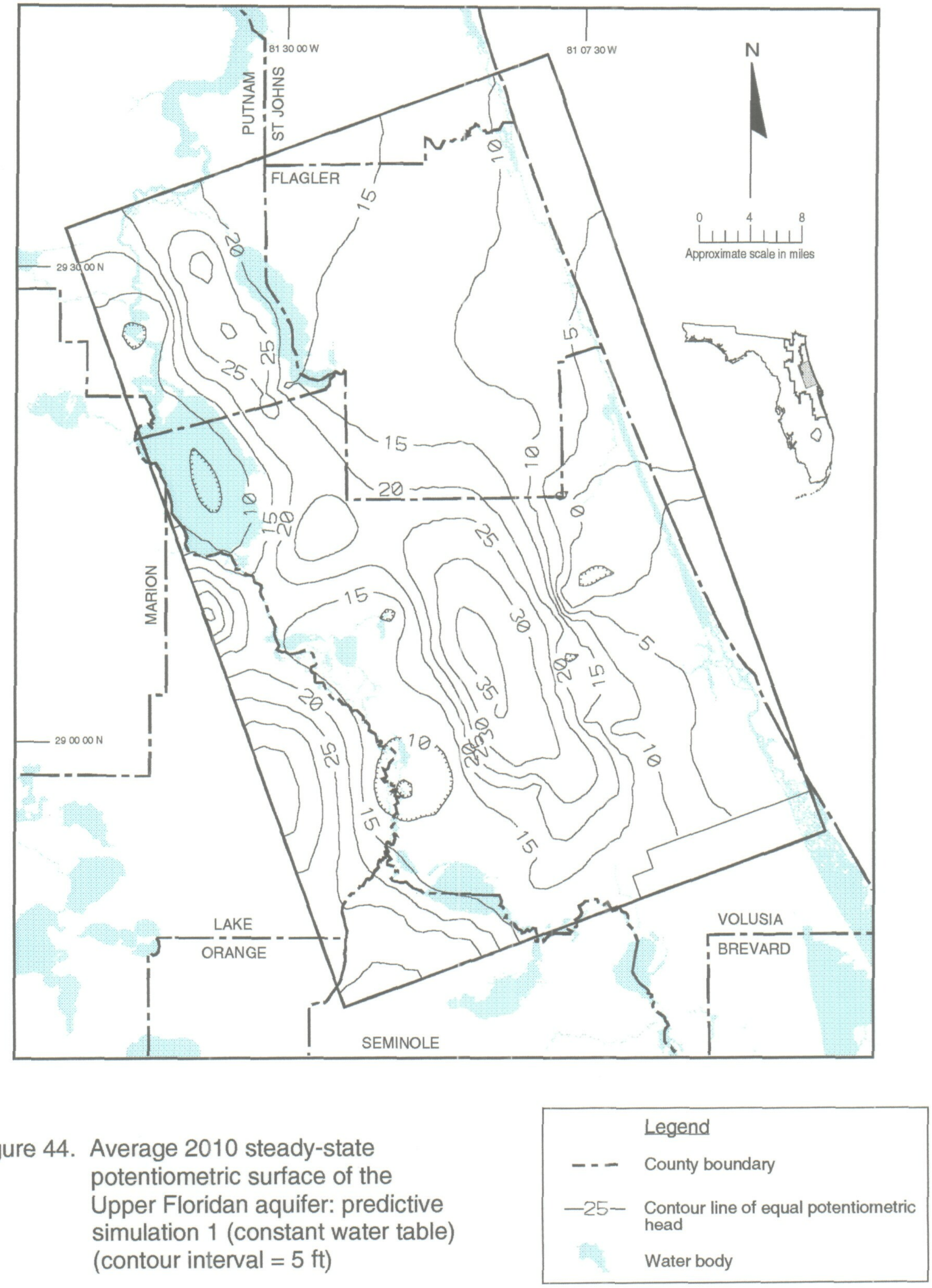


Figure 44. Average 2010 steady-state potentiometric surface of the Upper Floridan aquifer: predictive simulation 1 (constant water table) (contour interval = 5 ft)

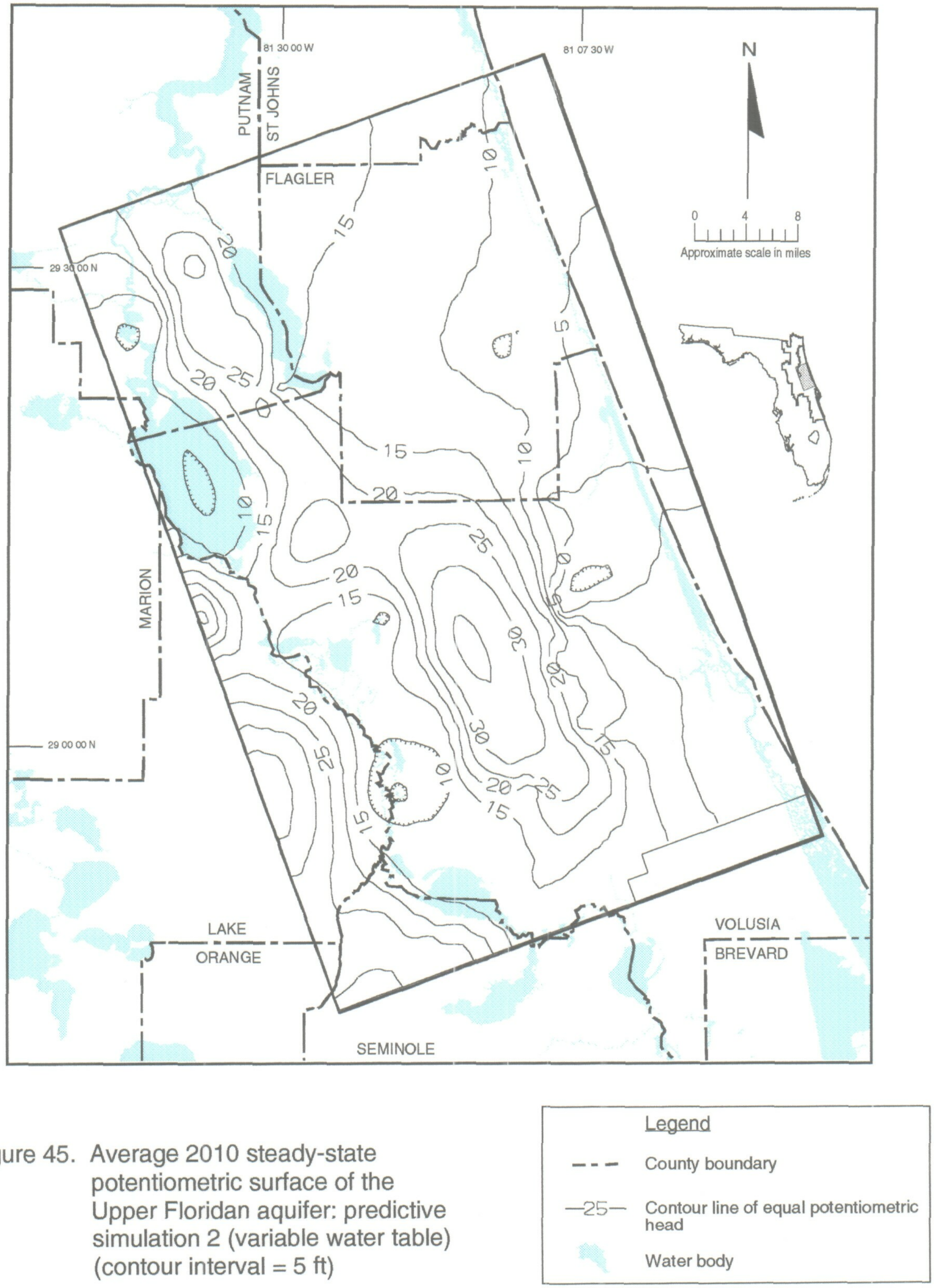


Figure 45. Average 2010 steady-state potentiometric surface of the Upper Floridan aquifer: predictive simulation 2 (variable water table) (contour interval = 5 ft)

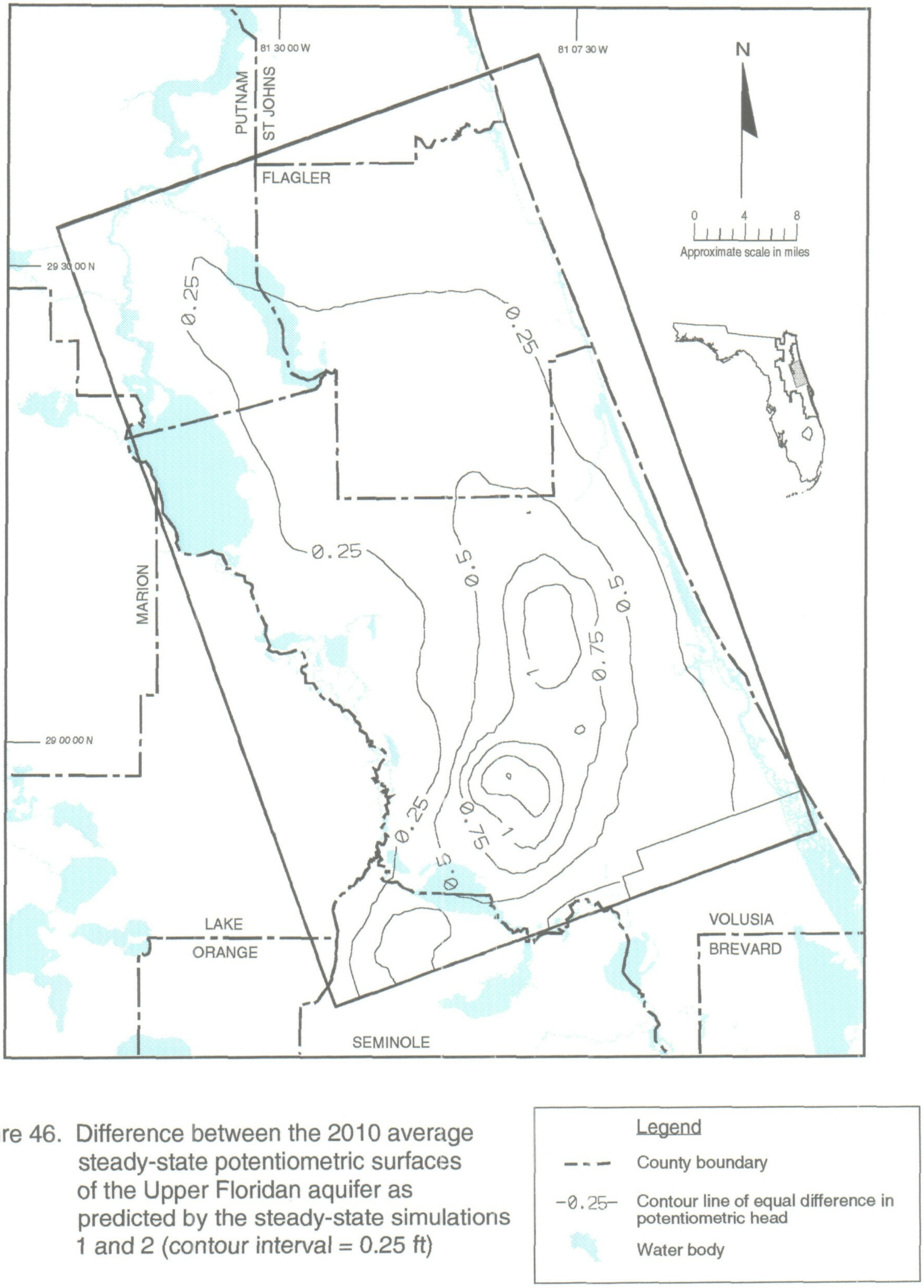


Figure 46. Difference between the 2010 average steady-state potentiometric surfaces of the Upper Floridan aquifer as predicted by the steady-state simulations 1 and 2 (contour interval = 0.25 ft)

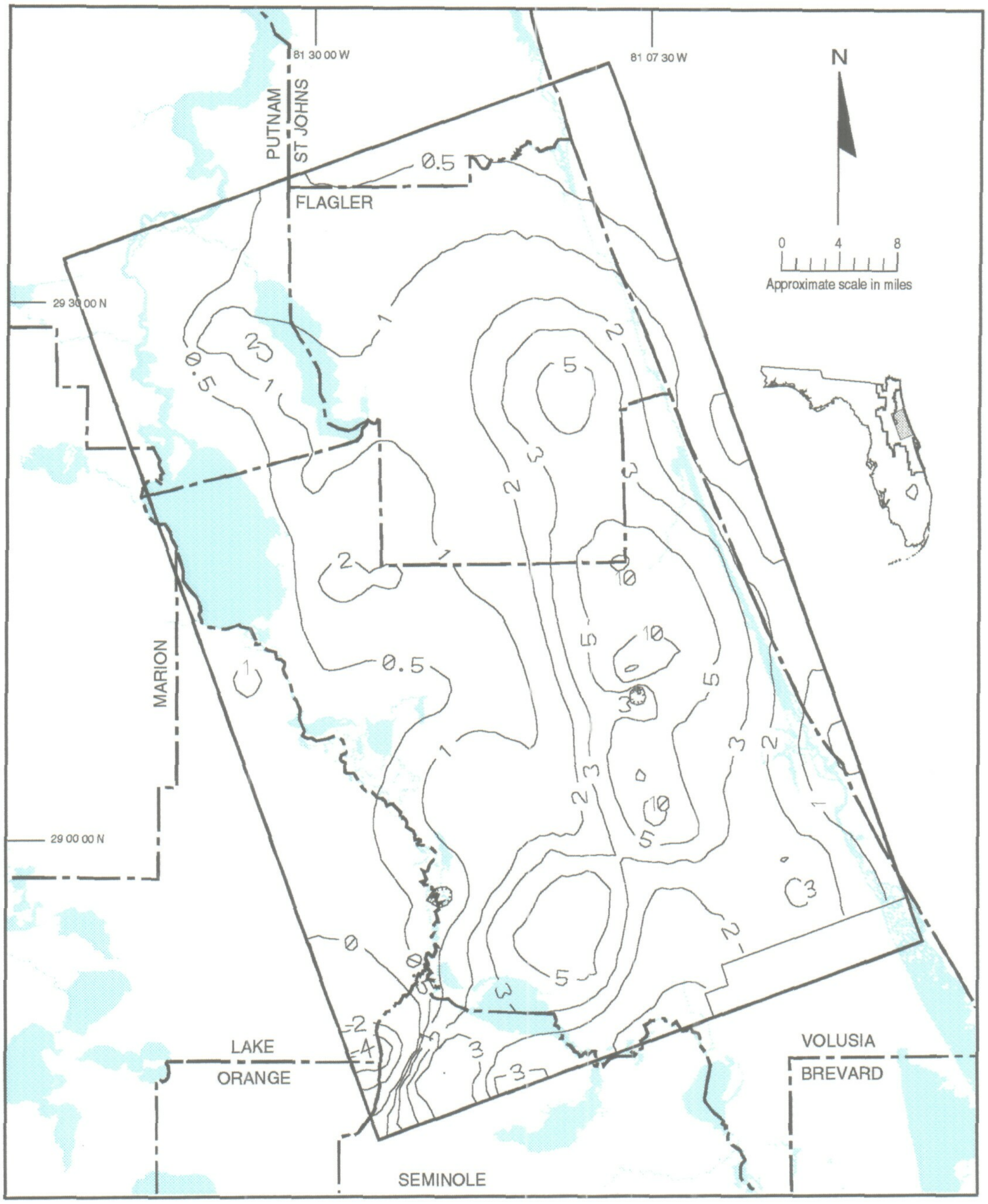


Figure 47. Difference between the simulated potentiometric surfaces of the Upper Floridan aquifer: simulated 1988 average steady-state minus 2010 average steady-state (contour interval = 5 ft, except where marked)

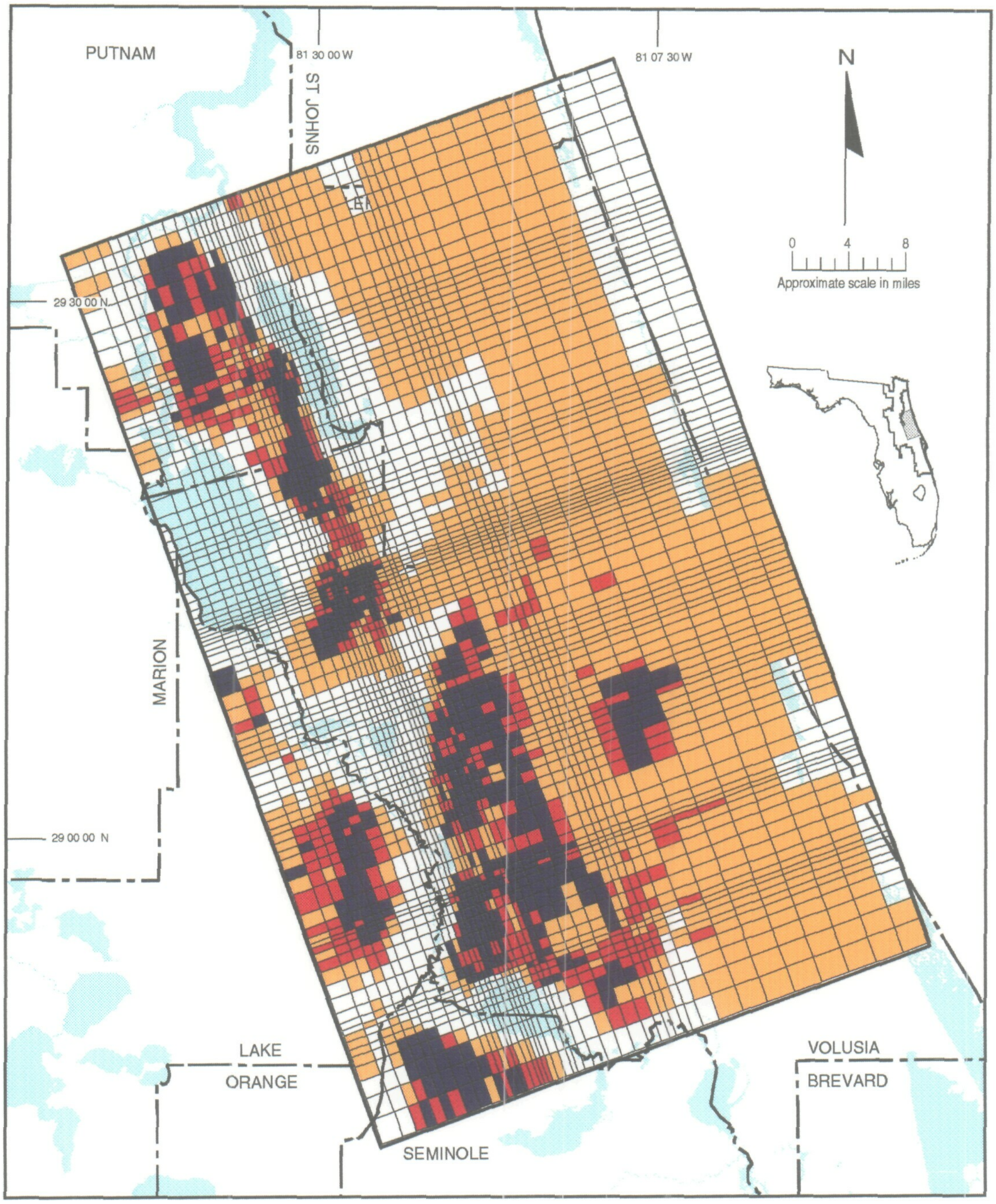


Figure 48. Predicted recharge/discharge for the Upper Floridan aquifer for 2010 steady-state conditions

Legend
- < 0 in/yr (discharge)
- 0 to 6 in/yr
- 6.1 to 12in/yr
- > 12 in/yr
- County boundary
- Water body

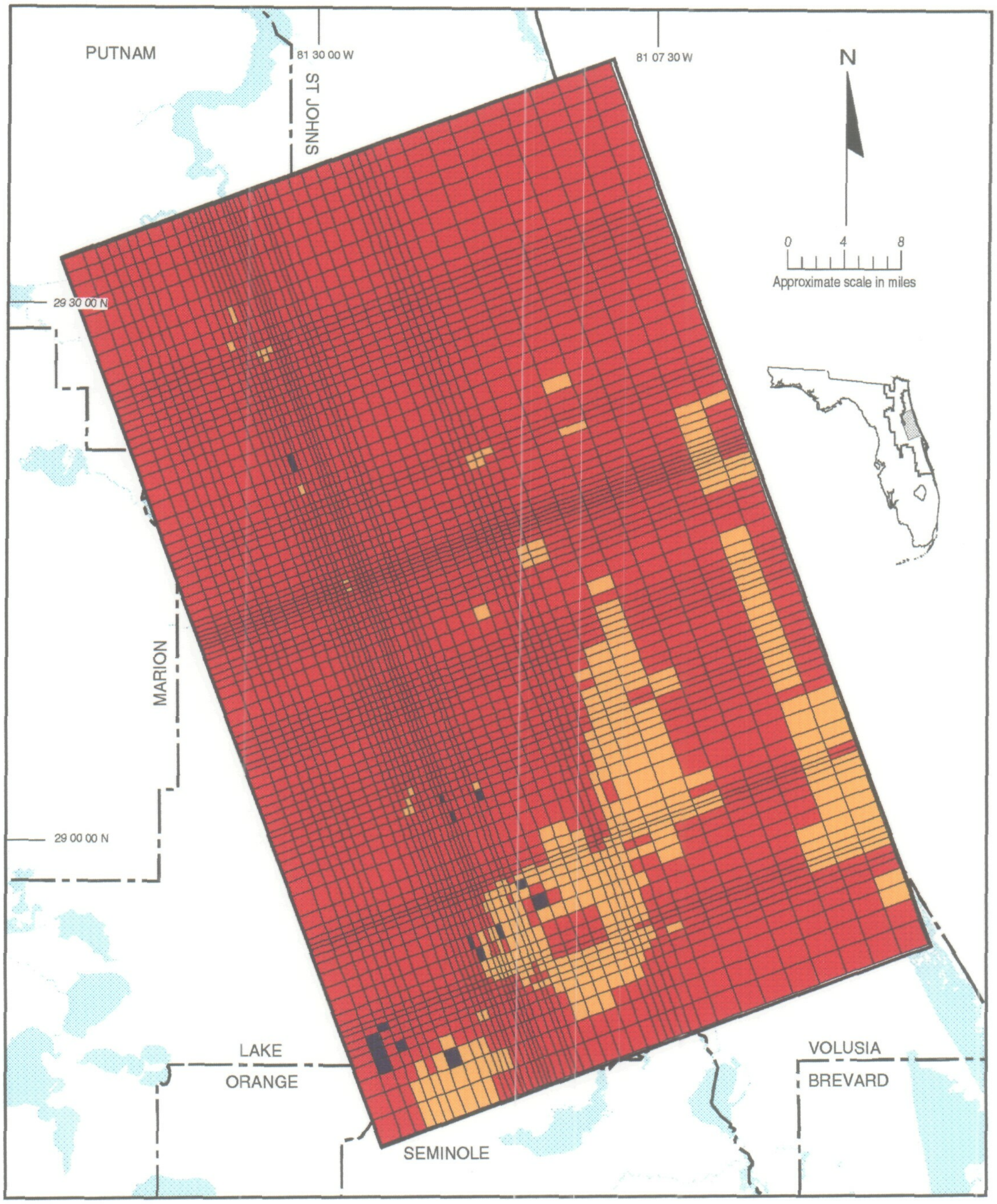


Figure 49. Difference in simulated recharge/discharge for the Upper Floridan aquifer between 1988 average steady-state conditions and 2010 average steady-state conditions

in public water supply withdrawals projected for those areas for 2010. Negative values of less than –1.0 in/yr along the Atlantic coast and the St. Johns River near Astor Park signify decreased discharge, also possibly in response to the increased 2010 public water supply pumping. Positive values are greater than 1.0 in/yr in a discharge area along the Wekiva River. In this area, simulated areal discharge has increased due to the assumed plugging and flow control of free-flowing wells, particularly those at Wekiva Falls Resort in Lake County (Table C1, p.167).

Spring flows predicted at drain cells by steady-state simulation 2 are, in general, lower than those predicted by steady-state simulation 1 (Table 9). This difference is to be expected, because simulation 2 results

Table 9. Comparison between simulated 1988 and predicted 2010 spring flows (in cubic feet per day)

Spring Name	Simulated Average 1988 Steady-State Flow Rate	Predicted 2010 Average Steady-State Flow Rate (simulation 1)	Predicted 2010 Average Steady-State Flow Rate (simulation 2)	Percent Difference Between 1988 and 2010*
Beecher Springs	676,461	661,683	656,874	3
Blue Spring	11,673,370	10,473,390	10,250,030	12
Croaker Hole Spring	6,482,491	6,462,361	6,455,600	<1
Gemini Springs	706,072	610,417	591,068	16
Green Springs	88,710	63,140	58,646	34
Island Springs	552,769	622,279	618,983	-12
Mud/Forest springs	206,822	204,640	204,067	1
Ponce de Leon Springs	2,209,531	2,155,978	2,131,376	4
Satsuma/Nashua springs	119,417	118,436	118,169	1
Welaka Spring	175,051	173,278	172,863	1
Total	22,890,694	21,545,602	21,257,676	7

*(Simulated 1988 flow - predicted 2010 simulation 2 flow) / (simulated 1988 flow)

in slightly lower predicted head values. More important, the differences between the simulated 1988 average steady-state spring flows and the predicted 2010 average steady-state spring flows (simulation 2) range from less than 5% at all the springs located in southeastern Putnam County to a high of 34% at Green Springs. Predicted average springflow reductions at the four springs in Volusia County (Ponce de Leon, Blue, Gemini, and Green) occur primarily in response to increased (relative to 1988) public, industrial, and institutional groundwater withdrawals in that county. Note that the predicted 2010 average flow at Island Springs is greater than that for 1988. This increase in spring flow is also due to the assumed control of free-flowing wells along the Wekiva River.

TRANSIENT FROST-AND-FREEZE SIMULATION

The calibrated transient model was used to perform the second major task required for this study: to evaluate the impacts upon the Floridan aquifer system from frost-and-freeze withdrawals. To complete this task, a transient simulation was conducted with frost-and-freeze pumping superimposed upon the 1988 steady-state calibrated model. As with the 1991 transient calibration, drawdown in the surficial aquifer system was assumed to not occur due to the relatively short time period during which frost-and-freeze withdrawals take place.

Initial and Boundary Conditions

Initial conditions were represented by the simulated 1988 average steady-state potentiometric levels and the corresponding 1988 average steady-state withdrawals.

Frost-and-freeze withdrawals for a hypothetical large-scale freeze were added to the 1988 average daily withdrawals. All permit locations were included from the CUP database that have allocations for frost-and-freeze withdrawals from the Floridan aquifer system as of the spring of 1994. Therefore, unlike the 1991 transient calibration, withdrawals were assumed to occur from both natural hammock and shadehouse ferneries, as well as from several golf courses and citrus or sod-farming sites. Modeled application rates for cut foliage equaled 110 gpm (0.158 mgd) per acre. This rate represents the average between the application rate for shadehouse ferneries (100 gpm/acre) and the application rate for natural hammock ferneries

(120 gpm/acre), assuming best management practices (Lynne and Kiker 1992b). The permitted withdrawal rate was used for nonfernery operations with frost-and-freeze allocations. All other assumptions regarding frost-and-freeze withdrawal rates are the same as those described for the 1991 calibration.

The transient simulations consisted of four stress periods (Table 10). The simulated freeze was patterned after the one that occurred in December 1989. The simulated freeze consisted of 2 days, with a combined total of 1.5 days of frost-and-freeze protection withdrawals separated by half-day recovery periods. Stress period 4 represents the recovery period after frost-and-freeze protection pumping was ceased.

Table 10. Stress periods used for the frost-and-freeze predictive simulation

Stress Period	Duration (days)	Type of Withdrawal
1	1.0	Average daily plus frost-and-freeze protection
2	0.5	Average daily only
3	0.5	Average daily plus frost-and-freeze protection
4	14.0	Average daily only

The areal distribution of freeze withdrawals for this simulation (Figure 50) is similar to that of the 1991 transient calibration (Figure 17), but the magnitude of the withdrawals is nearly double the amount estimated for the calibration period. Modelwide, the rate of frost-and-freeze protection withdrawals exceeds a total of 870 mgd.

Results of the Frost-and-Freeze Predictive Simulation

The maximum predicted drawdowns in the potentiometric surface of the Upper Floridan aquifer (computed at the end of stress period 3) are greatest at the centers of frost-and-freeze protection pumping (Figure 51). Maximum simulated drawdowns exceed 80 ft in northwestern Volusia County just east of Pierson and exceed 30 ft north of De Land. Maximum drawdowns in southeastern Putnam

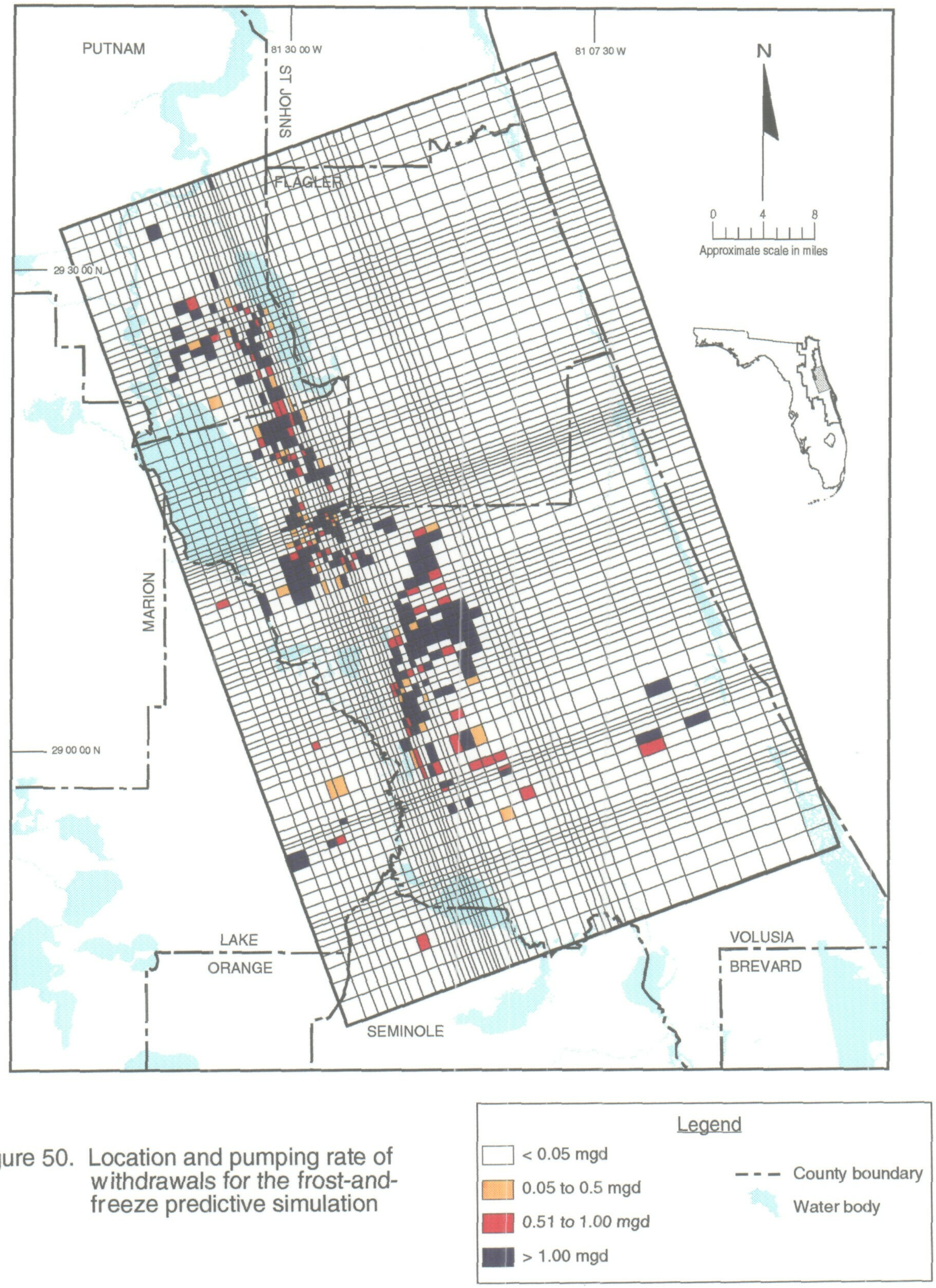


Figure 50. Location and pumping rate of withdrawals for the frost-and-freeze predictive simulation

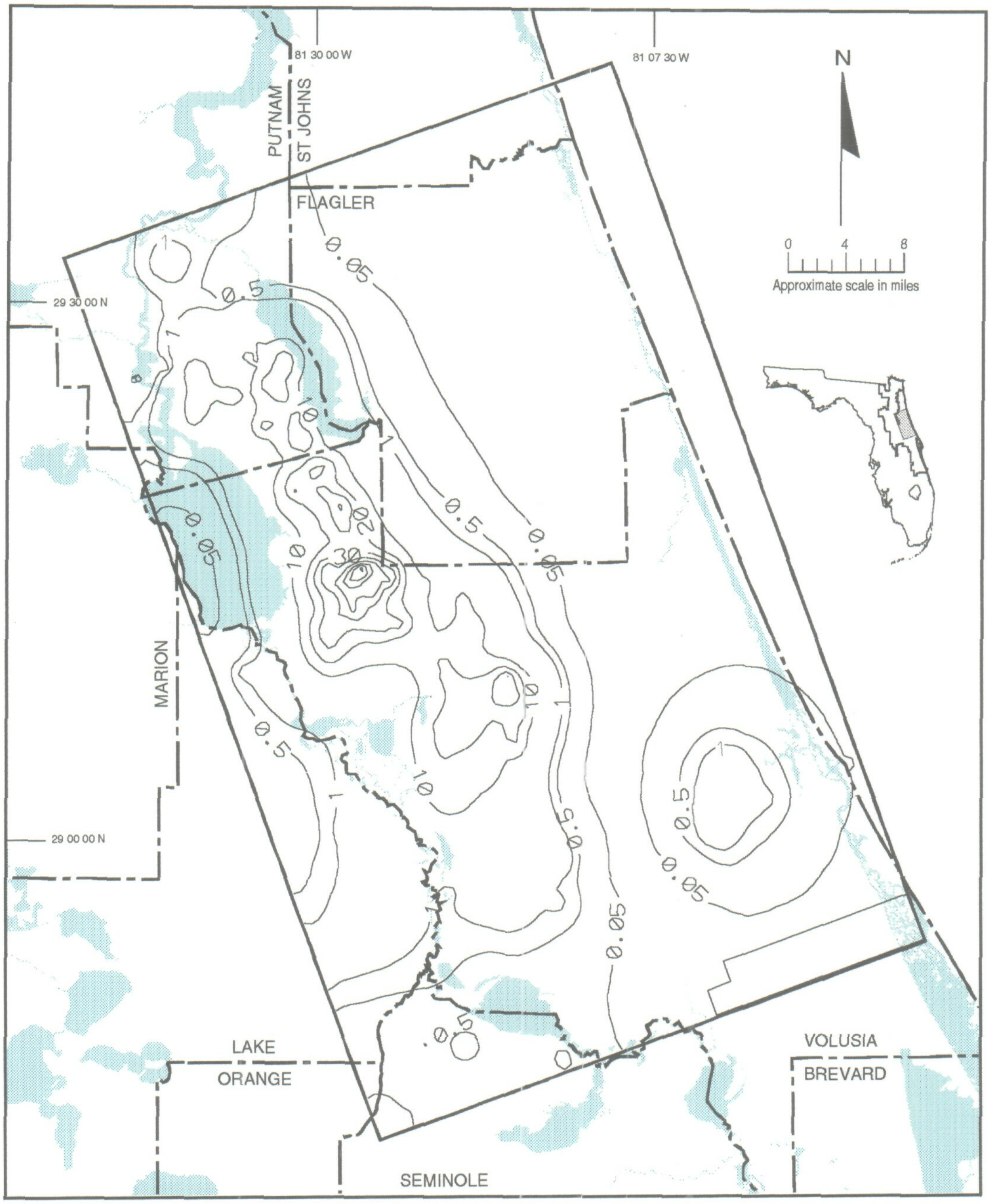


Figure 51. Predicted drawdown in the potentiometric surface of the Upper Floridan aquifer at the end of a 2-day period of pumping for frost-and-freeze protection (contour interval = 10 ft, except where marked)

Legend

County boundary

Contour line of equal change in potentiometric head

Water body

County exceed 20 ft near Crescent City. The predicted potentiometric surface of the Upper Floridan aquifer at the end of stress period 3 (Figure 52) is well below sea level in the Pierson area (at least –30 ft NGVD) and slightly below sea level in the Ponce de Leon Springs area and north of De Land. The region within which drawdown exceeds 0.05 ft extends throughout western Volusia County and southeastern Putnam County (Figure 51). Drawdown also occurs in Lake County and in southeastern Volusia County where additional centers of frost-and-freeze pumping are located. The drawdown does not extend far eastward from the WVSP area because of the relatively low transmissivity of the Upper Floridan aquifer along the Crescent City Ridge and in central Flagler and Volusia counties.

By the end of the simulation period (after 14 days of no frost-and-freeze protection pumping), the simulated potentiometric surface recovers to a level near that of the initial, steady-state condition (Figure 53). The simulated-head contours are similar to those depicted by Figure 24 for average 1988 steady-state conditions.

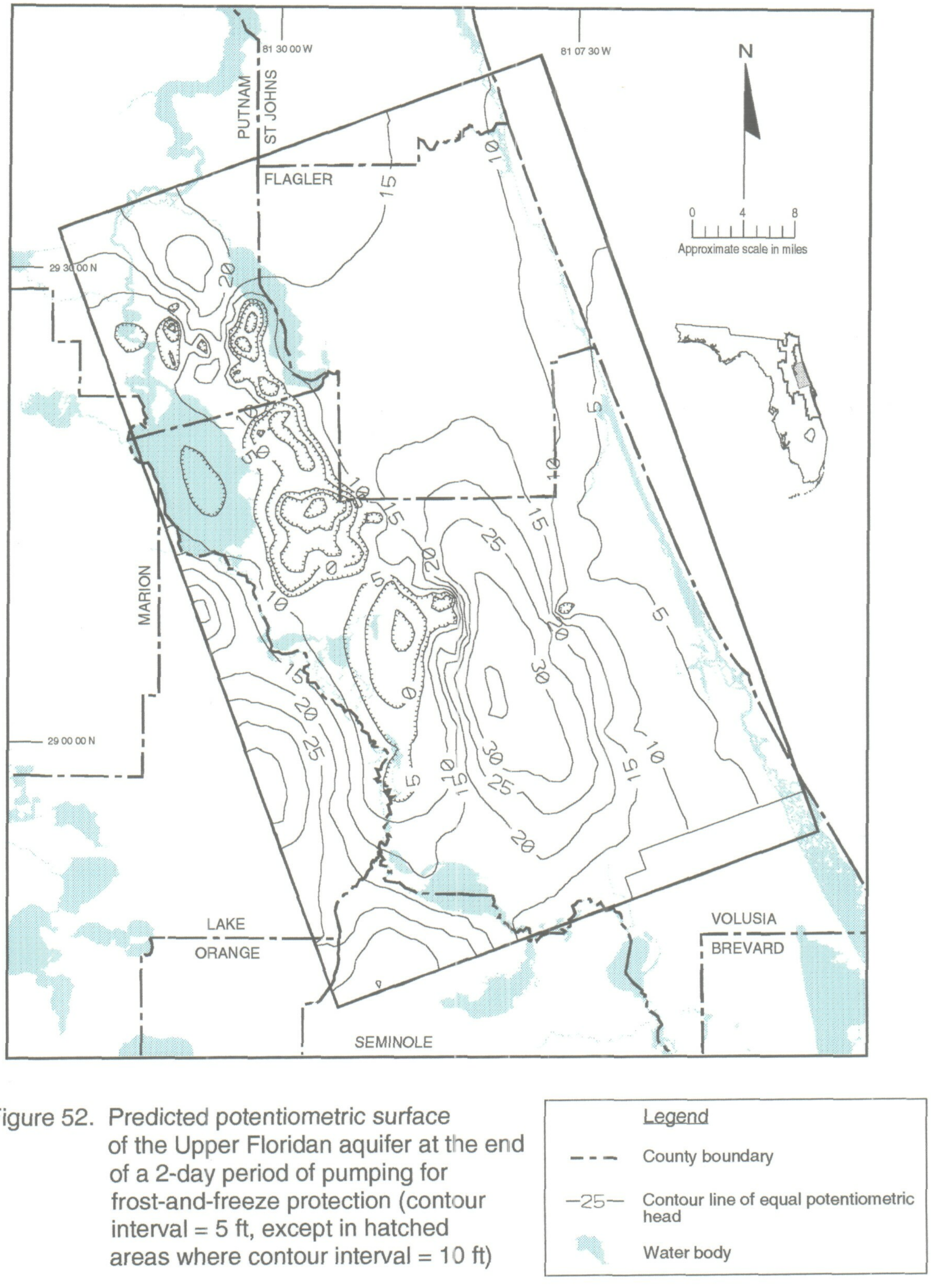


Figure 52. Predicted potentiometric surface of the Upper Floridan aquifer at the end of a 2-day period of pumping for frost-and-freeze protection (contour interval = 5 ft, except in hatched areas where contour interval = 10 ft)

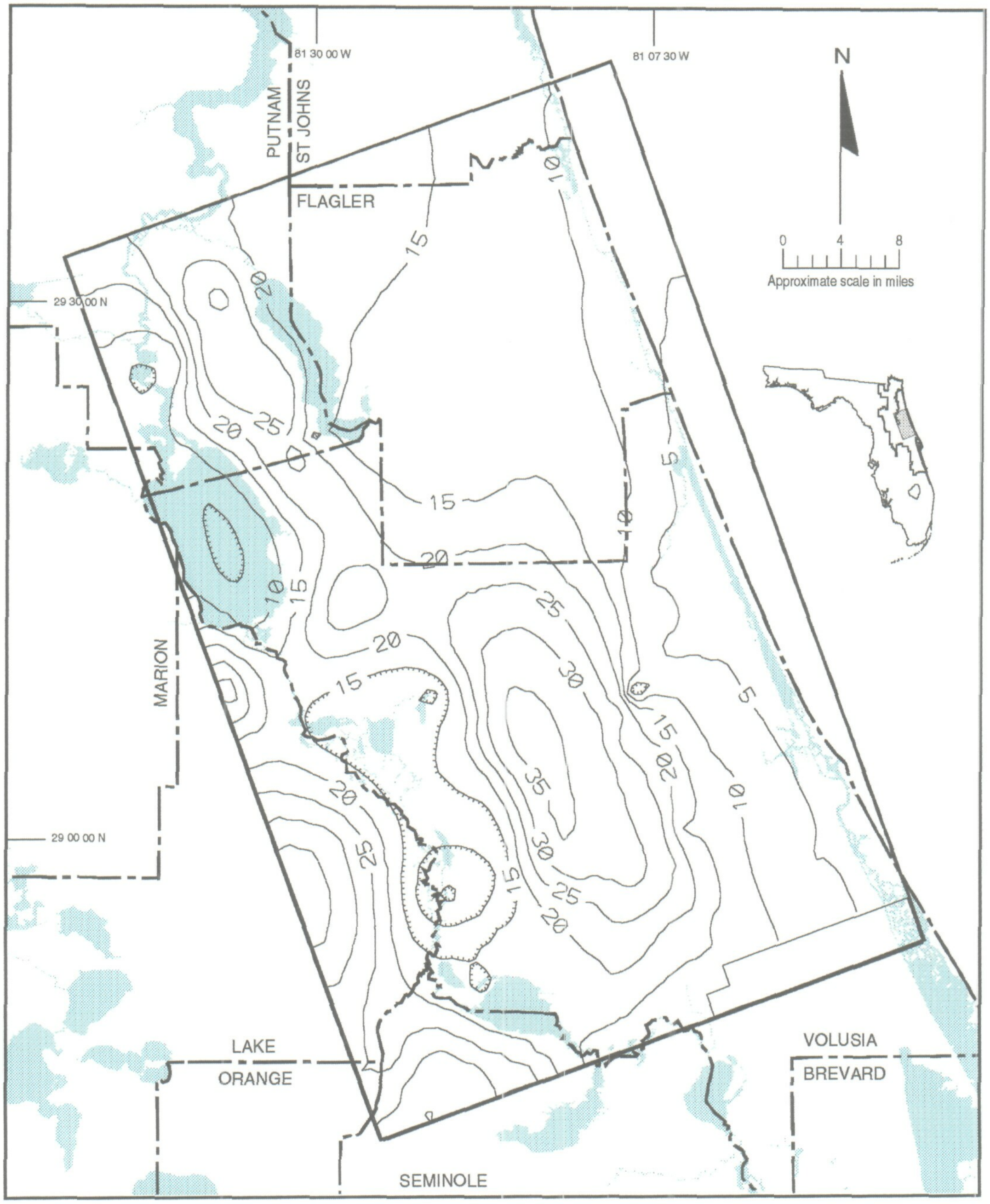


Figure 53. Predicted potentiometric surface of the Upper Floridan aquifer 14 days after a 2-day period of pumping for frost-and-freeze protection (contour interval = 5 ft)

Legend

County boundary

—25— Contour line of equal potentiometric head

Water body

DISCUSSION OF PREDICTIVE SIMULATION RESULTS

STEADY-STATE SIMULATIONS

Estimation of the potential impacts to the Floridan aquifer system due to increased withdrawals can be made by comparing changes in the computed heads and water balances between the simulated average predevelopment, 1988, and 2010 conditions. Differences in the simulated potentiometric surface of the Upper Floridan aquifer between predevelopment and 1988 (Figure 54) and between 1988 and 2010 (Figure 47) are greatest outside the WVSP area in eastern Volusia County and in Flagler County.

The only differences in model input between the predevelopment and 1988 simulations (except for slight differences in the prescribed hydraulic head of the surficial aquifer system) are the magnitude of GHB heads and the addition of well withdrawals. A comparison of Figures 13, 14, and 15 (1988 public-supply, agricultural, and domestic self-supplied withdrawals, respectively) with Figure 54 reveals that moderate potentiometric declines in the Upper Floridan aquifer were simulated in the WVSP area due to the introduction of widespread agricultural withdrawals and more localized (Crescent City, De Land, and Deltona) public-supply withdrawals. The modeled decline is similar to that observed at wells 17, 40, 38, and 41 (Figure 8). Larger, more extensive declines were simulated in eastern Volusia County, predominantly in response to public-supply withdrawals. Significant declines in northern Flagler County and in Seminole County are partially due to lower GHB heads along the northern and southwestern model boundaries as well as to groundwater withdrawals.

The only difference in model input between the 1988 and 2010 simulations is the magnitude and distribution of well withdrawals (primarily public-water supply). The largest withdrawal increases are projected for east and south of the WVSP area, as well as for Deltona in the southern portion of the WVSP area (compare Figure 13 with Figure 43). The greatest declines in the potentiometric surface of the Upper Floridan aquifer are subsequently projected for these areas (Figure 47).

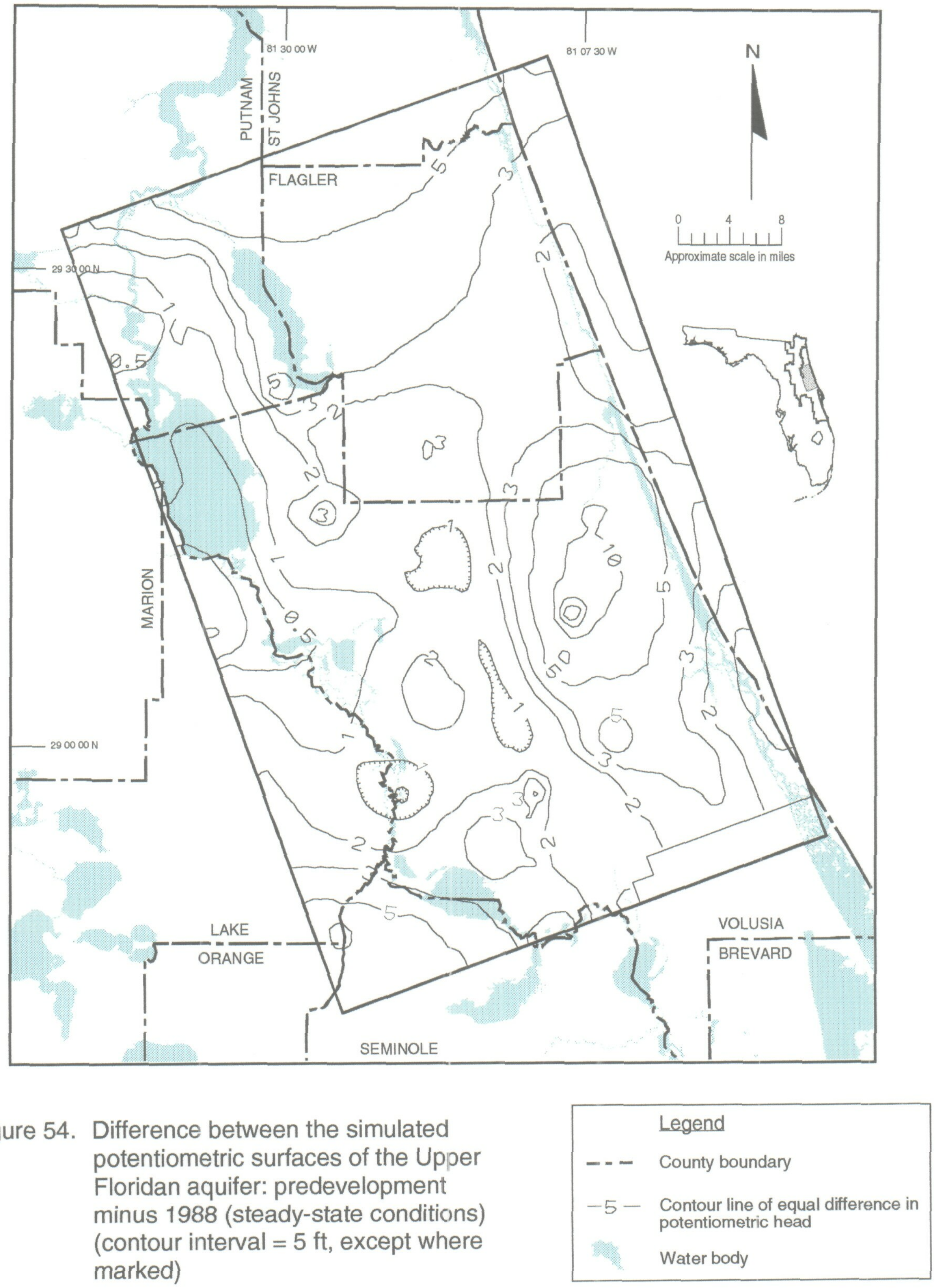


Figure 54. Difference between the simulated potentiometric surfaces of the Upper Floridan aquifer: predevelopment minus 1988 (steady-state conditions) (contour interval = 5 ft, except where marked)

A comparison of steady-state water balances provides further evidence that past and projected impacts to the Floridan aquifer system are smaller within the WVSP area than they are outside of it (Table 11).

Table 11. Simulated steady-state water balances, in million gallons per day (percent of total in parentheses)

	Modelwide			WVSP Area		
Inflow	Predevelopment	1988	2010	Predevelopment	1988	2010
Areal recharge	256 (65)	329 (75)	365 (77)	167 (80)	194 (83)	208 (83)
Lateral boundaries	135 (35)	108 (25)	110 (23)	43 (20)	39 (17)	44 (17)
Total inflow	391 (100)	437 (100)	475 (100)	210 (100)	233 (100)	252 (100)
Outflow	Predevelopment	1988	2010	Predevelopment	1988	2010
Areal discharge	184 (47)	137 (31)	124 (26)	24 (11)	20 (9)	19 (8)
Lateral boundaries	20 (5)	24 (5)	19 (4)	54 (26)	55 (23)	53 (21)
Wells	0 (0)	106 (24)	173 (36)	0 (0)	40 (17)	73 (29)
Springs	188 (48)	171 (39)	159 (34)	133 (63)	119 (51)	106 (42)
Total outflow	392 (100)	438 (100)	475 (100)	211 (100)	234 (100)	251 (100)

Note: WVSP = western Volusia/southeastern Putnam

Modelwide, the change in inflow components (as a percentage of the total) between predevelopment and 2010 is 12%, whereas for the WVSP portion of the model the change is only 3%. Likewise, changes in outflow components are generally greater modelwide than for the WVSP area. An obvious exception to this rule is the change in spring flow. The percentage decrease in spring flow is greater in the WVSP area because seven of the ten springs are located there. In fact, most of the modelwide decrease in spring flow is predicted at the three springs

(Blue, Gemini, and Green) that are located near or within the area of significant potentiometric decline around Deltona. However, 2010 spring flow is still projected to be significantly greater than all other outflow components within the WVSP area, but well withdrawals in the modelwide budget exceed spring flow.

FROST-AND-FREEZE PREDICTIVE SIMULATION

The tremendous volume of water withdrawn from the Upper Floridan aquifer for frost-and-freeze protection has an major effect upon groundwater flow within the Floridan aquifer system over a short time period. Frost-and-freeze protection pumping causes rapid, large drops in pressure within the aquifer at each of the many points of withdrawal. These pressure drops are observed as drawdown in the potentiometric surface (Figures 39, 40, 51, and 52). During frost-and-freeze pumping, an increase in hydraulic gradient occurs between sources of recharge to the affected part of the Upper Floridan aquifer (the water table and outlying portions of the Floridan aquifer), and a decrease in hydraulic gradient occurs between the affected parts of the Upper Floridan aquifer and natural discharge areas. Thus, the water removed by pumping is replaced by increases in inflow and decreases in outflow, including water from storage within the aquifer and adjacent confining beds (Figure 55).

The rate of inflow from aquifer storage peaks during the first time-step of each of the two frost-and-freeze withdrawal stress periods, then gradually decreases. At the onset of pumping, the sudden drop in potentiometric pressure causes compression of the sediments in the Upper Floridan aquifer, forcing water from them. Storage inflow also includes some additional fluid release due to water expansion caused by the pressure drop. As the decrease in pressure is transmitted upward to the USCU and the MSCU, water is squeezed from those sediments in the same fashion. Water derived from storage within the USCU and the MSCU (combined) is supplied to the model at gradually increasing rates that level off and actually decrease during the first stress period.

If pumping were to continue long enough, the pressure drop would be transmitted to the surficial aquifer system, eventually causing a gradual lowering of the water table and/or surface water body elevations. Analysis of potential drawdowns in the surficial aquifer

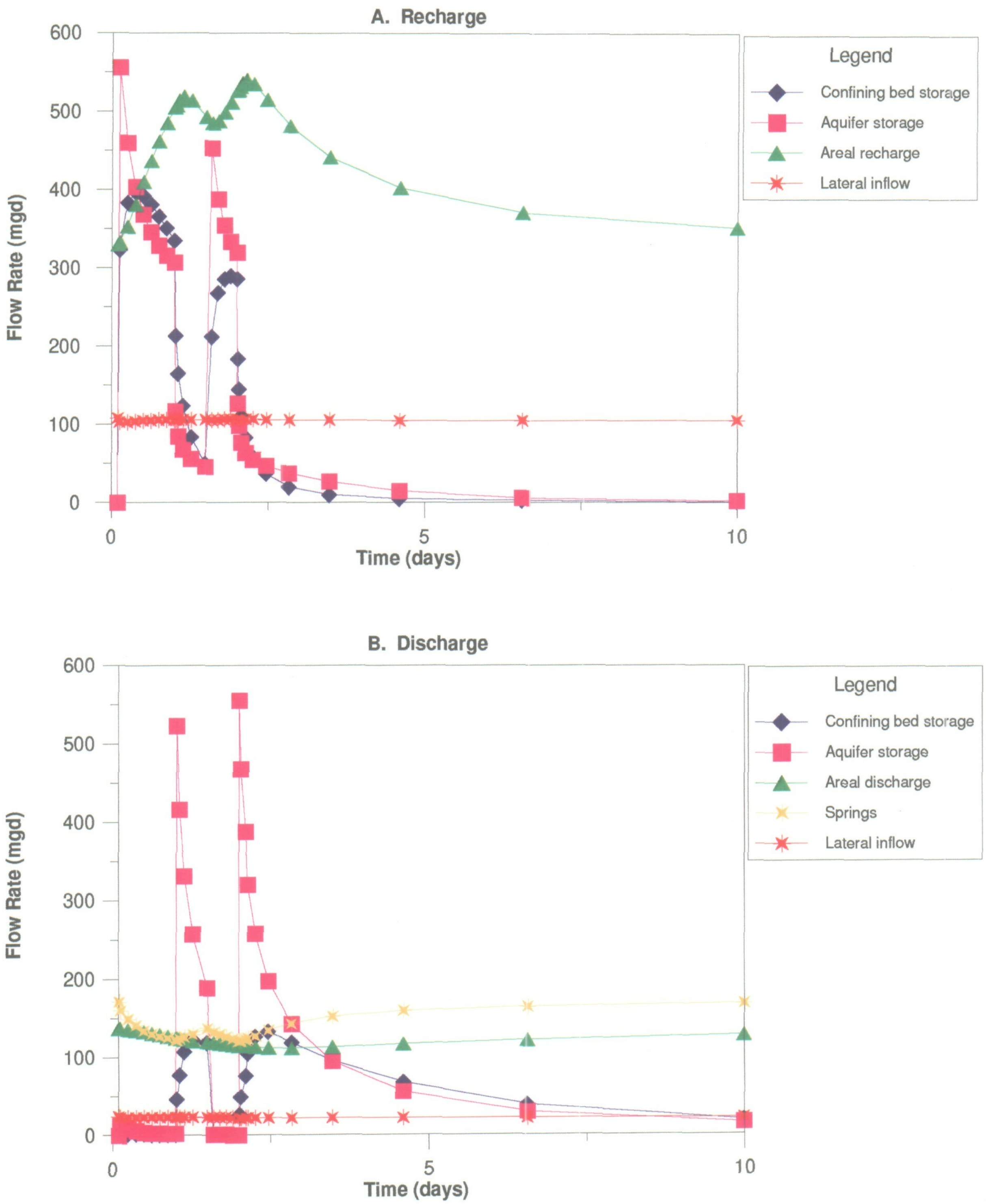


Figure 55. Change in volumetric budget with time during the frost-and-freeze predictive simulation

system due to frost-and-freeze withdrawals is not possible with the WVSP regional model because it contains a constant-head layer for the surficial aquifer system as an upper boundary condition. Estimation of the potential magnitude of drawdowns in the surficial aquifer system is beyond the scope of this project because of its large regional scale and relatively coarse discretization.

Areal recharge rates become greater than storage inflow rates during the first stress period (Figure 55, part A) as the vertical gradient between the surficial aquifer system and the elevation of the potentiometric surface of the Upper Floridan aquifer increases. The supply of water through the model's lateral boundaries barely changes throughout the simulation because head changes along the boundaries are minimal (Figure 51).

Decreases in simulated areal discharge rates from the Upper Floridan aquifer and simulated spring discharge rates occur during the frost-and-freeze stress periods (Figure 55, part B). Because most frost-and-freeze pumping occurs within recharge areas along the Crescent City and De Land ridges, the drop in areal discharge is relatively small and delayed due to the time required to reduce (or, in some places, reverse) the hydraulic gradient from pumping centers to discharge areas. Simulated springflow rates decrease more rapidly because several springs are adjacent to areas of heavy frost-and-freeze pumping. Significant reductions in simulated spring flow occur at Mud and Forest springs, Blue Spring, Beecher Springs, and Ponce de Leon Springs (Figure 56). Flow ceases completely during the frost-and-freeze stress periods at Ponce de Leon Springs because the simulated potentiometric surface temporarily drops below the spring pool elevation (2 ft NGVD). As with lateral inflow, changes in lateral outflow are insignificant (Figure 55, part B).

When frost-and-freeze protection withdrawals cease, water is returned to storage and hydraulic gradients, elevations, and water-balance components return to prepumping levels (Figures 53, 55, and 56). Huge simulated rates of return flow to aquifer storage result immediately (Figure 55, part B), followed by a rapid drop corresponding to the rapid recovery in potentiometric levels observed after freeze events (Figure 10).

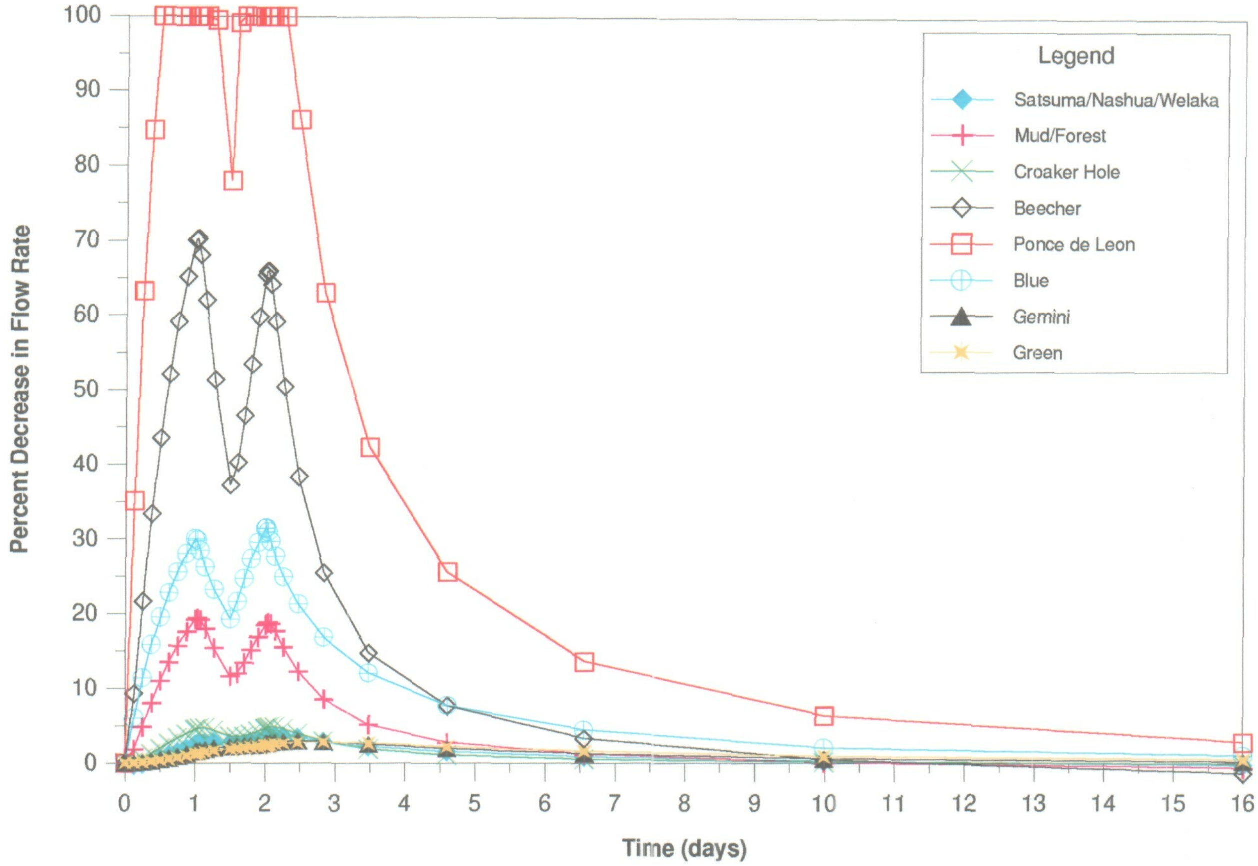


Figure 56. Decrease in simulated springflow rates (as percentage of initial flow rate) during the frost-and-freeze predictive simulation

Fourteen days after the cessation of frost-and-freeze protection withdrawals, the simulated water-balance components of the Floridan aquifer flow system have nearly recovered to initial steady-state rates.

CONCLUSIONS

A water resources evaluation of the Floridan aquifer system was conducted for a region containing the WVSP area in east-central Florida. The purpose of the study was to compare, on a regional basis, future water supply needs with the possible sources of fresh groundwater from the Floridan aquifer system within the WVSP area. Specific objectives of the project were (1) to estimate the possible (2010) impacts upon the fresh groundwater resources of the Floridan aquifer system within the WVSP area under average, steady-state conditions and (2) to estimate the possible impacts upon the fresh groundwater resources of the Floridan aquifer system within the WVSP area under short-term (transient) conditions during and after frost-and-freeze irrigation withdrawals.

A numerical groundwater flow model was developed that covers southeastern Putnam County, all of Flagler County, all of Volusia County except for the southeastern corner, and parts of adjacent counties. Once constructed, the model was calibrated so that it could simulate water levels within the Upper Floridan aquifer for both estimated predevelopment and observed 1988 average steady-state conditions. Model-simulated areal recharge rates to the Upper Floridan aquifer and spring discharge rates from the Upper Floridan aquifer for the steady-state calibrations also were compared to estimated and observed areal recharge rates and spring discharges. The model also was calibrated to transient conditions during and after a period of frost-and-freeze irrigation in January 1991 by comparing the simulated drawdown and recovery of the Upper Floridan aquifer to the observed drawdown and recovery of that aquifer.

A series of analyses was conducted that compares the sensitivity of model-simulated water levels in the Upper Floridan aquifer to changes in aquifer parameters and boundary conditions. In the WVSP area, simulated steady-state potentiometric levels are most sensitive to changes in the constant-head values of the surficial aquifer system and the leakance of the USCU. Simulated drawdown values computed during transient frost-and-freeze simulations are most sensitive to changes in the transmissivity and storativity of the Upper Floridan aquifer.

Two predictive scenarios were evaluated using the calibrated model. For the first scenario, a simulation was run using the same boundary conditions that were used for the 1988 steady-state calibration, except that the prescribed well withdrawals were updated to include 1994 withdrawals plus the increased public water supply pumping that is projected for 2010.

Impacts to the Floridan aquifer system due to the increase in average groundwater withdrawals between 1988 and 2010 are described in terms of changes in the potentiometric levels of the Upper Floridan aquifer, spring flows, and steady-state water budget flow rates. Simulated potentiometric and water budget flow rate changes are greater outside of the WVSP area than inside, except for southwestern Volusia County. The predicted average 2010 potentiometric surface of the Upper Floridan aquifer is more than 10 ft lower than the simulated 1988 surface in parts of eastern Volusia County, where the bulk of the increase in public supply withdrawals is projected to occur. It is more than 5 ft lower (relative to the simulated 1988 surface) throughout much of eastern Volusia County and part of eastern Flagler County. Within the WVSP area, differences range from 2 ft to greater than 5 ft throughout most of southwestern Volusia County. Differences are less than 2 ft elsewhere in the WVSP area, except for a small area just west of Crescent Lake in southeastern Putnam County and near Pierson in northwestern Volusia County. Changes in simulated water budget flow rates (except for spring flows) are greater when computed for the model as a whole rather than when computed for the WVSP area only. Most of the simulated change in steady-state springflow rates is predicted at the three springs (Blue, Gemini, and Green) located within southwestern Volusia County.

The second predictive scenario involved conducting a transient simulation with frost-and-freeze withdrawals superimposed upon simulated average 1988 steady-state conditions. Frost-and-freeze protection withdrawals for a hypothetical large-scale freeze similar to that which occurred during December 1989 were added to the 1988 average daily withdrawals. The simulation consisted of four stress periods representing a total of 1.5 days of frost-and-freeze protection withdrawals followed by a 14-day recovery period.

The simulated drawdown of the potentiometric surface of the Upper Floridan aquifer exceeds 1 ft throughout most of the WVSP area.

Maximum simulated drawdowns exceed 20 ft in southeastern Putnam County, 80 ft in northwestern Volusia County, and 30 ft in western Volusia County, north of De Land. The simulated potentiometric surface of the Upper Floridan aquifer recovers to near prefreeze levels by the end of the recovery period. Most of the water withdrawn for freeze protection is supplied by storage within the aquifer and adjacent confining units, an increase in recharge from the overlying surficial aquifer system, and decreases in discharge at springs located near areas of large withdrawals.

The errors that are inherent in the estimation of model inputs such as transmissivity, leakance, and hydraulic head in the surficial aquifer system, plus the errors inherent in measuring "known" quantities such as well and spring discharge rates, combine to produce uncertainty in all model predictions. This uncertainty can be lessened by conducting additional calibrations with new field data. Further calibration efforts would be significantly enhanced by the availability of additional hydrologic data. Specific suggestions are listed below.

- Construct more long-term monitoring sites with climatological instrumentation and observation wells completed within both the surficial aquifer system and the Lower Floridan aquifer. The establishment of well clusters with wells open to all three aquifers at the same location would enhance our knowledge of vertical groundwater gradients.

- Install continuous recorders on additional observation wells (including wells open to the surficial aquifer system and the Lower Floridan aquifer) to improve the understanding of the extent and magnitude of drawdowns due to frost-and-freeze withdrawals.

- Obtain additional data regarding the actual rates and locations of withdrawals for all agricultural water uses, including frost-and-freeze protection, to reduce the number of assumptions that need to be made before prescribing these withdrawals in the model. In lieu of the actual pumping rates being made available, an expansion of the SJRWMD Benchmark Farms Project to include more crops in more areas would be very beneficial.

- Increase the frequency at which flow rates are estimated at large springs so that the relationships between changes in rainfall, springflow, and groundwater withdrawals can be understood better.

When more hydraulic head data become available, particularly for the surficial aquifer system, this model should be revised to explicitly simulate hydraulic heads in the surficial aquifer system. It could then be used to examine potential changes in water levels in the surficial aquifer system due to changes in withdrawals from the Floridan aquifer system.

The groundwater flow model developed for this study has been shown to reasonably simulate estimated and observed potentiometric heads of the Upper Floridan aquifer, spring discharges, and areal recharge rates on a regional scale for two steady-state periods (average predevelopment and average 1988 conditions). It also has been shown to reproduce the observed drawdown and recovery patterns of the Upper Floridan aquifer for a short-term, transient period representing frost-and-freeze withdrawal conditions. Therefore, it can be considered useful for predicting heads in the Upper Floridan aquifer, spring discharges, and areal recharge rates for different steady-state conditions on a regional scale and for predicting drawdown and recovery in the Upper Floridan aquifer for periods of frost-and-freeze protection on a regional scale.

The model is considered regional in scale because the grid cell spacings range from a minimum of 1,500 ft to a maximum of 10,000 ft. Hydraulic parameters, such as transmissivity and leakance, are assumed to be homogeneous within the entire area represented by each grid cell. Boundary condition values, such as hydraulic head in the surficial aquifer system, and simulation results, such as head values for the Upper Floridan aquifer, are considered to be average values representative of the entire area encompassed by each grid cell. Therefore, this model should not be used to examine local-scale or subregional-scale problems (in an area smaller than at least several grid cells) where parameter inhomogeneities and/or changes in water table elevations would affect simulation results.

Examples of such problems include (1) lowering of lake or wetland water levels due to increased groundwater withdrawals,

(2) subsidence and/or sinkhole formation caused by pumping for frost-and-freeze protection, and (3) saline-water upconing or lateral intrusion that occurs in response to long-term drawdown in the Floridan aquifer system where the unit of freshwater is relatively thin. An examination of any of these problems can be better addressed using a local- or subregional-scale model that focuses upon specific areas where the problems are likely to occur. This model, however, can be used to provide lateral groundwater flow boundary conditions for local- or subregional-scale models that are constructed within the WVSP area.

REFERENCES

Anderson, M.P., and W. Woessner. 1992. *Applied groundwater modeling, simulation of flow and advective transport.* San Diego, Calif.: Academic Press, Inc.

Barraclough, J.T. 1962. *Ground water resources of Seminole County, Florida.* Report of Investigations 27. Tallahassee, Fla.: Florida Geological Survey.

Bentley, C.B. 1977. *Aquifer test analyses for the Floridan aquifer in Flagler, Putnam, and St. Johns counties, Florida.* Water-Resources Investigations 77-36. Tallahassee, Fla.: U.S. Geological Survey.

Bermes, B.J., G.W. Leve, and G.R. Tarver. 1963a. *Geology and ground-water resources of Flagler, Putnam, and St. Johns counties, Florida.* Report of Investigations 32. Tallahassee, Fla.: Florida Geological Survey.

———. 1963b. *Ground-water records of Flagler, Putnam, and St. Johns counties, Fla.* Information Circular 37. Tallahassee, Fla.: Florida Geological Survey.

Blackhawk Geosciences, Inc. 1992. *Time-domain electromagnetic measurements: east-central Florida.* Special Publication SJ92-SP5. Palatka, Fla.: St. Johns River Water Management District.

Blandford, T.N., and T. Birdie. 1992. *Regional ground-water flow modeling for east-central Florida with emphasis on Orange and Seminole counties.* Special Publication SJ92-SP17. Palatka, Fla.: St. Johns River Water Management District.

Blandford, T.N., T. Birdie, and J.B. Robertson. 1991. *Regional ground-water flow modeling for east-central Florida with emphasis on eastern and central Orange County.* Special Publication SJ91-SP4. Palatka, Fla.: St. Johns River Water Management District.

Boggess, W.G., A. Purvis, R.H. Stamps, R. Motes, and S. Ferenc. 1991. *Fernery management for groundwater quality protection: Leatherleaf* *grower survey*. University of Florida Institute of Food and Agricultural Sciences report to St. Johns River Water Management District. Palatka, Fla.

Boniol, D., D.A. Munch, and M. Williams. 1990. *Recharge areas of the Floridan aquifer in the Crescent City Ridge of southeast Putnam County, Florida*. Technical Publication SJ90-9. Palatka, Fla.: St. Johns River Water Management District.

———. 1993. *Mapping recharge to the Floridan aquifer using a geographic information system*. Technical Publication SJ93-5. Palatka, Fla.: St. Johns River Water Management District.

Brooks, H.K. 1961. The submarine spring off Crescent Beach, Florida. *Quarterly Journal of the Florida Academy of Sciences* 24(2):122–34.

Bush, P.W. 1978. *Hydrologic evaluation of part of central Volusia County, Florida*. Water-Resources Investigations 78-89. Tallahassee, Fla.: U.S. Geological Survey.

———. 1982. *Predevelopment flow in the Tertiary limestone aquifer, Southeastern United States: A regional analysis from digital modeling*. Water-Resources Investigations 82-905. Tallahassee, Fla.: U.S. Geological Survey.

Causey, L.V., and G.W. Leve. 1976. *Thickness of the potable-water zone in the Floridan aquifer*. Map Series 74. Tallahassee, Fla.: Florida Bureau of Geology.

Cooke, C.W. 1945. *Geology of Florida*. Bulletin 29. Tallahassee, Fla.: Florida Bureau of Geology.

Cooper, H.H., Jr., W.E. Kenner, and E. Brown. 1953. *Ground water in central and northern Florida*. Report of Investigations 10. Tallahassee, Fla.: Florida Geological Survey.

[EPA] Environmental Protection Agency. 1987. *Fact sheet, Volusia-Floridan sole-source aquifer*. Washington, D.C.

Faulkner, G.L. 1973. *Geohydrology of the Cross-Florida Barge Canal area with special reference to the Ocala vicinity.* Water-Resources Investigations 1-73. Tallahassee, Fla.: U.S. Geological Survey.

Florence, B.L. 1990. *Annual water use survey: 1988.* Technical Publication SJ90-12. Palatka, Fla.: St. Johns River Water Management District.

———. 1992. *Annual water use survey: 1990.* Technical Publication SJ92-4. Palatka, Fla.: St. Johns River Water Management District.

Freeze, R.A., and J.A. Cherry. 1979. *Ground Water.* Englewood Cliffs, N.J.: Prentice-Hall.

GeoTrans, Inc. 1992. *Wekiva River Basin groundwater flow and solute transport modeling study, phase 1: Regional groundwater flow model development.* Special Publication SJ92-SP19. Palatka, Fla.: St. Johns River Water Management District.

Geraghty and Miller, Inc. 1992. *Numerical modeling of ground-water flow and seawater intrusion, Volusia County, Florida.* Special Publication SJ92-SP6. Palatka, Fla.: St. Johns River Water Management District.

Gomberg, D.N. 1980. Available groundwater at National Gardens Trust, Volusia County, Florida. Unpublished report prepared for Bellemead Development Corp.

———. 1981. Water resources and available groundwater at Halifax Plantation, Volusia and Flagler counties, Florida. Unpublished report.

Huang, C., and S.A. Williams. 1996. *An iterative modeling procedure to evaluate drawdowns in a coupled-aquifer system: SURFDOWN and MODFLOW models.* Technical Publication SJ96-2. Palatka, Fla.: St. Johns River Water Management District.

Huddlestun, P.F. 1988. *A revision of the lithostratigraphic units of the coastal plain of Georgia: the Miocene through Holocene.* Bulletin 104. Atlanta, Ga.: Georgia Geological Survey.

Huff, M.D., and M. McKenzie-Arenberg. 1990. *Lower St. Johns and St. Marys ground water basins resource availability inventory.* Technical Publication SJ90-12. Palatka, Fla.: St. Johns River Water Management District.

Hughes, G.H. 1979. *Analysis of water-level fluctuations of Lakes Winona and Winnemisett— Two landlocked lakes in a karst terrain in Volusia County, Florida.* Water-Resources Investigations 79-55. Tallahassee, Fla.: U.S. Geological Survey.

Johnson, R.A. 1981. *Structural geologic features and their relationship to salt water intrusion in west Volusia, north Seminole, and northeast Lake counties.* Technical Publication SJ81-1. Palatka, Fla.: St. Johns River Water Management District.

Johnston, R.H., R.E. Krause, F.W. Meyer, P.D. Ryder, C.H. Tibbals, and J.D. Hunn. 1980. *Estimated potentiometric surface for the Tertiary limestone aquifer system, Southeastern United States, prior to development.* Open-File Report 80-406. Tallahassee, Fla.: U.S. Geological Survey.

Kimball-Lloyd, Inc. 1991. *Delineation of public water supply service areas and wastewater treatment plants for water-use projections.* Report to St. Johns River Water Management District. Palatka, Fla.

Kimrey, J.O. 1990. *Potential for ground-water development in central Volusia County, Florida.* Water-Resources Investigations Report 90-4010. Tallahassee, Fla.: U.S. Geological Survey.

Klein, H. 1975. *Depth to base of potable water in the Floridan aquifer.* 2d ed. Map Series 42. Tallahassee, Fla.: Florida Bureau of Geology.

Knochenmus, D.D. 1968. *Surface drainage characteristics in Volusia County, Florida.* Map Series 30. Tallahassee, Fla.: Florida Division of Geology.

Knochenmus, D.D., and M.E. Beard. 1971. *Evaluation of the quantity and quality of the water resources of Volusia County, Florida.* Report of Investigations 57. Tallahassee, Fla.: Florida Bureau of Geology.

Knochenmus, D.D., and G.H. Hughes. 1976. *Hydrology of Lake County, Florida.* Water-Resources Investigations Report 76-72. Tallahassee, Fla.: U.S. Geological Survey.

Leake, S.A., P.P. Leahy, and A.S. Navoy. 1994. *Documentation of a computer program to simulate transient leakage from confining units using the modular finite-difference ground-water flow model.* Open-File Report 94-59. Tucson, Ariz.: U.S. Geological Survey.

Lichtler, W.F. 1972. *Appraisal of water resources in the east-central Florida region.* Report of Investigations 61. Tallahassee, Fla.: Florida Bureau of Geology.

Lynne, G.D., and C.F. Kiker, eds. 1992a. *Needs and sources planning in the St. Johns River Water Management District: Agricultural land and water use projections for 1995 and 2010.* Special Publication SJ92-SP1. Palatka, Fla.: St. Johns River Water Management District.

———. 1992b. *Needs and sources planning in the St. Johns River Water Management District: Agricultural land and water use projections for 1995 and 2010 supplement.* Special Publication SJ92-SP2. Palatka, Fla.: St. Johns River Water Management District.

Marella, R. 1987. *Annual water use survey: 1980, revised edition.* Technical Publication SJ82-5. Palatka, Fla.: St. Johns River Water Management District.

Matson, G.C., and S. Sanford. 1913. *Geology and ground waters of Florida.* Water-Supply Paper 319. Washington, D.C.: U.S. Geological Survey.

McDonald, M.G., and A.W. Harbaugh. 1988. *A modular three-dimensional finite-difference ground-water flow model.* Techniques of Water-Resources Investigations, Book 6, Chapter A1. Washington, D.C.: U.S. Geological Survey.

McGurk, B.E., P. Bond, and D. Mehan. 1989. *Hydrogeologic and lithologic characteristics of the surficial sediments in Volusia County, Florida.* Technical Publication SJ89-7. Palatka, Fla.: St. Johns River Water Management District.

McKenzie-Arenberg, M. 1989. *Volusia ground water basin resource availability inventory.* Technical Publication SJ89-4. Palatka, Fla.: St. Johns River Water Management District.

McKenzie-Arenberg, M., and G. Szell. 1990. *Middle St. Johns ground water basin resource availability inventory.* Technical Publication SJ90-11. Palatka, Fla.: St. Johns River Water Management District.

Meisburger, E.P., and M.E. Field. 1976. Neogene sediments of Atlantic inner continental shelf of northern Florida. *The American Association of Petroleum Geologists Bulletin* 60(11):2019–37.

Mercer, J.W., S.D. Thomas, B.H. Lester, and R.W. Broome. 1984. *Saltwater intrusion in Volusia County, Florida, due to ground-water withdrawals.* Report to St. Johns River Water Management District, prepared by GeoTrans, Inc. Reston, Va.

Miller, J.A. 1986. *Hydrogeologic framework of the Floridan aquifer system in Florida and in parts of Georgia, Alabama, and South Carolina.* Professional Paper 1403-B. Washington, D.C.: U.S. Geological Survey.

Motz, L.H. 1978. Steady-state drawdowns in coupled aquifers. *Journal of the Hydraulics Division, ASCE* 104(HY7):1061–73.

———. 1981. Well-field drawdowns using coupled aquifer model. *Groundwater* 19(2):172–79.

Motz, L.H., W.O. Beddow II, M.R. Caprara, J.D. Gay, and S.M. Sheaffer. 1995. *North-central Florida regional ground-water investigation and flow model.* Special Publication SJ95-SP7. Palatka, Fla.: St. Johns River Water Management District.

Munch, D.A. 1979. *Test drilling report of northwest Volusia County.* Technical Publication SJ79-3. Palatka, Fla.: St. Johns River Water Management District.

Munch, D.A., D.J. Ripy, and R.A. Johnson. 1979. *Saline contamination of a limestone aquifer by connate intrusion in agricultural areas of St. Johns, Putnam, and Flagler counties, northeast Florida.* Technical

Publication 79-4. Palatka, Fla.: St. Johns River Water Management District.

Navoy, A.S. 1986. *Hydrogeologic data from a 2,000-foot deep core hole at Polk City, Green Swamp area, central Florida.* Water-Resources Investigations Report 84-4257. Tallahassee, Fla.: U.S. Geological Survey.

Navoy, A.S., and L.A. Bradner. 1987. *Ground-water resources of Flagler County, Florida* . Water-Resources Investigations Report 87-4021. Tallahassee, Fla.: U.S. Geological Survey.

Northeast Florida Regional Planning Council. 1991. *Future land use element, Putnam County Comprehensive Plan, May 30, 1991.* Jacksonville, Fla.

Phelps, G.G. 1984. *Recharge and discharge areas of the Floridan aquifer in the St. Johns River Water Management District and vicinity, Florida.* Water-Resources Investigations Report 82-4058. Tallahassee, Fla.: U.S. Geological Survey.

———. 1990. *Geology, hydrology, and water quality of the surficial aquifer system in Volusia County, Florida.* Water-Resources Investigations Report 90-4069. Tallahassee, Fla.: U.S. Geological Survey.

Popenoe, P., F.A. Kohout, and F.T. Manheim. 1984. Seismic-reflection studies of sinkholes and limestone dissolution features on the northeastern Florida shelf. In *Sinkholes: their geology, engineering, and environmental impact,* edited by B.F. Beck. Proceedings of the first multidisciplinary conference on sinkholes. Orlando, Fla.

Post, Buckley, Schuh, and Jernigan, Inc. 1990. *Floridan aquifer testing and analysis: Bull Creek Wildlife Management Area, Osceola County.* Report to South Brevard Water Authority. Orlando, Fla.

Rao, D.V., S.A. Jenab, and D.A. Clapp. 1989. *Rainfall analysis for northeast Florida, part 3: Seasonal rainfall data.* Technical Publication SJ89-1. Palatka, Fla.: St. Johns River Water Management District.

Rodis, H.G. 1989. *Potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity, September 1988.* Open-File Report 89-65. Tallahassee, Fla.: U.S. Geological Survey.

Rosenau, J.C., G.L. Faulkner, C.W. Hendry Jr., and R.W. Hull. 1977. *Springs of Florida.* 2d ed. Bulletin 31. Tallahassee, Fla.: Florida Bureau of Geology.

Ross, F.W., and D.A. Munch. 1980. *Hydrologic investigation of the potentiometric high centered about the Crescent City Ridge, Putnam County, Florida.* Technical Publication SJ80-3. Palatka, Fla.: St. Johns River Water Management District.

Rutledge, A.T. 1982. *Hydrology of the Floridan aquifer in northwest Volusia County, Florida.* Water-Resources Investigations Open-File Report 82-108. Tallahassee, Fla.: U.S. Geological Survey.

———. 1985a. *Ground-water hydrology of Volusia County, Florida, with emphasis on occurrence and movement of brackish water.* Water-Resources Investigations Report 84-4206. Tallahassee, Fla.: U.S. Geological Survey.

———. 1985b. *Use of double-mass curves to determine drawdown in a long-term aquifer test in north-central Volusia County, Florida.* Water-Resources Investigations Report 84-4309. Tallahassee, Fla.: U.S. Geological Survey.

Schiner, G.R. 1988. *Potentiometric surface of the Upper Floridan aquifer in the St. Johns River Water Management District and vicinity, May 1988.* Open-File Report 88-460. Tallahassee, Fla.: U.S. Geological Survey.

Scott, T.M. 1988. *The lithostratigraphy of the Hawthorn Group (Miocene) of Florida.* Bulletin 59. Tallahassee, Fla.: Florida Geological Survey.

Sellards, E.H., and H. Gunter. 1913. *The artesian water supply of eastern and southern Florida.* 5th annual report. Tallahassee, Fla.: Florida Geological Survey.

Simonds, E.P. Jr., B.F. McPherson, and P.W. Bush. 1980. *Shallow ground-water conditions and vegetation classification, central Volusia County, Florida.* Water-Resources Investigations Open-File Report 80-752. Tallahassee, Fla.: U.S. Geological Survey.

Singleton, V.D. 1990. *Investigation of potato water use in the tri-county area of Putnam, St. Johns, and Flagler counties, Florida.* Technical Publication SJ90-13. Palatka, Fla.: St. Johns River Water Management District.

———. 1996. *Benchmark Farms Project: Water use report on Leatherleaf fern and potatoes (1990–94).* Technical Publication SJ96-4. Palatka, Fla.: St. Johns River Water Management District.

Snell, L.J., and W. Anderson. 1970. *Water resources of northeast Florida.* Report of Investigations 54. Tallahassee, Fla.: Florida Bureau of Geology.

Snyder, S.W., M.W. Evans, A.C. Hine, and J.S. Compton. 1989. Seismic expression of solution collapse features from the Florida Platform. In *Proceedings of the third multidisciplinary conference on sinkholes and the engineering and environmental impact of karst,* edited by B.F. Beck. St. Petersburg Beach, Fla.

Southeastern Geological Society. 1986. *Hydrogeological units of Florida.* Special Publication 28. Tallahassee, Fla.: Florida Geological Survey.

Sprinkle, C.L. 1989. *Geochemistry of the Floridan aquifer system in Florida and parts of Georgia, South Carolina, and Alabama.* Professional Paper 1403-I. Washington, D.C.: U.S. Geological Survey.

Stamps, R.H., and D.Z. Haman. 1991. *Cold protection of leatherleaf fern in Lake, Putnam, and Volusia counties, Florida.* Special Publication SJ91-SP15. Palatka, Fla.: St. Johns River Water Management District.

Stamps, R.H., W.G. Boggess, and A.G. Smajstrla. 1991. Irrigation management practices in the leatherleaf fern industry. *Proceedings of the Florida State Horticultural Society* 104:328–30.

Steele, C. 1991. *Annual report on abandoned artesian wells.* Special Publications SJ91–SP7. Palatka, Fla.: St. Johns River Water Management District.

Stewart, J.W. 1980. *Areas of natural recharge to the Floridan aquifer in Florida.* Map Series 98. Tallahassee, Fla.: Florida Bureau of Geology.

Stringfield, V.T. 1936. *Artesian water in the Florida peninsula.* Water-Supply Paper 773-C. Washington, D.C.: U.S. Geological Survey.

———. 1966. *Artesian water in Tertiary limestone in the southeastern states.* Professional Paper 517-C. Washington, D.C.: U.S. Geological Survey.

Stringfield, V.T., and H.H. Cooper. 1951. *Geologic and hydrologic features of an artesian submarine spring east of Florida.* Report of Investigations 7. Tallahassee, Fla.: U.S. Geological Survey.

Szell, G. 1993. *Aquifer characteristics in the St. Johns River Water Management District, Florida.* Technical Publication SJ93-1. Palatka, Fla.: St. Johns River Water Management District.

Tibbals, C.H. 1981. *Computer simulation of the steady-state flow system of the Tertiary limestone (Floridan) aquifer system in east-central Florida.* Water-Resources Investigations Open-File Report 81-681. Tallahassee, Fla.: U.S. Geological Survey.

———. 1990. *Hydrology of the Floridan aquifer system in east-central Florida.* Professional Paper 1403-E. Washington, D.C.: U.S. Geological Survey.

Todd, D.K. 1980. *Groundwater hydrology.* 2d ed. New York: John Wiley and Sons.

Toth, D.L. 1988. *Salt water intrusion in coastal areas of Volusia, Brevard, and Indian River counties.* Technical Publication SJ88-1. Palatka, Fla.: St. Johns River Water Management District.

[USGS] U.S. Geological Survey. 1992. *Water resources data—Florida water year 1992.* Volume 1A, *Northeast Florida surface water.* Water-Data Report FL-92-1A. Tallahassee, Fla.

Vecchioli, J., C.H. Tibbals, A.D. Duerr, and C.B. Hutchinson. 1990. *Ground-water recharge in Florida—A pilot study in Okaloosa, Pasco, and Volusia counties.* Water-Resources Investigations Report 90-4195. Tallahassee, Fla.: U.S. Geological Survey.

Vergara, Barbara. 1994. *Water supply needs and sources assessment: 1994: St. Johns River Water Management District.* Technical Publication SJ94-7. Palatka, Fla.: St. Johns River Water Management District.

Vernon, R.O. 1951. *Geology of Citrus and Levy counties, Florida.* Bulletin 33. Tallahassee, Fla.: Florida Bureau of Geology.

Ward, D.S., and S.D. Thomas. 1987. *Saltwater intrusion in Volusia County, Florida, due to ground-water withdrawals: Refined model grid.* Report to the St. Johns River Water Management District by GeoTrans, Inc. Reston, Va.

White, W.A. 1958. *Some geomorphic features of central peninsular Florida.* Bulletin 41. Tallahassee, Fla.: Florida Bureau of Geology.

———. 1970. *The geomorphology of the Florida peninsula.* Bulletin 51. Tallahassee, Fla.: Florida Bureau of Geology.

Williams, S. 1997. *A regional flow model of the Volusia ground water basin.* Technical Publication SJ97-3. Palatka, Fla.: St. Johns River Water Management District.

Wyrick, G.G. 1960. *The ground-water resources of Volusia County, Florida.* Report of Investigations 22. Tallahassee, Fla.: Florida Geological Survey.

———. 1961. *Records of wells in Volusia County, Florida.* Information Circular 24. Tallahassee, Fla.: Florida Geological Survey.

APPENDIX A—INDEX TO OBSERVATION WELLS

Table A1. Index to observation wells used during this study

Well Number	SJRWMD Station Name	USGS Station Name	Local Well Name	Model Row	Model Column	Latitude	Longitude	Casing Depth (feet)	Total Depth (feet)	Hydrostrati-graphic Unit	Date Record Begins
1	P-0475	293554081342601	San Mateo Tower	1	21	29 35 54	81 34 26	65	85	USCU	1986
2	P-0474*		San Mateo Tower	1	21	29 35 54	81 34 26	132	220	UF	1986
3	P-0280*	293234081424101	Rodeheaver Ranch	2	3	29 32 34	81 42 41	152	295	UF	1977
4	P-0243*	293441081373401	R.C. Fox	2	11	29 34 41	81 37 34	108	210	UF	1975
5	P-0480*	293543081315301	B.T. Tilton	3	26	29 35 43	81 31 53	—	378	UF	1977
6	P-0382*	293113081370301	Dave Main	5	9	29 31 13	81 37 03	63	240	UF	1970
7	F-0200*	293754081121901	Matanzas Inlet	6	43	29 37 54	81 12 19	140	148	UF	1979
8	P-0408*†	292859081375701	Fruitland	7	8	29 28 59	81 37 57	117	148	UF	1978
9	P-0409	292859081375702	Fruitland	7	8	29 28 59	81 37 57	40	55	UC	1978
10	F-0204*	293337081230301	Dinner Island	7	36	29 33 37	81 23 03	86	113	UF	1978
11	F-0205	293337081230302	Dinner Island	7	36	29 33 37	81 23 03	—	—	UC	1978
12	F-0165*		Palm Coast LW20	7	39	29 35 29	81 19 17	127	200	UF	1977
13	F-0262*	293034081293001	H. Griffith	8	26	29 30 34	81 29 30	—	141	UF	1955
14	P-0416*†		Morris Fernery	9	7	29 26 57	81 37 52	95	187	UF	1980
15	P-0471*	292815081341501	Thunderbird Airport	9	13	29 28 24	81 34 15	104	144	UF	1975
16	P-0373*†	292621081375101	Mansfield Fernery	11	7	29 26 22	81 37 44	73	205	UF	1977
17	P-0270*	292528081383501	Fruitland Handyway	12	5	29 25 28	81 38 35	91	124	UF	1935
18	P-0517*†		Newbold Fernery	13	19	29 27 36	81 31 34	144	202	UF	1987
19	P-0690		M. Palmer	15	13	29 25 57	81 33 04	70	96	UF	1988
20	P-0242*†	292606081311101	Gautier Fernery	16	18	29 26 06	81 31 25	105	135	UF	1975
21	P-0421*	292254081382101	Drayton Island	17	4	29 22 54	81 38 21	—	100	UF	1980
22	F-0182*		Kings Farm well	18	34	29 27 37	81 22 02	192	446	UF	1979
23	P-0423*	292143081374601	Drayton Island	20	4	29 21 43	81 37 46	—	180	UF	1985
24	P-0410*	292218081333101	Georgetown	20	9	29 22 18	81 33 31	81	156	UF	1978
25	P-0735		Middle Road	21	9	29 21 24	81 34 52	330	360	UF	1992
26	P-0736		Middle Road	21	9	29 21 24	81 34 52	70	100	UF	1992
27	P-0737		Middle Road	21	9	29 21 24	81 34 52	50	60	USCU	1992
28	P-0734		Middle Road	21	9	29 21 24	81 34 52	10	20	UC	1992
29	F-0126*	292647081182001	G. Allen	21	38	29 26 47	81 18 20	122	310	UF	1975
30	F-0087*	292750081152001	USGS-FLG 14	21	39	29 27 50	81 15 20	—	417	UF	1936
31	F-0278*	292728081125601	Bunnell Airport	22	41	29 27 28	81 12 56	105	255	UF	1981
32		292128081295401*	Herren's well	23	17	29 21 28	81 29 54	—	140	UF	1978

Table A1—*Continued*

Well Number	SJRWMD Station Name	USGS Station Name	Local Well Name	Model Row	Model Column	Latitude	Longitude	Casing Depth (feet)	Total Depth (feet)	Hydrostratigraphic Unit	Date Record Begins
33	F-0261*	292342081183701	D. Sorenson	24	36	29 23 42	81 18 37	—	285	UF	1956
34	V-0155*	291835081324201	Pine Island	25	8	29 18 35	81 33 42	120	155	UF	1976
35	V-0185		Seville Fire Tower	25	15	29 19 41	81 29 42	30	45	UC	1985
36	V-0184*		Seville Fire Tower	25	15	29 19 41	81 29 42	74	101	UF	1985
37	F-0176*	292603081082502	Bulow Ruins	26	43	29 26 03	81 08 27	90	120	UF	1978
38	V-0510		SJRWMD	29	15	29 17 48	81 29 03	85	130	UF	1989
39	V-0064*		SJRWMD	29	18	29 18 23	81 28 08	113	166	UF	1979
40	V-0096*	291905081251001	R. Nolan	29	26	29 19 05	81 25 10	—	138	UF	1935
41	V-0095*	291715081281801	J.C. Mew	30	15	29 17 15	81 28 18	—	180	UF	1936
42	V-0065*	291508081302801	West of Pierson	33	9	29 15 08	81 30 28	97	180	UF	1979
43	V-0068*†	291458081294201	SJRWMD-West Pierson	34	11	29 14 58	81 29 42	63	125	UF	1979
44	V-0525		SJRWMD-West Pierson	34	11	29 14 58	81 29 42	4	14	UC	1990
45	V-0524		SJRWMD-West Pierson	34	11	29 14 58	81 29 42	29	39	USCU	1990
46	F-0251*	291818081190401	Relay Tower	34	32	29 18 18	81 19 04	80	150	UF	1985
47	F-0252	291818081190402	Relay Tower	34	32	29 18 18	81 19 04	10	21	UC	1985
48	V-0066*	29143381284102	SJRWMD	36	12	29 14 33	81 28 41	250	365	UF	1981
49	V-0069	291433081284104	SJRWMD	36	12	29 14 33	81 28 41	56	48	USCU	1978
50	V-0531		Pierson Airport	36	15	29 14 48	81 27 49	130	210	UF	1990
51	V-0530		Pierson Airport	36	15	29 14 48	81 27 49	800	1,060	LF	1990
52	V-0354		Pierson Airport	36	15	29 14 48	81 27 49	88	98	USCU	1992
53	V-0528		Pierson Airport	36	15	29 14 48	81 27 49	13	23	UC	1990
54	V-0147	291457081270901	USGS	36	17	29 14 57	81 27 09	128	140	UF	1978
55	F-0256*	291720081194401	South of Relay Tower	36	31	29 17 20	81 19 44	66	167	UF	—
56	V-0218		J. Taylor	37	17	29 14 47	81 27 03	92	302	UF	1986
57		291258081313701*	Southeast Lake George	38	7	29 12 58	81 31 37	80	90	UF	1978
58		291347081284701*	Cline, west of Pierson	38	11	29 13 47	81 28 47	87	100	UF	1978
59	V-0144*	291431081263101	Turner Road	39	18	29 14 31	81 26 31	85	125	UF	1978
60		291315081270301*	USGS-Mclaughlin	42	15	29 13 15	81 27 03	—	103	UF	1978
61	V-0089*†	291343081254601	Jones Fernery	42	19	29 13 43	81 25 46	112	414	UF	1977
62		291150081282501*	Harper	44	11	29 11 50	81 28 25	129	303	UF	1978
63	L-0045*	290950081315501	Astor Park well	46	5	29 09 50	81 31 55	204	254	UF	1936

Table A1—*Continued*

Well Number	SJRWMD Station Name	USGS Station Name	Local Well Name	Model Row	Model Column	Latitude	Longitude	Casing Depth (feet)	Total Depth (feet)	Hydrostrati-graphic Unit	Date Record Begins
64	V-0217	291221081235101	Richardson	46	22	29 12 21	81 23 51	—	100	UF	1978
65		291332081191001	USGS-Used 425	46	30	29 13 32	81 19 10	—	128	UF	1977
66	V-0062*†	291216081215601	Barberville	47	26	29 12 16	81 21 56	131	200	UF	1979
67	V-0063	291216081215602	Barberville	47	26	29 12 16	81 21 56	10	25	UC	1979
68	V-0090*†	291344081155701	USGS-Union Camp	47	34	29 13 44	81 15 57	74	151	UF	1978
69	V-0088	291344081155702	USGS-Union Camp	47	34	29 13 44	81 15 57	20	20	UC	1978
70		290647081342101*	USGS-north Alexander Springs	48	1	29 06 47	81 34 21	140	190	UF	1983
71	—	291149081190801*	L. Blackwelder	48	29	29 11 49	81 19 08	118	240	UF	1978
72	V-0213	290930081230201	Southeast Barberville	50	22	29 09 30	81 23 02	143	145	UF	1978
73		291036081175801*	Hendrix, SR 11	51	30	29 10 36	81 17 58	95	180	UF	1979
74	V-0127*	291302081063801	USGS-west of Daytona	54	41	29 13 02	81 06 38	84	240	UF	—
75	V-0086*†	291006081101004	USGS-Tiger Bay	57	38	29 10 06	81 10 10	122	222	UF	1975
76	V-0087	2910060811613	USGS-Tiger Bay	57	38	29 10 07	81 10 16	18	20	UC	1978
77		290244081302601*	USGS-17S28E03	58	3	29 02 44	81 30 26	85	92	UF	—
78	V-0156*	290512081213601	Booker-Glenwood	59	21	29 05 12	81 21 36	85	265	UF	1984
79	V-0099*	291025081050201	USGS-I-95 well	59	41	29 10 25	81 05 02	152	220	UF	1955
80	V-0187	291107081034201	Daytona Beach Airport	59	42	29 11 07	81 03 42	97	700	UF, MSCU	1985
81	V-0027*	290534081175001	USGS-F1, near De Land	61	28	29 05 34	81 17 50	85	114	UF	1966
82		290534081175002	USGS-F2, near De Land	61	28	29 05 34	81 17 50	245	259	UF	1966
83		290550081162601	Lawrence	61	29	29 05 50	81 16 26	70	107	UF	1965
84	V-0193		SJRWMD-Tomoka Tower	61	39	29 08 34	81 07 38	16	25	UC	1987
85	V-0192		SJRWMD-Tomoka Tower	61	39	29 08 34	81 07 38	60	80	USCU	1987
86	V-0188		SJRWMD-Tomoka Tower	61	39	29 08 34	81 07 38	92	250	UF	1987
87	V-0183		SJRWMD-Tomoka Tower	61	39	29 08 34	81 07 38	445		MSCU	1987
88	V-0080	290920081063001	USGS-6 in. near Daytona	61	40	29 09 23	81 06 12	102	235	UF	1955
89	V-0008	290920081063002	USGS-2 in. near Daytona	61	40	29 09 23	81 06 12	480	496	MSCU	1955
90	V-0200*		SJRWMD	61	44	29 10 31	80 59 04	99	159	UF	1985
91	V-0081*	290541081132902	USGS-04 near De Land	64	32	29 05 41	81 13 29	85	639	UF, MSCU	1955
92	V-0012	290541081132904	USGS-06 near De Land	64	32	29 05 41	81 13 29	1,275	1,290	LF	1969
93	V-0100	290541081132903	USGS-05 near De Land	64	32	29 05 41	81 13 29	639	1,200	MSCU, LF	1969
94		290047081232501*	USGS-17S29E	66	11	29 00 47	81 23 25	—	250	UF	1965

Table A1—*Continued*

Well Number	SJRWMD Station Name	USGS Station Name	Local Well Name	Model Row	Model Column	Latitude	Longitude	Casing Depth (feet)	Total Depth (feet)	Hydrostrati-graphic Unit	Date Record Begins
95		290138081203202*	USGS-J2, west De Land	67	19	29 01 38	81 20 32	252	500	UF	1966
96	V-0120*	290447081102301	USGS-I4, east De Land	67	37	29 04 47	81 10 23	92	241	UF	1978
97		285539081262901*	Pine Lakes	71	4	28 55 39	81 26 29	155	200	UF	—
98	V-0083	285638081203101	USGS-near Blue Spring	73	14	28 56 38	81 20 31	84	442	UF, MSCU	1981
99	V-0104*	285655081165601	USGS-Orange City A-1 E	76	23	28 56 55	81 16 56	152	171	UF	1966
100	V-0112	285655081165602	USGS-Orange City A-1 E	76	23	28 56 55	81 16 56	21	32	UC	1966
101	V-0082	285512081202801	USGS-south Blue Spring	77	12	28 55 12	81 20 28	106	200	UF	1981
102	V-0197		Orange City tower	78	18	28 54 42	81 18 14	20	30	UC	1985
103	V-0196*		Orange City tower	78	18	28 54 42	81 18 14	95	230	UF	1985
104		285359081161701*	Deltona P.S. No. 3	79	22	28 53 59	81 16 17	76	250	UF	1978
105	V-0101*†	285745081054001	USGS well—Alamana	80	38	28 57 45	81 05 40	113	121	UF	1936
106		284826081254601	USGS-S Hardin	84	2	28 48 26	81 25 46	200	200	UF	—
107	V-0102*	285221081095002	USGS-G2, Osteen	87	30	28 52 21	81 09 50	74	92	UF	1966
108	V-0199		SJRWMD-Lake Ashby	87	38	28 54 19	81 04 10	—	86	USCU	1986
109	V-0198		SJRWMD-Lake Ashby	87	38	28 54 19	81 04 10	88	122	USCU, UF	1986
110	V-0165*		W. Took Farm well	89	34	28 50 31	81 06 23	58	255	UF	1980
111	V-0166		W. Took Farm well	89	34	28 50 31	81 06 23	25	35	UC	1984
112		284750081132301*	USGS-No. 257	90	23	28 47 50	81 13 23	—	206	UF	1951

Note:
— = no data available
LF = Lower Floridan aquifer
MSCU = middle semiconfining unit
SJRWMD = St. Johns River Water Management District
SR = State Road
UC = unconfined (surficial aquifer system)
UF = Upper Floridan aquifer
USCU = upper semiconfining unit
USGS = United States Geological Survey

*Well used for 1988 steady-state calibration (Figure 26)
†Well with continuous recorder used for 1991 transient calibration

APPENDIX B—REGIONAL MODEL GRID: COORDINATES AND GRID SPACING

Table B1. Grid spacings (in feet) with origin at southwest corner of the regional model grid

Row Number	Row Length	Cumulative Row Length	Column Number	Column Width	Cumulative Column Width
1	5,000	326,075	1	7,500	7,500
2	5,000	321,075	2	5,000	12,500
3	5,625	316,075	3	4,000	16,500
4	5,625	310,450	4	3,500	20,000
5	7,500	304,825	5	3,750	23,750
6	6,250	297,325	6	3,000	26,750
7	6,250	291,075	7	4,375	31,125
8	5,000	284,825	8	5,000	36,125
9	3,750	279,825	9	4,250	40,375
10	2,500	276,075	10	3,500	43,875
11	2,500	273,575	11	2,500	46,375
12	2,625	271,075	12	2,000	48,375
13	3,000	268,450	13	2,000	50,375
14	3,000	265,450	14	2,000	52,375
15	3,000	262,450	15	1,500	53,875
16	3,000	259,450	16	2,250	56,125
17	3,000	256,450	17	2,250	58,375
18	3,750	253,450	18	1,500	59,875
19	3,750	249,700	19	1,500	61,375
20	5,000	245,950	20	1,500	62,875
21	5,000	240,950	21	2,000	64,875
22	6,250	235,950	22	3,000	67,875
23	5,000	229,700	23	2,500	70,375
24	3,750	224,700	24	1,750	72,125
25	3,750	220,950	25	2,500	74,625
26	2,500	217,200	26	3,500	78,125
27	2,500	214,700	27	5,000	83,125
28	3,000	212,200	28	5,000	88,125
29	3,750	209,200	29	5,000	93,125
30	3,750	205,450	30	5,250	98,375
31	3,000	201,700	31	4,500	102,875
32	3,000	198,700	32	3,000	105,875
33	3,000	195,700	33	2,500	108,375
34	2,000	192,700	34	3,000	111,375
35	2,000	190,700	35	3,000	114,375
36	1,500	188,700	36	4,000	118,375
37	1,500	187,200	37	6,000	124,375

Table B1—*Continued*

Row Number	Row Length	Cumulative Row Length	Column Number	Column Width	Cumulative Column Width
38	1,500	185,700	38	8,750	133,125
39	1,500	184,200	39	9,000	142,125
40	2,000	182,700	40	10,000	152,125
41	2,000	180,700	41	10,000	162,125
42	3,000	178,700	42	10,000	172,125
43	2,500	175,700	43	10,000	182,125
44	2,500	173,200	44	10,000	192,125
45	2,750	170,700	45	10,000	202,125
46	3,750	167,950			
47	5,125	164,200			
48	5,125	159,075			
49	3,750	153,950			
50	2,500	150,200			
51	2,500	147,700			
52	2,500	145,200			
53	2,800	142,700			
54	2,200	139,900			
55	3,000	137,700			
56	3,750	134,700			
57	3,750	130,950			
58	3,000	127,200			
59	3,000	124,200			
60	3,000	121,200			
61	3,000	118,200			
62	2,250	115,200			
63	3,000	112,950			
64	3,000	109,950			
65	3,000	106,950			
66	3,750	103,950			
67	3,750	100,200			
68	5,000	96,450			
69	7,500	91,450			
70	5,000	83,950			
71	3,375	78,950			
72	2,250	75,575			
73	1,500	73,325			
74	2,250	71,825			
75	3,000	69,575			

Table B1—*Continued*

Row Number	Row Length	Cumulative Row Length	Column Number	Column Width	Cumulative Column Width
76	3,750	66,575			
77	5,000	62,825			
78	5,000	57,825			
79	5,100	52,825			
80	3,750	47,725			
81	2,500	43,975			
82	1,875	41,475			
83	2,500	39,600			
84	2,750	37,100			
85	2,500	34,350			
86	3,750	31,850			
87	5,000	28,100			
88	6,250	23,100			
89	7,600	16,850			
90	9,250	9,250			

	Latitude	Longitude
NW grid corner	29 33 08	81 46 10
NE grid corner	29 44 40	81 10 22
SE grid corner	28 53 51	80 49 22
SW grid corner	28 42 26	81 25 00

Appendix C—Locations and Modeled Discharge Rates of Wells Used for the 1988 Steady-State Calibration and the 2010 Steady-State Predictive Simulation

Table C1. Public supply, commercial, and industrial groundwater withdrawals

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-035-0011AN	Palm Coast Utilities LW-32	23	41	29 26 22	81 12 38	0	112,132
2-035-0011AN	Palm Coast Utilities LW-30	23	40	29 26 21	81 13 50	0	112,132
2-035-0011AN	Palm Coast Utilities LW-14	23	40	29 26 15	81 13 15	0	112,132
2-035-0011AN	Palm Coast Utilities LW-23	23	40	29 26 02	81 14 15	0	112,132
2-035-0011AN	Palm Coast Utilities LW-21	24	40	29 25 38	81 13 05	0	112,132
2-035-0011AN	Palm Coast Utilities LW-31	24	40	29 25 24	81 13 16	0	112,132
2-035-0011AN	Palm Coast Utilities proposed LW-22	25	40	29 25 12	81 12 40	0	112,132
2-035-0011AN	Palm Coast Utilities LW-49	27	40	29 24 22	81 12 22	0	112,132
2-035-0018ANG	Washington Oaks State Park	6	43	29 37 56	81 12 36	13,476	13,476
2-035-0022AN	Marineland of Florida	5	43	29 40 03	81 12 49	1,571	1,671
2-035-0022AN	Marineland of Florida	5	43	29 39 55	81 12 42	1,571	1,671
2-035-0022AN	Marineland of Florida	5	43	29 39 54	81 12 51	1,571	1,671
2-035-0022AN	Marineland of Florida	5	43	29 39 46	81 12 46	1,571	1,671
2-035-0029AN	Plantation Bay	28	41	29 24 01	81 11 21	2,515	31,996
2-035-0029AN	Plantation Bay	28	41	29 23 52	81 11 21	2,515	31,996
2-035-0029AN	Plantation Bay	28	41	29 23 44	81 11 24	2,515	31,996
2-035-0030ANG	City of Flagler Beach	22	41	29 27 25	81 12 06	6,711	15,107
2-035-0030ANG	City of Flagler Beach	22	41	29 27 16	81 12 06	6,711	15,107
2-035-0030ANG	City of Flagler Beach	22	41	29 27 13	81 12 27	6,711	15,107
2-035-0030ANG	City of Flagler Beach	22	41	29 27 08	81 12 08	6,711	15,107
2-035-0030ANG	City of Flagler Beach	23	41	29 27 03	81 12 05	6,711	15,107
2-035-0030ANG	City of Flagler Beach	23	41	29 26 54	81 12 04	6,711	15,107
2-035-0030ANG	City of Flagler Beach	23	41	29 26 47	81 12 01	6,711	15,107
2-035-0030ANG	City of Flagler Beach	23	41	29 26 33	81 11 56	6,711	15,107
2-035-0030ANG	City of Flagler Beach	23	41	29 26 27	81 11 54	6,711	15,107
2-035-0030ANG	City of Flagler Beach	24	41	29 25 57	81 11 44	6,711	15,107
2-035-0057AN	Beverly Beach	19	43	29 31 18	81 08 59	4,278	8,690
2-035-0061ANV	Holiday Trailer Park	28	42	29 24 25	81 09 37	1,355	2,322
2-035-0062ANV	Commercial/industrial Rinker	20	39	29 28 43	81 16 05	4,011	4,278
2-035-0067ANVG	City of Bunnell—UF well	20	40	29 28 31	81 14 01	14,973	48,128
2-035-0067ANVG	City of Bunnell proposed well	21	41	29 28 31	81 13 25	14,973	38,503

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
—	Bulow KOA	26	42	29 25 40	81 08 50	9,358	12,032
2-069-0089AUMR	Astor Water Association	46	2	29 09 42	81 30 31	0	35,378
2-069-0089AUMR	Astor Water Association	47	2	29 09 01	81 34 18	31,684	35,378
2-069-0089AUMR	Astor Water Association	46	2	29 08 57	81 34 20	0	35,378
2-069-0785AUSMV	Wekiva Falls Resort	86	2	28 47 40	81 25 17	1,704,242	29,811
2-069-0825AN	Florida Hospital Medical Center	74	2	28 53 10	81 26 55	0	3,381
2-069-1045AUV	Church of Jesus Christ of Latter Day Saints	60	6	29 02 54	81 28 05	1,113	1,113
2-069-1045AUV	Church of Jesus Christ of Latter Day Saints	60	6	29 02 52	81 28 06	1,113	1,113
2-107-0055AUG	Crescent City High School	11	18	29 28 20	81 32 05	275	1,069
2-107-0055AUG	Crescent City High School	11	18	29 28 13	81 32 02	275	1,069
2-107-0084AN	Southern States Utilities: River Park	12	2	29 25 09	81 38 54	899	1,638
2-107-0084AN	Southern States Utilities: River Park	13	2	29 24 22	81 39 49	899	1,638
2-107-0084AN	Southern States Utilities: River Park	14	2	29 24 17	81 38 18	899	1,638
2-107-0084AN	Southern States Utilities: River Park	14	3	29 24 08	81 40 11	899	1,638
2-107-0086AN	Southern States Utilities: Hermits Cove	6	5	29 29 33	81 40 18	2,373	3,075
2-107-0088AN	Southern States Utilities: St. Johns Highlands	1	7	29 34 23	81 40 35	1,274	1,826
2-107-0137AN	Walt R. Bassett	7	13	29 29 53	81 34 45	0	2,682
2-107-0138ANV	Lake Como Water Association	9	13	29 28 45	81 34 15	1,070	1,532
2-107-0138ANV	Lake Como Water Association	9	13	29 28 43	81 34 15	1,070	1,532
2-107-0142ANVR	Welaka Research Center	7	5	29 28 21	81 39 46	0	0
2-107-0142ANVR	Welaka Research Center	8	6	29 28 13	81 39 01	0	0
2-107-0142ANVR	Welaka Research Center	7	5	29 28 12	81 39 34	0	0
2-107-0142ANVR	Welaka Research Center	7	5	29 28 11	81 39 37	0	0
2-107-0142ANVR	Welaka Research Center	8	6	29 28 09	81 39 02	0	0
2-107-0155ANGR	U.S. Fish & Wildlife Service, Fish Hatchery	8	5	29 26 28	81 38 53	13,369	13,369
2-107-0156AUSGR	U.S. Fish & Wildlife Service, Fish Hatchery	7	5	29 28 29	81 40 17	134	134
2-107-0156AUSGR	U.S. Fish & Wildlife Service, Fish Hatchery	7	5	29 28 21	81 40 06	33,422	33,422
2-107-0158AUS	Crescent City	17	20	29 25 42	81 30 26	15,419	17,959
2-107-0158AUS	Crescent City	17	20	29 25 40	81 30 26	15,419	17,959
2-107-0158AUS	Crescent City	17	20	29 25 39	81 30 26	15,419	17,959

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-107-0182ANV	U.A.W. Village	1	7	29 34 31	81 40 31	0	1,916
2-107-0182ANV	U.A.W. Village	1	7	29 34 29	81 40 28	0	1,916
2-107-0198AN	Dove Meadows Golf Course	11	16	29 27 59	81 33 05	0	0
2-107-0198AN	Dove Meadows Golf Course	11	16	29 27 57	81 32 54	0	0
2-107-0198AN	Dove Meadows Golf Course	11	16	29 27 52	81 32 43	0	0
2-107-0198AN	Dove Meadows Golf Course	11	16	29 27 48	81 32 46	0	0
2-107-0212AN	Shell Harbor Resort	4	6	29 31 21	81 40 35	0	0
2-107-0218ANG	Town of Welaka	7	6	29 28 40	81 38 56	0	13,235
—	Saratoga Harbor	4	5	29 31 51	81 40 52	0	3,342
—	Welaka Mobile Home Park	4	6	29 31 49	81 40 23	0	3,342
—	Southern States Utilities: Pomona Park	7	11	29 29 40	81 35 40	3,527	25,535
—	Sportsmans Harbor	6	4	29 29 15	81 40 33	0	6,283
2-117-0008AUGM	Seminole County (Greenwood Lakes)	90	6	28 44 25	81 20 51	168,126	317,356
2-117-0008AUGM	Seminole County (Country Club Heights)	90	6	28 44 01	81 19 46	1,941	178,062
2-117-0023ANGR2	Seminole County (Hanover Woods)	89	4	28 46 02	81 23 01	20,508	80,743
2-117-0026ANGM3	Sanford (Wellfield #3) W-3E	88	9	28 47 47	81 19 43	57,487	79,144
2-117-0026ANGM3	Sanford (Wellfield #3) W-3D	88	9	28 47 44	81 19 40	57,487	79,144
2-117-0026ANGM3	Sanford (Wellfield #3) W-3C	88	9	28 47 42	81 19 40	57,487	79,144
2-117-0026ANGM3	Sanford (Wellfield #3) W-3A	88	8	28 47 34	81 19 43	57,487	118,583
2-117-0026ANGM3	Sanford (Wellfield #3) W-3B	88	9	28 47 30	81 19 37	57,487	79,144
2-117-0026ANGM3	Sanford (Wellfield #4)	88	8	28 47 26	81 20 23	0	222,594
2-117-0026ANGM3	Sanford (Wellfield #2) W-2M	89	9	28 47 04	81 19 19	35,428	0
2-117-0026ANGM3	Sanford (Wellfield #2) W-2N	89	9	28 47 04	81 19 19	35,428	0
2-117-0026ANGM3	Sanford (Wellfield #2) W-2O	89	9	28 46 59	81 19 19	35,428	55,348
2-117-0026ANGM3	Sanford (Wellfield #2) W-2P	89	9	28 46 53	81 19 19	35,428	55,348
2-117-0026ANGM3	Sanford (Wellfield #2) W-2Q	89	8	28 46 47	81 19 20	0	55,348
2-117-0026ANGM3	Sanford (Wellfield #2) W-2R	89	8	28 46 41	81 19 19	0	55,348
2-117-0026ANGM3	Sanford (Wellfield #1, wells A–E, G–L)	90	11	28 45 50	81 17 00	24,3315	126,471
2-117-0026ANGM3	Sanford (Wellfield #1, W-1F)	90	10	28 45 25	81 17 16	0	0
2-117-0036AN	Margaret C. Cammack	88	7	28 47 48	81 21 18	3,009	4,026

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft³/day)	2010 Withdrawal (ft³/day)
2-117-0036AN	Margaret C. Cammack	88	7	28 47 48	81 21 18	3,009	4,026
2-117-0037ANF	Seminole County (Heathrow)	89	5	28 45 52	81 21 40	41,784	249,581
2-117-0051AN	Florida Mining & Materials	89	11	28 47 28	81 17 32	3,882	3,882
2-117-0053ANGM	Lake Mary /7	89	7	28 46 45	81 20 49	0	107,345
2-117-0053ANGM	Lake Mary /6	89	7	28 46 34	81 20 49	0	107,345
2-117-0053ANGM	Lake Mary /5	89	7	28 46 22	81 20 49	66,845	107,345
2-117-0053ANGM	Lake Mary /4	89	7	28 46 11	81 20 49	0	107,345
2-117-0053ANGM	Lake Mary /3	89	7	28 46 02	81 20 49	0	107,345
2-117-0053ANGM	Lake Mary /1	89	6	28 45 51	81 21 09	0	107,345
2-117-0053ANGM	Lake Mary /2	89	6	28 45 45	81 20 49	0	107,345
2-117-0118AN	Utilities of Florida (Crystal Lake)	89	9	28 47 06	81 18 52	4,230	9,625
2-117-0118ANRM	Utilities of Florida (Phillips)	89	9	28 46 31	81 18 56	4,230	2,807
2-117-0120AN	Utilities of Florida (Ravenna Park)	89	10	28 47 21	81 18 13	16,150	16,042
2-117-0121ANRM	Utilities of Florida (Park Ridge)	90	10	28 45 19	81 17 56	0	3,075
2-117-0179AUFMRG	Seminole County (Lake Monroe Utilities)	87	9	28 48 50	81 19 55	17,468	38,767
2-117-0181AN	B. Jaffe and B. Tresser	87	8	28 48 26	81 21 03	3,313	4,432
2-117-0181AN	B. Jaffe and B. Tresser	87	8	28 48 25	81 21 02	3,313	4,432
—	Twelve Oaks Mobile Home Park	86	8	28 49 23	81 21 29	0	4,011
—	Town & Country Mobile Home Park	86	6	28 48 46	81 22 17	0	2,005
—	United Tech-Stromberg-Carlson	89	6	28 46 16	81 21 03	5,749	10,829
2-127-0011	De Land: No construction as of 7/93	68	23	29 01 20	81 19 00	0	0
2-127-0011	De Land: 1990 construction	68	25	29 01 15	81 17 59	0	113,596
2-127-0011	De Land: 1990 construction	65	25	29 01 13	81 17 59	0	113,596
2-127-0011AUGM3F	De Land, Well 7	66	26	29 03 12	81 18 22	82,660	113,596
2-127-0011AUGM3F	De Land, Well 5	67	23	29 02 17	81 19 11	82,660	113,596
2-127-0011AUGM3F	De Land, Well 6	67	26	29 02 06	81 17 22	82,660	113,596
2-127-0011AUGM3F	De Land, Well 8	67	22	29 01 56	81 19 27	82,660	113,596
2-127-0011AUGM3F	De Land, Well 3	67	24	29 01 54	81 18 35	82,660	113,596
2-127-0011AUGM3F	De Land, Well 4	68	24	29 01 54	81 18 34	82,660	113,596
2-127-0011AUGM3F	De Land, Well 2	68	24	29 01 39	81 18 24	82,660	113,596

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 37	81 02 44	2,275	2,674
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 36	81 02 56	2,275	2,674
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 33	81 02 50	2,275	2,674
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 30	81 03 12	2,275	2,674
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 30	81 02 48	2,275	2,674
2-127-0028AU	Holly Hill, Eastern Wellfield	53	43	29 14 26	81 02 46	2,275	2,674
2-127-0028AU	Holly Hill, Western Wellfield	53	40	29 13 04	81 07 13	19,496	23,396
2-127-0028AU	Holly Hill, proposed	54	41	29 13 00	81 07 00	0	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 59	81 07 07	19,496	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 52	81 07 01	19,496	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 50	81 07 06	19,496	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 47	81 06 53	19,496	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 46	81 07 10	19,496	23,396
2-127-0028AU	Holly Hill, Western Wellfield	54	40	29 12 41	81 07 13	19,496	23,396
2-127-0032	Volusia County: Indian Lake Government Complex	61	39	29 08 25	81 08 39	13,168	20,819
2-127-0032	Volusia County: Indian Lake Government Complex	61	39	29 08 23	81 08 38	13,168	20,819
2-127-0044AU	Orange City Country Village	77	25	28 56 29	81 15 46	18,717	51,782
2-127-0086ANM	Sugar Mill Estates: 1990 construction	76	42	29 02 36	80 58 57	0	3,609
2-127-0086ANM	Sugar Mill Estates: 1990 construction	76	42	29 02 33	80 58 56	0	3,609
2-127-0086ANM	Southern States Utilities: Sugar Mill Estates	76	42	29 02 28	80 58 51	3,214	3,609
2-127-0086ANM	Southern States Utilities: Sugar Mill Estates	76	42	29 02 26	80 58 49	3,214	3,609
2-127-0086ANM	Southern States Utilities: Sugar Mill Estates	76	42	29 02 26	80 58 47	3,214	3,609
2-127-0086ANM	Southern States Utilities: Sugar Mill Estates	76	42	29 02 25	80 58 51	3,214	3,609
2-127-0086ANM	Sugar Mill Estates: 1990 construction	76	42	29 02 22	80 58 47	0	3,609
2-127-0086ANM	Sugar Mill Estates: 1990 construction	76	42	29 02 21	80 58 49	0	3,609
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 47	81 02 05	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 47	81 02 03	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 47	81 01 54	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 47	81 01 49	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 47	81 01 45	4,093	9,225

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 45	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 40	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	65	42	29 08 35	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	66	42	29 08 20	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	66	42	29 08 15	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	66	42	29 08 13	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	66	42	29 08 10	81 01 40	4,093	9,225
2-127-0092ANGM	Port Orange, Eastern Wellfield	66	42	29 08 09	81 01 46	4,093	9,225
2-127-0092ANGM	Port Orange, Western Wellfield	65	39	29 06 41	81 07 54	0	38,012
2-127-0092ANGM	Port Orange, proposed	65	38	29 06 30	81 08 40	0	38,012
2-127-0092ANGM	Port Orange, proposed	65	38	29 06 30	81 08 40	0	38,012
2-127-0092ANGM	Port Orange, proposed	65	38	29 06 30	81 08 40	0	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 06 15	81 08 16	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	65	38	29 06 14	81 08 39	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 06 04	81 08 17	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	39	29 06 02	81 07 55	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 06 01	81 08 33	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 05 54	81 08 16	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 05 50	81 08 38	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 05 43	81 08 14	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	67	38	29 05 41	81 07 58	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	66	38	29 05 39	81 08 36	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	67	38	29 05 38	81 07 59	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	67	38	29 05 31	81 07 54	35,471	38,012
2-127-0092ANGM	Port Orange, proposed	67	38	29 05 25	81 08 15	0	38,012
2-127-0092ANGM	Port Orange, proposed	67	38	29 05 25	81 08 15	0	38,012
2-127-0092ANGM	Port Orange, proposed	67	38	29 05 25	81 08 15	0	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	67	38	29 05 25	81 07 58	35,471	38,012
2-127-0092ANGM	Port Orange, Western Wellfield	67	38	29 05 21	81 07 54	35,471	38,012
2-127-0092ANGM	Port Orange, proposed C22	68	38	29 04 27	81 08 37	0	38,012

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0092ANGM	Port Orange, proposed C23	68	38	29 04 21	81 08 33	0	38,012
2-127-0092ANGM	Port Orange, proposed C31	68	38	29 04 20	81 07 55	0	38,012
2-127-0092ANGM	Port Orange, proposed C24	68	38	29 04 08	81 08 23	0	38,012
2-127-0092ANGM	Port Orange, proposed C30	69	38	29 04 05	81 08 10	0	38,012
2-127-0092ANGM	Port Orange, proposed C25	69	38	29 03 55	81 08 20	0	38,012
2-127-0092ANGM	Port Orange, proposed C29	69	38	29 03 48	81 07 50	0	38,012
2-127-0092ANGM	Port Orange, proposed C26	69	38	29 03 47	81 08 30	0	38,012
2-127-0092ANGM	Port Orange, proposed C28	69	38	29 03 40	81 08 10	0	38,012
2-127-0093AN	Deltona /17	78	26	28 56 33	81 10 53	48,508	107,379
2-127-0093AN	Deltona /18	78	26	28 56 32	81 10 51	48,508	107,379
2-127-0093AN	Deltona /15	79	24	28 56 31	81 10 53	48,508	107,379
2-127-0093AN	Deltona /19	78	31	28 55 47	81 15 15	48,508	107,379
2-127-0093AN	Deltona /4	81	26	28 55 23	81 14 37	48,508	107,379
2-127-0093AN	Deltona /20	78	31	28 55 20	81 11 27	48,508	107,379
2-127-0093AN	Deltona /1&2	83	27	28 54 19	81 15 25	48,508	107,379
2-127-0093AN	Deltona /8	81	26	28 54 04	81 15 25	48,508	107,379
2-127-0093AN	Deltona /6	81	26	28 54 03	81 15 27	48,508	107,379
2-127-0093AN	Deltona /3	81	26	28 53 59	81 16 17	48,508	107,379
2-127-0093AN	Deltona /14	80	24	28 53 52	81 14 12	48,508	107,379
2-127-0093AN	Deltona /16	79	30	28 53 48	81 14 10	48,508	107,379
2-127-0093AN	Deltona /9	80	22	28 53 48	81 14 10	48,508	107,379
2-127-0093AN	Deltona /12	80	24	28 53 42	81 14 07	48,508	107,379
2-127-0093AN	Deltona /21	78	31	28 52 32	81 10 45	48,508	107,379
2-127-0093AUNM	Deltona post-1988 /36	80	30	28 57 37	81 11 20	0	107,379
2-127-0093AUNM	Deltona /24	86	29	28 57 36	81 11 21	48,508	107,379
2-127-0093AUNM	Deltona post-1988 /35	79	24	28 57 04	81 12 50	0	107,379
2-127-0093AUNM	Deltona post-1988 /28	84	28	28 56 34	81 11 56	0	107,379
2-127-0093AUNM	Deltona /23	86	29	28 56 21	81 13 28	48,508	107,379
2-127-0093AUNM	Deltona /10	84	28	28 55 16	81 10 59	48,508	0
2-127-0093AUNM	Deltona post-1988 /34	80	24	28 54 17	81 15 24	0	107,379

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft³/day)	2010 Withdrawal (ft³/day)
2-127-0093AUNM	Deltona post-1988 /27	83	26	28 54 06	81 15 28	0	107,379
2-127-0093AUNM	Deltona post-1988 /25	86	28	28 54 00	81 16 18	0	107,379
2-127-0093AUNM	Deltona post-1988 /33	79	22	28 53 31	81 14 38	0	107,379
2-127-0093AUNM	Deltona /5	77	31	28 53 00	81 13 27	48,508	0
2-127-0093AUNM	Deltona post-1988 /38	78	30	28 52 57	81 12 16	0	107,379
2-127-0093AUNM	Deltona /22	85	26	28 52 57	81 12 12	48,508	107,379
2-127-0093AUNM	Deltona post-1988 /32	84	28	28 52 54	81 12 14	0	107,379
2-127-0093AUNM	Deltona post-1988 /40	77	31	28 52 48	81 14 15	0	107,379
2-127-0093AUNM	Deltona post-1988 /39	77	29	28 52 34	81 11 37	0	107,379
2-127-0093AUNM	Deltona post-1988 /37	78	28	28 52 34	81 10 42	0	107,379
2-127-0093AUNM	Deltona post-1988 /30	81	25	28 51 28	81 13 20	0	107,379
2-127-0146AN	Spruce Creek, proposed	69	41	29 04 53	81 02 52	0	10,738
2-127-0146AN	Spruce Creek	69	41	29 04 50	81 02 57	21,644	10,738
2-127-0146AN	Spruce Creek, proposed	69	41	29 04 48	81 02 59	0	10,738
2-127-0146AN	Spruce Creek	69	41	29 04 44	81 03 04	21,644	10,738
2-127-0146AN	Spruce Creek, proposed	69	41	29 04 42	81 03 06	0	10,738
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	72	38	29 01 28	81 07 13	0	58,752
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	72	38	29 01 24	81 07 09	0	58,752
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	72	38	29 01 20	81 07 04	0	58,752
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	72	38	29 01 18	81 07 14	0	58,752
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	73	38	29 01 05	81 07 15	0	58,752
2-127-0214ANG	New Smyrna, proposed SR 44 wellfield	73	38	29 01 04	81 07 09	0	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	75	39	29 00 52	81 05 30	39,708	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	75	39	29 00 48	81 05 23	39,708	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	76	39	29 00 43	81 05 09	39,708	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	76	39	29 00 40	81 05 02	39,708	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	76	39	29 00 36	81 04 51	39,708	58,752
2-127-0214ANG	New Smyrna, Samsula Wellfield	76	39	29 00 36	81 04 35	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 52	80 57 48	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 52	80 57 39	39,708	58,752

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	43	28 59 52	80 57 30	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 44	80 57 48	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 44	80 57 39	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 44	80 57 30	39,708	58,752
2-127-0214ANG	New Smyrna, Glencoe Wellfield	80	42	28 59 36	80 57 39	39,708	58,752
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	42	29 11 30	81 04 07	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	42	29 11 26	81 04 17	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	41	29 11 22	81 04 40	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	42	29 11 22	81 04 25	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	41	29 11 17	81 04 48	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	41	29 11 14	81 04 55	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St., inactive	58	41	29 11 09	81 05 10	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St. /45	58	41	29 11 06	81 05 16	78,513	201,872
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St. /46	58	41	29 11 02	81 05 25	78,513	161,497
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St. /47	58	41	29 10 57	81 05 40	78,513	161,497
2-127-0320ANG	Daytona Beach, proposed	56	39	29 10 50	81 09 22	0	0
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St. /48	58	40	29 10 46	81 06 36	78,513	232,219
2-127-0320ANG	Daytona Beach, West Wellfield—Brennan/2	58	40	29 10 42	81 07 11	124,789	235,695
2-127-0320ANG	Daytona Beach, East Wellfield—Marion St. /49	58	40	29 10 41	81 06 44	78,513	201,872
2-127-0320ANG	Daytona Beach, proposed	57	39	29 10 40	81 09 19	0	0
2-127-0320ANG	Daytona Beach, West Wellfield—Brennan/1	58	40	29 10 34	81 07 00	124,789	196,390
2-127-0320ANG	Daytona Beach, proposed	57	39	29 10 30	81 09 16	0	0
2-127-0320ANG	Daytona Beach, proposed	57	39	29 10 20	81 09 13	0	0
2-127-0320ANG	Daytona Beach, proposed	57	39	29 10 10	81 09 10	0	0
2-127-0320ANG	Daytona Beach, Western Wellfield /21	58	39	29 09 56	81 09 25	0	64,171
2-127-0320ANG	Daytona Beach, Western Wellfield /20	58	39	29 09 52	81 09 12	0	108,957
2-127-0320ANG	Daytona Beach, Western Wellfield /19	58	39	29 09 41	81 09 13	0	108,957
2-127-0320ANG	Daytona Beach, Western Wellfield /18	59	39	29 09 31	81 09 11	0	54,144
2-127-0320ANG	Daytona Beach, Western Wellfield /17	59	39	29 09 23	81 09 13	0	199,332
2-127-0320ANG	Daytona Beach, Western Wellfield /16	59	39	29 09 16	81 09 11	0	110,963

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0320ANG	Daytona Beach, Western Wellfield /15	59	39	29 09 10	81 09 23	0	41,176
2-127-0320ANG	Daytona Beach, Western Wellfield /14	60	39	29 09 03	81 08 58	0	35,695
2-127-0320ANG	Daytona Beach, Western Wellfield /13	60	39	29 08 58	81 08 51	0	70,455
2-127-0320ANG	Daytona Beach, Western Wellfield /12	61	39	29 08 49	81 08 47	0	73,663
2-127-0320ANG	Daytona Beach, Western Wellfield /11	61	39	29 08 40	81 08 47	124,789	84,893
2-127-0320ANG	Daytona Beach, Western Wellfield /10	61	39	29 08 32	81 08 41	124,789	42,246
2-127-0320ANG	Daytona Beach, Western Wellfield /3	61	39	29 08 30	81 07 47	124,789	36,096
2-127-0320ANG	Daytona Beach, Western Wellfield /4	61	39	29 08 28	81 07 52	124,789	62,299
2-127-0320ANG	Daytona Beach, Western Wellfield /5	61	39	29 08 24	81 08 03	124,789	63,503
2-127-0320ANG	Daytona Beach, Western Wellfield /9	61	39	29 08 21	81 08 36	124,789	44,519
2-127-0320ANG	Daytona Beach, Western Wellfield /6	61	39	29 08 21	81 08 12	124,789	65,241
2-127-0320ANG	Daytona Beach, Western Wellfield /7	61	39	29 08 16	81 08 24	124,789	28,610
2-127-0320ANG	Daytona Beach, Western Wellfield /8	61	39	29 08 13	81 08 33	124,789	54,412
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 39	81 09 02	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 32	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 29	81 04 03	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 27	81 04 07	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 23	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 22	81 03 54	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 21	81 03 53	30,159	35,963
2-127-0348ANGM3	Ormond Beach, SR 40 Wellfield	48	42	29 16 17	81 06 02	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 15	81 09 02	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	42	29 16 15	81 04 33	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 14	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 12	81 04 05	30,159	35,963
2-127-0348ANGM3	Ormond Beach, SR 40 Wellfield	48	42	29 16 11	81 05 58	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 10	81 04 03	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 09	81 04 07	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 06	81 09 02	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	42	29 16 06	81 04 29	30,159	35,963

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 16 05	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	43	29 16 05	81 03 59	30,159	35,963
2-127-0348ANGM3	Ormond Beach, SR 40 Wellfield	48	42	29 16 02	81 06 09	84,893	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	42	29 16 01	81 04 35	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Division Avenue	49	42	29 15 59	81 04 42	30,159	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 57	81 09 39	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 57	81 09 30	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 57	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 57	81 09 07	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 48	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, Hudson Wellfield	47	40	29 15 39	81 09 19	0	35,963
2-127-0348ANGM3	Ormond Beach, SR 40 Wellfield	49	41	29 15 28	81 06 46	84,893	35,963
2-127-0348ANGM3	Ormond Beach, SR 40 Wellfield	49	41	29 15 24	81 07 08	84,893	35,963
2-127-0348ANGM3	Ormond Beach, Rima Ridge	49	39	29 13 37	81 11 04	0	35,963
2-127-0348ANGM3	Ormond Beach, Rima Ridge	50	39	29 13 25	81 11 02	0	35,963
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	52	34	29 11 20	81 15 06	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	52	35	29 11 17	81 14 03	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	52	34	29 11 11	81 14 54	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	35	29 11 08	81 14 00	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	52	34	29 11 03	81 14 44	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	36	29 10 58	81 13 45	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	35	29 10 57	81 14 08	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	35	29 10 56	81 13 58	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	35	29 10 55	81 14 20	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	34	29 10 50	81 14 40	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	34	29 10 35	81 14 39	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	54	33	29 10 25	81 15 02	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	53	32	29 10 24	81 15 25	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	54	33	29 10 22	81 15 12	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	54	34	29 10 19	81 14 38	0	0

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	54	32	29 10 10	81 15 27	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	55	34	29 10 08	81 14 38	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	55	32	29 09 55	81 15 29	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	55	34	29 09 53	81 14 38	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	55	32	29 09 45	81 15 30	0	0
2-127-0348ANGM3	Ormond Beach, proposed Central Wellfield	55	33	29 09 45	81 14 38	0	0
2-127-0387AN	John Knox Village	76	22	28 56 46	81 17 10	2,106	6,684
2-127-0387AN	John Knox Village	76	22	28 56 45	81 17 15	2,106	6,684
2-127-0387AN	John Knox Village	76	22	28 56 45	81 17 14	2,106	6,684
2-127-0392AUNM	The Duval Home	59	22	29 05 15	81 21 16	6,090	9,625
2-127-0393ANR	The Duval Home	59	25	29 05 53	81 20 07	0	2,540
2-127-0393ANR	The Duval Home	59	26	29 05 48	81 19 47	0	2,540
2-127-0399AU	Florida Mining & Materials, Plant 3	61	43	29 10 26	81 01 39	571	903
2-127-0400AN	Florida Mining & Materials, Plant 1	55	43	29 13 45	81 02 14	2,095	3,312
2-127-0420AN	Volusia County, West Orange City /11	75	16	28 56 27	81 19 36	0	1,260
2-127-0420AN	Volusia County, Orange County Industrial Park /1	77	21	28 56 00	81 17 43	4,724	4,724
2-127-0420AN	Volusia County, Breezewood North /2	77	20	28 55 46	81 17 55	0	0
2-127-0420AN	Volusia County, Four Towns /5	77	19	28 55 21	81 17 58	52,994	84,633
2-127-0420AN	Volusia County, Breezewood South /3	77	21	28 55 21	81 17 35	19,030	21,438
2-127-0420AN	Volusia County, Terra Alta /5	78	17	28 54 45	81 18 17	4,834	7,178
2-127-0420AN	Volusia County, Highland Country Estate /9	78	17	28 54 43	81 18 27	7,120	30,999
2-127-0420AN	Volusia County, Glen Abbey /8	79	19	28 54 14	81 17 32	16,197	51,226
2-127-0420AN	Volusia County, Glen Abbey /7	79	19	28 54 14	81 17 28	16,197	51,226
2-127-0420AN	Volusia County, Lake Marie #2	79	16	28 53 49	81 18 43	9,357	16,959
2-127-0420AN	Volusia County, Lake Marie #1	79	16	28 53 48	81 18 44	9,357	16,959
2-127-0420ANG	Volusia County	74	18	28 57 09	81 18 58	8,725	13,794
2-127-0420ANG	Volusia County Highland Country Estate /10	78	17	28 54 43	81 18 29	7,120	30,999
2-127-0421	De Land, Brandywine	62	26	29 04 41	81 19 06	61,600	56,139
2-127-0422AN	De Land, Spring Garden	62	25	29 04 27	81 19 28	1,721	1,497
2-127-0422AN	De Land, Spring Garden	62	25	29 04 27	81 19 26	1,721	1,497

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0424AN	De Land, Longleaf Plantation	70	26	28 59 45	81 16 54	16,041	17,723
2-127-0425AN	De Land, Tomoka Woods	55	30	29 09 08	81 16 24	1,575	1,804
2-127-0426	De Land, Woodland Manor	60	26	29 05 26	81 19 15	7,801	11,125
2-127-0427AN	De Land, Glenwood Estates	62	23	29 04 26	81 20 00	2,088	2,346
2-127-0428AN	De Land, Holiday Hills	69	22	29 00 06	81 19 01	3,259	3,555
2-127-0428AN	De Land, Holiday Hills	69	22	29 00 03	81 19 02	3,259	3,555
2-127-0433AN	Lake Helen Villa	74	30	28 59 03	81 13 04	6,103	4,679
2-127-0475AUMF	North Macmillan	69	13	28 59 36	81 21 54	211	0
2-127-0513AN	Edgewater	82	43	28 58 55	80 56 08	18,650	47,390
2-127-0513AN	Edgewater	82	43	28 58 52	80 56 15	18,650	47,390
2-127-0513AN	Edgewater	82	43	28 58 50	80 56 21	18,650	47,390
2-127-0513AN	Edgewater	82	43	28 58 49	80 56 28	18,650	47,390
2-127-0513AN	Edgewater	82	43	28 58 48	80 56 33	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 12	80 56 51	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 03	80 56 47	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 01	80 57 36	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 01	80 57 29	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 00	80 57 45	18,650	47,390
2-127-0513AN	Edgewater	86	42	28 57 00	80 57 40	18,650	47,390
2-127-0515AU	FPL Lake Monroe	82	20	28 52 27	81 16 19	4,228	6,685
2-127-0515AU	FPL Lake Monroe	82	20	28 52 20	81 16 24	4,228	6,685
2-127-0515AU	FPL Lake Monroe	83	20	28 52 09	81 16 25	4,228	6,685
2-127-0518AN	Falcon Development, Pine Run	42	42	29 19 44	81 07 00	0	0
2-127-0522AU	Volusia County Agricultural Center	70	30	29 01 03	81 13 22	1,070	3,676
2-127-0522AU	Volusia County Agricultural Center	70	30	29 00 50	81 13 33	0	3,676
2-127-0526AU	Sherwood Medical Company	66	28	29 03 42	81 15 52	10,428	16,576
2-127-0526AU	Sherwood Medical Company	66	28	29 03 36	81 16 00	10,428	16,576
2-127-0526AU	Sherwood Medical Company	66	28	29 03 33	81 15 59	0	0
2-127-0544AU	Howard S. Dorr	89	31	28 50 50	81 08 33	2,409	2,183
2-127-0545AU	Florida Power & Light, Sanford Power Plant	77	16	28 54 45	81 18 55	10,528	19,892

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0545AU	Florida Power & Light, Sanford Power Plant	78	16	28 54 45	81 18 51	10,528	19,892
2-127-0545AU	Florida Power & Light, Sanford Power Plant	81	12	28 51 57	81 19 08	10,528	19,892
2-127-0545AU	Florida Power & Light, Sanford Power Plant	81	12	28 51 52	81 19 08	10,528	19,892
2-127-0548AU	West Volusia Memorial Hospital	66	24	29 02 39	81 19 07	7,325	2,313
2-127-0549AU	Methodist Childrens Home	83	22	28 52 17	81 15 26	6,410	4,812
2-127-0549AU	Methodist Childrens Home	84	22	28 52 06	81 15 49	0	4,812
2-127-0564AN	Tymber Creek Utilities	48	41	29 15 57	81 07 38	12,232	23,963
2-127-0591ANV	Culligan Water Cond.	70	23	28 59 33	81 18 04	2,564	2,564
2-127-0608ANG	Pierson-Taylor High School	36	16	29 14 47	81 27 35	3,095	9,759
2-127-0608ANG	Pierson-Taylor High School	36	15	29 14 41	81 27 49	3,095	9,759
2-127-0608ANGM	Town of Pierson	36	15	29 14 47	81 27 47	0	19,868
2-127-0608ANGM	Town of Pierson	36	15	29 14 47	81 27 45	0	19,868
2-127-0613AN	The Trails Inc.	48	40	29 15 37	81 08 49	42,718	77,424
2-127-0646AN	Lake Helen	72	29	28 59 29	81 14 01	12,620	38,466
2-127-0646AN	Lake Helen	74	29	28 58 41	81 13 51	0	38,466
2-127-0646AN	Lake Helen	74	28	28 58 37	81 13 57	17,103	0
2-127-0648AUSG	Florida Department of Education	57	42	29 12 28	81 03 03	1,905	3,011
2-127-0662AN	Hacienda Del Rio	88	44	28 55 35	80 52 55	23,768	13,606
2-127-0670AUVM2	Ardmore Farms	64	27	29 04 06	81 18 10	0	9,488
2-127-0670AUVM2	Ardmore Farms	64	27	29 04 03	81 18 14	2,005	9,488
2-127-0670AUVM2	Ardmore Farms	64	27	29 04 00	81 18 15	0	9,488
2-127-0674ANV	Orange City /3	75	21	28 56 42	81 17 54	22,594	122,185
2-127-0674ANV	Orange City /2	75	21	28 56 40	81 17 54	22,594	122,185
2-127-0674ANV	Orange City /1 and 4	75	21	28 56 36	81 17 55	22,594	244,367
2-127-0684ANV	Sunshine Holiday Park	37	41	29 20 40	81 08 19	9,314	16,882
2-127-0690ANG	Volusia County—Deltona North DW-1	77	27	28 56 59	81 14 19	6,602	18,687
2-127-0690ANG	Volusia County—Deltona North PSW3	77	27	28 56 47	81 14 33	0	0
2-127-0690ANG	Volusia County—Deltona North PSW2	77	27	28 56 40	81 14 44	971	10,588
2-127-0690ANG	Volusia County—Deltona North PSW1	77	27	28 56 37	81 14 43	1,970	21,798
2-127-0747AUVG	De Land High School	67	27	29 02 25	81 17 13	1,337	446

Table C1—*Continued*

CUP Number	Wellfield Name/Well Number	Row	Column	Latitude	Longitude	1988 Withdrawal (ft^3/day)	2010 Withdrawal (ft^3/day)
2-127-0751AN	Florida Mining & Materials	67	17	29 01 10	81 21 21	267	423
2-127-0755AN	Commercial/industrial	49	41	29 15 22	81 06 30	6,684	10,568
2-127-0755AN	Commercial/industrial	49	41	29 15 14	81 06 46	6,684	10,568
2-127-0762AN	Taylor Precast—commercial/industrial	68	17	29 00 53	81 20 59	1,470	2,325
2-127-0767AN	Miller Enterprises	26	15	29 19 00	81 29 33	27	42
2-127-0767AN	Miller Enterprises	26	15	29 18 59	81 29 31	27	42
2-127-0773AUV	Kove Association	89	29	28 50 18	81 10 18	2,139	0
2-127-0773AUV	Kove Association	89	29	28 50 16	81 10 18	2,139	9,424
2-127-0785AN	Square D Co.—household plus comm./industrial	75	43	29 03 19	80 58 15	183	289
2-127-0792AN	Gus Simos—restaurant	41	42	29 19 56	81 07 38	670	1,059
2-127-0793AUV	Lemon Bluff	90	30	28 49 02	81 08 15	3,774	6,839
2-127-0841AN	Rinker Materials	66	23	29 02 00	81 19 08	0	4,100
2-127-0848AN	Saxon Medical Center	78	22	28 54 54	81 16 57	0	4,776
2-127-0848AN	Saxon Medical Center	78	22	28 54 50	81 16 56	0	4,776
2-127-0852AUV	Gemini Springs Ranch	81	14	28 52 09	81 18 38	0	1,691
2-127-0852AUV	Gemini Springs Ranch	82	14	28 51 45	81 18 39	0	1,691
2-127-0855AUV	Volusia County, Cassadaga	75	28	28 58 10	81 14 10	3,342	5,640
2-127-0859AN	Hiatt Auto	54	24	29 08 11	81 21 18	0	359
—	Kingston Shores	33	44	29 23 20	81 05 10	3,369	5,310
—	Tomoka Correctional Facility	58	38	29 09 23	81 09 53	33,181	43,713
—	Deleon Springs State Recreational Area	54	23	29 07 55	81 21 52	546	546
—	L. Beresford Water Association	68	17	29 00 30	81 20 45	21,425	43,875
—	T.G. Lee Dairy	73	25	28 58 06	81 16 41	14,305	14,305
—	FDNR, Blue Spring State Park	74	15	28 56 40	81 20 06	2,139	2,139
					Total (ft^3/day)	9,157,690	17,450,950
					Total (mgd)	68	131

Note: — = no data available
CUP = consumptive use permit
ft^3/day = cubic feet per day
FDNR = Florida Department of Natural Resources
mgd = million gallons per day
SR = state road

Table C2. Agricultural groundwater withdrawals

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-035-0001AUR	Potatoes and corn	AG	4	30	29 35 52	81 27 52		12,226	12,226	0
2-035-0001AUR	Potatoes and corn	AG	4	30	29 35 53	81 27 50		12,226	12,226	0
2-035-0003AUR	Cabbage	AG	29	31	29 20 33	81 20 56		6,248	6,248	0
2-035-0004AU	Cabbage, pasture, sod	AG	30	30	29 19 31	81 20 55		7,790	7,790	0
2-035-0004AU	Cabbage, pasture, sod	AG	30	30	29 19 42	81 20 57		7,790	7,790	0
2-035-0004AU	Cabbage, pasture, sod	AG	30	30	29 19 42	81 20 55		7,790	7,790	0
2-035-0004AU	Cabbage, pasture, sod	AG	30	30	29 19 57	81 20 51		7,790	7,790	0
2-035-0005AU	Cabbage, corn, potatoes	AG	4	30	29 35 44	81 27 55		6,172	6,172	0
2-035-0008AN	Cabbage, watermelons	AG	20	30	29 25 31	81 24 02		7,752	7,752	0
2-035-0009AU	Cabbage, corn, potatoes	AG	20	30	29 25 38	81 23 16		13,270	13,270	0
2-035-0009AU	Cabbage, corn, potatoes	AG	21	31	29 25 38	81 23 02		13,270	13,270	0
2-035-0009AU	Cabbage, corn, potatoes	AG	21	31	29 25 39	81 22 38		13,270	13,270	0
2-035-0009AU	Cabbage, corn, potatoes	AG	20	31	29 25 52	81 22 39		13,270	13,270	0
2-035-0009AU	Cabbage, corn, potatoes	AG	20	31	29 26 04	81 22 38		13,270	13,270	0
2-035-0012AUM2	Potatoes	AG	15	36	29 29 28	81 21 21		12,440	12,440	0
2-035-0013AU	Cabbage, corn, potatoes	AG	17	33	29 28 05	81 22 25		8,229	8,229	0
2-035-0013AU	Cabbage, corn, potatoes	AG	17	33	29 28 05	81 22 18		8,229	8,229	0
2-035-0013AU	Cabbage, corn, potatoes	AG	17	34	29 28 16	81 22 12		8,229	8,229	0
2-035-0013AU	Cabbage, corn, potatoes	AG	17	34	29 28 17	81 22 18		8,229	8,229	0
2-035-0013AU	Cabbage, corn, potatoes	AG	16	34	29 28 42	81 22 28		8,229	8,229	0
2-035-0013AU	Cabbage, corn, potatoes	AG	16	34	29 28 56	81 22 12		8,229	8,229	0
2-035-0014AU	Cabbage, corn, potatoes	AG	17	33	29 28 14	81 22 39		6,172	6,172	0
2-035-0015AU	Cabbage, corn, potatoes	AG	15	31	29 28 54	81 24 24		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	30	29 29 03	81 25 03		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	30	29 29 04	81 24 40		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	31	29 29 04	81 24 22		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	30	29 29 16	81 24 54		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	31	29 29 16	81 24 40		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	31	29 29 16	81 24 37		7,286	7,286	0
2-035-0015AU	Cabbage, corn, potatoes	AG	14	31	29 29 17	81 24 22		7,286	7,286	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-035-0015AU	Cabbage, corn, potatoes	AG	14	31	29 29 28	81 24 31		7,286	7,286	0
2-035-0016AU	Cabbage, corn, potatoes	AG	15	32	29 29 04	81 23 55		6,172	6,172	0
2-035-0019AU	Sod	AG	29	33	29 20 49	81 19 41		4,903	4,903	0
2-035-0019AU	Sod	AG	29	33	29 20 50	81 19 28		4,903	4,903	0
2-035-0020AU	Watermelons	AG	30	26	29 18 35	81 24 43	B	3,208	3,208	0
2-035-0020AU	Watermelons	AG	30	26	29 18 39	81 24 32	A	3,208	3,208	0
2-035-0021AU	Cabbage, corn	AG	32	33	29 19 30	81 18 55		7,173	7,173	0
2-035-0021AU	Cabbage, corn	AG	33	32	29 18 35	81 18 58		7,173	7,173	0
2-035-0021AU	Cabbage, corn	AG	33	32	29 18 51	81 18 56		7,173	7,173	0
2-035-0021AU	Cabbage, corn	AG	32	33	29 19 15	81 18 55		7,173	7,173	0
2-035-0021AU	Cabbage, corn	AG	32	33	29 19 15	81 18 40		7,173	7,173	0
2-035-0021AU	Cabbage, corn	AG	32	33	29 19 30	81 18 41		7,173	7,173	0
2-035-0023AU	Corn, potatoes	AG	18	33	29 27 37	81 22 14		6,286	6,286	0
2-035-0023AU	Corn, potatoes	AG	18	33	29 27 37	81 22 04		6,286	6,286	0
2-035-0023AU	Corn, potatoes	AG	18	33	29 27 50	81 22 11		6,286	6,286	0
2-035-0023AU	Corn, potatoes	AG	18	34	29 28 00	81 22 15		6,286	6,286	0
2-035-0023AU	Corn, potatoes	AG	18	34	29 28 01	81 22 02		6,286	6,286	0
2-035-0024AU	Corn, potatoes	AG	18	34	29 28 15	81 21 46		6,809	6,809	0
2-035-0024AU	Corn, potatoes	AG	18	35	29 28 16	81 21 31		6,809	6,809	0
2-035-0024AU	Corn, potatoes	AG	17	35	29 28 28	81 21 46		6,809	6,809	0
2-035-0025AU	Corn, potatoes	AG	17	32	29 28 13	81 22 59		6,984	6,984	0
2-035-0026AU	Corn, potatoes	AG	17	33	29 28 14	81 22 33		6,984	6,984	0
2-035-0027AU	Corn, potatoes	AG	20	32	29 26 18	81 22 33		6,984	6,984	0
2-035-0028AU	Cabbage, corn	AG	21	30	29 25 25	81 23 17		4,099	4,099	0
2-035-0028AU	Cabbage, corn	AG	21	30	29 25 25	81 23 17		4,099	4,099	0
2-035-0028AU	Cabbage, corn	AG	21	30	29 25 25	81 23 17		4,099	4,099	0
2-035-0032AU	Corn, potatoes	AG	15	32	29 28 56	81 23 12		7,333	7,333	0
2-035-0032AU	Corn, potatoes	AG	15	32	29 29 05	81 23 22		7,333	7,333	0
2-035-0032AU	Corn, potatoes	AG	15	32	29 29 07	81 23 12		7,333	7,333	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-035-0034AU	Corn, potatoes	AG	15	31	29 28 54	81 23 46		4,802	4,802	0
2-035-0034AU	Corn, potatoes	AG	15	32	29 29 07	81 23 41		4,802	4,802	0
2-035-0034AU	Corn, potatoes	AG	15	32	29 29 07	81 23 33		4,802	4,802	0
2-035-0034AU	Corn, potatoes	AG	14	32	29 29 18	81 23 32		4,802	4,802	0
2-035-0035AU	Cabbage, corn	AG	29	34	29 20 52	81 18 56		6,148	6,148	0
2-035-0035AU	Cabbage, corn	AG	31	33	29 19 44	81 18 53		6,148	6,148	0
2-035-0035AU	Cabbage, corn	AG	31	33	29 19 55	81 18 52		6,148	6,148	0
2-035-0035AU	Cabbage, corn	AG	30	34	29 20 21	81 18 34		6,148	6,148	0
2-035-0035AU	Cabbage, corn	AG	30	34	29 20 44	81 18 52		6,148	6,148	0
2-035-0036AU	Potatoes	AG	20	33	29 26 20	81 21 46		3,922	3,922	0
2-035-0036AU	Potatoes	AG	20	34	29 26 20	81 21 20		3,922	3,922	0
2-035-0036AU	Potatoes	AG	20	34	29 26 54	81 21 11		3,922	3,922	0
2-035-0036AU	Potatoes	AG	20	35	29 26 55	81 20 56		3,922	3,922	0
2-035-0036AU	Potatoes	AG	19	36	29 27 22	81 20 42		3,922	3,922	0
2-035-0036AU	Potatoes	AG	19	36	29 27 31	81 20 12		3,922	3,922	0
2-035-0036AU	Potatoes	AG	19	36	29 27 34	81 20 39		3,922	3,922	0
2-035-0036AU	Potatoes	AG	19	36	29 27 37	81 20 20		3,922	3,922	0
2-035-0036AU	Potatoes	AG	19	36	29 27 58	81 20 36		3,922	3,922	0
2-035-0038AU	Corn, potatoes	AG	20	30	29 25 38	81 23 49		3,492	3,492	0
2-035-0038AU	Corn, potatoes	AG	20	30	29 25 49	81 23 49		3,492	3,492	0
2-035-0039AU	Corn, potatoes	AG	20	29	29 25 48	81 24 26		6,984	6,984	0
2-035-0041AU	Potatoes	AG	21	30	29 24 59	81 23 16		20,215	20,215	0
2-035-0041AU	Potatoes	AG	21	30	29 25 10	81 23 26		0	0	0
2-035-0042AU	Cabbage, corn	AG	21	31	29 24 59	81 22 45		6,148	6,148	0
2-035-0042AU	Cabbage, corn	AG	21	31	29 25 16	81 22 36		6,148	6,148	0
2-035-0043AU	Potatoes	AG	19	31	29 26 41	81 22 48		3,110	3,110	0
2-035-0044AU	Corn, potatoes	AG	15	30	29 28 34	81 24 50		8,148	8,148	0
2-035-0044AU	Corn, potatoes	AG	15	30	29 28 36	81 25 06		8,148	8,148	0
2-035-0044AU	Corn, potatoes	AG	15	30	29 28 43	81 25 06		8,148	8,148	0
2-035-0045AU	Corn, potatoes	AG	15	30	29 28 26	81 24 44		6,984	6,984	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-035-0046AU	Corn, potatoes	AG	15	30	29 28 23	81 25 01		8,730	8,730	0
2-035-0046AU	Corn, potatoes	AG	15	30	29 28 23	81 24 43		8,730	8,730	0
2-035-0048AU	Pasture	AG	22	31	29 24 50	81 22 45		0	0	0
2-035-0049AU	Cabbage, corn	AG	21	30	29 24 57	81 23 24		15,370	15,370	0
2-035-0050AU	Cabbage, potatoes	AG	21	30	29 24 44	81 23 19		5,380	5,380	0
2-035-0051AU	Cabbage, potatoes	AG	21	30	29 24 44	81 23 34		5,380	5,380	0
2-035-0052AU	Cabbage, corn	AG	22	30	29 24 30	81 22 57		12,142	12,142	0
2-035-0053AU	Cabbage, potatoes	AG	21	30	29 25 10	81 23 49		5,964	5,964	0
2-035-0054AU	Cabbage, corn	AG	20	29	29 25 49	81 24 57		16,433	16,433	0
2-035-0054AU	Cabbage, corn	AG	19	29	29 26 14	81 24 42		16,433	16,433	0
2-035-0058AUS	Pasture, vegetables	AG	28	31	29 21 01	81 20 56		6,165	6,165	0
2-035-0058AUS	Pasture, vegetables	AG	29	31	29 20 38	81 20 55		6,165	6,165	0
2-035-0065ANV	Golf course	AG	28	44	29 25 49	81 06 24		6,352	6,352	0
2-035-0065ANV	Golf course	AG	28	44	29 25 47	81 06 27		6,352	6,352	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 38	81 29 53	A	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 37	81 29 52	B	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 36	81 29 51	C	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 35	81 29 58	D	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 34	81 29 56	E	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 32	81 29 55	F	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 31	81 29 54	G	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 30	81 29 53	H	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 30	81 29 59	I	2,255	1,879	0
2-035-0068ANM	Sod—Trivett	AG	8	26	29 30 30	81 29 59	L	2,255	1,879	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	34	30	29 18 01	81 20 10		5,157	5,157	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	36	30	29 17 23	81 19 48		5,157	5,157	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	35	30	29 17 42	81 20 07		5,157	5,157	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	35	31	29 17 42	81 19 43		5,157	5,157	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	35	31	29 17 50	81 19 25		5,157	5,157	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	34	30	29 17 52	81 20 24		5,157	5,157	0
2-035-0070AUV	Sod, trees—Skinner Wholesale Nursery	AG	34	31	29 17 54	81 19 49		5,157	5,157	0
2-035-FLAGLER	Broccoli, corn	AG	16	30	29 28 12	81 25 01		18,600	18,600	0
2-069-0224AN	Fern	FG	65	6	29 00 21	81 27 21		1,870	1,870	105,880
2-069-0318AU	Fern	FG	72	6	28 55 43	81 25 30		1,309	1,309	74,116
2-069-0587AU	Fern	FS	76	1	28 53 10	81 28 11		3,365	3,365	190,584
2-069-0605AU	Fern	FG	45	2	29 09 13	81 34 10		748	748	42,352
2-069-0761AUSF	Fern	FG	75	1	28 53 09	81 28 56		2,617	2,617	148,232
2-069-0773ANS	Fern	FS	75	5	28 54 12	81 25 41		1,870	1,870	105,880
2-069-0773ANS	Fern	FS	75	4	28 54 22	81 25 56		1,870	1,870	105,880
2-069-0773ANS	Fern	FS	75	4	28 54 22	81 25 53		1,870	1,870	105,880
2-069-0774ANS	Fern	FS	45	2	29 09 26	81 34 33		467	467	26,470
2-069-0775AUSF	Fern	FG	69	6	28 58 02	81 26 18		280	280	15,882
2-069-0794AUS	Fern	FG	76	1	28 52 43	81 28 07		5,609	5,609	317,640
2-069-0799ANV	Fern	FG	69	7	28 58 19	81 25 46		374	374	21,176
2-069-0894AN	Fern	FG	72	6	28 55 38	81 25 24		7,478	7,478	423,520
2-069-0894AN	Fern	FG	72	6	28 55 39	81 25 12		7,478	7,478	423,520
2-069-0894AN	Fern	FG	72	6	28 55 43	81 25 24		7,478	7,478	423,520
2-107-0002AN	Fern	FG	20	16	29 23 46	81 31 08		1,496	1,496	84,704
2-107-0004AUM2	Nursery	AG	21	18	29 22 51	81 29 51		92,243	92,243	0
2-107-0004AUM2	Nursery	AG	21	19	29 22 58	81 29 37		92,243	92,243	0
2-107-0004AUM2	Nursery	AG	21	19	29 23 20	81 29 47		92,243	92,243	0
2-107-0004AUM2	Skinner's Nursery	AG	21	18	29 22 51	81 29 51		16,610	16,610	0
2-107-0004AUM2	Skinner's Nursery	AG	21	19	29 22 58	81 29 37		16,610	16,610	0
2-107-0004AUM2	Skinner's Nursery	AG	21	19	29 23 20	81 29 47		16,610	16,610	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-107-0004AUM2	Skinner's Nursery	AG	20	20	29 24 09	81 29 58		16,610	16,610	0
2-107-0006AUM3	Radtke Ferneries	FS	17	15	29 25 10	81 32 02	A	0	1,246	70,587
2-107-0007AUR	Fern	FG	20	16	29 23 11	81 30 46	A	0	1,122	63,528
2-107-0008ANR	Fern	FG	21	16	29 22 23	81 30 28	A	5,609	5,609	317,640
2-107-0012ANM	Fern	FS	10	7	29 26 45	81 37 28	A	0	623	35,293
2-107-0012ANM	Fern	FS	10	7	29 26 45	81 37 53	C	0	623	35,293
2-107-0012ANM	Fern	FS	10	7	29 26 45	81 37 28	E	0	623	35,293
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 57	81 37 51	A	0	608	34,411
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 57	81 37 43	B	0	608	34,411
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 55	81 37 38	C	972	608	34,411
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 57	81 37 26	D	972	608	34,411
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 49	81 37 46	E	972	608	34,411
2-107-0013ANM	Morris Ferneries	FG	10	7	29 26 47	81 38 03	F	0	608	34,411
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 57	81 37 50	A	2,991	2,493	141,173
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 57	81 37 43	B	2,991	2,493	141,173
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 55	81 37 38	C	2,991	2,493	141,173
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 57	81 37 26	D	2,991	2,493	141,173
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 50	81 37 46	E	2,991	2,493	141,173
2-107-0014AN	Morris Ferneries	FG	10	7	29 26 55	81 38 02	F	0	2,493	141,173
2-107-0015AU	Morris Ferneries	FG	12	6	29 25 49	81 38 07	A	374	374	0
2-107-0015AU	Morris Ferneries	FG	12	6	29 25 48	81 38 07	B	374	374	0
2-107-0015AU	Morris Ferneries	FG	12	6	29 25 45	81 38 06	C	374	374	0
2-107-0015AU	Morris Ferneries	FG	12	6	29 25 53	81 37 55	D	374	374	0
2-107-0016AN	Morris Ferneries	FG	11	7	29 26 33	81 37 52	A	1,870	1,870	105,880
2-107-0016AN	Morris Ferneries	FG	11	7	29 26 32	81 37 58	B	1,870	1,870	105,880
2-107-0017AU	Richardson Fernery	FG	15	9	29 25 19	81 35 06	A	2,493	2,493	141,173
2-107-0017AU	Richardson Fernery	FG	15	9	29 25 15	81 35 00	B	2,493	2,493	141,173
2-107-0017AU	Richardson Fernery	FG	15	9	29 25 12	81 35 03	C	2,493	2,493	141,173
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 30	81 31 33	A	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 07	81 31 30	A	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 08	81 31 33	B	2,692	2,375	134,530

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 04	81 31 26	C	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 34	81 31 28	D	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 06	81 31 28	E	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 01	81 31 25	F	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	12	20	29 28 10	81 31 34	G	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 41	81 31 45	H	0	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 32	81 31 40	I	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 24	81 31 33	J	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 27	81 31 27	L	2,692	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	13	19	29 27 26	81 31 41	M	0	2,375	134,530
2-107-0018ANM	Forest Groves—Newbold	FS	11	20	29 28 13	81 31 40	N	2,692	2,375	134,530
2-107-0019AU	Fern	FG	14	16	29 26 42	81 32 17	A	3,739	3,739	211,760
2-107-0020AU	Fern	FG	14	18	29 26 48	81 31 37	A	2,617	2,617	148,232
2-107-0022AU	Fern	FG	10	7	29 26 39	81 38 01	A	748	748	42,352
2-107-0025AU	Smiley Nursery	AG	19	17	29 24 25	81 30 51	A	2,406	4,812	0
2-107-0025AU	Smiley Nursery	AG	19	17	29 24 23	81 30 57	B	2,406	0	0
2-107-0026AN	Potatoes	AG	22	22	29 22 50	81 28 43	A	1,037	1,037	0
2-107-0026AN	Potatoes	AG	22	23	29 22 51	81 28 08	B	1,037	1,037	0
2-107-0026AN	Potatoes	AG	22	23	29 22 50	81 28 06	C	1,037	1,037	0
2-107-0026AN	Potatoes	AG	22	23	29 22 51	81 28 03	D	1,037	1,037	0
2-107-0026AN	Potatoes	AG	22	23	29 22 51	81 27 55	E	1,037	1,037	0
2-107-0028AN	Fern	FS	14	17	29 26 42	81 31 54		3,116	3,116	176,467
2-107-0028AN	Fern	FS	14	18	29 26 42	81 31 39		3,116	3,116	176,467
2-107-0030ANMR	Cowart—Fern	FS	13	8	29 25 49	81 36 03	B	187	187	10,588
2-107-0031AU	Potatoes	AG	22	22	29 22 41	81 28 24	A	9,719	9,719	0
2-107-0031AU	Potatoes	AG	22	22	29 22 45	81 28 32	B	9,719	9,719	0
2-107-0031AU	Potatoes	AG	22	19	29 22 39	81 29 26	C	9,719	9,719	0
2-107-0031AU	Potatoes	AG	21	19	29 22 45	81 29 27	D	9,719	9,719	0
2-107-0031AU	Potatoes	AG	22	21	29 22 40	81 29 03	E	9,719	9,719	0
2-107-0031AU	Potatoes	AG	22	18	29 22 23	81 29 43	F	9,719	9,719	0
2-107-0031AU	Potatoes	AG	22	18	29 22 10	81 29 31	G	9,719	9,719	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-107-0031AU	Potatoes	AG	22	19	29 22 23	81 29 17	H	9,719	9,719	0
2-107-0032AU	Peaches	AG	8	9	29 28 35	81 36 51	A	6,532	6,532	0
2-107-0032AU	Peaches	AG	8	8	29 28 22	81 36 56	B	6,532	6,532	0
2-107-0033AU	Corn, fern, hay, pasture	FG	10	16	29 28 09	81 33 09		810	810	45,881
2-107-0033AU	Corn, fern, hay, pasture	FG	10	15	29 28 11	81 33 15		810	810	45,881
2-107-0033AU	Corn, fern, hay, pasture	FG	10	16	29 28 14	81 33 11		810	810	45,881
2-107-0033AU	Corn, fern, hay, pasture	FG	10	16	29 28 17	81 33 11		810	810	45,881
2-107-0033AU	Corn, fern, hay, pasture	FG	9	14	29 28 23	81 33 52		810	810	45,881
2-107-0033AU	Corn, fern, hay, pasture	FG	10	15	29 28 07	81 33 13		810	810	45,881
2-107-0038ANMR	Woody foliage	AG	18	19	29 25 07	81 30 27	A	7,789	7,789	0
2-107-0038ANMR	Woody foliage	AG	19	20	29 24 53	81 30 15	B	7,789	7,789	0
2-107-0038ANMR	Woody foliage	AG	19	20	29 24 51	81 30 06	C	7,789	7,789	0
2-107-0038ANMR	Woody foliage	AG	19	21	29 24 43	81 29 48	D	7,789	7,789	0
2-107-0038ANMR	Woody foliage	AG	19	19	29 24 43	81 30 19	E	0	7,789	0
2-107-0038ANMR	Woody foliage	AG	19	21	29 24 42	81 29 48	F	0	7,789	0
2-107-0039AU	Fern	FG	12	18	29 27 43	81 31 56	A	3,739	3,739	211,760
2-107-0040ANM	Fern	FS	20	16	29 23 39	81 31 04	A	4,674	3,116	176,467
2-107-0040ANM	Fern	FS	20	16	29 23 44	81 30 54	B	0	3,116	176,467
2-107-0041ANMR	Fern	FG	15	9	29 25 10	81 34 47	A	4,113	4,113	232,936
2-107-0042AU	Fern	FS	13	17	29 27 23	81 32 25	A	1,496	1,496	84,704
2-107-0042AU	Fern	FS	13	17	29 27 21	81 32 19	B	1,496	1,496	84,704
2-107-0046AU	Fern	FG	13	19	29 27 15	81 31 34	A	1,309	1,309	74,116
2-107-0047AU	Fern	FG	13	18	29 27 26	81 32 02	A	1,496	1,496	84,704
2-107-0056ANM	Fern	FG	11	7	29 26 35	81 37 32	A	3,178	3,178	179,996
2-107-0056ANM	Fern	FG	11	7	29 26 30	81 37 34	B	3,178	3,178	179,996
2-107-0056ANM	Fern	FG	11	7	29 26 22	81 37 32	C	3,178	3,178	179,996
2-107-0056ANM	Fern	FG	11	7	29 26 36	81 37 28	D	3,178	3,178	179,996
2-107-0056ANM	Fern	FG	11	7	29 26 29	81 37 39	E	3,178	3,178	179,996
2-107-0057ANR	Fern	FG	8	8	29 28 36	81 37 09	A&B	3,178	3,178	179,996
2-107-0058AUNM	Fern	FG	8	9	29 28 23	81 36 29	B	1,309	872	49,411
2-107-0058AUNM	Fern	FG	8	9	29 28 26	81 36 22	C	0	872	49,411

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-107-0060AU	Fern	FG	13	6	29 25 33	81 37 47	A	2,430	2,430	137,644
2-107-0061AN	Fern, pasture	FS	11	12	29 27 25	81 34 21	A	2,617	2,617	148,232
2-107-0062AU	Fern	FG	14	17	29 27 00	81 32 03	A	4,113	4,113	232,936
2-107-0066ANRM	Citrus	AG	11	17	29 28 05	81 32 30	A	727	727	105,880
2-107-0078AN	Fern	FS	21	14	29 22 36	81 31 12	A	0	2,033	115,145
2-107-0078AN	Fern	FS	21	14	29 22 31	81 31 12	B	0	2,033	115,145
2-107-0078AN	Fern	FS	21	14	29 22 23	81 31 13	C	0	2,033	115,145
2-107-0081AN	Fern, woody ornamentals	FG	3	8	29 33 22	81 39 41	A	3,552	3,552	201,172
2-107-0081AN	Fern, woody ornamentals	FG	3	8	29 33 21	81 39 44	B	3,552	3,552	201,172
2-107-0082AU	Cabbage, corn, potatoes	AG	3	26	29 35 56	81 31 52	A	4,363	4,363	0
2-107-0082AU	Cabbage, corn, potatoes	AG	3	26	29 35 47	81 31 52	B	4,363	4,363	0
2-107-0082AU	Cabbage, corn, potatoes	AG	3	26	29 35 40	81 31 51	C	4,363	4,363	0
2-107-0092AU	Fern, turf grass	FG	14	21	29 27 11	81 30 49	A	125	125	7,059
2-107-0092AU	Fern, turf grass	FG	14	21	29 27 11	81 30 46	B	125	125	7,059
2-107-0097AU	Fern	FG	19	13	29 24 08	81 32 17	A	935	935	52,940
2-107-0097AU	Fern	FG	19	13	29 24 02	81 32 19	B	935	935	52,940
2-107-0098AU	Fern	FG	20	8	29 22 03	81 34 48	A	1,122	1,122	63,528
2-107-0099AU	Fern	FG	19	11	29 23 46	81 32 47	A	2,543	2,543	143,997
2-107-0099AU	Fern	FG	19	12	29 23 27	81 32 47	C	2,543	2,543	143,997
2-107-0099AU	Fern	FG	19	11	29 23 23	81 32 50	D	2,543	2,543	143,997
2-107-0099AU	Fern	FG	19	12	29 23 39	81 32 38	E	2,543	2,543	143,997
2-107-0099AU	Fern	FG	19	11	29 23 32	81 32 48	B	2,543	2,543	143,997
2-107-0100AU	Fern	FG	14	18	29 27 03	81 31 38	A	4,674	4,674	264,700
2-107-0101ANM	Fern	FS	16	16	29 25 56	81 32 04	A	3,131	2,783	157,644
2-107-0101ANM	Fern	FS	16	16	29 25 56	81 31 49	B	3,131	2,783	157,644
2-107-0101ANM	Fern	FS	16	17	29 25 47	81 31 49	C	3,131	2,783	157,644
2-107-0101ANM	Fern	FS	16	17	29 25 52	81 31 48	D	3,131	2,783	157,644
2-107-0101ANM	Fern	FS	16	16	29 25 41	81 32 06	I	0	2,783	157,644
2-107-0102AU	Citrus, fern	FS	15	14	29 25 55	81 32 39	C	4,019	4,019	227,642
2-107-0102AU	Citrus, fern	FS	15	14	29 25 45	81 32 29	D	4,019	4,019	227,642
2-107-0102AU	Citrus, fern	FS	16	15	29 25 49	81 32 24	F	4,019	4,019	227,642

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-107-0102AU	Citrus, fern	FS	15	14	29 25 57	81 32 56	A	4,019	4,019	227,642
2-107-0102AU	Citrus, fern	FS	15	14	29 25 58	81 32 47	B	4,019	4,019	227,642
2-107-0102AU	Citrus, fern	FS	16	14	29 25 36	81 32 31	E	4,019	4,019	227,642
2-107-0102AU	Citrus, fern	FS	16	15	29 25 48	81 32 26	G	4,019	4,019	227,642
2-107-0104ANM	Fern, peaches	FG	21	17	29 22 43	81 30 13	A	4,767	3,814	215,995
2-107-0104ANM	Fern, peaches	FG	21	17	29 22 40	81 30 08	B	4,767	3,814	215,995
2-107-0104ANM	Fern, peaches	FG	21	18	29 22 42	81 30 06	C	0	3,814	215,995
2-107-0105AU	Fern	FG	19	12	29 23 32	81 32 35	A	2,991	2,991	169,408
2-107-0106AURM2	Fern, citrus, woody ornamentals	FS	12	10	29 26 47	81 34 48	A	1,963	1,570	88,939
2-107-0106AURM2	Fern, citrus, woody ornamentals	FS	12	10	29 26 50	81 34 48	B	0	1,570	88,939
2-107-0107ANM	Cabbage	AG	4	23	29 32 44	81 32 21	A	11,424	5,712	0
2-107-0107ANM	Cabbage	AG	4	23	29 34 03	81 32 27	B	0	5,712	0
2-107-0109AUM	Fern	FG	20	16	29 23 12	81 30 58	A	3,926	3,926	222,348
2-107-0110AU	Fern	FG	1	19	29 35 58	81 35 19	A	2,804	2,804	158,820
2-107-0110AU	Fern	FG	1	19	29 35 57	81 35 17	B	2,804	2,804	158,820
2-107-0111AU	Citrus	AG	18	18	29 24 48	81 30 37	A	414	414	0
2-107-0112AU	Fern	FG	12	21	29 27 52	81 31 14	A	935	935	52,940
2-107-0113AU	Fern	FG	14	6	29 24 58	81 37 23	A	3,988	3,988	225,877
2-107-0113AU	Fern	FG	14	6	29 24 50	81 37 32	B	3,988	3,988	225,877
2-107-0113AU	Fern	FG	15	6	29 24 37	81 37 22	C	3,988	3,988	225,877
2-107-0113AU	Fern	FG	15	6	29 24 35	81 37 22	D	3,988	3,988	225,877
2-107-0113AU	Fern	FG	15	6	29 24 37	81 37 35	E	3,988	3,988	225,877
2-107-0113AU	Fern	FG	15	6	29 24 38	81 37 22	F	3,988	3,988	225,877
2-107-0114AU	Fern	FG	13	7	29 25 54	81 37 18	A	1,496	1,496	84,704
2-107-0114AU	Fern	FG	13	7	29 25 49	81 37 15	B	1,496	1,496	84,704
2-107-0116ANRF	Fern	FS	9	11	29 28 19	81 35 19	A	0	2,991	169,408
2-107-0117AU	Fern	FG	14	13	29 26 32	81 33 19	A	2,991	2,991	169,408
2-107-0119AUM	Fern and citrus	FG	13	9	29 26 23	81 35 36	A	0	5,982	338,816
2-107-0120AN	Fern	FG	17	16	29 25 02	81 31 51	A	5,048	2,524	142,938
2-107-0120AN	Fern	FG	17	16	29 24 59	81 31 50	B	5,048	2,524	142,938
2-107-0120AN	Fern	FG	17	16	29 25 03	81 31 48	C	0	2,524	142,938

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-107-0120AN	Fern	FG	17	16	29 25 02	81 31 47	D	0	2,524	142,938
2-107-0133ANM	Fern	FG	14	8	29 25 41	81 36 10	A	0	5,235	296,464
2-107-0139ANV	Fern	FS	13	7	29 25 41	81 37 03	A	2,991	2,991	0
2-107-0140ANR	Fern	FG	20	16	29 23 40	81 31 03	A	1,870	935	52,940
2-107-0140ANR	Fern	FG	20	17	29 23 44	81 30 53	B	0	935	52,940
2-107-0154US	Fern	FG	17	16	29 25 14	81 31 42	A	561	561	31,764
2-107-0160AUS	Fern	FG	15	16	29 26 19	81 32 19	A	2,617	2,617	148,232
2-107-0163AUS	Fern	FG	15	20	29 26 47	81 31 03	A	1,309	1,309	74,116
2-107-0164ANM	Fern	FS	22	17	29 22 06	81 30 04	B	997	748	42,352
2-107-0164ANM	Fern	FS	22	17	29 22 07	81 30 06	C	0	748	42,352
2-107-0167AUS	Citrus	AG	19	17	29 24 18	81 30 42	A	872	872	127,056
2-107-0169AUS	Fern	FG	19	11	29 23 32	81 32 55	A	2,368	2,368	134,115
2-107-0169AUS	Fern	FG	19	11	29 23 30	81 32 56	B	2,368	2,368	134,115
2-107-0177AN	Citrus	AG	18	16	29 25 01	81 31 33	A	5,812	5,812	154,011
2-107-0179ANY	Fern and citrus	FS	18	16	29 25 01	81 31 39	B	0	2,243	127,056
2-107-0181ANV	Fern	FG	22	16	29 22 11	81 30 27	A	561	561	31,764
2-107-0186AN	Fern	FG	18	16	29 24 56	81 31 47	A	0	1,122	63,528
2-107-0187ANM	Fern	FS	18	17	29 25 05	81 31 14	D	0	1,421	80,469
2-107-0187ANM	Fern	FS	18	17	29 24 56	81 31 20	E	0	1,421	80,469
2-107-0188AUS	Fern	FS	13	12	29 26 30	81 33 52	A	561	561	31,764
2-107-0189AN	Tree farm	FS	14	17	29 26 47	81 32 03	B	0	2,617	0
2-107-0190AN	Fern	FG	7	14	29 30 31	81 34 42	A	1,496	1,496	0
2-107-0193AN	Squash	AG	18	18	29 25 08	81 30 50	A	6,148	6,148	0
2-107-0194AN	Fern	FS	15	9	29 25 08	81 35 04	A	0	1,309	74,116
2-107-0195ANV	Watermelons	AG	7	6	29 28 39	81 39 09	A	1,738	1,738	0
2-107-0196AN	Fern, flowers, ornamentals, woody ornamentals	FG	16	5	29 23 42	81 37 56	A	3,739	3,739	211,760
2-107-0198AN	Golf course—Dove Meadows	AG	11	16	29 27 48	81 32 46	A	0	20,971	0
2-107-0198AN	Golf course—Dove Meadows	AG	11	16	29 27 52	81 32 43	B	0	20,971	0
2-107-0198AN	Golf course—Dove Meadows	AG	11	16	29 27 57	81 32 54	C	0	20,971	0
2-107-0198AN	Golf course—Dove Meadows	AG	11	16	29 27 59	81 33 05	D	0	20,971	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-107-0200AN	Citrus	AG	15	13	29 25 49	81 32 59	B	0	872	127,056
2-107-0204AN	Fish farm use	AG	22	23	29 22 42	81 27 45	A	5,775	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 47	81 27 39	B	5,775	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 47	81 27 45	C	5,775	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 48	81 27 43	D	2,887	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 47	81 27 39	F	0	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 39	81 27 40	H	0	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 37	81 27 45	I	0	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 38	81 27 41	K	0	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 37	81 27 40	L	0	6,300	0
2-107-0204AN	Fish farm use	AG	22	23	29 22 37	81 27 39	M	0	6,300	0
2-107-0204AN	Fish propagation	AG	22	23	29 22 39	81 27 43	G	0	6,300	0
2-107-0205AN	Fern	FG	16	14	29 25 33	81 32 34	A	872	872	49,411
2-107-0205AN	Fern	FG	16	14	29 25 33	81 32 35	B	872	872	49,411
2-107-0205AN	Fern	FG	16	14	29 25 36	81 32 36	C	872	872	49,411
2-107-0207AN	Citrus	AG	18	18	29 25 18	81 30 56	A	5,086	5,086	211,764
2-107-0208AN	Fern	FS	8	8	29 28 40	81 37 20	A	0	7,478	423,520
2-107-0210AN	Tree fern	FG	8	8	29 28 39	81 37 26	A	4,674	4,674	0
2-107-0210AN	Tree fern	FG	8	8	29 28 40	81 37 20	B	4,674	4,674	0
2-107-0213ANM	Fern	FS	5	7	29 31 03	81 39 12	A	0	1,870	0
2-107-0213ANM	Fern	FS	5	7	29 30 29	81 39 12	B	0	1,870	0
2-107-0215AN	Fern	FG	19	15	29 24 02	81 31 33	A	0	1,870	105,880
2-107-0216AN	Fern	FG	9	9	29 28 06	81 36 43	A	0	4,487	254,112
2-107-0217AUV	Fern	FS	13	6	29 25 32	81 38 03	A	1,449	1,449	82,057
2-107-0217AUV	Fern	FS	13	6	29 25 38	81 37 59	B	0	1,449	82,057
2-107-0220AN	Fern	FS	13	10	29 26 26	81 34 51	A	0	2,243	127,056
2-107-0221AN	Tree fern	FG	8	8	29 28 25	81 37 20	A	0	7,478	0
2-107-0222AN	Cabbage, corn, potatoes	AG	3	25	29 35 47	81 32 22	A	0	4,363	0
2-107-0222AN	Cabbage, corn, potatoes	AG	3	25	29 35 37	81 32 21	B	0	4,363	0
2-107-0222AN	Cabbage, corn, potatoes	AG	3	25	29 35 45	81 32 13	C	0	4,363	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-107-0223AN	Tree fern	FS	13	7	29 25 44	81 37 33	A	0	654	0
2-107-0224AN	Potatoes	AG	2	27	29 36 28	81 31 39	A	0	6,220	0
2-107-0224AN	Potatoes	AG	2	27	29 36 39	81 31 40	B	0	6,220	0
2-107-0224AN	Potatoes	AG	2	27	29 36 16	81 31 48	C	0	6,220	0
2-107-0224AN	Potatoes	AG	2	27	29 36 33	81 31 46	D	0	6,220	0
2-107-0224AN	Potatoes	AG	2	27	29 36 34	81 31 35	E	0	6,220	0
2-107-0226AN	Fern	FS	15	6	29 24 41	81 37 18	A	0	1,870	105,880
2-107-0227AN	Fern	FG	13	13	29 27 00	81 33 38	A	0	5,609	317,640
2-107-0242AN	Pomona Park Tree Fernery	FS	8	9	29 28 38	81 36 33	A	0	11,217	0
2-107-0242AN	Pomona Park Tree Fernery	FS	8	9	29 28 54	81 36 52	B	0	11,217	0
2-107-0244ANM	Tree fern	FG	14	19	29 26 59	81 31 20	A	0	7,478	0
2-107-0245AN	Tree fern	FG	14	18	29 26 59	81 31 58	A	0	5,048	0
2-107-0248AN	Tree fern	FG	9	14	29 28 40	81 34 02	A	0	3,739	0
2-107-0249AN	Citrus	AGS	7	13	29 29 45	81 35 03	A	0	1,816	264,700
2-107-0250AN	Tree fern	FG	18	16	29 24 51	81 31 53	A	0	5,609	0
2-107-0251AN	Tree fern	FG	7	13	29 29 48	81 34 52	A	0	14,956	0
2-107-0253AN	Fern	FG	14	9	29 25 54	81 34 49	A	0	5,609	317,640
2-107-0253AN	Fern	FG	14	9	29 25 48	81 34 48	B	0	5,609	317,640
2-107-0254AU	Fern	FG	19	13	29 24 00	81 32 29	A	0	3,552	201,172
2-107-0257AN	Citrus	AG	18	16	29 24 42	81 31 35	A	0	145	21,070
2-107-0257AN	Citrus	AG	18	16	29 24 43	81 31 37	B	0	145	21,070
2-117-0024	Fern	FG	88	9	28 47 44	81 19 03	A	1,309	1,309	0
2-117-0050	Woody ornamentals	AG	87	5	28 47 54	81 22 35		6,843	6,843	0
2-117-0075	Small vegetable	AG	89	22	28 47 55	81 14 05	A	194	194	0
2-117-0075	Small vegetable	AG	89	22	28 47 40	81 13 59		194	194	0
2-117-0075	Small vegetable	AG	89	22	28 47 55	81 14 05		194	194	0
2-117-0075	Small vegetable	AG	89	22	28 48 06	81 14 00		194	194	0
2-117-0075	Small vegetable	AG	89	22	28 48 09	81 14 05		194	194	0
2-117-0075	Small vegetable	AG	89	22	28 48 15	81 14 04		194	194	0
2-117-0075	Small vegetable	AG	89	22	28 48 15	81 14 00		194	194	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-117-0077	Small vegetable	AG	89	22	28 48 17	81 14 05		3,258	3,258	0
2-117-0122	Nursery—woody ornamentals	AG	88	6	28 47 43	81 21 51		4,888	4,888	0
2-117-0136	Flowers and foliage—potted plants	AG	88	9	28 47 42	81 18 56	A	2,662	2,662	105,880
2-117-0239AUV	Mayfair Golf Club	AG	89	9	28 46 51	81 19 14	A	0	1,612	0
2-127-0001AN	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 13	81 17 13		3,116	3,116	176,467
2-127-0001AN	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 20	81 17 08		3,116	3,116	176,467
2-127-0002AU	GW from Floridan aquifer—fern	FG	48	29	29 11 48	81 19 08	A	1,421	1,421	0
2-127-0003AUR	GW from Floridan aquifer—fern	FG	57	22	29 06 29	81 21 41	A	1,122	1,122	63,528
2-127-0004AN	GW from Floridan aquifer—fern	FG	71	27	28 59 10	81 16 07	A	1,683	1,683	95,292
2-127-0006AN	GW from Floridan aquifer—citrus and vegetable	AG	58	26	29 06 19	81 19 23	A	2,782	1,391	0
2-127-0006AN	GW from Floridan aquifer—citrus and vegetable	AG	58	26	29 06 26	81 19 15	B	0	1,391	0
2-127-0007AU	GW from Floridan aquifer—fern	FG	43	10	29 12 07	81 28 30	A	3,739	3,739	211,760
2-127-0008AU	GW from Floridan aquifer—fern	FG	43	10	29 12 08	81 28 35	A	1,122	1,122	63,528
2-127-0009AN	GW from Floridan aquifer—fern	FG	42	13	29 13 05	81 27 41	A	5,235	2,617	148,232
2-127-0009AN	GW from Floridan aquifer—fern	FG	42	14	29 13 10	81 27 43	B	0	2,617	148,232
2-127-0012AN	Citrus, fern, flowers	AG	57	20	29 06 14	81 21 36	A	3,433	3,433	0
2-127-0013AU	GW from Floridan aquifer/SW from pond—fern	FS	57	29	29 07 59	81 17 45	A	872	654	37,058
2-127-0013AU	GW from Floridan aquifer/SW from pond—fern	FS	56	29	29 08 04	81 17 38	B	872	654	37,058
2-127-0013AU	GW from Floridan aquifer/SW from pond—fern	FS	57	29	29 08 02	81 17 39	C	0	654	37,058
2-127-0014ANM2R	GW from the Floridan aquifer—citrus and fern	FG	66	22	29 02 26	81 20 05	A	2,430	2,430	137,644
2-127-0015AUF	Fern and woody ornamentals	FG	57	26	29 06 50	81 19 31	A	654	654	37,058
2-127-0015AUF	Fern and woody ornamentals	FG	57	26	29 06 51	81 19 33	B	654	654	37,058

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0015AUF	Fern and woody ornamentals	FG	58	26	29 06 42	81 19 29	C	654	654	37,058
2-127-0015AUF	Fern and woody ornamentals	FG	58	26	29 06 44	81 19 31	D	654	654	37,058
2-127-0016AUMR	De Land golf course	AG	70	23	28 59 14	81 17 47	A	565	423	0
2-127-0016AUMR	De Land golf course	AG	70	23	28 59 16	81 17 58	B	565	423	0
2-127-0016AUMR	De Land golf course	AG	70	23	28 59 17	81 17 55	C	565	423	0
2-127-0016AUMR	De Land golf course	AG	70	23	28 59 13	81 17 52	D&E	0	423	0
2-127-0017AN	Fern	FS	43	12	29 12 35	81 27 54	A	5,422	2,711	153,526
2-127-0017AN	Fern	FS	43	11	29 12 28	81 27 58	B	0	2,711	153,526
2-127-0017AN	Fern	FS	42	13	29 12 37	81 27 58	C	0	2,711	153,526
2-127-0018AU	GW from the Floridan aquifer—fern	FG	61	21	29 04 08	81 21 18	A	2,617	2,617	148,232
2-127-0019AUNM	GW from the Floridan aquifer—fern	FG	57	26	29 07 10	81 19 58	A	3,614	3,614	204,701
2-127-0019AUNM	GW from the Floridan aquifer—fern	FG	57	26	29 07 10	81 20 09	C	3,614	3,614	204,701
2-127-0019AUNM	GW from the Floridan aquifer—fern	FG	56	26	29 07 17	81 20 11	B	3,614	3,614	204,701
2-127-0020ANM	Assorted fern	FG	38	17	29 14 31	81 26 59	A	1,122	1,122	63,528
2-127-0021AU	GW from the Floridan aquifer—fern	FG	37	13	29 14 25	81 28 12	A	1,122	1,122	63,528
2-127-0022AU	GW from the Floridan aquifer—fern	FG	38	16	29 14 34	81 27 08	A	935	935	52,940
2-127-0023AU	Fern	FS	41	18	29 13 57	81 26 13	A	3,365	3,365	190,584
2-127-0024AU	GW from the Floridan aquifer—nursery	FG	36	13	29 14 37	81 28 20	D	1,496	1,496	84,704
2-127-0024AU	GW from the Floridan aquifer—nursery	FG	36	13	29 14 44	81 28 25	A	1,496	1,496	84,704
2-127-0024AU	GW from the Floridan aquifer—nursery	FG	36	13	29 14 40	81 28 21	B	1,496	1,496	84,704
2-127-0024AU	GW from the Floridan aquifer—nursery	FG	36	13	29 14 34	81 28 20	C	1,496	1,496	84,704
2-127-0025AU	GW from the Floridan aquifer—fern	FG	65	22	29 02 40	81 20 11	A	1,683	1,683	95,292
2-127-0025AU	GW from the Floridan aquifer—fern	FG	65	22	29 02 43	81 20 12	B	1,683	1,683	95,292
2-127-0026AN	GW from the Floridan aquifer—fern	FG	64	21	29 03 14	81 20 34	A	1,496	1,496	84,704
2-127-0027AU	Tree fern, livestock	FG	65	20	29 02 34	81 20 38	A	9,348	4,674	0
2-127-0027AU	Tree fern, livestock	FG	65	20	29 02 35	81 20 33	B	0	4,674	0
2-127-0029AU	Assorted ferns and ornamentals	FG	53	26	29 08 48	81 20 31	A	2,056	2,056	116,468

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0029AU	Assorted ferns and ornamentals	FG	53	26	29 08 46	81 20 30	B	2,056	2,056	116,468
2-127-0029AUR	Assorted ferns and ornamentals	FG	53	26	29 08 48	81 20 25	C	2,056	2,056	116,468
2-127-0029AUR	Assorted ferns and ornamentals	FG	53	26	29 08 48	81 20 18	D	2,056	2,056	116,468
2-127-0030AU	GW from the Floridan aquifer—fern	FG	54	26	29 08 29	81 20 33	A	1,870	1,870	105,880
2-127-0031AUR	GW from the Floridan aquifer—fern	FG	35	17	29 15 19	81 27 01	A	935	935	52,940
2-127-0033AU	Fern	FG	28	20	29 18 57	81 27 49	A	0	10,282	231,016
2-127-0033AUM4	Fern	FG	28	20	29 18 56	81 27 42	B	20,565	10,282	231,016
2-127-0033AUM4	Fern	FG	27	20	29 19 05	81 27 48	C	20,565	10,282	231,016
2-127-0033AUM4	Fern	FG	28	19	29 18 57	81 28 04	D	0	10,282	231,016
2-127-0034ANM	Fern	FG	64	24	29 03 30	81 19 21	A	1,122	1,122	63,528
2-127-0035AU	GW from Floridan aquifer/SW from pond—fern	FG	56	29	29 08 10	81 17 53	A	1,870	1,246	0
2-127-0035AU	GW from Floridan aquifer/SW from pond—fern	FG	56	29	29 08 10	81 17 46	B	0	1,246	0
2-127-0036ANMR	GW from Floridan aquifer/SW from pond—fern	FG	57	28	29 07 49	81 18 02	A	841	841	47,646
2-127-0037AU	GW from Floridan aquifer/SW from lake—fern	FG	57	29	29 07 49	81 17 40	A	1,870	1,870	105,880
2-127-0038AU	GW from the Floridan aquifer—fern	FG	57	28	29 07 48	81 17 57	A	2,430	2,430	137,644
2-127-0039ANMR	Fern	FG	38	16	29 14 24	81 27 19	A	0	7,478	423,520
2-127-0040AUR	GW from the Floridan aquifer—fern	FG	76	22	28 56 28	81 17 33	A	1,994	1,994	112,939
2-127-0040AUR	GW from the Floridan aquifer—fern	FG	76	22	28 56 30	81 17 35	B	1,994	1,994	112,939
2-127-0040AUR	GW from the Floridan aquifer—fern	FG	76	22	28 56 28	81 17 35	C	1,994	1,994	112,939
2-127-0041AN	GW from the Floridan aquifer—fern	FG	44	12	29 12 08	81 27 58	A	4,292	2,146	121,550
2-127-0041AN	GW from the Floridan aquifer—fern	FG	43	11	29 12 10	81 28 03	B	0	2,146	121,550
2-127-0042AUR	Leatherleaf and tree ferns	FG	70	22	28 59 30	81 18 28	A	1,168	1,168	66,175
2-127-0042AUR	Leatherleaf and tree ferns	FG	69	22	28 59 35	81 18 27	B	1,168	1,168	66,175
2-127-0042AUR	Leatherleaf and tree ferns	FG	69	22	28 59 39	81 18 31	C	1,168	1,168	66,175
2-127-0042AUR	Leatherleaf and tree ferns	FG	70	22	28 59 30	81 18 27	D	1,168	1,168	66,175
2-127-0043AU	Fern and citrus	FS	60	29	29 06 31	81 16 22	A	1,496	1,196	67,763
2-127-0043AU	Fern and citrus	FS	60	29	29 06 17	81 16 30	B	1,496	1,196	67,763

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0043AU	Fern and citrus	FS	60	29	29 06 26	81 16 30	C	0	1,196	67,763
2-127-0045ANRM	Fern	FS	44	11	29 12 03	81 28 17	A	0	685	38,823
2-127-0046ANR	Tree fern	FG	37	16	29 14 30	81 27 14	A	0	1,870	0
2-127-0047AURM	Fern	FG	40	11	29 13 28	81 28 44	A	561	561	31,764
2-127-0047AURM	Fern	FG	40	11	29 13 31	81 28 44	B	561	561	31,764
2-127-0047AURM	Fern	FG	40	11	29 13 31	81 28 34	C	561	561	31,764
2-127-0048ANR	Landscape	AG	67	23	29 02 16	81 19 19	A	0	1,801	0
2-127-0049AUR	GW from the Floridan aquifer	FG	37	17	29 14 46	81 26 41	A	561	561	31,764
2-127-0050AU	GW from Floridan aquifer/SW from pond—fern	FS	56	27	29 07 43	81 19 09	A	1,246	1,246	70,587
2-127-0050AU	GW from Floridan aquifer/SW from pond—fern	FS	56	27	29 07 42	81 19 14	B	1,246	1,246	70,587
2-127-0051AU	GW from the Floridan aquifer—fern	FG	26	18	29 19 25	81 28 26	A	2,898	2,898	164,114
2-127-0051AUNM2R	GW from the Floridan aquifer—fern	FG	26	18	29 19 27	81 28 38	B	2,898	2,898	164,114
2-127-0051AUNM2R	GW from the Floridan aquifer—fern	FG	26	18	29 19 22	81 28 29	C	2,898	2,898	164,114
2-127-0052AU	Fern	FG	24	13	29 19 58	81 30 42	A	3,552	2,368	134,115
2-127-0052AU	Fern	FG	24	12	29 20 02	81 30 54	B	0	2,368	134,115
2-127-0053AU	GW from the Floridan aquifer	FG	27	20	29 19 22	81 27 49	A	2,898	2,898	164,114
2-127-0053AU	GW from the Floridan aquifer	FG	27	20	29 19 24	81 27 51	B	2,898	2,898	164,114
2-127-0056AU	GW from the Floridan aquifer	FG	29	19	29 18 02	81 27 42	A	3,365	3,365	190,584
2-127-0057AU	Fern	FG	23	19	29 21 17	81 29 01	A	5,048	2,524	142,938
2-127-0057AU	Fern	FG	23	19	29 21 13	81 29 01	B	0	2,524	142,938
2-127-0058AU	Fern	FS	45	10	29 11 11	81 28 28	A	2,430	2,430	137,644
2-127-0058AU	Fern	FS	46	10	29 11 01	81 28 31	B	2,430	2,430	137,644
2-127-0058AU	Fern	FS	46	10	29 11 02	81 28 23	C	2,430	2,430	137,644
2-127-0059AUR	Leatherleaf fern	FG	46	22	29 12 15	81 23 43		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	22	29 12 18	81 23 51		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	22	29 12 18	81 23 48		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	22	29 12 19	81 24 04		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	22	29 12 21	81 23 46		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	23	29 12 24	81 23 46		2,056	2,056	116,468

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0059AUR	Leatherleaf fern	FG	46	23	29 12 26	81 23 42		2,056	2,056	116,468
2-127-0059AUR	Leatherleaf fern	FG	46	23	29 12 32	81 23 46		2,056	2,056	116,468
2-127-0062AU	GW from the Floridan aquifer—fern	FG	74	29	28 58 49	81 13 06	A	2,991	2,991	169,408
2-127-0064AU	GW from the Floridan aquifer—fern	FG	57	24	29 06 33	81 20 29		3,365	3,365	190,584
2-127-0064AU	GW from the Floridan aquifer—fern	FG	57	25	29 06 33	81 20 25		3,365	3,365	190,584
2-127-0064AU	GW from the Floridan aquifer—fern	FG	57	25	29 06 34	81 20 28		3,365	3,365	190,584
2-127-0064AU	GW from the Floridan aquifer—fern	FG	57	25	29 06 35	81 20 22		3,365	3,365	190,584
2-127-0065AU	GW from the Floridan aquifer—fern	FG	37	16	29 14 42	81 27 09	A	1,496	1,496	84,704
2-127-0066AU	Fern, citrus (5%)	FG	42	14	29 12 53	81 27 09		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	14	29 12 54	81 27 15		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	14	29 12 56	81 27 15		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	15	29 12 56	81 26 56		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	14	29 12 57	81 27 12		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	43	16	29 12 57	81 26 43		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	15	29 13 06	81 26 57		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	15	29 13 09	81 27 02		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	15	29 13 15	81 27 14		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	15	29 13 18	81 26 58		1,709	1,709	0
2-127-0066AU	Fern, citrus (5%)	FG	42	16	29 13 21	81 26 56		1,709	1,709	0
2-127-0068AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 32	81 20 58	A	935	935	52,940
2-127-0068AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 30	81 21 00	B	935	935	52,940
2-127-0069AUR	GW from the Floridan aquifer—fern	FG	53	25	29 08 46	81 20 56	A	3,739	3,739	211,760
2-127-0070AUR	GW from the Floridan aquifer—fern	FG	56	25	29 07 31	81 20 40	A	3,240	3,240	183,525
2-127-0070AUR	GW from the Floridan aquifer—fern	FG	56	25	29 07 28	81 20 41	B	3,240	3,240	183,525
2-127-0070AUR	GW from the Floridan aquifer—fern	FG	56	25	29 07 23	81 20 42	C	3,240	3,240	183,525
2-127-0072AU	GW from Floridan aquifer/SW from pond—fern	FG	63	21	29 03 40	81 20 51	A	2,243	1,683	95,292
2-127-0072AUR	GW from Floridan aquifer/SW from pond—fern	FG	63	21	29 03 42	81 21 03	B	2,243	1,683	95,292
2-127-0072AUR	GW from Floridan aquifer/SW from pond—fern	FG	63	21	29 03 44	81 20 45	C	0	1,683	95,292

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0073AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 27	81 20 57	C	748	748	42,352
2-127-0073AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 28	81 21 01	A	748	748	42,352
2-127-0073AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 28	81 20 51	B	748	748	42,352
2-127-0073AUR	GW from the Floridan aquifer—fern	FG	54	25	29 08 26	81 20 57	D	748	748	42,352
2-127-0074AUR	Citrus	AG	61	29	29 06 03	81 16 31	A	3,158	3,158	423,520
2-127-0076AU	GW from the Floridan aquifer—fern	FG	46	22	29 12 21	81 24 15	A	5,063	5,063	286,723
2-127-0076AUR	GW from the Floridan aquifer—fern	FG	46	22	29 12 21	81 24 13	B	5,063	5,063	286,723
2-127-0077AUR	GW from the Floridan aquifer—fern	FG	38	16	29 14 33	81 27 04	A	1,122	1,122	63,528
2-127-0078AUR	GW from the Floridan aquifer—fern	FG	47	29	29 13 01	81 19 09	A	5,609	2,804	158,820
2-127-0078AUR	GW from the Floridan aquifer—fern	FG	47	29	29 12 58	81 19 03	B	0	2,804	158,820
2-127-0079ANGR	Turf grass	AG	69	24	29 00 17	81 17 53	A	4,517	4,517	0
2-127-0080AU	GW from Floridan aquifer/SW from recovery pond—fern	FG	44	9	29 11 16	81 29 17	B	1,028	1,028	58,234
2-127-0080AU	GW from Floridan aquifer/SW from recovery pond—fern	FG	44	9	29 11 22	81 29 17	A	1,028	1,028	58,234
2-127-0080AU	GW from Floridan aquifer/SW from recovery pond—fern	FG	44	9	29 11 19	81 29 17	C	1,028	1,028	58,234
2-127-0081AU	GW from the Floridan aquifer—fern	FG	26	15	29 19 21	81 29 35	A	841	841	47,646
2-127-0082AU	GW from the Floridan aquifer—fern	FG	58	25	29 06 28	81 20 08	A	5,609	5,609	317,640
2-127-0083ANM2	GW from Floridan aquifer/SW from pond—fern	AGS	49	28	29 11 03	81 19 21	A	4,826	4,826	105,880
2-127-0084ANMR	Fern, citrus (3%)	FS	50	26	29 10 08	81 21 00		2,119	2,119	119,997
2-127-0084ANMR	Fern, citrus (3%)	FS	50	26	29 10 08	81 20 52		2,119	2,119	119,997
2-127-0084ANMR	Fern, citrus (3%)	FS	50	26	29 10 09	81 21 00		2,119	2,119	119,997
2-127-0084ANMR	Fern, citrus (3%)	FS	50	26	29 10 09	81 21 00		2,119	2,119	119,997
2-127-0084ANMR	Fern, citrus (3%)	FS	50	26	29 10 12	81 20 52		2,119	2,119	119,997
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 12 03	81 03 05		807	807	0
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 11 57	81 03 07		807	807	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 11 58	81 03 06		807	807	0
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 11 59	81 03 03		807	807	0
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 12 00	81 03 07		807	807	0
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 12 00	81 03 00		807	807	0
2-127-0085AN	GW from the Floridan aquifer—landscape	AG	58	42	29 12 12	81 02 53		807	807	0
2-127-0087AUMR	Leatherleaf and tree ferns	FG	61	21	29 04 10	81 21 08	A	1,683	1,683	95,292
2-127-0087AUMR	Leatherleaf and tree ferns	FG	61	21	29 04 11	81 21 14	B	1,683	1,683	95,292
2-127-0087AUMR	Leatherleaf and tree ferns	FG	61	20	29 04 12	81 21 21	C	1,683	1,683	95,292
2-127-0088AUMR	GW from the Floridan aquifer—fern	FG	58	21	29 06 04	81 21 43	A	1,496	1,496	84,704
2-127-0089ANR	GW from the Floridan aquifer—fern	FG	59	24	29 05 40	81 20 07	A	1,028	1,028	58,234
2-127-0089ANR	GW from the Floridan aquifer—fern	FG	59	24	29 05 35	81 20 14	B	1,028	1,028	58,234
2-127-0089ANR	GW from the Floridan aquifer—fern	FG	59	24	29 05 38	81 20 14	C	1,028	1,028	58,234
2-127-0089ANR	GW from the Floridan aquifer—fern	FG	59	24	29 05 40	81 20 10	D	1,028	1,028	58,234
2-127-0090AUR	Fern	FG	29	15	29 18 04	81 29 15	A	2,991	2,991	169,408
2-127-0090AUR	Fern	FG	29	14	29 17 54	81 29 08	B	2,991	2,991	169,408
2-127-0094AUR	Fern	FS	27	15	29 18 57	81 29 20	A	935	467	26,470
2-127-0094AUR	Fern	FS	27	15	29 18 57	81 29 23	B	0	467	26,470
2-127-0094AUR	Fern	FS	27	15	29 19 00	81 29 21	C	0	467	26,470
2-127-0095AU	GW from the Floridan aquifer—fern	FG	23	17	29 21 10	81 29 31	A	748	748	42,352
2-127-0095AU	GW from the Floridan aquifer—fern	FG	23	17	29 21 08	81 29 29	B	748	748	42,352
2-127-0096ANR	Fern	FG	47	17	29 10 52	81 25 15	A	2,056	1,028	58,234
2-127-0096ANR	Fern	FG	47	17	29 10 53	81 25 19	B	0	1,028	58,234
2-127-0098AN	Fern	FS	40	20	29 14 14	81 25 40	B	3,842	3,842	217,583
2-127-0098AN	Fern	FS	41	20	29 14 09	81 25 37	C	3,842	3,842	217,583
2-127-0098ANRM	Fern	FS	40	20	29 14 19	81 25 42	A	3,842	3,842	217,583
2-127-0099ANR	Fern	FG	28	20	29 18 45	81 27 29	A	0	3,739	211,760

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0100AN	Fern, livestock, watermelons	FG	45	18	29 12 06	81 25 28	A	0	1,870	105,880
2-127-0101ANF	Fern	FG	57	24	29 06 54	81 20 52	A	0	1,496	84,704
2-127-0102AUR	Tree fern	FG	46	19	29 11 46	81 24 50	A	1,122	1,122	0
2-127-0103ANF	Fern	FG	58	25	29 06 20	81 20 08	A	3,739	3,739	211,760
2-127-0104AU	GW from the Floridan aquifer—fern	FG	45	9	29 11 16	81 29 04	A	1,870	1,870	105,880
2-127-0105AU	GW from the Floridan aquifer—fern	FG	59	21	29 05 16	81 21 24	A	1,870	1,870	105,880
2-127-0106AN	Fern, citrus (9%)	FG	42	12	29 12 37	81 28 09	A	4,674	4,674	264,700
2-127-0107ANR	Fern	FG	36	12	29 14 28	81 28 46	A	0	1,870	105,880
2-127-0108AU	GW from Floridan aquifer/SW from pond—fern	FG	34	12	29 15 12	81 28 58	A	5,422	3,614	204,701
2-127-0108AU	GW from Floridan aquifer/SW from pond—fern	FG	35	12	29 14 57	81 28 53	B	0	3,614	204,701
2-127-0109AUR	GW from the Floridan aquifer—fern	FG	33	12	29 15 27	81 29 01	A	2,991	2,991	169,408
2-127-0110AUR	GW from the Floridan aquifer—fern	FG	41	19	29 14 08	81 25 53	A	0	0	0
2-127-0110AUR	GW from the Floridan aquifer—fern	FG	41	19	29 14 06	81 25 51	B	0	0	0
2-127-0111AUR	GW from Floridan aquifer/SW from pond—fern	FS	34	12	29 15 06	81 29 05	A	1,309	1,309	74,116
2-127-0112AU	GW from the Floridan aquifer—fern	FG	69	22	28 59 45	81 18 36	A	6,356	3,178	179,996
2-127-0112AU	GW from the Floridan aquifer—fern	FG	69	22	28 59 39	81 18 37	B	0	3,178	179,996
2-127-0113AN	GW from the Floridan aquifer—fern	FG	58	22	29 06 01	81 21 34	A	5,982	2,991	169,408
2-127-0113AN	GW from the Floridan aquifer—fern	FG	58	21	29 06 01	81 21 30	B	0	2,991	169,408
2-127-0114AU	GW from the Floridan aquifer—fern	FG	37	15	29 14 28	81 27 43	A	3,926	3,926	222,348
2-127-0115ANM3R	GW from Floridan aquifer/SW from pond—fern	FS	46	29	29 13 52	81 19 22	B	1,246	748	42,352
2-127-0115ANM3R	GW from Floridan aquifer/SW from pond—fern	FS	46	29	29 13 55	81 19 27	A	1,246	748	42,352
2-127-0115ANM3R	GW from Floridan aquifer/SW from pond—fern	FS	46	29	29 13 49	81 19 22	C	1,246	748	42,352
2-127-0115ANM3R	GW from Floridan aquifer/SW from pond—fern	FS	45	30	29 13 55	81 19 35	D	0	748	42,352

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0115ANM3R	GW from Floridan aquifer/SW from pond—fern	FS	46	30	29 13 51	81 19 26	F	0	748	42,352
2-127-0116AN	Fern	FG	46	29	29 13 41	81 19 38	A	491	491	27,794
2-127-0116AN	Fern	FG	46	29	29 13 41	81 19 29	B	491	491	27,794
2-127-0116AN	Fern	FG	46	30	29 13 42	81 19 15	C	491	491	27,794
2-127-0116AN	Fern	FG	46	30	29 13 35	81 19 30	D	491	491	27,794
2-127-0117AU	Underhill—fern	FS	42	27	29 14 47	81 22 31	A	4,378	3,502	198,349
2-127-0117AU	Underhill—fern	FS	42	27	29 14 38	81 22 35	B	4,378	3,502	198,349
2-127-0117AU	Underhill—fern	FS	42	26	29 14 26	81 22 37	C	4,378	3,502	198,349
2-127-0117AU	Underhill—fern	FS	42	27	29 14 34	81 22 26	D	4,378	3,502	198,349
2-127-0117AU	Underhill—fern	FS	43	27	29 14 33	81 22 09	E	0	3,502	198,349
2-127-0117AU	Underhill—fern	FS	43	27	29 14 25	81 22 06	F	0	3,502	198,349
2-127-0117AU	Underhill—fern	FS	43	27	29 14 17	81 22 11	G	0	3,502	198,349
2-127-0118AN	GW from the Floridan aquifer—fern	FG	46	6	29 09 41	81 30 59	A	5,609	2,804	158,820
2-127-0118AN	GW from the Floridan aquifer—fern	FG	47	6	29 09 38	81 30 59	B	0	2,804	158,820
2-127-0120AUR	GW from the Floridan aquifer—fern	FG	46	20	29 12 11	81 24 59	A&B	1,496	1,496	84,704
2-127-0121AUR	GW from the Floridan aquifer—fern	FG	43	14	29 12 49	81 27 05	A	1,122	1,122	63,528
2-127-0122AUMR	GW from the Floridan aquifer—fern	FG	46	22	29 12 22	81 29 27	A	3,739	1,870	105,880
2-127-0122AUMR	GW from the Floridan aquifer—fern	FG	42	9	29 12 25	81 29 24	B	0	1,870	105,880
2-127-0123AU	GW from the Floridan aquifer—fern	FG	43	15	29 12 52	81 26 59	C	598	598	33,882
2-127-0123AU	GW from the Floridan aquifer—fern	FG	43	15	29 12 51	81 26 58	D	598	598	33,882
2-127-0123AU	GW from the Floridan aquifer—fern	FG	43	15	29 12 49	81 26 58	E	598	598	33,882
2-127-0123AURM	GW from the Floridan aquifer—fern	FG	43	15	29 12 52	81 26 55	A	598	598	33,882
2-127-0123AURM	GW from the Floridan aquifer—fern	FG	43	15	29 12 48	81 26 55	B	598	598	33,882
2-127-0124AUR	GW from the Floridan aquifer—fern	FG	69	28	29 01 09	81 15 10	A	561	561	31,764
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	44	17	29 12 32	81 25 49	A	2,150	1,229	69,578
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	44	17	29 12 28	81 25 49	B	2,150	1,229	69,578
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	44	18	29 12 32	81 25 40	C	2,150	1,229	69,578
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	44	18	29 12 28	81 25 40	D	2,150	1,229	69,578
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	45	17	29 12 22	81 25 52	E	0	1,229	69,578
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	45	17	29 12 21	81 25 50	F	0	1,229	69,578

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0125AUR	GW from the Floridan aquifer—fern	FG	44	18	29 12 30	81 25 40	G	0	1,229	69,578
2-127-0127AUR	GW from the Floridan aquifer—fern	FG	57	25	29 06 57	81 20 12	A	1,028	1,028	58,234
2-127-0128AUR	GW from the Floridan aquifer—fern	FG	60	22	29 04 49	81 20 49	A	748	748	42,352
2-127-0129AUR	GW from the Floridan aquifer—fern	FG	60	21	29 04 49	81 21 25	A	1,683	1,683	95,292
2-127-0130AUFM	Creel & North—fern	FS	25	13	29 19 38	81 30 17	A	0	1,309	74,116
2-127-0131AUNM3	Hagstrom—fern	FG	56	31	29 09 02	81 16 11	A	3,552	3,552	201,172
2-127-0131AUNM3	Hagstrom—fern	FG	57	30	29 08 05	81 16 38	B	3,552	3,552	201,172
2-127-0131AUNM3	Hagstrom—fern	FG	57	30	29 08 00	81 16 36	C	3,552	3,552	201,172
2-127-0132ANRM	Register—fern	FS	23	16	29 21 31	81 30 25	A	0	4,601	260,606
2-127-0132ANRM	Register—fern	FS	23	16	29 21 07	81 30 16	B	0	4,601	260,606
2-127-0133AUR	GW from the Floridan aquifer—fern	FG	47	9	29 10 17	81 28 48	A	1,589	1,589	89,998
2-127-0133AUR	GW from the Floridan aquifer—fern	FG	47	9	29 10 17	81 28 45	B	1,589	1,589	89,998
2-127-0134ANM3	Fern	FS	46	11	29 10 50	81 27 36	A	2,510	2,197	124,409
2-127-0134ANM3	Fern	FS	46	11	29 10 55	81 27 32	B	2,510	2,197	124,409
2-127-0134ANM3	Fern	FS	46	11	29 10 50	81 27 22	C	2,510	2,197	124,409
2-127-0134ANM3	Fern	FS	46	11	29 10 44	81 27 21	D	2,510	2,197	124,409
2-127-0134ANM3	Fern	FS	46	11	29 10 58	81 27 36	E	0	2,197	124,409
2-127-0135AU	GW from the Floridan aquifer—fern	FG	64	20	29 03 10	81 20 59	A	1,168	1,168	66,175
2-127-0135AUR	GW from the Floridan aquifer—fern	FG	64	20	29 03 08	81 20 57	B	1,168	1,168	66,175
2-127-0136AUR	GW from the Floridan aquifer—fern	FG	64	20	29 03 12	81 20 56	A	2,243	2,243	127,056
2-127-0137AN	GW from the Floridan aquifer—fern	FG	69	27	29 00 32	81 16 31	A	1,309	1,309	74,116
2-127-0137ANR	GW from the Floridan aquifer—fern	FG	69	27	29 00 25	81 16 31	B	1,309	1,309	74,116
2-127-0138AU	GW from Floridan aquifer/SW from pond—fern	FS	52	25	29 09 09	81 21 12	B	1,870	1,870	105,880
2-127-0138AU	GW from Floridan aquifer/SW from pond—fern	FS	52	25	29 09 15	81 21 13	A	1,870	1,870	105,880
2-127-0139ANM	GW from Floridan aquifer/SW from Shuman pond—citrus and fern	FS	50	26	29 10 04	81 21 11	A	1,122	897	50,822
2-127-0139ANM	GW from Floridan aquifer/SW from Shuman pond—citrus and fern	FS	50	26	29 09 50	81 21 16	B	0	897	50,822

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0139ANM	GW from Floridan aquifer/SW from Shuman pond—citrus and fern	FS	52	25	29 09 05	81 21 09	C	1,122	897	50,822
2-127-0140AU	GW from Floridan aquifer/SW from Lake Odom	FS	51	25	29 09 22	81 21 31	B	2,991	1,994	112,939
2-127-0140AU	GW from Floridan aquifer/SW from Lake Odom	FS	51	25	29 09 24	81 21 33	A	0	1,994	112,939
2-127-0143ANMR	Fern	FG	30	19	29 17 37	81 27 18	A	3,178	2,543	143,997
2-127-0143ANMR	Fern	FG	30	19	29 17 40	81 27 22	B	3,178	2,543	143,997
2-127-0143ANMR	Fern	FG	30	20	29 17 44	81 27 22	C	3,178	2,543	143,997
2-127-0143ANMR	Fern	FG	30	20	29 17 36	81 27 25	D	3,178	2,543	143,997
2-127-0143ANMR	Fern	FG	30	20	29 17 37	81 27 22	E	0	2,543	143,997
2-127-0144AU	GW from the Floridan aquifer	FG	68	18	29 00 40	81 20 27	A	3,365	3,365	190,584
2-127-0145AUM2R	GW from the Floridan aquifer—fern	FG	57	25	29 06 38	81 20 28	A	1,683	1,010	57,175
2-127-0145AUM2R	GW from the Floridan aquifer—fern	FG	57	25	29 06 38	81 20 28	C	0	1,010	57,175
2-127-0145AUM2R	GW from the Floridan aquifer—fern	FG	57	25	29 06 44	81 20 31	B	0	1,010	57,175
2-127-0145AUM2R	GW from the Floridan aquifer—fern	FG	57	25	29 06 43	81 20 32	D	1,683	1,010	57,175
2-127-0145AUM2R	GW from the Floridan aquifer—fern	FG	57	25	29 06 44	81 20 29	E	1,683	1,010	57,175
2-127-0147AU	GW from the Floridan aquifer—golf course	AG	70	41	29 04 23	81 03 05		9,951	9,951	0
2-127-0147AU	GW from the Floridan aquifer—golf course	AG	70	41	29 04 27	81 02 43		9,951	9,951	0
2-127-0147AU	GW from the Floridan aquifer—golf course	AG	70	41	29 04 27	81 02 43		9,951	9,951	0
2-127-0147AU	GW from the Floridan aquifer—golf course	AG	69	41	29 04 58	81 02 59		9,951	9,951	0
2-127-0148AUMR	GW from Floridan aquifer/SW from pond—fern	FS	64	27	29 03 49	81 18 05	A	1,371	1,371	77,645
2-127-0148AUMR	GW from Floridan aquifer/SW from pond—fern	FS	64	27	29 03 53	81 18 07	B	1,371	1,371	77,645
2-127-0149AN	GW from the Floridan aquifer—fern	FG	64	29	29 04 34	81 15 34	A	1,122	1,122	63,528
2-127-0151AURM	James O. Taylor—fern	FG	36	12	29 14 34	81 28 40	A	2,617	2,617	148,232

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0152ANR	James O. Taylor—fern	FG	35	21	29 15 41	81 25 54	A	3,365	3,365	190,584
2-127-0153AUMR	James O. Taylor—fern	FS	38	22	29 15 07	81 25 13	A	3,552	2,368	134,115
2-127-0153AUMR	James O. Taylor—fern	FS	38	22	29 15 03	81 25 18	B	0	2,368	134,115
2-127-0154AUR	James O. Taylor—fern	FG	40	20	29 14 20	81 25 47	A	3,365	3,365	190,584
2-127-0155AUR	James O. Taylor—fern	FG	41	19	29 13 57	81 25 49	A	2,804	2,804	158,820
2-127-0155AUR	James O. Taylor—fern	FG	41	19	29 13 52	81 25 46	B	2,804	2,804	158,820
2-127-0156AURM	James O. Taylor—fern	FG	38	18	29 14 43	81 26 27	A	2,991	2,991	169,408
2-127-0157AUR	James O. Taylor—fern	FG	37	18	29 14 58	81 26 29	A	374	374	21,176
2-127-0158AUR	James O. Taylor—fern	FG	36	19	29 15 15	81 26 31	A	995	995	56,328
2-127-0159AUR	James O. Taylor—fern	FG	36	17	29 14 59	81 26 56	A	1,496	1,496	84,704
2-127-0160AU	James O. Taylor—fern	FG	37	14	29 14 31	81 28 07	A	505	505	28,588
2-127-0160AURM	James O. Taylor—fern	FG	37	14	29 14 32	81 28 05	B	505	505	28,588
2-127-0161AUNR	Nursery—vegetables	AG	64	23	29 03 09	81 19 56	A	3,860	6,269	0
2-127-0161AUNR	Nursery—vegetables	AG	64	23	29 03 13	81 19 59	B	3,860	6,269	0
2-127-0161AUNR	Nursery—vegetables	AG	64	22	29 03 19	81 19 42	C	3,860	6,269	0
2-127-0161AUNR	Nursery—vegetables	AG	64	23	29 03 14	81 19 50	D	3,860	6,269	0
2-127-0161AUNR	Nursery—vegetables	AG	64	23	29 03 19	81 19 37	E	0	6,269	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 33	81 20 25	A	1,402	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 38	81 20 26	B	1,402	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 40	81 20 29	C	1,402	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 39	81 20 30	D	0	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 41	81 20 30	E	0	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 42	81 20 17	F	0	701	0
2-127-0162AN	Nursery—vegetables	FS	63	22	29 03 39	81 20 17	G	0	701	0
2-127-0165AUR	GW from the Floridan aquifer—fern	FG	35	18	29 15 19	81 26 41	A	3,739	3,739	211,760
2-127-0166AN	GW from the Floridan aquifer—fern	FG	37	24	29 15 34	81 24 23	A	6,263	4,175	236,465
2-127-0166AN	GW from the Floridan aquifer—fern	FG	37	24	29 15 35	81 24 12	C	0	4,175	236,465
2-127-0166AN	GW from the Floridan aquifer—fern	FG	38	24	29 15 30	81 24 13	B	6,263	4,175	236,465
2-127-0167AUR	GW from the Floridan aquifer—fern	FG	40	11	29 13 21	81 28 58	A	748	748	42,352
2-127-0168AUR	GW from the Floridan aquifer—fern	FG	38	19	29 14 49	81 26 12	A	2,243	2,243	127,056

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0171AU	GW from Floridan aquifer/SW from Bowman Lake	FS	37	22	29 15 16	81 25 31	A	2,991	2,991	169,408
2-127-0172ANM2R	GW from Floridan aquifer/SW from Bowman Lake	FS	37	22	29 15 10	81 25 32	A	1,122	1,122	63,528
2-127-0173AN	GW from Floridan aquifer/SW from pond—fern	FS	56	22	29 06 48	81 21 37	A	1,496	1,496	84,704
2-127-0174ANR	GW from the Floridan aquifer—fern	FG	29	18	29 18 17	81 28 04	A&B	8,974	8,974	508,224
2-127-0176AU	Hagstrom—fern	FG	57	22	29 06 08	81 21 35	A	1,870	1,870	105,880
2-127-0176AU	Hagstrom—fern	FG	58	22	29 06 08	81 21 31	B	1,870	1,870	105,880
2-127-0177AUNFM	Hagstrom—fern	FG	60	22	29 04 57	81 20 50	A	1,496	1,496	84,704
2-127-0178AU	Hagstrom—fern	FG	59	30	29 07 04	81 16 04	A	3,926	3,926	222,348
2-127-0178AU	Hagstrom—fern	FG	59	30	29 07 04	81 15 56	B	3,926	3,926	222,348
2-127-0179AUR	Hagstrom—fern	FG	40	15	29 14 28	81 25 53	A	1,870	1,870	105,880
2-127-0179AUR	Hagstrom—fern	FG	40	15	29 14 28	81 25 47	B	1,870	1,870	105,880
2-127-0180AUR	Hagstrom—fern	FS	41	15	29 13 40	81 27 18	A	2,804	2,804	158,820
2-127-0180AUR	Hagstrom—fern	FS	41	15	29 13 35	81 27 22	B	2,804	2,804	158,820
2-127-0181AUR	Hagstrom—fern	FG	38	18	29 14 50	81 26 26	A	6,730	6,730	381,168
2-127-0182AUMR	Hagstrom—fern	FS	40	15	29 13 50	81 27 28	A	1,558	1,558	88,233
2-127-0182AUMR	Hagstrom—fern	FS	40	15	29 13 56	81 27 25	B	1,558	1,558	88,233
2-127-0184AU	Hagstrom—fern	FG	39	18	29 14 33	81 26 23	A	1,870	1,870	105,880
2-127-0185AUR	Hagstrom—fern	FS	40	16	29 13 59	81 26 48	A	1,870	1,870	105,880
2-127-0186AU	GW from the Floridan aquifer—fern	FG	39	13	29 14 01	81 28 03	A	374	374	21,176
2-127-0187AU	GW from the Floridan aquifer—fern	FG	62	23	29 04 06	81 20 11	A	2,056	2,056	116,468
2-127-0187AU	GW from the Floridan aquifer—fern	FG	63	23	29 03 59	81 20 10	B	2,056	2,056	116,468
2-127-0188AU	GW from the Floridan aquifer—fern	FG	42	19	29 13 45	81 25 41	A	2,617	2,617	148,232
2-127-0189AU	GW from the Floridan aquifer—fern	FG	39	20	29 14 35	81 25 49	C	2,337	2,337	0
2-127-0189AU	GW from the Floridan aquifer—fern	FG	40	21	29 14 30	81 25 37	D	2,337	2,337	0
2-127-0189AUMR	GW from the Floridan aquifer—fern	FG	39	20	29 14 35	81 25 55	A	2,337	2,337	0
2-127-0189AUMR	GW from the Floridan aquifer—fern	FG	39	20	29 14 34	81 25 50	B	2,337	2,337	0
2-127-0190AUMR	GW from the Floridan aquifer—fern	FG	40	20	29 14 26	81 25 39	A	2,991	2,991	169,408
2-127-0191AN	GW from the Floridan aquifer—fern	FG	37	19	29 15 03	81 26 13	A	4,736	4,736	268,229

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-127-0191AN	GW from the Floridan aquifer—fern	FG	37	19	29 15 01	81 26 15	B	4,736	4,736	268,229
2-127-0191AUM2	GW from the Floridan aquifer—fern	FG	37	19	29 15 01	81 26 15	C&D	4,736	4,736	268,229
2-127-0192ANM	GW from Floridan aquifer/SW from pond—fern	FS	37	16	29 14 47	81 27 22	B	0	312	17,647
2-127-0192ANMR	GW from Floridan aquifer/SW from pond—fern	FS	36	16	29 14 49	81 27 24	A	467	312	17,647
2-127-0193AN	GW from the Floridan aquifer—fern	FG	57	24	29 06 42	81 20 42	A	1,608	1,608	91,057
2-127-0194AUR	Floral Greens International	FG	55	27	29 08 18	81 19 47	A	1,346	1,346	76,234
2-127-0194AUR	Floral Greens International	FG	55	27	29 08 18	81 19 45	B	1,346	1,346	76,234
2-127-0194AUR	Floral Greens International	FG	55	27	29 08 15	81 19 44	C	1,346	1,346	76,234
2-127-0194AUR	Floral Greens International	FG	60	25	29 0515	81 19 48	D	1,346	1,346	76,234
2-127-0194AUR	Floral Greens International	FG	55	27	29 08 13	81 19 48	E	1,346	1,346	76,234
2-127-0195AUR	Floral Greens International	FG	54	28	29 08 50	81 19 00	A	5,609	5,609	317,640
2-127-0196AUR	GW from the Floridan aquifer—fern	FG	48	28	29 11 52	81 19 50	B	3,926	3,926	222,348
2-127-0196AUR	GW from the Floridan aquifer—fern	FG	48	28	29 11 58	81 19 52	A	3,178	3,178	179,996
2-127-0197AU	GW from the Floridan aquifer—fern	FG	55	29	29 08 57	81 17 55	A	3,739	3,739	211,760
2-127-0198AU	Floral Greens International	FG	57	30	29 07 52	81 16 27	C	0	2,524	142,938
2-127-0198AU	Floral Greens International	FG	58	30	29 07 46	81 16 20	D	0	2,524	142,938
2-127-0198AUR	Floral Greens International	FG	57	30	29 07 49	81 16 30	A	5,048	2,524	142,938
2-127-0198AUR	Floral Greens International	FG	57	30	29 07 55	81 16 15	B	5,048	2,524	142,938
2-127-0199ANM	Fern	FG	38	17	29 14 39	81 26 37	A&B	4,113	4,113	232,936
2-127-0200AU	Fern	FG	55	29	29 08 47	81 17 48	A	5,235	5,235	296,464
2-127-0201AU	Burnsed Ferneries	FG	35	17	29 15 13	81 27 07	A	748	748	42,352
2-127-0202AU	Burnsed Ferneries	FG	41	19	29 14 01	81 25 58	A	1,496	1,496	84,704
2-127-0203AU	Burnsed Ferneries	FG	36	19	29 15 22	81 26 20	A	2,991	2,991	169,408
2-127-0204AN	Burnsed Ferneries	FG	35	19	29 15 30	81 26 24	A	4,674	4,674	264,700
2-127-0204AN	Burnsed Ferneries	FG	35	20	29 15 33	81 26 09	B	4,674	4,674	264,700
2-127-0205AU	Burnsed Ferneries	FG	36	19	29 15 22	81 26 24	A	2,243	2,243	127,056
2-127-0206AN	Fern	FS	26	13	29 18 59	81 30 37	A	0	561	31,764
2-127-0208AU	GW from the Floridan aquifer—fern	FG	36	20	29 15 26	81 26 12	A	4,113	4,113	232,936
2-127-0209AN	Fern—Mason	FG	37	17	29 14 51	81 26 53	A	427	374	21,176

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0209AN	Fern—Mason	FG	37	17	29 14 51	81 26 58	B	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 51	81 26 56	C	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 50	81 27 00	D	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 49	81 26 57	E	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 53	81 26 55	F	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 53	81 26 53	G	427	374	21,176
2-127-0209AN	Fern—Mason	FG	37	17	29 14 52	81 26 56	H	0	374	21,176
2-127-0210AU	Woody ornamentals	AG	35	17	29 15 12	81 26 57	A	581	6,146	0
2-127-0211AN	GW from the Floridan aquifer—fern	FG	64	26	29 03 53	81 18 11	A	2,991	2,991	169,408
2-127-0212AN	GW from the Floridan aquifer—fern	FG	38	14	29 14 13	81 27 42	A&B	1,870	1,870	105,880
2-127-0213ANMF	GW from Floridan aquifer/SW from Lake Alice	FG	38	15	29 14 21	81 27 29	A	2,056	2,056	116,468
2-127-0213ANMF	GW from Floridan aquifer/SW from Lake Alice	FG	38	15	29 14 18	81 27 22	B	748	748	42,352
2-127-0215AUR	GW from the Floridan aquifer—fern	FG	35	21	29 15 34	81 26 03	A	4,611	4,611	261,171
2-127-0215AUR	GW from the Floridan aquifer—fern	FG	33	13	29 15 32	81 25 56	B	4,611	4,611	261,171
2-127-0215AUR	GW from the Floridan aquifer—fern	FG	36	21	29 15 25	81 25 58	C	4,611	4,611	261,171
2-127-0216AU	GW from the Floridan aquifer—fern	FG	63	21	29 03 33	81 20 43	B	1,059	1,059	59,999
2-127-0216AU	GW from the Floridan aquifer—fern	FG	63	21	29 03 33	81 20 42	A	1,059	1,059	59,999
2-127-0216AU	GW from the Floridan aquifer—fern	FG	63	21	29 03 27	81 20 45	C	1,059	1,059	59,999
2-127-0217ANF	Hall Ferneries	FG	63	22	29 03 44	81 20 34	A	0	2,991	169,408
2-127-0218AU	Hall Ferneries	FS	60	21	29 04 54	81 21 24	A	1,309	1,309	74,116
2-127-0220AN	P. Booker—fern, citrus	FG	59	21	29 05 11	81 21 38	A	3,552	2,368	134,115
2-127-0220AN	P. Booker—fern, citrus	FG	59	21	29 05 10	81 21 43	B	3,552	2,368	134,115
2-127-0220AN	P. Booker—fern, citrus	FG	59	21	29 05 11	81 21 32	C	0	2,368	134,115
2-127-0221AN	Stone—fern	FG	30	22	29 17 45	81 26 34	A	3,240	2,430	137,644
2-127-0221AN	Stone—fern	FG	30	22	29 17 39	81 26 34	B	3,240	2,430	137,644
2-127-0221AN	Stone—fern	FG	31	21	29 17 32	81 26 33	C	3,240	2,430	137,644
2-127-0221AN	Stone—fern	FG	30	21	29 17 45	81 26 34	D	0	2,430	137,644
2-127-0223AN	GW from the Floridan aquifer—fern	FG	35	17	29 15 20	81 27 11	A&C	748	748	42,352
2-127-0223AN	GW from the Floridan aquifer—fern	FG	35	17	29 15 20	81 27 06	B	748	748	42,352

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 26	81 28 47	A	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 21	81 28 47	B	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 23	81 28 44	C	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 24	81 28 39	D	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 27	81 28 40	E	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	13	29 15 32	81 28 38	F	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	14	29 15 29	81 28 35	G	935	935	52,940
2-127-0224AUR	Bennett—fern	FG	33	14	29 15 29	81 28 31	H	935	935	52,940
2-127-0225AU	Bennett—fern	FS	42	11	29 12 43	81 28 26	A	2,617	1,745	98,821
2-127-0225AU	Bennett—fern	FS	42	11	29 12 40	81 28 26	B	0	1,745	98,821
2-127-0226AN	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 03	81 17 13	A	3,739	2,493	141,173
2-127-0226AN	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 10	81 17 05	B	0	2,493	141,173
2-127-0227AN	GW from the Floridan aquifer—fern	FG	57	22	29 06 19	81 21 21	A	3,178	3,178	179,996
2-127-0228AN	GW from Floridan aquifer/SW from pond—fern	FS	56	30	29 08 53	81 16 43	A	1,683	1,683	95,292
2-127-0229AUR	GW from the Floridan aquifer—fern	FG	56	27	29 07 57	81 18 54	A	1,122	1,122	63,528
2-127-0230AUR	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 10	81 16 52	A	4,487	4,487	254,112
2-127-0230AUR	GW from Floridan aquifer/SW from pond—fern	FS	55	30	29 09 11	81 17 00	B	4,487	4,487	254,112
2-127-0231AN	Fern	FG	52	25	29 09 06	81 21 30	A&B	187	187	10,588
2-127-0232AU	GW from the Floridan aquifer	FG	35	18	29 15 20	81 26 52	A	561	561	31,764
2-127-0233AU	GW from Floridan aquifer/SW from pond—fern	FS	60	30	29 06 27	81 15 52	A	3,116	3,116	176,467
2-127-0234ANM	G. James—fern	FS	38	22	29 15 08	81 24 54	A	0	3,583	202,937
2-127-0234ANM	G. James—fern	FS	40	23	29 14 52	81 24 28	B	0	3,583	202,937
2-127-0234ANM	G. James—fern	FS	40	23	29 14 52	81 24 19	C	0	3,583	202,937
2-127-0234ANM	G. James—fern	FS	40	23	29 14 51	81 24 38	D	0	3,583	202,937
2-127-0234ANM	G. James—fern	FS	40	24	29 14 48	81 24 10	E	0	3,583	202,937

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-127-0235AN	Fern	FG	56	29	29 08 13	81 17 38	B	2,243	2,243	127,056
2-127-0236AN	Kirkland Sod	AG	76	38	29 00 22	81 06 16		17,901	17,901	0
2-127-0236AN	Kirkland Sod	AG	75	38	29 00 50	81 06 23		17,901	17,901	0
2-127-0236AN	Kirkland Sod	AG	75	38	29 00 55	81 05 57		17,901	17,901	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	70	41	29 03 53	81 02 22		3,770	3,770	288,770
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	72	41	29 03 11	81 01 45		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		3,770	3,770	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 27	81 02 05		0	0	0
2-127-0237AN	GW from Floridan aquifer/SW from shallow aquifer—sod	AGS	71	41	29 03 52	81 01 48		0	0	0
2-127-0238AU	GW from the Floridan aquifer—fern	FG	59	24	29 05 54	81 20 31	A	1,972	1,972	111,703
2-127-0238NM	GW from the Floridan aquifer—fern	FG	59	24	29 05 52	81 20 36	B	1,972	1,972	111,703
2-127-0240AN	GW from Floridan aquifer/SW from pond—fern	FS	56	30	29 08 49	81 16 24	A&B	1,246	1,246	70,587
2-127-0241ANM	Jones—fern	FG	40	18	29 14 04	81 26 28	A	0	855	48,402
2-127-0241ANM	Jones—fern	FG	40	18	29 14 06	81 26 25	B	0	855	48,402
2-127-0241ANM	Jones—fern	FG	40	17	29 14 07	81 26 34	E	1,196	855	48,402
2-127-0241ANM	Jones—fern	FG	40	17	29 14 03	81 26 30	F	1,196	855	48,402
2-127-0241ANM	Jones—fern	FG	40	17	29 14 05	81 26 23	G	1,196	855	48,402
2-127-0243AU	Jones—fern	FG	45	29	29 14 05	81 19 34	A&B	1,870	1,870	105,880
2-127-0244AN	Fern	FG	35	19	29 15 28	81 26 32	A	7,478	7,478	423,520
2-127-0247AN	GW from the Floridan aquifer—fern	FG	49	29	29 11 21	81 18 44	A	1,870	1,870	0
2-127-0248AU	GW from the Floridan aquifer—fern	FG	66	23	29 02 24	81 19 18	A	2,243	2,243	127,056
2-127-0249AN	GW from the Floridan aquifer—fern	FG	38	11	29 13 58	81 28 49	A	1,122	1,122	63,528
2-127-0253AN	GW from Floridan aquifer/SW from lake—fern	FS	42	20	29 13 53	81 25 25	A	2,742	2,742	155,291

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0253AN	GW from Floridan aquifer/SW from lake—fern	FS	42	20	29 13 59	81 25 26	B	2,742	2,742	155,291
2-127-0255AN	Blackwelder	FG	54	26	29 08 29	81 20 27	A	2,617	2,617	148,232
2-127-0256AN	Blackwelder	AG	52	26	29 09 14	81 20 31	A	790	790	0
2-127-0256AN	Blackwelder	AG	53	26	29 09 11	81 20 26	B	790	790	0
2-127-0257AU	Kepler—fern	FG	50	26	29 10 07	81 21 10	A	1,122	1,122	63,528
2-127-0258AN	Kepler—fern and citrus	FS	50	27	29 10 03	81 20 42	A&B	0	1,683	95,292
2-127-0259AN	Lawrence—fern	FS	48	29	29 12 08	81 18 57	A	4,754	4,160	235,583
2-127-0259AN	Lawrence—fern	FS	48	29	29 12 10	81 18 57	B	4,754	4,160	235,583
2-127-0259AN	Lawrence—fern	FS	48	29	29 12 10	81 19 07	C	4,754	4,160	235,583
2-127-0259AN	Lawrence—fern	FS	48	29	29 11 53	81 19 26	D	0	4,160	235,583
2-127-0260AU	GW from the Floridan aquifer—fern	FG	64	21	29 03 11	81 20 43	A	2,337	2,337	132,350
2-127-0260AU	GW from the Floridan aquifer—fern	FG	64	21	29 03 20	81 20 37	B	2,337	2,337	132,350
2-127-0261AUM	GW from Floridan aquifer/SW from Lake Sixma	FS	78	28	28 56 31	81 13 06	A	748	748	42,352
2-127-0262ANR	Fern	FG	58	29	29 07 27	81 16 49	A	2,991	2,991	169,408
2-127-0263AU	Fern	FG	60	22	29 04 56	81 20 41	A	1,664	1,664	94,233
2-127-0263AU	Fern	FG	60	23	29 04 56	81 20 36	B	1,664	1,664	94,233
2-127-0264AN	GW from the Floridan aquifer—fern	FG	45	11	29 11 23	81 27 58	A	1,122	1,122	63,528
2-127-0265AUR	GW from the Floridan aquifer—fern	FG	36	17	29 15 04	81 27 01	A	1,683	1,683	95,292
2-127-0266AU	GW from the Floridan aquifer—fern	FG	35	19	29 15 22	81 26 30	A	1,542	1,542	87,351
2-127-0266AU	GW from the Floridan aquifer—fern	FG	36	19	29 15 18	81 26 32	B	1,542	1,542	87,351
2-127-0267AU	GW from Floridan aquifer/SW from Lake Sixma	FG	47	9	29 10 04	81 28 46	A	1,870	1,870	105,880
2-127-0268AU	GW from the Floridan aquifer—fern	FG	47	9	29 09 52	81 28 21	A&B	4,113	4,113	232,936
2-127-0269AN	Riviera County Club golf course	AG	51	43	29 15 24	81 03 51		6,283	6,283	0
2-127-0269AN	Riviera County Club golf course	AG	51	43	29 15 28	81 03 34		6,283	6,283	0
2-127-0269AN	Riviera County Club golf course	AG	51	43	29 15 31	81 03 16		6,283	6,283	0
2-127-0270AN	GW from the Floridan aquifer—fern	AG	49	29	29 11 04	81 19 07	A	6,482	3,241	0
2-127-0270AN	GW from the Floridan aquifer—fern	AG	49	28	29 10 56	81 19 09	B	0	3,241	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0271AU	GW from the Floridan aquifer—fern	FG	43	14	29 12 41	81 27 13	A	232	232	13,129
2-127-0272AN	GW from Floridan aquifer/SW from Lakes Vernon and Inez—fern	FS	43	16	29 12 47	81 26 43	A	523	523	29,646
2-127-0274AU	GW from Floridan aquifer/SW from pond—fern	FS	57	25	29 06 39	81 20 09	A	1,496	1,496	84,704
2-127-0277AN	Foliage	AG	66	20	29 02 01	81 20 31	B	0	3,316	0
2-127-0277AN	GW from the Floridan aquifer—foliage	AG	66	20	29 02 03	81 20 32	A	6,632	3,316	0
2-127-0279AU	Golf course	AGS	64	44	29 09 58	80 58 51		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 09 59	80 58 50		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 00	80 58 53		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 01	80 58 44		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 02	80 58 43		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 03	80 58 46		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 04	80 58 50		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 05	80 58 48		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 05	80 58 47		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 07	80 58 48		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 08	80 58 48		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 09	80 58 49		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 10	80 58 50		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 11	80 58 57		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 11	80 58 56		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 12	80 58 51		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 14	80 58 53		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 16	80 58 54		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 16	80 58 54		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 18	80 58 56		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 19	80 58 56		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 19	80 58 55		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 20	80 58 57		0	0	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-127-0279AU	Golf course	AGS	64	44	29 10 21	80 58 58		0	0	0
2-127-0279AU	Golf course	AGS	64	44	29 10 21	80 58 58		0	0	0
2-127-0281AU	GW from the Floridan aquifer—fern	FG	32	21	29 16 58	81 26 32	A	1,496	1,496	84,704
2-127-0282AN	GW from the Floridan aquifer—fern	FG	35	12	29 14 48	81 29 01	A	499	499	28,235
2-127-0282AN	GW from the Floridan aquifer—fern	FG	35	12	29 14 50	81 29 02	B&C	499	499	28,235
2-127-0282AN	GW from the Floridan aquifer—fern	FG	35	12	29 14 51	81 28 59	D	499	499	28,235
2-127-0283AU	GW from the Floridan aquifer—fern	FG	39	18	29 14 36	81 26 24	C	0	1,246	70,587
2-127-0283AU	GW from the Floridan aquifer—fern	FG	38	18	29 14 38	81 26 24	A	3,739	1,246	70,587
2-127-0283AU	GW from the Floridan aquifer—fern	FG	39	18	29 14 36	81 26 18	B	0	1,246	70,587
2-127-0284ANF	GW from the Floridan aquifer—fern	FG	53	26	29 08 59	81 20 49	A	2,991	1,496	84,704
2-127-0284ANF	GW from the Floridan aquifer—fern	FG	53	26	29 08 58	81 20 41	B	0	1,496	84,704
2-127-0285AU	GW from the Floridan aquifer—fern	FG	57	29	29 08 01	81 17 31	B	2,804	2,804	158,820
2-127-0285AU	GW from the Floridan aquifer—fern	FG	57	29	29 08 07	81 17 23	A	2,804	2,804	158,820
2-127-0287AN	GW from the Floridan aquifer—fern	FG	52	26	29 09 15	81 20 33	A	7,478	3,739	211,760
2-127-0287AN	GW from the Floridan aquifer—fern	FG	53	26	29 09 08	81 20 24	B	0	3,739	211,760
2-127-0289AU	GW from Floridan aquifer/SW from pond—fern	FG	23	17	29 21 14	81 29 50	A	4,206	3,365	190,584
2-127-0289AU	GW from Floridan aquifer/SW from pond—fern	FG	23	17	29 21 18	81 29 46	B	0	3,365	190,584
2-127-0289AU	GW from Floridan aquifer/SW from pond—fern	FG	23	17	29 21 27	81 30 00	C	4,206	3,365	190,584
2-127-0290AN	GW from the Floridan aquifer—fern	FG	66	19	29 01 56	81 20 41	A	1,683	1,683	95,292
2-127-0291AN	GW from the Floridan aquifer—fern	FG	24	12	29 19 48	81 31 03	A	8,974	4,487	254,112
2-127-0291AN	GW from the Floridan aquifer—fern	FG	24	12	29 19 35	81 31 03	B	0	4,487	254,112
2-127-0291AN	GW from the Floridan aquifer—fern	FG	24	12	29 19 54	81 31 05	C	0	4,487	254,112
2-127-0291AN	GW from the Floridan aquifer—fern	FG	24	12	29 19 53	81 30 56	D	8,974	4,487	254,112
2-127-0292AUMR	Deltona Golf Club	AG	79	27	28 55 31	81 14 04	A	11,292	5,646	0
2-127-0292AUMR	Deltona Golf Club	AG	78	27	28 55 43	81 14 18	B	11,292	5,646	0
2-127-0292AUMR	Deltona Golf Club	AG	78	27	28 55 31	81 14 04	C	11,292	5,646	0
2-127-0293AU	GW from the Floridan aquifer—fern	FG	57	28	29 07 38	81 18 08	A	2,991	2,991	169,408

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0295AU	GW from the Floridan aquifer—fern	FG	54	25	29 08 15	81 21 08	A	710	710	40,234
2-127-0297AU	Pasture and fern	AGS	47	28	29 12 57	81 20 18	A	3,978	2,984	142,938
2-127-0297AU	Pasture and fern	AGS	47	28	29 12 46	81 20 15	B	3,978	2,984	142,938
2-127-0300AU	GW from the Floridan aquifer—fern	FG	45	21	29 12 25	81 24 33	A	1,496	1,496	84,704
2-127-0301AU	GW from the Floridan aquifer—fern	FG	27	14	29 18 53	81 29 38	A	1,683	1,683	95,292
2-127-0302AU	GW from the Floridan aquifer—fern	FG	33	13	29 15 43	81 29 03	A	3,739	3,739	211,760
2-127-0303AU	GW from the Floridan aquifer—fern	FG	69	19	28 59 51	81 20 05	B	467	467	26,470
2-127-0303AU	GW from the Floridan aquifer—fern	FG	69	19	28 59 53	81 20 05	A	467	467	26,470
2-127-0304AU	GW from the Floridan aquifer—fern	FG	57	22	29 06 11	81 21 43	A	2,991	2,991	169,408
2-127-0306AU	GW from the Floridan aquifer—fern	FG	37	14	29 14 30	81 27 58	A	1,870	1,870	105,880
2-127-0307AU	GW from the Floridan aquifer—fern	FG	32	13	29 15 58	81 28 48	A	1,402	1,402	79,410
2-127-0308AN	GW from Floridan aquifer/SW from pond—fern	FS	23	12	29 20 30	81 31 16	A	2,056	2,056	116,468
2-127-0308AN	GW from Floridan aquifer/SW from pond—fern	FS	23	12	29 20 17	81 31 07	C	2,056	2,056	116,468
2-127-0308AN	GW from Floridan aquifer/SW from pond—fern	FS	23	12	29 20 27	81 31 11	B	2,056	2,056	116,468
2-127-0309AU	GW from the Floridan aquifer—fern	FG	26	13	29 18 46	81 30 09	A	841	841	47,646
2-127-0310AN	GW from the Floridan aquifer—fern	FG	40	17	29 14 16	81 26 33	A&B	4,861	4,861	275,288
2-127-0312AU	GW from Floridan aquifer/SW from pond—fern	FS	22	19	29 22 03	81 29 24	A	0	654	37,058
2-127-0314AU	GW from the Floridan aquifer—fern	FG	45	16	29 12 06	81 26 02	A	1,402	1,402	79,410
2-127-0314AU	GW from the Floridan aquifer—fern	FG	45	17	29 12 06	81 25 57	B	1,402	1,402	79,410
2-127-0315AU	J. Taylor—fern	FS	36	12	29 14 32	81 28 54	A	3,402	2,835	160,585
2-127-0315AU	J. Taylor—fern	FS	35	12	29 14 37	81 28 57	B	0	2,835	160,585
2-127-0315AU	J. Taylor—fern	FS	35	12	29 14 42	81 28 53	C	3,402	2,835	160,585
2-127-0315AU	J. Taylor—fern	FS	36	10	29 14 21	81 29 26	D	3,402	2,835	160,585
2-127-0315AU	J. Taylor—fern	FS	35	12	29 14 52	81 28 55	E	3,402	2,835	160,585
2-127-0315AU	J. Taylor—fern	FS	36	11	29 14 36	81 28 50	F	0	2,835	160,585
2-127-0316AUMR	Shaffer—fern	FS	37	20	29 15 09	81 26 04	A	935	935	52,940

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0317AU	Shaffer—fern	FG	40	19	29 14 13	81 25 51	A	1,309	1,309	74,116
2-127-0318AN	GW from the Floridan aquifer—fern	FG	34	11	29 15 02	81 29 12	A	2,290	2,290	129,703
2-127-0318AN	GW from the Floridan aquifer—fern	FG	34	11	29 14 53	81 29 13	B	2,290	2,290	129,703
2-127-0319AU	GW from the Floridan aquifer—fern	FG	36	13	29 14 37	81 28 30	B	1,683	1,683	95,292
2-127-0319AU	GW from the Floridan aquifer—fern	FG	36	13	29 14 39	81 28 27	A	1,683	1,683	95,292
2-127-0323AU	GW from Floridan aquifer/SW from Lake Botts	FS	41	14	29 13 22	81 27 20	A	997	997	56,469
2-127-0324AU	GW from the Floridan aquifer—fern	FG	36	18	29 15 13	81 26 46	A	0	0	0
2-127-0327AN	GW from the Floridan aquifer—fern	FG	37	16	29 14 48	81 27 09	A&B	748	748	42,352
2-127-0328AN	GW from Floridan aquifer/SW from pond—fern	FS	40	11	29 13 18	81 28 48	A	748	748	42,352
2-127-0329AN	GW from Floridan aquifer/SW from pond—fern	FS	43	10	29 12 02	81 28 25	A	0	0	0
2-127-0331AU	Zurel & Co.	FG	33	13	29 15 37	81 28 41	A	2,243	2,243	127,056
2-127-0331AU	Zurel & Co.	FG	33	13	29 15 35	81 28 40	B	2,243	2,243	127,056
2-127-0332AU	Zurel & Co.	FG	46	19	29 12 01	81 25 11	A	1,122	1,122	63,528
2-127-0332AU	Zurel & Co.	FG	46	18	29 11 58	81 25 12	B	1,122	1,122	63,528
2-127-0333AU	GW from the Floridan aquifer—fern	FG	58	25	29 06 27	81 20 17	A	3,365	3,365	190,584
2-127-0334AU	GW from the Floridan aquifer—fern	FG	45	13	29 11 36	81 27 09	A	1,122	1,122	63,528
2-127-0335AU	GW from the Floridan aquifer—fern	FG	72	23	28 58 17	81 17 27	A	1,496	1,496	84,704
2-127-0335AU	GW from the Floridan aquifer—fern	FG	72	23	28 58 16	81 17 25	B	1,496	1,496	84,704
2-127-0336AN	GW from Floridan aquifer/SW from Tuie Lake	FS	36	18	29 15 08	81 26 40	A	1,557	1,557	88,198
2-127-0337AU	GW from the Floridan aquifer—fern	FG	36	16	29 14 52	81 27 28	A	1,870	1,870	105,880
2-127-0338AU	GW from Floridan aquifer/SW from pond—fern	FS	39	20	29 14 42	81 25 51	A	1,870	1,870	105,880
2-127-0339AN	GW from Floridan aquifer/SW from pond—fern	FS	35	22	29 15 43	81 25 42	A	2,243	2,243	127,056
2-127-0339AN	GW from Floridan aquifer/SW from pond—fern	FS	35	22	29 15 39	81 25 43	B	2,243	2,243	127,056

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-127-0339AN	GW from Floridan aquifer/SW from pond—fern	FS	35	22	29 15 39	81 25 43	C&D	2,243	2,243	127,056
2-127-0340AU	GW from Floridan aquifer/SW from Cooter Pond—fern	FS	46	9	29 10 50	81 28 58	A	1,683	1,683	95,292
2-127-0341AU	GW from the Floridan aquifer—fern	FG	44	9	29 11 22	81 29 08	A	2,991	2,991	169,408
2-127-0342AU	GW from Floridan aquifer/SW from Stone Pond—fern	FS	45	9	29 11 16	81 29 00	A	280	280	15,882
2-127-0344AN	GW from Floridan aquifer/SW from Lake Emporia—fern	FS	44	10	29 11 48	81 28 28	A&B	623	623	35,293
2-127-0345AN	Fern	FS	35	18	29 15 30	81 26 41	A	0	1,496	84,704
2-127-0346AU	GW from Floridan aquifer/SW from pond—fern	FS	40	11	29 13 18	81 28 56	A	467	467	26,470
2-127-0347AU	GW from the Floridan aquifer—fern	FG	43	9	29 11 55	81 29 27	A	2,243	2,243	127,056
2-127-0347AU	GW from the Floridan aquifer—fern	FG	43	9	29 11 48	81 29 25	B	2,243	2,243	127,056
2-127-0349ANM	Fern	FG	59	26	29 06 07	81 19 25	A	0	1,496	0
2-127-0349ANM	Fern	FG	59	26	29 06 07	81 19 22	B	0	1,496	0
2-127-0349ANM	Fern	FG	59	26	29 06 07	81 19 20	C	0	1,496	0
2-127-0349ANM	Fern	FG	59	26	29 06 07	81 19 16	D	0	1,496	0
2-127-0349ANM	Fern	FG	59	26	29 06 07	81 19 13	E	7,478	1,496	0
2-127-0350AU	GW from the Floridan aquifer—fern	FG	64	20	29 03 14	81 21 03	A	1,122	1,122	63,528
2-127-0351AU	GW from the Floridan aquifer—fern	FG	43	11	29 12 21	81 28 24	A	561	561	31,764
2-127-0352AN	Richardson—fern	FS	42	9	29 12 14	81 29 18	A	1,589	1,589	89,998
2-127-0352AN	Richardson—fern	FS	42	10	29 12 17	81 29 12	B	1,589	1,589	89,998
2-127-0352AN	Richardson—fern	FS	42	9	29 12 13	81 29 13	C	1,589	1,589	89,998
2-127-0354AN	Sugar Mill Country Club—golf course	AG	76	42	29 02 10	80 58 52		8,469	8,469	154,010
2-127-0354AN	Sugar Mill Country Club—golf course	AG	75	42	29 02 41	80 59 29		8,469	8,469	0
2-127-0354AN	Sugar Mill Country Club—golf course	AG	75	42	29 02 42	80 59 31		8,469	8,469	0
2-127-0355AU	GW from the Floridan aquifer—fern	FG	26	15	29 19 00	81 29 28	A	187	187	10,588

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0357AU	GW from the Floridan aquifer—fern	FG	66	23	29 02 14	81 19 23	A	654	654	37,058
2-127-0357AU	GW from the Floridan aquifer—fern	FG	66	23	29 02 11	81 19 22	B	654	654	37,058
2-127-0358AU	GW from the Floridan aquifer—fern	FG	43	10	29 11 57	81 28 39	B	1,309	654	37,058
2-127-0358AU	GW from the Floridan aquifer—fern	FG	44	10	29 11 53	81 28 40	A	0	654	37,058
2-127-0360AU	GW from the Floridan aquifer—fern	FG	30	18	29 17 25	81 27 44	A	2,243	2,243	127,056
2-127-0361AN	Fern	FS	46	9	29 10 29	81 29 08	A	0	523	29,646
2-127-0361AN	Fern	FS	46	9	29 10 29	81 29 13	B	0	523	29,646
2-127-0361AN	Fern	FS	46	9	29 10 31	81 29 08	C	0	523	29,646
2-127-0361AN	Fern	FS	46	9	29 10 30	81 28 55	D	0	523	29,646
2-127-0362AU	Fern	FG	46	19	29 11 56	81 25 09	A	561	561	31,764
2-127-0363AN	Fern	FS	46	9	29 10 28	81 29 13	A	5,609	5,609	317,640
2-127-0366AU	GW from the Floridan aquifer—foliage	AG	45	22	29 12 38	81 24 27	A	5,481	5,481	211,760
2-127-0367AUR	GW from the Floridan aquifer—fern	FG	27	18	29 19 09	81 28 20	A	1,570	1,570	88,939
2-127-0368ANM2R	Cont. Floral Greens	FS	59	21	29 05 28	81 21 41		3,272	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	59	21	29 05 29	81 21 47		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	59	21	29 05 29	81 21 44		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 36	81 21 50		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 40	81 21 40		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 40	81 21 40		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	22	29 05 40	81 21 27		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 43	81 21 37		3,272	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 45	81 21 45		0	1,091	61,763
2-127-0368ANM2R	Cont. Floral Greens	FS	58	21	29 05 49	81 21 49		0	1,091	61,763
2-127-0369AU	GW from Floridan aquifer/SW from pond—fern	FS	59	30	29 07 04	81 15 53	A	2,243	2,243	127,056
2-127-0370AU	Lawrence-Sunridge Fern	FS	62	29	29 05 50	81 16 01	A	2,094	2,094	118,586
2-127-0370AU	Lawrence-Sunridge Fern	FS	62	29	29 05 46	81 16 01	B	2,094	2,094	118,586
2-127-0370AU	Lawrence-Sunridge Fern	FS	61	29	29 05 52	81 16 10	C	2,094	2,094	118,586
2-127-0370AU	Lawrence-Sunridge Fern	FS	62	29	29 05 32	81 16 16	D	2,094	2,094	118,586
2-127-0372AU	Lawrence-Sunridge Fern	FG	56	29	29 08 19	81 17 59	A	2,991	2,991	169,408

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft³/day)	2010 Estimated Withdrawal (ft³/day)	Estimated Frost-Freeze Withdrawal (ft³/day)
2-127-0374AU	Lawrence-Sunridge Fern	FG	56	25	29 07 09	81 20 27	A	841	841	47,646
2-127-0374AU	Lawrence-Sunridge Fern	FG	56	25	29 07 12	81 20 29	B	0	841	47,646
2-127-0375AUNF	Lawrence-Sunridge Fern	FG	57	22	29 06 43	81 21 37	A	1,870	1,870	105,880
2-127-0376AU	GW from the Floridan aquifer	FG	27	15	29 18 45	81 29 19	A	935	935	52,940
2-127-0377AU	GW from Floridan aquifer/SW from pond—fern	FS	37	11	29 14 03	81 29 08	A&B	499	499	28,235
2-127-0379AN	Tedder Groves—citrus and fern	AG	53	29	29 09 39	81 17 46	A	6,158	3,079	96,257
2-127-0379AN	Tedder Groves—citrus and fern	AG	54	30	29 09 32	81 17 27	B	6,158	3,079	250,267
2-127-0379AN	Tedder Groves—citrus and fern	AG	54	29	29 09 38	81 17 33	C	0	3,079	231,016
2-127-0379AN	Tedder Groves—citrus and fern	AG	54	29	29 09 26	81 17 21	D	0	3,079	250,267
2-127-0380AU	GW from the Floridan aquifer—fern	FG	67	19	29 01 30	81 20 31	A	1,496	1,496	84,704
2-127-0381AN	Fern	FG	57	26	29 07 02	81 19 41	A	2,804	2,804	158,820
2-127-0381AN	Fern	FG	57	26	29 06 52	81 19 40	C	0	2,804	158,820
2-127-0383AU	GW from the Floridan aquifer—fern	FG	47	17	29 11 03	81 25 12	A	1,496	1,496	84,704
2-127-0384AU	GW from the Floridan aquifer—pasture	AG	23	10	29 19 59	81 32 00	A	7,885	7,885	0
2-127-0385AU	GW from the Floridan aquifer—fern	FS	30	21	29 17 40	81 26 48	A	7,229	7,229	409,403
2-127-0386AUR	GW from the Floridan aquifer—fern	FS	39	19	29 14 41	81 26 15	A	0	748	42,352
2-127-0389AUMR	GW from the Floridan aquifer—fern	FG	30	17	29 17 17	81 27 57	A	0	0	0
2-127-0389AUMR	GW from the Floridan aquifer—fern	FG	31	17	29 17 09	81 27 57	B	0	0	0
2-127-0390AN	Alpha Fern Co.	FS	45	19	29 12 19	81 25 11	A	2,238	1,958	110,909
2-127-0390AN	Alpha Fern Co.	FS	45	19	29 12 20	81 25 02	B	2,238	1,958	110,909
2-127-0390AN	Alpha Fern Co.	FS	45	19	29 12 33	81 25 07	C	2,238	1,958	110,909
2-127-0390AN	Alpha Fern Co.	FS	44	20	29 12 26	81 25 29	D	2,238	1,958	110,909
2-127-0390AN	Alpha Fern Co.	FS	44	20	29 12 39	81 25 20	E	0	1,958	110,909
2-127-0394AU	GW from the Floridan aquifer—livestock	AG	23	11	29 20 10	81 31 36	A	32	32	0
2-127-0395AU	GW from the Floridan aquifer—citrus	AG	74	29	28 58 42	81 13 18	A	2,290	2,290	0
2-127-0395AU	GW from the Floridan aquifer—citrus	AG	75	29	28 58 28	81 13 10	B	2,290	2,290	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0396AN	GW from Floridan aquifer/SW from pond—nursery	AGS	68	42	29 06 44	81 00 52		1,827	1,827	0
2-127-0396AN	GW from Floridan aquifer/SW from pond—nursery	AGS	68	42	29 06 39	81 00 39		1,827	1,827	0
2-127-0396AN	GW from Floridan aquifer/SW from pond—nursery	AGS	68	42	29 06 42	81 00 52		1,827	1,827	0
2-127-0396AN	GW from Floridan aquifer/SW from pond—nursery	AGS	68	42	29 06 43	81 00 40		1,827	1,827	0
2-127-0396AN	GW from Floridan aquifer/SW from pond—nursery	AGS	68	42	29 06 47	81 00 40		1,827	1,827	0
2-127-0398AU	GW from the Floridan aquifer—fern	FG	63	20	29 03 18	81 21 08	A	561	561	31,764
2-127-0398AU	GW from the Floridan aquifer—fern	FG	63	20	29 03 17	81 21 02	B	0	561	31,764
2-127-0402AU	GW from Floridan aquifer/SW from pond—fern	FS	44	9	29 11 29	81 29 07	A	1,215	1,215	68,822
2-127-0403AU	GW from the Floridan aquifer—fern	FG	26	12	29 18 54	81 30 42	A	2,056	2,056	116,468
2-127-0405AN	GW from Floridan aquifer/SW from cow pond—fern	FS	24	15	29 20 01	81 29 47	A	25,051	15,031	163,636
2-127-0405AN	GW from Floridan aquifer/SW from cow pond—fern	FS	24	16	29 20 28	81 29 34	B	0	15,031	96,257
2-127-0405AN	GW from Floridan aquifer/SW from cow pond—fern	FS	24	16	29 20 36	81 29 45	C	0	15,031	173,262
2-127-0406AU	GW from Floridan aquifer/SW from pond—fern	FS	35	13	29 14 45	81 28 32	A	1,496	1,496	84,704
2-127-0408AU	Larson—fern	FS	46	8	29 10 23	81 29 28	A	0	320	18,151
2-127-0408AU	Larson—fern	FS	46	8	29 10 31	81 29 21	B	0	320	18,151
2-127-0408AU	Larson—fern	FS	46	9	29 10 36	81 29 22	C	0	320	18,151
2-127-0408AU	Larson—fern	FS	46	9	29 10 37	81 29 20	D	1,122	320	18,151
2-127-0408AU	Larson—fern	FS	46	9	29 10 38	81 29 22	E	0	320	18,151
2-127-0408AU	Larson—fern	FS	46	9	29 10 41	81 29 14	F	0	320	18,151
2-127-0409AU	GW from the Floridan aquifer—fern	FG	35	12	29 14 42	81 28 46	A	280	280	15,882
2-127-0409AU	GW from the Floridan aquifer—fern	FG	35	12	29 14 44	81 28 46	B	280	280	15,882

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0411AU	GW from the Floridan aquifer—fern	FG	30	17	29 17 23	81 27 54	A	2,617	2,617	148,232
2-127-0412AU	GW from the Floridan aquifer—fern	FG	40	12	29 13 38	81 28 31	A	748	748	42,352
2-127-0413AU	GW from the Floridan aquifer—fern	FG	43	12	29 12 23	81 27 56	A	374	374	21,176
2-127-0413AU	GW from the Floridan aquifer—fern	FG	43	12	29 12 20	81 27 55	B	374	374	21,176
2-127-0414AU	GW from Floridan aquifer/SW from Shaw Lake—fern	FS	38	17	29 14 40	81 26 45	A	2,243	2,243	127,056
2-127-0415AU	GW from the Floridan aquifer—fern	FG	39	17	29 14 27	81 26 33	A	4,487	4,487	254,112
2-127-0417AN	GW from Floridan aquifer/SW from pond—fern	FS	58	25	29 06 26	81 20 01	A	1,683	1,683	95,292
2-127-0417AN	GW from Floridan aquifer/SW from pond—fern	FS	58	26	29 06 29	81 19 57	B	1,683	1,683	95,292
2-127-0418AU	GW from the Floridan aquifer—fern	FG	72	22	28 58 08	81 17 54	A	2,617	2,617	148,232
2-127-0431AU	GW from the Floridan aquifer—fern	FG	26	14	29 18 54	81 29 43	A	561	561	31,764
2-127-0432AURM	Fern	FS	25	13	29 19 19	81 30 05	A	0	1,683	95,292
2-127-0433ANRM	Landscape irrigation	AG	74	29	28 59 03	81 13 04	A	12,004	12,004	0
2-127-0434AU	GW from the Floridan aquifer—fern	FG	38	15	29 14 26	81 27 37	A	748	748	42,352
2-127-0436ANR	Tree fern	FG	37	14	29 14 19	81 28 08	A	0	2,991	0
2-127-0437AU	GW from the Floridan aquifer—fern	FG	46	19	29 11 46	81 24 59	A	935	467	26,470
2-127-0437AU	GW from the Floridan aquifer—fern	FG	46	19	29 11 45	81 25 03	B	0	467	26,470
2-127-0438AU	GW from the Floridan aquifer—fern	FG	46	22	29 12 24	81 24 09	A	1,870	1,870	105,880
2-127-0439AU	GW from the Floridan aquifer—fern	FG	57	24	29 06 47	81 20 36	A	3,365	3,365	190,584
2-127-0440AU	GW from Floridan aquifer/SW from pond—fern	FS	40	11	29 13 28	81 28 27	A	1,122	1,122	63,528
2-127-0441AU	GW from the Floridan aquifer—fern	FG	55	26	29 08 13	81 20 32	A	374	374	21,176
2-127-0441AU	GW from the Floridan aquifer—fern	FG	55	26	29 08 14	81 20 30	B	374	374	21,176
2-127-0441AU	GW from the Floridan aquifer—fern	FG	55	26	29 08 13	81 20 30	C	374	374	21,176
2-127-0442AN	GW from the Floridan aquifer—fern	FG	44	17	29 12 27	81 25 42	A	748	748	42,352
2-127-0443AU	GW from the Floridan aquifer—fern	FG	66	19	29 02 14	81 20 59	A	2,804	2,804	158,820
2-127-0443AU	GW from the Floridan aquifer—fern	FG	66	19	29 02 12	81 20 55	B	2,804	2,804	158,820
2-127-0444AU	GW from the Floridan aquifer—fern	FG	64	20	29 02 56	81 20 58	A	2,991	2,991	169,408
2-127-0444AU	GW from the Floridan aquifer—fern	FG	64	20	29 03 01	81 20 58	B	2,991	2,991	169,408

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0444AU	GW from the Floridan aquifer—fern	FG	64	20	29 03 00	81 20 55	C	2,991	2,991	169,408
2-127-0445AU	GW from the Floridan aquifer—fern	FG	62	23	29 04 20	81 20 03	A	935	935	52,940
2-127-0446AN	GW from the Floridan aquifer—fern	FG	45	19	29 12 15	81 25 01	A	1,683	1,683	95,292
2-127-0446AN	GW from the Floridan aquifer—fern	FG	45	19	29 12 10	81 25 04	B	1,683	1,683	95,292
2-127-0447AU	GW from the Floridan aquifer—fern	FG	45	10	29 11 09	81 28 44	A	1,122	1,122	63,528
2-127-0448ANR	GW from the Floridan aquifer—fern	FG	46	12	29 11 07	81 27 25	A	0	3,739	211,760
2-127-0450AN	GW from the Floridan aquifer—fern	FG	23	19	29 21 41	81 29 08	A	3,739	3,739	211,760
2-127-0450AN	GW from the Floridan aquifer—fern	FG	23	19	29 21 41	81 29 02	B	3,739	3,739	211,760
2-127-0451AU	Pattilo—fern	FG	66	21	29 02 12	81 20 25	A	1,028	1,028	58,234
2-127-0451AU	Pattilo—fern	FG	65	21	29 02 33	81 20 22	B	3,739	3,739	211,760
2-127-0451AU	Pattilo—fern	FG	66	22	29 02 08	81 19 48	C	2,617	2,617	148,232
2-127-0451AU	Pattilo—fern	FG	66	22	29 02 08	81 19 57	D	1,028	1,028	58,234
2-127-0451AU	Pattilo—fern	FG	67	21	29 01 46	81 20 18	E	3,552	3,552	201,172
2-127-0452AU	GW from the Floridan aquifer—fern	FG	69	27	29 01 14	81 16 21	A	3,552	3,552	201,172
2-127-0453AU	Citrus	FG	68	27	29 02 09	81 16 28	A	187	187	0
2-127-0454AU	GW from the Floridan aquifer—fern	FG	63	22	29 03 56	81 20 24	A	997	997	56,469
2-127-0454AU	GW from the Floridan aquifer—fern	FG	63	22	29 03 57	81 20 26	B	997	997	56,469
2-127-0454AU	GW from the Floridan aquifer—fern	FG	63	22	29 03 56	81 20 29	C	997	997	56,469
2-127-0455AU	GW from Floridan aquifer/SW from pond—fern	FS	50	26	29 10 18	81 21 09	A	0	374	21,176
2-127-0456AU	GW from Floridan aquifer/SW from sinkhole—fern	FS	57	26	29 07 03	81 19 44	A	795	795	44,999
2-127-0457AN	Fern	FS	59	28	29 06 45	81 17 30	A	1,215	1,215	68,822
2-127-0459AU	GW from the Floridan aquifer—fern	FG	56	28	29 07 50	81 18 36	A	0	2,898	164,114
2-127-0460AU	GW from the Floridan aquifer—fern	FG	24	15	29 20 18	81 29 54	A	0	0	0
2-127-0461AU	GW from the Floridan aquifer—fern	FG	67	22	29 01 45	81 19 53	A	561	561	31,764
2-127-0462AU	GW from the Floridan aquifer—fern	FG	24	15	29 19 58	81 29 56	A	654	654	37,058
2-127-0463AU	GW from Floridan aquifer/SW from pond—nursery	AGS	65	25	29 03 24	81 18 39	C	0	5,367	0
2-127-0463AU	GW from Floridan aquifer/SW from pond—nursery	AGS	65	25	29 03 23	81 18 40	D	0	5,367	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0464AN	GW from the Floridan aquifer—fern	FG	64	24	29 03 39	81 19 21	A	1,122	1,122	0
2-127-0464AN	GW from the Floridan aquifer—fern	FG	64	24	29 03 39	81 19 26	B	1,122	1,122	0
2-127-0466AN	GW from the Floridan aquifer—fern	FG	45	16	29 12 01	81 26 03	A	1,028	1,028	58,234
2-127-0466AN	GW from the Floridan aquifer—fern	FG	45	16	29 12 01	81 26 01	B	1,028	1,028	58,234
2-127-0466AN	GW from the Floridan aquifer—fern	FG	45	16	29 12 01	81 25 59	C	1,028	1,028	58,234
2-127-0466AN	GW from the Floridan aquifer—fern	FG	45	16	29 12 01	81 25 57	D	1,028	1,028	58,234
2-127-0467ANR	Fern	FS	47	10	29 10 23	81 27 58	A	0	2,493	141,173
2-127-0467ANR	Fern	FS	47	10	29 10 32	81 27 55	B	0	2,493	141,173
2-127-0468AU	GW from the Floridan aquifer—fern	FG	62	20	29 03 59	81 21 27	A&B	1,496	1,496	84,704
2-127-0470AU	GW from the Floridan aquifer—fern	FG	50	26	29 10 09	81 20 48	A&B	1,215	1,215	68,822
2-127-0471AU	GW from Floridan aquifer/SW from pond—nursery	AGS	76	40	29 01 00	81 02 38		3,146	3,146	121,550
2-127-0471AU	GW from the Floridan aquifer/SW from pond—nursery	AGS	77	40	29 00 48	81 02 34		3,146	3,146	121,550
2-127-0471AU	GW from Floridan aquifer/SW from pond—nursery	AGS	76	40	29 00 55	81 02 37		3,146	3,146	121,550
2-127-0472AU	GW from the Floridan aquifer—fern	FG	60	22	29 05 06	81 20 57	A	748	748	0
2-127-0472AU	GW from the Floridan aquifer—fern	FG	60	22	29 05 05	81 20 52	B	748	748	0
2-127-0474AURM2	Fern	FS	59	28	29 06 29	81 17 36	A	0	499	28,235
2-127-0476AN	GW from Floridan aquifer/SW from swamp—fern	FS	46	29	29 13 36	81 19 14	A	855	544	30,801
2-127-0476AN	GW from Floridan aquifer/SW from swamp—fern	FS	46	30	29 13 37	81 19 11	B	0	544	30,801
2-127-0476AN	GW from Floridan aquifer/SW from swamp—fern	FS	46	30	29 13 55	81 19 11	C	0	544	30,801
2-127-0476AN	GW from Floridan aquifer/SW from swamp—fern	FS	46	30	29 13 57	81 19 04	D	0	544	30,801
2-127-0476AN	GW from Floridan aquifer/SW from swamp—fern	FS	46	30	29 13 48	81 19 10	E	0	544	30,801
2-127-0477AU	GW from the Floridan aquifer—fern	FG	23	20	29 21 09	81 28 30	A	5,982	5,982	338,816

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0478AU	GW from Floridan aquifer—fern and vegetables	FG	35	17	29 15 11	81 27 01	A	0	0	0
2-127-0479AU	GW from the Floridan aquifer—fern	FG	25	16	29 19 54	81 29 42	A	2,984	2,984	168,984
2-127-0480AU	GW from the Floridan aquifer—fern	FG	25	17	29 19 47	81 28 54	A	4,699	4,699	266,112
2-127-0480AU	GW from the Floridan aquifer—fern	FG	25	17	29 19 52	81 28 54	B	4,699	4,699	266,112
2-127-0480AU	GW from the Floridan aquifer—fern	FG	25	17	29 19 46	81 28 53	C	4,699	4,699	266,112
2-127-0481AU	GW from the Floridan aquifer—fern	FG	24	20	29 21 02	81 28 26	A	2,991	2,991	169,408
2-127-0482AU	GW from the Floridan aquifer—fern	FG	43	9	29 12 05	81 29 17	A	654	654	37,058
2-127-0483AN	GW from Floridan aquifer/SW from pond—fern	FS	47	16	29 10 53	81 25 34	A	935	935	52,940
2-127-0484AN	GW from the Floridan aquifer—fern	FG	32	13	29 16 08	81 28 56	A&B	1,122	1,122	63,528
2-127-0485AU	GW from the Floridan aquifer—fern	FG	56	26	29 07 26	81 19 44	A	2,243	2,243	127,056
2-127-0486AU	GW from the Floridan aquifer—fern	FG	57	27	29 07 04	81 19 06	A	6,955	2,318	131,291
2-127-0486AU	GW from the Floridan aquifer—fern	FG	57	27	29 07 09	81 19 14	B	0	2,318	131,291
2-127-0486AU	GW from the Floridan aquifer—fern	FG	57	27	29 06 58	81 19 14	C	0	2,318	131,291
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	51	22	29 09 03	81 22 28	H	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	52	24	29 09 06	81 21 47	A	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	52	24	29 09 08	81 21 50	B	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	52	24	29 08 00	81 21 50	C	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	52	24	29 08 59	81 21 41	D	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	51	24	29 09 12	81 21 54	E	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	52	23	29 08 56	81 22 03	F	2,509	2,509	0
2-127-0487AU	GW from the Floridan aquifer—livestock	AG	51	23	29 09 16	81 22 22	G	2,509	2,509	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0488AU	GW from the Floridan aquifer—fern	FG	69	26	29 00 01	81 17 03	A	1,870	1,870	105,880
2-127-0489AU	GW from the Floridan aquifer—fern	FG	47	13	29 10 46	81 26 37	A	748	748	42,352
2-127-0490AU	GW from the Floridan aquifer—fern	FG	57	22	29 06 15	81 21 30	A	935	935	52,940
2-127-0491AU	GW from the Floridan aquifer—fern	FG	37	16	29 14 32	81 27 28	A	1,683	1,683	95,292
2-127-0492AU	GW from the Floridan aquifer—fern	FG	35	18	29 15 21	81 26 48	A	748	748	42,352
2-127-0493AN	GW from Floridan aquifer/SW from pond—fern	FS	23	18	29 21 09	81 29 22	A	0	1,335	75,629
2-127-0494AU	GW from the Floridan aquifer—fern	FG	35	11	29 14 43	81 29 07	A	1,870	1,870	105,880
2-127-0495AU	GW from Floridan aquifer/SW from Lake Louise, Mud Lake, and Mcbride—fern	FS	23	13	29 20 19	81 30 54	A	1,402	1,402	79,410
2-127-0496AU	GW from Floridan aquifer/SW from pond—fern	FS	23	14	29 20 26	81 30 38	B	2,493	1,870	105,880
2-127-0496AU	GW from Floridan aquifer/SW from pond—fern	FS	23	13	29 20 23	81 30 43	A	2,493	1,870	105,880
2-127-0496AU	GW from Floridan aquifer/SW from pond—fern	FS	23	14	29 20 23	81 30 32	C	0	1,870	105,880
2-127-0497AU	GW from Floridan aquifer/SW from pond—fern	FS	35	13	29 14 47	81 28 37	A	1,870	1,870	105,880
2-127-0499AU	GW from Floridan aquifer/SW from pond—fern	FS	24	17	29 20 14	81 29 02	A	0	2,243	127,056
2-127-0500AURM	Strawn Groves—citrus	AGS	49	27	29 10 44	81 20 50	A	0	6,351	154,011
2-127-0500AURM	Strawn Groves—citrus	AGS	49	28	29 10 34	81 20 03	B	0	6,351	154,011
2-127-0500AURM	Strawn Groves—citrus	AGS	49	28	29 10 34	81 20 01	C	0	6,351	154,011
2-127-0500AURM	Strawn Groves—citrus	AGS	49	28	29 10 50	81 19 38	D	0	6,351	154,011
2-127-0500AURM	Strawn Groves—citrus	AGS	49	28	29 10 50	81 19 36	E	0	6,351	154,011
2-127-0501AU	GW from the Floridan aquifer—citrus, hay	AG	58	24	29 06 10	81 20 33	A	2,053	2,053	275,288
2-127-0502AU	GW from the Floridan aquifer—citrus	AG	60	22	29 04 59	81 21 01	A	842	842	112,868
2-127-0503AU	GW from the Floridan aquifer—fern	FG	55	27	29 08 05	81 19 44	A	1,262	505	28,588

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0503AUR	GW from the Floridan aquifer—fern	FG	55	27	29 08 05	81 19 38	B	0	505	28,588
2-127-0503AUR	GW from the Floridan aquifer—fern	FG	56	27	29 08 01	81 19 37	C	0	505	28,588
2-127-0503AUR	GW from the Floridan aquifer—fern	FG	56	27	29 08 00	81 19 37	D	0	505	28,588
2-127-0503AUR	GW from the Floridan aquifer—fern	FG	56	27	29 08 00	81 19 44	E	1,262	505	28,588
2-127-0504AN	GW from the Floridan aquifer—fern	FG	65	20	29 02 26	81 20 50	A	2,493	2,493	141,173
2-127-0504AN	GW from the Floridan aquifer—fern	FG	65	20	29 02 25	81 20 46	B	2,493	2,493	141,173
2-127-0504AN	GW from the Floridan aquifer—fern	FG	65	20	29 02 24	81 20 54	C&D	2,493	2,493	141,173
2-127-0505AN	GW from the Floridan aquifer—turf	AG	69	25	29 00 39	81 17 36	A	4,517	4,517	0
2-127-0506AN	GW from the Floridan aquifer—turf	AG	78	22	28 54 43	81 16 32	A	3,388	3,388	0
2-127-0508AU	GW from the Floridan aquifer—fern	FG	76	25	28 56 51	81 16 01	A	3,365	3,365	190,584
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 37	81 28 55	A&B	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 37	81 28 52	C	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 36	81 28 56	D	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 35	81 28 56	E	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 36	81 28 52	F	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 35	81 28 56	G	280	280	15,882
2-127-0510AN	GW from the Floridan aquifer—fern	FG	33	13	29 15 34	81 28 56	H	280	280	15,882
2-127-0511AU	GW from the Floridan aquifer—fern	FG	24	12	29 19 46	81 30 52	A	2,524	841	47,646
2-127-0511AU	GW from the Floridan aquifer—fern	FG	24	12	29 19 47	81 30 49	B	0	841	47,646
2-127-0511AU	GW from the Floridan aquifer—fern	FG	24	12	29 19 50	81 30 53	C	0	841	47,646
2-127-0512AUVM3	Roy Smith Fern	FS	27	14	29 18 40	81 29 33	A	0	6,543	0
2-127-0514AU	Citrus, fern	FS	52	26	29 09 08	81 20 45	C	1,683	1,683	95,292
2-127-0514AUM	Citrus, fern	FS	53	26	29 09 06	81 20 42	A&B	1,683	1,683	95,292
2-127-0516ANMG	Landscape irrigation for Pierson-Taylor High School	AG	36	15	29 14 47	81 27 35	A	3,601	3,601	0
2-127-0516ANMG	Landscape irrigation for Pierson-Taylor High School	AG	36	14	29 14 41	81 27 49	B	3,601	3,601	0
2-127-0517AN	GW from Floridan aquifer/SW from pond—fern	FG	39	20	29 14 34	81 25 43	A	1,309	1,309	74,116
2-127-0520AU	GW from the Floridan aquifer—fern	FG	37	16	29 14 44	81 27 28	A	374	374	21,176
2-127-0521AU	GW from the Floridan aquifer—fern	FG	37	16	29 14 40	81 27 15	A	1,870	1,870	105,880

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0523AU	GW from the Floridan aquifer—fern	FG	66	19	29 01 50	81 20 45	B	1,402	1,402	79,410
2-127-0523AU	GW from the Floridan aquifer—fern	FG	66	19	29 01 47	81 20 42	A	1,402	1,402	79,410
2-127-0524AUF	GW from the Floridan aquifer	FG	61	22	29 04 31	81 21 00	A	748	748	42,352
2-127-0525AUM	Fern	FS	45	9	29 11 10	81 28 56	A	0	573	32,470
2-127-0527AU	GW from the Floridan aquifer—fern	FG	53	27	29 09 16	81 20 20	A	935	935	52,940
2-127-0527AU	GW from the Floridan aquifer—fern	FG	53	27	29 09 12	81 20 20	B	935	935	52,940
2-127-0528AU	GW from Floridan aquifer/SW from Cowart Lake—fern	FS	29	16	29 18 01	81 28 46	A	2,056	2,056	116,468
2-127-0529AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 00	81 26 51	A	3,178	3,178	179,996
2-127-0529AU	GW from the Floridan aquifer—fern	FG	37	19	29 15 01	81 26 47	B	3,178	3,178	179,996
2-127-0530AUF	GW from Floridan aquifer/SW from pond—fern	FS	51	29	29 10 34	81 18 01	A	0	1,496	84,704
2-127-0531AU	GW from the Floridan aquifer—fern	FG	35	17	29 15 27	81 27 14	A&B	1,402	1,402	79,410
2-127-0532AU	GW from the Floridan aquifer—fern	FG	40	10	29 13 27	81 29 02	A	374	374	21,176
2-127-0533AU	GW from the Floridan aquifer—fern	FG	42	19	29 13 44	81 25 41	B	1,122	1,122	63,528
2-127-0533AU	GW from the Floridan aquifer—fern	FG	42	19	29 13 46	81 25 43	A	1,122	1,122	63,528
2-127-0534AU	GW from Floridan aquifer/SW from pond—fern	FS	71	29	28 59 47	81 14 05	A	1,994	1,994	112,939
2-127-0535AU	GW from the Floridan aquifer—fern	FG	66	21	29 01 56	81 20 18	A&B	1,683	1,683	95,292
2-127-0536AU	GW from the Floridan aquifer—fern	FG	60	21	29 04 41	81 21 23	A	1,870	1,870	105,880
2-127-0537AU	GW from the Floridan aquifer—fern	FG	55	23	29 07 30	81 21 37	A	467	467	26,470
2-127-0538AUG	GW from the Floridan aquifer—fern	FG	40	11	29 13 27	81 28 56	A	374	374	21,176
2-127-0539AU	GW from the Floridan aquifer—fern	FG	64	22	29 03 20	81 20 24	A	748	748	42,352
2-127-0539AU	GW from the Floridan aquifer—fern	FG	64	22	29 03 19	81 20 20	B	748	748	42,352
2-127-0540AU	GW from the Floridan aquifer—fern	FG	56	27	29 07 56	81 19 03	A	1,496	1,496	84,704
2-127-0541AU	GW from the Floridan aquifer—fern	FG	40	18	29 14 14	81 26 26	A	2,243	2,243	127,056
2-127-0542AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 05	81 27 15	A	2,555	2,555	144,703
2-127-0542AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 04	81 27 09	B	2,555	2,555	144,703
2-127-0542AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 03	81 27 10	C	2,555	2,555	144,703
2-127-0543AU	GW from the Floridan aquifer—fern	FG	27	19	29 19 17	81 28 08	A	4,019	4,019	227,642

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0546AU	GW from Floridan aquifer/SW from Lake Pierson—fern	FS	39	13	29 14 16	81 28 04	A	0	561	31,764
2-127-0547AU	GW from Floridan aquifer/SW from pond—fern	FS	34	13	29 15 03	81 28 47	C	0	337	19,058
2-127-0547AU	GW from Floridan aquifer/SW from pond—fern	FS	34	13	29 15 09	81 28 47	A	0	337	19,058
2-127-0547AU	GW from Floridan aquifer/SW from pond—fern	FS	34	12	29 15 08	81 28 55	B	0	337	19,058
2-127-0547AUM	GW from Floridan aquifer/SW from pond—fern	FS	34	12	29 15 12	81 28 55	D	0	337	19,058
2-127-0547AUM	GW from Floridan aquifer/SW from pond—fern	FS	35	14	29 15 03	81 28 21	E	0	337	19,058
2-127-0550AUF	GW from the Floridan aquifer—fern	FG	45	11	29 11 16	81 28 00	A	1,496	1,496	84,704
2-127-0551AN	Z. Saul—fern	FG	42	11	29 12 31	81 28 34	A	0	1,496	84,704
2-127-0552AN	Z. Saul—fern	FG	42	11	29 12 30	81 28 29	A	0	1,496	84,704
2-127-0553AUF	Z. Saul—fern	FG	43	11	29 12 16	81 28 19	A	3,552	3,552	201,172
2-127-0554AU	GW from the Floridan aquifer—fern	FG	43	11	29 12 14	81 28 15	A	1,496	1,496	84,704
2-127-0555AU	GW from the Floridan aquifer—fern	FG	43	11	29 12 22	81 28 13	A	2,056	2,056	116,468
2-127-0556AU	GW from the Floridan aquifer—fern	FG	45	10	29 11 24	81 28 24	A	2,243	2,243	127,056
2-127-0557AUF	GW from the Floridan aquifer—fern	FG	46	9	29 10 56	81 28 51	A	2,991	2,991	169,408
2-127-0558AU	GW from the Floridan aquifer—fern	FG	35	18	29 15 29	81 26 56	A	748	748	42,352
2-127-0559AN	GW from the Floridan aquifer—fern	FG	44	11	29 11 53	81 27 52	A	1,870	1,870	105,880
2-127-0561AUS	Turner Farms—vegetables	AG	88	33	28 51 36	81 07 05	A	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	33	28 51 23	81 07 05	B	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	33	28 51 10	81 07 05	C	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	33	28 50 56	81 07 04	D	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	88	34	28 51 35	81 06 39	E	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	34	28 51 26	81 06 36	F	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	34	28 51 24	81 06 29	G	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	34	28 51 11	81 06 29	H	4,992	4,992	0
2-127-0561AUS	Turner Farms—vegetables	AG	89	34	28 51 12	81 06 21	I	4,992	4,992	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0561AUS	Turner Farms—vegetables	AG	89	34	28 50 46	81 06 32	J	4,992	4,992	0
2-127-0562AU	GW from the Floridan aquifer	FG	62	21	29 04 02	81 20 59	A	748	748	42,352
2-127-0563AN	Fern	FG	35	11	29 14 45	81 29 11	A	0	935	52,940
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 18 16	81 02 56		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 18 17	81 02 55		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	48	44	29 17 39	81 02 40		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 17 51	81 02 40		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 17 54	81 02 40		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 17 55	81 02 41		3,025	3,025	0
2-127-0565ANV	Oceanside Country Club—golf course	AG	47	44	29 18 04	81 02 44		3,025	3,025	0
2-127-0568ANV	GW from Floridan aquifer/SW from pond—fern	FS	73	22	28 57 52	81 17 42	A	537	537	30,441
2-127-0568ANV	GW from Floridan aquifer/SW from pond—fern	FS	73	22	28 57 56	81 17 44	B	537	537	30,441
2-127-0568ANV	GW from Floridan aquifer/SW from pond—fern	FS	73	22	28 57 53	81 17 43	C	537	537	30,441
2-127-0569AU	GW from Floridan aquifer/SW from Lake Hester—fern	FS	44	11	29 11 52	81 27 58	A	1,870	1,870	105,880
2-127-0573AUS	GW from the Floridan aquifer—fern	FG	39	18	29 14 29	81 26 23	A	374	374	21,176
2-127-0574ANV	GW from Floridan aquifer/SW from pond—fern	FS	63	29	29 04 48	81 16 25	A	1,309	1,309	74,116
2-127-0575ANVR	GW from Floridan aquifer/SW from Lake Hires—fern	FS	57	29	29 07 51	81 17 12	A	1,870	1,870	105,880
2-127-0576ANV	GW from the Floridan aquifer—fern	FG	71	28	28 59 16	81 14 45	A	608	608	34,411
2-127-0576ANV	GW from the Floridan aquifer—fern	FG	71	28	28 59 18	81 14 44	B	608	608	34,411

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0577ANV	GW from the Floridan aquifer—fern	FG	69	18	29 00 06	81 20 22	A	841	841	47,646
2-127-0577ANV	GW from the Floridan aquifer—fern	FG	69	19	28 59 59	81 19 53	B	841	841	47,646
2-127-0578ANV	GW from the Floridan aquifer—fern	FG	59	27	29 06 00	81 19 00	A	2,493	2,493	141,173
2-127-0578ANV	GW from the Floridan aquifer—fern	FG	60	26	29 05 52	81 19 00	B&D	2,493	2,493	141,173
2-127-0578ANV	GW from the Floridan aquifer—fern	FG	59	27	29 05 59	81 18 51	C	2,493	2,493	141,173
2-127-0579ANMR	Hagstrom—fern	FS	41	13	29 13 26	81 27 32	C&D	2,010	2,010	113,821
2-127-0580ANV	GW from Floridan aquifer/SW from pond—fern	FS	35	18	29 15 27	81 26 46	A	1,589	1,589	89,998
2-127-0581ANV	GW from the Floridan aquifer—fern	FG	45	9	29 11 11	81 29 10	A	1,683	1,683	95,292
2-127-0582ANVF	GW from Floridan aquifer/SW from pond—fern	FS	46	9	29 11 02	81 28 53	A	935	467	26,470
2-127-0582ANVF	GW from Floridan aquifer/SW from pond—fern	FS	45	9	29 11 01	81 28 55	B	0	467	26,470
2-127-0582ANVF	GW from Floridan aquifer/SW from pond—fern	FS	45	9	29 11 03	81 28 56	C	0	467	26,470
2-127-0583ANV	GW from the Floridan aquifer—fern	FG	63	23	29 03 38	81 20 03	A	748	748	42,352
2-127-0583ANV	GW from the Floridan aquifer—fern	FG	63	23	29 03 42	81 20 03	B	748	748	42,352
2-127-0584ANV	GW from the Floridan aquifer—fern	FG	41	11	29 13 05	81 28 44	A	1,870	1,870	105,880
2-127-0585AUS	GW from the Floridan aquifer—fern	FG	38	20	29 14 48	81 25 59	A	497	497	28,164
2-127-0588ANM2	Fern	FG	25	16	29 19 45	81 29 21	A	2,991	2,991	169,408
2-127-0590ANR	Fern	FG	25	10	29 18 44	81 31 55	A	3,739	3,739	211,760
2-127-0593AUS	GW from the Floridan aquifer—fern	FG	62	25	29 04 38	81 19 16	A	3,739	3,739	211,760
2-127-0594ANVF	GW from the Floridan aquifer—fern	FG	58	25	29 06 28	81 20 23	A	1,870	1,870	105,880
2-127-0595AUS	GW from the Floridan aquifer—fern	FG	58	24	29 06 26	81 20 28	A	1,028	1,028	58,234
2-127-0595AUSF	GW from the Floridan aquifer—fern	FG	58	24	29 06 27	81 20 27	B	1,028	1,028	58,234
2-127-0597AUSF	GW from the Floridan aquifer—fern	FG	42	9	29 12 13	81 29 28	A	1,542	1,542	87,351
2-127-0597AUSF	GW from the Floridan aquifer—fern	FG	42	9	29 12 14	81 29 23	B	1,542	1,542	87,351
2-127-0599AN	Floriturf	AG	89	37	28 51 13	81 04 29		15,249	15,249	0
2-127-0599AN	Floriturf	AG	89	37	28 51 13	81 04 11		15,249	15,249	0
2-127-0599AN	Floriturf	AG	89	37	28 51 24	81 04 15		15,249	15,249	0
2-127-0601AUSR	GW from the Floridan aquifer—fern	FG	29	21	29 18 39	81 27 23	A	374	374	21,176

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0602AUSF	GW from the Floridan aquifer—fern	FG	55	27	29 08 35	81 19 12	A	561	561	31,764
2-127-0603AUSRM	GW from the Floridan aquifer—fern	FG	66	20	29 01 53	81 20 25	A&B	1,309	1,309	74,116
2-127-0604ANS	GW from the Floridan aquifer—fern	FG	61	19	29 04 13	81 21 39	A	1,870	1,870	105,880
2-127-0605AUS	GW from the Floridan aquifer—fern	FG	66	22	29 02 02	81 19 50	A	841	841	47,646
2-127-0605AUS	GW from the Floridan aquifer—fern	FG	66	22	29 02 01	81 19 49	B	841	841	47,646
2-127-0607AUSF	GW from Floridan aquifer/SW from pond—fern	FS	23	12	29 20 14	81 31 18	A	0	514	29,117
2-127-0607AUSF	GW from Floridan aquifer/SW from pond—fern	FS	23	11	29 20 08	81 31 23	B	0	514	29,117
2-127-0609AUSF	GW from the Floridan aquifer—fern	FG	63	29	29 04 58	81 16 35	A	1,122	1,122	63,528
2-127-0610ANF	GW from Floridan aquifer/SW from Cowart Lake—fern	FS	28	16	29 18 15	81 28 43	A	2,804	2,804	158,820
2-127-0612AUS	GW from the Floridan aquifer—fern	FG	25	13	29 19 13	81 30 32	A	1,496	1,496	84,704
2-127-0615AUS	GW from Floridan aquifer/SW from pond—fern	FS	73	29	28 59 08	81 13 28	A	0	1,496	84,704
2-127-0616AUS	GW from the Floridan aquifer—fern	FG	62	20	29 03 53	81 21 17	A	2,243	2,243	127,056
2-127-0616AUS	GW from the Floridan aquifer—fern	FG	62	20	29 03 50	81 21 23	B	2,243	2,243	127,056
2-127-0616AUS	GW from the Floridan aquifer—fern	FG	62	19	29 03 58	81 21 35	C	2,243	2,243	127,056
2-127-0619AUSF	GW from the Floridan aquifer—fern	FG	31	14	29 16 27	81 28 43	A	1,122	1,122	63,528
2-127-0620AUS	GW from the Floridan aquifer—fern	FG	59	24	29 05 45	81 20 09	A	1,496	1,496	84,704
2-127-0621AUS	GW from Floridan aquifer/SW from pond—fern	FS	27	13	29 18 40	81 30 00	A	872	872	49,411
2-127-0621AUSF	GW from Floridan aquifer/SW from pond—fern	FS	27	14	29 18 43	81 29 50	B	872	872	49,411
2-127-0622AUS	GW from Floridan aquifer/SW from pond—fern	FS	30	17	29 17 25	81 28 11	A	0	654	37,058
2-127-0627AUS	GW from the Floridan aquifer—fern	FG	46	19	29 11 43	81 25 04	A	3,552	3,552	201,172
2-127-0629AUS	GW from Floridan aquifer/SW from pond—fern	FG	64	22	29 03 28	81 20 02	A	374	374	21,176
2-127-0630AUS	GW from the Floridan aquifer—fern	FG	64	22	29 03 22	81 20 14	A	748	748	42,352
2-127-0631AUS	GW from the Floridan aquifer—fern	FG	69	22	29 00 11	81 18 47	A	748	748	42,352

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0631AUS	GW from the Floridan aquifer—fern	FG	69	22	29 00 10	81 18 47	B	748	748	42,352
2-127-0632AUSF	GW from the Floridan aquifer—fern	FG	33	13	29 15 18	81 28 54	A	1,122	1,122	63,528
2-127-0633AUS	GW from the Floridan aquifer—fern	FG	55	25	29 08 02	81 20 53	A	2,991	2,991	169,408
2-127-0634AUS	GW from the Floridan aquifer—fern	FG	52	25	29 09 05	81 21 09	A	1,196	1,196	67,763
2-127-0635AUSF	GW from the Floridan aquifer—fern	FG	69	22	29 00 17	81 19 05	A	2,243	2,243	127,056
2-127-0636AUSF	GW from the Floridan aquifer—fern	FG	67	20	29 01 21	81 20 23	A	608	608	34,411
2-127-0636AUSF	GW from the Floridan aquifer—fern	FG	67	19	29 01 18	81 20 25	B	608	608	34,411
2-127-0637AUSF	GW from the Floridan aquifer—fern	FG	45	16	29 11 57	81 25 58	A	1,122	1,122	63,528
2-127-0638AUS	GW from the Floridan aquifer—citrus	AG	68	28	29 01 59	81 15 33	A	9,474	9,474	0
2-127-0642ANS	GW from Floridan aquifer/SW from pond—fern	FS	25	16	29 19 54	81 29 35	A	280	280	15,882
2-127-0643AUS	GW from the Floridan aquifer—fern	FG	39	14	29 14 05	81 27 45	A	0	374	21,176
2-127-0643AUS	GW from the Floridan aquifer—fern	FG	39	14	29 14 01	81 27 43	B	0	374	21,176
2-127-0644ANS	GW from Floridan aquifer/SW from cow pond—fern	FS	23	17	29 21 02	81 29 25	A	0	5,609	317,640
2-127-0645AUSF	GW from the Floridan aquifer—fern	FG	36	16	29 14 55	81 27 16	A	1,683	1,683	95,292
2-127-0647AUS	Tomoka Oaks Golf and Country Club—turf	AG	47	42	29 17 29	81 05 38		6,352	6,352	0
2-127-0647AUS	Tomoka Oaks Golf and Country Club—turf	AG	47	42	29 17 34	81 05 55		6,352	6,352	0
2-127-0647AUS	Tomoka Oaks Golf and Country Club—turf	AG	47	42	29 17 43	81 05 31		6,352	6,352	0
2-127-0647AUS	Tomoka Oaks Golf and Country Club—turf	AG	46	43	29 17 50	81 05 48		6,352	6,352	0
2-127-0651AUSF	GW from Floridan aquifer/SW from Stone Pond—fern	FS	44	10	29 11 30	81 28 42	A	2,617	2,617	148,232
2-127-0652AUS	GW from the Floridan aquifer—fern	FG	26	12	29 18 54	81 30 40	A	1,870	1,870	105,880
2-127-0655ANV	GW from Floridan aquifer/SW from pond—fern	FS	35	12	29 14 45	81 28 59	B	654	436	24,705

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0655ANV	GW from Floridan aquifer/SW from pond—fern	FS	35	12	29 14 46	81 28 57	A	0	436	24,705
2-127-0657anv	Fern	FG	28	18	29 18 34	81 28 13	A	0	1,432	81,104
2-127-0658ANV	GW from the Floridan aquifer—fern	FG	28	18	29 18 37	81 28 05	A	1,324	1,324	74,963
2-127-0659ANV	GW from the Floridan aquifer—pasture	AG	74	29	28 58 51	81 13 31	A	6,570	6,570	0
2-127-0667AN	Loadholtz—citrus and fern	FS	27	16	29 18 47	81 28 51	A	0	1,870	105,880
2-127-0676AUSF	GW from the Floridan aquifer—fern	FG	56	27	29 07 56	81 19 03	A	374	374	21,176
2-127-0678AN	Fern	FG	69	27	29 01 20	81 16 02	A	0	748	42,352
2-127-0679AN	Fern	FG	55	27	29 08 12	81 19 22	A	0	561	31,764
2-127-0680ANV	GW from the Floridan aquifer—fern	FG	70	21	28 59 12	81 18 51	A	7,702	7,702	436,226
2-127-0681ANV	GW from the Floridan aquifer—fern	FG	70	19	28 58 44	81 19 33	A&B	2,113	2,113	119,644
2-127-0683AU	GW from the Floridan aquifer—fern	FG	57	22	29 06 32	81 21 49	A	1,346	1,346	76,234
2-127-0686AN	GW from the Floridan aquifer—fern	FG	57	28	29 07 45	81 18 18	A&B	374	374	21,176
2-127-0687AN	Citrus and fern	FG	68	17	29 00 42	81 20 51	A	6,356	6,356	359,992
2-127-0689ANV	GW from Floridan aquifer/SW from canal—fern	FS	60	29	29 06 40	81 16 22	A	1,380	920	52,093
2-127-0689ANV	GW from Floridan aquifer/SW from canal—fern	FS	60	30	29 06 44	81 16 20	B	0	920	52,093
2-127-0693AN	Fern	FG	46	9	29 10 21	81 28 52	A	0	1,047	59,293
2-127-0694AN	GW from Floridan aquifer/SW from pond—fern	FS	24	12	29 19 42	81 30 52	A&C	187	187	10,588
2-127-0694AN	GW from Floridan aquifer/SW from pond—fern	FS	24	12	29 19 42	81 30 49	B	0	0	0
2-127-0695AN	Lane—fern	FG	59	30	29 07 05	81 16 10	A	0	1,215	68,822
2-127-0696AN	Citrus	AG	54	29	29 09 28	81 17 48	A	1,407	1,407	96,257
2-127-0697AN	Lucas—citrus	AG	43	11	29 12 34	81 28 30	A	0	671	0
2-127-0698ANG	Fern	FG	36	16	29 14 58	81 27 12	A	0	1,383	78,351
2-127-0700AU	GW from the Floridan aquifer—fern	FG	55	25	29 07 55	81 20 42	A	1,776	1,776	100,586
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 16	81 18 12	C	848	848	0

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 10	81 18 20	D	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	26	29 02 26	81 18 00	A	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 18	81 18 12	B	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	26	29 02 09	81 18 06	E	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 05	81 18 20	F	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	26	29 02 05	81 18 04	G	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	26	29 02 05	81 18 02	H	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 04	81 18 08	I	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 04	81 18 06	J	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	25	29 02 02	81 18 16	K	848	848	0
2-127-0702ANV	Stetson Univ. urban landscape—turf grass	AG	67	26	29 02 01	81 17 53	L	848	848	0
2-127-0703AN	Fern	FS	23	15	29 20 37	81 30 24	A	3,739	3,739	211,760
2-127-0705AN	Citrus	AG	77	30	28 57 40	81 12 13	A	0	790	81,626
2-127-0707AN	Fern	FS	40	19	29 14 19	81 26 10	A–C	0	2,991	169,408
2-127-0708AU	GW from the Floridan aquifer—fern	FG	64	21	29 03 04	81 20 43	A	5,422	2,711	153,526
2-127-0708AU	GW from the Floridan aquifer—fern	FG	64	20	29 03 06	81 20 50	B	0	2,711	153,526
2-127-0709AU	GW from the Floridan aquifer—fern	FG	25	17	29 19 33	81 28 59	B	1,683	1,683	95,292
2-127-0709AU	GW from the Floridan aquifer—fern	FG	25	17	29 19 42	81 28 58	A	1,683	1,683	95,292
2-127-0714AUM	Fern	FS	24	14	29 20 28	81 30 10	A	0	3,739	211,760
2-127-0716AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 10	81 26 29	A	2,056	2,056	116,468

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0716AU	GW from the Floridan aquifer—fern	FG	36	19	29 15 05	81 26 30	B	2,056	2,056	116,468
2-127-0716AU	GW from the Floridan aquifer—fern	FG	36	17	29 15 12	81 26 31	C	2,056	2,056	116,468
2-127-0719AN	GW from the Floridan aquifer—fern	FG	56	23	29 07 17	81 21 20	A	2,243	2,243	127,056
2-127-0720AUV	Glen Abbey Golf Course	AGS	79	19	28 53 39	81 17 25	A&D	7,058	7,058	0
2-127-0721AUV	GW from the Floridan aquifer—fern	FG	55	25	29 07 55	81 20 42	A	935	935	52,940
2-127-0723AN	Tree fern	FS	47	30	29 13 23	81 19 05	A	0	12,152	0
2-127-0724AN	Fern	FS	23	15	29 20 37	81 30 07	A	0	1,496	84,704
2-127-0725AN	Citrus	AG	57	29	29 07 44	81 17 15	A	790	790	96,257
2-127-0725AN	Citrus	AG	57	29	29 07 45	81 17 11	B	0	790	96,257
2-127-0726AN	Tree fern	FG	67	19	29 01 05	81 20 31	A	0	6,730	0
2-127-0728AUV	GW from the Floridan aquifer—fern	FG	57	29	29 08 00	81 17 35	A	1,047	1,047	59,293
2-127-0729AN	Fern	FG	67	20	29 01 42	81 20 33	A	0	3,739	211,760
2-127-0730ANM	Fern	FG	44	15	29 12 29	81 26 48	A	0	2,954	167,290
2-127-0731AUV	GW from the Floridan aquifer—fern	FG	44	10	29 11 53	81 28 47	A	2,991	2,991	169,408
2-127-0737AN	Tree fern	FG	34	11	29 14 48	81 29 20	A	0	1,870	0
2-127-0738AN	Tree fern	FG	25	15	29 1 941	81 29 45	A	0	2,804	158,820
2-127-0741AUV	GW from the Floridan aquifer—fern	FG	49	20	29 09 31	81 23 37	A	1,122	1,122	63,528
2-127-0743ANR	Debary Golf Course	AGS	78	15	28 54 13	81 19 00	A	0	9,881	0
2-127-0752AN	Fern	FG	23	21	29 21 08	81 28 24	A	0	1,122	63,528
2-127-0757AN	Fern	FG	30	18	29 17 33	81 27 33	A	0	3,103	175,761
2-127-0758AN	Fern	FS	57	30	29 07 47	81 16 47	A	0	1,496	84,704
2-127-0769AN	Fern	FG	63	21	29 03 44	81 20 58	A	0	4,861	275,288
2-127-0769AN	Fern	FG	63	21	29 03 45	81 20 46	B	0	4,861	275,288
2-127-0770AUV	Fern	FS	24	11	29 195 4	81 31 19	A	0	1,496	84,704
2-127-0774AN	Fish farm	AG	77	29	28 57 39	81 12 38	A	0	10,164	0
2-127-0778AUV	Fern	FG	42	9	29 12 09	81 29 19	A&B	0	2,991	169,408
2-127-0794AN	Citrus	AG	67	27	29 02 46	81 16 54	A	0	474	4,813
2-127-0794AN	Citrus	AG	67	27	29 02 46	81 16 54	B	0	474	115,508
2-127-0801ANM	Fern	FS	47	9	29 10 19	81 28 39	A	0	1,449	82,057
2-127-0801ANM	Fern	FS	47	9	29 10 22	81 28 37	B	0	1,449	82,057
2-127-0801ANM	Fern	FS	47	9	29 10 25	81 28 40	C	0	1,449	82,057

Table C2—*Continued*

CUP No.	Project	Code	Row	Column	Latitude	Longitude	Well No.	1988 Estimated Withdrawal (ft^3/day)	2010 Estimated Withdrawal (ft^3/day)	Estimated Frost-Freeze Withdrawal (ft^3/day)
2-127-0802AN	Citrus	AG	56	29	29 08 31	81 17 25	A	0	2,684	0
2-127-0816AN	Todd Ferneries	FS	43	16	29 12 39	81 26 27	A	0	1,636	92,645
2-127-0822AN	Tree fern, woody ornamental	FG	65	24	29 02 49	81 19 09	A	0	3,412	0
2-127-0822AN	Tree fern, woody ornamental	FG	65	24	29 02 53	81 19 09	B&C	0	3,412	0
2-127-0825ANM	Thompson Fernery	FS	47	9	29 10 17	81 29 01	A	0	642	36,352
2-127-0825ANM	Thompson Fernery	FS	47	9	29 10 17	81 29 02	B	0	642	36,352
2-127-0825ANM	Thompson Fernery	FS	47	9	29 10 18	81 29 06	C	0	642	36,352
2-127-0825ANM	Thompson Fernery	FS	47	9	29 10 15	81 29 02	D	0	642	36,352
2-127-0825ANM	Thompson Fernery	FS	47	9	29 10 17	81 29 09	E	0	642	36,352
2-127-0832AN	Fern	FS	22	16	29 21 28	81 30 02	A	0	1,496	84,704
2-127-0840AN	Azaleas	AGS	25	14	29 19 22	81 29 41	A	0	1,644	0
2-127-0846ANG	Landscape/turf grass	AG	86	31	28 53 03	81 09 40	A	0	3,501	0
2-127-0846ANG	Landscape/turf grass	AG	86	30	28 53 06	81 09 46	B	0	3,501	0
2-127-0846ANG	Landscape/turf grass	AG	86	30	28 53 17	81 09 48	C	0	3,501	0
2-127-0847ANV	Southridge Golf Course	AG	69	26	29 00 59	81 17 19	A	0	11,433	0
2-127-0847ANV	Southridge Golf Course	AG	69	26	29 01 01	81 17 07	B	0	11,433	0
2-127-0856AN	Hagstrom—fern	FG	54	22	29 07 46	81 22 04	A&B	0	9,348	0
2-127-0857AN	Fern	FS	45	11	29 11 38	81 27 59	A	0	3,116	176,467
2-127-0857AN	Fern	FS	45	11	29 11 37	81 27 55	B	0	3,116	176,467
					Total (ft^3/day)			3,703,217	4,425,013	11,750,312
					Total (mgd)			28	33	876

Note: AG = nonfern, groundwater pumpage only
AGS = nonfern, both ground and surface water pumpage
CUP = consumptive use permit
ft^3day = cubic feet per day
FG = fern, groundwater pumpage only
FS = fern, both ground and surface water pumpage
GW = groundwater
mgd = million gallons per day
No. = number
SW = surface water