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PROJECTED AQUIFER DRAWDOWNS PALM BAY UTILITY CORPORATION WELLFIELD BREVARD COUNTY, FLORIDA

by

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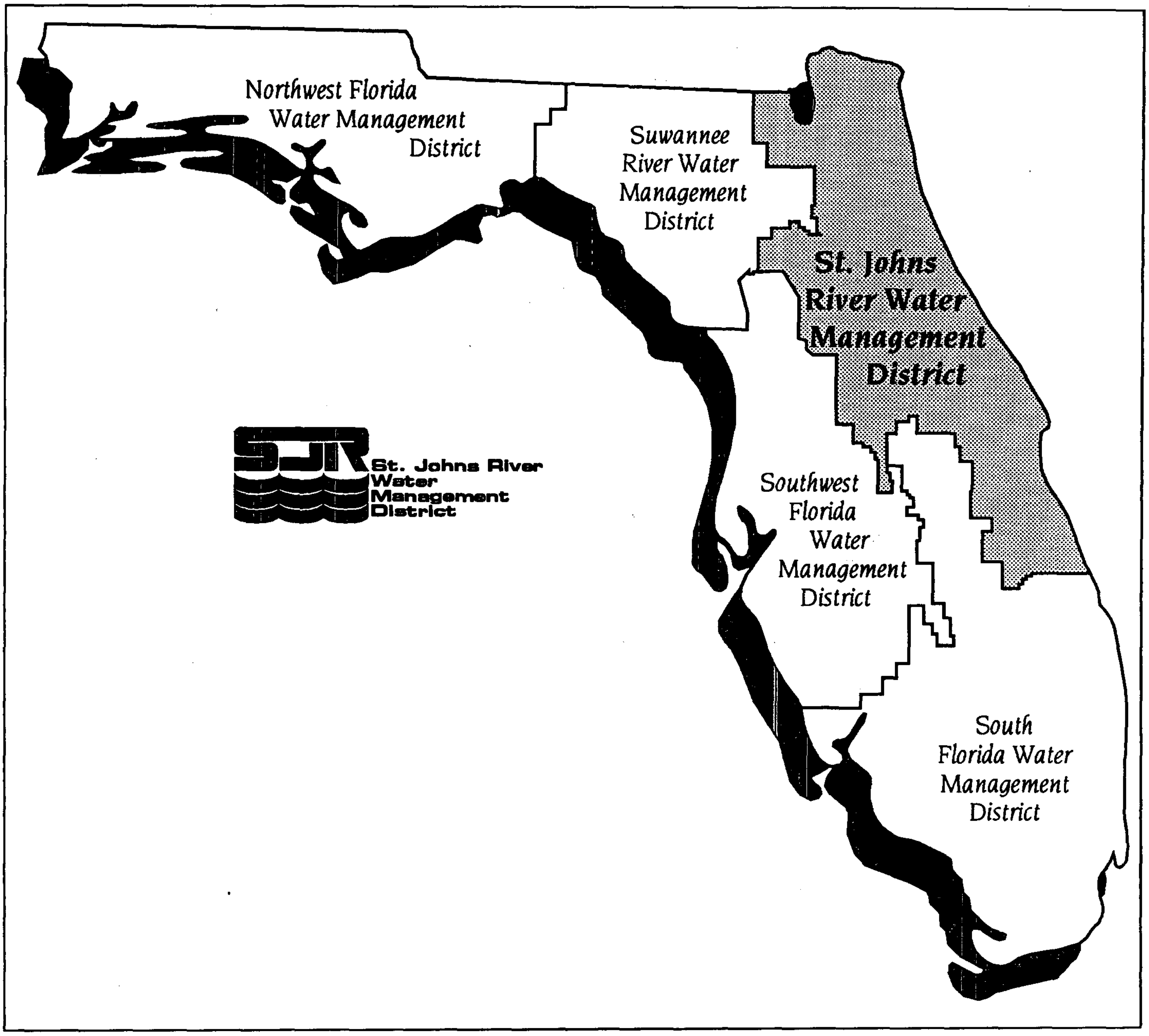

The **St. Johns River Water Management District** (SJRWMD) was created by the Florida Legislature in 1972 to be one of five water management districts in Florida. It includes all or part of 19 counties in northeast Florida. The mission of SJRWMD is to manage water resources to ensure their continued availability while maximizing environmental and economic benefits. It accomplishes its mission through regulation; applied research; assistance to federal, state, and local governments; operation and maintenance of water control works; and land acquisition and management.

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ABSTRACT. This paper is part of an assessment of water supply needs and sources, in which the St. Johns River Water Management District has been required to identify areas expected to have inadequate water resources to meet the water supply demand in 2010. Two analytical models, MLTLAY and SURFDOWN, were used to simulate changes in the water table and the potentiometric surfaces of the surficial aquifer system (SAS) and the Upper Floridan aquifer (UFA) based on 2010 projected pumpages at the Palm Bay Utility Corporation wellfield. The MLTLAY model calculates drawdowns in a multilayered, leaky-artesian aquifer system. The SURFDOWN model calculates drawdowns for a coupled two-aquifer system. Both models assume homogeneous, isotropic, and steady-state conditions. Simulated 1988 drawdowns at the wells ranged from 16.54 to 42.97 feet (ft) for SAS and was 8.66 ft for UFA. Simulated 2010 drawdowns ranged from 4.93 to 34.92 ft for SAS and was 29.12 ft for UFA. The change in drawdown at the wells ranged from -37.41 to 0.54 ft for SAS and was 20.46 ft for UFA. The increased pumpage between 1988 and 2010 will cause up to 7 ft of additional drawdown in the water table (unconfined portion of SAS). The simulated drawdowns for projected pumpages at this wellfield have a modest effect on the elevation of the water table and a pronounced effect on the elevation of the potentiometric surface of the confined portion of SAS. Projected pumpage has a small effect on the elevation of the potentiometric surface of UFA, except for drawdown at the well.

Section 17-40.501, *Florida Administrative Code*, requires the St. Johns River Water Management District (SJRWMD) to identify "specific geographical areas that have water resource problems which have become critical or are anticipated to become critical within the next 20 years." As part of this identification, SJRWMD is studying water supply needs and sources to determine those areas expected to have inadequate water resources to meet the projected 2010 water supply demand. Regional numerical ground water models and local analytical ground water models are used as part of this overall assessment.

The evaluation discussed here is based on the results of two analytical models, which were used to simulate the impacts associated with ground water withdrawals at the Palm Bay Utility Corporation wellfield (Figures 1 and 2). The evaluation was used as part of the overall assessment of water supply needs and sources to arrive at the projected 2010 districtwide drawdown in the water table and elevation of the potentiometric surfaces of the surficial aquifer and Floridan aquifer systems.

Within the area covered by the wellfield, there are two aquifer systems: the surficial and the Floridan. Two ground water flow systems occur within the surficial aquifer system. The uppermost system consists of water-saturated sand with a trace of silt and shell and exists under unconfined conditions (Geraghty & Miller 1982; Tom Sievers, pers. com. 1994a). It is referred to in this paper as the unconfined portion of the surficial aquifer system. The lower system consists of sand, shells, silt, and sandstone and exists under confined conditions (Geraghty & Miller 1982; Tom Sievers, pers. com. 1994a). It is referred to in this paper as the confined portion of the surficial aquifer system. These two systems are separated by a confining unit referred to in this paper as the semiconfining unit of the surficial aquifer. The Hawthorn Group acts as the upper confining unit, separating the surficial aquifer system and the Upper Floridan aquifer. The Upper Floridan aquifer is a vertically continuous sequence of carbonate rocks of generally high permeability. In the study

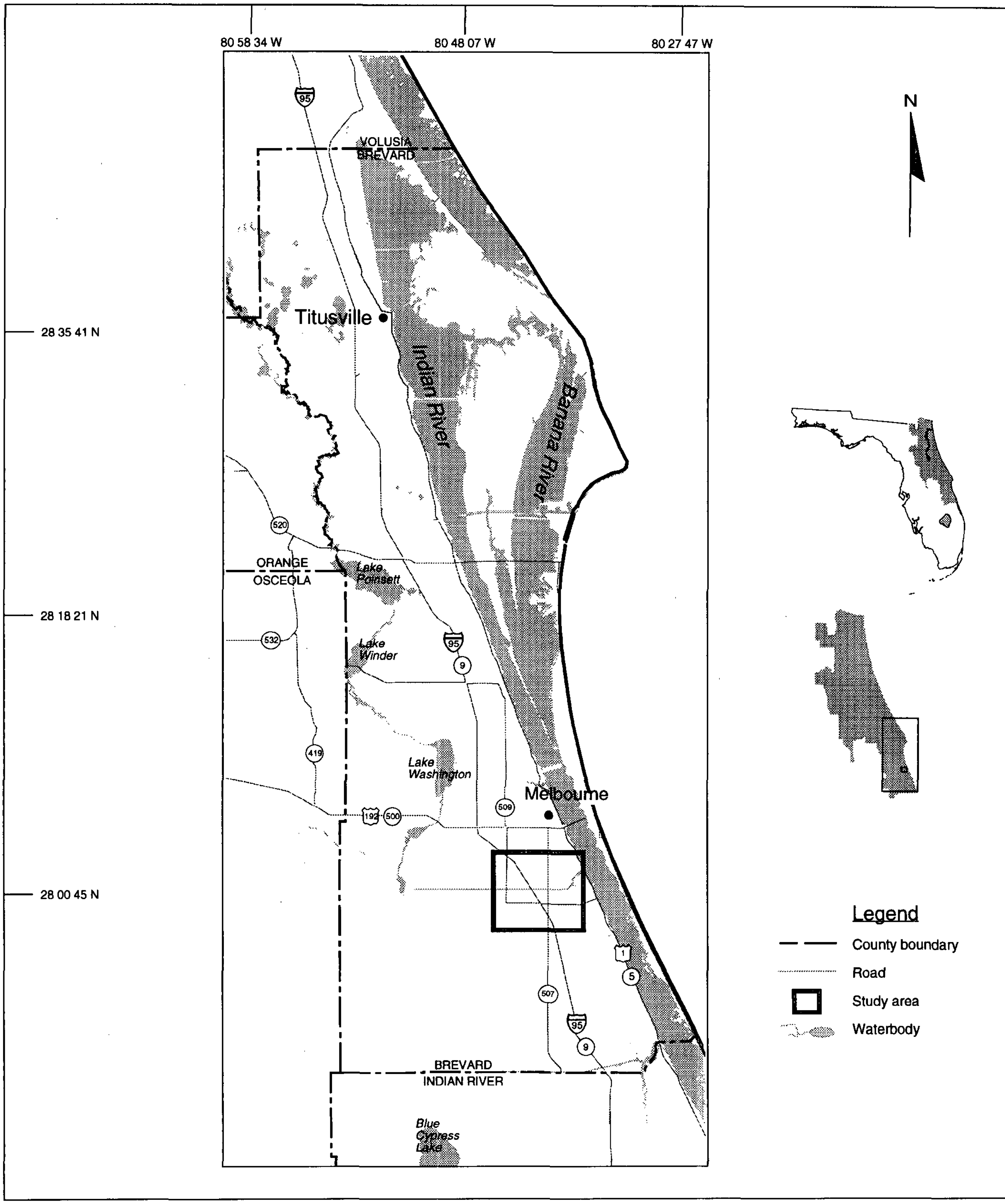


Figure 1. Location of the model domain for the Palm Bay Utility Corporation wellfield

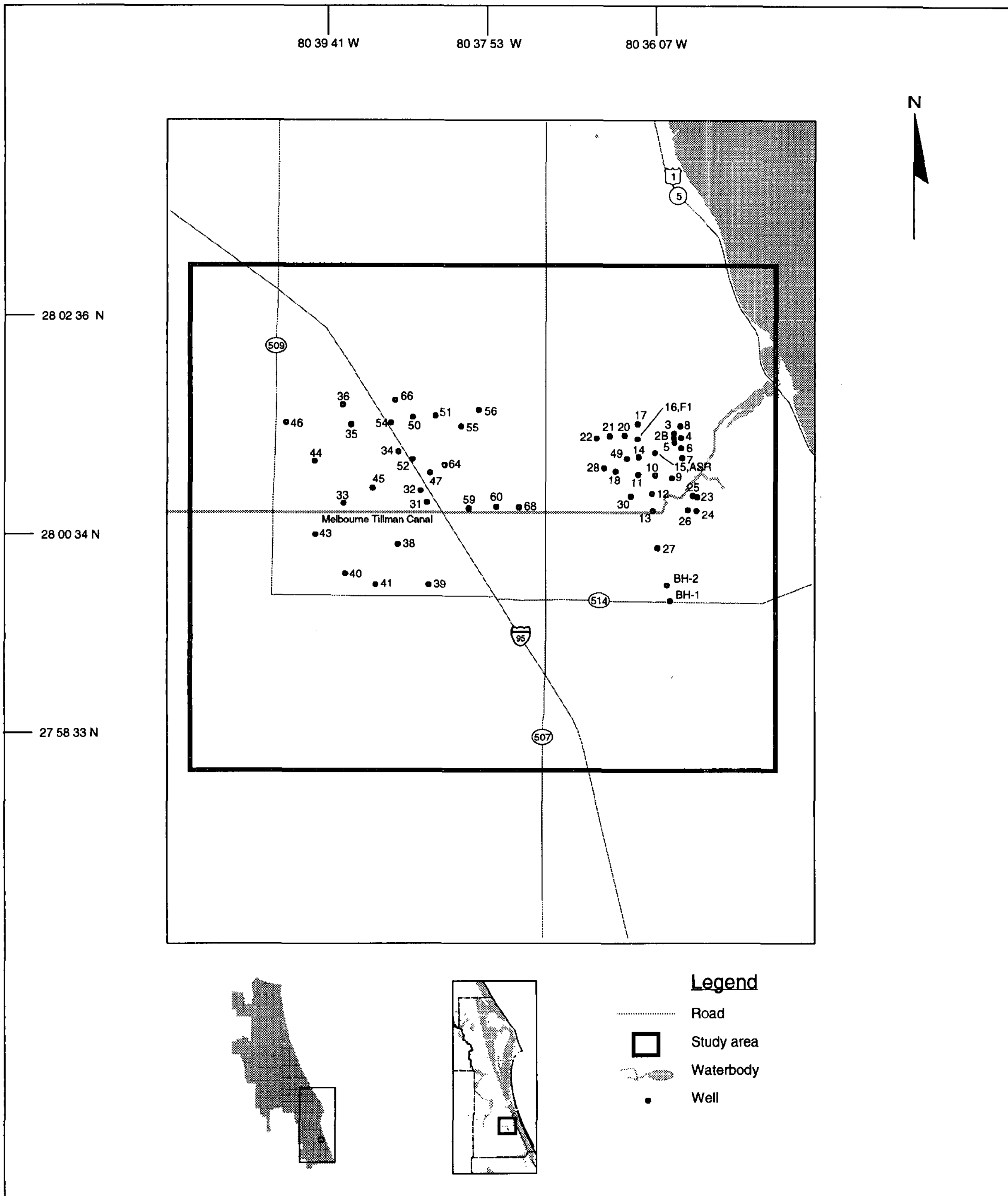


Figure 2. Model domain and well locations of the Palm Bay Utility Corporation

area, the Upper Floridan aquifer consists of the Suwannee and Ocala limestones and the upper part of the Avon Park Formation.

The City Council of Palm Bay created the Palm Bay Utility Corporation (PBUC) on November 19, 1992. Prior to this time, General Development Utilities (GDU) and the City of Melbourne supplied water to Palm Bay. On December 16, 1992, PBUC purchased the utility from GDU. To avoid confusion and maintain continuity, the GDU wellfield, which supplied water to Palm Bay in 1988, will be referred to as the PBUC wellfield.

The PBUC wellfield withdraws water from both the surficial aquifer and the Floridan aquifer systems. In 1988, the PBUC wellfield withdrew 4.15 million gallons per day (mgd) from 24 surficial aquifer wells and 1 Upper Floridan aquifer well (Tom O'Brian, pers. com. 1994). By March 1994, 15 additional surficial aquifer wells had been constructed and 1 existing surficial aquifer well had been taken out of service. In 2010, PBUC plans to withdraw 7.59 mgd from 55 surficial aquifer wells and 1 Upper Floridan aquifer well (Tom Sievers, pers. com. 1994b); 39 of these wells were in place in 1994. The proposed locations for the remaining 17 wells are based on Tom Sievers (pers. com. 1994c). All surficial wells are in the confined portion of the surficial aquifer system and are screened.

From November 1987 to March 1988, an aquifer storage recovery (ASR) facility was constructed at the PBUC wellfield. ASR is a water management tool that can be used to help meet peak demands on a water supply system. Excess water available from the surficial aquifer system during the low demand season (October through March) is stored in the Upper Floridan aquifer and later withdrawn to help meet peak demands (April through September). Presumably, all water injected into the Upper Floridan aquifer during the low demand season is withdrawn during the peak demand season. Because water stored in the ASR facility has been withdrawn from the surficial aquifer system and because it operates seasonally, it is not considered in the analyses presented in this paper.

METHODS

Impacts to the ground water flow system resulting from withdrawals from the PBUC wellfield were evaluated using first the MLTLAY model (SJRWMD unpublished) and then the SURFDOWN model (Huang 1994, draft). The MLTLAY model uses a linear analytical solution for a multilayered, leaky-artesian aquifer system to calculate the amount of drawdown in the surficial aquifer system and the Upper Floridan aquifer. The method assumes that homogeneous and isotropic conditions prevail in the surficial aquifer and Floridan aquifer systems. The model simulated steady-state conditions. The model considers the flow of water through multiple aquifers separated by semipervious leaky layers. The model has the capability of simulating the withdrawal of water from either the surficial aquifer system or the Upper Floridan aquifer or from both simultaneously.

In general, the MLTLAY model calculates drawdowns in the surficial aquifer and Floridan aquifer systems as a result of pumping stresses on each system. Based on available hydraulic and hydrologic parameters (e.g., pumping rates, transmissivity, and leakance coefficient), the model determines the drawdowns in these aquifer systems. Average parameter values are used throughout the entire model domain. Because site-specific elevations of the potentiometric surface of the Floridan aquifer system within the model domain do not exist, the Floridan aquifer drawdowns could not be calibrated or verified. However, an estimated 2010 potentiometric surface map of the Floridan aquifer system can be created by subtracting the 2010 simulated drawdowns from the measured 1988 elevation of the potentiometric surface for the model domain (Schiner 1988). Such a map would indicate only the impact of increased pumping rates on the elevation of the ground water at the wellfield.

The SURFDOWN model is based on an analytical solution for a coupled two-aquifer system in which pumping from an underlying aquifer is balanced by a reduction in evapotranspiration from an overlying aquifer (Motz 1978). SURFDOWN is used to solve for drawdowns in the water table of the unconfined portion of the surficial aquifer system as a function of drawdowns in the potentiometric surface of the confined portion of the surficial aquifer system, which were derived from the MLTLAY model. SURFDOWN is an analytical, steady-state, two-layered flow model. The analysis is based on the assumption that homogeneous and isotropic conditions prevail in both the unconfined and confined portions of the surficial aquifer system.

These models do not take into account surficial water features, such as canals. The Melbourne Tillman Canal is near some of the production wells. Drawdowns in the unconfined portion of the surficial aquifer system could be affected by induced infiltration from the canal.

The model domains were chosen to be large enough to include the most significant drawdown in the area around the wellfield. There is little or no drawdown beyond the extent of the model domain. The dimensions of the model domain are 35,000 feet (ft) wide and 30,000 ft long.

Aquifer characteristics used in the models include transmissivity of the confined and unconfined portions of the surficial aquifer system and the Upper Floridan aquifer, leakance of the semiconfining unit of the surficial aquifer system and of the upper confining unit, and the evapotranspiration reduction coefficient (Table 1). The transmissivity of the confined portion of the surficial aquifer system averages approximately 12,000 gallons per day per foot (gpd/ft). Geraghty & Miller (1982) reported ranges of 7,600 to 17,160 gpd/ft for transmissivity in this aquifer. In 1989, Engineering-Science reported ranges of 9,000 to 36,000 gpd/ft for transmissivity in

Table 1. Aquifer characteristics used in the MLTLAY and SURFDOWN models, Palm Bay Utility Corporation wellfield

Aquifer Characteristic	Value
Evapotranspiration reduction coefficient	0.00055 (ft/day)/ft
Transmissivity—unconfined portion of the surficial aquifer system	1,020 gpd/ft
Leakance—semiconfining unit of the surficial aquifer system	0.006 (gpd/ft^2)/ft
Transmissivity—confined portion of the surficial aquifer system	12,000 gpd/ft
Leakance—upper confining unit	0.0019 (gpd/ft^2)/ft
Transmissivity—Upper Floridan aquifer	17,200 gpd/ft

Note: (ft/day)/ft = feet per day per foot
gpd/ft = gallons per day per foot
(gpd/ft^2)/ft = gallons per day per square foot per foot

Source: Geraghty & Miller 1982; Tom Sievers, pers. com. 1994c; CH2M HILL 1989; Tibbals 1990

this aquifer (Tom Sievers, pers. com. 1994c). All of these values were generally obtained from specific capacity tests performed on the production wells. The transmissivity of the unconfined portion of the surficial aquifer system was determined using the following formula:

Transmissivity = aquifer saturated thickness × hydraulic conductivity

Geraghty & Miller (1982) and boring logs (Tom Sievers, pers. com. 1994a) indicated that the average saturated thickness of the unconfined portion of the surficial aquifer system is 30 ft, based on an estimated depth to water of 5 ft below land surface at the wellfield (Tom Sievers, pers. com. 1994b). Geologic information indicates that the unconfined portion of the surficial aquifer system is composed of sand with a trace of silt and shell (Geraghty & Miller 1982; Tom Sievers, pers. com. 1994a). Based on the geologic information and the saturated thickness, an assumed hydraulic conductivity of 34 gallons per day per square foot was used to determine the transmissivity of the unconfined portion of the surficial aquifer system. This value is consistent with values reported by Fetter (1980) for this lithology. The transmissivity of the Upper Floridan aquifer (CH2M HILL 1989), measured in gallons per day per foot, came from an aquifer performance test.

Leakance of the semiconfining unit of the surficial aquifer system is very variable and ranges from 0.001 to 0.108 gallons per day per square foot per foot [(gpd/ft^2)/ft] (Tom Sievers, pers. com. 1994c). An average value of 0.006 (gpd/ft^2)/ft was used for the leakance of the semiconfining unit of the surficial aquifer system. Leakance for the upper confining unit came from CH2M HILL (1989).

The evapotranspiration reduction coefficient, measured in feet per day per foot, was determined using a graph from Tibbals (1990, E10). The evapotranspiration reduction coefficient describes the rate at which evapotranspiration is reduced per unit of water table drawdown. It is based upon a depth to the water table of 5 ft below land surface at the wellfield.

Well pumpage rates for 1988 and 2010, measured in million gallons per day, were used in the model (Table 2). Pumpage for each well at the PBUC wellfield in 1988 was based on the annual metered readings for each well (Tom O'Brian, pers. com. 1994) and represents the average annual pumpage at the well. PBUC withdrew a total of 4.15 mgd in 1988 (Tom O'Brian, pers. com. 1994).

The 2010 total projected average pumpage at the PBUC wellfield is estimated to be 7.59 mgd (Tom Sievers, pers. com. 1994b). This projected pumpage is based on 55 surficial aquifer wells and 1 Upper Floridan aquifer well (Tom Sievers, pers. com. 1994b). The total projected average pumpage for 2010 was distributed among the 39 existing and 17 proposed wells in 1994 (Tom Sievers, pers. com. 1994b). All proposed wells were assumed to pump at 150 gallons per minute. Pumpage for existing wells was based on average 1993 pumpage. Operation of the wells was assumed to be as specified in the consumptive use permit for the wellfield. Withdrawals were reduced proportionally in all wells to result in an average withdrawal rate of 7.59 mgd, which represents the anticipated 2010 average hourly flow for the existing water treatment plant (Tom Sievers, pers. com. 1994b). Although the projected pumpage at the wellfield is greater in 2010 than in 1988, individual well pumpages increased at only 4 wells and decreased at 20 wells between 1988 and 2010. The 15 wells installed in 1994 and the proposed 17 wells to be installed by 2010 account for the majority of the increase in projected pumpage.

RESULTS

Drawdowns measured in December 1988 at the PBUC wellfield were compared to model-calculated drawdowns that used pumpage values measured in December 1988 (Table 3) (Tom Sievers, pers. com. 1994b). The difference between measured and calculated drawdowns was less than 4 ft at nine of the production wells (41 percent). For the majority of the wells, the measured drawdown is greater than the calculated drawdown. Differences between measured and calculated drawdowns that are greater than 4 ft are likely due to poor well efficiency caused by silting of the gravel packs, encrustation of the well screen, or other well fouling problems. Differences also may be due to the variation in transmissivity values of the confined portion of the surficial aquifer system and leakance values of the semiconfining

Table 2. Pumpage values for wells in the surficial aquifer and Floridan aquifer systems used in the MLTLAY and SURFDOWN models, Palm Bay Utility Corporation wellfield

Well	Latitude	Longitude	1988 Pumpage (mgd)	Projected 2010 Pumpage (mgd)
2B	280128	803555	0.021	NA
3	280131	803555	0.053	0.061
4	280128	803550	0.174	0.068
5	280125	803554	0.087	0.075
6	280122	803550	0.127	0.061
7	280117	803549	0.180	0.095
8	280135	803550	0.139	0.095
9	280105	803556	0.174	0.041
10	280106	803607	0.328	0.219
11	280107	803618	0.100	0.102
12	280056	803609	0.219	0.102
13	280046	803609	0.258	0.153
14	280117	803618	0.080	0.071
15	280120	803607	0.197	0.041
16	280127	803619	0.198	0.007
17	280136	803619	0.358	0.012
18	280109	803633	0.082	0.092
20	280130	803627	0.322	0.204
21	280129	803637	0.209	0.008
22	280128	803646	0.138	0.066
23	280053	803539	0.195	0.092
24	280046	803540	0.135	0.122
25*	280054	803542	NA	0.178
26*	280046	803545	NA	0.117
27*	280024	803606	NA	0.290
28	280111	803641	0.196	0.007
30*	280054	803623	NA	0.316
31°	280051	803838	NA	0.153
32°	280058	803842	NA	0.153

Note: mgd = million gallons per day
NA = not applicable

*Not in service in 1988
°Proposed wells

Table 2—*Continued*

Well	Latitude	Longitude	1988 Pumpage (mgd)	Projected 2010 Pumpage (mgd)
33°	280050	803933	NA	0.153
34°	280120	803857	NA	0.153
35°	280136	803928	NA	0.153
36°	280148	803934	NA	0.153
38°	280026	803857	NA	0.153
39°	280003	803837	NA	0.153
40°	280009	803932	NA	0.153
41°	280003	803912	NA	0.153
43°	280032	803952	NA	0.153
44°	280115	803952	NA	0.153
45°	280059	803914	NA	0.153
46°	280138	804011	NA	0.153
47*	280108	803836	NA	0.199
49	280116	803626	0.149	0.020
50*	280140	803847	NA	0.163
51*	280141	803832	NA	0.143
52*	280116	803848	NA	0.239
54*	280137	803902	NA	0.168
55*	280135	803815	NA	0.183
56*	280145	803804	NA	0.204
59*	280047	803810	NA	0.127
60*	280048	803752	NA	0.051
64*	280113	803826	NA	0.204
66°	280151	803859	NA	0.153
68*	280048	803737	NA	0.255
BH-1°	275953	803558	NA	0.153
BH-2°	280002	803600	NA	0.153
F-1†	280127	803619	0.033	0.340

Note: mgd = million gallons per day
NA = not applicable

*Not in service in 1988
°Proposed wells
†Upper Floridan aquifer system well that is not part of the aquifer storage recovery facility

Table 3. Comparison of measured (December 1988) and calculated drawdowns, Palm Bay Utility Corporation wellfield

Well	Measured* Drawdown (ft)	Calculated Drawdown (ft)	Drawdown Difference (ft)
2B	49	16.95	32.05
3	25.17	17.86	7.31
4	28.67	25.92	2.75
5	21.83	22.20	-0.37
6	27.83	23.30	4.53
7	34.59	26.36	8.23
8	33.83	21.57	12.26
9	46.75	30.68	16.07
10	38.83	41.92	-3.09
11	27.91	27.62	0.29
12	37.33	32.16	5.17
13	21.67	21.73	-0.06
14	31.92	30.28	1.64
15	29.33	32.82	3.49
16	14.84	38.75	3.09
17	----	48.24	----
18	39	29.86	9.14
20	29.66	47.39	-17.73
21	45.42	24.22	21.20
22	55.17	23.69	31.48
23	28.42	35.89	-7.47
24	----	25.05	----
28	37.5	37.76	-0.26
49	25.67	40.19	-14.52

*From Tom Sievers, pers. com. 1994b

--- indicates not measured

unit of the surficial aquifer system. Because measured drawdowns are greater than calculated drawdowns for the majority of the wells, the differences in drawdowns probably are due to poor well efficiencies. The values of the aquifer characteristics actually used in the model produced the best agreement between measured and calculated drawdowns in the production wells. Therefore, these aquifer characteristics were used to predict the 2010 impact on the ground water flow system. Site-specific elevations of the potentiometric surface of the Floridan aquifer system in the PBUC wellfield are not available for a similar comparison.

Drawdowns calculated by the model are based on the assumption that all wells were pumping 100 percent of the time; however, the wells are actually pumped on a rotated basis. The wells in the model were allowed to pump 100 percent of the time because the purpose of using the model was to examine the long-term regional impacts of the wellfield. Consequently, site-specific results, which would be sensitive to the number of wells pumping and the amount of time each well was pumped, were not necessary.

The change in simulated drawdowns in the potentiometric surface from 1988 to 2010 at the wells ranged from -37.41 to 0.54 ft for the surficial aquifer system and was 20.46 ft for the Floridan aquifer system (Table 4). However, new surficial aquifer system wells proposed to be added to the wellfield will cause 8–35 ft of drawdown at the wells for the surficial aquifer system in 2010. Simulated 1988 drawdowns ranged from 16.54 to 42.97 ft for the surficial aquifer system and was 8.66 ft for the Floridan aquifer system. Simulated 2010 drawdowns ranged from 4.93 to 34.92 ft for the surficial aquifer system and was 29.12 ft for the Floridan aquifer system. SURFDOWN does not calculate drawdowns for the water table (unconfined portion of the surficial aquifer system) at the wells. However, it is designed to calculate drawdowns at the nodes of a model grid for contouring.

Simulated drawdowns at the PBUC wellfield were contoured for 1988 and 2010 for the unconfined and confined portions of the surficial aquifer system and the Floridan aquifer system (Figures 3–8). Differences between the drawdowns in 1988 and 2010 were contoured for the unconfined and confined portions of the surficial aquifer system and the Floridan aquifer system (Figures 9–11). Figures 3–8 show the localized effect that pumping of these wells has on the aquifers. In reality, the effect of the pumping extends beyond the model domain.

DISCUSSION

The results of the modeling indicate that, between 1988 and 2010, water levels for the unconfined and confined portions of the surficial aquifer system will decline in the western and southeastern parts of the modeled area and will rise in the northeastern part (Figures 9 and 10). This is because more wells are proposed

Table 4. Simulated drawdowns for wells in the surficial aquifer and Floridan aquifer systems, Palm Bay Utility Corporation wellfield

Well	Simulated 1988 Drawdown (ft)	Simulated 2010 Drawdown (ft)	Drawdown Difference (ft)
2B	16.54	NA	NA
3	17.50	12.38	-5.12
4	27.26	13.18	-14.08
5	21.68	14.21	-7.47
6	24.03	12.80	-11.23
7	26.69	14.78	-11.91
8	21.18	13.57	-7.61
9	26.10	11.01	-15.09
10	41.38	27.55	-13.83
11	20.43	17.40	-3.03
12	29.56	17.54	-12.02
13	29.70	20.14	-9.56
14	21.04	13.49	-7.55
15	30.33	10.65	-19.68
16	32.34	7.08	-25.26
17	42.97	5.56	-37.41
18	16.64	13.55	-3.09
20	42.03	23.09	-18.94
21	29.19	5.47	-23.72
22	19.78	8.91	-10.87
23	23.08	17.01	-6.07
24	17.10	17.64	0.54
22*		23.62	NA
26*		17.70	NA
27*		29.99	NA
28	24.71	4.93	-19.78
30*		34.92	NA
31°		18.85	NA
32°		20.08	NA
33°		16.36	NA

Note: ft = foot
NA = not applicable

*Not in service in 1988
°Proposed wells

Table 4—*Continued*

Well	Simulated 1988 Drawdown (ft)	Simulated 2010 Drawdown (ft)	Drawdown Difference (ft)
34°		19.91	NA
35°		17.17	NA
36°		16.62	NA
38°		16.17	NA
39°		15.44	NA
40°		15.82	NA
41°		15.88	NA
43°		15.62	NA
44°		15.87	NA
45°		17.08	NA
46°		15.36	NA
47*		25.14	NA
49	25.47	8.61	-16.86
50*		19.98	NA
51*		17.41	NA
52*		28.31	NA
54*		20.22	NA
55*		20.70	NA
56*		21.51	NA
59*		14.16	NA
60*		7.51	NA
64*		24.19	NA
66°		17.79	NA
68*		25.55	NA
BH-1°		16.57	NA
BH-2°		17.07	NA
F-1[t]	8.66	29.12	20.46

Note: ft = foot
NA = not applicable

*Not in service in 1988
°Proposed wells
[t]Upper Floridan aquifer system well that is not part of the aquifer storage recovery facility

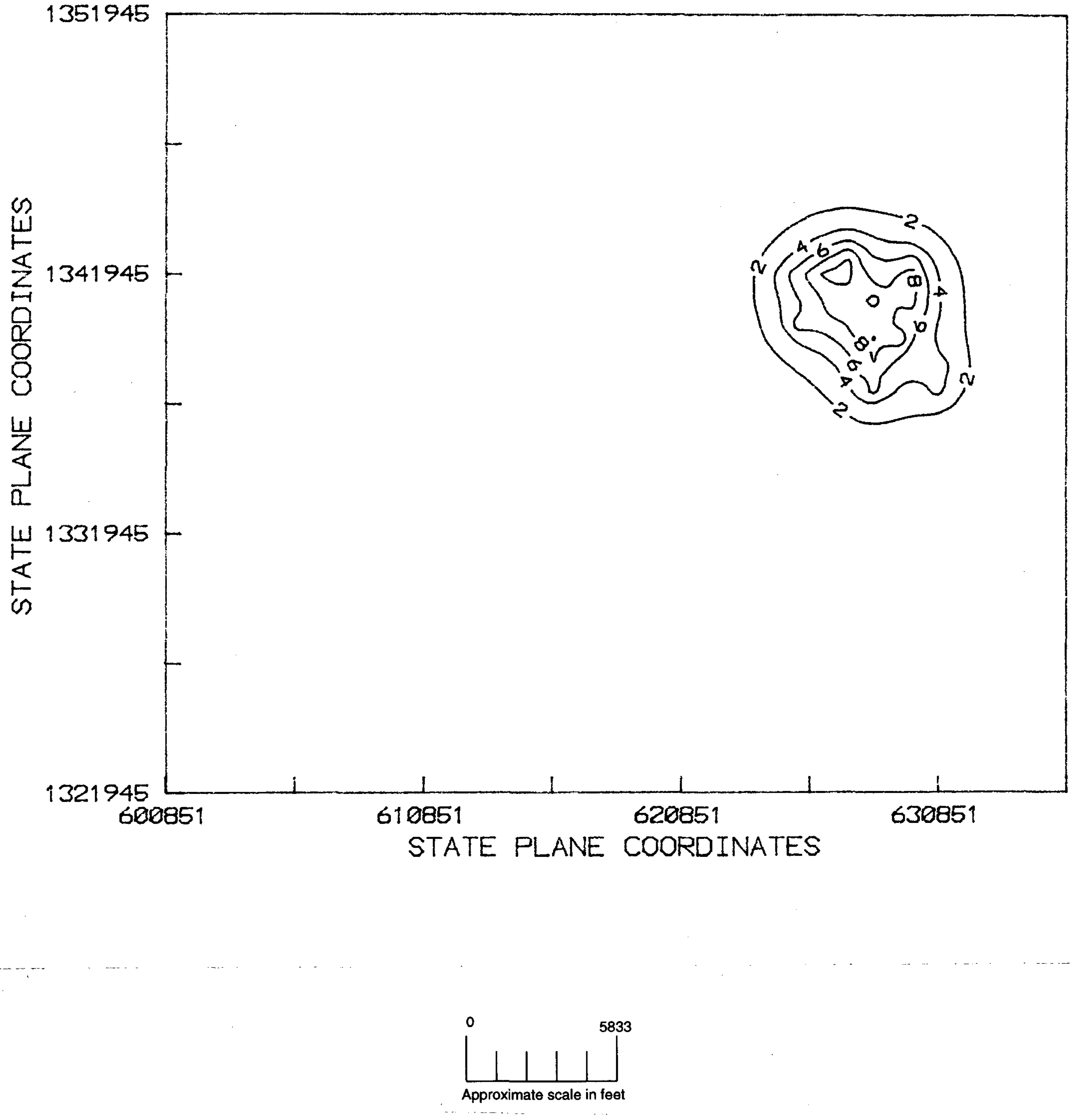


Figure 3. Simulated 1988 drawdowns in the unconfined portion of the surficial aquifer system at the Palm Bay Utility Corporation wellfield (measured in feet)

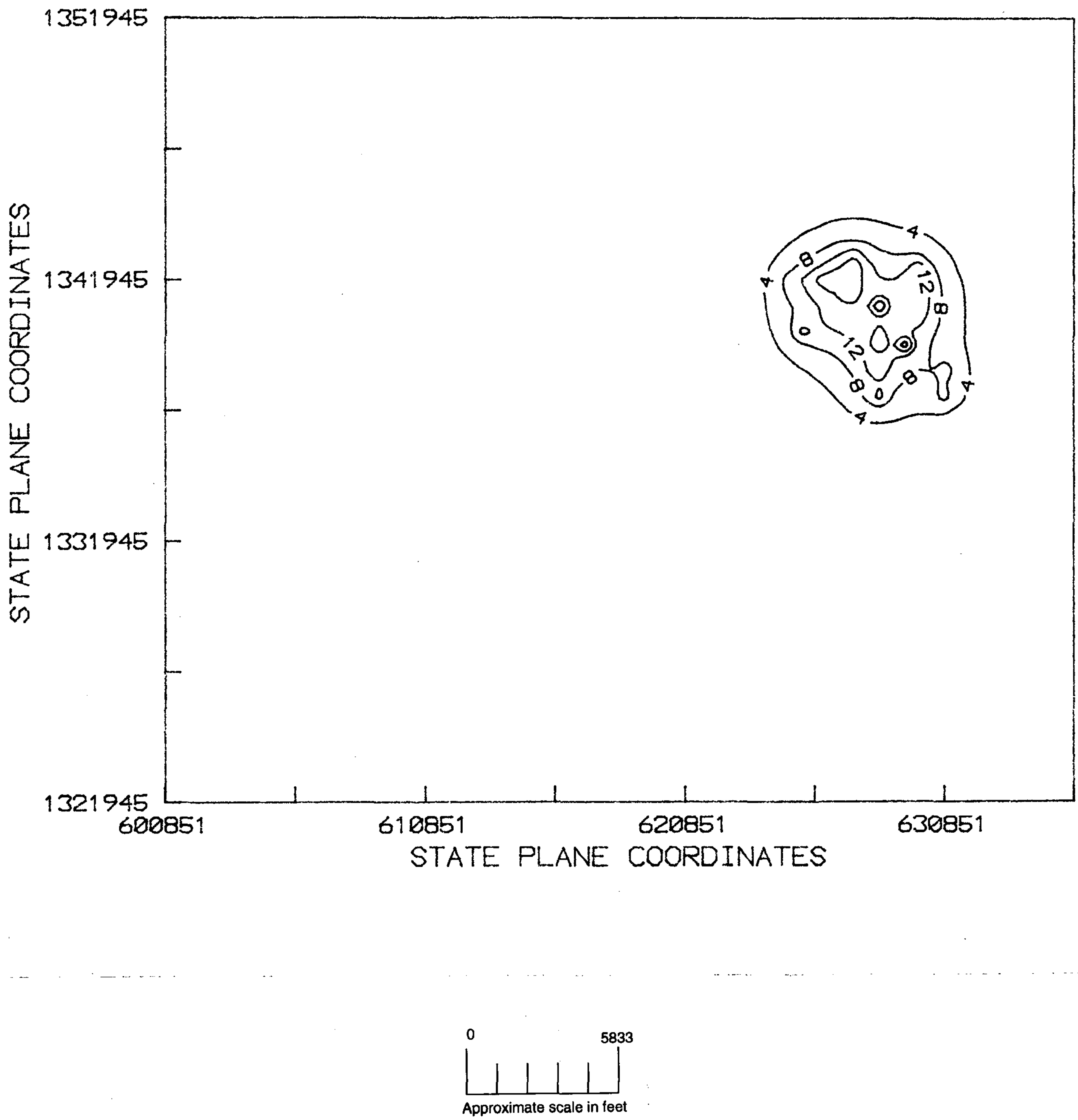


Figure 4. **Simulated 1988 drawdowns in the confined portion of the surficial aquifer system at the Palm Bay Utility Corporation wellfield (measured in feet)**

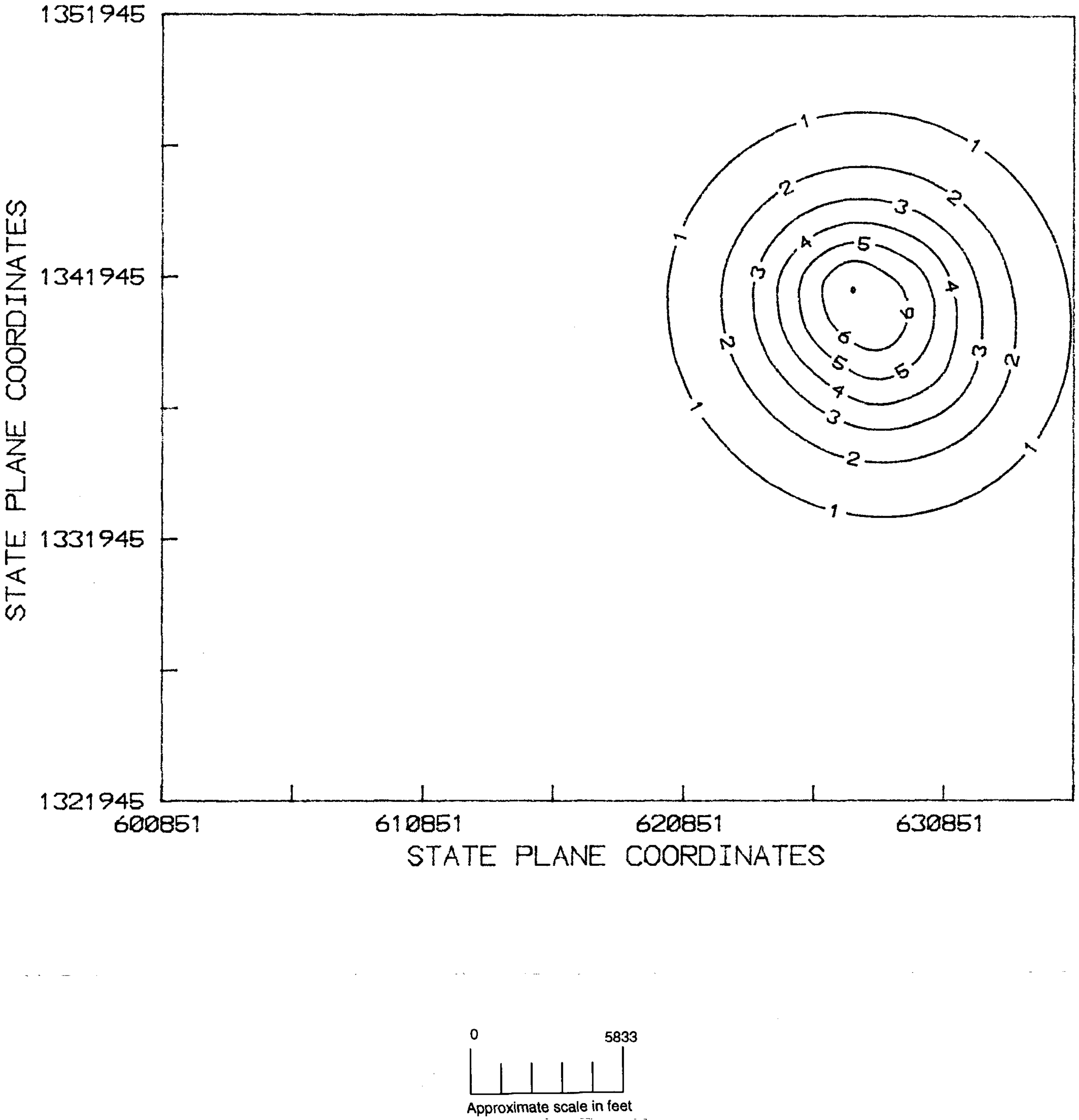
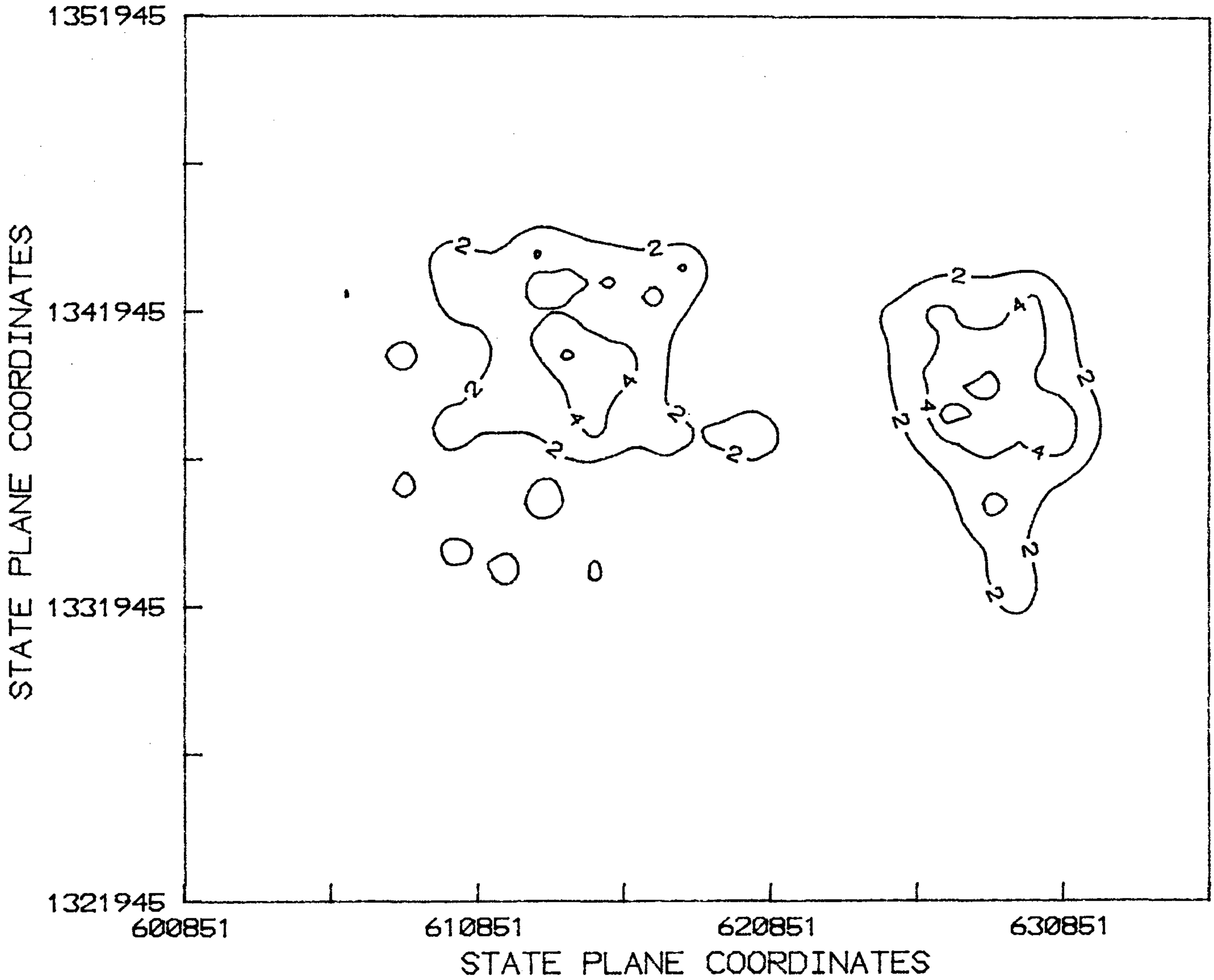


Figure 5. **Simulated 1988 drawdowns in the Upper Floridan aquifer at the Palm Bay Utility Corporation wellfield (measured in feet)**



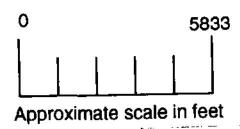


Figure 6. **Simulated 2010 drawdowns in the unconfined portion of the surficial aquifer system at the Palm Bay Utility Corporation wellfield (measured in feet)**

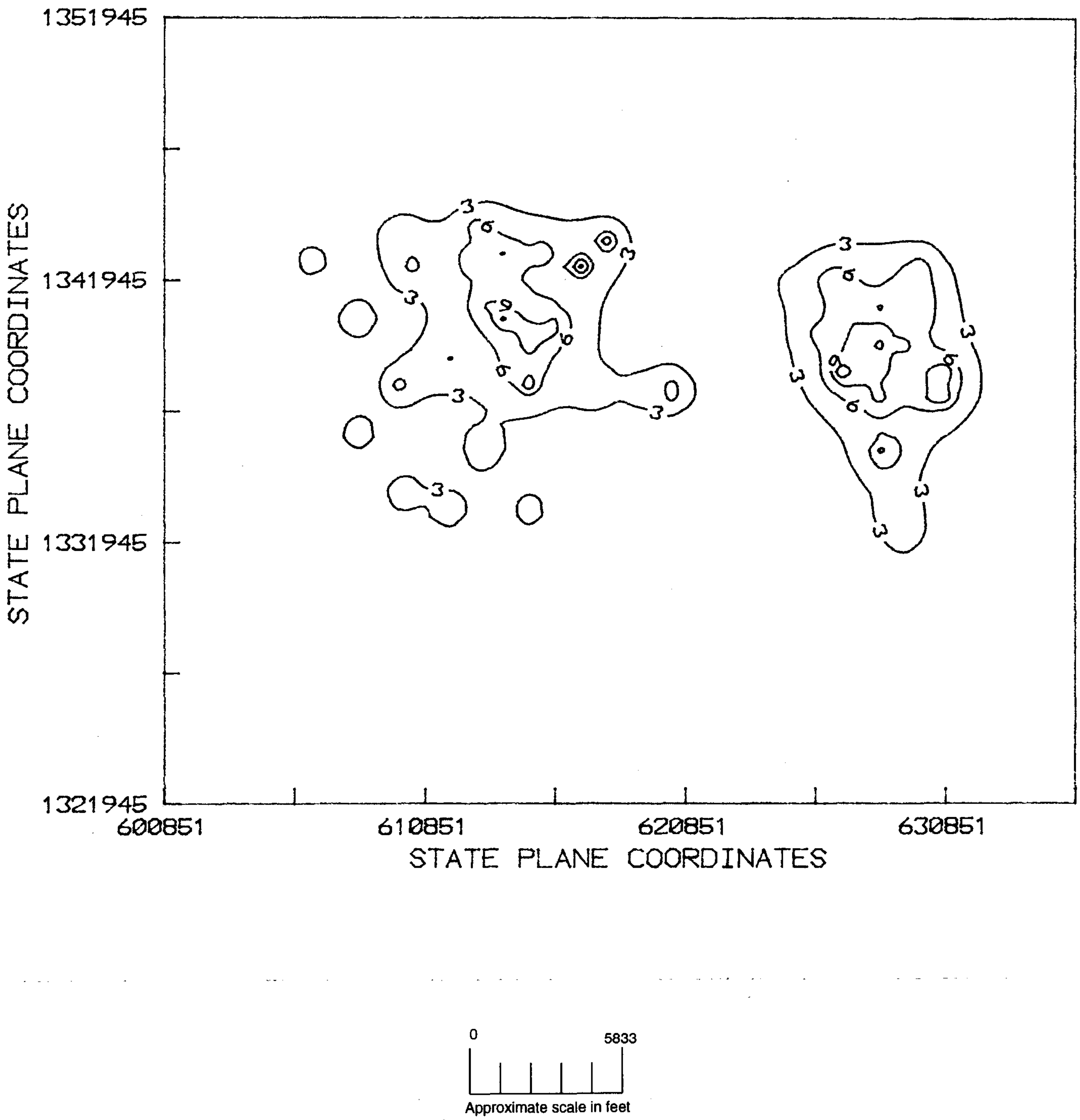


Figure 7. Simulated 2010 drawdowns in the confined portion of the surficial aquifer system at the Palm Bay Utility Corporation wellfield (measured in feet)

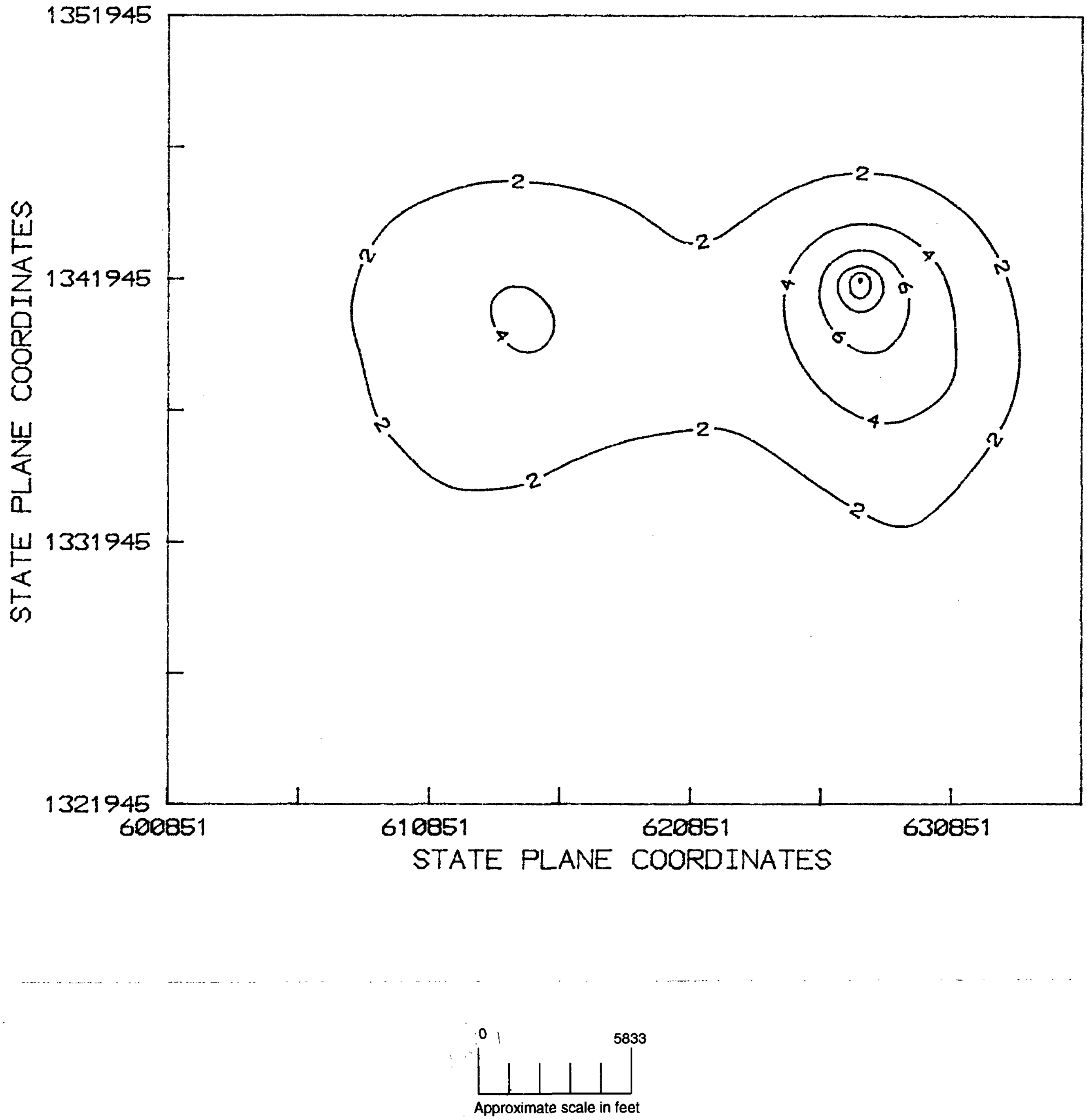
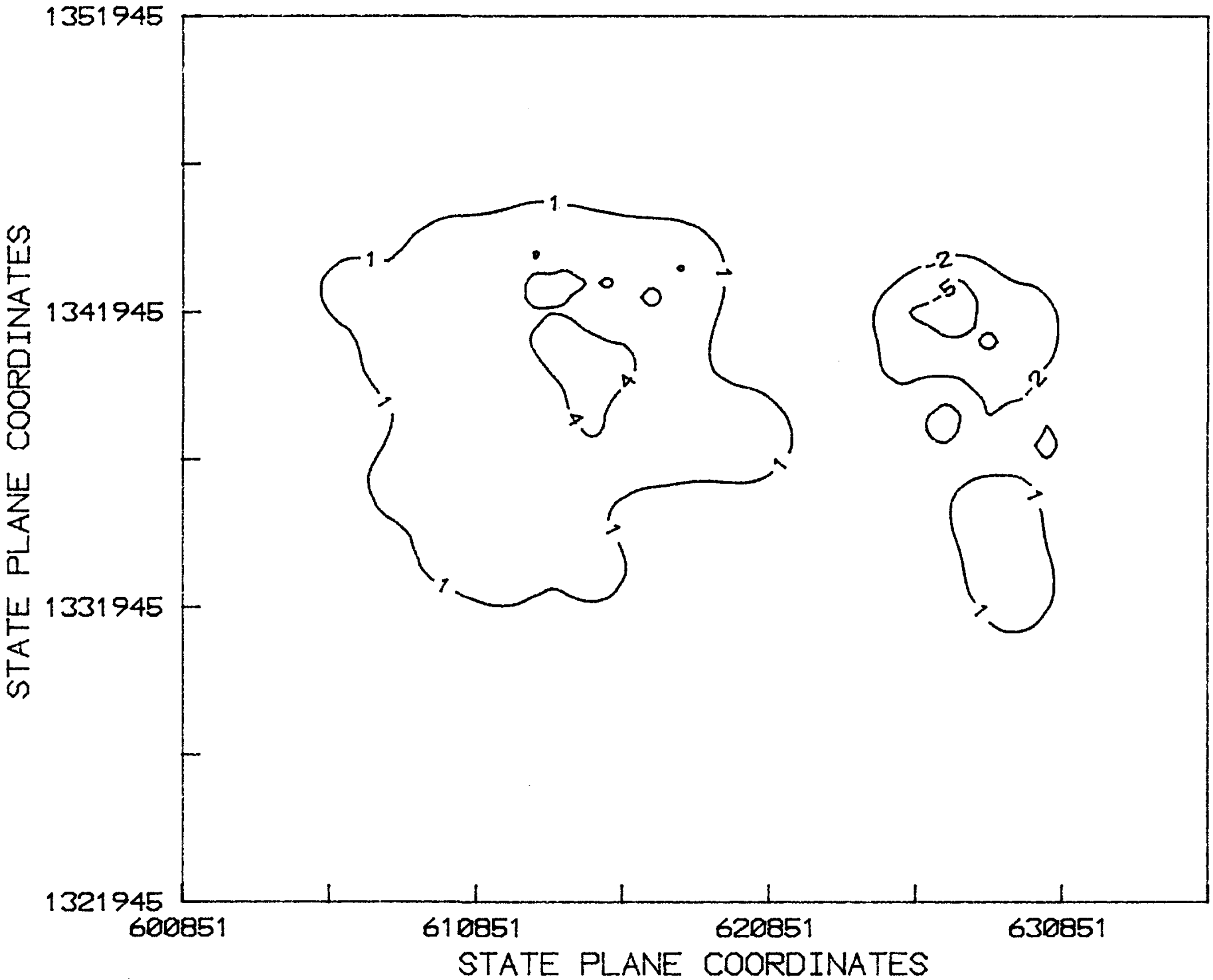


Figure 8. Simulated 2010 drawdowns in the Upper Floridan aquifer at the Palm Bay Utility Corporation wellfield (measured in feet)



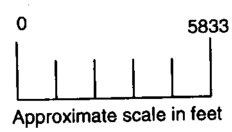


Figure 9. Difference in simulated drawdowns between 1988 and 2010 for the unconfined portion of the surficial aquifer system at the Palm Bay Utility Corporation wellfield (measured in feet). *Negative values indicate an increase in water levels.*

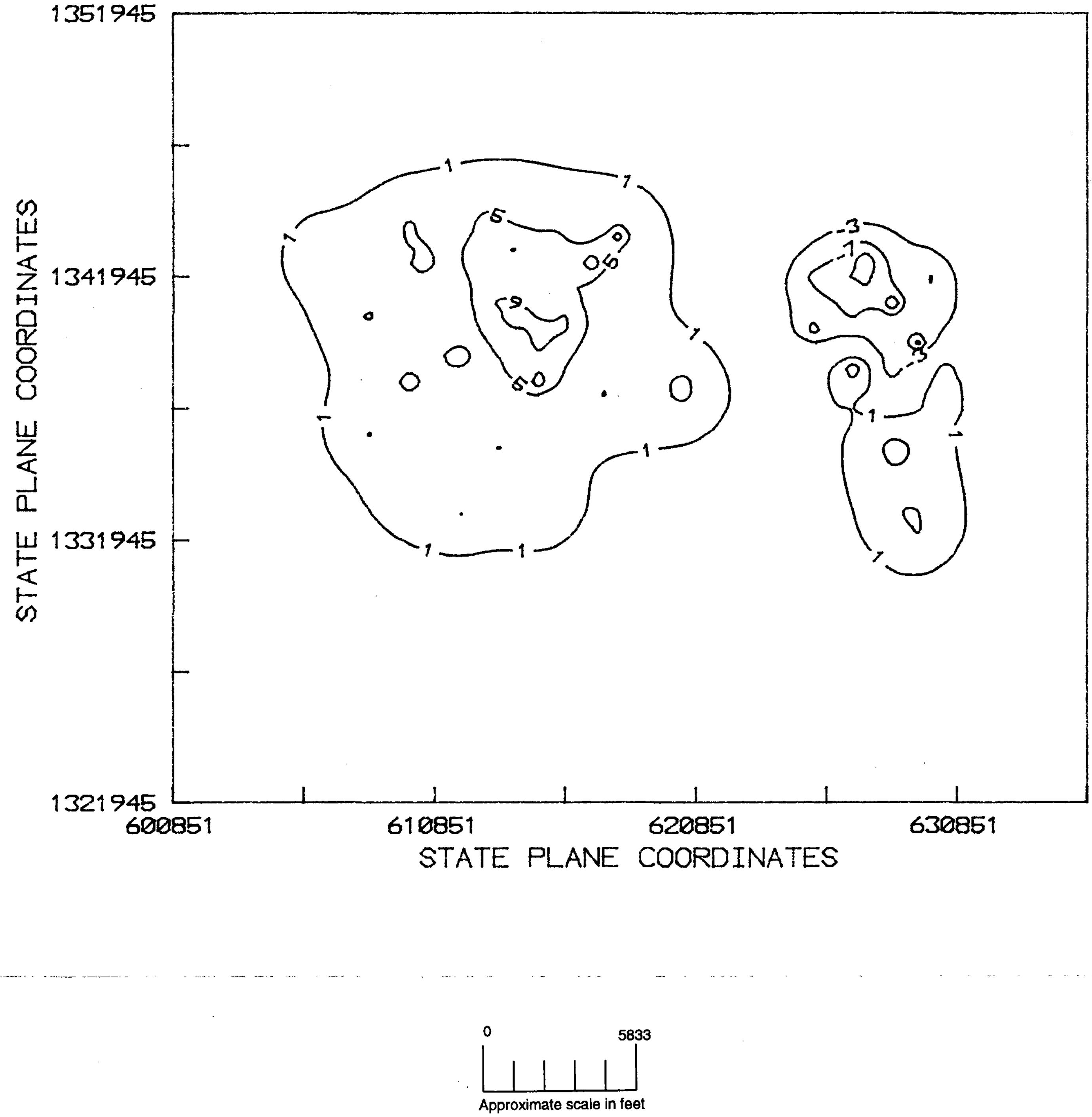


Figure 10. **Difference in simulated drawdowns between 1988 and 2010 for the confined portion of the surficial aquifer at the Palm Bay Utility Corporation wellfield (measured in feet).** ***Negative values indicate an increase in water levels.***

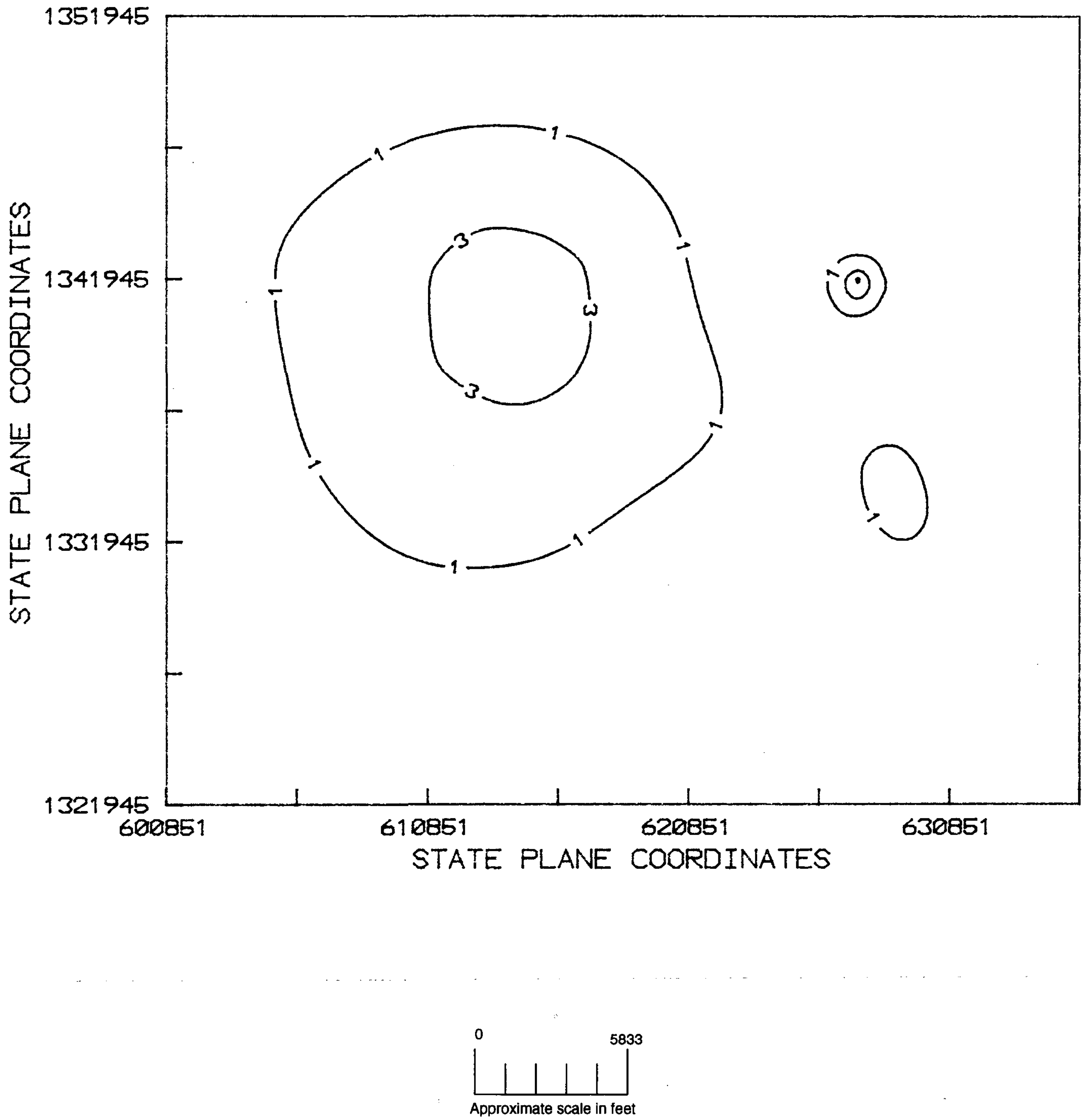


Figure 11. **Difference in simulated drawdowns between 1988 and 2010 for the Upper Floridan aquifer at the Palm Bay Utility Corporation wellfield (measured in feet)**

to be pumped in the western and southeastern parts of the wellfield in 2010 than were pumped in 1988. Pumpage at the PBUC wellfield in 2010 is based on 32 "new" wells (15 installed in 1994 and 17 to be installed) and the removal of 1 old surficial aquifer system well. The new wells are proposed to be located to the south and west of the wells that were in service in 1988. The incorporation of additional surficial aquifer system wells and reduced pumpage from existing wells will produce higher heads in the unconfined and confined portions of the surficial aquifer system in the northeastern portion of the modeled area in 2010 as compared to 1988 (Figures 3, 4, 6, and 7).

The difference in drawdowns between 1988 and 2010 vary throughout the model domain (Figures 9 and 10). Water levels in the unconfined portion of the surficial aquifer system are projected to decline by 7 ft and the potentiometric surface of the confined portion of the surficial aquifer system is projected to decline by 13 ft in the western portion of the modeled area. In the southeastern portion of the model area, between 1988 and 2010, water levels in the unconfined portion of the surficial aquifer are projected to decrease by up to 4 ft and the potentiometric surface of the surficial aquifer is projected to decrease by up to 9 ft. In the northeastern portion of the modeled area, between 1988 and 2010, water levels in the unconfined portion of the surficial aquifer are projected to increase by up to 8 ft and the potentiometric surface of the surficial aquifer is projected to increase by up to 15 ft. Higher heads in the northeastern portion of the modeled area should act as a buffer to help retard lateral saltwater intrusion in the surficial aquifer system. Lower heads in the southeastern portion of the model area could facilitate lateral saltwater intrusion in the surficial aquifer system.

The difference in drawdowns between 1988 and 2010 for the Upper Floridan aquifer is less than 3 ft beyond the immediate vicinity of the well (Figure 11) and 20.46 ft at the well (Table 4). The drawdown difference is not symmetrically distributed around the one Upper Floridan well because of the high leakance value of the upper confining unit. The drawdown difference for the Upper Floridan aquifer is strongly influenced by the drawdown difference for the confined portion of the surficial aquifer system. Upper Floridan aquifer water is discharged to the overlying, confined surficial aquifer system where the heads in the confined surficial aquifer system are lower than heads in the Upper Floridan aquifer. As water discharges from the Upper Floridan aquifer, drawdown occurs in that aquifer. For comparison, the elevation of the potentiometric surface of the Upper Floridan aquifer was approximately 32 ft above mean sea level (msl) at the one Upper Floridan aquifer well in May 1988 (Schiner 1988). Projected pumpage in 2010 at the PBUC wellfield is projected to lower the elevation of the potentiometric surface to about 27 ft msl away from the immediate vicinity of the well and to about 12 ft msl at the Upper Floridan well.

Average values of transmissivity (Table 1) were used for the aquifer characteristics in the MLTLAY and SURFDOWN models. If the maximum reported value of transmissivity (36,000 gpd/ft) for the confined portion of the surficial aquifer system were used instead of an average value (12,000 gpd/ft), calculated drawdowns for the confined portion of the surficial aquifer system would be reduced by approximately one-third. Similarly, if the minimum value (7,600 gpd/ft) were used for the transmissivity of the confined portion of the surficial aquifer system, calculated drawdowns for this system would be increased by approximately 63 percent. In view of the reported variable nature of transmissivity for the confined portion of the surficial aquifer system, an average value was used appropriately in this report.

CONCLUSIONS

Pumpage differences between 1988 and 2010 will cause water levels to increase in one portion of the model domain and to decrease in other portions. Individual well pumpages will increase at 4 wells and decrease at 20 wells. The 15 wells installed in 1994 and the proposed 17 wells to be installed by 2010 account for the majority of the increase in projected pumpage.

Increased individual well pumpage at the PBUC wellfield between 1988 and 2010 is projected to have a modest effect (less than or equal to 4 ft) on the elevation of the unconfined portion of the surficial aquifer system and a pronounced effect (less than or equal to 9 ft) on the elevation of the potentiometric surface of the confined portion of the surficial aquifer system. These declines are in the western and southeastern parts of the PBUC wellfield. More wells are proposed to be pumped in the western and southeastern parts of the PBUC wellfield in 2010 as compared to 1988.

Decreased individual well pumpage at the PBUC wellfield between 1988 and 2010 is projected to cause a moderate-to-pronounced rise (5- and 11-ft) in the elevation of the water table of the unconfined portion of the surficial aquifer system and the potentiometric surface of the confined portion of the surficial aquifer system. These rises are in the northeastern part of the PBUC wellfield.

Higher heads in the northeastern portion of the model area should act as a buffer to help retard lateral saltwater intrusion in the surficial aquifer system. Lower heads in the southeastern portion of the model area could facilitate lateral saltwater intrusion in the surficial aquifer system.

Increased pumpage at the Upper Floridan aquifer well in the PBUC wellfield between 1988 and 2010 is projected to have a small effect (less than 3 ft) on the elevation of the potentiometric surface of the Upper Floridan aquifer, except for drawdown at the well. Projected pumpage will cause about 20 ft of additional drawdown in the elevation of the potentiometric surface of the Upper Floridan aquifer at the well.

The results of this study will be used with regional ground water models in the final analysis of water supply needs and sources within SJRWMD to ensure that future wellfield expansions occur in a manner that is not detrimental to the water and vegetative resources.

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CONVERSION TABLE

Multiply	By	To Obtain
foot (ft)	0.3048	meter (m)
million gallons per day (mgd)	3.785×10^{3}	cubic meters per day (m^3/d)
gallons per day per foot (gpd/ft)	1.242×10^{-2}	square meters per day (m^2/d)
gallons per day per square foot (gpd/ft^2)	4.075×10^{-2}	meters per day (m/d)
gallons per day per square foot per foot ([gpd/ft^2]/ft)	0.1337	meters per day per meter ([m/d]/m)
feet per day per foot ([ft/d]/ft)	1.0	meters per day per meter ([m/d]/m)