HSW Engineering, Inc
15711 Mapledale Blvd., Suite B
Tampa, Florida 33624
(813) 968-7722 ♦ (813) 962-2406
www.hsweng.com

TECHNICAL MEMORANDUM

Date: September 21, 2015

To: Charles Doud, P.E., Orlando Utilities Commission

From: Dean Mades, P.E., HSW Engineering, Inc.
Ken Watson, Ph.D., HSW Engineering, Inc.

Subject: Evaluation of Water Table Drawdown at the Stanton Energy Center (SEC) near Orlando, FL

Introduction

HSW Engineering was retained by Orlando Utilities Commission (OUC) to evaluate the potential effects of proposed underdrain systems on groundwater levels in the vicinity of the existing Recycle Pond and proposed Recycle Pond Expansion at Stanton Energy Center (Figure 1). There is particular interest in the effects on the water table at existing wetlands near the recycle ponds.

The proposed Recycle Pond Expansion and modifications to the existing Recycle Pond, North Coal Storage Area Runoff Pond (NCSAP), and South Coal Storage Area Runoff Pond (SCSARP) will include 2,100-, 4,200-, 2,400-, and 2,000-foot long seepage underdrain collection systems, respectively (Ardaman & Associates, 2014). The design inverts of the 6-inch diameter slotted HDPE pipe/gravel pack underdrain systems are about 62 feet (NAVD88) or about 18 feet (ft) below the estimated seasonal high water table elevation near the ponds. A pumping system will be utilized to control the water level within the underdrain systems.

A numerical groundwater flow model representative of the hydrogeological conditions at the SEC and vicinity was developed and used to calculate groundwater level decline (i.e., drawdown) attributable to the operation of the underdrain systems.

Groundwater Flow Model Development

The groundwater flow model was developed using GMS, a graphical user interface for MODFLOW-2000 (Harbaugh, Banta, Hill, and McDonald, 2000). MODFLOW-2000 is an industry standard, computer code developed by the United States Geological Survey (USGS). MODFLOW is a three-dimensional groundwater model that uses a finite difference approximation to solve a groundwater flow equation.

The groundwater model was developed by adding features associated with the Environmental Resource Permit (ERP) modification application, particularly the proposed underdrain systems and reconfiguration of the Recycle Pond system. The model was configured as an impact model that calculates groundwater-level change, or drawdown, attributable to the proposed engineered features. A positive valued drawdown indicates a decrease in groundwater level, and a negative value indicates an increase.

The model was parameterized to be consistent with the regional hydrogeological framework of the U.S. Geological Survey (USGS) east-central Florida regional groundwater model (Sepulveda, et al, 2012), local data collected on-site (Ardaman & Associates, 2014), and proposed underdrain system characteristics.

The model has three layers representing the surficial aquifer, intermediate confining unit, and Floridan aquifer. The surficial aquifer is the primary focus of this evaluation.

The 80 ft thick surficial aquifer represented by the model is consistent with the USGS regional model. The low permeability sediments collected from soil borings near the recycle pond at a depth beginning 40 ft below land surface (Figure 2) are representative of localized conditions and presumed to be unrepresentative of regional conditions. While assuming a confining layer at a 40 ft depth would decrease the simulated amount of seepage withdrawn using the underdrain system, it would have little impact on the simulated water table drawdown because the underdrain system inverts are at a depth of just 18 ft below land surface.

The Stanton Energy Center (SEC) and vicinity are in an area where the potentiometric surface of the Floridan aquifer ranges between about 35 and 40 feet relative to the 1929 National Geographic Vertical Datum (NGVD, Figure 3). The potentiometric surface is about 40 feet lower than the on-site water table of about 75 feet NGVD (Ardaman & Associates, 2014) and the Floridan aquifer is being recharged by deep percolation from the shallower hydrogeological units (Figure 4). Operation of the underdrain systems will not induce upward leakage from the Floridan aquifer into the surficial aquifer because the systems will be operated to lower the water table by about 18 feet.

A model area was prescribed that extends well beyond the area of interest, i.e., the SEC and wetlands near the recycle ponds, to minimize the influence of model boundary conditions. The 12.7 square mile modeling area encompasses an area centered on the SEC and extends 23,600 feet from east to west and 15,000 feet from north to south (Figure 5). The modeling area is represented by rectangular cells defined by a non-uniformly spaced grid for the 3-layer model. The grid comprises 241 rows and 316 columns dimensioned with cell dimensions ranging from 30 feet × 37 feet near the ponds to 118 feet × 75 feet near the model boundaries. MODFLOW calculates the groundwater level, drawdown, and flow within each of the 228,468 discrete cells represented by the 3-layer grid.

Boundary conditions were prescribed to represent the significant features that affect groundwater flow. No attempt was made to represent the minimal regional gradients in the water table and Florida aquifer potentiometric surface that exist prior to dewatering because it is an impact-model analysis. Although land surface varies regionally between about 60 and 90 feet NGVD (Figure 2), the initial water table elevation for the model was set at a horizontal 75 feet, consistent with on-site monitoring well data. The bottom of model layer 3 (Floridan aquifer) is represented as a no-flow boundary (NFB) condition.

A general head boundary (GHB) condition that effectively extends the model area outward an additional mile in each direction was set for the cells lying along the perimeter of the model in each model layer (Figure 5). A GHB head of 75 was set for the surficial aquifer (model layer 1) to represent the average water table elevation, and a GHB head of 35 feet was prescribed for the Floridan aquifer (layer 3).

The underdrain systems are represented as line segments coincident with the engineering plan in model layer 1 (the surficial aquifer). The existing underdrain systems at the recycle pond and coal storage area runoff ponds are reportedly “ineffective” (Ardaman &Associates, 2014). The effect of the proposed underdrain systems is represented as the difference between the water table elevations (drawdown) simulated with and without the underdrain systems. The seepage collection underdrain systems are designed with an invert elevation of 62 ft, corresponding to a depth of 18 ft below land surface and the estimated seasonal high water table elevation (SHWL) of 80 ft within the construction area (Ardaman & Associates, 2014). A CHB head of 57 feet was prescribed to represent the maximum water table drawdown relative to a starting head of 75 feet that is presumed to occur instantaneously when the underdrain systems begin operating.

A net recharge of 2 inches/year was prescribed for the surficial aquifer to represent the regional recharge of the Florida aquifer, consistent with the USGS regional model (Figure 4).

The unlined Makeup Pond located immediately east of the existing Recycle Pond and a drainage ditch system hydraulically connected to the Makeup Pond are represented as a CHB and source of recharge to the water table. One segment of the drainage ditch system extends from the southwest corner of the Makeup Pond about 2,800 feet due west along the south side of the existing Recycle Pond to the southwest corner of the proposed Recycle Pond Expansion. A shorter segment intercepts the east-west ditch segment near the southwest corner of the existing Recycle Pond and extends about 1,110 feet north and northwest along the west side of the existing Recycle Pond. The ditch system is deep enough to convey water to and from the Makeup Pond along the length of the ditch system.

Inflows to the Makeup Pond include stormwater runoff from the east-central portion of SEC and treated water transmitted from nearby Orange County sanitary and landfill facilities to the Makeup Pond as needed to maintain a relatively constant pond water level. A constant value of 75 ft NAVD88 was prescribed for the Makeup Pond and drainage ditch system CHBs based on the average of pond water levels measured between January 2005 and September 2015.

The vertical dimensions and aquifer hydraulic parameters prescribed for the modeling area and associated references are listed in Table 1.

Table 1. Aquifer characteristics represented by the groundwater model

Aquifer Characteristics	Layer 1 (Surficial Aquifer)	Layer 2 (Intermediate Confining Unit)	Layer 3 (Floridan Aquifer)
Thickness (ft)	80[2]	100[2]	100[2]
Horizontal hydraulic conductivity (ft/day)	10[1]	0.00114[3]	250[2]
Vertical hydraulic conductivity (ft/day)	1[4]	0.00114[3]	25[4]
Specific storage (ft^{-1})	--	1.0E-6[2]	2.0E-6[2]
Specific yield	0.14[2]	--	--

[1] Engineering report with site-specific information (Ardaman & Associates, 2014).
[2] USGS regional model (Sepulveda, et al, 2012).
[3] Prescribed to represent a 2 inch per year net recharge of the Floridan aquifer.
[4] Professional judgment.

Results

The groundwater model was run as a transient simulation for a duration of 180 days. Output was created in the form of contour maps of drawdown near the site at the end of 90 days and 180 days subsequent to the immediate operation of the underdrain systems (Figure 6 and Figure 7).

Past research by the SWFWMD (1999) determined that a wetland condition change was apparent in palustrine cypress wetlands when the water level in a wetland declined more than 1.8 feet. After 180 days, the maximum water table drawdowns calculated within four wetland areas range between 0 ft at wetlands more distant from the underdrain systems to about 0.5 ft at the closest (Table 2, Figure 7). This drawdown range is well below the threshold water-level decline determined by the SWFWMD's research.

Average seepage rates calculated for the CHB cells representing the four underdrain systems total 365,590 and 349,640 ft^3/day after 90 and 180 days of operation, respectively (Table 3). The individual

system seepage rates range from 176,300 ft^3/day at the Existing Recycle Pond after 90 days of operation to 13,190 ft^3/day at the South Coal Storage Area Runoff Pond after 180 days of operation.

Table 2. Calculated water table drawdown at wetlands near the recycle ponds and coal storage areas

Planting/Mitigation area	Range in simulated drawdown after 90 days (ft)	Range in simulated drawdown after 180 days (ft)
3.1	0.02 - 0.3	0.1 - 0.5
3.2	0 – 0.03	0 – 0.16
3.5	0 - 0	0 – 0
3.6	0 - 0	0 - 0

Table 3. Average calculated seepage rates captured by the underdrain systems after operating for 180 days

Location	Average Seepage Rate After Operating 90 Days (ft^3/day)	Average Seepage Rate After Operating 180 Days (ft^3/day)
Existing Recycle Pond	176,300	172,200
Recycle Pond Expansion	135,300	133,900
North Coal Storage Area Runoff Pond	37,890	30,350
South Coal Storage Area Runoff Pond	16,100	13,190
Total	365,590	349,640

References

Ardaman & Associates, 2014, Engineering Report for Design of Proposed Recycle Ponds Expansion and Existing Lined Ponds Modification, contract report dated August 25, 2014, prepared for Orlando Utilities Commission, Orlando, Florida, 256 pp.

Harbaugh, A.W., Banta, E.R., Hill, M.C., and McDonald, M.G., 2000, MODFLOW-2000, the U.S. Geological Survey Modular Ground-Water Model-User Guide to Modularization Concepts and the Ground-Water Flow Process: U.S. Geological Survey Open-File Report 00-92, 121 pp.

Sepulveda, Nicasio, Tiedeman, C.R., O'Reilly, A.M., Davis, J.B., Burger, Patrick, 2012, Groundwater Flow and Water Budget in the Surficial and Floridan Aquifer Systems in East-Central Florida: U.S. Geological Survey Scientific Investigations Report 2012-5161, 214 pp.

Southwest Florida Water Management District, 1999, Northern Tampa Bay Minimum Flows and Levels White Papers, Brooksville, FL.

FIGURES

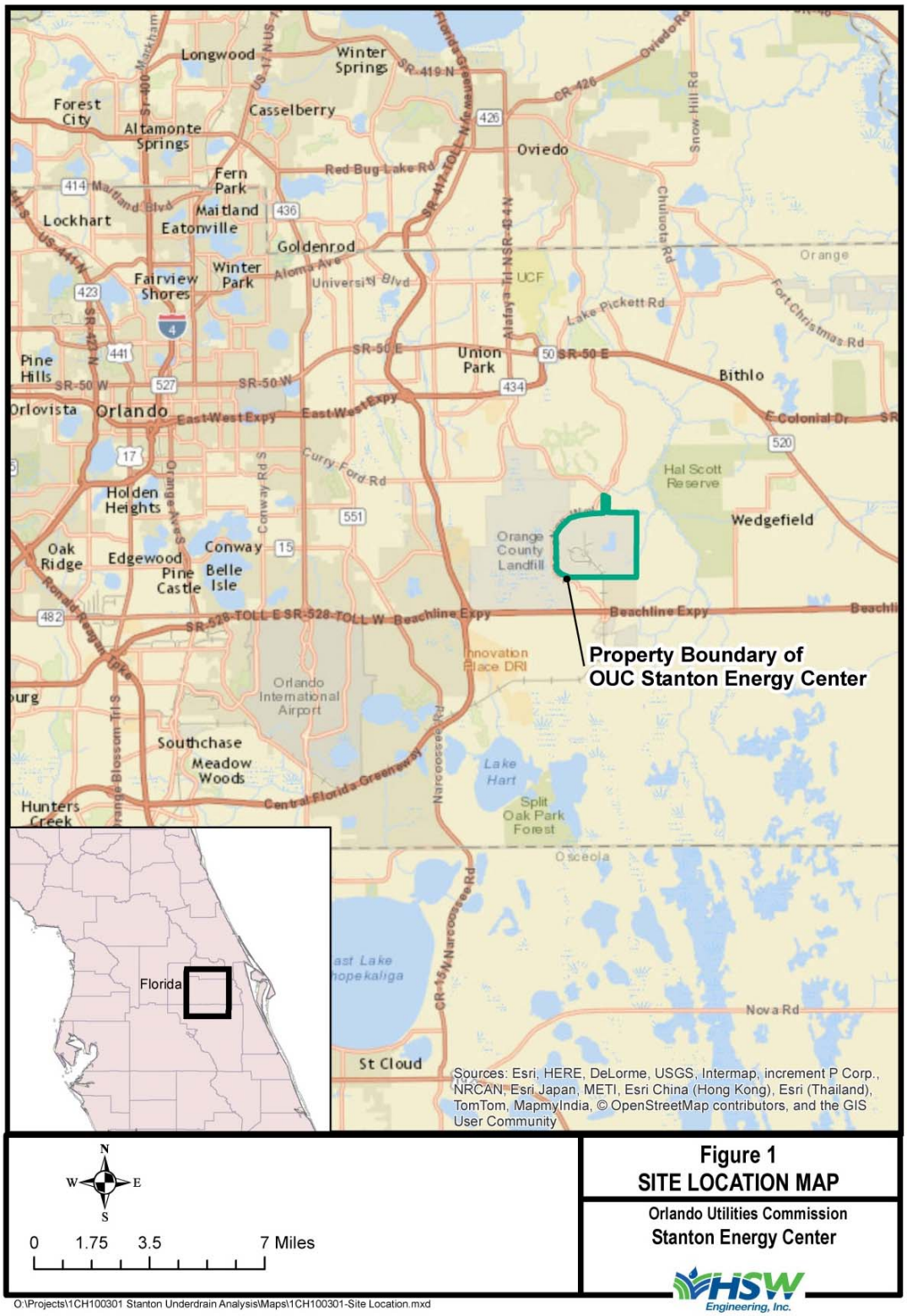

Figure 1. Site location map

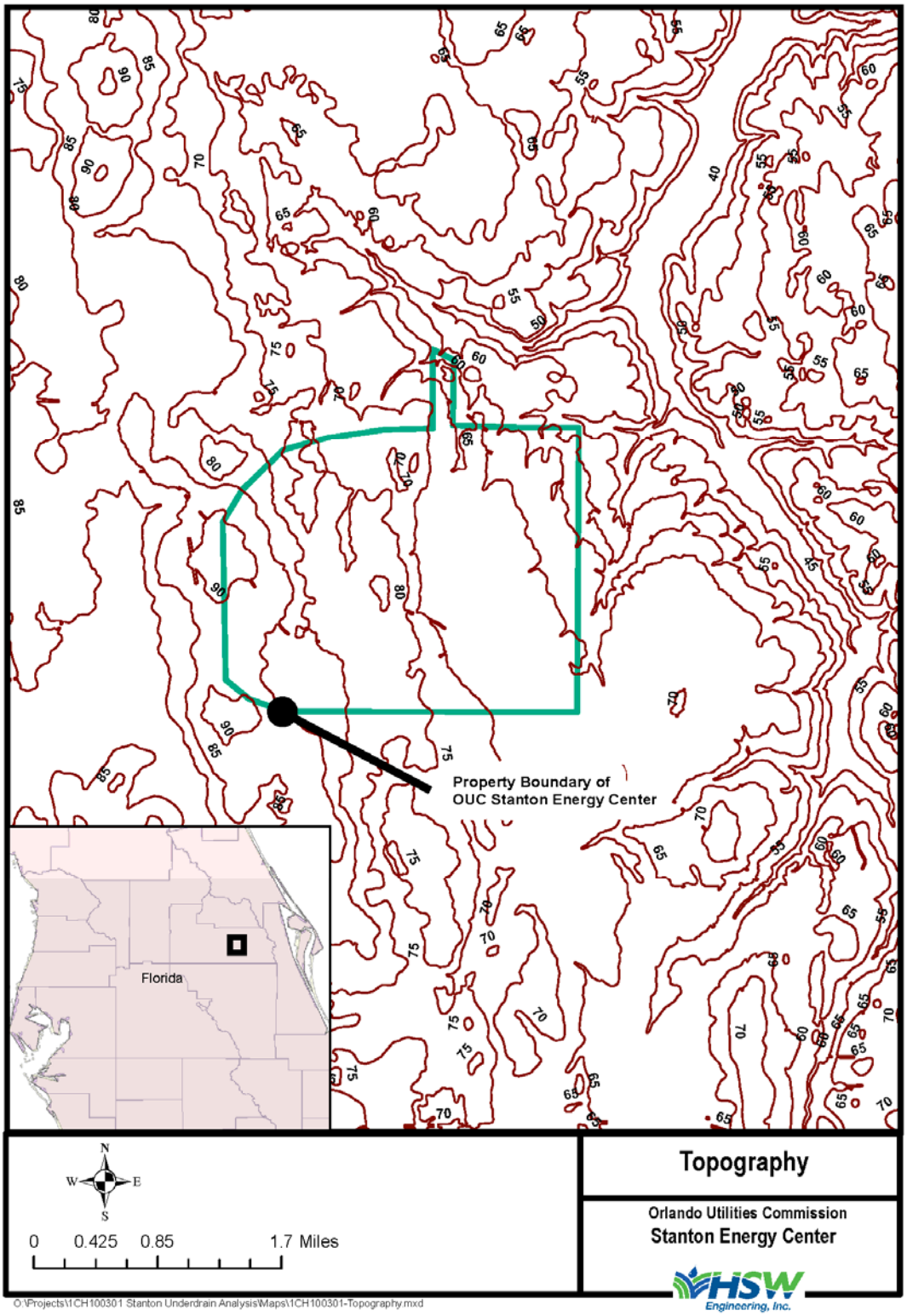

Figure 2. Land surface topography
[Elevation in feet NGVD]

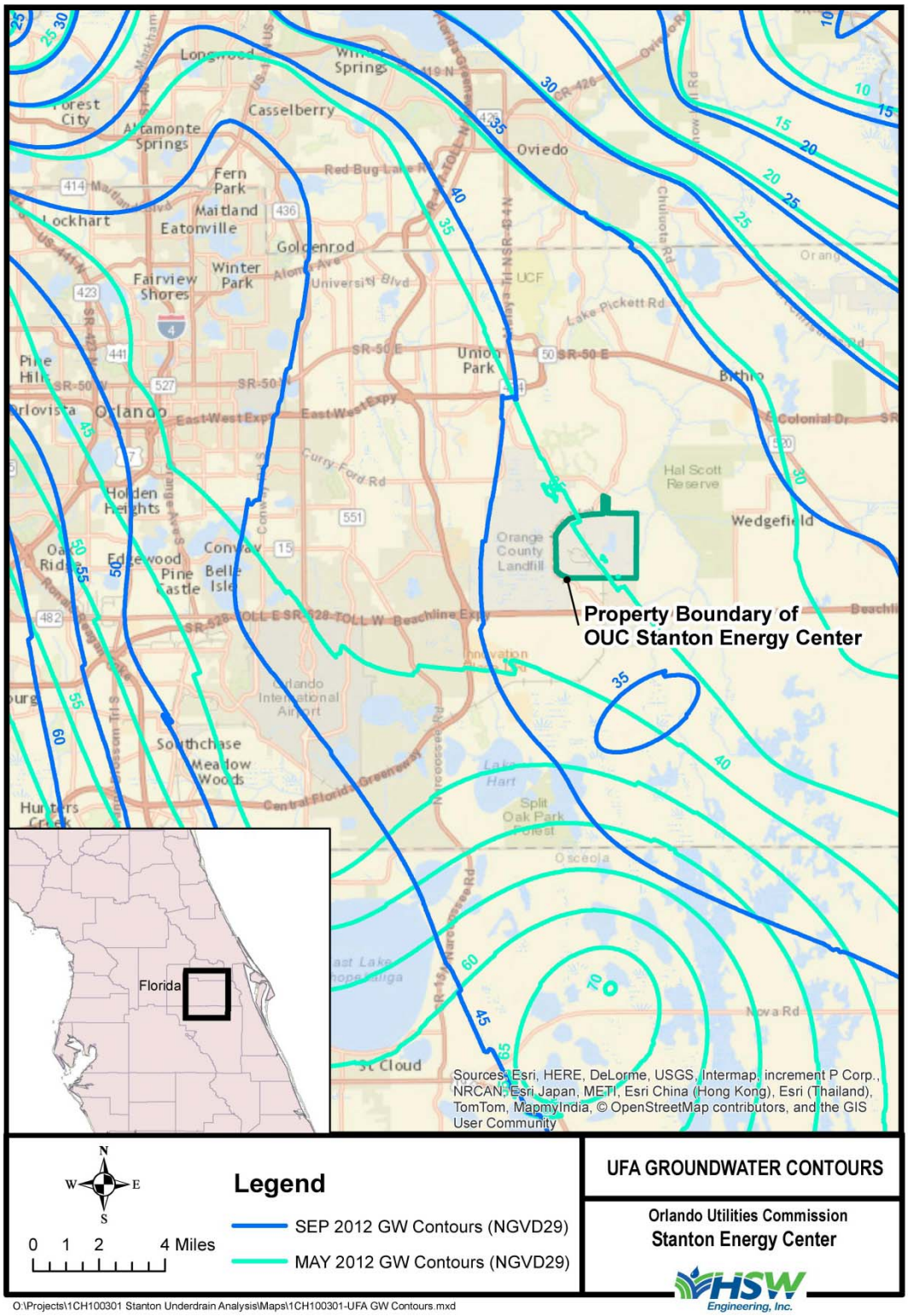

Figure 3. Upper Floridan Aquifer potentiometric surface
[Elevation in feet NGVD]

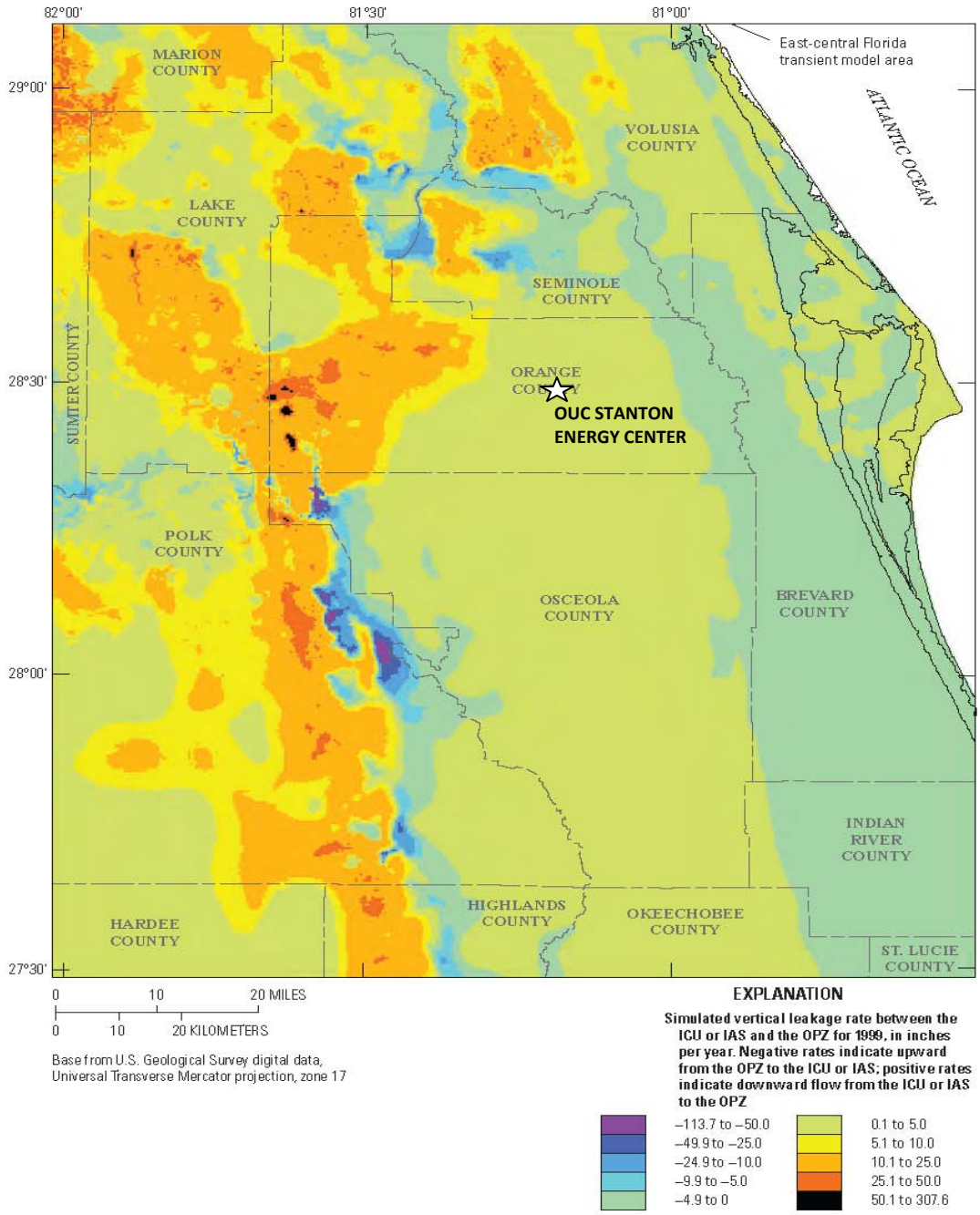

Figure 108. Simulated vertical leakage rates between the intermediate confining unit/intermediate aquifer system (ICU/IAS, layer 2) and the Ocala permeable zone (OPZ, layer 3), average 1999 conditions.

Figure 4. Regional distribution of calculated vertical leakage to the Upper Floridan Aquifer [Source: Sepulveda et al, 2012]

Figure 5. Groundwater modeling area and finite-difference grid

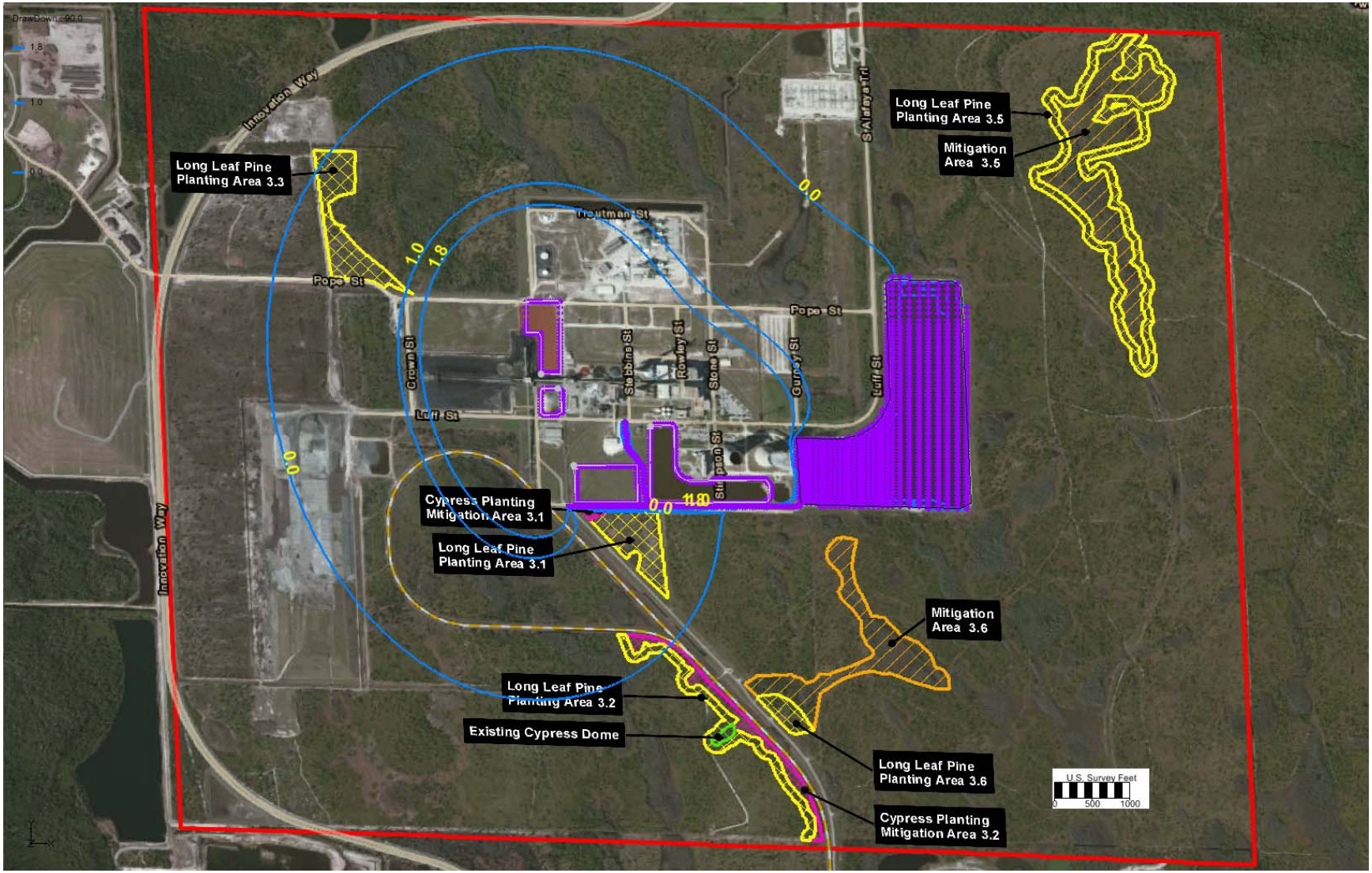

Figure 6. Water table drawdown contours (feet) after operating 90 days
[Combined calculated average pumpage from the four underdrain systems is 365,590 ft^3/day]

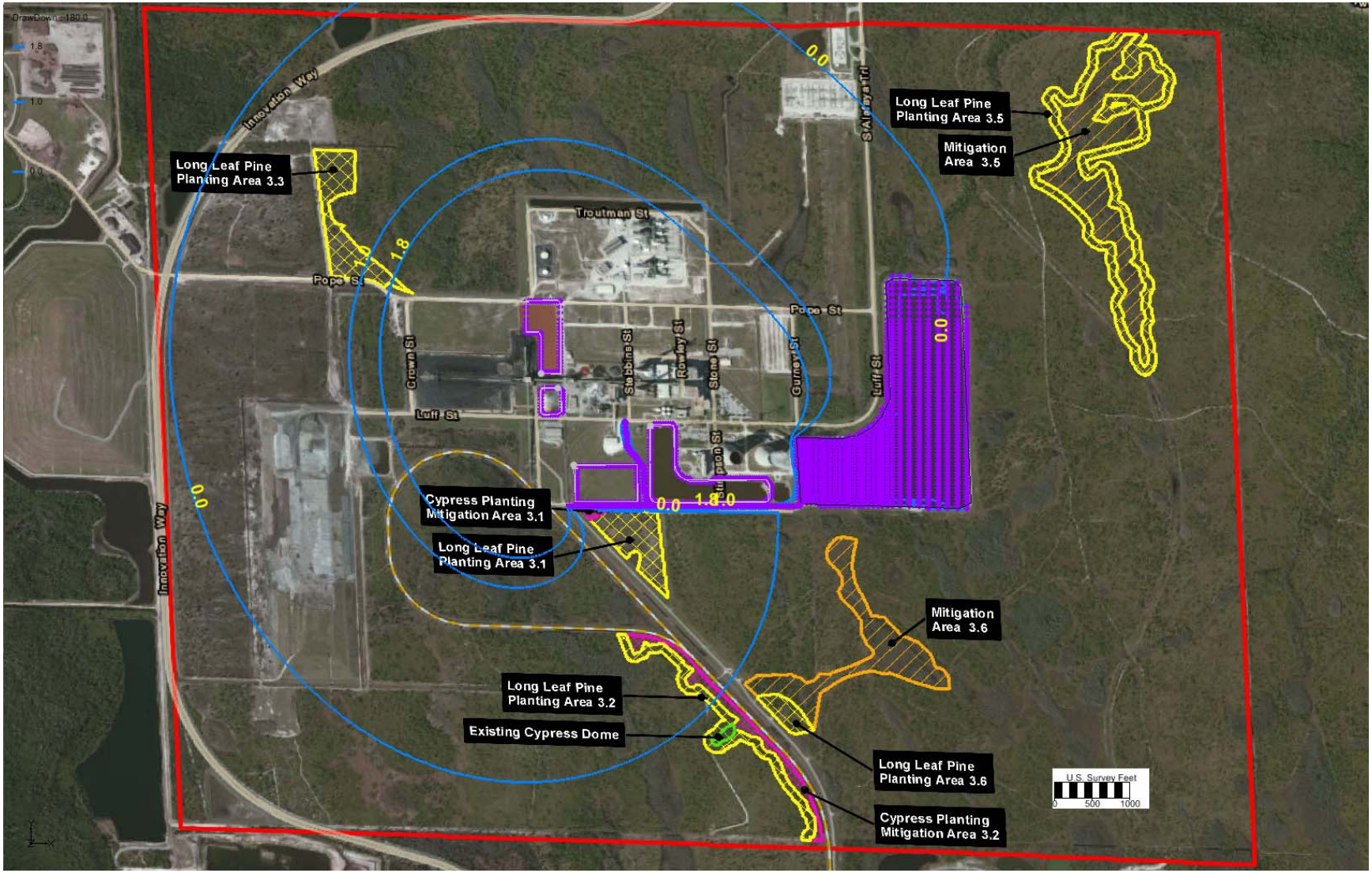

Figure 7. Water table drawdown contours (feet) after operating 180 days
[Combined calculated average pumpage from the four underdrain systems is 349,640 ft^3/day]