APPENDIX 10.9

DEWATERING PLAN

FPL PORT EVERGLADES ENERGY CENTER

January 2012

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Florida Power & Light (FPL) proposes to modernize Units 1 through 4 (i.e., conventional dual-fuel fired generating units and support facilities) at the existing Port Everglades Power Plant into a modern, highly efficient, lower-emission next-generation clean energy center using the latest combined cycle technology. The existing Port Everglades Power Plant is expected to be renamed the Port Everglades Energy Center (PEEC) with an in-service date for the modernized Plant of June 2016.

The existing Port Everglades Power Plant is located at 8100 Eisenhower Road, Fort Lauderdale, Broward County, Florida. The Port Everglades Plant began operating in the 1960s. FPL plans to demolish the existing power plant and construct PEEC on the site. Construction of PEEC will begin in 2013 and be completed by 2016. Demolition of the existing plant and construction of the PEEC will require dewatering of the surficial aquifer.

This report describes the dewatering plan and the geohydrologic model that was used to calculate the volumes of water produced and the potential impacts associated with dewatering operations.

AVAILABLE HYDROGEOLOGIC DATA

Hydrogeologic data specific to the Port Everglades Power Plant site was obtained from on-site boring logs, potentiometric maps of Broward County, water elevation data from the South Florida Water Management District (SFWMD) DBHYDRO data base, and from other publicly available sources.

Ardaman & Associates, Inc. performed subsurface exploration drilling at the site. The drilling occurred over a period of two months from December 2003 to January 2004. Eight borings were drilled, logged, and sampled. Samples from the borings were collected for grain size analysis. Golder used these data, the lithological descriptions, and depths from the boring logs to establish the model layer thicknesses and elevations.

Groundwater elevations at the up-gradient model boundaries were estimated from Broward County water table maps. Based on data from the U.S. Department of Commerce National Oceanic and Atmospheric Administration (NOAA), mean sea level of the ocean and Port Everglades harbor is approximately 0.7 feet above the National Geodetic Vertical Datum of 1929 (NGVD 29). All elevations used in the model are referenced to NGVD 29.

Surficial and Biscayne Aquifer hydrologic characteristics were based on information obtained from U.S. Geological Survey (USGS) and SFWMD. Two wells listed in SFWMD's database (wells BEPD-127 and BEPD-299) are near the site. The surficial aquifer hydraulic conductivity determined from testing these two wells is approximately 2 feet per day (ft/day).

DEWATERING PLAN

A schedule of the proposed work is presented in Table 1. The project dewatering plan has three sequential phases; one for demolition and two for construction. The phases and their durations are as follows:

- Demolition (2 months)
- Intake circulating water pipe construction (3 months)
- Discharge circulating water pipe construction (4 months)

During the demolition phase the existing circulating water pipes will be removed. Construction of the new intake pipes is estimated to take 3 months, while construction of the new discharge pipes is estimated to take 4 months. These areas require dewatering below the water table, and the intake and discharge pipes will be dewatered sequentially.

The model simulates the demolition and construction dewatering that will occur below the water table. Most of the remaining demolition and construction work will occur above the water table elevation. One minor exception is the steam turbine condensate pumps and blowdown tank, which are a few feet deeper than the majority of work. However, these areas are of limited horizontal extent and the aquifer in this area will be dewatered from previous construction activities. Consequently, significant additional dewatering is not required for these areas and these components were not included in the model.

MODEL SET-UP

The dewatering analysis was based on calculations using the numerical model MODFLOW 2000. This model uses a finite-difference approach to approximate the partial-differential flow equations and is based on flow through a three dimensional array of cells. The graphic pre- and post-processor program, Groundwater Vistas Version 6 (Scientific Software Group), was used to facilitate model input and output.

The grid that was developed for the simulation consists of 6 layers with 138 columns and 131 rows in each layer, resulting in 108,468 total model cells. The cell dimensions range from a minimum of 17 feet (ft) by 18 ft in the area of interest to a maximum of 88 ft by 97 ft at the model boundaries. The total model domain covers an area of approximately 57 million square feet (2.05 square miles).

The 6-layer model was used to match the stratigraphy and the vertical extent of impermeable sheet piling found around the port and canals. The stratigraphy is based on the boring logs and SFWMD aquifer data. The top elevation of the model is set to 16 ft NGVD 29, based on survey data provided by FPL for the area where construction dewatering will be required. The thickness of each layer is as follows:

- Layer 1 – 20 ft;
- Layer 2 – 5 ft;
- Layer 3 – 12.5 ft;
- Layer 4 – 12.5 ft;
- Layer 5 – 15 ft; and
- Layer 6 – 200 ft.

This yields a total model thickness of 265 ft. Layers 3, 4, and 5 represent one stratigraphic unit that has been subdivided to match boundary conditions.

The four stratigraphic units are listed below:

- Layer 1: Water table aquifer, fill material composed of sand and limestone (20 ft thick; 16 ft to −4 ft NGVD 29);
- Layer 2: Confining Layer, sandy silt with high organic content (5 ft thick; −4 ft to −9 ft NGVD 29);
- Layer 3-5: Biscayne Aquifer, fine-grained sand (40 ft thick; −9 ft to −49 ft NGVD 29); and
- Layer 6: Biscayne Aquifer, limestone with sand and shell (200 ft thick; −49 ft to −249 ft NGVD 29).

The model implicitly places no-flow boundaries at the bottom of the lowest layer. No flow boundaries were also applied to areas where sheet pile bulkheads limit flow into or out of the aquifer (Figure 1). Conductance values for the general head boundaries were calculated using the layer hydraulic conductivity and the distance between the model boundary and constant head boundary estimated from aerial maps. A constant head boundary (elevation 0.7 ft NGVD 29) was assigned to layer 5, along the port turning basin and slips (Figure 1). This allows flow from the port turning basin and channel to move through the upper Biscayne aquifer to the lower Biscayne aquifer.

The river package boundary condition was assigned to the intake and discharge canals north and south of the dewatering area (Figure 1). The river package generates a constant head that allows groundwater to flow into the canal if the constant head assigned is lower than the water table, and allows canal water to flow out if the head is higher than the water table. Based on the depth of the intake and discharge canals, the river package boundary condition was applied to layers 1, 2, and 3.

The drain package boundary condition was applied to the regions of demolition and construction dewatering (Figure 1 and Table 2). The drain cells are assigned a head value and water is continuously removed to maintain the specified head. Low hydraulic conductivity walls were assigned to the cells north and south of the dewatering area along the canals, to simulate sheet piling (Figure 1).

An average surface recharge of 0.5 inches per year was assigned to the entire model domain. The recharge rate was selected to produce a water table elevation in the area of the power plant of 1.0 to 1.5 ft NGVD 29, which is consistent with water levels observed in a nearby monitor well and with the Broward county water table maps. Also, this recharge rate is reasonable considering the high percent impervious surface in the port area.

Other assumptions made during the model setup include:

- Ground surface elevation is constant;
- Layers are a uniform thickness;
- Thickness of riverbed is 1 ft; and
- Thickness of drain bed is 1 ft.

MODEL HYDRAULIC PARAMETERS

The input parameters used in MODFLOW 2000 (those representing the hydraulic characteristics of the system) include the following:

- Lateral hydraulic conductivities (Kx and Ky);
- Vertical hydraulic conductivity (Kz);
- Porosity (n);
- Specific yield (Sy); and
- Storage (S).

The input parameters were entered into the model using consistent units of feet and days. The base model used estimated average values for Kx, Ky, and Kz for each stratigraphic unit. The data used in the model are based on literature values and professional judgment. The hydrogeologic values used in the base case model are shown in Table 3.

The following conditions were applied to the hydraulic parameters:

- Kx = Ky in each layer and the layers are homogeneous;
- Kz = Kx /10;
- Riverbed hydraulic conductivity equals Kz of the layer; and
- Drain bed hydraulic conductivity equals Kx of the layer.

The model was run in steady–state mode for 1 day without the drain cells to establish background water level conditions. Then the model was run for 270 days in transient mode with the drain cells activated to simulate the dewatering process. After the base case was run, eight additional scenarios were simulated to evaluate model sensitivity.

SENSITIVITY ANALYSIS

The dewatering model was not calibrated because there was insufficient site-specific water level data. Therefore, as a proxy, multiple sensitivity analyses were performed to understand the influence of several parameters. The sensitivity analyses focused on the parameters and boundary conditions that were judged to be the most sensitive, including the following:

- Hydraulic conductivity of layers 1 and 2; and
- Surface recharge.

The scenarios and the corresponding variation of the model parameters are presented in Table 4. The horizontal and vertical conductivity of layer 1 and layer 2 were changed to reflect expected maximum and minimum rates. The recharge was increased to represent the influence of a wet season on the unpaved surfaces of the dewatering area during demolition and construction.

RESULTS AND CONCLUSIONS

The dewatering quantities calculated by the model are separated into two components: the initial dewatering quantity and the maintenance quantity. The initial dewatering quantity is the volume of water pumped in the first 1 to 5 days of each dewatering phase to dewater the aquifer. The maintenance quantity is the volume of water that must be pumped over the remainder of the dewatering project to maintain the dewatered conditions. Results for multiple scenarios are found in Table 5.

The model results show that approximately 1.5 to 3 million gallons (MG) will be pumped during the initial dewatering of all three phases (combined total), and between 0.5 to 10 MG likely will be pumped during the maintenance period over the remaining 9 months. The model simulations show that approximately 15 to 25 percent of the total water produced will be pumped during the demolition phase (Phase 1 of the dewatering plan), approximately 50 percent of the water will be pumped during construction of the intake circulating water pipes (Phase 2) and the remaining water will be pumped during construction of the discharge circulating water pipes (Phase 3).

The maintenance dewatering volumes are sensitive to the degree of confinement provided by the sandy silt layer underlying the fill (model layer 2). Comparing the Base Case Scenario with Scenario 7 shows that, if this layer were missing completely, the maintenance pumping volume would increase from 0.5 MG to 10.1 MG. While the boring logs from the site show that this layer is reasonably continuous, there is no site-specific data on the vertical hydraulic conductivity of this layer. As previously discussed, the values used were based on grain size data, literature and professional judgment.

Scenarios 5 and 8 provide more conservative estimates, relative to the Base Case Scenario, of the expected maintenance volumes. Maintenance volumes likely will be between 1.0 MG and 3.5 MG but could be as high as 10 MG.

Maintenance volumes are also sensitive to the surface recharge rate. Once demolition and construction has commenced, impervious surfaces may be temporarily replaced with unpaved pervious surfaces. This could significantly increase the surface recharge rate and the required maintenance pumping volumes. Scenario 6 shows the potential dewatering quantities if the sandy silt layer (layer 2) were missing and the surface recharge rate in the dewatering area were increased to 50 inches per year. This is an extreme scenario representing a very wet year with little or no off-site surface drainage. Under this scenario, up to 49 MG would be pumped to maintain a dewatered condition. While Scenario 6 is extreme and probably unrealistic, maintenance volumes of up to 10 MG could be required to maintain the dewatered condition.

Figures 2, 3 and 4 show the maximum drawdown contours in the surficial aquifer at the end of each phase of the dewatering plan. These figures show that there should be no adverse off-site impacts from the dewatering process.

TABLES

Table 1: Dewatering Schedule for Demolition and Construction at Port Everglades Energy Center

<table>
<tr><th>Dewatering Depth</th><th>Month 1</th><th>Month 2</th><th>Month 3</th><th>Month 4</th><th>Month 5</th><th>Month 6</th><th>Month 7</th><th>Month 8</th><th>Month 9</th></tr>
<tr><td>25 ft bgs</td><td colspan="2">Demolition</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>20 ft bgs</td><td></td><td></td><td colspan="3">Intake Circulation Water Line</td><td colspan="4">Discharge Circlulation Water Line</td></tr>
<tr><td>DNR</td><td></td><td></td><td colspan="3">ST Foundation</td><td>ST Step-up XFMR</td><td></td><td></td><td></td></tr>
<tr><td>24 ft bgs</td><td></td><td></td><td></td><td></td><td></td><td>Condensate Pumps</td><td>ST Blowdown Tank</td><td></td><td></td></tr>
<tr><td>DNR</td><td></td><td></td><td></td><td colspan="2">CT Foundation Unit 1</td><td colspan="2">HRSG Foundation Unit 1</td><td>CT XFMR Unit 1</td><td></td></tr>
<tr><td>DNR</td><td></td><td></td><td></td><td></td><td colspan="2">CT Foundation Unit 2</td><td colspan="2">HRSG Foundation Unit 2</td><td>CT XFMR Unit 2</td></tr>
<tr><td>DNR</td><td></td><td></td><td></td><td></td><td></td><td colspan="2">CT Foundation Unit 3</td><td colspan="2">HRSG Foundation Unit 3</td></tr>
<tr><td>DNR</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td>CT XFMR Unit 3</td></tr>
</table>

Notes:
bgs = below ground surface (g.s.= 16 ft NGVD 29)
ST = Steam Turbine
CT = Combustion Turbine
XFMR = Transformer
DNR = Dewatering Not Required, except to remove stormwater.

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Checked by: GMP

Table 2: Model Boundary Conditions for Drain Settings

Location	**Phase**	**Dewatering Depth** (ft NGVD 29)	**Hydraulic conductivity** (ft/day)
Southwest Layer 1	Demolition	0.75	2
Southeast Layer 1	Demolition	-4	2
Southeast Layer 2	Demolition	-9	0.03
North Layer 1	Intake	-4	2
South Layer 1	Discharge	-4	2

Table 3: Hydrogeology of the Model Parameters for Port Everglades

Layer	1	2	3	4	5	6
Thickness (ft)	20	5	12.5	12.5	16	200
Aquifer Type	Unconfined	Unconfined	Confined	Confined	Confined	Confined
Unit	Fill	Organics	Sand	Sand	Sand	Limestone
Hydraulic Conductivity Zone	Sandy Limestone	Sandy Silt	Fine Sand	Fine Sand; Limestone Fragments	Fine Sand; Limestone Fragements	Limestone and Sand
Kx (ft/day)	2	0.03	35	35	35	1500
Kz (ft/day)	0.2	0.003	3.5	3.5	3.5	150
Sy	0.2	0.1	0	0	0	0
S	0	0	0.0001	0.0001	0.0001	0.0001
n	0.2	0.3	0.2	0.2	0.2	0.2

Notes:
Kx = horizontal hydraulic conductivity
Kz = vertical hydraulic conductivity
Sy = specific yield
S = specific storage
n = porosity

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Checked by: GMP

Table 4: Sensitivity Scenarios and Parameters

Scenario	Layer	Kh (ft/day)	Kv (ft/day)	Recharge (ft/day)	Description
Base Model	1	2	0.2	0.00011	Base Case
	2	0.03	0.003	NA	
Scenario 1	1	2	0.2	0.011 [a]	Base Case with High Recharge
	2	0.03	0.003	NA	
Scenario 2	1	4	0.4	0.00011	High K Fill (Layer 1)
	2	0.03	0.003	NA	
Scenario 3	1	1	0.1	0.00011	Low K Fill (Layer 1)
	2	0.03	0.003	NA	
Scenario 4	1	2	0.2	0.00011	Low K Organics (Layer 2)
	2	0.01	0.001	NA	
Scenario 5	1	2	0.2	0.00011	Layer 2 K=0.1; High K Orangics (Layer 2)
	2	0.1	0.01	NA	
Scenario 6	1	2	0.2	0.011 [a]	Layer 2 K=2; High recharge, Organics Missing (Layer 2)
	2	2	0.2	NA	
Scenario 7	1	2	0.2	0.00011	Layer 2 K=2; Organics Missing (Layer 2)
	2	2	0.2	NA	
Scenario 8	1	2	0.2	0.00011	Layer 2 K=0.5; Variation of Layer 2 K
	2	0.5	0.05	NA	

[a] Only within the dewatering area

Notes:

K = Kh = Kx = Ky = horizontal hydraulic conductivity

Kv = Kz = vertical hydraulic conductivity

Values that are changed relative to Base Case

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Checked by: GMP

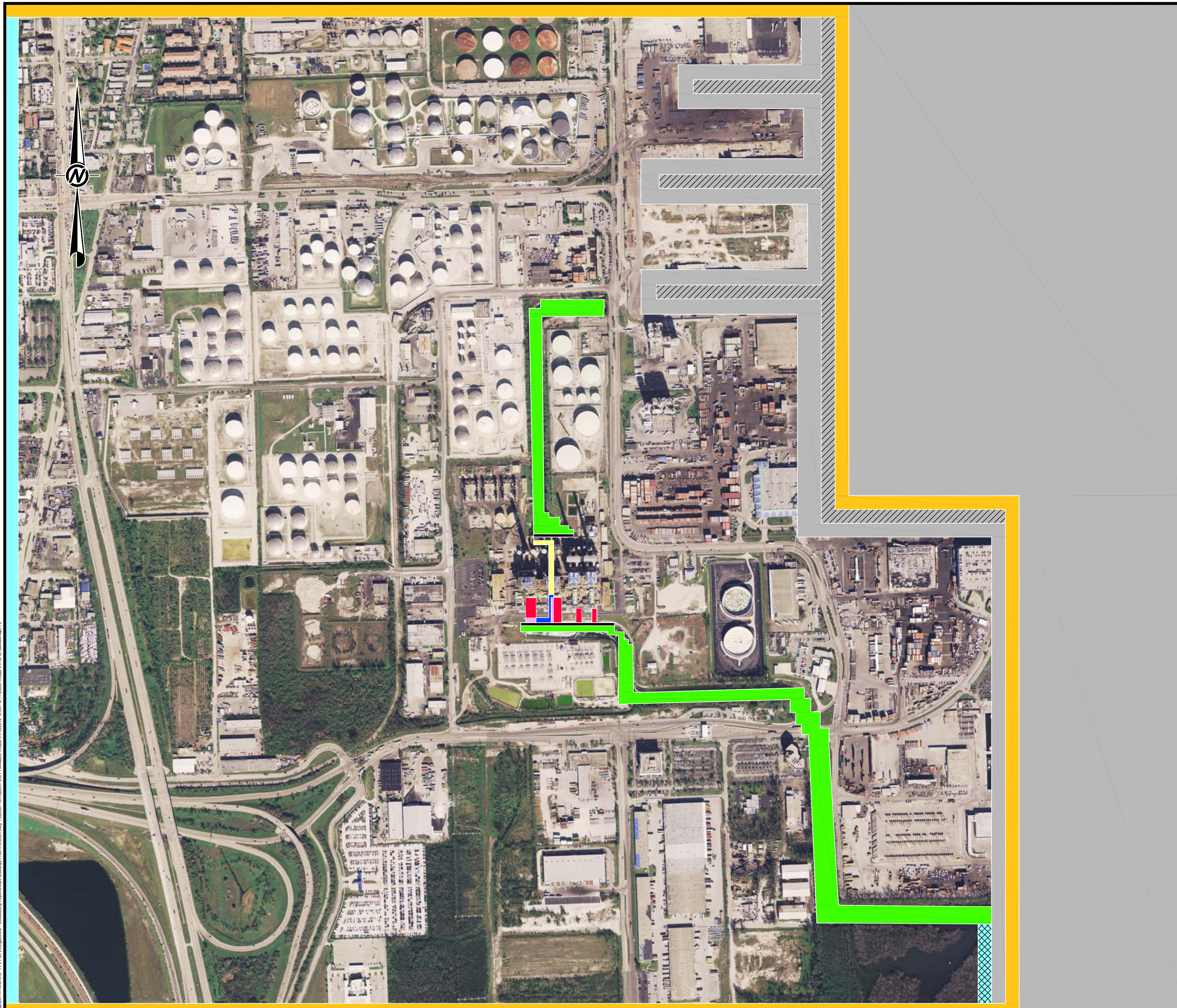
Table 5: Dewatering Volumes for the Base Case and Eight Alternative Scenarios

Scenario	Total Volumes (MG)		
	Dewatering	Maintenance	Total
Base Case	1.50	0.50	2.00
Scenario 1	2.35	1.15	3.50
Scenario 2	2.85	0.32	3.17
Scenario 3	0.75	1.34	2.09
Scenario 4	1.58	0.32	1.90
Scenario 5	1.47	1.06	2.53
Scenario 6	2.58	49.02	51.60
Scenario 7	1.78	10.11	11.89
Scenario 8	1.5	3.33	4.83

Notes:
Dewatering Volumes pumped in 3 Phases 60 to 90 days apart, 1 to 5 days per phase.
Maintenance Volumes pumped over 255 to 267 days.
Total Dewatering Schedule 270 days.
MG= million gallons

Created by: KTR
Checked by: GMP

FIGURES



LEGEND

- GENERAL HEAD BOUNDARY (ALL LAYERS)
- GENERAL HEAD BOUNDARY (LAYERS 1-5)
- GENERAL HEAD BOUNDARY (LAYER 6 ONLY, NO FLOW IN ALL OTHER LAYERS)
- NO FLOW BOUNDARY (ALL LAYERS)
- CONSTANT HEAD BOUNDARY (LAYER 5)
- WALL BOUNDARY (LAYERS 1-3)
- RIVER BOUNDARY (LAYERS 1-3)
- DEMOLITION DRAINS (LAYERS 1-2)
- INTAKE CIRCULATING WATER PIPE CONSTRUCTION DRAINS (LAYER 1)
- DISCHARGE CIRCULATING WATER PIPE CONSTRUCTION DRAINS (LAYER 1)
- DEMOLITION AND DISCHARGE CWP CONSTRUCTION DRAINS (LAYER 1)

350 0 350 700
SCALE FEET

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0						

PROJECT

FPL
PORT EVERGLADES ENERGY CENTER

TITLE

MODEL BOUNDARY CONDITIONS

PROJECT No.		113-87618	FILE No.	11387618-D001
DESIGN	KSR	10/24/11	SCALE	AS SHOWN
CADD	MRM	10/28/11	**FIGURE 1**	
CHECK	RCM	01/18/12		
REVIEW	KFK	01/18/12		

NOTES

1.) CONTOUR INTERVAL 1 FOOT.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0						

PROJECT

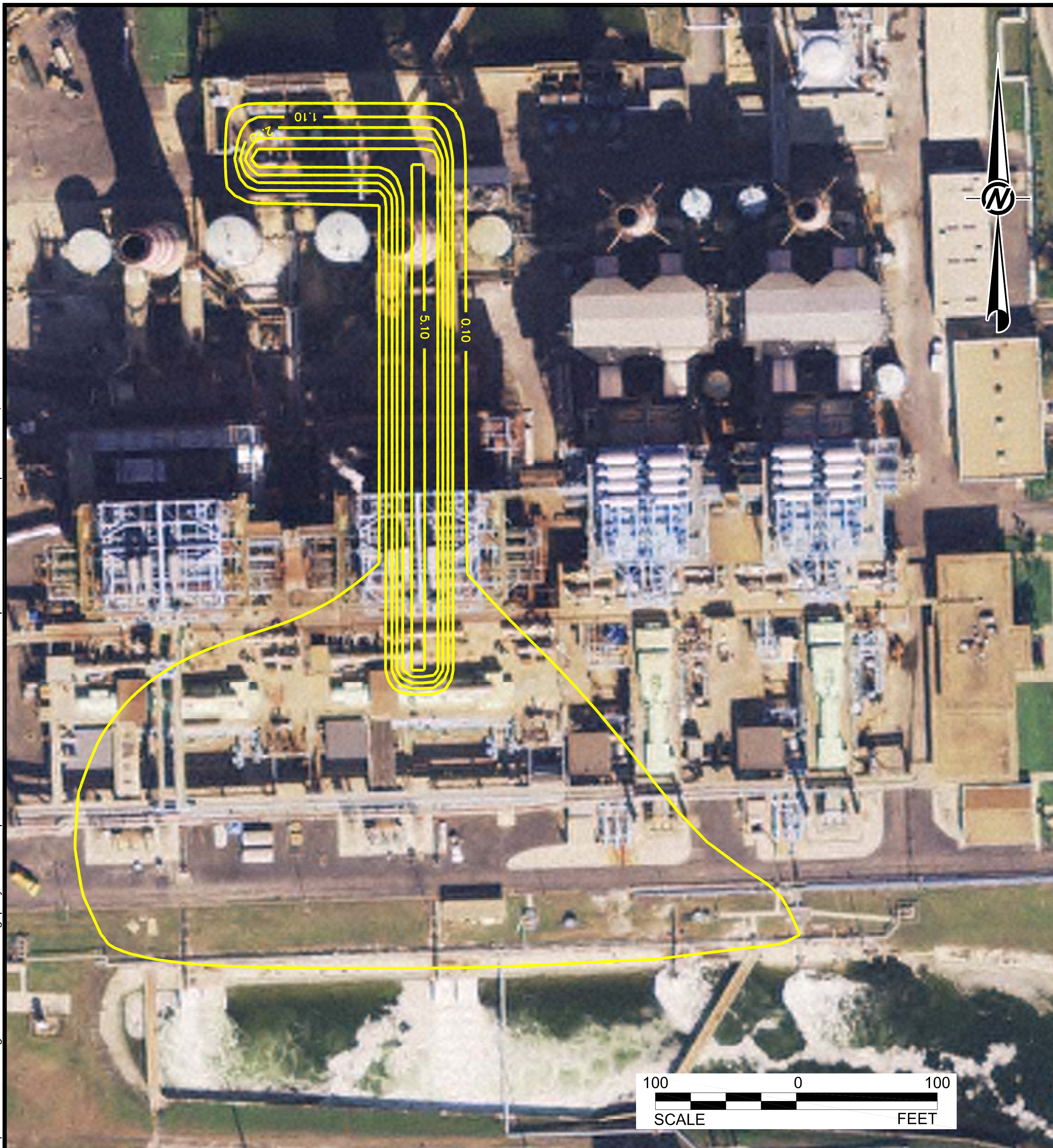
FPL
PORT EVERGLADES ENERGY CENTER

TITLE

DRAWDOWN IN THE SURFICIAL AQUIFER
DEMOLITION DEWATERING, PHASE 1

PROJECT No.		113-87618	FILE No. 11387618-D002A
DESIGN	KTR	10/28/11	SCALE AS SHOWN
CADD	MRM	10/28/11	**FIGURE 2**
CHECK	RCM	01/18/12	
REVIEW	KFK	01/18/12	

FPL



NOTES

1.) CONTOUR INTERVAL 1 FOOT.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0						

PROJECT

FPL
PORT EVERGLADES ENERGY CENTER

TITLE

DRAWDOWN IN SURFICIAL AQUIFER INTAKE DEWATERING, PHASE 2

PROJECT No.		113-87618	FILE No.	11387618-D002B
DESIGN	KTR	10/28/11	SCALE	AS SHOWN
CADD	MRM	10/28/11	**FIGURE 3**	
CHECK	RCM	01/18/12		
REVIEW	KFK	01/18/12		

FPL

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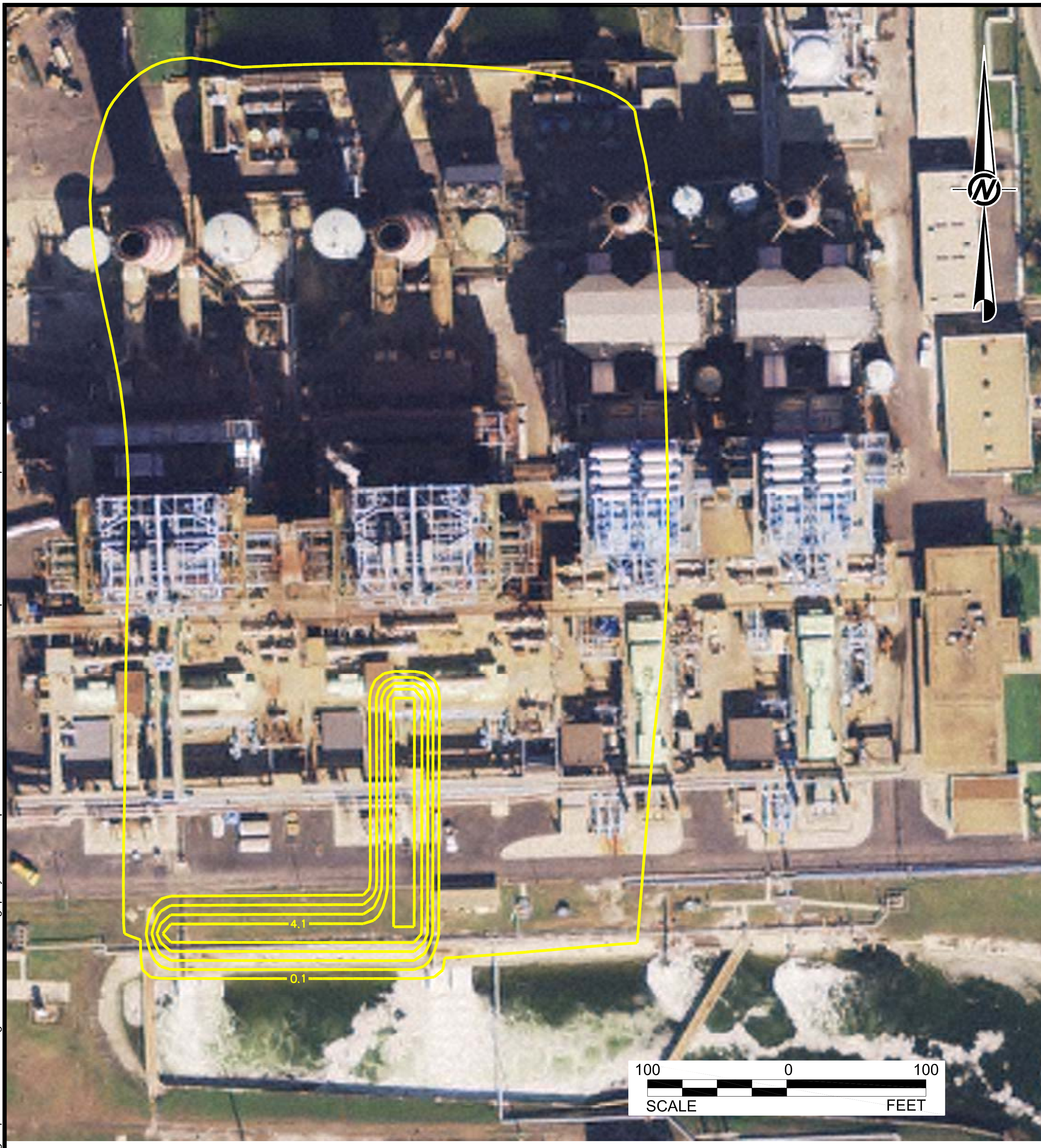

NOTES

1.) CONTOUR INTERVAL 1 FOOT.

REV	DATE	DES	REVISION DESCRIPTION	CADD	CHK	RVW
0						

PROJECT

FPL
PORT EVERGLADES ENERGY CENTER

TITLE

DRAWDOWN IN SURFICIAL AQUIFER DISCHARGE DEWATERING, PHASE 3

PROJECT No.		113-87618
DESIGN	KTR	10/28/11
CADD	MRM	10/28/11
CHECK	RCM	01/18/12
REVIEW	KFK	01/18/12

FILE No. 11387618-D002C

SCALE AS SHOWN

FIGURE 4

FPL

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