HARDEE POWER STATION

SITE CERTIFICATION APPLICATION/ ENVIRONMENTAL ASSESSMENT

CHAPTER 5

EFFECTS OF PLANT OPERATION

CHAPTER 5

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5.0 EFFECTS OF PLANT OPERATION

5.1 EFFECTS OF OPERATION OF THE HEAT DISSIPATION SYSTEM

5.1.1 Temperature Effect on Receiving Body of Water

As previously described in Section 3.5, a 231 ha (570 acre) cooling reservoir will be used for condenser cooling/heat dissipation for the steam portion of the Hardee Power Station. The reservoir will function as the condenser cooling water supply, condenser cooling point of discharge and heat dissipation system. The cooling reservoir has been designed to (1) collect, store and supply water for use in condenser cooling and (2) reject heat through evaporative, radiant and other cooling mechanisms.

As a recirculating/recycling cooling system, the reservoir is designed to maximize water reuse and thereby minimize groundwater withdrawals. Water makeup of the reservoir will include direct rainfall, runoff and seepage from the upland watershed, treated wastewaters and, as necessary, pumped deep well (Floridan Aquifer) water. To accommodate the infrequent discharges which may occur during extreme (wet) meteorological conditions, a reservoir overflow to Payne Creek is proposed.

To evaluate the potential discharge impacts of the cooling reservoir operation on the adjacent Payne Creek, several component analyses were conducted. First, a reservoir thermal analysis was conducted to determine the reservoir performance and operating conditions during the annual cycle, including a determination of the "cooled" recirculating water/reservoir discharge temperature. Second, a long-term reservoir water balance analysis was conducted to determine water makeup requirements and reservoir discharge conditions. Finally, a mixing zone analysis was conducted to determine the extent of thermal impacts in Payne Creek due to potential reservoir discharges.

To evaluate and predict cooling reservoir performance (e.g., temperature and evaporation), a monthly thermal model analysis was performed. The thermal model was developed based on work by Sonnichsen (1975), and utilized an energy budget/equilibrium temperature approach for determining the exchange of energy between air and water. This approach uses a variety of available meteorological data (e.g., air temperature, dew point, relative humidity, wind speed, etc.).

The temperature within the reservoir was evaluated using the available regional meteorological data for two operational scenarios: (1) the normal operating conditions and (2) a maximum, worst case condition. The results of this reservoir thermal analysis are summarized in Tables 5.1.1-1 and 5.1.1-2, respectively. During average anticipated operating conditions the predicted maximum temperature on the cold side is 32°C (89°F) during July; during the maximum, worst case conditions, the predicted maximum temperature on the cold side is 34°C (93°F) during July. These are monthly average temperatures; daily variations within these months may occur and result in slightly higher temperatures.

Regarding the accuracy and applicability of this model, it should be noted that the natural equilibrium water temperature (e.g., reservoir water temperature without reservoir plant loading) was estimated as part of the overall analysis process. Using the available data, the calculated monthly equilibrium water temperatures generally correspond with temperatures that could be expected in a shallow lake in central/south Florida. More critical, the calculated annual total lake evaporation of 126 cm/yr (49.6 inches/year) corresponds with the various estimates of lake evaporation in the region ranging from 119 to 130 cm (47 to 51 inches) year. Therefore, it is concluded that this analysis' methodology accurately represents the evaporative phenomenon in the geographic region of the proposed plant and, therefore, is an accurate estimate of the anticipated evaporation from the proposed cooling reservoir.

To evaluate the frequency of discharge, a reservoir water balance analysis was conducted. Water flows into the reservoir include: rainfall into the reservoir; surface runoff and surficial aquifer seepage from the upland basin; treated wastewater discharged to the reservoir; and makeup water pumped from the Floridan Aquifer. Water flows out of the reservoir include:

Table 5.1.1-1. Estimation of Evaporation from the Proposed Hardee Power Station Cooling Reservoir at the Average Annual Load Conditions (Page 1 of 2)

Item	Units	Jan	Feb	Mar	Apr	May	Jun	Jul
Average Air Temperature	Degrees F	61.8	63.1	67.1	72.1	76.6	80.2	81.3
Average Dew Point Temperature	Degrees F	53	54	57	60	67	72	73
Relative Humidity	%	73	72	70	66	72	76	76
Daily Average Wind Speed	mph	7	8	9	8	7	6	6
Wind Speed Function		104.3	114.8	126.7	114.8	104.3	95.2	95.2
Net Short Wave Radiation	$BTU/ft^2/day$	1,210	1,447	1,754	1,994	2,205	2,124	1,976
Cloud Cover Fraction	%	53	47	48	47	46	58	63
Net Incoming Radiation	$BTU/ft^2/day$	3,669	3,911	4,335	4,709	5,039	5,133	5,048
Water Vapor Pressure	mm Hg	10.2	10.6	11.8	13.2	16.8	19.9	20.6
Equilibrium Temperature	degrees F	64.2	65.7	68.5	72.2	77.8	87.1	89.0
Saturated Vapor Pressure	mm Hg	15.2	16.1	17.7	20.1	24.2	32.6	34.7
Evaporation at Equilibrium Temperature	Gal per day	1,482,870	1,795,370	2,125,580	2,252,370	2,194,650	3,437,870	3,816,850
	Inches/month	2.9	3.5	4.2	4.4	4.3	6.8	7.5
Plant Operational Load Factor	%	27	27	27	100	51	27	27
Reservoir Hot Side Temperature	degrees F	84.5	85.9	88.6	96.7	98.8	107.2	109.0
Reservoir Cool Side Temperature	degrees F	64.5	65.9	68.6	76.7	78.8	87.2	89.0
Saturated Vapor Pressure	mm Hg	17.6	18.2	19.7	28.1	29.3	35.8	37.9
Evaporation at Heated Temperature	Gal per day	2,194,650	2,480,870	2,846,120	4,863,820	3,707,180	4,304,110	4,683,090
	Inches/month	4.3	4.9	5.6	9.6	7.3	8.5	9.2

Note: Maximum delta T across condenser = 20 degrees F
Maximum Circulating Water Pump Rate = 195,000 gallons/minute
Cooling Reservoir Size = 570 acres
Climatalogical/Meteorological data from the National Oceanic and Atmospheric Administration
Methodology Based on Sonnichsen (1975)

Table 5.1.1-1. Estimation of Evaporation from the Proposed Hardee Power Station Cooling Reservoir at the Average Annual Load Conditions (Page 2 of 2)

Item	Units	Aug	Sep	Oct	Nov	Dec	Total	Average
Average Air Temperature	Degrees F	81.6	80.2	74.7	67.4	62.7	--	--
Average Dew Point Temperature	Degrees F	73	72	66	58	54	--	--
Relative Humidity	%	75	76	74	72	73	--	--
Daily Average Wind Speed	mph	6	6	7	7	8	--	--
Wind Speed Function		95.2	95.2	104.3	104.3	114.8	--	--
Net Short Wave Radiation	$BTU/ft^2/day$	1,828	1,672	1,480	1,317	1,110	--	--
Cloud Cover Fraction	%	61	60	47	46	52	--	--
Net Incoming Radiation	$BTU/ft^2/day$	4,896	4,694	4,267	3,896	3,589	--	--
Water Vapor Pressure	mm Hg	20.6	19.9	16.2	12.3	10.6	--	--
Equilibrium Temperature	degrees F	83.8	80.0	72.6	67.6	63.9	--	--
Saturated Vapor Pressure	mm Hg	29.4	26	20.3	17.1	15.1	--	--
Evaporation at Equilibrium Temperature	Gal per day	2,382,150	1,651,260	1,215,950	1,423,560	1,468,940	--	2,103,950
	Inches/month	4.7	3.2	2.4	2.8	2.9	49.6	--
Plant Operational Load Factor	%	27	27	100	51	27	--	43
Reservoir Hot Side Temperature	degrees F	103.9	100.1	97.7	89.3	84.1		
Reservoir Cool Side Temperature	degrees F	83.9	80.1	77.7	69.3	64.1	--	--
Saturated Vapor Pressure	mm Hg	32.4	28.9	29	21.7	17.2	--	--
Evaporation at Heated Temperature	Gal per day	3,194,240	2,436,290	3,796,150	2,787,800	2,154,440	--	3,287,400
	Inches/month	6.3	4.8	7.5	5.5	4.2	77.5	--

Note: Maximum delta T across condenser = 20 degrees F
Maximum Circulating Water Pump Rate = 195,000 gallons/minute
Cooling Reservoir Size = 570 acres
Climatalogical/Meterorological data from the National Oceanic and Atmospheric Administration
Methodology Based on Sonnichsen (1975)

Table 5.1.1-2. Estimation of Evaporation from the Proposed Hardee Power Station Cooling Reservoir at Worst Case Load Conditions (Page 1 of 2)

Item	Units	Jan	Feb	Mar	Apr	May	Jun	Jul
Average Air Temperature	Degrees F	61.8	63.1	67.1	72.1	76.6	80.2	81.3
Average Dew Point Temperature	Degrees F	53	54	57	60	67	72	73
Relative Humidity	%	73	72	70	66	72	76	76
Daily Average Wind Speed	mph	7	8	9	8	7	6	6
Wind Speed Function		104.3	114.8	126.7	114.8	104.3	95.2	95.2
Net Short Wave Radiation	$BTU/ft^2/day$	1,210	1,447	1,754	1,994	2,205	2,124	1,976
Cloud Cover Fraction	%	53	47	48	47	46	58	63
Net Incoming Radiation	$BTU/ft^2/day$	3,669	3,911	4,335	4,709	5,039	5,133	5,048
Water Vapor Pressure	mm Hg	10.2	10.6	11.8	13.2	16.8	19.9	20.6
Equilibrium Temperature	degrees F	64.2	65.7	68.5	72.2	77.8	87.1	89.0
Saturated Vapor Pressure	mm Hg	15.2	16.1	17.7	20.1	24.2	32.6	34.7
Evaporation at Equilibrium Temperature	Gal per day	1,482,870	1,795,370	2,125,580	2,252,370	2,194,650	3,437,870	3,816,850
	Inches/month	2.9	3.5	4.2	4.4	4.3	6.8	7.5
Plant Operational Load Factor	%	100	100	100	100	100	100	100
Reservoir Hot Side Temperature	degrees F	90.7	91.7	92.9	96.7	107.2	110.9	112.6
Reservoir Cool Side Temperature	degrees F	70.7	71.2	72.9	76.7	82.2	90.9	92.6
Saturated Vapor Pressure	mm Hg	22.9	23.4	24.8	28.1	33.5	43.9	46.2
Evaporation at Heated Temperature	Gal per day	3,766,490	4,178,310	4,683,490	4,863,820	4,952,790	6,496,770	6,929,890
	Inches/month	7.4	8.2	9.2	9.6	9.7	12.8	13.6

Note: Maximum delta T across condenser = 20 degrees F
Maximum Circulating Water Pump Rate = 195,000 gallons/minute
Cooling Reservoir Size = 570 acres
Climatalogical/Meteorological data from the National Oceanic and Atmospheric Administration
Methodology Based on Sonnichsen (1975)

Table 5.1.1-2. Estimation of Evaporation from the Proposed Hardee Power Station Cooling Reservoir at Worst Case Load Conditions (Page 2 of 2)

Item	Units	Aug	Sep	Oct	Nov	Dec	Total	Average
Average Air Temperature	Degrees F	81.6	80.2	74.7	67.4	62.7	--	--
Average Dew Point Temperature	Degrees F	73	72	66	58	54	--	--
Relative Humidity	%	75	76	74	72	73	--	--
Daily Average Wind Speed	mph	6	6	7	7	8	--	--
Wind Speed Function		95.2	95.2	104.3	104.3	114.8	--	--
Net Short Wave Radiation	BTU/ft2/day	1,828	1,672	1,480	1,317	1,110	--	--
Cloud Cover Fraction	%	61	60	47	46	52	--	--
Net Incoming Radiation	BTU/ft2/day	4,896	4,694	4,267	3,896	3,589	--	--
Water Vapor Pressure	mm Hg	20.6	19.9	16.2	12.3	10.6	--	--
Equilibrium Temperature	degrees F	83.8	80.0	72.6	67.6	63.9	--	--
Saturated Vapor Pressure	mm Hg	29.4	26	20.3	17.1	15.1	--	--
Evaporation at Equilibrium Temperature	Gal per day	2,382,150	1,651,260	1,215,950	1,423,560	1,468,940	--	2,103,950
	Inches/month	4.7	3.2	2.4	2.8	2.9	49.6	--
Plant Operational Load Factor	%	100	100	100	100	100		100
Reservoir Hot Side Temperature	degrees F	108.0	104.7	97.7	93.5	89.7	--	--
Reservoir Cool Side Temperature	degrees F	88.0	84.7	77.7	73.5	69.7	--	--
Saturated Vapor Pressure	mm Hg	40.2	36.3	29	25.2	22.3	--	--
Evaporation at Heated Temperature	Gal per day	5,305,700	4,439,460	3,796,150	3,825,810	3,819,240	--	4,754,830
	Inches/month	10.4	8.7	7.5	7.5	7.5	112.1	--

Note: Maximum delta T across condenser = 20 degrees F
Maximum Circulating Water Pump Rate = 195,000 gallons/minute
Cooling Reservoir = 570 acres
Climatalogical/Metorological data from the National Oceanic and Atmospheric Administration
Metodology Based on Sonnichsen (1975)

evaporation; seepage out into the surficial aquifer; leakance down through the confining layers into deeper confined aquifers; and discharges to Payne Creek.

These water flows into and out of the proposed cooling reservoir were estimated using available hydrological data. Rainfall inputs to the reservoir were estimated based on observed monthly rainfall for Wauchula from 1934 through 1984 (51-years). Surface water runoff and surficial aquifer seepage for the reservoir watershed was estimated based on available Payne Creek flows, correlated to long-term (1934 - 1984) streamflow records for the Peace River. The tributary reservoir watershed area was estimated to be 125 ha (310 acres) based on Agrico's proposed reclamation plan and reclamation topography. Long-term reservoir evaporation was estimated on the methodology and data presented in Table 5.1.1-1 for the average annual load conditions. Leakance was estimated based on available regional data, compiled by USGS and phosphate mining operations. Reservoir side seepage losses were estimated based on anticipated reservoir and groundwater levels, the edge and side design and anticipated construction materials.

To facilitate water management during varying climatic conditions, 0.6 m (2 ft) of allowable operational fluctuation in reservoir water level is planned. This will allow storage of water during wet conditions within the reservoir for later use and evaporative consumption during later dry periods. If the water level were to fall below the minimum limit [i.e., 0.6 m (2 ft) below the design maximum], sufficient makeup water will be pumped from the Floridan Aquifer well(s) to maintain the reservoir at the minimum elevation. Conversely, if the water level were to rise above the maximum limit (i.e., during extreme meteorological conditions), sufficient water will flow over the control weir to maintain the reservoir at the design maximum elevation. Reservoir makeup and discharge requirements were estimated based on this allowable operational fluctuation.

Based on this monthly water balance analysis for the 51-year period, 1934 - 1984, predicted reservoir elevation is presented in Figure 5.1.1-1. This analysis, as presented in Figure 5.1.1-1, shows the cooling reservoir level will be operated below the control/discharge elevation of 37.8 m (124 ft) MSL most of the time.

Based on the long-term modeling analysis, and given a maximum control elevation of 37.8 m (124 ft) MSL and a minimum control elevation of 37.2 m (122 ft) MSL, the cooling reservoir elevation will be typically maintained below 37.5 m (123 ft) MSL. Thus, based on 51 years of long-term analysis, the reservoir will exceed 37.5 m (123 ft) MSL during only 9 periods during the 51-year period of record.

Based on this monthly water balance analysis, the proposed reservoir is estimated to have not discharged during the 51-year period of analysis (see Figure 5.1.1-2). Any discharges which may occur will only occur during extremely wet meteorological conditions.

These extremely limited discharge occurrences are a direct result of: (1) significant reservoir water losses due to evaporation and seepage through the reservoir sides and (2) the positive impact of the 0.6 m (2 ft) of allowable operational fluctuation in reservoir water level; allowing water management and conservation. Average annual evaporative losses are approximately 3.29 million gallons per day (mgd): average side seepage is approximately 0.92 mgd.

Based on this analysis, reservoir discharge will be very infrequent; when reservoir discharges do occur, they will be subject to significant dilution by the Payne Creek flow.

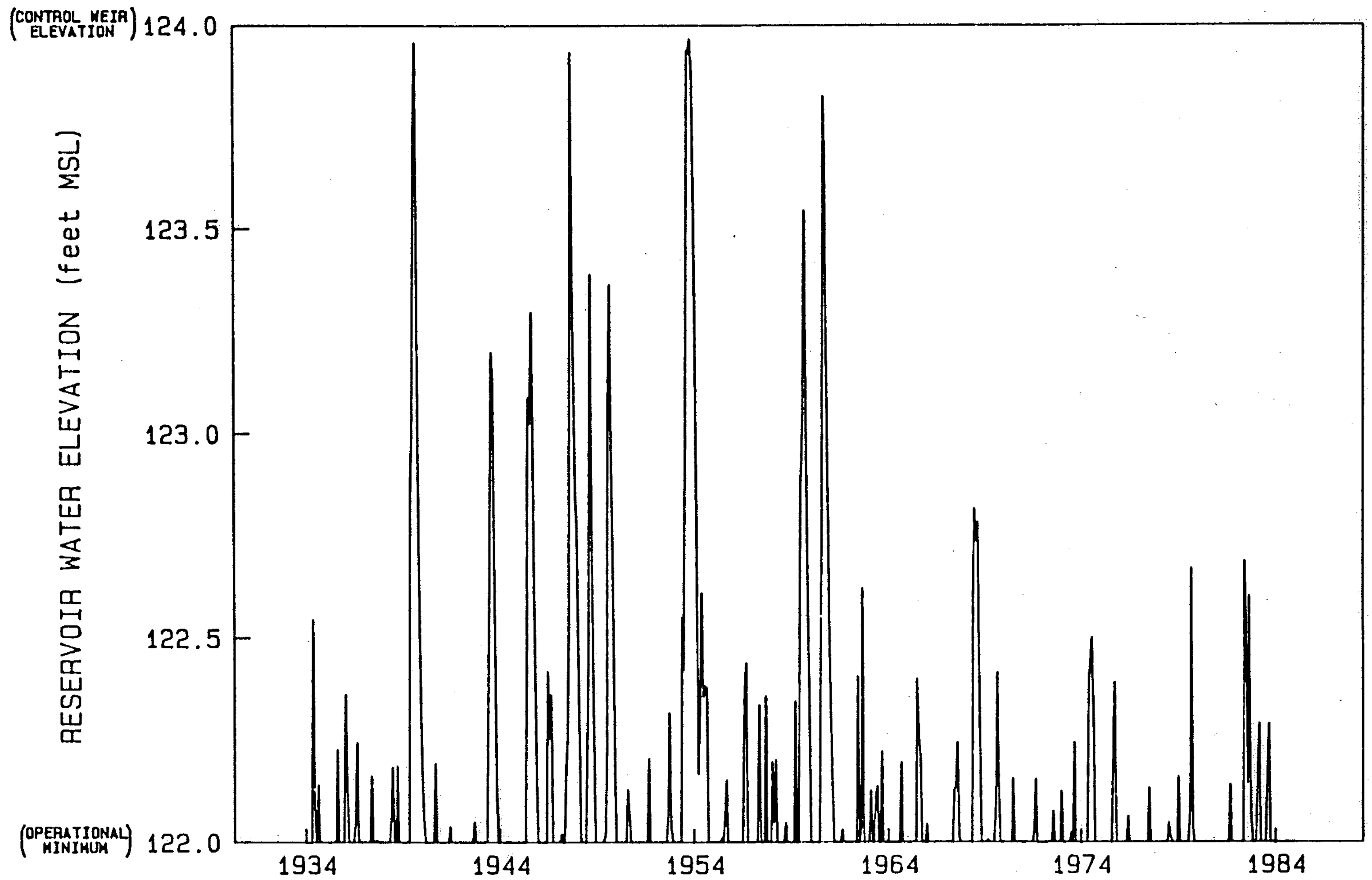

Figure 5.1.1-1 PREDICTED COOLING RESERVOIR ELEVATIONS (51 YEARS)

Hardee Power Station

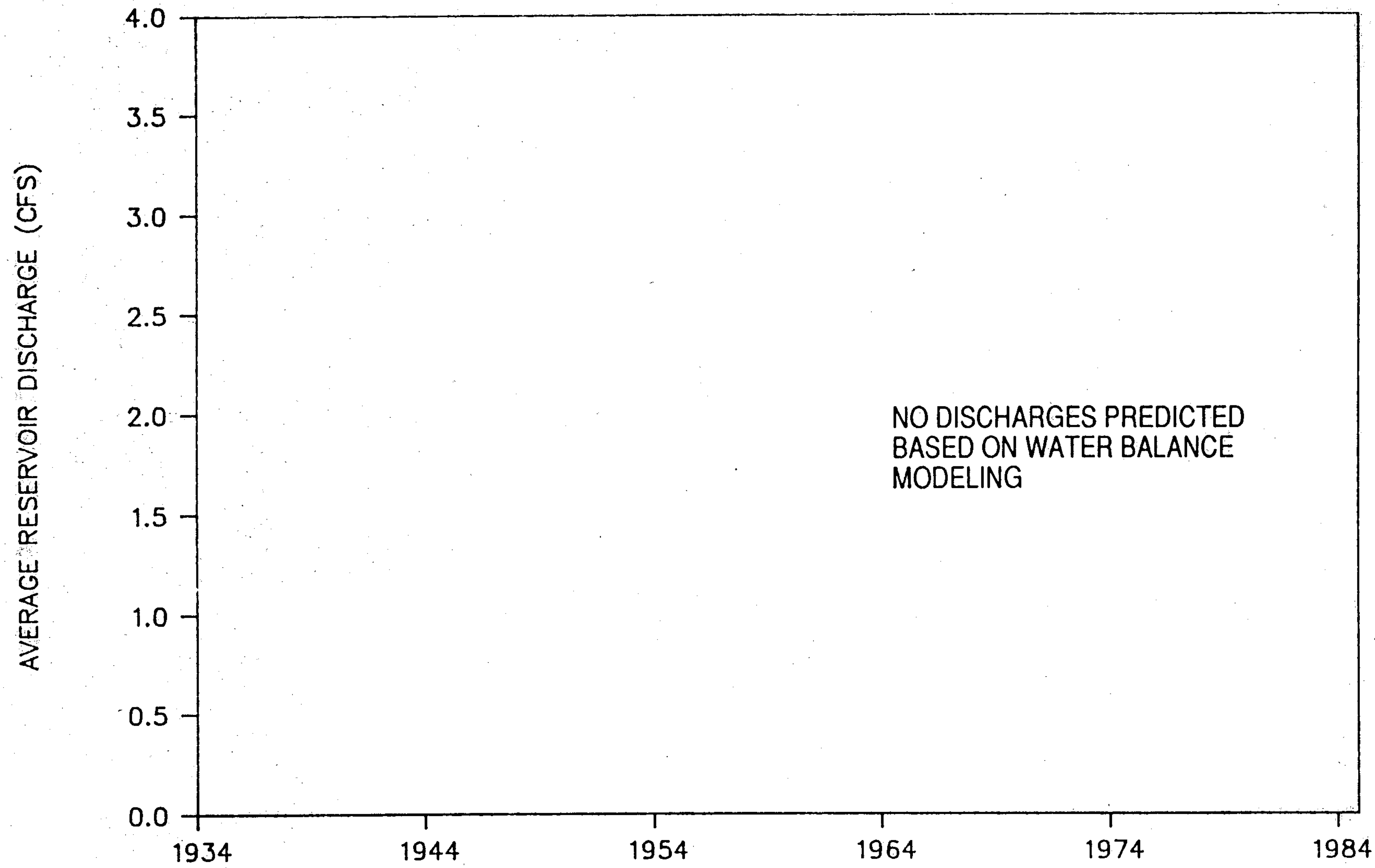

Figure 5.1.1-2 PREDICTED COOLING RESERVOIR DISCHARGES

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To evaluate event specific discharges and the associated dilution, a HEC-1 model analysis was conducted for the Payne Creek and the cooling reservoir.

The HEC-1 model has been used previously by Agrico to determine pre- and post-mining peak flows to Payne Creek for the preparation of their reclamation plan.

Two different extreme rainfall events were analyzed: the 10-year, 24-hour storm [19 cm (7.5 inches)] and the 25-year, 24-hour storm [23 cm (9.0 inches)]. Model geometry was determined based on available USGS topographic data and topographic (cross section) data collected as part of the monitoring program. Soil conditions were estimated based on curve numbers presented and used in the Agrico modeling program. In accordance with the methodology previously used and accepted by DNR in the Agrico modeling program, the HEC-1 Payne Creek peak flows were adjusted by a factor of 0.7 to adjust for surface storage in the wetlands, and detention and/or routing through the relatively flat Payne Creek sub-basin. For this analysis, a base flow of 22 cfs was included, reflecting an average water yield of approximately 0.9 cfs per square mile (based on USGS data for Payne Creek as previously presented in Section 2.3.4).

Based on the prediction and analysis of anticipated reservoir elevations, previously presented in Figure 5.1.1-1, the initial (i.e., pre-event) reservoir elevation was assumed to be 37.5 m (123 ft) MSL. As previously discussed, this condition is predicted to occur only 9 times in 51-years or approximately once every five years. Therefore, the assumed initial reservoir elevation of 37.5 m (123 ft) MSL reflects a conservative estimate of wet season reservoir elevation. This conservative estimate of wet season reservoir water elevation and the estimate of infrequent extreme rainfall events (i.e., the 10-year and 25-year, 24-hour storms) represent worst case discharge conditions.

Based on this HEC-1 analysis, the anticipated Payne Creek runoff hydrograph at the plant site for the 10-year, 24-hour rainfall is presented in

Figure 5.1.1-3. Peak Payne Creek flow is estimated to be 4,167 cfs and occurs approximately 17 hours after the start of rainfall. The tail of the HEC-1 Payne Creek hydrograph was extended using a constant rate of recession (e.g. constant percentage decrease with each time step).

Under the previously described reservoir conditions [i.e., wet season elevation of 37.5 m (123 ft) MSL], no discharge from the reservoir is predicted as a result of the 10-year, 24-hour rainfall. The 0.3m (1 ft) of storage provided within the reservoir below the discharge weir is sufficient to retain the direct rainfall and runoff into the reservoir from the 10-year, 24-hour rainfall. Under these 10-year, 24-hour rainfall conditions, the reservoir water level will rise from 37.5 m (123 ft) MSL to 37.7 m (123.86 ft) MSL or just under the 37.8 m (124 ft) MSL control or discharge elevation.

Based on this HEC-1 analysis, the anticipated Payne Creek runoff hydrograph at the plant site for the 25-year, 24-hour rainfall is presented in Figure 5.1.1-4. Peak Payne Creek flow is estimated to be 5,372 cfs and occurs approximately 17 hours after the start of rainfall. Peak flow unit discharge was calculated to be 231 cfs per square mile; the peak flow unit discharge determined in the previous Agrico HEC-1 modeling was calculated to be 215 cfs per square mile. Thus, the peak flows predicted in this analysis are very similar to those previously predicted in the Agrico studies. Given that the actual portions of Payne Creek modeled under these two studies were different, this small difference is not considered to be significant. The tail of the HEC-1 Payne Creek hydrograph was extended using a constant relative rate of recession (e.g. constant percentage decrease with each time step). Based on this recession, Payne Creek flow decreases to the average (base) flow of 22 cfs in approximately three days.

Reservoir discharge in response to the 25-year, 24-hour rainfall is presented in Figure 5.1.1-5. During this storm, no reservoir discharge

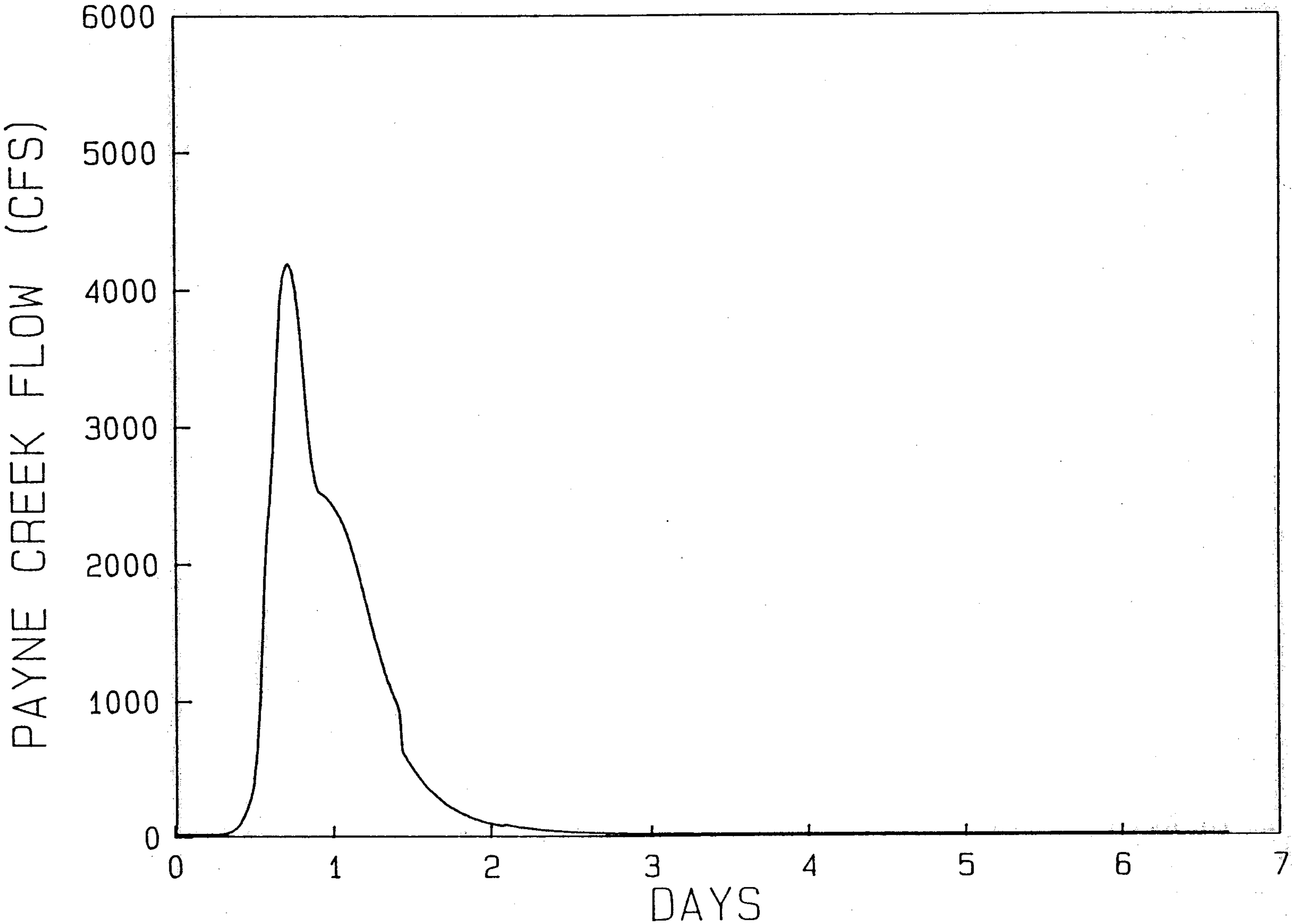

Figure 5.1.1-3 PAYNE CREEK RUNOFF HYDROGRAPH (10-YEAR, 24-HOUR STORM)

Hardee Power Station

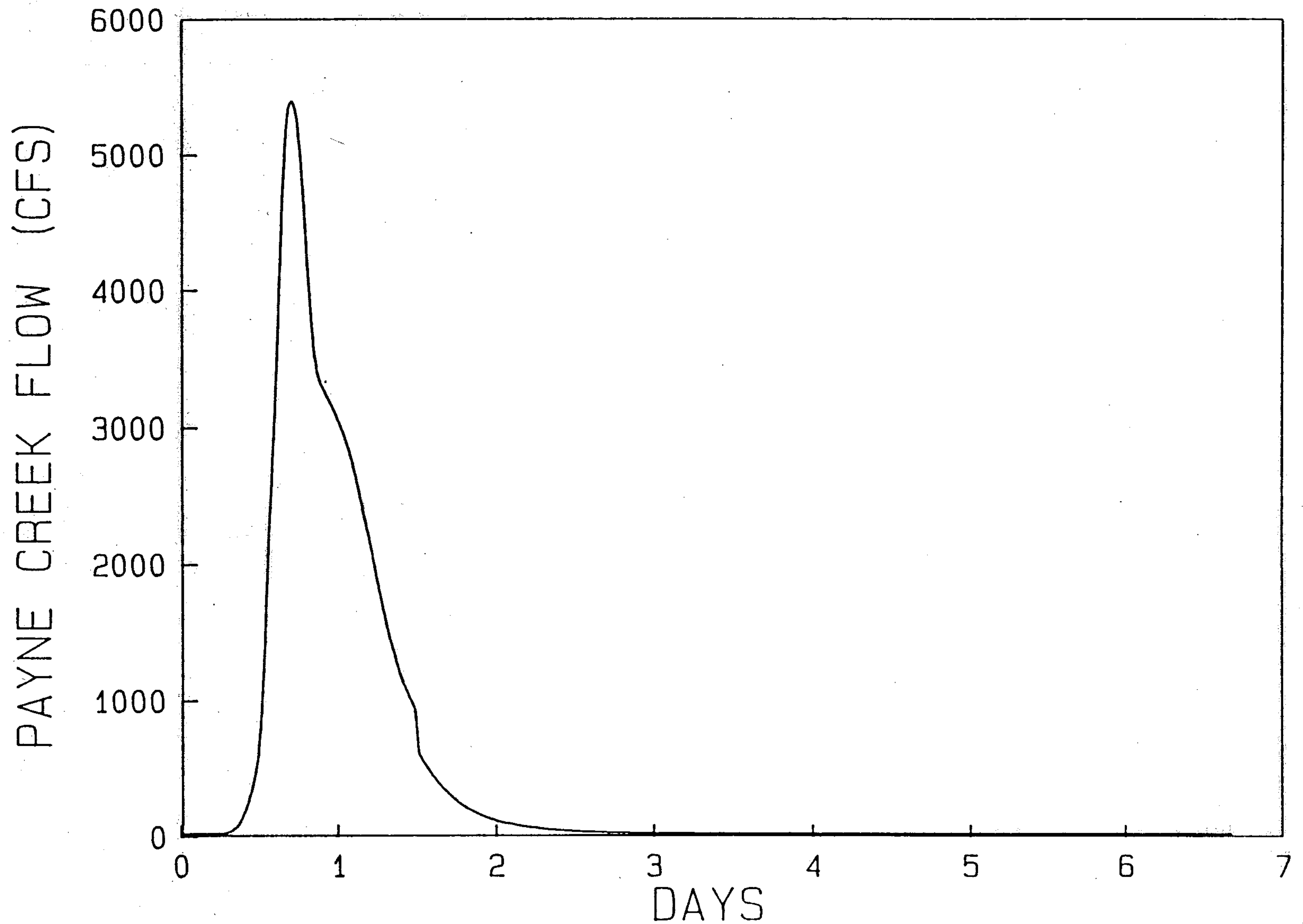

Figure 5.1.1-4 PAYNE CREEK RUNOFF HYDROGRAPH (25-YEAR, 24-HOUR STORM)

Hardee Power Station

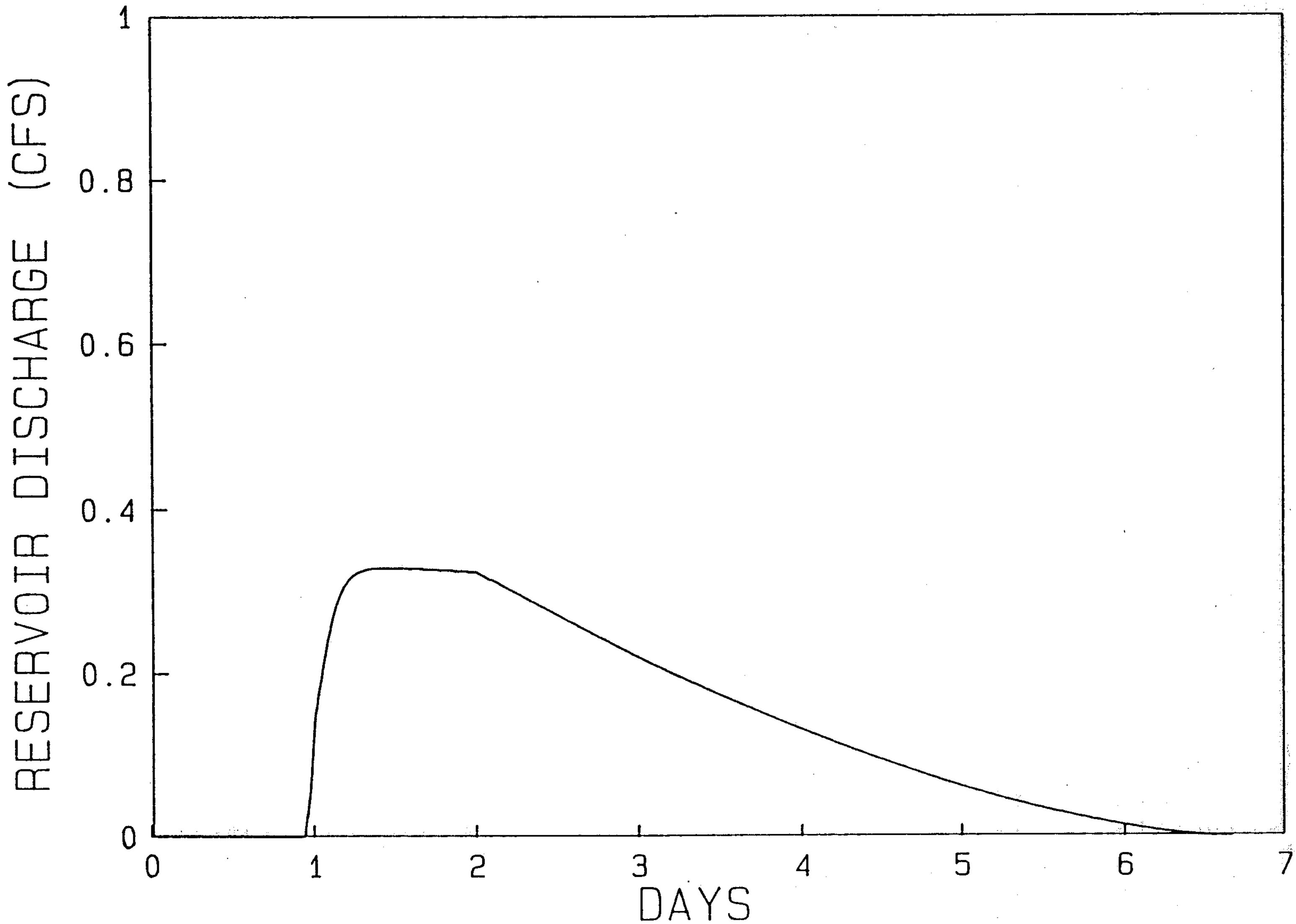

Figure 5.1.1-5 PREDICTED COOLING RESERVOIR DISCHARGE (25-YEAR, 24-HOUR STORM)

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occurs early during the rainfall; reservoir discharge begins 20 hours after the start of rainfall. Prior to this time, the one foot of storage provided by the reservoir prevents reservoir discharge; discharge only occurs after the available reservoir storage is filled. Peak reservoir discharge of approximately 0.33 cfs occurs at approximately 33 hours, and then begins decreasing. Maximum water elevation in the reservoir is estimated to be 37.8 m (124.04 ft) MSL or approximately 1.2 cm (0.04 ft) above the control elevation.

For the cooling reservoir, the decline in the rate of discharge from the reservoir was estimated based on the decline in the volume of water accumulated in the reservoir above the weir elevation. This volume and associated reservoir level was estimated based on losses from the reservoir due to weir discharges and net evaporative/seepage losses. Based on the revised water balance information, the reservoir will operate on a average daily deficit of 1,777,000 gpd, if no makeup water is pumped from the Floridan Aquifer wells. Weir discharge losses were estimated based on the declining water level above the 10 foot sharp crested weir set at 124 feet MSL. Based on these two factors, reservoir discharge will decrease to zero in approximately 6.5 days after the beginning of the 25-year, 24-hour rainfall.

Potential for discharge impacts was evaluated by comparing these Payne Creek and the reservoir discharge hydrographs for the 25-year, 24-hour rainfall. These two hydrographs are superimposed and presented in revised Figure 5.1.1-6. (Note: These hydrographs are presented on two radically different scales). Due to the slower rate of recession of the reservoir discharge as compared with Payne Creek, the relative dilution of discharge waters with Payne Creek decreases after the storm.

Given these worst case modeling analyses, the worst case dilution conditions would occur if the Payne Creek were to recede to average base flow conditions (22 cfs) while the reservoir continued to discharge at the predicted peak rate of 0.33 cfs for the 25-year, 24-hour storm. This

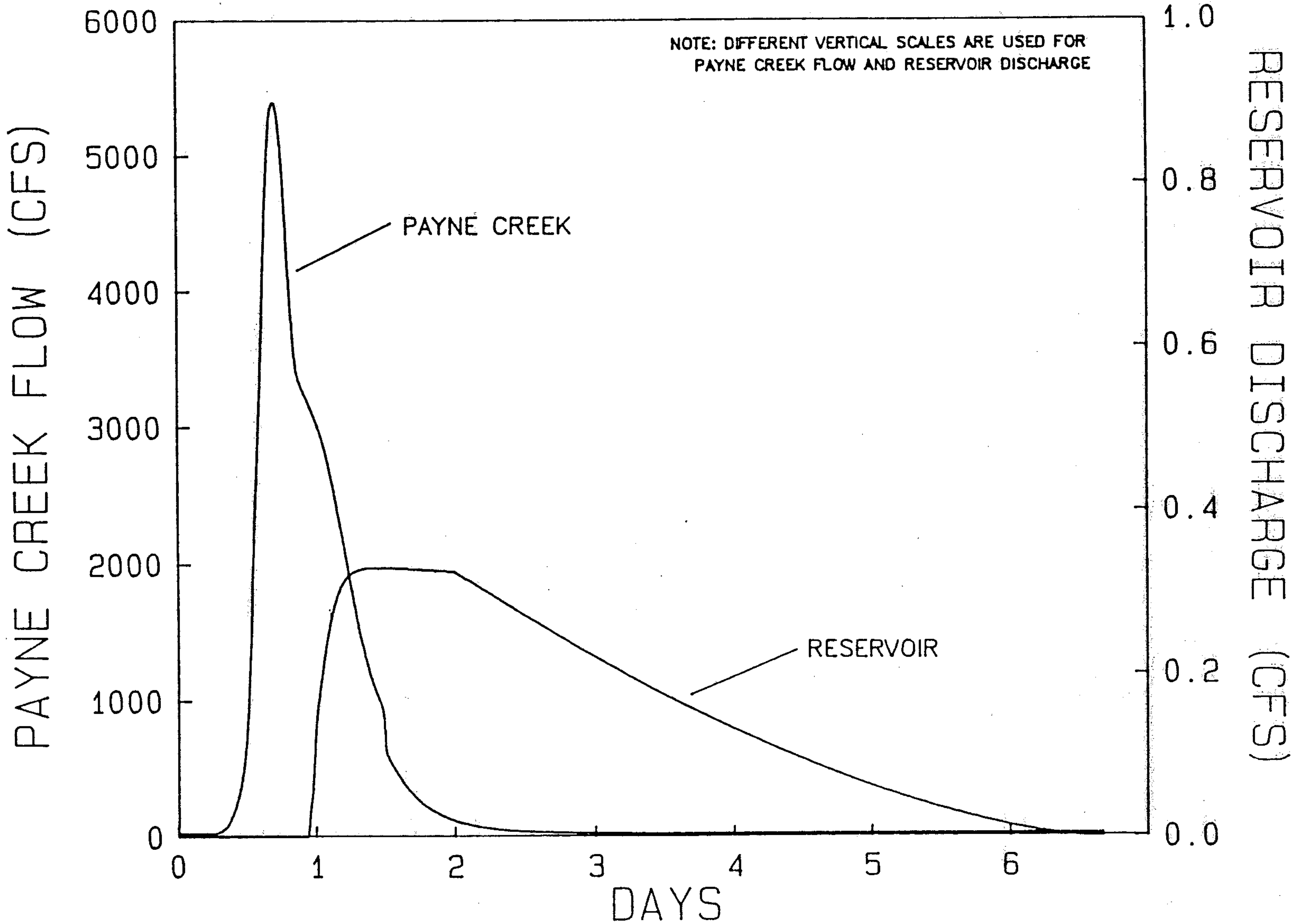

Figure 5.1.1-6 COMPARISON OF PAYNE CREEK FLOW AND RESERVOIR DISCHARGE FOR THE 25-YEAR, 24-HOUR STORM

Hardee Power Station

corresponds to an relative dilution of 1.5 percent. As this is less dilution than that which is estimated by comparing the Payne Creek and the reservoir discharge hydrographs, this represents the worst case conditions which would result from discharges from the 25-year, 24-hour rainfall event. Given that actual dilution will probably be greater, this analysis is conservative.

The mixing and dispersion of these reservoir discharges to Payne Creek, and resulting temperature impacts were estimated using the following dispersion model presented by Fischer, et al. (1979). To execute the dispersion analysis, the various model parameters and coefficients were estimated based on available data and information. For the purposes of this analysis, the water quality parameter of interest (i.e., temperature) was considered to be a conservative parameter. Potentially there may be some additional radiant or evaporative cooling within the discharge swale and plume areas, therefore, assumption is conservative since it overestimates the magnitude of the impact.

Reservoir discharge thermal impact modeling conditions were estimated based on the average predicted reservoir discharges and Payne Creek flow conditions during these discharge conditions. Although most significant discharge conditions are predicted to occur in the fall, worst case (i.e., July) temperature conditions were assumed. For the reservoir discharge conditions, a worst case condition of 35°C (95°F) was assumed, to reflect the worst case load conditions [34°C (93°F)] predicted for July, plus an additional 1.1°C (2°F) loading to reflect short-term reservoir variability, adverse meteorological conditions, etc. For Payne Creek, the maximum observed stream temperature 30°C (86°F), based on historical monitoring data previously collected by Agrico) was used as maximum, worst case conditions. As such, these modeling conditions reflect maximum reservoir and creek thermal conditions.

The results of this modeling analysis are summarized in Table 5.1.1-3. Based on this modeling analysis, the cooling reservoir discharges will be quickly diluted by Payne Creek flows. For example, at a distance of 15 m

Table 5.1.1-3. Hardee Power Station Cooling Reservoir Water Discharge and Payne Creek Dispersion Modeing - Maximum (July) Temperature Conditions

Payne Creek Conditions		
River Channel Width	20	feet
Average River Depth	2.5	feet
River Discharge	22	feet3/second
Average Flow Velocity	0.500	feet/second
Flow Shear Velocity	0.259	feet/second
Transverse Mixing Coeff.	0.389	feet2/second
Background Water Quality	86	degrees F
Reservoir Water Discharge Conditions		
Discharge Flow Rate	0.33	feet3/second
Discharge Water Quality	95	degrees F

Distance Downstream (feet)	Mixed Concentration (degrees F) at Various Distances (feet) Across Payne Creek										
	0	0.5	1	1.5	2	2.5	3	4	5	10	20
0	95.0	86.0	86.0	86.0	86.0	86.0	86.0	86.0	86.0	86.0	86.0
50	86.2	86.2	86.2	86.2	86.2	86.2	86.2	86.2	86.2	86.1	86.0
100	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
150	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
200	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
250	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
300	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
350	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
400	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
450	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
500	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
550	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
600	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
650	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
700	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
750	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
800	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
850	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
900	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
950	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,000	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,050	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,100	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,150	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,200	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1
1,250	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1	86.1

(50 ft) below the point of discharge, the maximum plume temperature is 30.1°C (86.2°F), or approximately 0.1°C (0.2°F) above background conditions. At this point, the thermal plume will be virtually indistinguishable from background conditions.

To evaluate potential thermal impacts during cooler periods (i.e., during those times when creek organisms may be acclimated to colder temperatures and thus potentially more susceptible to thermal shock), an additional analysis was conducted to reflect potential worst case creek and cooling reservoir temperatures in October. For the reservoir discharge conditions, a worst case condition of 27°C (80°F) was assumed, to reflect the predicted October - worst case load conditions (26°C or 78°F) plus an additional 1.1°C (2°F) loading to include short-term reservoir variability, adverse meteorological conditions, etc. For Payne Creek, a minimum October stream temperature of 17.8°C (64°F) was assumed to reflect worst case receiving water conditions (i.e., maximum difference between reservoir effluent and creek conditions). This minimum October stream temperature is significantly lower than the observed October stream temperature of 24°C (75°F) measured in the monitoring program and lower than the estimated natural or equilibrium water temperature of 22.6°C (72.6°F) calculated in Table 5.1.1-1; this assumed minimum October stream temperature corresponds with the observed November stream temperature measured in the monitoring program. As such, this combination of maximum reservoir and minimum creek temperatures, and the resulting temperature differential of 8.9°C (16°F), represents a potential worst case condition regarding thermal shock.

The results of this modeling analysis are summarized in Table 5.1.1-4. As previously demonstrated by similar modeling analyses, the cooling reservoir discharges will be quickly diluted by Payne Creek flows. For example, at a distance of 15 m (50 ft) below the point of discharge, the maximum plume temperature is 17.9°C (64.3°F), or approximately 0.15°C (0.3°F) above background conditions. At this point, the thermal plume will be virtually indistinguishable from background conditions.

Table 5.1.1-4. Hardee Power Station Cooling Reservoir Water Discharge and Payne Creek Dispersion Modeing - October Temperature Conditions

Payne Creek Conditions		
River Channel Width	20	feet
Average River Depth	2.5	feet
River Discharge	22	feet3/second
Average Flow Velocity	0.500	feet/second
Flow Shear Velocity	0.259	feet/second
Transverse Mixing Coeff.	0.389	feet2/second
Background Water Quality	64	degrees F
Reservoir Water Discharge Conditions		
Discharge Flow Rate	0.33	feet3/second
Discharge Water Quality	80	degrees F

Distance Downstream (feet)	Mixed Concentration (degrees F) at Various Distances (feet) Across Payne Creek										
	0	0.5	1	1.5	2	2.5	3	4	5	10	20
0	80.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0	64.0
50	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.3	64.2	64.1
100	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.1
150	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
200	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
250	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
300	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
350	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
400	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
450	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
500	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
550	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
600	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
650	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
700	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
750	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
800	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
850	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
900	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
950	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,000	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,050	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,100	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,150	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,200	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2
1,250	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2	64.2

This substantial mixing and dispersion is a direct function of the Payne Creek conditions during the infrequent periods when a cooling reservoir discharge is required. As previously discussed, due to the evaporative losses and the ability to fluctuate the reservoir level to manage available water, discharges from the cooling reservoir will only be required during extreme meteorological conditions. Similarly, during the extreme meteorological conditions, Payne Creek flows will increase substantially. Thus, discharges from the reservoir will occur during high flow conditions in Payne Creek; during these periods, there will be a substantial dilution of the reservoir water. The impacts of these infrequent discharges are further minimized by the proposed sheetflow discharge into Payne Creek.

Based on the available data and the impact analysis presented herein, it is anticipated the reservoir discharges of the proposed cooling reservoir will not cause adverse thermal impacts or significantly increase the temperature of Payne Creek, or impair or interfere with its existing or anticipated future beneficial use. This is because of the comparatively high creek flows which will quickly dilute all reservoir discharges. With a minimal mixing zone [e.g., less than 30 m (100 ft)], the proposed infrequent reservoir discharges will meet all requirements of Chapter 17-3.05(1)(d)(i), Florida Administrative Code (F.A.C.).

5.1.2 Effects on Aquatic Life

5.1.2.1 Thermal Impacts

As discussed in Section 5.1.1, minimum or no discharge will occur from the cooling reservoir into Payne Creek. Furthermore, it is anticipated that reservoir discharge will be required only during very intensive, wet periods, such as hurricanes or major frontal storms. These periods of discharge will coincide with natural high flow in the creek, thus the effluent will be subject to significant dilution.

The predicted maximum average reservoir temperature, on the cold side is conservatively estimated to be 32°C (89°F) during July and the maximum worst case monthly discharge condition is 34°C (93°F) (see Section 5.1.1) during July. The predicted maximum average discharge temperature conditions are within the acceptable water quality criteria for peninsular Florida, and thus should not affect the aquatic resources. Discharge of effluent at the predicted maximum worst case temperature will exceed the water quality temperature limitation for peninsular Florida [criteria of 33°C (92°F) versus discharge of 34°C (93°F)]. However, applicable temperature criterion will be met outside the requested mixing zone. Based on creek flow and anticipated dilution, the temperature impacts under worst conditions should be localized in the immediate vicinity of the point of discharge. At a distance of 15 m (50 ft), the thermal plume will be virtually indistinguishable from background concentrations. No impacts are anticipated outside the plume (see Section 5.1.1).

5.1.2.2 Impingement and Entrainment

Impingement and entrainment effects are not potential sources of impact because all plant make up water will be groundwater, surface runoff and precipitation. Surface waters will not be used.

5.1.2.3 Thermal Shock

Based on the assumption that the highest Payne Creek water temperature of 30°C (86°F) occurs during July, and that the estimated worst case plant discharge during the summer is 34°C (93°F), a temperature differential of 3.9°C (7°F) may occur.

As discussed in Section 5.1.1 ambient temperature in Payne Creek during the infrequent discharge conditions will be found in 90 percent of the stream's width. Thus the potential for greatest thermal shock will be localized within 15 m (50 ft) downstream from the discharge point (see Table 5.1.1-3). During summer conditions, aquatic organisms will be acclimated to high temperature conditions, thus they may be more tolerant to higher temperatures. Fish can detect and avoid areas of thermal stress. Because of the localized area of impact no thermal blockage will occur. Additional modeling was carried out to evaluate potential worst conditions during the winter months. The assumptions included a reservoir temperature of 27°C (80°F) and a creek temperature of 18°C (64°F). The modeling carried out predicts that the cooling reservoir discharge will be quickly diluted by Payne Creek flows. Within 30 m (100 ft) of the discharge point, the plume temperature is predicted to be 0.1°C (0.2°F) above background (see Table 5.1.1-4). Class III water quality standards will be met at the edge of the mixing zone and applicable water quality criteria will be met within the mixing zone. Based on the worst cases modeled, no impact is anticipated outside the mixing zone.

5.1.3 Biological Effects of Modified Circulation

No water intakes will be placed in the creek and minimal infrequent discharges will take place. Based on the physical and biological conditions of Payne Creek, the thermal mixing zone described in Section 5.1.1 will not have an adverse impact on the biological communities of Payne Creek. Due to the size of the cooling reservoir and the anticipated retention time in the system, no major changes in water quality are anticipated in Payne Creek, thus no impacts are anticipated on the aquatic communities.

Due to the planned preventive measures, factors such as scouring, erosion and deposition of suspended solids are not expected to cause major effects on Payne Creek. During periods of discharge, the water volume may increase slightly over flood conditions, but it is not anticipated to affect the biological communities.

5.1.4 Effects of Offstream Cooling

5.1.4.1 Groundwater/Surface Water Interchange

Groundwater and surface waters interchange directly along Payne Creek which forms the southwestern boundary of the site. Except for recent alluvium, the material in the bed of Payne Creek is comprised of clays of the Bone Valley Formation which also forms the base of the Surficial Aquifer. Groundwater flows parallel to the water table towards Payne Creek where it is discharged forming a significant component of base flow during periods of low flow.

Operation of the cooling reservoir will do little to modify this general pattern. Some redistribution of flow in the surficial aquifer would be expected during construction but a new pattern will become established after the reservoir is filled. During operation, the reservoir bottom will become less permeable as a result of reactions between the dissolved solids in the reservoir water and the clayey sands. The change in the amount of groundwater/surface water interchange at Payne Creek will be minimal because the downstream face of the berm is a flat slope of 20:1 (horizontal to vertical) and is set back from the Payne Creek Floodplain. These two features effectively reduce the hydraulic gradients in the vicinity of the reservoir.

5.1.4.2 Fogging

The Tampa area experiences approximately 22 days a year during which fog reduces visibility to 0.4 km (1/4 mile) or less. Night ground fog occurs frequently during the cooler winter months. The annual frequency of night fog occurrence at the project site is expected to be similar to that of the Tampa area. However, at the project site, fog will vary in duration and intensity during the day from that observed in the Tampa area because of the inland location of the project site.

The cooling reservoir will be constructed on 231 ha (570 acres) of mined lands that will be reclaimed after mining. There are existing ponds owned by CFI that are located adjacent to the project site as well as ponds in the surrounding area. The north and south CFI ponds, the closest to the site, are located on approximately 71 ha (175 acres) immediately to the east of the property site. Because of the number and size of existing phosphate related ponds, the proposed cooling reservoir is not expected to significantly increase the amount of fog that currently exists in the area. Indeed, the proposed cooling reservoir does not utilize forced evaporation, such as cooling towers, and would not produce similar fogging conditions.

5.1.5 Measurement Programs

5.1.5.1 Groundwater Monitoring And Assessment Methodology

MONITORING

Information required by Chapter 17-28.700(6)(d), F.A.C., is provided in this application. As part of operational monitoring, three shallow monitoring wells will be installed: one background well upgradient of the reservoirs; one well at the edge of the zone of discharge; and one well downgradient from the reservoir.

IMPACT ASSESSMENT

Hydrologic models used to describe and predict the movement of groundwaters and dissolved solutes include both analytical and numerical methods. The computer codes used for evaluation of the site are capable of execution on both IBM OS2 or IBM AT microcomputers. Results files are then networked to a DEC VAX minicomputer for contour plotting of results using Intergraph Digital Terrain Modeling software. These programs are summarized as follows:

FDMODEL - a finite difference groundwater model based on the USGS IADI method. This model is used for regional studies and is capable of modeling surface water bodies contained within a phreatic aquifer, confined aquifers, diffuse recharge/leakage, and point sources of recharge and/or leakage. This model is a two-dimensional model and must be used with superposition to evaluate multi-level aquifers.

FEMODEL - a finite element groundwater model based on the Galerkin method. This model is capable of incorporating an irregular spaced grid so that drawdowns near pumping or injection wells can be modeled. Both phreatic and confined aquifers can be modeled with variable pumping schedules and anisotropic transmissibility.

PTRANS - an analytic solute transport model for point discharges made in one-dimensional or two-dimensional saturated porous media. Both momentary and permanent injections of solute can be evaluated at any time and distance from the source considering dispersion, advection, and reaction.

FETRANS - a finite element solute transport model based on the Galerkin method. This two-dimensional model is capable of incorporating an irregular spaced grid so that irregular shaped areas can be modeled. Nodes can be held at constant or variable concentrations with variable pumping schedules. Transport is allowed by hydrodynamic dispersion and molecular diffusion; retardation can be modeled by reducing the advection velocity.

Parameter evaluation techniques consisted of reviewing pumping test data for the appropriate aquifer and determining geometric mean value for each parameter. Groundwater flow velocities were developed from piezometer slug testing on site (see Section 2.3.2). Transport parameters were derived from the literature.

5.1.5.2 Surface Water Monitoring

The temperature monitoring program is structured to provide the necessary data on operational water temperatures at the site for determination of project compliance and impacts. Temperatures will be recorded during discharge events from the cooling reservoir (RES-1).

The locations of the temperature monitoring station are shown in Figure 5.1.5-1.

5.1.5.3 Biological Monitoring

Because of the lack of anticipated ecological impacts no biological monitoring is proposed at this time.

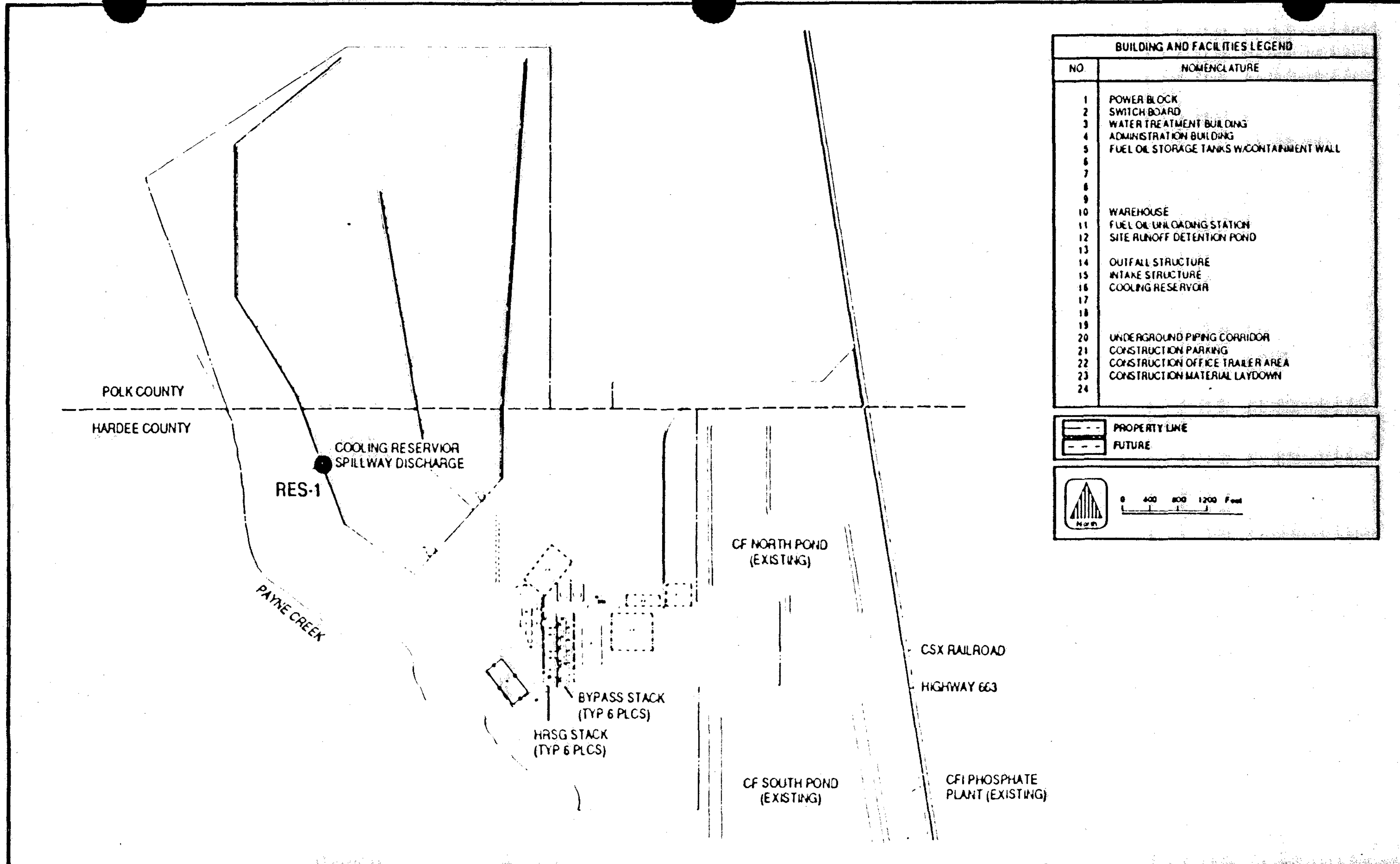

Figure 5.1.5-1 OPERATIONAL MONITORING TEMPERATURE AND WATER QUALITY STATION LOCATIONS

Hardee Power Station

5.2 EFFECTS OF CHEMICAL AND BIOCIDE DISCHARGES

5.2.1 Industrial Wastewater Discharges

5.2.1.1 Surface Water Discharges

In addition to the previously described recirculating cooling system discharges, the Hardee Power Station will have three other types of wastewater discharges: low volume plant wastewaters; plant related sanitary wastewater; and plant site stormwater. Treatment and potential impacts of low volume plant wastewaters are discussed below; plant site stormwater and plant related sanitary wastewater are discussed in Sections 5.3 and 5.5, respectively.

In general, the proposed plant as designed will treat, retain, and/or recycle wastewater flows to the maximum extent possible and thus minimize offsite surface water discharges, consistent with FDER policy. As such, the proposed plant wastewaters will have virtually no adverse surface water quality impacts on downstream water quality of Payne Creek.

Power plant low volume wastewaters include plant and equipment drain wastes, boiler blowdown, softener regeneration brines, plant water pretreatment filter backwash and sanitary wastewaters. Anticipated generation rates for these wastewater streams have been previously presented in Figures 3.5-1 through 3.5-3. Given the anticipated fuels (i.e., gas or oil), no fuel or flue gas desulfurization related wastewaters are anticipated.

The proposed plant will incorporate a neutralization basin to treat softener regeneration brines and miscellaneous chemical drain wastes prior to discharge to the cooling reservoir. This proposed neutralization basin will treat these wastes by: pH neutralization; flow equalization; sedimentation; and mixing and dilution. These neutralized and treated wastewaters will be discharged to the cooling reservoir. Miscellaneous floor drains will be directed to an oil separator and then discharged to the cooling reservoir for reuse as cooling water.

Given the plant size, overall design, and anticipated fuels, low volume plant wastewaters will be relatively small flows and relatively good quality. Under average annual conditions, the total quantity of these wastewaters will be approximately 488 cubic meter/day (129,000 gallons/day) for the plant under average annual load conditions. Anticipated low volume wastewater quality has been previously presented in Section 3.5. The cooling reservoir will be neither waters of the State of Florida or waters of the United States and, therefore, no discharge criteria or effluent limitations apply. It is anticipated that plant low volume wastewaters will be treated to levels equivalent to those effluent criteria prior to discharge to the cooling reservoir.

Use of the cooling reservoir to receive these treated plant wastewaters maximizes the retention and recycle of treated wastewater flows and thus minimizes offsite surface water discharges.

The net dilution received by these wastewaters within the reservoir, prior to surface or subsurface discharge from the reservoir, is a function of the total freshwater entering the reservoir. As previously presented in Figure 3.5-3, approximately 16,707 cubic meters/day (4,414,000 gallons per day) of rainfall, upland runoff and surficial groundwater seepage, and Lower Floridan Aquifer makeup water will enter the reservoir. Therefore, plant wastewaters will receive an overall 34:1 dilution within the reservoir prior to release to adjacent surface or subsurface waters as either surface or groundwater discharges.

Based on the anticipated plant and cooling reservoir water balance (previously presented in Figure 3.5-3) and reservoir inflow water quality (including the treated plant wastewaters and sanitary wastewaters), the long-term reservoir water quality has been estimated. Given the increased evaporative losses, and the minimized discharge, some "evapo-concentration" of water quality constituents will occur over the life of the reservoir. The long-term reservoir water quality (i.e., after 30 years of facility operation) has been estimated based on a mass balance of all reservoir water inflows and outflows; typical reservoir water inflow quality and predicted reservoir (discharge) quality are presented in Table 5.2.1-1. FDER Class III water quality criteria applicable to discharges from the reservoir are presented for comparison.

In evaluating these estimates of reservoir quality, two important factors merit special note. First, these reservoir effluent estimates are based on chemical mass balances of water inflow and outflows, and do not take into account any chemical reaction, precipitation, sedimentation, deposition or biological activity which may occur in the reservoir. These physio-chemical and/or biological activities may result in significant removal of suspended and/or dissolved material from the water column; such removal would significantly reduce actual reservoir and discharge concentrations.

Table 5.2.1-1. Summary of Estimated Cooling Reservoir and Intake Water Quality Conditions, and Reservoir Quality for the Hardee Power Station (Page 1 of 2)

Parameter	Reservoir Intake/Influent Water Quality: Surface Runoff	Surficial Aquifer	Floridan Aquifer Makeup	Treated Neutralization Basin Effluent	Cooling Reservoir Quality[1]	FDER Class III Water Quality Criteria
Calcium, mg/L as CaCO3	63	83	113	1130	240	
Magnesium, mg/L as CaCO3	39	30	49	490	100	
Sodium, mg/L as CaCO3	17	30	37	3050	200	
Potassium, mg/L as CaCO3	0	1	8	80	16	
Total Hardness, mg/L as CaCO3	102	113	162	1620	340	
Alkalinity, mg/L as CaCO3	61	83	160	0	260	>20
Sulfate, mg/L as CaCO3	37	30	26	4540	250	
Chloride, mg/L as CaCO3	21	34	21	210	50	
Silca, mg/L	5.4	17	27	270	60	
Fluoride, mg/L	1.0	0.57	2.0	20	4.1	10
Cyanide, mg/L	<0.004	<0.004	<0.005	0.05	0.01	0.005
MBAS, mg/L	0.040	0.040	<0.180	1.8	0.36	0.5
Oil and Grease, mg/L	<5	<5	<5	0	<5	5
Turbidity, NTU	1.7	51	14	10	31	29 above Background
pH, units	7	7.5	7.5	6-9	7.5	6.0-8.5
Total Dissolved Solids, mg/L	190	158	342	6860	860	
Specific Conductivity, umhos/cm	173	225	320	12100	1080	1275
Total Kjeldahl Nitrogen, mg/L	0.74	0.14	0.39	3.9	0.9	
Ammonia Nitrogen, mg/L	0.11	0.07	0.20	2.0	0.4	
Unionized Ammonia, mg/L[2]	0.001	0.002	0.007	0.022	0.014	0.02
Organic Nitrogen, mg/L	0.65	0.07	0.19	1.9	0.4	
Nitrate+Nitrite-Nitrogen, mg/L	0.50	0.085	0.031	0.3	0.1	
Total Nitrogen, mg/L	1.24	0.24	0.421	4.2	1.0	
Orthophosphorus, mg/L	0.41	0.47	0.20	2.0	0.5	
Total Phosphorus, mg/L	0.44	2.08	0.20	2.0	0.8	
Arsenic, ug/L	<5	<9	<10	0.1	20	50
Barium, ug/L	<10	<10	75	750	150	
Beryllium, ug/L	<3	10	<0.9	9	4.0	1100
Cadmium, ug/L	<0.4	6	<0.7	7	2.6	1.2
Chromium, ug/L	<10	<10	13	130	28	50
Copper, ug/L	7	65	7	70	27	30
Iron, ug/L	293	1700	420	0	980	1000

Table 5.2.1-1. Summary of Estimated Cooling Reservoir and Intake Water Quality Conditions, and Reservoir Quality for the Hardee Power Station (Page 2 of 2)

Parameter	Reservoir Intake/Influent Water Quality: Surface Runoff	Surficial Aquifer	Floridan Aquifer Makeup	Treated Neutralization Basin Effluent	Cooling Reservoir Qulaity[1]	FDER Class III Water Quality Criteria
Lead, ug/L	6.1	<6.7	14	140	29	30
Manganese, ug/L	7.9	28	28	0	47	
Mercury, ug/L	0.24	0.24	<0.2	2	0.5	0.2
Nickel, ug/L	16	16	23	230	49	100.
Selenium, ug/L	<5	<5	16	160	32	25
Silver, ug/L	<0.08	<0.08	<0.4	4	0.8	0.07
Strontium, ug/L	100	100	300	3000	610	
Zinc, ug/L	7.4	<50	143	1400	280	1000 30
Alpha, Gross (pC/L)	1.7	30	8.4	84	22.2	15
Radium 226 (pC/L)	0.7	2.0	3.0	30	6.2	5

Note: 1. Reservior quality estimates are based on mass balances and do not take into account any chemical reaction, precipitation, sedimentation, deposition or biological activity which may occur in the reservoir and act to remove material from the water column and thus reduce reservoir concentrations.

2. Unionized ammonia concentrations are based on a worst case reservoir water temperature of 95°F (35°C).

Second, in the determination of neutralization basin or reservoir concentrations for the various parameters in which one or more source waters were less than the analytical detection limit, the source water concentration was mathematically assumed to be at the reported analytical detection limit. Given the concentrating effect of long-term cooling reservoir operation and the demineralizer resin regeneration, this presumption of the presence of these parameters at these concentrations significantly influences the long-term reservoir concentration. If these parameters are present at concentrations substantially less than the analytical detection limits, predicted long-term reservoir concentrations will be reduced proportionally. Thus, the mathematical assumption of these concentrations at the reported analytical detection limits results in a maximum or worst case estimate.

Given both factors (the absence of physio-chemical and/or biological removal and the assumption of the analytical detection limit as the actual concentration), these estimates are conservative estimates of reservoir discharge quality.

Based on these long-term (30-year) water quality estimates, the cooling reservoir discharges may exceed the applicable FDER Class III water quality criteria for cyanide, turbidity, cadmium, mercury, selenium, silver, gross alpha, and radium.

To assess mixing and dilution of the these discharges and to estimate the mixing zone necessary to meet the applicable FDER Class III water quality criteria, the runoff and mixing models previously described in Section 5.1.1 were used. As previously estimated using the reservoir water balance and HEC-1 models, the reservoir will only discharge for storms which exceed the 10-year, 24-hour rainfall. Thus, reservoir discharges will be infrequent and subject to substantial dilution.

Based on the predicted discharge and streamflow rates for the 25-year, 24-hour storm, the estimated mixing zone lengths and widths are summarized in Table 5.2.1-2; detailed modeling results are summarized in Appendix 11.5.5. Given the low discharge rates and relatively high streamflow rates, mixing zones lengths are typically very short and mixing zone widths correspondingly narrow. The mixing depth will extend the entire depth of the water column. For cyanide, turbidity, cadmium, mercury, selenium, silver, gross alpha, and radium, the mixing zone length required to meet the applicable FDER Class III water quality criteria is 15 m (50 ft) or less.

Regarding reservoir effluent concentrations of mercury and silver, both have been estimated based on the presumption of these contaminants present in makeup waters at levels equal to the analytical detection limits (as discussed above). Therefore, these mixing zone lengths reflect this conservative effluent estimating methodology. The creek areas within these mixing zone lengths meet all requirements for mixing zones as specified in Chapter 17-4.244, F.A.C.

Given the anticipated reservoir water quality, the treatment provided to plant wastewaters, the infrequent occurrences of discharge (previously discussed in Section 5.1.1), and immediate and substantial dilution afforded by Payne Creek flows during the infrequent discharge events, no adverse water quality impacts are predicted. Based on these data, surface discharge of cooling reservoir water will not significantly or adversely increase water quality concentrations of Payne Creek, impair or interfere with any existing or anticipated future beneficial use of these waters, or cause or contribute to any contravention of FDER General or Class III water quality criteria.

5.2.1.2 Groundwater Discharges

There will be no direct chemical or biocide discharges to groundwater. Possible indirect discharges could occur from seepage from the cooling

Table 5.2.1-2. Summary of Estimated Cooling Reservoir Discharge Water Quality Mixing Zones Necessary to Meet Class III Water Quality Criteria for the Hardee Power Station

Parameter	Payne Creek (Station PC-2) Streamflow Quality	660 MW Plant Cooling Reservoir Effluent Quality	Required Mixing Zone Length (feet)	Required Mixing Zone Width (feet)	FDER Class III Water Quality Criteria
Cyanide, mg/L	<0.004	0.010	<50	<3	0.005
Turbidity, NTU	1.5	31	<50	<3	29 NTU above ambient
Cadmium, ug/L	<0.4	2.6	50	<3	1.2
Mercury[1], ug/L	0.1	0.5	50	<3	0.2
Selenium, ug/L	<5	32	<50	<3	25
Silver[2], ug/L	<0.04	0.8	<50	<3	0.07
Alpha, Gross (pC/L)	1.7	22.2	<50	<3	15
Radium 226 (pC/L)	0.5	6.2	<50	<3	5

Note: 1. No mercury was detected (at a detection limit of 0.2 ug/L) in Payne Creek during high flow conditions; therefore, a stream concentration of half of the detection limit was assumed as a basis for estimating the mixing zone length.

2. No silver was detected (at a detection limit of 0.08 ug/L) in Payne Creek during the field monitoring program; therefore, a stream concentration of half of the detection limit was assumed as a basis for estimating the mixing zone length.

reservoir and the runoff detention pond and as accidental spills from chemical handling and storage areas.

The cooling reservoir will be constructed of in-situ earth materials creating a permeable filter bed. Given the depth of the reservoir, seepage will be primarily to the surficial aquifer. As described in the previous section and in Section 3, the reservoir receives wellwater from the Florida Aquifer as makeup and various treated plant wastewater flows. This results in a minimum of 40:1 dilution for wastewaters prior to any seepage to groundwater. It also results in an increase in concentration of various water quality parameter over time. Design water analysis is shown in Table 3.5.1-1 and anticipated cooling reservoir water quality is given in Table 3.5.1-2.

The impact of seepage of water with the anticipated quality can be considered by comparing concentrations of key parameters to existing water quality in the surficial aquifer and to pertinent drinking water standards. These parameters (total dissolved solids, chlorides, and sulfates) were chosen because they are widely reported and common problems in drinking water. The relative differences found can also be applied to other parameters. Table 5.2.1-1 provides a summary of background and projected reservoir concentrations after 30 years, and drinking water standards for the three parameters.

A contour map showing the selected groundwater quality parameters after 30 years of plant operation are shown in Figure 5.2.1-1. This map was prepared using a two-dimensional finite element model to simulate the concentrations produced by full contact of the reservoir water with the surficial aquifer groundwater. Solute concentrations were held constant for the full depth of the aquifer directly under the reservoir. No retardation or adsorption of the cations by clayey soils was taken into account in this simulation. Transport of solute was allowed by advection within the pores of the Surficial Aquifer at a uniform groundwater velocity of 5 mm/day towards the south-southwest. Both longitudinal and transverse dispersivity

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Alpha, Gross (pC/L)	1.7	22.2	<50	<3	15
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Note: 1. No mercury was detected (at a detection limit of 0.2 ug/L) in Payne Creek during high flow conditions; therefore, a stream concentration of half of the detection limit was assumed as a basis for estimating the mixing zone length.

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reservoir and the runoff detention pond and as accidental spills from chemical handling and storage areas.

The cooling reservoir will be constructed of in-situ earth materials creating a permeable filter bed. Given the depth of the reservoir, seepage will be primarily to the surficial aquifer. As described in the previous section and in Section 3, the reservoir receives wellwater from the Florida Aquifer as makeup and various treated plant wastewater flows. This results in a minimum of 34:1 dilution for wastewaters prior to any seepage to groundwater. It also results in an increase in concentration of various water quality parameter over time. Design water analysis is shown in Table 3.5.1-1 and anticipated cooling reservoir water quality is given in Table 3.5.1-2.

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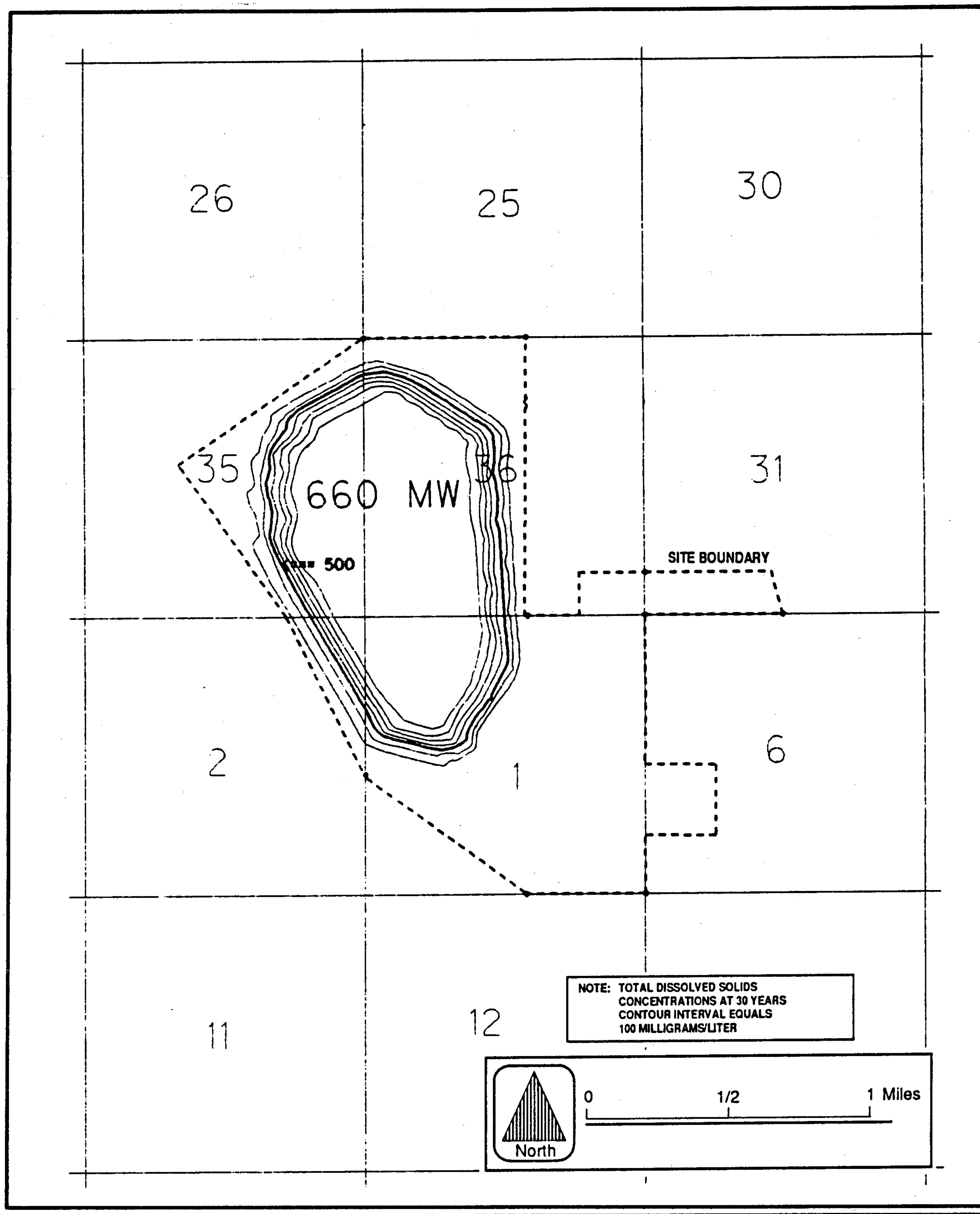

Figure 5.2.1-1 PREDICTED GROUNDWATER DISCHARGE FOR 660 MW FACILITY

Hardee Power Station

and molecular diffusion were taken into account using parameters derived from Freeze and Cherry (1979).

The analysis indicated that the concentrations remain localized in the immediate vicinity of the reservoir. Concentrations at the end of 30 years are indistinguishable from background levels within 0.4 km (0.25 mile) of the reservoir. At the end of 30 years, the 250 mg/liter SO_4 isopleth and the 500 mg/liter TDS isopleth will have moved 320 ft from the inside of the cooling reservoir berm (see Figure 5.2.1-2).

At the edge of this zone of discharge, groundwater concentrations will meet the applicable groundwater quality standards. The edge of this zone of discharge is within the Applicant's property and will not threaten or impair any present or future water supplies. This zone of discharge is in compliance with FDER regulations Chapter 17-28.700(3) and (4) F.A.C.

In order to more closely define the movement of the 500 mg/liter TDS contour with time, additional analyses were conducted using a one-dimensional technique and incorporating a retardation factor of 1.0 (no retardation).

Seepage from the runoff detention pond will be discontinuous and much less than seepage from the cooling reservoir. In addition, there is no recycling activity to concentrate water quality parameters. The pond will be designed to satisfy criteria for maintenance of water quality. As a result, no adverse impact to groundwater quality should occur.

Impacts to groundwater resulting from accidental spills will also be precluded by design of the chemical (including oil) storage and handling areas. Berms and impermeable liners will surround oil, acid and caustic tanks such that any spills are contained and seepage to groundwater is prevented.

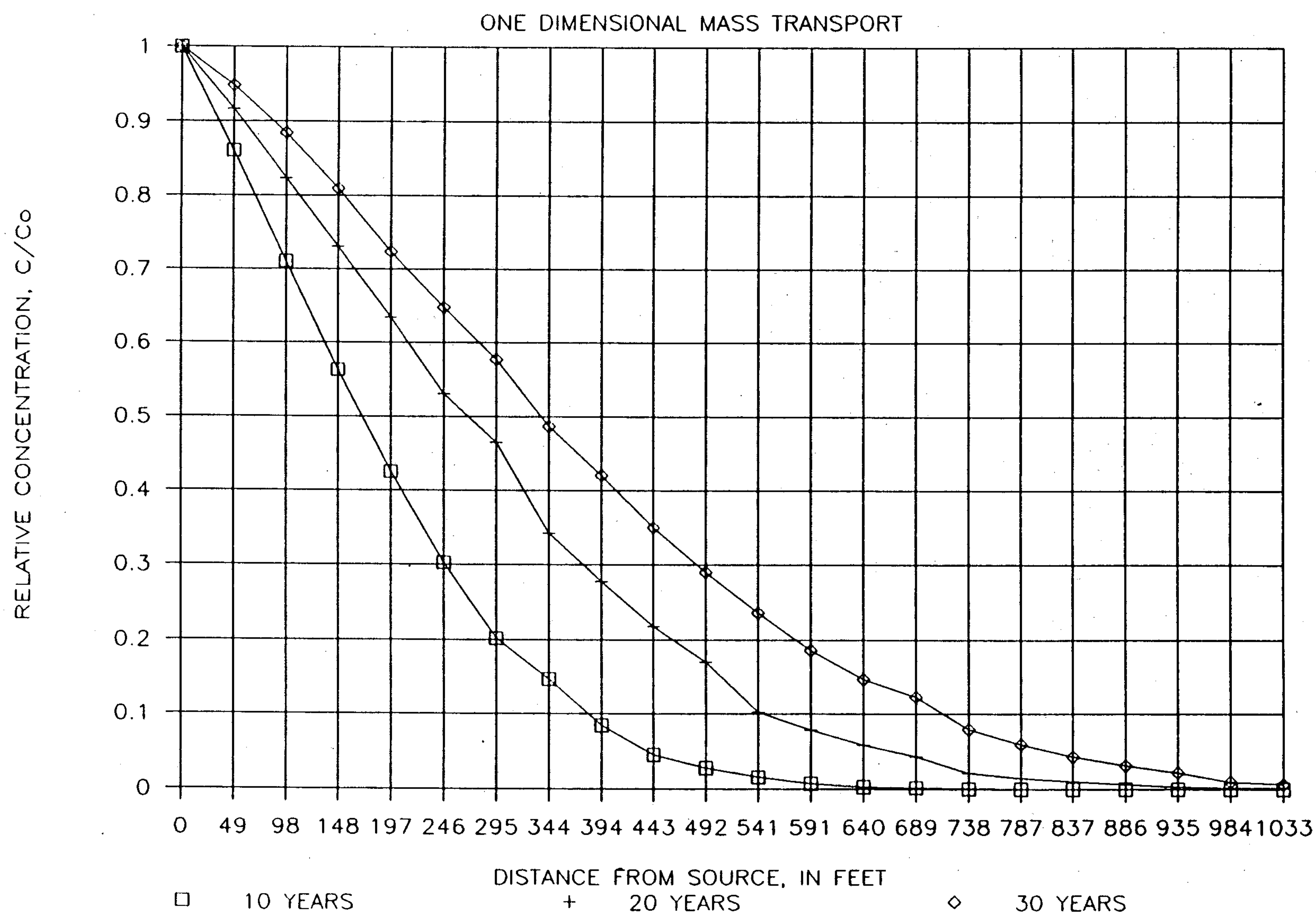

Figure 5.2.1-2 PREDICTED SOLUTE TRANSPORT FROM COOLING RESERVOIR

Hardee Power Station

5.2.1.3 Biological Impacts

The long-term reservoir water quality was presented on Table 5.2.1-1. For those parameters estimated to exceed the FDER Water Quality Criteria, a mixing zone was defined in Section 5.2.1 (Table 5.2.1-2). The parameters requiring a mixing zone are estimated to be at concentrations not acutely toxic. Transport of reservoir water through ground water will further dilute the water quality concentrations. No biological impacts are anticipated on Payne Creek from this potential impact.

Intermittent shock chlorination will be used to prevent biofouling of the circulating water system. Based on the anticipated residence time of the water in the cooling reservoir, the dilution factors, and the natural decay, the level of total residual oxidants near the reservoir outfall should be undetectable. If other biocides are used in the cooling reservoir and the circulating system in the future, under similar conditions, they should also be undetectable if discharged as part of the reservoir outfall.

The sanitary wastewater system and the make up water demineralization system will also use chemicals for their processes. Based on the treatment provided prior to discharge to the cooling reservoir, these influents to the cooling reservoir are not expected to be a major toxicity issue. Chemicals used for cleaning of the heat recovery steam generator and feedwater piping will not be stored onsite and will be administered by means of a temporary system. The chemical cleaning contractor will either dispose of the chemical cleaning wastes offsite or treat the wastes in a portable treatment system prior to routing the wastewater to the cooling reservoir.

5.2.1.4 Biological Monitoring

Because of the lack of anticipated ecological impacts no biological monitoring is proposed at this time.

5.2.2 Cooling Tower Blowdown

Cooling towers were not selected as the primary cooling alternative, but are considered a feasible secondary alternative. This cooling alternative is discussed in Chapter 8.

5.2.3 Measurement Programs

5.2.3.1 Assessment Methodology - Surface Water

Methodologies used to determine the impacts for the following monitoring program has been discussed in detail in Sections 5.1.1 and 5.1.2. The following monitoring program has been developed to monitor predicted impacts and, as appropriate, provide a quantitative basis for implementing any necessary project modifications.

5.2.3.2 Physical Chemical Monitoring

The cooling reservoir discharge station, RES-1, will be sampled during any discharge events.

5.3 IMPACTS ON WATER SUPPLIES

5.3.1 Surface Water

There are no known consumptive water withdrawals from Payne Creek downstream of the proposed plant; therefore, no adverse impacts regarding consumptive water withdrawals are anticipated. Existing uses of Payne Creek include recreational uses and wetland/habitat functions. Potential impacts to wetland/habitat functions are discussed below.

Functionally, the proposed cooling reservoir is a surface reservoir designed to manage all surface and subsurface water inflows and outflows. The cooling reservoir water balance has been presented in Figures 3.5-1 through 3.5-3. Based on the proposed cooling reservoir design, approximately 1,080,000 gallons/day (or approximately 1.67 cfs) will seep through the reservoir edge bordering Payne Creek and into the groundwater systems adjacent to Payne Creek.

Given the estimated reservoir drainage basin area of 190 ha (470 acres) and the design reservoir area of 231 ha (570 acres), water drainage from approximately 421 ha (1,040 acres) or 14.1 square km (1.6 squares miles) are influenced by the cooling reservoir. Thus, this edge seepage loss is equivalent to a long-term water yield of approximately 1.03 cfs per mile for the influenced drainage basin. This is very similar to the expected long-term water yield from the Payne Creek areas (estimated in Table 2.3.3-2 to be approximately 0.9 cfs mile). Thus, groundwater systems adjacent to Payne Creek and the associated wetlands will receive water quantity subsidies similar to what they currently receive. This water will be uniformly distributed during the year. Whereas this will have little impact to Payne Creek and the adjacent wetlands during wet periods, this will subsidize the Payne Creek floodplain during dry periods. Therefore, the proposed cooling reservoir should not have a significant adverse water quantity impact to the wetlands adjacent to Payne Creek.

5.3.2 Groundwater

5.3.2.1 Consumptive Use Impacts

The main consumptive use impact from the operation of the Hardee Power Station would be the withdrawal of potable water from the Floridan Aquifer. Three 2,000 gpm wells will be required for full build out. A maximum withdrawal rate of 7.7 mgd is proposed for the 660 megawatt plant at the site. Small quantities of water will also be used for drinking water, plant maintenance (cleaning) water, and miscellaneous water use at the plant.

During dry months, groundwater from the Florida Aquifer will be needed to augment the cooling water reservoir. Preliminary design of the wellfield for such a withdrawal is based upon 3 deep wells screened in the Avon Park Dolomite each with a capacity of 2,000 gpm. These 3 wells would be spaced a minimum of 30 m (100 ft) apart to provide adequate redundancy in cases of accidental loss of a well or unscheduled well maintenance. Multiple wells also provide better efficiency for wells and pumps and operate within their performance envelope.

The parameters listed in Table 5.3.2-1 were used to evaluate drawdown at the well and site boundary. These parameters were used with the modified Thesis equation and the law of superposition to determine the drawdown at various distances from the pumping wells.

Worst case water consumption scenarios suggest that a peak short-term water withdrawal of 15.4 mgd may be required for the 660 MW plant. For a dry period lasting 120 days (November through February), drawdowns around the two pumping wells were calculated using a two-dimensional finite element model. Results are shown in Figure 5.3.2-1. As can be seen from these results, even peak short term withdrawals will not produce excessive drawdown at the site boundaries so long as the wellfield located more than 122 m (400 ft) away from the site boundaries. Given the proposed location, 427 m (1,400 ft) from the nearest site boundary a maximum drawdown of <0.9 m (<3 ft) at the boundary is predicted.

5.3.2.2 Recharge of Water Table Aquifer

The presence of the cooling water reservoir results in increased percolation of surface water into the ground water system due to the hydraulic head in the reservoir. Preliminary water budgets which considered monthly precipitation and evaporation rates suggest that as much as 10 cm (4 inches) of recharge to the surficial aquifer would occur per month through the bottom of the 231 ha (570 acre) cooling water reservoir. Both finite difference and finite element computer models indicate that the groundwater table would mound up during each dry season, thereby recharging the intermediate aquifer system on a long-term basis.

5.3.3 <u>Drinking Water</u>

There will be no impacts to potable water supplies. Payne Creek is not a source of drinking water. There are no municipal wells within 8 km (5 miles) of the site; most wells listed in Section 2.3.3 are in fact monitoring wells and are not used as potable drinking water supply wells. Predicted drawdown contours, discussed in Section 5.3.1, confirms that the

Table 5.3.2-1. Average Preliminary Deep Well Aquifer Parameters for Hardee Power Station (Avon Park Dolomite)

Aquifer	Floridan
Transmissivity	1,000,000 GPD/FT
Storativity	0.005
Depth to Static Water	85 FT
Proposed Plant Grade	117 FT

Source: Hydrology of the South Rockland Area and Vicinity-Polk and Hardee Counties. Report prepared by Dames & Moore for Agrico Chemical Company, 1979.

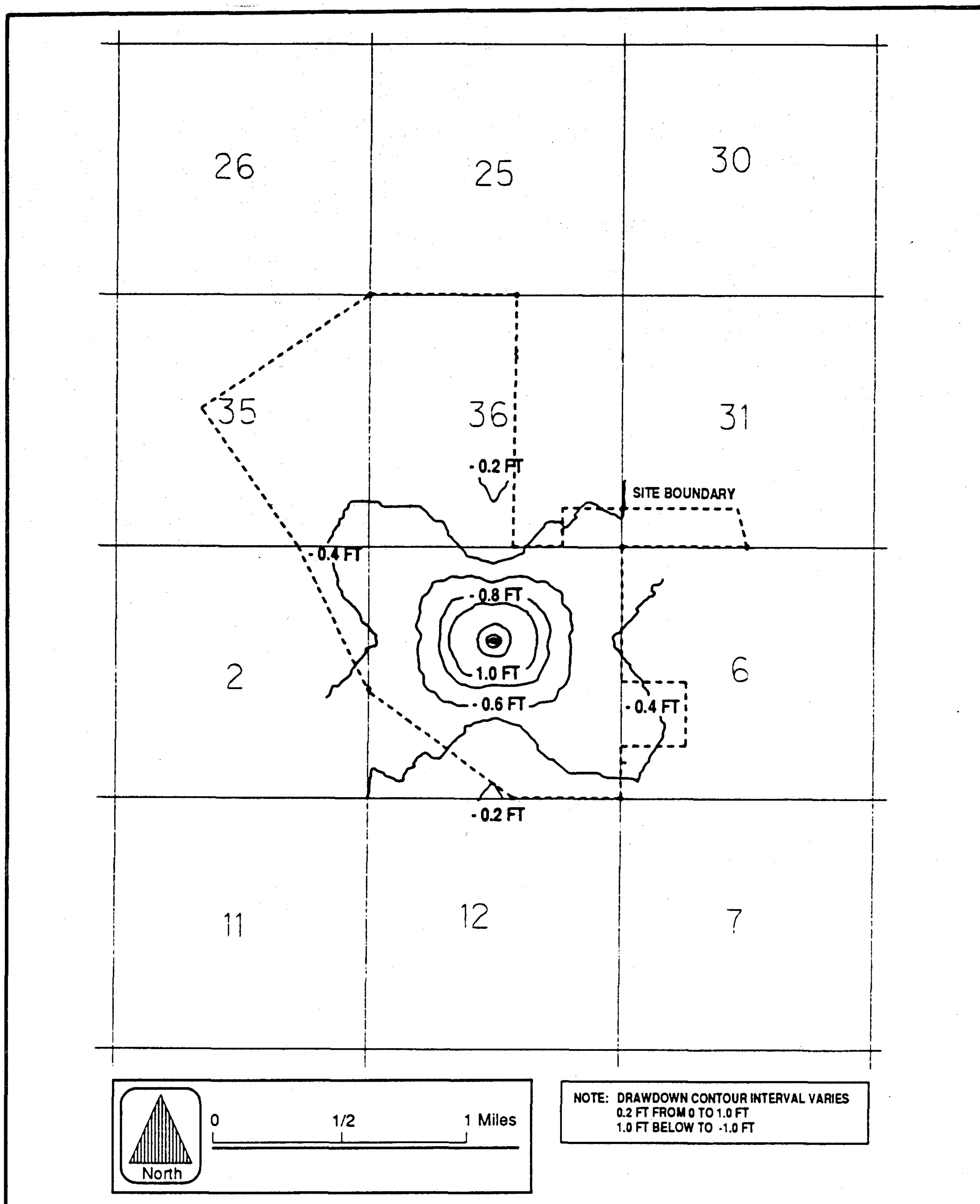

Figure 5.3.2-1 PREDICTED GROUNDWATER DRAWDOWN

Hardee Power Station

cone of drawdown does not impact the domestic water supply wells of adjacent property owners.

5.3.4 Leachate and Runoff

The plant site drainage and stormwater system will be designed to meet all applicable Southwest Florida Water Management District and Florida Department of Environmental Regulation stormwater quantity and quality control requirements. Given the site topography, plant runoff will be discharged, after treatment, to Payne Creek. Details regarding this stormwater system design are presented in Appendix 11.5.6.

Given the anticipated fuels (i.e., gas or oil), no fuel related stormwaters (e.g., coal pile runoff) are anticipated. Discharge of treated stormwater will have no adverse impacts on downstream water quality.

There are no sources of leachate on the proposed plant site.

5.3.5 Measurement Programs

5.3.5.1 Assessment Methodology - Surface Water

Methodologies used to determine the impacts are discussed in detail in Section 5.3.1.

5.3.5.2 Physical Chemical Monitoring

See Section 5.2.3.2.

5.4 SOLID/HAZARDOUS WASTE DISPOSAL IMPACTS

5.4.1 Solid Waste

Because of the type of fuels (e.g., natural gas and fuel oil) for the Hardee Power Station, only small quantities of solid wastes will be generated at the plant (see Section 3.7.1). Solid wastes will be limited to general trash, sanitary waste treatment sludge, and infrequent replacement of demineralized resins. The sanitary waste sludge will be disposed of off site by a contractor. Other wastes will be disposed of by a trash disposal contractor to an available sanitary landfill. There will be no on site disposal of solid wastes. Because of the small quantities of wastes generated no significant impacts to existing landfill space are predicted.

5.4.2 Hazardous Wastes

The only potential hazardous wastes generated by the operation of the Hardee Power Station are waste streams produced during regeneration of the demineralizers (see Section 3.7.2). These waste streams will be neutralized in a neutralization basin and become non-hazardous.

Acid cleaning wastes (see Section 3.6.5) will either be disposed of off site at a licensed facility or neutralized in a portable treatment system prior to routing the wastewater to the cooling reservoir.

No on or offsite impacts will result from the wastes generated by the operation of the facility.

5.5 SANITARY AND OTHER WASTE DISCHARGES

As previously discussed in Sections 3.6.3 and 5.2.1, sanitary wastewaters will be treated and discharged to the cooling reservoir for dilution and reuse in the cooling system. Sanitary wastewaters will be treated in a sewage treatment plant, thus accomplishing secondary treatment. All effluent will be chlorinated prior to discharge to the cooling reservoir.

No adverse cooling reservoir or offsite water quality impacts due to sanitary wastewater discharges are anticipated; details regarding cooling reservoir water quality and receiving water impacts are presented in Section 5.2.

No other wastewater discharges are anticipated.

5.6 AIR QUALITY IMPACTS

5.6.1 Impact Assessment

5.6.1.1 Analysis Approach and Assumptions

GENERAL MODELING APPROACH

The general modeling approach followed USEPA and FDER modeling guidelines for determining compliance with AAQS and PSD increments. In general, when model predictions are used to determine compliance with AAQS and PSD increments, current policies stipulate that the highest annual average and highest, second-highest short-term (i.e., 24-hours or less) concentrations can be compared to the applicable standard when 5 years of meteorological data are used. The highest, second-highest concentration is calculated for a receptor field by:

1. Eliminating the highest concentration predicted at each receptor,
2. Identifying the second-highest concentration at each receptor, and
3. Selecting the highest concentration among these second-highest concentrations.

This approach is consistent with the air quality standards, which permit a short-term average concentration to be exceeded once per year at each receptor.

To develop the maximum short-term concentrations for the proposed facility, the general modeling approach was divided into screening and refined phases to reduce the computation time required to perform the modeling analysis. The basic difference between the two phases is the receptor grid used when predicting concentrations, the number of emission points, and the number of meteorological periods evaluated. In general, concentrations for the screening phase were predicted using a coarse receptor grid, limited number of major sources, and a 5-year meteorological record.

After a final list of highest, second-highest short-term concentrations was developed, the refined phase of the analysis was conducted by predicting concentrations for a refined receptor grid centered on the receptor at which the highest, second-highest concentration from the screening phase was produced. The air dispersion model was executed for the meteorological periods during which both the highest and second-highest concentrations were predicted to occur at that receptor, based on the screening phase results. This approach was used to ensure that valid highest, second-highest concentrations were obtained. Descriptions of the emission inventory and receptor grids used in the screening and refined phases of the analysis are presented in the following sections with detailed discussions given in the PSD Permit Application.

MODEL SELECTION

The selection of a model was based on its applicability to simulate impacts in areas surrounding the proposed facility. Within 3.0 km of the proposed facility, the terrain can be described as simple, i.e., flat to gently rolling. As defined in the USEPA modeling guidelines, simple terrain is considered to be an area where the terrain features are all lower in elevation than the top of the stack(s) under evaluation. Beyond 3.0 km and within 50 km of the proposed facility's site, the terrain has maximum elevations of 15 m (50 ft) above ground elevation at the facility. These areas are also considered to be simple since the stacks being modeled are greater than the terrain elevation. Therefore, a simple terrain model was used to predict maximum ground-level concentrations.

The Industrial Source Complex Short Term (ISCST) dispersion model (USEPA, 1988a) was used to evaluate the pollutant emissions from proposed facility and existing major facilities. This model is contained in USEPA's User's Network for Applied Modeling of Air Pollution (UNAMAP), Version 6 (USEPA, 1988b). The ISCST model is applicable to sources located in either flat or rolling terrain where terrain heights do not exceed stack heights. Major features of the ISCST model are presented in Table 5.6.1-1.

The ISCST model has rural and urban options which affect the wind speed profile exponent law, dispersion rates, and mixing-height formulations used in calculating ground level concentrations. The criteria used to determine when the rural or urban mode is appropriate are based on land use near the

Table 5.6.1-1. Major Features of the ISCST Model

ISCST Model Features
o Polar or Cartesian coordinate systems for receptor locations
o Rural or one of three urban options which affect wind speed profile exponent, dispersion rates, and mixing height calculations
o Plume rise due to momentum and buoyancy as a function of downwind distance for stack emissions (Briggs, 1969, 1971, 1972, and 1975)
o Procedures suggested by Huber and Snyder (1976); Huber (1977); and Schulmann and Hanna (1986) and Schulmann and Scire (1980) for evaluating building wake effects
o Procedures suggested by Briggs (1974) for evaluating stack-tip downwash
o Separation of multiple point sources
o Consideration of the effects of gravitational settling and dry deposition on ambient particulate concentrations
o Capability of simulating point, line, volume and area sources
o Capability to calculate dry deposition
o Variation with height of wind speed (wind speed-profile exponent law)
o Concentration estimates for 1-hour to annual average
o Terrain-adjustment procedures for elevated terrain including a terrain truncation algorithm
o Receptors located above local terrain, i.e., "flagpole" receptors
o Consideration of time-dependent exponential decay of pollutants
o The method of Pasquill (1976) to account for buoyancy-induced dispersion
o A regulatory default option to set various model options and parameters to EPA recommended values (see text for regulatory options used)
o Procedure for calm-wind processing

Source: USEPA, 1988a

proposed plant's surroundings (Auer, 1978). If the land use is classified as heavy industrial, light-moderate industrial, commercial, or compact residential for more than 50% of the area within a 3 km radius circle centered on the proposed source, the urban option should be selected. Otherwise, the rural option is more appropriate. Based on a review of the land use around the facility and discussions with the FDER, the rural mode was selected because of the lack of residential, industrial and commercial development within 3 km the proposed facility site.

In this analysis, the USEPA regulatory options were used to address maximum impacts. These options included:

1. Final plume rise at all receptor locations,
2. Stack-tip downwash,
3. Buoyancy-induced dispersion,
4. Default wind speed profile coefficients for rural or urban option,
5. Default vertical potential temperature gradients, and
6. Calm wind processing.

METEOROLOGICAL DATA

Meteorological data used in the ISCST model to determine air quality impacts consisted of a concurrent 5-year period of hourly surface weather observations and twice-daily upper air soundings from the National Weather Service (NWS) stations at Tampa International Airport and Ruskin, respectively. The 5-year period of meteorological data was from 1982 through 1986.

The NWS station in Tampa, located approximately 67 km to the west-northwest of the proposed site, was selected for use in the study because it is the closest primary weather station to the study area with similar surrounding topographical feature. In addition, FDER requested the use of these meteorological data. This station also has the most readily available and complete database which is representative of the plant site. Descriptions of the meteorological data collected at this station are presented in

Section 2.3.7 with method used to process the data discussed in the PSD Permit Application.

EMISSION INVENTORY

Preliminary modeling indicated that the proposed facility's impacts could be above the significant impact levels for SO_2, NO_2 and PM at distances of approximately 50, 50, and 10 km, respectively, from the facility. Therefore, the emission inventories for those pollutants were developed from available databases, such as FDER's Air Pollution Inventory System (APIS) and previous studies performed by KBN. A detailed discussion about the development of the emission inventory is presented in the PSD Permit Application.

In order to reduce the model computation time but effectively model sources that are most likely to interact with the proposed facility, modeling was performed in screening and refined phases. In the screening phase, only those sources with emissions above a certain threshold, based on the source's distance from the proposed facility, were modeled.

Summaries of the amount of modeled emissions in the screening phase compared to the refined phase by distance categories from the proposed facility are given in Tables 5.6.1-2 through 5.6.1-4. For the SO_2 modeling analysis, approximately 98% of the SO_2 emissions in the refined phase were modeled in the screening phase. As indicated, most of the emissions occur beyond 30 km from the proposed facility.

For the NO_2 modeling analysis, approximately 98% of the NO_2 emissions in the refined analysis were modeled in the screening phase. Similar to the SO_2 emission sources, most of the NO_2 emissions occur beyond 30 km from the proposed facility.

For the PM modeling analysis, approximately 75% of the PM emissions were modeled in the screening phase. There were no emission sources within 10 km

Table 5.6.1-2. Summary of Modeled SO_2 Emissions Used for Screening and Refined Analyses for the Hardee Power Station

Distance From Proposed Site (km)	Threshold Emissions (TPY)	Refined Analysis	Screening Analysis	
		Emissions (TPY)	Emissions (TPY)	Percent Modeled of Refined Analysis
0 - 15	> 500	6,005	5,730	95.4
15 - 20	> 1000	5,216	4,647	89.1
20 - 25	> 1500	15,876	13,943	87.8
25 - 30	> 2000	21,025	16,629	79.1
30 - 50	> 3000	501,286	499,711	99.7
0 - 50		549,408	540,660	98.4

Table 5.6.1-3. Summary of Modeled NO_2 Emissions Used for Screening and Refined Analyses for the Hardee Power Station

Distance From Proposed Site (km)	Threshold Emissions (TPY)	Refined Analysis	Screening Analysis	
		Emissions (TPY)	Emissions (TPY)	Percent Modeled of Refined Analysis
0 - 15	> 500	0	0	--
15 - 20	> 1000	610	0	0.0
20 - 25	> 1500	0	0	--
25 - 30	> 2000	0	0	--
30 - 50	> 3000	111,768	110,386	98.8
0 - 50		112,378	110,386	98.2

Table 5.6.1-4. Summary of Modeled PM Emissions Used for Screening and Refined Analyses for the Hardee Power Station

Distance From Proposed Site (km)	Threshold Emissions (TPY)	Refined Analysis	Screening Analysis	
		Emissions (TPY)	Emissions (TPY)	Percent Modeled of Refined Analysis
0 - 15	> 500	1,705	1,705	100.0
15 - 20	> 1000	1,550	0	0.0
20 - 25	> 1500	3,136	0	0.0
25 - 30	> 2000	3,875	0	0.0
30 - 50	> 3000	32,295	29,982	92.8
0 - 50		42,561	31,687	74.5

of the proposed facility (the significant impact distance) with most emissions occurring beyond 30 km from the proposed facility.

RECEPTOR LOCATIONS

As discussed in Section 5.6.1.1, the general modeling approach considered screening and refined phases to address compliance with maximum allowable PSD Class II increments and AAQS. In the ISCST modeling, concentrations were predicted for the screening phase using several receptor grids. The locations of the receptors were based on identifying the areas in which maximum concentrations would be expected due to the proposed unit. A total of 344 receptors were located in a radial grid centered on the proposed facility. The grid extended from the plant property out to 6.0 km from the plant site. The specific location of each receptor is presented in the PSD Permit Application.

After the screening modeling was completed, refined short-term modeling was conducted using a receptor grid centered on the receptor which had the highest, second-highest short-term concentrations. The receptors were located at intervals of 100 m between the distances considered in the screening phase along 9 radials, at 2 degree increments, centered on the radial which the maximum concentration was produced.

To ensure that a valid highest, second-highest concentration was calculated, concentrations were predicted for the refined grid for the periods that produced both the highest and second-highest concentration from the screening receptor grid.

Refined modeling analysis was performed for the annual average period but used a different approach than that used for short-term average periods. Because the spatial distributions of annual average concentrations are not expected to vary significantly from those produced from the screening analysis, concentrations were calculated at the receptor which produced the highest annual concentration in the screening analysis. For this analysis, concentrations were calculated for the entire year using the refined emission inventory.

BACKGROUND CONCENTRATIONS

To estimate total air quality concentrations, a background concentration must be added to the modeling results. The background concentration is considered to be the air quality concentration contributed by sources not included in the modeling evaluation.

The background concentrations for the modeling analysis were presented in Section 2.3.7.2. Based on this analysis, the background 3-, 24-hour, and annual average SO_2 concentrations are assumed to be 267, 51, and 11 ug/m^3, respectively. For NO_2 concentrations, the annual average background concentration is assumed to be 45 ug/m^3. For PM concentrations, the background 24-hour and annual average concentrations are assumed to be 91 and 45 ug/m^3, respectively. These background levels were added to model-predicted concentrations to estimate total air quality levels for comparison to AAQS.

BUILDING DOWNWASH CONSIDERATIONS

Based on the building dimensions associated with buildings or structures at the proposed facility, the stack for the proposed unit will be less than GEP. Therefore, the potential for building downwash to occur must be considered in the modeling analysis.

The procedures used for addressing the effects of building downwash are those recommended in the ISC Dispersion Model User's Guide. The building height, length, and width are input to the model which are used to modify the dispersion parameters.

The building dimensions considered for the proposed facility are presented in Table 5.6.1-5. In these analyses, building downwash conditions were assumed to occur for all directions around each stack although these conditions may not occur for certain directions. Based on sensitivity

Table 5.6.1-5. Structure Dimensions* and GEP Stack Height Calculations* for the Hardee Power Station

Structure	Building Dimensions (ft) Height	Length	Width	Maximum Projected Width	GEP Stack Height
HRSG*	45	50	25	56	113
Combustion Turbine Enclosure**	40	1175	75	1178	100

Note: These structure dimensions produced the worst case impacts for an HRSG stack height of 75 feet.

* Used in modeling analyses.

** Based on a single structure that encloses all the combustion turbines associated with a 660 MW plant.

analyses performed for the proposed facility, higher concentrations were produced with the building dimension using a height of 45 ft which also produced the highest GEP height. Therefore, the building dimensions associated with this height were used in performing subsequent model calculations.

5.6.1.2 Model Results

PROPOSED FACILITY ONLY

For the screening modeling analysis, a summary of the maximum SO_2, NO_2, PM, CO, Be, and Hg concentrations due to the proposed facility is presented in Table 5.6.1-6. These results are presented for a range of operating conditions that could produce high impacts by modeling each unit with the maximum emission rate or minimum flow rate. The conditions were as follows:

1. Case 1: Maximum emissions at 0°C (32°F);
2. Case 2: Maximum emissions at 35°C (95°F);
3. Case 3: Minimum flow rate at 0°C (32°F);
4. Case 4: Minimum flow rate at 35°C (95°F).

As indicated in Table 5.6.1-6, the concentrations are predicted for the operating conditions with minimum flow rates (Cases 3 and 4). It should be noted that the modeled SO_2 emissions were specific for each case because the maximum predicted impacts were relatively high when compared to the PSD Class II increments. For the other pollutants, the emissions from Case 1, which had the highest emissions among the cases, were modeled for all four cases. Therefore, for pollutants other than SO_2 the maximum impacts predicted for Cases 2 through 4 are conservative because lower impacts would be predicted if the true emissions associated with each case were modeled.

The maximum predicted 3-, 24-hour and annual SO_2 concentrations are 424, 62.5 and 6.7 ug/m^3, respectively. The maximum 24-hour concentration is above the de minimis monitoring level and, therefore, preconstruction monitoring data are required to be submitted by the Applicant as part of the permit application. As indicated in Section 2.3.7.2, existing monitoring

Table 5.6.1-6. Maximum Concentrations Predicted for the Combined Cycle Plant (660 MW) for 4 Operating Designs in the Screening Modeling Analysis

Pollutant	Averaging Period	Maximum Concentrations (ug/m^3)				Air Quality Requirements (ug/m^3)	
		Maximum Emissions		Minimum Flow Rate		De Minimis Levels	PSD Class II Increment
		32°F Case 1	95°F Case 2	32°F Case 3	95°F Case 4		
SO_2	3-hour	196	281	359	424	NA	512
	24-hour	54.7	53.8	62.5	60.0	13	91
	Annual	5.8	5.7	6.7	6.5	NA	20
PM(TSP)	24-hour	5.1	5.9	6.4	7.5	10	37
	Annual	0.54	0.63	0.68	0.82	NA	19
PM(PM10)	24-hour	5.1	5.9	6.4	7.5	10	NA
	Annual	0.54	0.63	0.68	0.82	NA	NA
NO2	Annual	2.9	3.3	3.6	4.3	14	25
CO	1-hour	99.0	112.0	130.3	178.5	NA	NA
	8-hour	21.4	24.2	26.1	38.0	575	NA
Be	24-hour	0.0002	0.0003	0.0003	0.0004	0.001	NA
Hg	24-hour	0.0011	0.0012	0.0013	0.0016	0.25	NA

NA = Not applicable

* Modeled as 3 stacks, each separated by 100 m.

data collected by the FDER are being used in this application to satisfy preconstruction monitoring requirements and to establish background concentrations.

The maximum predicted 24-hour and annual average PM concentrations are 7.5 and 0.82 ug/m^3, respectively. Because the maximum 24-hour concentration is below the de minimis monitoring level, preconstruction monitoring is not required for the permit application.

The maximum predicted annual NO_2 concentration is 4.6 ug/m^3, which is below the de minimis monitoring level. Similar to the PM concentrations, preconstruction monitoring requirements is not required for the permit application.

The maximum predicted 1- and 8-hour average CO concentrations are 179 and 38.0 ug/m^3, respectively, which are less than the significance levels. The maximum 8-hour concentration is also less than the de minimis monitoring levels and, therefore, preconstruction monitoring is not required. Because the maximum predicted impacts due to the proposed facility are less than the CO significance levels, additional modeling is not required for this pollutant.

The maximum predicted 24-hour average Be and Hg concentrations are 0.0004 and 0.0016 ug/m^3, respectively, which are less than the de minimis monitoring levels. Therefore, preconstruction monitoring is not required for these pollutants.

PSD CLASS II INCREMENT CONSUMPTION

For the refined modeling analysis, summaries of the maximum SO_2, PM, and NO_2 concentrations predicted for comparison to the PSD Class II increments are presented in Table 5.6.1-7. These results show that maximum concentrations due to all PSD sources are less than the maximum allowable PSD Class II increments for all averaging periods and pollutants.

Table 5.6.1-7. Maximum Predicted SO_2, PM, and NO_2 Concentrations for Comparison to PSD Class II Increments

Averaging Period	Maximum Concentration (ug/m^3)	PSD Class II Increment (ug/m^3)
SO_2 Concentrations		
3-Hour*	424	512+
24-Hour*	66.0	91+
Annual	81.0	20
PM (TSP) Concentrations		
24-Hour*	8.0	37+
Annual	0.9	19
NO_2 Concentrations		
Annual	4.6	25

* Highest, second-highest concentrations predicted for this averaging period.

\+ Not to be exceeded more than once per year.

The maximum 3-hour average SO_2 PSD increment consumption from the refined analysis is predicted to be 424 ug/m^3, which is 83% of the maximum allowable PSD Class II increment of 512 ug/m^3, not to be exceeded more than once per year.

The maximum 24-hour average SO_2 PSD increment consumption from the refined analysis is predicted to be 66.0 ug/m^3, which is 73% of the maximum allowable PSD Class II increment of 91 ug/m^3, not to be exceeded more than once per year.

The maximum annual average SO_2 PSD increment consumption from the refined analysis is predicted to be 8.1 ug/m^3, which is 41% of the maximum allowable PSD Class II increment of 20 ug/m^3.

The maximum 24-hour average TSP PSD increment consumption from the refined analysis is predicted to be 8.0 ug/m^3, which is 22% of the maximum allowable PSD Class II increment of 37 ug/m^3, not to be exceeded more than once per year.

The maximum annual average TSP PSD increment consumption from the refined analysis is predicted to be 0.9 ug/m^3, which is 6% of the maximum allowable PSD Class II increment of 19 ug/m^3.

The maximum annual average NO_2 PSD increment consumption from the refined analysis is predicted to be 4.6 ug/m^3, which is 17% of the maximum allowable PSD Class II increment of 25 ug/m^3.

TOTAL AIR QUALITY IMPACT

For the refined modeling analysis, summaries of the maximum total SO_2, PM, and NO_2 concentrations predicted for comparison to the AAQS are presented in Table 5.6.1-8.

Table 5.6.1-8. Maximum Predicted SO_2, PM and NO_2 Concentrations from the Hardee Power Station for Comparison to AAQS

Averaging	Maximum Concentration (ug/m^3)	AAQS (ug/m^3)
<u>SO_2 Concentrations</u>		
3-Hour*	691	1300+
24-Hour*	169	260+
Annual	30.3	60
*<u>PM (TSP) Concentrations</u>		
24-Hour*	112	150+
Annual	48.6	50
*<u>NO_2 Concentrations</u>		
Annual	50.6	100

* Highest, second-highest concentration for this average period.

+ Not to be exceeded more than once per year.

The total concentrations are determined from the impacts of the modeled sources added to the background concentration determined from monitoring data. These results show that the maximum SO_2, PM, and NO_2 concentrations due to all sources are below the AAQS for all averaging periods.

The maximum 3-hour average SO_2 concentration due to all sources from the refined analysis is predicted to be 691 ug/m^3, which is 53% of the AAQS of 1300 ug/m^3, not to be exceeded more than once per year. The proposed facility contributed 61% to this maximum 3-hour average concentration.

The maximum 24-hour average SO2 concentration due to all sources is predicted to be 169 ug/m^3, which is 65% of the AAQS of 260 ug/m^3, not to be exceeded more than once per year. The proposed facility contributed 29% to this maximum 24-hour concentration.

The maximum annual average SO_2 concentration due to all sources is predicted to be 30.3 ug/m^3, which is 51% of the AAQS of 60 ug/m^3. The proposed facility contributed 20% to the maximum concentration.

The maximum 24-hour PM concentration due to all sources is predicted to be 112 ug/m^3, which is 75% of the AAQS of 150 ug/m^3. The proposed facility did not contribute to this maximum concentration.

The maximum annual average concentration due to all sources is predicted to be 48.6 ug/m^3, which is 97% of the AAQS of 50 ug/m^3. The proposed facility contributed less than 2% to the maximum concentration.

The maximum annual average NO_2 concentrations of 50.9 ug/m^3 due to all sources is below the AAQS of 100 ug/m^3. The proposed facility contributed approximately 8.4% to the maximum concentration.

5.6.1.3. Additional Impact Analysis

SOILS

Soils in the site region have been disrupted and altered by phosphate mining. They were originally sandy, siliceous hyperthermic Haploquods with very strongly acid subsoils. The undisturbed soils of the Payne Creek floodplain formed in unconsolidated loamy textured sediment influenced by calcareous material (Robbins, et al., 1984). They are coarse-loamy siliceous, hyperthermic Typic Ochraqualfs.

SO_2 and NO_2 that reach the soil by deposition from the air are converted by physical and biotic processes to sulfates and nitrates. (CO, particulates, and metals have no affect on soils at the levels predicted.) The effects can be beneficial to plants if either sulfates or nitrates in native soils are less than plant requirements for optimum growth. However, sulfates and nitrates can also increase acidity of unbuffered soils, causing adverse effects due to changes in nutrient availability and cycling. The predicted concentrations of SO_2 and NO_2 from stack emissions are not expected to have a significant adverse affect on soils in the vicinity because (1) the predicted concentrations of both gases are low, (2) Payne Creek floodplain and other wetland soils contain organic matter and/or calcium carbonate nodules that buffer changes in acidity, and (3) ground limestone will be applied to lands being reclaimed for pasture and citrus. Therefore, the facility is not expected to have a significant adverse impact on regional vegetation or soils.

VEGETATION AND WILDLIFE

The response of vegetation and wildlife to atmospheric pollutants is influenced by the concentration of the pollutant, duration of the exposure and the frequency of exposures. The pattern of pollutant exposure expected from the facility is that of a few episodes of relatively high ground-level concentration which occur during certain meteorological conditions interspersed with long periods of extremely low ground-level concentrations. If there are any effects of stack emissions on plants and animals they will be from the short-term, higher doses. A dose is the product of the concentration of the pollutant and the duration of the exposure. The impact of the Hardee Power Station on regional vegetation and wildlife was assessed by comparing pollutant doses that are predicted from modeling with threshold doses reported from the scientific literature which could adversely affect plant or animal species typical of those present in the region.

Sulfur Dioxide--The maximum total 3-hour average SO_2 concentration predicted in the Hardee Power Station region is 691 ug/m^3. This concentration is predicted to occur about 0.5 km (0.24 miles) north of the stacks and represents the concentration that would occur during the worst-case meteorological conditions of the past five years (see Chapter 7.0). The maximum 3-hour average ground-level concentration predicted for the other four years ranged from 579 to 634 ug/m^3. These concentrations would occur between one and six km (0.6 to 3.7 miles) from the stacks with directions ranging from north to east-southeast. Concentrations decrease with distance beyond the location of the maximum concentration.

The maximum total predicted 24-hour average SO_2 concentration is 169 ug/m^3 and is located approximately 2 km (1.24 miles) east-southeast of the stacks. The maximum total predicated annual SO_2 concentration is 30.3 ug/m^3. This concentration is predicted to occur 1.75 km (1.1 miles) to the east of the stacks.

These concentrations and averaging times can be compared with SO_2 doses known to adversely affect plant and animal species (Tables 5.6.1-9 and 5.6.1-10). The expected doses from operation of the Hardee Power Station combined with background sources are much lower than doses known to cause a detrimental effect on vegetation and wildlife.

Nitrogen Oxides--The maximum predicted 3-hour, 24-hour and annual average NO_2 concentrations due to the Hardee Power Station are predicted to be 297, 42 and 4.6 ug/m^3, respectively. The maximum total predicted annual average concentrations due to all sources is 50.9 ug/m^3 which includes a background concentration of 45 ug/m^3 derived from monitoring data in Bartow. The NO_2

Table 5.6.1-9. SO_2 and NO_2 Doses Reported to Affect Plant Species Similar to Vegetation in the Region of the Hardee Power Plant

Pollutant	Species	Dose and Effect	Reference
SO_2	Strawberry	1,040 ug/m^3 for 6 hours per day for 3 days had no affect on growth	Rajput, et al., 1977
SO_2	Citrus	2,080 ug/m^3 for 23 days with 10 day interruption reduced leaf area	Matsushima and Brewer, 1972
SO_2	Ryegrass	42 ug/m^3 for 26 weeks or 367 ug/m^3 for 131 days reduced dry weight	Bell, et al., 1979 Ayazaloo and Bell, 1981
SO_2	Tomato	1,258 ug/m^3 for 5 hours per day, for 57 days, reduced growth	Kohut, et al., 1983
SO_2	Duckweed	390 ug/m^3 for 6 weeks reduced growth	Fankhauser, et al., 1976
SO_2	Lichens (Parmotrema and Ramalina spp.)	400 ug/m^3 6 hours per week for 10 weeks reduced CO_2 uptake and biomass gain of Ramalina, not Parmotrema	Hart, et al., 1988
SO_2	Bald Cypress	1,300 and 2,600 ug/m^3 for 48 hours. Only 2600 ug/m^3 reduced leaf area.	Shanklin and Kozlowski, 1985
SO_2	Green Ash	210 ug/m^3 for 4 hours per day, 5 days per week for 6 weeks reduced growth	Chappelka, et al., 1988
NO_2	Ryegrass	39.5 ug/m^3 for 6 minutes had no affect on shoot weight	Lane and Bell, 1984
NO_2	Citrus	470 ug/m^3 for 290 days injured trees	Thompson, et al., 1970
NO_2	Sphagnum	11.7 ug/m^3 averaged over 18 months compared with control of 4.8 ug/m^3 (exceeded 15 ug/m^3 4 times) reduced growth	Press, et al., 1986

Table 5.6.1-10. Examples of Lowest Observed Effect Levels of Air Pollutants Adapted from Newman (1981) and Newman and Schreiber (1988)

Pollutant	Reported Effect	Concentration (ug/m^3)	Exposure
Sulfur Dioxide	respiratory stress in guinea pigs	427 to 854	1 hour
	respiratory stress in rats	267	7 hours/day;* 5 day/week for 10 weeks
	decreased abundance in deer mice	13-157	continually** for 5 months
Nitrogen Dioxide	respiratory stress in mice	1,917	3 hours
	respiratory stress in guinea pigs	95 to 950 ug/m^3	8 hr/day for* 122 days

* Used to compare as a range between 3-hour and 24-hour averaging times.

** Used to compare with annual averaging times.

doses known to adversely affect some plant and animal species that have been tested are shown in Tables 5.6.1-9 and 5.6.1-10. The predicted doses of NO_2 due to the proposed facility are far lower than the doses reported to injure vegetation and animals; therefore, the proposed facility's NO_2 emissions are not expected to have an adverse affect on vegetation and wildlife.

Total Suspended Particulates--The maximum total 24-hour and annual average concentrations are predicted to be 112 and 48.6 ug/m^3, respectively. These concentrations are predicted to occur between 1.75 to 6 km from the stacks. High deposition of particulates on plant leaves can reduce photosynthesis through shading and impede diffusion of gases. However, at least 5 g/m^2 leaf surface of particulates are required to cause these impacts (Thompson, et al., 1984). This concentration is not expected due to the maximum predicted impacts from the Hardee Power Station. Predicted particulate levels are lower than reported effects levels in animals (Newman, 1975).

Carbon Monoxide--The maximum predicted 1-hour and 8-hour average CO concentrations due to the facility are 179 and 38 ug/m^3, respectively. Soil microorganisms can use carbon monoxide as a carbon source and are a major sink for this pollutant (Bennett and Hill, 1975). Plants are not known to be injured by CO. No adverse impacts to vegetation are expected from CO emissions from the Hardee Power Station. Predicted carbon monoxide levels are lower than levels known to affect animals (Newman, 1975).

Beryllium--The maximum 24-hour average Be concentration due to the proposed facility is predicted to be 0.0004 ug/m^3. Levels of Be greater than 2 ug/g in nutrient solution have been found to reduce growth of experimental plants (Gough, et al., 1979). Therefore, the low levels of Be predicted from plant operation are not expected to adversely affect vegetation. Inhalation of levels of Be greater than 35 ug/m^3 for 6 months produced respiratory changes in rats. These levels are significantly greater than predicted values, therefore no effects are predicted to occur (Newman, 1975).

Mercury--The maximum 24-hour average Hg concentration due to the proposed facility is predicted to be 0.0016 ug/m^3. Siegle, et al., (1984) reported that 7 days of exposure to 50 ug/m^3 Hg vapor resulted in massive leaf abscission in 15 plant species and cultivars. This dose is orders of magnitude higher than the dose expected from operation of the Hardee Power Station. Therefore, the predicted Hg concentrations due to the proposed facility are not expected to adversely affect vegetation. Predicted mercury levels are significantly lower than reported effects levels in animals (Newman, 1975).

5.7 NOISE IMPACTS

5.7.1 Impacts to Adjacent Properties

The noise monitoring data collected during the on-site field sampling effort were utilized in the noise impact analysis at the proposed property boundaries. The impact analysis was performed using NOISECALC (NYDPS, 1986), a sound propagation computer program. (See Appendix 11.7 for a brief discussion of NOISECALC's modeling criteria and data output.)

The USEPA, has developed indoor and outdoor noise level criteria for various land use categories that were promulgated as a guideline for protecting public health and welfare (Table 5.7.1-1). These criteria are related to short-term sound pressure level (SPL) measurement periods, i.e., 24-hour equivalent SPL [L_{eq} (24)] and Day-Night average SPL (L_{dn}). The L_{eq} is the equivalent constant SPL that would be equal in sound energy to the varying SPL over the same period of time. The L_{dn} is the 24-hour average SPL calculated for the two daily time periods, i.e., day and night, with a 10 dBA weighing added to the nighttime SPL. The equation for L_{dn} is:

$$L_{dn} = 10 \log 1/24 \left[15 \times 10^{(Ld/10)} + 9 \times 10^{[(Ln + 10)/10)]}\right]$$

where: L_d = daytime L_{eq} for the period from 0700 to 2200 hours

L_n = nighttime L_{eq} for the period from 2200 to 0700 hours.

The USEPA recommends an outdoor $L_{eq}(24)$ of 70 dBA for general unpopulated lands and an outdoor L_{dn} of 55 dBA for residential areas. As stated

Table 5.7.1-1. USEPA Recommended Noise Criteria

		Indoor			Outdoor		
	Measure+	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects (b)
Residential with Outside Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq}(24)$		70			70	
Residential with no Outside Space	L_{dn}	45	45				
	$L_{eq}(24)$		70				
Commercial	$L_{eq}(24)$	(a)	70	70(c)	(a)	70	70(c)
Inside Transportation	$L_{eq}(24)$	(a)	70	(a)			
Industrial	$L_{eq}(24)$(d)	(a)	70	70(c)	(a)	70	70(c)
Hospitals	L_{dn}	45		45	55		55
	$L_{eq}(24)$		70			70	
Educational	$L_{eq}(24)$	45		45	55		55
	$L_{eq}(24)$(d)		70			70	
Recreational Areas	$L_{eq}(24)$	(a)	70	70(c)	(a)	70	70(c)
Farm Land and General Unpopulated Land	$L_{eq}(24)$				(a)	70	70(c)

Code:

a. Since different types of activities appear to be associated with different levels, identification of a maximum level for activity interference may be difficult except in those circumstances where speech communications is a critical activity.

b. Based on lowest level.

c. Based only on hearing loss.

d. An $L_{eq(8)}$ of 75 dB may be identified in these situations so long as the exposure over the remaining 16 hours per day is low enough to result in a negligible contribution to the 24-hour average, i.e., no greater than an L_{eq} of 60 dB.

\+ L_{dn} = Day-night average A-weighted equivalent sound level, with a 10-decibel weighting applied to night time levels.

L_{eq} (24) = Equivalent A-weighted sound level over 24 hours.

Source: EPA, 1974

earlier (see Section 2.3.8), neither Polk County nor Hardee County has a noise ordinance for receiving lands.

Table 5.7.1-2 presents the proposed facility's octave band input data, based upon preliminary engineering design information, that was used in the NOISECALC program. The program calculated SPLs due to the proposed facility, utilizing the on-site background and minimum L_{eq}s noise levels, (Tables 5.7.1-3 and 5.7.1-4, respectively). As indicated, the maximum calculated SPL impact with the background levels taken into account was 67.9 dBA at Site 4 for background L_{eq} and 67.5 dBA at Site 4 for minimum background. The minimum predicted SPL impacts occurred at Site 6 (residences) with a value of 43.9 dBA for minimum background and at Site 3 with 49.2 dBA for L_{eq} background.

The overall predicted noise impacts of the proposed facility at the property boundary are calculated to be less than 3 dBA above ambient background levels as indicated at Sites 1 and 2. Since attenuation factors, such as ground cover, foliage, etc., were not used in determining the noise impacts, the actual impact of the proposed facility at the property boundary may be well below 3 dBA above background. The data confirms that the proposed facility's noise impact would be unmeasureable at the property boundary due to the fact that the SPL of the proposed facility (including background) is within 4 dBA of the ambient background noise levels.

5.7.2 Impact to Biota

The projected noise from plant operation will not have any affect on surrounding biota. No sensitive wildlife communities, i.e., rookeries, occur within 1.6 km (1 mile) of the plant. Wildlife species in the area have been exposed to similar noise conditions from mining and other industrial activities in this region for years.

Table 5.7.1-2. Sound Power Levels of Dominant Sources for Each Combined Cycle Unit

Source Type*	Sound Pressure Levels (dB)	Octave Band Center Frequency, Hz								
		31.5	63	125	250	500	1K	2K	4K	8K
Combustion Turbine (2 ea)	136	135	128	118	111	108	102	99	93	90
Steam Turbine	120	111	117	115	110	106	102	99	91	85
Boiler Feed Pumps	105	93	95	97	97	97	97	97	94	87
Air Compressor	109	98	94	99	98	96	99	104	101	94
Total for Combined Cycle (1 ea)	136	135	128	120	114	110	107	107	103	96

* Based upon preliminary engineering design information

Table 5.7.1-3. Impact Results Using Average Leq Background Values [All values dBA]

Site	Description	Background*	Proposed Facility w/o Background	Proposed Facility W/ Background
1	Northeast Boundary of Proposed Facility	49.4	49.4	52.4
2	Southeast Boundary of Proposed Facility	43.3	53.5	53.9
3	Southsoutheast of Proposed Facility	41.9	48.4	49.2
4	Southwest of Proposed Facility (Adjacent to)	58.0	67.4	67.9
5	Southeast of Proposed Facility (Adjacent to)	41.8	67.4	67.4
6	South of Proposed Facility (@ Residences)	49.0	42.8	49.9

* Average values of collected data.

Table 5.7.1-4. Impact Results Using Average Minimum Background Values [All values dBA]

Site	Description	Background*	Proposed Facility w/o Background	Proposed Facility W/ Background
1	Northeast Boundary of Proposed Facility	49.4	49.4	49.5
2	Southeast Boundary of Proposed Facility	43.3	53.5	53.5
3	Southsoutheast of Proposed Facility	41.9	48.4	48.5
4	Southwest of Proposed Facility (Adjacent to)	58.0	67.4	67.5
5	Southeast of Proposed Facility (Adjacent to)	41.8	67.4	67.4
6	South of Proposed Facility (@ Residences)	49.0	42.8	43.9

* Average values of collected data.

5.8 CHANGES TO NON-AQUATIC SPECIES POPULATION

5.8.1 Flora

Potential impacts to onsite and regional vegetation due to plant operation arise primarily from the cooling system and stack emissions.

COOLING SYSTEM

The 231 ha (570 acre) cooling reservoir will be located in an area that has been mined and already partially excavated at the time of construction. Water sources for the reservoir will be surficial groundwater, surface runoff, rainfall, and a deep well. Most water loss will be through evaporation and subsurface seepage. Surface water runoff to Payne Creek from the cooling reservoir will be during extremely wet conditions and very infrequent (see Section 5.1.1). The overflow will be directed to a protected channel which will sheet flow over a 6 to 9 m (20 to 30 ft) length of rip-rap before it reaches the creek. No adverse impact to the creek is expected because the flow to the creek is very infrequent and the water will sheet flow over a 9 m (30 ft) or greater length of the floodplain and a 5 to 9 m (15 to 30 ft) width of floodplain before it reaches the creek. This wide area of flow through floodplain vegetation will dissipate flow energy and filter undissolved solids.

The volume of water that enters Payne Creek by subsurface seepage from the cooling reservoir will be equivalent to the volume of water that the creek received from tributaries and stormwater runoff before the site was mined. However, instead of receiving water in pulses during rainfall events, there will be a steady stabilized flow to the floodplain. This will not affect the small swamp that is preserved onsite because most of the vegetation consists of bayhead species. These species, e.g., loblolly bay and sweetbay magnolia, are naturally adapted to areas kept wet by steady seepage from higher terrain (Wharton, et al., 1976).

The flatwoods vegetation of the floodplain is at present being overgrown by a maturing hardwood canopy due to lack of fire. Steady seepage with no long intervening drought periods will enhance the invasion of hardwood forest into what is now a flatwoods community. Peat will probably accumulate over the life of the plant in these areas because the soil will be more continuously saturated. The rates of decomposition and mineralization of organic matter will be retarded. If peat does accumulate the floodplain may become more efficient in removing nitrogen and other pollutants from water that overflows the creek bank.

Deciduous hardwood trees are more prevalent in wetlands that receive pulses of flooding alternating with lower flow. They receive more oxygen in the root zones during low flow. Flooding periods carry dissolved nutrients from upstream and upland areas as well as organic nutrients, which mineralize during dry periods. Steady seepage flows favor evergreen hardwoods because these species tolerate less fertile conditions. There may be an increase in evergreen hardwoods in the upper floodplain area onsite that will be more influenced by cooling reservoir seepage. Flooding will still occur in the onsite floodplain due to surface flow from areas upstream of the cooling reservoir during periods of high rainfall. The floodplain is expected to consist of a mixture of species types. It will contain a greater abundance of evergreen and deciduous hardwoods and fewer flatwoods species than it does at present.

OFFSITE WETLANDS

Effects of water supplied by relatively consistent subsurface flow rather than pulses of stormwater runoff will be less pronounced with distance downstream of the site. The steady water supply will maintain water in the channel during drought periods to a greater degree than if the facility were not built. The large offsite wetland adjacent to the northwest corner of the site will be slightly wetter than it is at present due to seepage from the cooling reservoir. However, this wetland probably historically received more water before the surrounding uplands were mined than it does now. No adverse impact is expected to this wetland due to seepage from the cooling reservoir.

The temperature of the cooling reservoir water will vary with the season but it is not expected to exceed 35°C (95°F) during the summer. This is 2-3°C (4-5°F) warmer than a natural pond of similar depth and size would be. Subsurface seepage water may warm the overlying ground 1-2°C (2-3°F). Water temperature in Payne Creek near the point of discharge during worst-case conditions is expected to be approximately 32°C (89.6°F).

Levitt (1972) reported that many species can endure temperatures of 35-45°C (96°-113°F), but are killed by a temperature of 45-46°C (113-115°F). The effects of heated effluent on wetland vegetation have been reported by researchers at the Savannah River Plant in South Carolina. Ludwigia leptocarpa, a herbaceous semi-aquatic species, exhibited higher seed production and shoot height in thermally altered sites than in a control site. Under controlled temperatures in a growth chamber shoot height and plant biomass were higher at 32°C (89.6°F) and lower at 42°C (107.6°F) than the 22°C (71.6°F) control plants (Christy and Sharitz, 1980). Donovan, et al., 1988 studied growth of bald cypress, water tupelo, black willow and button bush seedlings under various water temperature and flooding regimes. Growth with water temperatures about 5°C (9°F) higher than ambient temperatures was similar to growth with ambient water temperatures. However, growth in saturated or flooded conditions with water temperatures about 10°C (18°F) higher than ambient temperatures [ranging from 28 to 45°C (82 to 113°F) throughout the year] resulted in detrimental effects to all species. Since the water temperature of Payne Creek is not expected to exceed 32°C (89.6°F) even under worst case conditions, no damage to floodplain vegetation is expected from the discharge from the cooling reservoir.

Submerged and floating vegetation will probably establish in the cooling reservoir. If aquatic vegetation in the cooling reservoir becomes so abundant that flow into and out of the condensers is impeded, then vegetation will be controlled by mechanical or chemical methods.

5.8.2 Fauna

The cooling reservoir will probably be used for foraging and resting habitat by wading birds and other avian species as well as mammals, e.g., raccoons, and reptiles and amphibians. No adverse impacts will occur to fauna utilizing the cooling reservoir.

5.9 TRANSPORTATION IMPACTS AND OTHER PLANT OPERATION EFFECTS

Operation of the Hardee Power Station will require approximately 80 employees working over three shifts daily. As with the construction effort, it is anticipated that a majority of the operating jobs will be filled by people already residing within commuting distance of the plant. Consequently, traffic associated with the operation of the facility will be dispersed over area roads and should not affect any one particular access route. In addition, since the workforce will be divided into three shifts, the number of operation employee vehicles can easily be absorbed into the area traffic network without creating any delays or changes to area traffic flow.

5.10 ARCHAEOLOGICAL SITES

Because of the lack of archaeological sites on the Hardee Power Station property no active, on-site post-construction monitoring is planned. However, if any cultural resources are discovered, the Applicant will implement the "chance-find" procedures described in Section 4.8.

5.11 RESOURCES COMMITTED

The major irreversible and irretrievable commitments of state and local resources due to operation of the Hardee Power Station are the use of land, and the consumption of water, natural gas and fuel oil.

The land areas used by the Hardee Power Station would have otherwise been mined and reclaimed to pastureland. The Hardee Power Station project will use the lands for energy production.

Some ground and surface water will be consumed (i.e., evaporated) in the operation of the cooling reservoir. The amounts used are negligible compared to the available local supply. Section 5.3 discusses the amounts available and to be consumed. No short- or long-term impacts to local surface and groundwater resources or water users are anticipated from the proposed water use by the Hardee Power Station.

Natural gas and fuel oil will be consumed as fuel. The amounts are described in Chapter 3. This is an irreversible and irretrievable commitment of national energy resources for the production of energy for the state of Florida.

5.12 VARIANCES

Mixing zones and zones of discharges will be required for specific surface water and ground water parameters, as discussed in Sections 5.1.1 and 5.2.1. To the extent that any of these will exceed the allowable length or other applicable limitations, variances will be required.

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