TECHNICAL BACKGROUND DOCUMENT

Environmental Evaluation of Existing and Proposed Mining Operations VOLUME IV

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May 1985

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4.0 WETLANDS EVALUATION

After classifying the wetlands on site, typical wetlands within each type and size class were selected for detailed study and evaluation. Several wetlands classifications have evolved and are widely used in various parts of the United States; the more notable systems have been developed by Martin et al. (1953), Stewart and Kantrud (1971), and Golet and Larson (1974). The system for classification of wetlands and aquatic habitats developed by the Fish and Wildlife Service (Cowardin et al. 1979) was used to classify wetlands in the project area (Section 3.3.3). The primary objective of this classification system is to impose boundaries on natural ecosystems for the purpose of inventory, evaluation, and management (see Section 3.3.11 for detail of methodology).

Following classification, a literature review coupled with field and laboratory studies on selected wetlands was conducted to ascertain their physical and biological characteristics. The selected wetlands were evaluated for their functional value utilizing two methodologies:

- ° modified Wetlands Evaluation Procedure (Reppert et al. 1979) and
- ° the Method for Wetland Functional Assessment developed for the Federal Highway Administration (Adamus 1983).

The results of the field studies conducted on the selected wetlands are presented in the following sections. Results of the two evaluation procedures are provided in Appendix C.

4.1 Overview of Project Area Wetlands

The majority (92%) of the individual wetlands in the project area are <25 acres in size, simplistic to slightly complex in vegetation diversity and structure, and hydrologically isolated or weakly/periodically connected (Section 3.3.9). Approximately 6% of the individual wetlands are >25 acres but <100 acres. Only 2% of the individual wetlands are >100 acres, yet account for nearly 76% of the total wetland acreage (24,735 acres). The size class distribution of the individual wetlands in the project area and the number of wetlands evaluated from each size class are presented in Table 4.1-1.

4.2 General Features of Selected Wetlands

Eleven wetlands, considered representative of the range of wetland types and sizes on the project site, were selected for detailed evaluation

Table 4.1-1. Size Class Distribution of Wetlands in Project Area.

Size Class	No. of Individual Wetlands	% of Individual Wetlands	No. of Wetlands Evaluated
<5	1277	72	3
>5-10	198	11	1
>10-25	153	9	0
>25-50	74	4	3
>50-75	22	1	1
>75-100	8	<1	0
>100	30	2	3
Total	1762	100	11

(Table 4.1-1, Figure 4.2-1), including the two largest wetlands, Bee Haven Bay (approx. 6400 acres) and Swift Creek Swamp (approx. 1500 acres). Prior to evaluation of general features of each of the selected wetlands, each wetland was delineated and classified, as were all other wetlands on the project site (Section 3.3.3), according to the Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976) and the U.S. Fish and Wildlife Service classification (Cowardin et al. 1979) (Table 4.2-1). Additionally, vegetation transects were run through each of the eleven selected wetlands to characterize dominant species, community structure, and general features (see Section 3.3.11 for methodology).

4.2.1 Wetland 2734

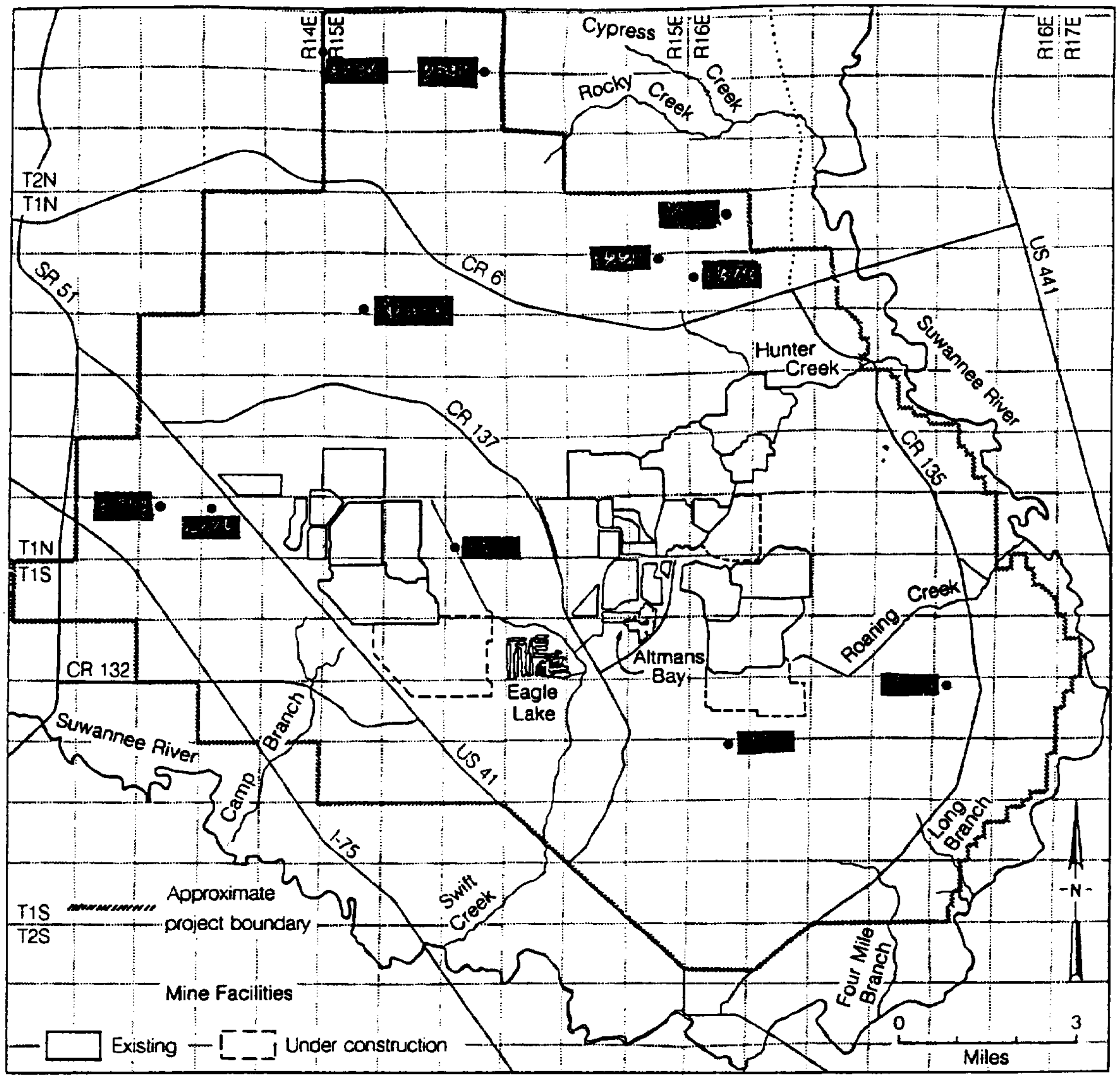
This wetland is a small (approx. 8 acres), hydrologically isolated, perched wetland located within the Rocky Creek drainage area (Figure 4.2-2). The species composition of this wetland is typical of small cypress - swamp tupelo systems in north-central Florida as reported by Monk and Brown (1965). Dominant canopy species are swamp tupelo (*Nyssa biflora*) and pond cypress (*Taxodium ascendens*) with minor occurrence of sweetbay (*Magnolia virginiana*) and slash pine (*Pinus elliottii*) (Table 4.2-2). Soils underlying small, isolated cypress systems such as this typically consist of acidic, organic peat and muck. Based on field probes throughout the wetland, the organic layer varies from approximately 0.2 to 2.7 ft and is underlain by a layer of packed sands and clays.

Although no water was present during the field survey, based on water marks and lichen lines observed, the maximum depth of inundation is approximately 2.3 ft in the center of the wetland. The primary source of water in the wetland is direct rainfall with a contribution from runoff from surrounding planted pinelands. Water loss is through evapotranspiration. No outflow from the wetland was observed.

Surrounding land use is planted pine (15-20 year age class). Past disturbance in this wetland includes fire and logging within the past 15-20 years.

4.2.2 Wetland 2696

This rather small (approx. 35 acres), hydrologically isolated wetland is located in the Rocky Creek drainage area (Figure 4.2-3). The dominant canopy species is pond cypress with slash pine and swamp tupelo being minor components of the canopy (Table 4.2-3). The organic layer was found to vary from 0.4 to 1.5 ft, with an underlying layer of tightly packed sand and clay. The main source of water is direct rainfall with a small amount of runoff from surrounding uplands. Water loss is through evapotranspiration. No standing water was observed at the time of the survey; however, lichen lines and water marks indicate a maximum depth of flooding of approximately 0.8 ft. Much of this wetland had no lichen lines or water marks present, indicating little inundation except in deeper pockets. The surrounding land use is planted pine of the 5-10 year age class.



NOTE: Does not reflect all areas affected by mining or mine support activities. See Figure 1.1-2.

• Location of wetland transect (labeled with wetland number)

Figure 4.2-1. Wetland Evaluation Locations.

Table 4.2-1. Classification of Selected Wetlands on the Project Site.

Wetland Number	Acres	FWS Code[1]	FLU Code[2]
2734	8	PF02/1Cag	6311
2696	35	PF02/1Cag	6311
2014	6400	See Table 4.2-4	
1370	2	PF02/1Cag	6311
1227	40	PF02/1Cag	6311
1378	235 (170)	PF02/1Cag	6311
	(60)	PF01/4Cag	6312
	(5)	PF01/3Cag	6211
1690	55	PF02/1Cag	6311
1175	3	PF02/1Cag	6311
2275	3	PF02/1Cag	6311
2139	45	PF02/1Cag	6311
2550	1500	PF01/4Cadg	6312

[1]U.S. Fish and Wildlife Service Classification according to Cowardin et al. 1979.

[2]Florida Land Use and Cover Classification according to Fla. Dept. of Admin. 1976.

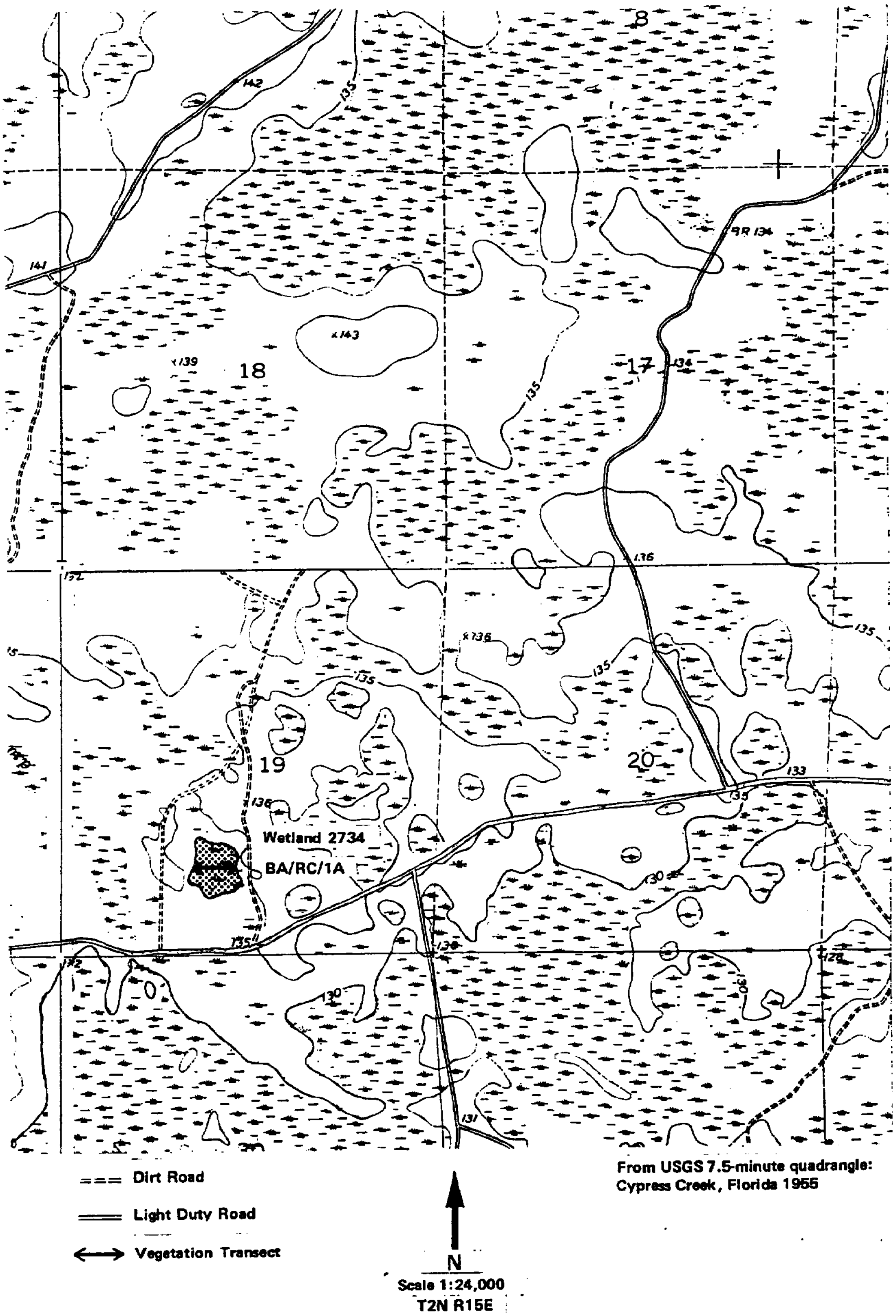


Figure 4.2-2. Wetland 2734, Rocky Creek Drainage Area.

Table 4.2-2. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 2734 Drainage Rocky Creek

Type PF02/1Cag Size (ac) 8 Surrounding area planted pine 10-15 yrs

Disturbance fire/logging 15-20 yrs ago Plot interval (ft) 50

Total length of transect (ft) 500 Location T2N R15E Section 19

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Nyssa biflora	50.00	32.81	42.86	125.67	0.90		
Taxodium ascendens	40.00	48.37	42.86	131.23	0.90		
Magnolia virginiana	7.50	3.44	9.52	20.46	0.50		
Pinus elliottii	2.50	15.37	4.76	22.63	0.10		
SUBCANOPY							
Lyonia lucida	33.33		27.78	61.11	0.50		
Clethra alnifolia	16.67		22.22	38.89	0.40		
Nyssa biflora	41.67		33.33	75.00	0.60		
Taxodium ascendens	8.33		16.67	25.00	0.30		
HERBACEOUS							
Lyonia lucida			37.50	70.83	0.30	33.33	0.30
Sphagnum sp.			12.50	23.61	0.10	11.11	0.10
Clethra alnifolia			37.50	81.94	0.30	44.44	0.40
Ilex sp.			12.50	23.61	0.10	11.11	0.10

Mean distance (ft) 8 Mean area/individual (sq ft) 57 Density/acre 768

Total basal area (sq ft) 49,679

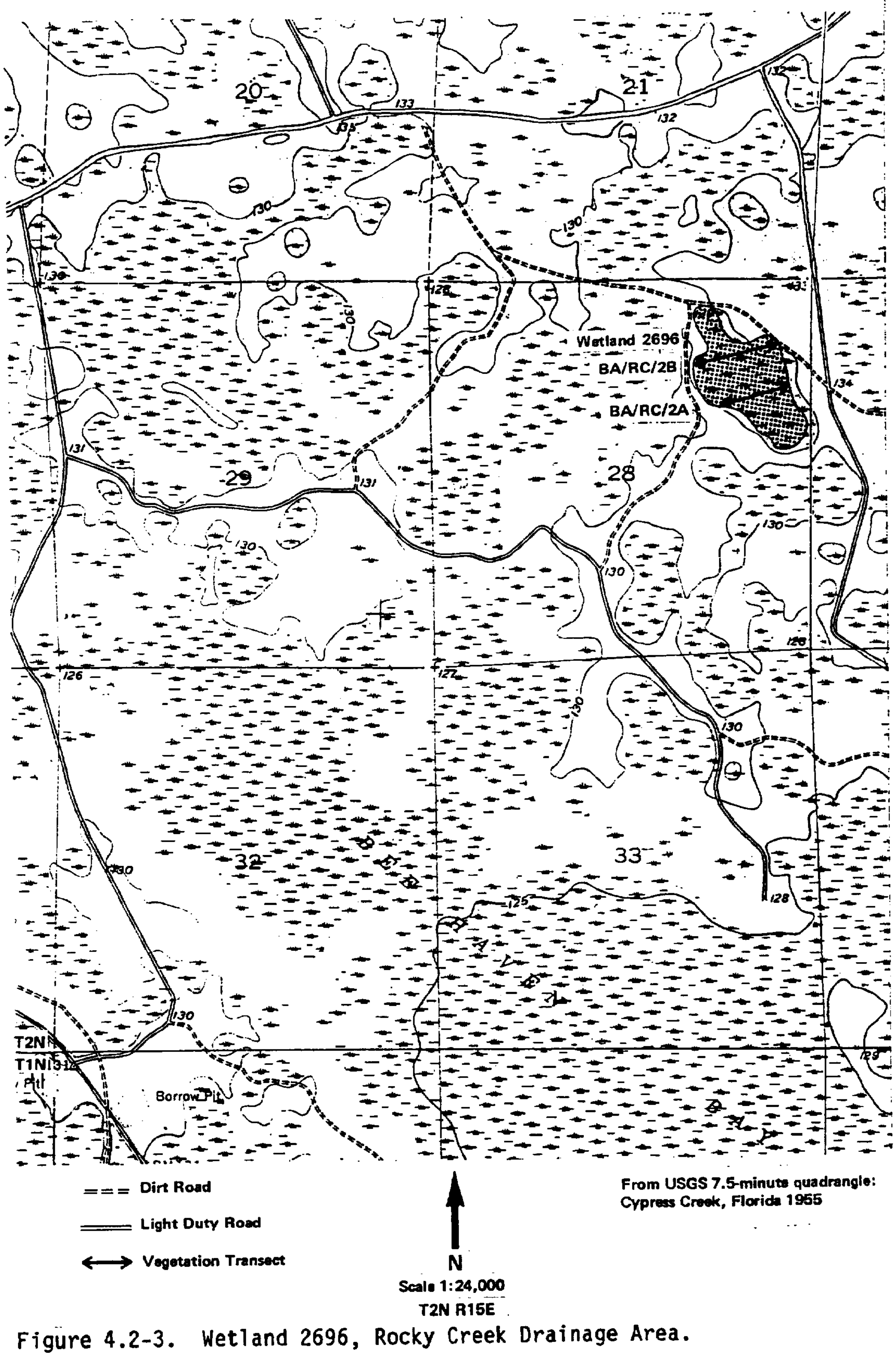


Figure 4.2-3. Wetland 2696, Rocky Creek Drainage Area.

Table 4.2-3. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 2696 Drainage Rocky Creek

Type PF02/1Cag Size (ac) 35 Surrounding area planted pine 5-10 yrs

Disturbance logged 50 yrs ago; old turpentine stumps Plot interval (ft) 100

Total length of transect (ft) 1400 Location T2N R15E Section 28

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	69.57	84.14	55.56	209.27	0.94		
Pinus elliottii	13.91	10.34	20.37	44.62	0.34		
Nyssa biflora	16.52	5.54	24.07	46.13	0.41		
SUBCANOPY							
Taxodium ascendens	34.12		29.73	63.85	0.69		
Pinus elliottii	4.76		5.41	10.17	0.13		
Nyssa biflora	18.25		20.27	38.52	0.47		
Lyonia lucida	30.95		25.68	56.63	0.59		
Clethra alnifolia	5.5		8.11	13.61	0.19		
Persea borbonia	3.17		5.41	8.58	0.13		
Myrica cerifera	3.17		5.41	8.58	0.13		
HERBACEOUS							
Lyonia lucida			33.33	66.33	0.59	33.00	2.09
Clethra alnifolia			22.81	38.08	0.41	15.27	0.97
Taxodium ascendens			3.51	4.50	0.06	0.99	0.06
Osmunda cinnamomea			3.51	5.48	0.06	1.97	0.13
Pieris phillyreifolia			12.28	28.04	0.22	15.76	1.00
Sphagnum sp.			5.26	6.74	0.09	1.48	0.09
Smilax laurifolia			3.51	6.96	0.06	3.45	0.22
Woodwardia areolata			5.26	8.71	0.09	3.45	0.22
Lachnanthes caroliniana			1.75	3.23	0.03	1.48	0.09
Cyperus sp.			5.26	26.95	0.09	21.69	1.38
Dulichium arundinaceum			1.75	2.74	0.03	0.99	0.06
Hypericum fasciculatum			1.75	2.24	0.03	0.49	0.03

Mean distance (ft) 10 Mean area/individual (sq ft) 103 Density/acre 422

Total basal area (sq ft) 23,670

There is evidence of fire and logging disturbance in the wetland within the past 25 years.

4.2.3 Wetland 2014

This large wetland, also known as Bee Haven Bay, covers 6400 acres in the Rocky Creek drainage area. The wetland is functionally divided by CR 6 into northern and southern sections (Figure 4.2-4). The southern section, encompassing approximately 3800 acres, was the subject of evaluation. Twenty-five different FWS wetland categories (Cowardin et al. 1979) were identified for the entire 6400 acres (Table 4.2-4). The area is vegetated by various forested, shrub, and emergent plant communities interspersed with upland "pine islands." Pond cypress, slash pine, swamp tupelo, various bays (Magnolia virginiana, Gordonia lasianthus, and Persea borbonia) and red maple (Acer rubrum) comprise the forested communities; fetterbush (Lyonia lucida) is the chief component of the shrub community; and Virginia chain fern (Woodwardia virginica) and redroot (Lachnanthes caroliniana) are the dominant herbaceous species (Table 4.2-5). The surrounding area is primarily planted pine and pine flatwoods, although there is some land under cultivation on the northern border south of CR 6. Past disturbance includes a repeated history of logging, fire, and drainage in some areas, while other areas are relatively free of recent perturbations.

Soils undoubtedly vary throughout Bee Haven Bay but are generally acidic, organic peat and muck underlain by an impermeable lens of hard-packed sand and clays. The organic layer was found to vary from <1 ft to >7 ft.

This wetland occurs within the extreme headwater reaches of the Rocky Creek drainage area and covers approximately 6 sq mi or 12% of the 52 sq mi basin. It receives water from direct rainfall as well as runoff from its surrounding subbasin. Water depths vary from areas which are saturated but not inundated to localized depressions 1-2 ft deep. As indicated by the lack of a lichen line throughout much of the wetland, recent inundation has been limited to localized pockets where pond cypress is the dominant species.

4.2.4 Wetland 1370

Wetland 1370 is a small (approx. 2 acres), isolated, perched wetland within the Hunter Creek drainage area (Figure 4.2-5). The Hunter Creek drainage area covers approximately 14 sq mi of the Suwannee River basin. The surrounding area is sharply demarcated by stands of planted pine (Pinus elliottii) of the 15-year age class.

The dominant canopy species are swamp tupelo, pond cypress, and slash pine (Table 4.2-6). The organic layer varies within this wetland from 0.8 to 1.5 ft and is underlain by a layer of packed sands and variously colored clays.

This wetland has experienced and continues to experience disturbance through silvicultural practices. Past logging of cypress is evidenced by several remaining stumps. Old pine "turpentine stumps" and remnants

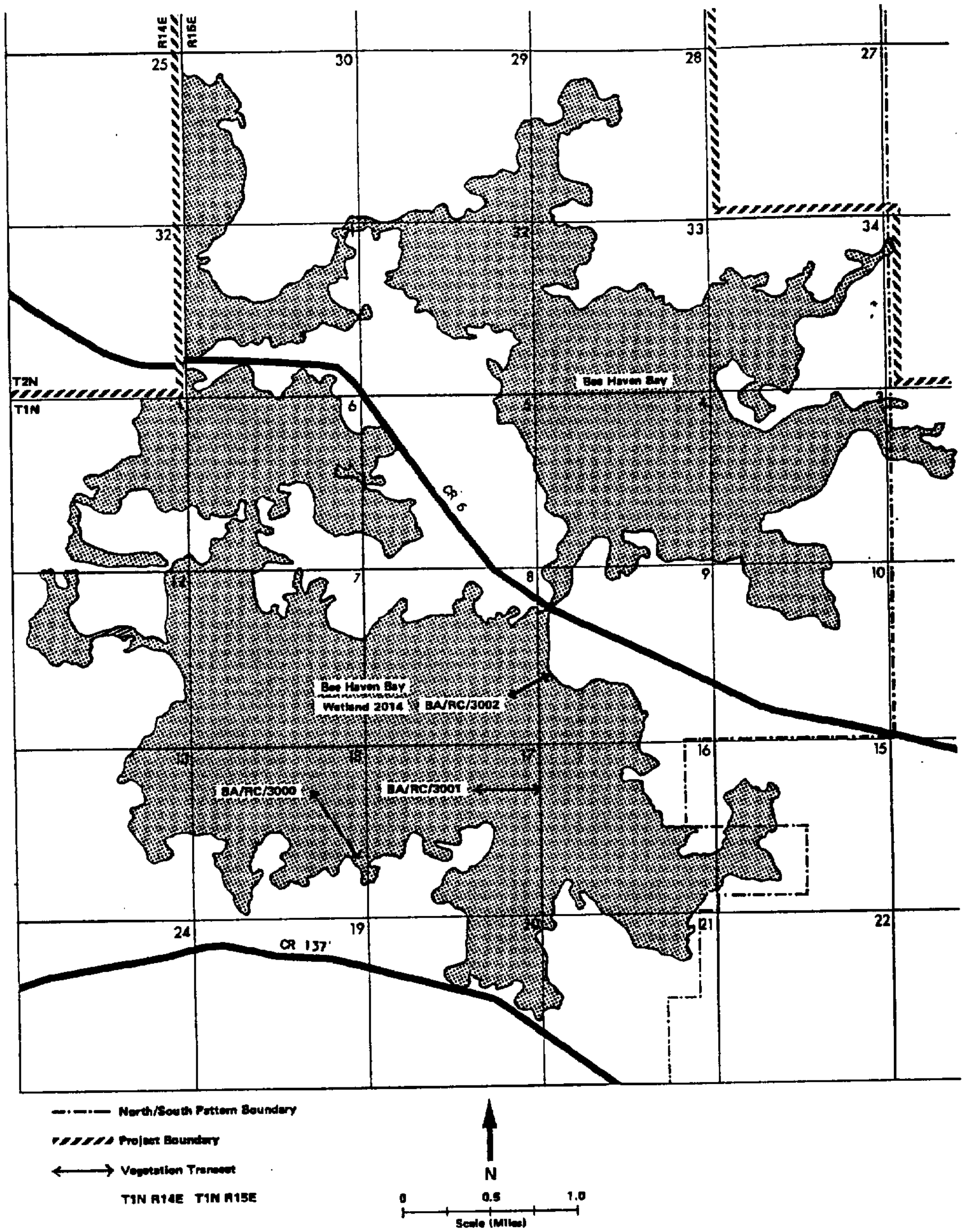


Figure 4.2-4. Wetland 2014, Bee Haven Bay, Rocky Creek Drainage Area.

Table 4.2-4. Wetland Classifications and Acreages for Wetland 2014 (Bee Haven Bay).

FWS Code[1]	FLU Code[2]	Acres	% of Total
PEM1Cag	6410	2	<0.1
PEM4/5Cag	6410	230	3.6
PEM5Cag	6410	1	<0.1
PFO1/PSS3Cag	6211	10	0.2
PFO1/3Cag	6211	185	2.9
PFO1/4Cag	6312	190	3.0
PFO1/Cag	6211	1	<0.1
PFO2/PEM3Cag	6110	80	1.2
PFO2/PEM5Cag	6110	5	<0.1
PFO2/PSS3Cag	6110	215	3.4
PFO2/1Cag	6311	1345	21.0
PFO2/3Cag	6311	135	2.1
PFO2/4Cag	6110	445	7.0
PFO3/PSS3Cag	6212	135	2.1
PFO3/1 Cag	6212	10	0.2
PFO3/2Cag	6311	215	3.4
PFO3/4Cag	6312	300	4.7
PFO3Cag	6212	1130	17.7
PFO4/PEM3Cag	6312	20	0.3
PFO4/PSS3Cag	6312	600	9.4
PFO4/3Cag	6312	100	1.6
PSS3/PFO2Cag	6213	40	0.6
PSS3/PFO3Cag	6213	15	0.2
PSS3/PFO4Cag	6213	930	14.5
PSS3Cag	6213	60	0.9
Total Acreage		6400	100

[1]U.S. Fish and Wildlife Service Classification according to Cowardin et al. 1979.

[2]Florida Land Use and Cover Classification according to Fla. Dept. of Admin. 1976.

Table 4.2-5. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Bee Haven Bay BA/RC/3000A Wetland No. 2014 Drainage Rocky Creek

Type Table 4.2-4 Size (ac) 6400 Surrounding area planted pine

Disturbance logged 25 yrs ago; fire 15 yrs ago Plot interval (ft) 50

Total length of transect (ft) 140 Location T1N R15E Section 18

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Pinus elliottii	10.34	27.53	16.67	54.54	0.38		
Magnolia virginiana	24.15	13.86	27.78	65.79	0.63		
Acer rubrum	10.34	6.89	11.10	28.33	0.25		
Taxodium ascendens	10.34	9.26	16.67	36.27	0.38		
Nyssa biflora	44.83	42.46	27.78	115.07	0.63		
SUBCANOPY							
Magnolia virginiana	21.88		20.00	41.88	0.63		
Lyonia lucida	21.88		24.00	45.88	0.75		
Myrica cerifera	6.25		8.00	14.25	0.25		
Acer rubrum	6.25		8.00	14.25	0.25		
Nyssa biflora	31.25		24.00	55.25	0.75		
Clethra alnifolia	6.25		8.00	14.25	0.25		
Itea sp.	3.12		4.00	7.12	0.13		
Ilex cassine	3.12		4.00	7.12	0.13		
HERBACEOUS							
Clethra alnifolia			50.00	100.00	0.50	1.00	0.57
Lyonia lucida			25.00	50.00	0.25	0.50	0.29
Vitis spp.			12.50	25.00	0.13	0.13	0.07
Smilax laurifolia			12.50	25.00	0.13	0.13	0.07

Mean distance (ft) 9 Mean area/individual (sq ft) 78 Density/acre 558

Total basal area (sq ft) 33,853

Table 4.2-5 (Continued). SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Bee Haven Bay BA/RC/3000B Wetland No. 2014 Drainage Rocky Creek

Type Table 4.2-4 Size (ac) 6400 Surrounding area planted pine

Disturbance logged 25 yrs ago; fire 15 yrs ago Plot interval (ft) 100

Total length of transect (ft) 1300 Location T1N R15E Section 18

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Pinus elliottii	11.11	29.48	16.67	57.26	0.08		
Magnolia virginiana	11.11	19.52	16.67	47.30	0.08		
Acer rubrum	11.11	5.73	16.67	33.51	0.08		
Gordonia lasianthus	11.11	5.00	16.67	33.78	0.08		
Persea borbonia	55.55	39.27	33.33	128.15	0.15		
SUBCANOPY							
Magnolia virginiana	7.14		7.69	14.83	0.15		
Acer rubrum	7.14		15.39	22.53	0.23		
Ilex cassine	7.14		15.39	22.53	0.23		
Persea borbonia	67.86		53.85	121.71	1.22		
Taxodium ascendens	10.72		7.69	18.41	0.18		
HERBACEOUS							
Woodwardia virginica			32.00	123.88	0.61	91.88	75.77
Decodon verticillatus			4.00	4.48	0.08	0.48	0.39
Lachnanthes caroliniana			12.00	13.77	0.23	1.77	1.46
Xyris sp.			4.00	4.48	0.08	0.47	0.39
Andropogon capillipes			4.00	4.19	0.08	0.19	0.15
Cyperus sp.			4.00	4.28	0.08	0.28	0.23
Cyrilla racemiflora			4.00	4.28	0.08	0.28	0.23
Persea borbonia			20.00	24.10	0.38	4.10	3.39
Acer rubrum			4.00	4.09	0.08	0.09	0.08
Smilax laurifolia			4.00	4.09	0.08	0.09	0.08
Clethra alnifolia			4.00	4.18	0.08	0.18	0.15
Cladium sp.			4.00	4.18	0.08	0.18	0.15

Mean distance (ft) 13.1 Mean area/individual (sq ft) 172 Density/acre 254

Total basal area (sq ft) 7814

Table 4.2-5 (Continued). SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Bee Haven Bay BA/RC/3001 Wetland No. 2014 Drainage Rocky Creek

Type Table 4.2-4 Size (ac) 6400 Surrounding area pine flatwoods/planted pine

Disturbance logged cypress 15-20 yrs ago Plot interval (ft) 100

Total length of transect (ft) 900 Location T1N R15E Section 17

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Pinus elliottii	20.28	20.40	17.65	58.33	0.33		
Nyssa biflora	14.49	8.29	20.59	43.37	0.39		
Taxodium ascendens	27.54	37.43	26.47	91.44	0.50		
Persea borbonia	4.35	2.42	8.82	15.59	0.17		
Gordonia lasianthus	24.64	22.51	17.65	64.80	0.33		
Magnolia virginiana	8.70	8.95	8.82	26.47	0.17		
SUBCANOPY							
Nyssa biflora	20.97		24.24	45.21	0.44		
Persea borbonia	11.29		18.18	29.47	0.33		
Taxodium ascendens	4.84		6.06	10.90	0.11		
Lyonia lucida	41.94		30.30	72.24	0.56		
Clethra alnifolia	1.61		3.03	4.64	0.06		
Gordonia lasianthus	16.13		12.12	28.25	0.22		
Acer rubrum	1.61		3.03	4.64	0.06		
Magnolia virginiana	1.61		3.03	4.64	0.06		
HERBACEOUS							
Clethra alnifolia			32.14		0.50	43.33	1.44
Rhus radicans			10.71		0.17	8.33	0.28
Woodwardia areolata			3.57		0.06	1.67	0.06
Persea borbonia			10.71		0.17	6.67	0.22
Smilax laurifolia			3.57		0.06	1.67	0.06
Lyonia lucida			39.29		0.61	38.33	1.28

Mean distance (ft) 9.5 Mean area/individual (sq ft) 90 Density/acre 484

Total basal area (sq ft) 24,464

Table 4.2-5 (Continued). SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Bee Haven Bay BA/RC/3002 Wetland No. 2014 Drainage Rocky Creek

Type Table 4.2-4 Size (ac) 6400 Surrounding area planted pine/agriculture

Disturbance logged 20 yrs ago Plot interval (ft) 100

Total length of transect (ft) 700 Location T1N R15E Sections 8 & 9

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	39.29	81.41	38.89	159.59	1.00		
Nyssa biflora	7.14	2.29	5.56	14.99	0.14		
Magnolia virginiana	25.00	5.45	27.78	58.23	0.71		
Gordonia lasianthus	3.57	0.75	5.56	9.88	0.14		
Persea borbonia	25.00	10.10	22.22	57.32	0.57		
SUBCANOPY							
Magnolia virginiana	26.67		30.77	57.44	0.57		
Lyonia lucida	60.00		38.46	98.46	0.71		
Nyssa biflora	10.00		23.08	33.08	0.43		
Ilex sp.	3.33		7.69	11.02	0.15		
HERBACEOUS							
Lyonia lucida			45.45		0.71	95.00	2.71
Magnolia virginiana			54.55		0.86	5.00	0.14

Mean distance (ft) 12 Mean area/individual (sq ft) 134 Density/acre 325

Total basal area (sq ft) 22,391

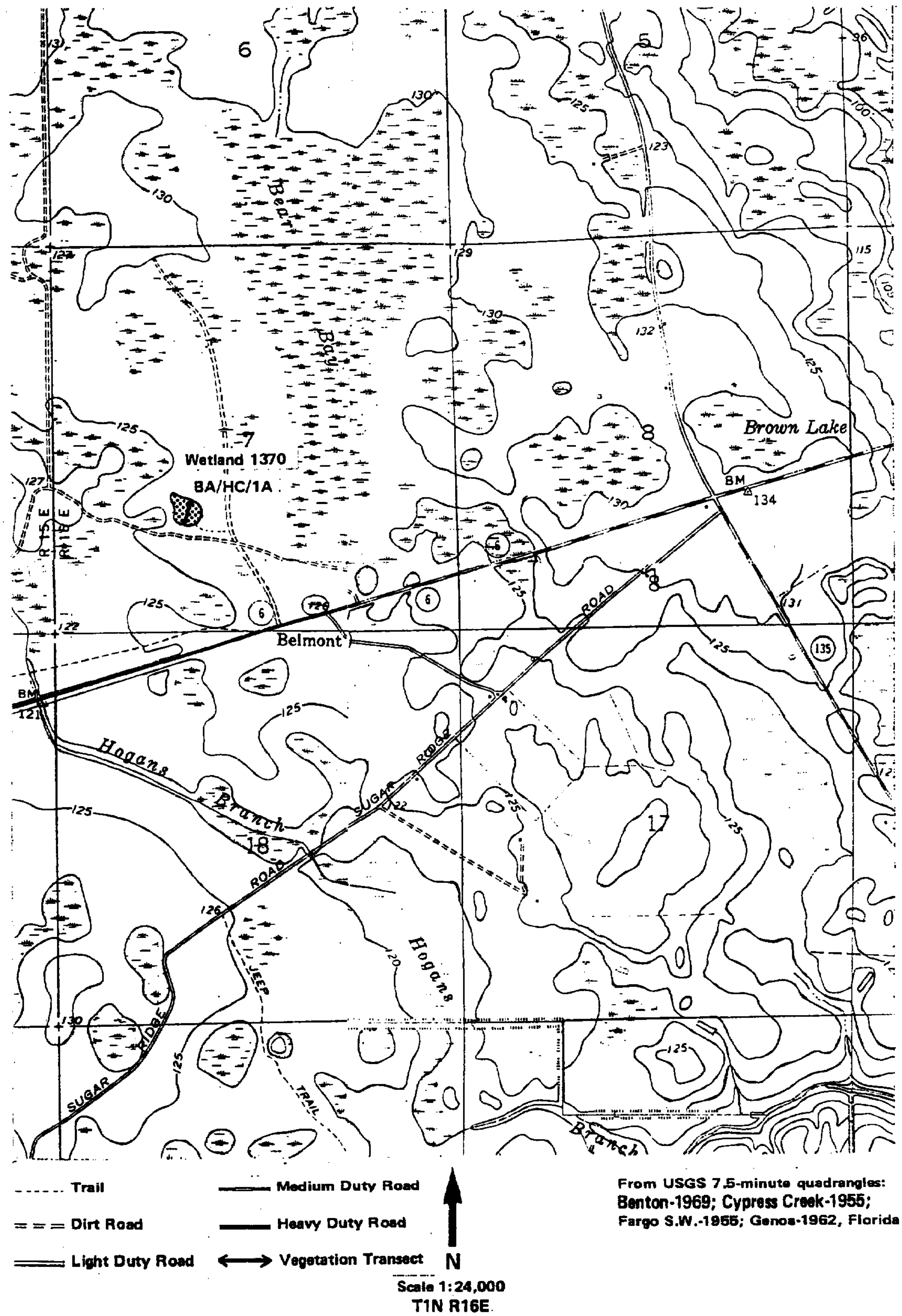


Figure 4.2-5. Wetland 1370, Hunter Creek Drainage Area.

Table 4.2-6. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 1370 Drainage Hunter Creek

Type PF02/1Cag Size (ac) 2 Surrounding area planted pine

Disturbance fire 10 yrs ago; old turpentine stumps Plot interval (ft) 50

Total length of transect (ft) 200 Location T1N R16E Section 7

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Nyssa biflora	43.75	19.19	37.50	100.44	0.75		
Taxodium ascendens	37.50	49.35	37.50	124.35	0.75		
Pinus elliottii	18.75	31.45	25.00	75.20	0.50		
SUBCANOPY							
Nyssa biflora	68.75		50.00	118.75	0.50		
Pinus elliottii	6.25		12.50	18.75	0.13		
Taxodium ascendens	12.50		12.50	25.00	0.13		
Acer rubrum	6.25		12.50	18.75	0.13		
Magnolia virginiana	6.25		12.50	18.75	0.13		
HERBACEOUS							
Lyonia lucida			12.50	35.23	0.13	22.73	1.25
Clethra alnifolia			25.00	61.36	0.25	36.36	2.00
Taxodium ascendens			12.50	21.59	0.13	9.09	0.50
Saururus cernuus			12.50	17.05	0.13	4.55	0.25
Woodwardia virginica			12.50	26.14	0.13	13.64	0.75
Smilax laurifolia			12.50	21.59	0.13	9.09	0.50
Rhus radicans			12.50	17.05	0.13	4.55	0.25

Mean distance (ft) 11 Mean area/individual (sq ft) 122 Density/acre 358

Total basal area (sq ft) 20,228

of fire lanes and ditching indicate past utilization for production of naval products. Currently, the surrounding area is planted in slash pine, and the boundary of the wetland depression has been ditched. Fire scars indicate the occurrence of fire within the past 10 years.

The primary source of water for Wetland 1370 is direct rainfall, although it receives some runoff from a few hundred feet of the planted pineland which surrounds it. At the time of sampling (1 October 1981), there was no standing water present. The maximum depth of inundation, based on the presence of a lichen line and water marks on trees in the central portion of the depression, is approximately 0.6 ft. No outflow from this wetland was observed, with water loss through evapotranspiration only.

4.2.5 Wetland 1227

This wetland is an isolated, perched wetland located within the Hunter Creek drainage area (Figure 4.2-6). It encompasses approximately 40 acres and is vegetated by a mixture of pond cypress and swamp tupelo with some slash pine (Table 4.2-7). The surrounding area is sharply demarcated by stands of planted pine of the 15-20 year age class.

The organic layer varies within this wetland from a few inches at its edge to approximately 3.2 ft near the center and is underlain by a layer of packed sand and variously colored clays.

Past disturbance in this wetland consists of logging approximately 15-20 years ago and a number of drainage cuts near its perimeter.

The primary source of water for Wetland 1227 is direct rainfall, although it receives some runoff from the surrounding planted pine. At the time of sampling (21 October 1981), water was at or near the surface over most of the wetland. A few local shallow depressions contained some standing water. The maximum depth of inundation based on the height of the lichen line and water marks on trees was approximately 0.6 ft; however, at 26 of the 31 points sampled along two transects which crossed the wetland from edge to edge, there was no apparent lichen line, indicating constant water levels at or below the ground surface. Except for a few slight drainage ditches which do not connect to any apparent flow way, there is no outflow from this cypress head, indicating water loss is primarily through evapotranspiration.

4.2.6 Wetland 1378

Wetland 1378 (Bear Bay) is a perched wetland located within the Hunter Creek drainage area (Figure 4.2-7). It encompasses approximately 235 acres and is vegetated by a mixture of pond cypress, swamp tupelo, slash pine, loblolly bay (Gordonia lasianthus), and red bay (Persea borbonia) (Table 4.2-8). The surrounding area is sharply demarcated by stands of planted slash pine of various age classes from 0-5 years to 15-20 years, with the 15-20 year age class being predominant.

Although current detailed soils data are not published for this wetland, a generalized soil map prepared by the Soil Conservation Service and

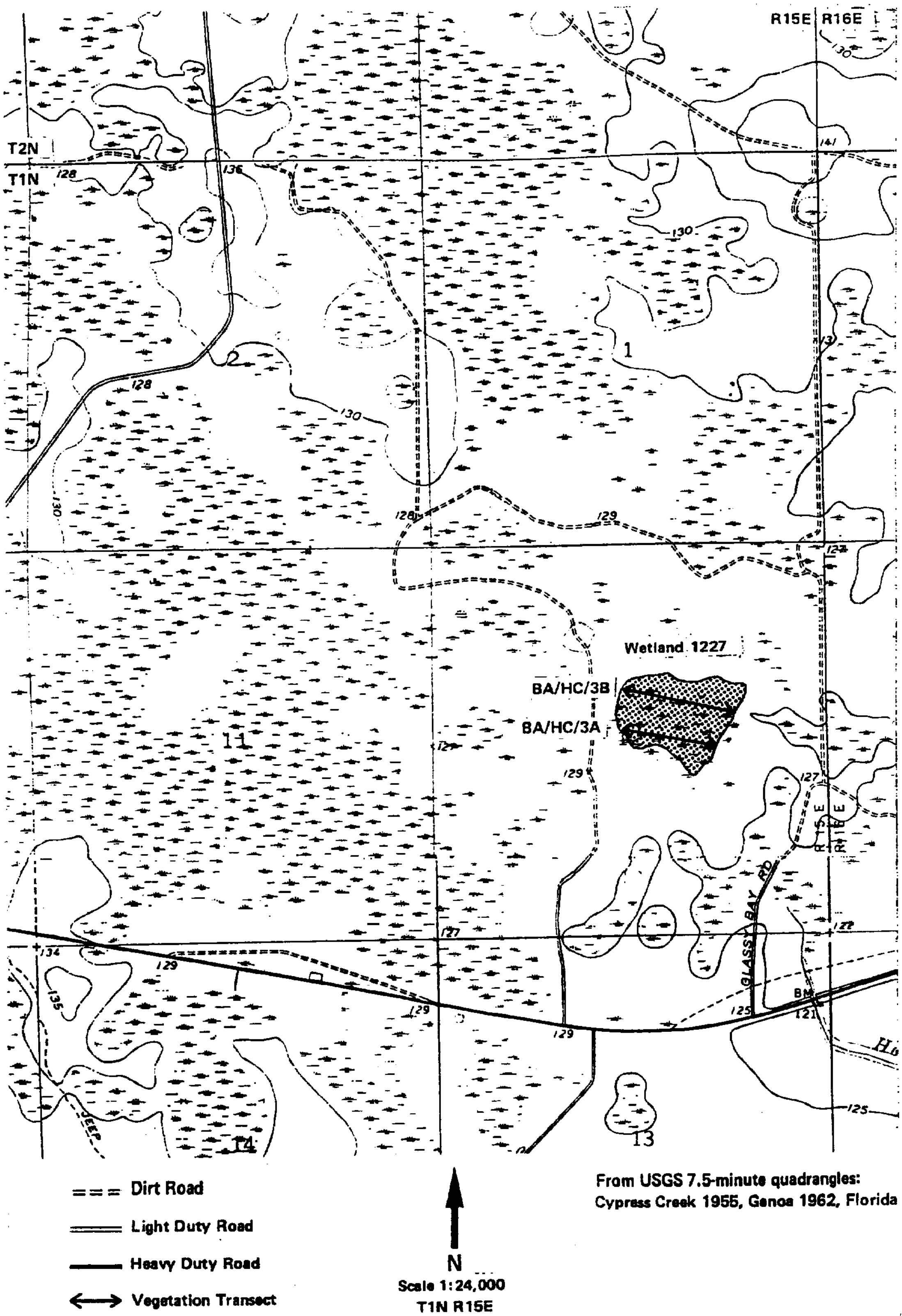


Figure 4.2-6. Wetland 1227, Hunter Creek Drainage Area.

Table 4.2-7. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 1227 Drainage Hunter Creek

Type PF02/1Caq Size (ac) 40 Surrounding area planted pine

Disturbance logged 15-20 yrs ago Plot interval (ft) 100

Total length of transect (ft) 3100 Location T1N R15E Section 12

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	54.03	67.91	45.90	167.84	0.91		
Pinus elliottii	7.26	7.39	13.11	27.76	0.26		
Nyssa biflora	38.71	24.69	40.98	104.38	0.80		
SUBCANOPY							
Taxodium ascendens	15.32		15.63	30.95	0.32		
Nyssa biflora	52.42		43.75	96.17	0.90		
Lyonia lucida	19.35		21.85	41.20	0.45		
Myrica cerifera	4.84		7.81	12.65	0.08		
Clethra alnifolia	4.84		6.25	11.09	0.06		
Magnolia virginiana	1.61		3.13	4.74	0.03		
Cephalanthus occidentalis	1.61		1.56	3.17	0.02		
HERBACEOUS							
Clethra alnifolia			31.67	61.43	0.61	29.76	1.97
Lyonia lucida			33.33	69.43	0.65	36.10	2.39
Smilax laurifolia			5.00	7.93	0.09	2.93	0.19
Saururus cernuus			6.67	16.91	0.13	10.24	0.68
Persea borbonia			3.33	8.21	0.06	4.88	0.32
Pieris phillyreifolius			1.67	8.50	0.03	6.83	0.45
Sphagnum spp.			10.00	12.93	0.19	2.93	0.19
Ludwigia spp.			1.67	3.13	0.03	1.46	0.09
Dulichium arundinaceum			3.33	7.23	0.06	3.90	0.26
Myrica cerifera			1.67	2.16	0.03	0.49	0.03
Cephalanthus occidentalis			1.67	2.16	0.03	0.49	0.03

Mean distance (ft) 11 Mean area/individual (sq ft) 115 Density/acre 378

Total basal area (sq ft) 20,988

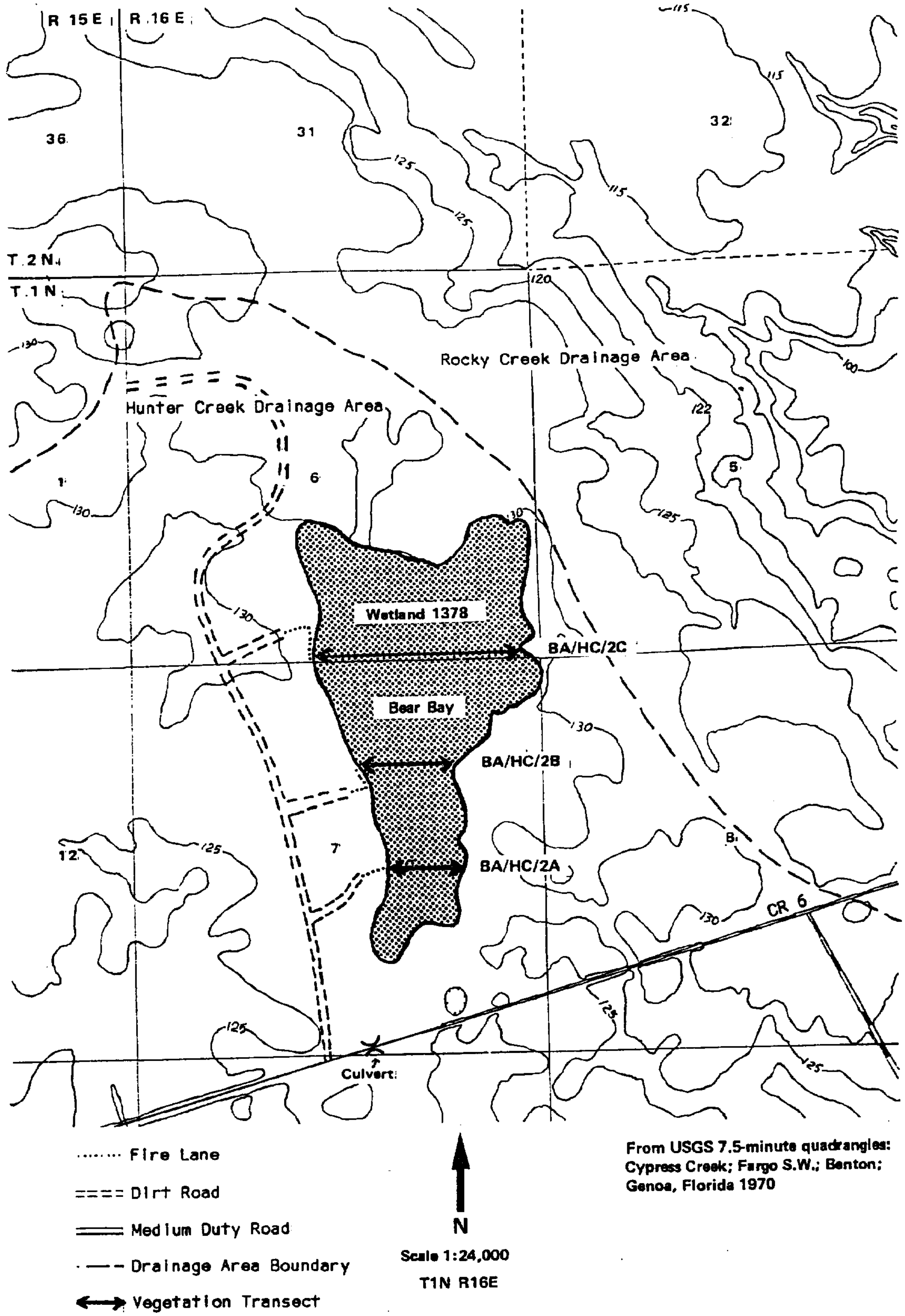


Figure 4.2-7. Wetland 1378 (Bear Bay), Hunter Creek Drainage Area.

Table 4.2-8. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Bear Bay Wetland No. 1378 Drainage Hunter Creek

Type PF02/1Cag, PF01/4Cag, PF01/3Cag Size (ac) 235 Surrounding area planted pine

Disturbance logged/fire 15-20 yrs ago Plot interval (ft) 100

Total length of transect (ft) 4200 (3 transects) Location T1N R16E Sections 6 & 7

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Nyssa biflora	44.31	28.15	43.06	115.52	0.74		
Taxodium ascendens	44.31	62.64	41.67	148.62	0.71		
Gordonia lasianthus	8.38	6.16	9.72	24.26	0.17		
Pinus elliottii	2.40	2.32	4.17	8.89	0.07		
Persea borbonia	0.60	0.74	1.39	2.73	0.02		
SUBCANOPY							
Nyssa biflora	49.10		40.24	89.34	0.79		
Lyonia lucida	35.93		36.59	72.52	0.71		
Gordonia lasianthus	1.20		2.44	3.64	0.05		
Clethra alnifolia	6.59		10.99	17.58	0.21		
Myrica cerifera	0.60		1.22	1.82	0.02		
Taxodium ascendens	6.59		8.54	15.13	0.17		
HERBACEOUS							
Lyonia lucida			36.76	91.79		55.03	1.95
Rhus radicans			1.47	2.81		1.34	0.05
Woodwardia areolata			5.88	8.56		2.68	0.10
Clethra alnifolia			42.65	77.55		34.90	1.24
Smilax laurifolia			7.35	10.71		3.36	0.12
Acer rubrum			2.94	4.28		1.34	0.05
Gordonia lasianthus			1.47	2.14		0.67	0.02
Centella asiatica			1.47	2.14		0.67	0.02

Mean distance (ft) 9 Mean area/individual (sq ft) 73 Density/acre 599

Total basal area (sq ft) 25,521

published by the Florida Department of Administration (1975) indicates the area has nearly level, very poorly drained soils subject to periodic flooding. Inspection of the soils indicates that they are highly organic and include a peat layer which varies in depth from a few inches at the outer perimeter to as much as 4 ft in the center. The peat layer is underlain with sand and an impermeable layer of variously colored clays.

Bear Bay has experienced past disturbance in the form of drainage and logging. Fire lanes also have been constructed and maintained around its perimeter following the establishment of the planted pine. Based on field observations, the wetland last experienced a significant fire more than 15 years ago, and logging of cypress was at least 15-20 years ago. Decaying cypress stumps still stand and are overgrown by fetterbush and sweet pepperbush.

Bear Bay occurs in the Hunter Creek basin which receives runoff, after high intensity summer storms, from approximately 0.5 sq mi; however, direct rainfall is the primary source of its water. Water is present in varying amounts throughout the year. During the dry season, small non-contiguous open water areas occur toward the center, although most of these do not exceed a width of 100 ft.

During periods of high water in spring and summer, there is an intermittent slow discharge to the south through a culvert under CR 6, approximately 1000 ft south of the southern boundary of the wetland. From this point, water flows into Hogans Branch and then into Hunter Creek. A ditch has been constructed in the past from the south end of the wetland, probably during previous logging operations. It is presently overgrown with vegetation and shows no evidence of scouring. Large quantities of water are lost through evapotranspiration, especially in summer when cypress, swamp tupelo, and other deciduous species are in full foliage (Heimburg 1976).

4.2.7 Wetland 1690

Wetland 1690 is an isolated, perched wetland located in the Roaring Creek drainage area of the Suwannee River basin (Figure 4.2-8). It encompasses approximately 55 acres and is vegetated by a mixture of swamp tupelo, pond cypress, slash pine, and bays (Table 4.2-9). The surrounding area is predominantly planted slash pine (of the 15-25 year class) and pine flatwoods. Soils underlying this wetland are generally acidic, organic peat and muck which vary in depth to approximately 4.0 ft and are underlain by a layer of packed sand and clay.

This wetland has been logged in the past 40 years and has experienced severe fires within the last 15 years. Natural drainage patterns in the surrounding pinelands have been altered by fire lanes and roadside ditching. No outflow from this wetland was observed, with water loss through evapotranspiration.

The primary source of water for Wetland 1690 is direct rainfall, although it receives some runoff from the surrounding pinelands. At the

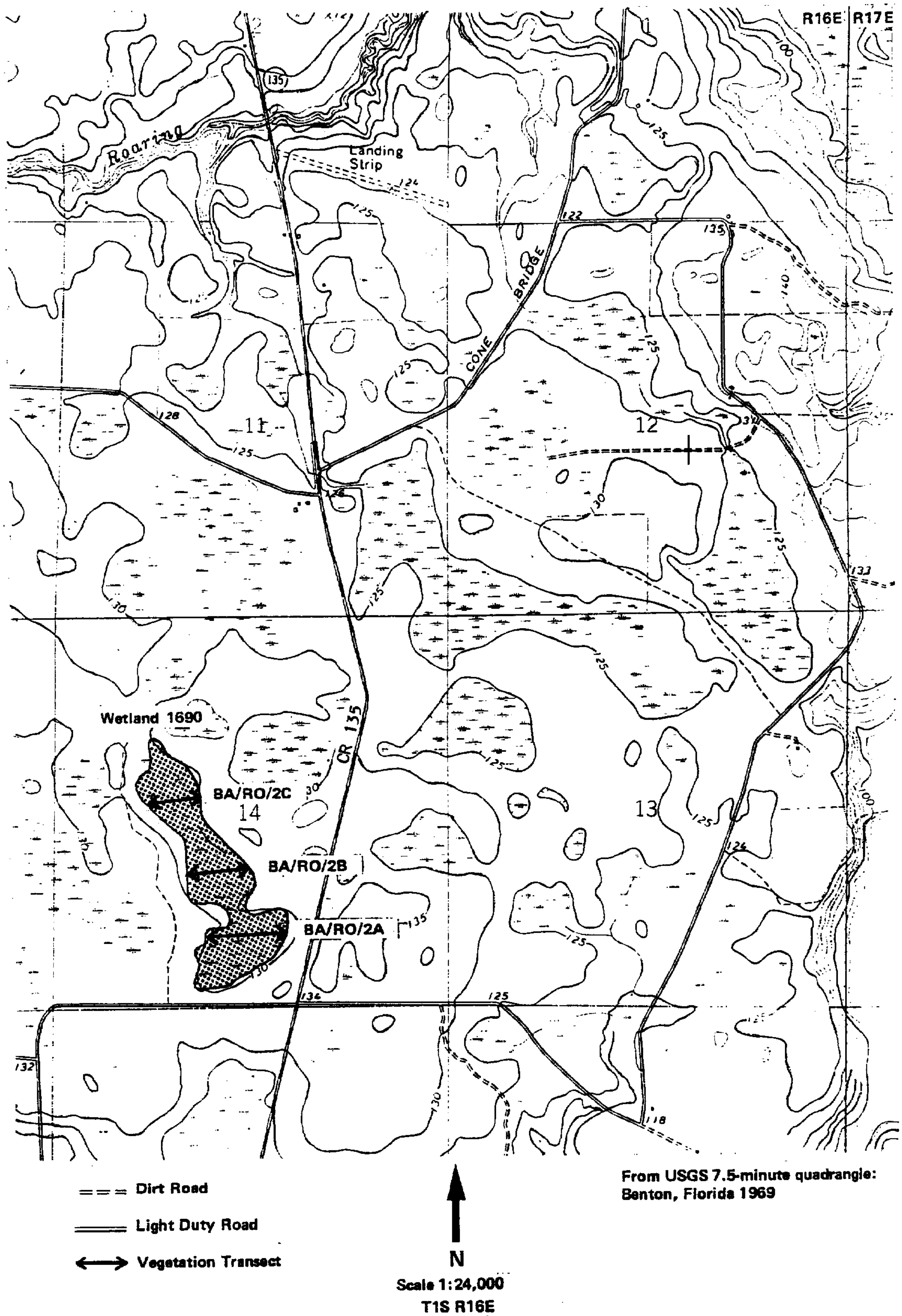


Figure 4.2-8. Wetland 1690, Roaring Creek Drainage Area.

Table 4.2-9. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 1690 Drainage Roaring Creek

Type PF02/1Cag Size (ac) 55 Surrounding area planted pine

Disturbance logged 30-40 yrs ago; fire 15-20 yrs ago Plot interval (ft) 50

Total length of transect (ft) 1900 Location T1S R16E Section 14

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Nyssa biflora	45.10	33.75	37.97	116.82	0.79		
Pinus elliottii	10.46	18.12	15.19	43.77	0.32		
Gordonia lasianthus	9.15	3.49	8.86	21.50	0.18		
Magnolia virginiana	9.15	16.09	10.13	35.37	0.21		
Persea borbonia	7.19	11.15	7.59	25.93	0.16		
Taxodium ascendens	18.95	17.39	20.25	56.59	0.42		
SUBCANOPY							
Lyonia lucida	43.84		37.21	81.05	0.84		
Nyssa biflora	33.56		32.56	66.12	0.74		
Gordonia lasianthus	4.11		2.33	6.44	0.05		
Cephalanthus occidentalis	0.68		1.16	1.84	0.03		
Magnolia virginiana	6.85		11.62	18.47	0.26		
Acer rubrum	1.37		2.33	3.70	0.05		
Taxodium ascendens	5.48		8.14	13.62	0.18		
Clethra alnifolia	4.11		4.65	8.76	0.11		
HERBACEOUS							
Clethra alnifolia			21.43	35.01	0.32	13.58	0.66
Lyonia lucida			62.50	143.98	0.92	81.48	4.05
Sphagnum sp.			8.93	11.58	0.13	2.65	0.13
Nyssa biflora			1.79	2.85	0.03	1.06	0.05
Magnolia virginiana			3.57	4.63	0.05	1.06	0.05
Acer rubrum			1.79	2.32	0.03	0.53	0.03

Mean distance (ft) 9 Mean area/individual (sq ft) 82 Density/acre 531

Total basal area (sq ft) 26,490

time of sampling, there was no standing water present, and the maximum depth of inundation, based on the presence of a lichen line and water marks, was approximately 1.2 ft, with most of the wetland being inundated to a maximum depth of approximately 0.8 ft.

4.2.8 Wetland 1175

Wetland 1175 is a small (approx. 3 acres), isolated, perched wetland located within the Suwannee River Mine drainage area (Figure 4.2-9). It is vegetated predominantly by pond cypress with minor occurrence of swamp tupelo (Table 4.2-10). The surrounding area is sharply demarcated by recently clearcut planted pine (15 year age class when cut). The organic layer varies to a depth of approximately 2.3 ft and is underlain by a layer of packed sand and clay.

Past disturbances have resulted from logging. Cypress has been logged in the wetland within the last ten years and fire lanes have altered drainage. Old fire scars indicate the occurrence of a rather severe fire within the last 25 years.

The Suwannee River Mine drainage area, which covers approximately 29 sq mi, receives its water primarily from direct precipitation. The area of immediate runoff into Wetland 1175 would be only slightly larger than the actual wetland area. At the time of sampling (1 October 1981), there was a maximum of approximately 0.9 ft of standing water in the wetland. The maximum depth of inundation based on the lichen line and water marks is approximately 1.3 ft. No outflow from this wetland was observed, with water loss through evapotranspiration.

4.2.9 Wetland 2275

Wetland 2275 is a small (approx. 3 acres), isolated, perched wetland located within the Camp Branch drainage area (Figure 4.2-10). It is vegetated by a mixture of pond cypress and swamp tupelo, with pond cypress being the dominant cypress species (Table 4.2-11). The surrounding area is planted pine of the 10-15 year age class. The organic layer varies within this wetland from approximately 0.8 ft to 2.4 ft and is underlain by a layer of packed sands and clays.

Disturbances to this wetland include logging of cypress within the past 25 years and some alteration of natural drainage patterns caused by surrounding silvicultural activities. No evidence of recent fire was observed.

This wetland's primary source of water is direct rainfall, although it receives some slight runoff from the immediately surrounding planted pinelands. At the time of sampling (19 October 1981), there was no standing water present, and, based on the absence of an obvious lichen line or water marks, this cypress head does not currently experience any significant inundation. No outflow from this wetland was observed; water loss is through evapotranspiration.

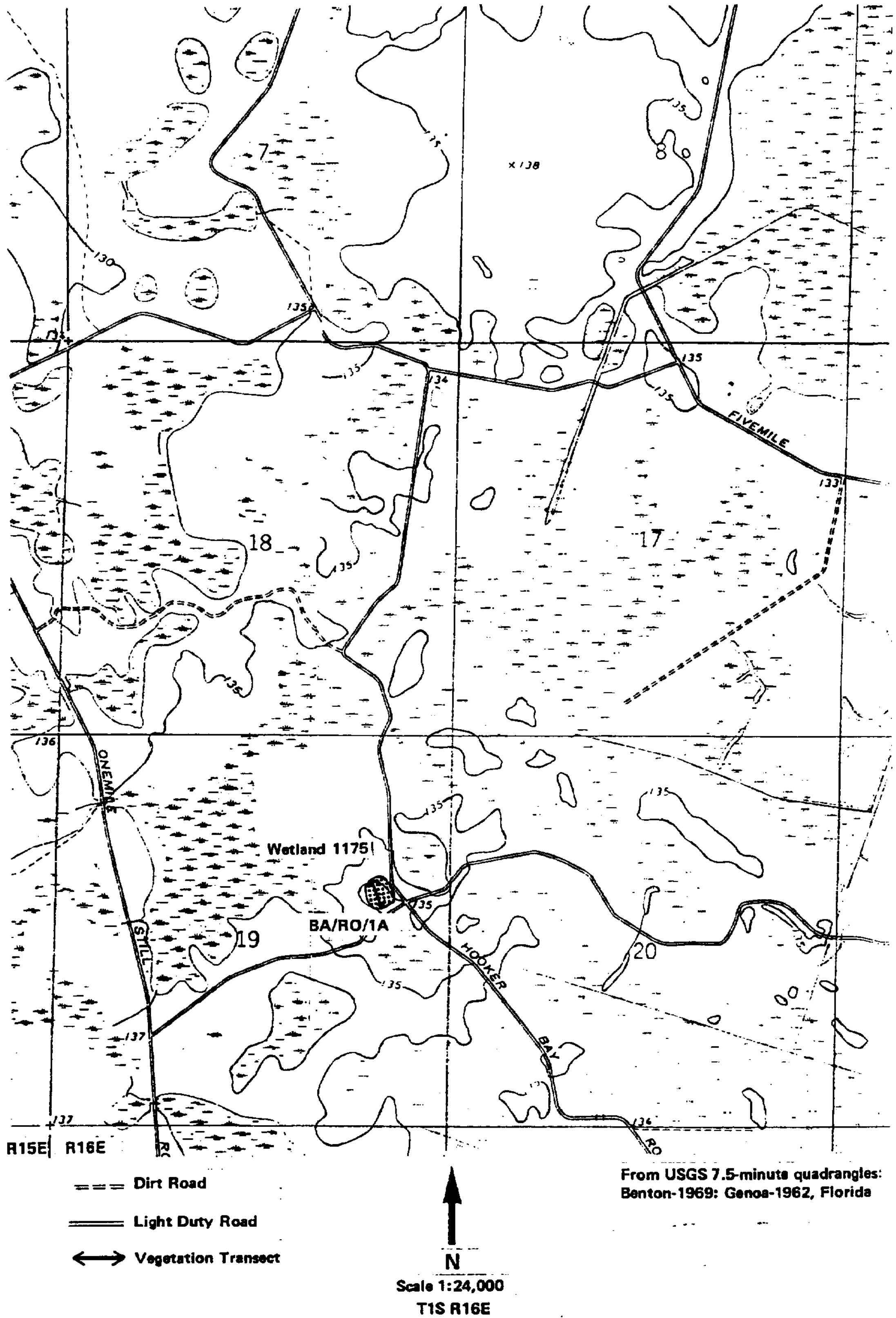


Figure 4.2-9. Wetland 1175, Suwannee River Mine Drainage Area.

Table 4.2-10. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 1175 Drainage Suwannee River Mine

Type PF02/1Cag Size (ac) 3 Surrounding area planted pine

Disturbance fire 25 yrs ago; logged 10 yrs ago Plot interval (ft) 50

Total length of transect (ft) 300 Location T1S R16E Section 19

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	95.83	94.47	85.71	276.01	1.00		
Nyssa biflora	4.17	5.52	14.29	23.98	0.17		
SUBCANOPY							
Myrica cerifera	33.33		18.75	52.08	0.50		
Lyonia lucida	29.17		31.25	60.42	0.83		
Clethra alnifolia	12.50		18.75	31.25	0.50		
Ilex virginiana	4.17		6.25	10.42	0.17		
Nyssa biflora	8.33		12.50	20.83	0.33		
Cephalanthus occidentalis	8.33		6.25	14.58	0.17		
Taxodium ascendens	4.17		6.25	10.42	0.17		
HERBACEOUS							
Woodwardia virginiana			21.42	103.12	1.00	81.70	30.50
Clethra alnifolia			14.29	21.43	0.66	7.14	2.70
Sphagnum sp.			21.42	24.10	1.00	2.68	1.00
Tillandsia usneoides			21.42	24.10	1.00	2.68	1.00
Pontederia cordata			3.57	4.02	0.17	0.45	0.17
Lycopus virginiana			3.57	4.46	0.17	0.89	0.33
Cyperus sp.			3.57	4.02	0.17	0.45	0.17
Lyonia lucida			7.14	10.71	0.33	3.57	1.33
Myrica cerifera			3.57	4.02			

Mean distance (ft) 11 Mean area/individual (sq ft) 119 Density/acre 367

Total basal area (sq ft) 18,006

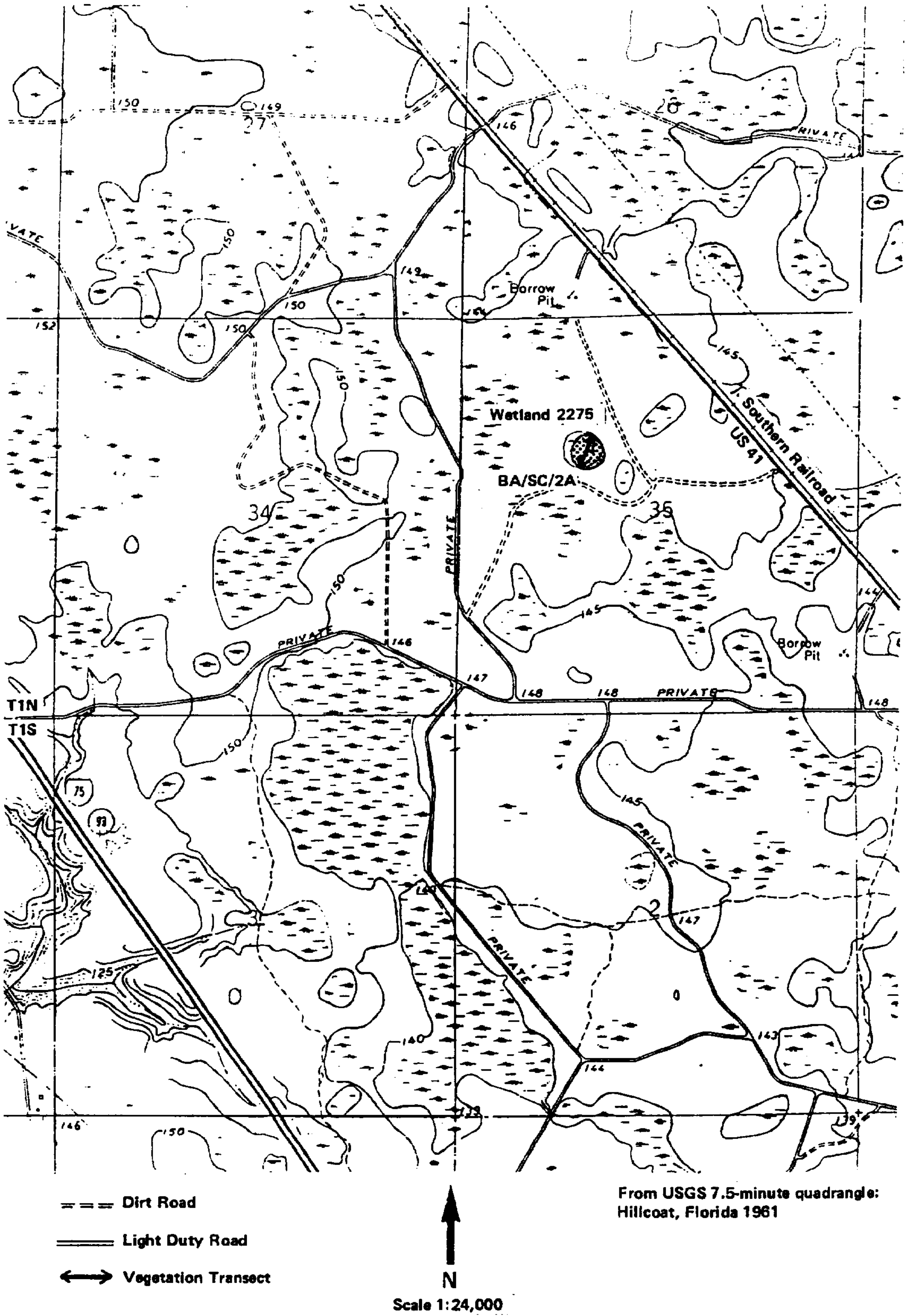


Figure 4.2-10. Wetland 2275, Camp Branch Drainage Area.

Table 4.2-11. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 2275 Drainage Camp Branch

Type PF02/1Caq Size (ac) 3 Surrounding area planted pine 10-15 yrs

Disturbance logged 25-30 yrs ago Plot Interval (ft) 50

Total length of transect (ft) 350 Location T1N R14E Section 35

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	71.43	77.67	60.00	209.10	0.86		
Nyssa biflora	28.57	22.33	40.00	90.90	0.57		
SUBCANOPY							
Nyssa biflora	38.46		40.00	78.46	0.85		
Lyonia lucida	53.85		46.67	100.52	1.00		
Clethra alnifolia	3.85		6.67	10.52	0.14		
Taxodium ascendens	3.85		6.67	10.52	0.14		
HERBACEOUS							
Clethra alnifolia			83.33	150.00	0.29	66.67	0.71
Lyonia lucida			16.67	50.00	0.14	33.33	0.14

Mean distance (ft) 11 Mean area/individual (sq ft) 116 Density/acre 376

Total basal area (sq ft) 16,038

4.2.10 Wetland 2139

Wetland 2139 is an essentially isolated, perched wetland encompassing approximately 45 acres within the Camp Branch drainage area (Figure 4.2-11). It is vegetated by swamp tupelo, pond cypress, sweetbay, red maple, slash pine, and red bay (Table 4.2-12). Past disturbance includes logging and alteration of natural drainage features as a result of surrounding silvicultural activities.

Soils underlying wetlands of this type generally are acidic, organic peat and muck with a maximum peat and/or muck depth of approximately 3.6 ft. This wetland is underlain by a tightly packed, relatively impermeable sand and clay lens.

Due to its isolated position, direct rainfall is the primary source of water supporting this wetland. It has a very small immediate drainage area from which it receives some slight runoff. At the time of sampling (19 October 1981), there was no standing water in the wetland. The lack of obvious lichen lines throughout the wetland indicates that a significant degree of inundation is lacking and, although the soils may be high in moisture content for periods of the year, standing water is not customarily present. Fire lanes and some ditching, ostensibly for drainage, connect this wetland to other nearby wetlands. No significant hydrologic link was noted. Water loss, except in extreme storm events, is primarily through evapotranspiration.

4.2.11 Wetland 2550

Wetland 2550 or Swift Creek Swamp is a broad, flat, forested depression that forms the headwaters of Swift Creek (Figure 4.2-12). It may be functionally divided into an upper section and a lower section with the functional break being a "pinch point" in the southeast corner of Section 29 T1N R15E (Figure 3.3-2 in map pocket).

The upper section can be further divided into three areas according to current usage. Area 1 of the upper section has been ditched and diked for disposal of sand tailings from the Swift Creek Mine. Area 2, located adjacent to area 1 on the north, receives effluent from the Swift Creek Mine. Area 3, adjacent to areas 1 and 2 and downstream, has been essentially unaltered by mining operations.

The lower section of Swift Creek Swamp, encompassing approximately 1500 acres, has been channelized with a straight bermed ditch running its length which carries flow from the upper section of Swift Creek Swamp, including effluent from the Swift Creek Mine and Chemical Complex. It is bordered on the east by planted pinelands and on the west by Swift Creek Mine.

Vegetation includes a mixture of swamp tupelo, pond cypress, red maple, sweetbay, slash pine, and various other hardwood species (Table 4.2-13). Soils in this section of Swift Creek Swamp are acidic, organic peat and muck underlain by a tightly packed, impermeable sand and clay layer. The depth of organics to the sand/clay lens varies from <1.0 ft deep near the borders to a maximum recorded depth of 5.9 ft.

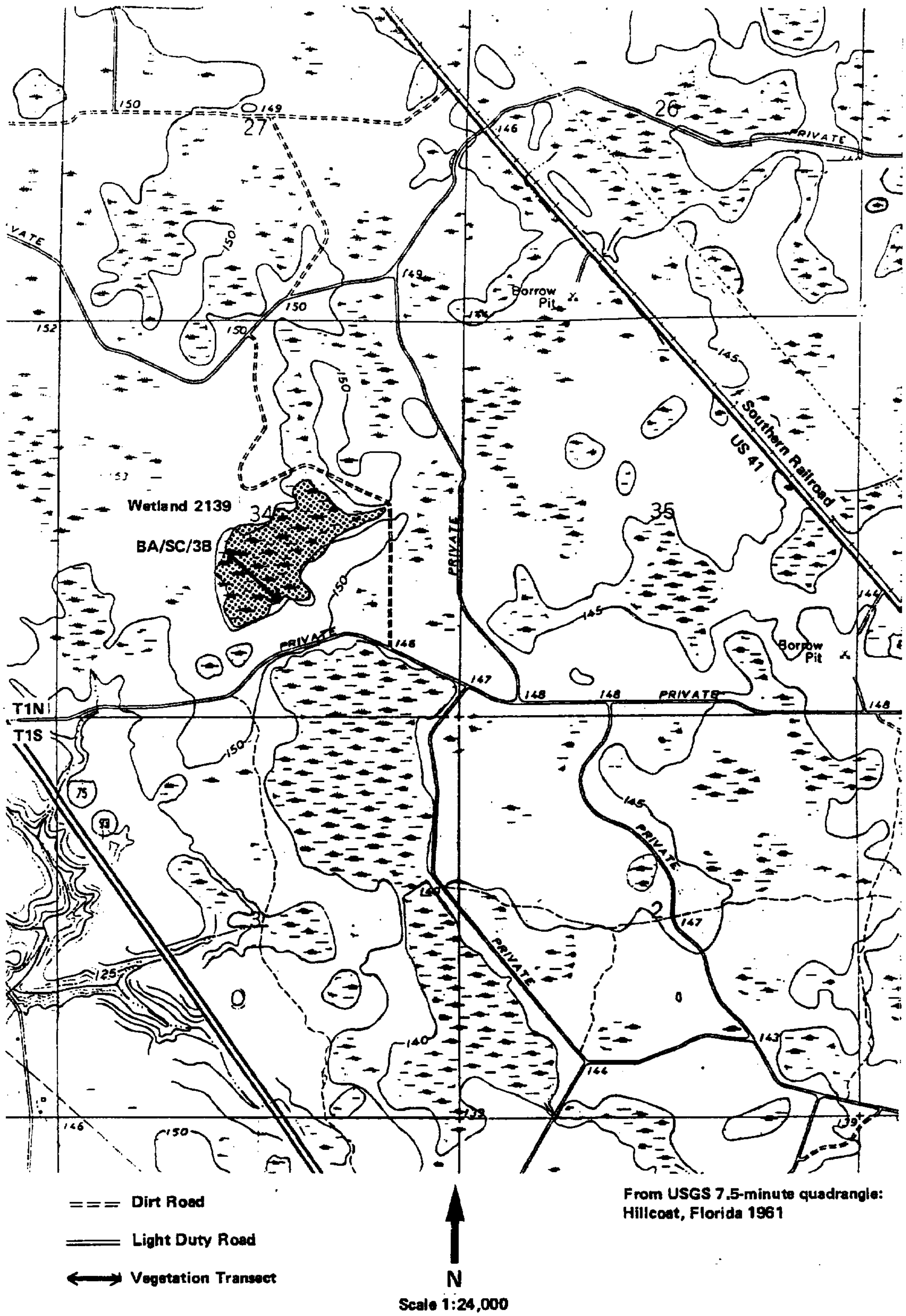


Figure 4.2-11. Wetland 2139, Camp Branch Drainage Area.

Table 4.2-12. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Unnamed Wetland No. 2139 Drainage Camp Branch

Type PF02/1Cag Size (ac) 45 Surrounding area planted pine

Disturbance drainage ditch Plot interval (ft) 50

Total length of transect (ft) 1350 Location T1N R14E Section 34

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Taxodium ascendens	4.85	5.42	8.10	18.37	0.12		
Pinus elliottii	0.97	4.61	2.70	8.28	0.04		
Nyssa biflora	82.52	81.53	67.57	231.62	0.96		
Acer rubrum	4.85	1.87	5.40	12.12	0.08		
Magnolia virginiana	5.83	6.09	13.51	25.43	0.19		
Persea borbonia	0.97	0.48	2.70	4.15	0.04		
SUBCANOPY							
Nyssa biflora	33.33		26.92	60.25	0.54		
Lyonia lucida	36.27		30.77	67.04	0.62		
Clethra alnifolia	15.69		25.00	40.69	0.50		
Cephalanthus occidentalis	1.96		1.92	3.88	0.04		
Taxodium ascendens	1.96		1.92	3.88	0.08		
Magnolia virginiana	9.80		11.54	21.34	0.23		
Myrica cerifera	0.98		1.92	2.90	0.04		
HERBACEOUS							
Lyonia lucida			47.37	85.83	0.35	38.46	0.77
Clethra alnifolia			47.37	106.99	0.35	59.62	1.19
Sphagnum sp.			5.26	7.18	0.04	1.92	0.42

Mean distance (ft) 11 Mean area/individual (sq ft) 119 Density/acre 366

Total basal area (sq ft) 20,724

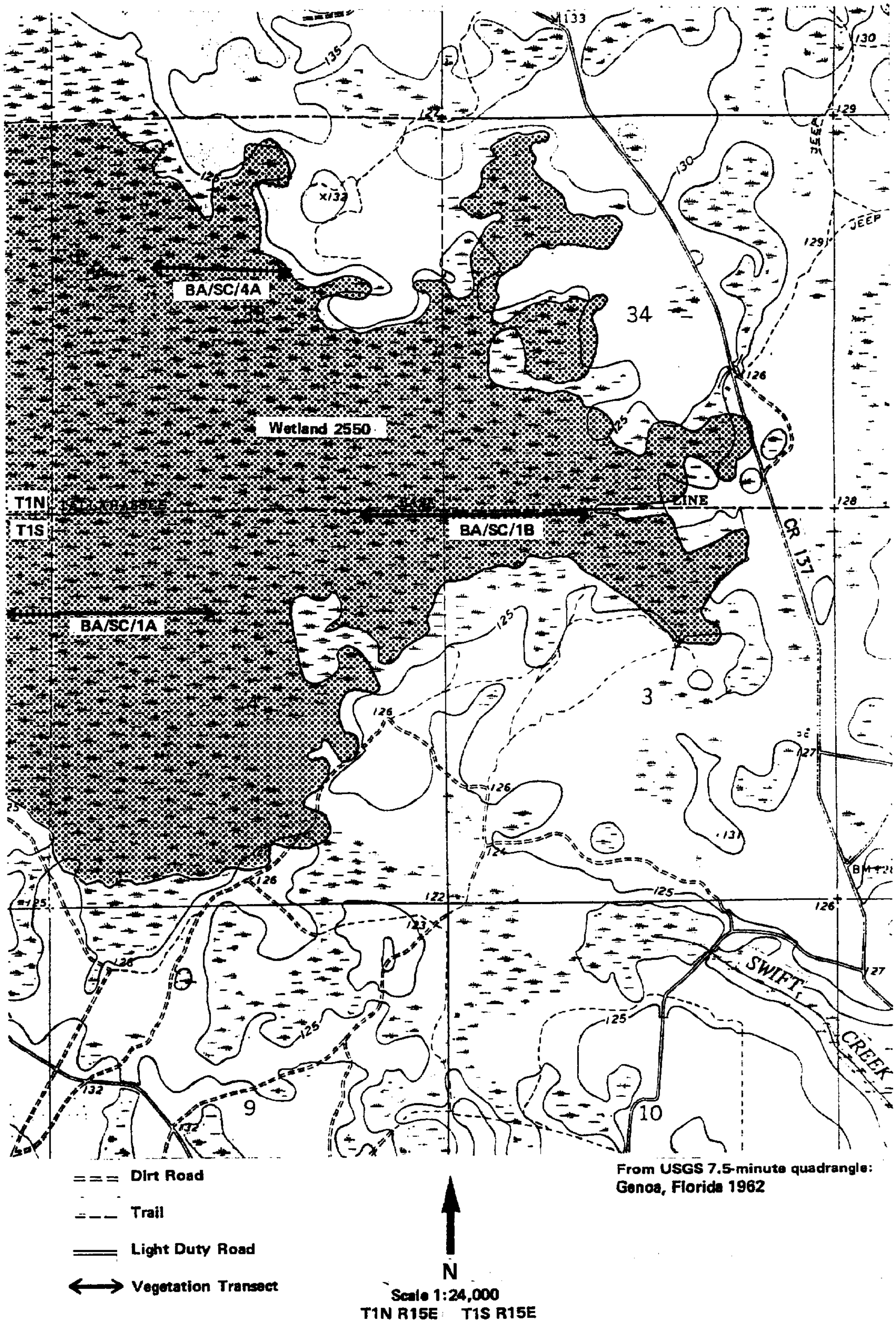


Figure 4.2-12. Wetland 2550, Swift Creek Mine Drainage Area.

Table 4.2-13. SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Lower Swift Creek Swamp Wetland No. 2550 Drainage Swift Creek Mine

Type PF01/4Cadg Size (ac) 1500 Surrounding area SCCC, planted pine, clearcut

Disturbance logged 25-50 yrs ago Plot interval (ft) 50 and 100

Total length of transect (ft) 8300 Location T1N R15E Sections 32, 33, 34
T1S R15E Sections 3, 4, 5

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
CANOPY							
Acer rubrum	21.17	21.94	23.19	66.30	0.54		
Lyonia lucida	0.18	0.14	0.30	0.62	0.01		
Nyssa biflora	37.90	29.18	32.53	99.61	0.76		
Taxodium ascendens	14.23	23.29	16.57	54.09	0.39		
Magnolia virginiana	21.89	21.90	21.39	65.18	0.50		
Persea borbonia	0.71	0.81	0.90	2.42	0.02		
Ilex opaca	0.18	0.04	0.30	0.52	0.01		
Pinus elliottii	0.18	0.43	0.30	0.91	0.01		
Gordonia lasianthus	3.38	2.25	4.22	9.85	0.10		
Ilex sp.	0.18	0.03	0.30	0.51	0.01		
SUBCANOPY							
Nyssa biflora	30.18		27.02	57.20	0.61		
Acer rubrum	40.54		33.85	74.39	0.77		
Lyonia lucida	1.96		2.80	4.76	0.06		
Gordonia lasianthus	1.79		2.48	4.27	0.06		
Clethra alnifolia	11.61		14.60	26.21	6.33		
Magnolia virginiana	7.41		9.63	17.04	0.22		
Saururus cernuus	0.18		0.31	0.49	0.01		
Taxodium ascendens	4.11		5.59	9.70	0.13		
Ilex sp.	0.36		0.62	0.98	0.01		
Persea borbonia	1.25		1.55	2.80	0.04		
Pinus elliottii	0.18		0.31	0.49	0.01		
Myrica cerifera	0.71		1.24	1.95	0.03		

Mean distance (ft) 11 Mean area/individual (sq ft) 115 Density/acre 379

Total basal area (sq ft) 26,396

Table 4.2-13 (Continued). SUMMARY DATA SHEET -- WETLANDS VEGETATION

Wetland Lower Swift Creek Swamp Wetland No. 2550 Drainage Swift Creek Mine

Type PF01/4Cadg Size (ac) 1500 Surrounding area SCCC, planted pine, clearcut

Disturbance logged 25-50 yrs ago Plot interval (ft) 50 and 100

Total length of transect (ft) 8300 Location T1S R15E Sections 3, 4, 5
T1N R15E Sections 32, 33, 34

Species	Relative Density	Relative Basal Area	Relative Frequency	Importance	Frequency	Relative Herbaceous Density	Herbaceous Density
HERBACEOUS							
Lyonia lucida			6.28	11.92	0.09	5.64	0.23
Clethra alnifolia			22.22	35.80	0.32	13.58	0.54
Magnolia virginiana			1.45	4.45	0.02	3.00	0.12
Rhus radicans			11.59	19.70	0.17	8.11	0.26
Unidentified mint			7.25	11.48	0.11	4.23	0.17
Saururus cernuus			6.76	13.11	0.09	6.35	0.25
Woodwardia areolata			22.22	60.67	0.32	38.45	1.53
Vitis sp.			7.73	11.96	0.11	4.23	0.17
Limnobium spongia			0.97	6.61	0.01	5.64	0.23
Acer rubrum			6.28	11.22	0.09	4.94	0.20
Gordonia lasianthus			1.93	4.58	0.02	2.65	0.11
Osmunda cinnamomea			1.93	2.99	0.03	1.06	0.04
Centella asiatica			0.48	0.66	0.01	0.18	0.01
Itea virginica			0.48	1.19	0.01	0.71	0.09
Polygonum hydropiperoides			0.97	1.32	0.01	0.35	0.01
Persea borbonia			0.97	1.32	0.01	0.35	0.01
Hypericum fasciculatum			0.48	1.01	0.007	0.53	0.02

Mean distance (ft) 11 Mean area/individual (sq ft) 115 Density/acre 379

Total basal area (sq ft) 26,396

The entire swamp has been repeatedly logged, as is evidenced by several size and age classes of cypress stumps, and a straight, bermed ditch has been cut through the length of the swamp. An old logging road penetrates the swamp from the south, extending to a central island which was the focus of a clearcut logging operation in the immediate past. Two other drainage ditches have been cut across the natural flow pattern on the eastern side. The major ditching in Swift Creek Swamp has had an impact in "drying up" the swamp, as evidenced by the advanced oxidation of the organic substrate in many locations.

Swift Creek Swamp is in the headwater position of the Swift Creek Mine drainage area which covers approximately 22 sq mi. Water supporting the swamp comes from direct rainfall and runoff from the surrounding planted pine. The lack of a lichen line and the oxidized condition of the organic matter in much of the swamp indicate it does not experience any significant periods of inundation. It is undoubtedly much drier than it was historically. Water loss from the swamp is primarily through evapotranspiration although there may be some seepage into the drainage canal.

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5.0 RELATIONSHIP OF PROPOSED ACTIONS TO LAND USE PLANS

The 1979 population estimate for Hamilton County was 8761, and by the year 2000 only about 10,700 people are predicted to be in the county (Florida Div. of Economic Development 1981). As of 1975, approximately 3.3% of the county, or 10,859 of the 327,578 acres, was classified as urban (Table 5.0-1). The vast majority of Hamilton County, 294,212 acres (90%), is forested (mainly commercial forests) or in agriculture. Projections for the county are that urban areas will expand moderately by the year 2000 (NCFRPC 1977b). While large areas in the county have development potential (NCFRPC 1977b), whether or not the development will be realized is uncertain. Future land use predictions indicate that the vast majority of Hamilton County, including the current OXY mining area, will be "conservation" areas (NCFRPC 1977b).

Conservation areas are "land and waters having some intrinsic value" and include: areas subject to 100-yr floods, significant forest areas, game management areas, significant mineral deposits, and lands with significant soil, drainage, or other physical restrictions for community or urban development. A large portion of the lands in Hamilton County are classified as "conservation" areas; however, this does not mean that development is wholly precluded from these areas, but that thorough consideration should be given to these areas by the local government agency prior to development approval. More specifically, the goals, objectives, and policies of the land use plan should be considered and used as a guide by local government for approval of development in these areas.

For rock and mineral resources, the stated objective is (NCFRPC 1977b): "To plan for and guide the mining and utilization of mineral resources tempered by a consideration of the balance between long-term national, state, and regional needs as well as regional environmental and social cost." Specific goals include the wise management of mineral resources and land reclamation compatible with the environment. Policies of the land use plan are:

1) land reclamation in mine areas,
2) planned land use,
3) mining and reclamation ordinances by local governments,
4) prudent use of resources, and
5) more efficient mining techniques.

In its mining (Section 2.0) and reclamation plans (Section 3.3.10), OXY meets these goals and policies by wise use of the mineral resources and reclamation of mined lands to productive uses. OXY's reclamation plans include replacement of mined wetlands on an acre-for-acre basis, so that net wetland acreage will not be lost in the area.

Table 5.0-1. Profile of Existing Land Use for Hamilton County and Proposed Acreages of Mining and Mine Support Facilities in Each Land Use Category.

Land Use Category	Hamilton County[1] (acres)	Percent	Project Area[2] (acres)	Alternative Mine Plans[2] (affected acres)			
				A	B	C	D
Urban and Built-up	10,859	3.3	688	25	95	28	27
Agriculture	69,583	21.2	7,945	791	1,176	997	1,067
Forested	224,629	68.6	50,477	7,874	17,645	13,774	17,235
Water	820	0.3	590	10	67	18	23
Wetland	11,560[3]	3.5	24,735[3]	0	9,264	2,452	8,601
Other (extractive)	10,127[3]	3.1	15,769[3]	1,184	2,340	1,357	908
Total	327,578	100.0	100,204	9,884	30,587	18,626	27,861

[1]Data for c. 1975 from NCFRPC (1977b).

[2]Estimates from c. 1979 aerial photography.

[3]There are discrepancies in estimates of wetlands and other acreages quoted by different sources, possibly as a result of some studies classifying isolated depressions as wetlands while others may include them with the surrounding uplands. For example, the National Wetlands Reconnaissance Survey by the U.S. Fish and Wildlife Service estimated 73,481 acres of wetlands in Hamilton County.

OXY has evaluated four alternative mine plans for future mining operations in Hamilton County (Section 2.2). Existing land use and the proposed mining acreage of each land use category under each mining alternative are summarized in Table 5.0-1.

Land use planning and management for the county is administered by the North Central Florida Regional Planning Council, Hamilton County Planning Board, Suwannee River Water Management District, and Florida Department of Transportation, as discussed in the following sections.

5.1 North Central Florida Regional Planning Council

Hamilton County and the proposed OXY mining area are within the 11-county region of the North Central Florida Regional Planning Council (NCFRPC), a sub-division of the Florida Department of Community Affairs. The NCFRPC carries out the policies of the Bureau of Land and Water Management for the North Florida region. Generally, the Division's policies relating to the efficient use of Florida's minerals (including protection and reclamation) encourage the protection of future mineral extraction sites through sequential and time-phased land use regulation. Mineral policies require mandatory reclamation of mining sites and encourage innovations in land reclamation technology. The NCFRPC functions as an advisory planning agency and has assisted Hamilton County in preparing comprehensive growth and development plans and ordinances and regulations needed to implement the plans.

The NCFRPC recognizes that water resources and good water quality, wildlife populations and habitats, and streams, floodplains, and other wetlands are important to the overall ecological integrity of the area (NCFRPC 1977b). Industrial activities and development should be conducted in a manner most compatible with existing natural conditions.

The NCFRPC guides development through the Development of Regional Impact (DRI) process. The DRI document assesses the impact a proposed activity may have on:

- the environment and natural resources of the region;
- the economy of the region;
- public facilities including water, sewer, and solid waste disposal;
- public transportation facilities;
- available housing; and
- other criteria for determining regional impact, provided such criteria and related policies have been adopted by the regional planning agency.

The NCFRPC policies attempt to guide future development through three general land use categories (NCFRPC 1977b):

- Preservation - Those lands that have major ecological, hydrological, physiographical, historical, or socioeconomic importance to the public at large, such as selected coastal marshes and freshwater swamps, prime agricultural areas, and rivers. Public policy should attempt to protect the function or value associated with these areas consistent with private property rights.

- Conservation - Lands and waters having some intrinsic value attached to them, such as significant forest areas, game management areas, significant mineral deposits, and lands with soil, drainage, or other physical restrictions for urban development. Development of these areas should be reviewed and allowed only after thorough consideration by the local government.

- Development - Those areas that are 1) presently developed, 2) undeveloped but intrinsically suitable for intensive development, and 3) undeveloped but possessing minor physical limitations to development that can be corrected. It is recommended that development or expansion in these areas be monitored and guided to minimize conflicts in land use goals.

Based on a land use map of existing conditions in c. 1975-1976 for the 11-county region including Hamilton County (NCFRPC 1977c), the OXY project area, located in the northern section of the region, is shown primarily as forested lands, with some agricultural lands, in addition to mining lands. Land use for the OXY mine area in the year 2000 is projected to be conservation areas after mining and reclamation.

The preservation areas in Hamilton County mainly correspond with the 100-year floodplain along the Suwannee River. As a result of the 1974 DRI application for the OXY site (Fla. Dept. of Admin. 1974), reviewed and approved by the NCFRPC, the floodplains along these streams were excluded from future mine plans. OXY agreed with the State that in mining of phosphate reserves, no minerals would be removed from or waste disposal areas constructed on 1) the 100-year floodplain of the Suwannee River, 2) the floodplains of major creeks for at least 0.5 mi upstream from the creek's confluence with the Suwannee, and 3) land within a 500 ft radius of any third magnitude or larger spring or any major sinkhole (Fla. Dept. of Admin. 1974). The boundaries of the excluded area were based on U.S. Geological Survey 100-year flood-prone maps, and a minimum buffer zone of 500 ft was to exist on either side of the river. This agreement effectively excluded 10,000 acres of the original DRI application as well as neutralized conflicts of land use and industrial activities in the area.

The NCFRPC (1977d) described significant natural areas within its boundaries. The only such area near proposed OXY mining activity is the Suwannee River, which as waters of the State and waters of the United States, receives both state and federal protection. Activities that may impact the Suwannee River receive additional scrutiny because of the river's Outstanding Florida Water designation. Thus, OXY's mitigation and reclamation efforts will consider the NCFRPC's policy of protecting the river and adjacent wetlands and wildlife habitat.

The NCFRPC also recognizes the importance of maintaining the socioeconomic integrity of its area of responsibility. The council strives to "plan for and guide the mining and utilization of mineral resources tempered by a consideration of the balance between long-term national, state and regional needs as well as regional environmental and social cost" (NCFRPC 1977b).

5.2 Hamilton County Planning Board

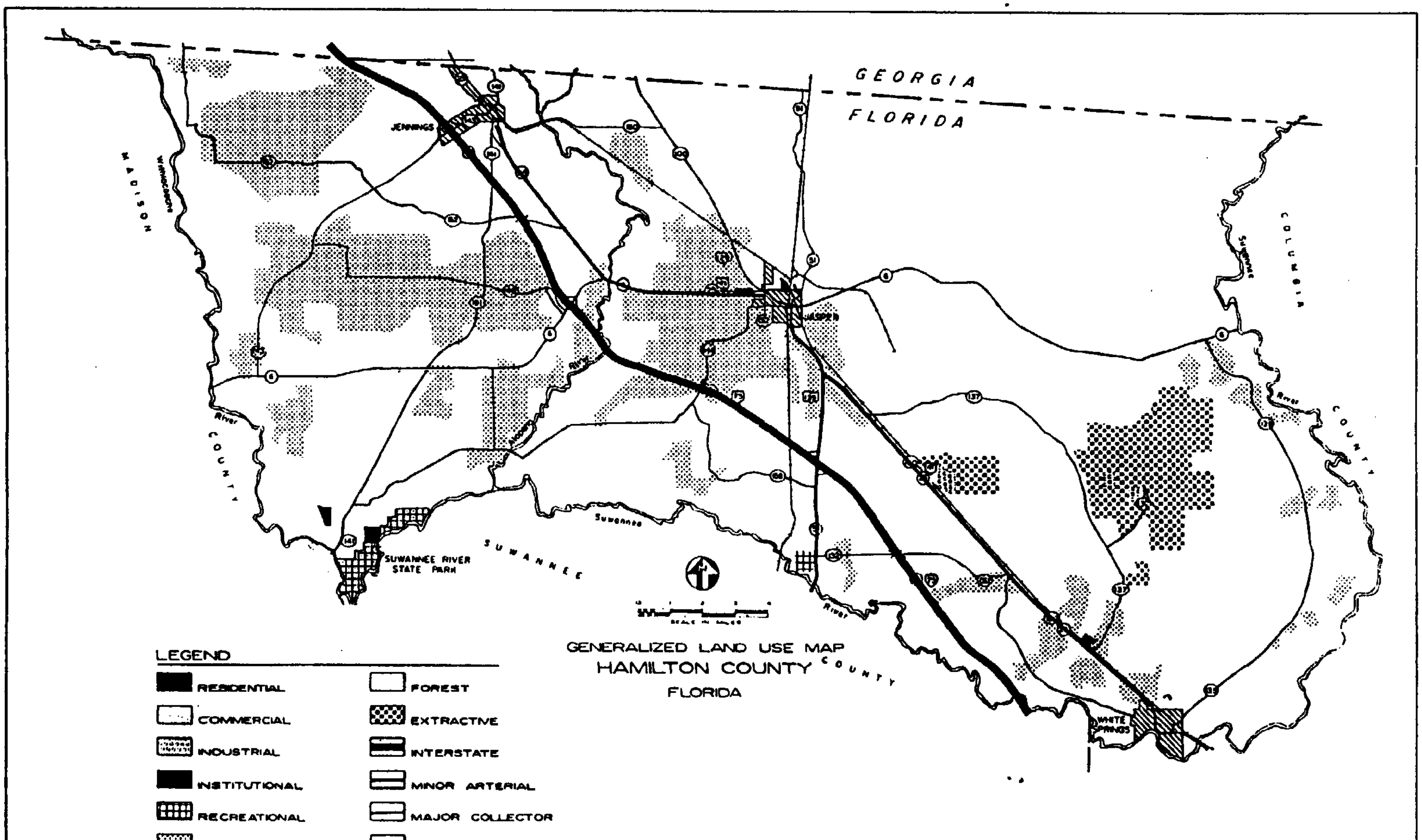
The Hamilton County Planning Board is responsible for managing the growth and development of the county under the guidance of the three-volume Hamilton County Comprehensive Plan (NCFRPC 1980). Volume 1 (Inventory) evaluates the physical and socioeconomic characteristics of the county. Volume 2 (Plan) inventories the natural resources (including soils, wetlands, forests, and agriculture), mineral resources, population, transportation, and growth impact evaluation system for assessing future growth. Volume 3 (Regulations) had not been adopted by the county as of January 1984.

As part of the Hamilton County Comprehensive Plan, Boughey et al. (1976) prepared a Hamilton County land use map describing conditions existing in c. 1975-1976 (Figure 5.2-1). The map indicates that of the approximately 327,600 acres in Hamilton County, 90% is forested or in agriculture (Table 5.0-1). As of c. 1975-1976, approximately 10,127 acres had been mined or were utilized for mine support facilities. The present and proposed mining areas are surrounded mainly by forested area. The official land use plan maps for Hamilton County are on display at the Hamilton County courthouse and at the city halls of Jasper, Jennings, and White Springs.

The Comprehensive Plan establishes several important development goals for Hamilton County that may be related to phosphate mining (NCFRPC 1980):

- Encourage intensive future growth and development in the general area of existing urban centers in order to maximize the efficient provision of public services and facilities and protect the natural, forested, and agricultural areas of the county from scattered and inefficient development.
- Protect and conserve the lands bordering the Suwannee, Withlacoochee, and Alapaha rivers from developments which would have environmentally and aesthetically harmful effects on these areas and which would increase potential flood hazards to area residents.
- Require the sound environmental reclamation of all mineral and earth resources extraction sites so that they can be productively used after the resource is depleted.

OXY's mining and reclamation plans meet and exceed these goals in all its mining alternatives. Although mining will occur in forested and agricultural areas, mining is not proposed in any areas designated as prime agricultural lands. No mining is planned for areas bordering the Suwannee River, and lands mined by OXY will be reclaimed according to the rules set forth in Chapter 16C-16, FAC, so that viable, productive land forms will result at post-mining.



Taken from Boughey et al. 1976.

Figure 5.2-1. Generalized Land Use Map, Hamilton County, Florida, 1976.

There are no conflicts between the Hamilton County Mining Ordinance (No. 48-81) and the proposed OXY mining plans. The ordinance requires that all areas disturbed by mining after 20 January 1981 be reclaimed in accordance with the provisions in Section VIII of the ordinance.

As a result of recommendations made by the Suwannee River Resource Planning and Management Committee in 1982, counties along the Suwannee River were encouraged to develop floodplain ordinances. The intent of the Hamilton County Floodplain Ordinance is to conserve and maintain the floodplain of the Suwannee River and its tributaries. Mining in these floodplains has been excluded from OXY mining plans (Section 5.1). Therefore, no conflicts exist between any of OXY's mining alternatives and this ordinance.

The Hamilton County Conservation Element is set forth in Volume 2, Part 2 of the Community Facilities Plan (NCFRPC 1977a). Its function is to discourage any development or industry in environmentally sensitive areas and to guide development activities in an environmentally compatible manner. The Conservation Element recognizes the importance of water resources and important habitats. Through enforcement of the principles in the Conservation Element, the county "should insure that the mining activities do not permanently degrade the future use of lands...." (NCFRPC 1977a). OXY's mining and reclamation plans meet the goals of the conservation element by restoring viable, productive lands for future use.

5.3 Suwannee River Water Management District

Hamilton County is located in the Suwannee River Water Management District (SRWMD), a regional state agency responsible for water quantity management, development of the district's water use plan, and other water management activities as described in Chapter 373, Florida Statutes. The SRWMD has no land use management plan; however, it has been indirectly involved in planning by participating in the development of a model ordinance for controlling development in the 100-year floodplain of the Suwannee River and its tributaries. The ordinance has been adopted by Hamilton County along with other counties in the Suwannee River basin.

The SRWMD's land acquisition program has the potential to impact land use within the district. The intent of the program is to obtain lands related to the supply, management, conservation, and protection of water resources such as floodplains and flood-prone areas, swamps and other wetlands, areas of high groundwater recharge, and sinkholes (SRWMD 1983). The SRWMD has designated no specific lands for acquisition and there are no plans to designate any OXY mine lands for acquisition (pers. comm. Joe Flanagan, SRWMD).

5.4 Florida Department of Transportation

The Florida Department of Transportation (FDOT) is responsible for road and bridge construction and maintenance and therefore must be aware of land use and potential changes in land use so that accurate long-term projections for transportation needs can be made. The FDOT has mapped current land use for portions of the state, but not in Hamilton County or the proposed OXY mine area; furthermore, FDOT has not formulated a long-term land use plan for future expansion of highways within Hamilton County. The regional FDOT office in Lake City develops plans for rural areas generally for a period of five years. The only project planned for the OXY area is the construction of a small bridge over Swift Creek (Section 15, R15E T1S) for the fiscal year 1986-1987 (pers. comm., James H. Pitman, Lake City FDOT). This project should present no conflict with any of the mining alternatives proposed by OXY.

5.5 Summary

OXY's mining and reclamation activities are in accordance with rules and regulations of local, regional, state, and federal agencies for the wise management of mineral resources and land reclamation to restore productive land uses compatible with the environment. Few other development activities are subject to such rules and regulations requiring reclamation of productive lands at the end of the development activity. In the case of the phosphate industry, regulations require restoration of disturbed lands to productive ecosystems and land uses similar to those which existed prior to mining (Ch. 16C-16, FAC). In its proposed reclamation plans, OXY provides for reestablishment of ecosystems and land uses (Section 3.3.10).

5.6 Literature Cited

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6.0 PROBABLE IMPACTS ON THE ENVIRONMENT

6.1 Physiographic Characteristics

Impacts on the physiography of the OXY project area as a result of mining are directly associated with overburden and matrix extraction and creation of land and lakes, elevated fill, and tailings fill areas which affects soils, topography, and drainage basin size. Overburden and matrix extraction affects stream characteristics in mining alternatives in which stream sections will be mined. Probable impacts on the physiographic characteristics are discussed in the following sections as they relate to the various mining alternatives.

6.1.1 Alternative A: No Mining or Mine Support in Wetlands

Approximately 9183 acres (9% of the project area) will be mined, with a total excavation of approximately 530,768,000 cu yd of overburden material and matrix (Section 2.2.1). Overburden ranges in depth across the project area from approximately 10-30 ft thick, with ore matrix averaging about 15 ft. This yields a total excavation depth of only 30-50 ft; therefore, extraction will not adversely affect the integrity of the primary Hawthorn confining bed and the underlying Floridan Aquifer limestone (Section 3.1).

The process of overburden and matrix extraction will result in an immediate, although temporary, impact on the topography as a result of mine pits and cast overburden piles. There is a potential for soil erosion and dust from the unvegetated overburden piles. Runoff will be collected in perimeter ditches and in adjacent mine pits and will be clarified before entering surface water courses, thus minimizing the impacts. Dust will not have a significant impact because there are seldom high winds in the project area (Section 3.2.3).

Another temporary land form change is associated with the diked waste clay disposal areas (mean dam height approximately 24 ft above land surface). There is an extremely low potential of dam failure and washout of clay wastes to surrounding areas. The likelihood of such an occurrence is remote because dams are built, maintained, and inspected pursuant to regulations in Chapter 17-9, FAC; these standards are considered more than adequate by the engineering community.

The sinkhole potential within the project area is expected to remain the same as under existing conditions for all of the mining alternatives. Factors that would tend to increase the sinkhole potential in an area include: 1) increased recharge rates, 2) increased overburden pressure on underlying cavernous rock, and 3) a significant increase in the hydraulic gradient between the Surficial Aquifer and the Floridan Aquifer with time. None of these factors is expected to significantly increase as a result of the proposed mining operations for any of the alternatives.

Drainage basin sizes will also change during mining activities. Base flows may be reduced to little or no flow in some streams, thereby affecting aquatic resources. The changing flow regime in the streams may result in changes in bed load movement in the streams. However, these impacts are temporary as the drainage area will be reclaimed to approximately its original size per requirements of Ch. 16C-16, FAC.

Reclamation activities on lands proposed for mining and mandatory lands previously mined will result in creation of land and lakes, elevated fill, and tailings fill areas over 18,496 acres of the project area (Table 6.1-1). The topography of the reclaimed area will be slightly rolling, with the occurrence of lake systems, few of which currently exist in the geographical area. The lakes will provide productive fish and wildlife habitat and recreational activities (duck hunting and fishing) for the general area.

Soils characteristics of the reclaimed lands will be different from those prior to mining. Overburden material (20-30 ft thick) is reworked during reclamation and spread to other locations. This redeposited material is more heterogeneous, less stratified, and less dense than the original soils. The matrix, less the product, is separated into clay, sand, and mudball waste products which are used, in addition to the overburden material, in reclamation.

A comparison of natural soils in the project area, classified as Troup and Leon fine sands, with reclaimed land soils (approximately six years after reclamation) indicated that reclaimed land soils were generally less acidic than the undisturbed soils or natural soils in the project area (Blue 1981). The reclaimed soils contained more extractable phosphorus, calcium, and magnesium, but were similar in concentrations of micronutrients. Organic matter, which has a positive influence on water-holding capacity, was generally lower on reclaimed lands and in overburden material than in natural soils; however, due to the presence of more clay in reclaimed and disturbed overburden material, water-holding capacities were similar in soils before and after mining.

Reclaimed soils will be subject to erosion for the period after grading and other earthwork and before revegetation. Although erosion potential is higher for reclaimed soils than for natural, undisturbed soils, impacts should be minimal and temporary, as significant revegetation cover can be established because of Florida's long growing season. Chapter 16C-16, FAC, requires that vegetative cover be established by the next growing season after reclamation.

6.1.2 Alternative B: Mining All Wetlands Containing Reserves

Under this alternative approximately 25,899 acres are proposed for mining; total excavation will result in removal of approximately 1.5 billion cu yd of overburden material and matrix (Section 2.2.2). Probable physiographic impacts are similar to those discussed for Alternative A (Section 6.1.1). Under Alternative B, however, a larger area will be subject to reclamation (Table 6.1-1), wetlands containing reserves will be mined, and portions of tributary streams will be mined and reclaimed. Streambed mining and reclamation will impact water

Table 6.1-1. Acreages of Reclamation Types by Mining Alternative.[1]

Mining Alternative	Land and Lakes	Elevated Fill	Tailings Fill	Total Reclaimed[2]
A: No Mining or Mine Support in Wetlands	7,537	9,062	1,897	18,496
B: Mining All Wetlands Containing Reserves	14,373	18,112	6,366	38,851
C: Mining Only Small Isolated or Weakly/ Periodically Connected Wetlands Containing Reserves	11,046	12,262	3,582	26,890
D: Mining in Areas Requiring Only ACOE Permits	12,640	17,492	6,166	36,298

[1]Based on mining and reclamation after 1982; includes lands that would be reclaimed under the non-mandatory reclamation program (Ch. 16C-17, FAC), if approved.

[2]Excludes 941 acres of land and lakes and 944 acres of tailings fill reclamation types reclaimed prior to January 1982 and 919 acres of cooling ponds/gypsum stacks.

quality and aquatic resources (Sections 6.2, 6.3, and 6.4). Streams will be rerouted to mine the original streambed. Recreation of stream channels following mining may change the slope, sinuosity, and substrate of the streams.

The acreage of wetlands in the project area will be reduced during mining; however, this will be temporary, as reclamation plans call for replacement of wetland acreage mined on a 1:1 basis. Reclaimed land will occupy approximately 38,851 acres (39%) of the project area at completion of mining (Table 6.1-1).

6.1.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Under Alternative C, approximately 16,746 acres are proposed for mining, with extraction of approximately 981,169,000 cu yd of overburden material and matrix (Section 2.2.3). Only small isolated or weakly/periodically connected wetlands containing reserves will be mined and reclaimed. Impacts associated with this mining alternative are similar to those described for Alternatives A and B. Wetland acreage will be temporarily reduced during mining, with replacement of wetland acreage mined on a 1:1 basis. Reclaimed land will occupy 26,890 acres or 27% of the project area (Table 6.1-1).

6.1.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Approximately 24,157 acres are proposed for mining under this alternative; total excavated material is calculated to be approximately 1.4 billion cu yd (Section 2.2.4). Impacts on physiographic characteristics are similar to those described previously. The acreage of the wetlands in the project area will be temporarily reduced, with reclamation of wetland acreage on a 1:1 basis. Reclaimed land will occupy 36,298 acres or approximately 36% of the project area (Table 6.1-1).

6.1.5 Literature Cited

Blue, W.G. 1981. Occidental Chemical Company's proposed land forms: their forage productivity potential and usefulness for agriculture. Report prepared for Occidental Chemical Agricultural Products, Inc. 8 pp.

6.2 Ecology

6.2.1 Upland Communities

Fifteen upland community types occupy approximately 74,191 acres (74%) of the project area. These communities are categorized into five major land use groups:

Land Use Group	Acreage	% Upland Community	% Project Area
Croplands/pasturelands	7,945	10.7	7.9
Pineland systems	37,991	51.2	38.0
Mixed forest	12,399	16.7	12.4
Other hardwoods	87	0.1	<0.1
Mining and processing lands	15,769	21.3	15.7
TOTAL	74,191	100.0	74.0

Pineland systems are the major upland communities (51%), with 24,861 acres (65%) of the 37,991 acres of pineland systems consisting of planted coniferous forest (slash pine plantations). Forest management activities, ongoing mining, and logging have altered the natural vegetation communities in the project area (Section 3.3.2), thereby reducing their functional values and diminishing their value for wildlife. An evaluation of upland community types indicated that upland habitats in the project area are generally of low to moderate value (Section 3.3.8).

6.2.1.1 Probable Impacts of Mining and Reclamation Activities

6.2.1.1.1 Mining

Upland communities in the project area will be affected by site preparation, excavation of overburden and matrix, and construction of auxiliary facilities.

Flora. Preparation of mining blocks is sequential so that only a portion of a mine site is disturbed at any one time. Under the proposed mining alternatives, no upland community will be completely affected during the life of the mine. Preparation begins with installation of drainage ditches to remove surface water and lower the water tables within the mining block. Clearing of the block and construction of internal ditches and support facilities effectively eliminates all vegetation. Marketable timber will be removed prior to final clearing in commercial forest areas whether mining occurs or not. After excavation of the overburden and matrix, interim vegetation associations will arise as a result of invasion by early successional upland species on overburden piles and wetland species in mine pits, which typically contain water.

Reclamation (per requirements of Ch. 16C-16, FAC) occurs as soon as is practically possible after mining to restore viable productive vegetation communities through planting and seeding of native plant species (Section 3.3.10). Because no upland community types will be totally disturbed by mining in any of the proposed alternatives, the vegetation species associated with these community types will remain a part of the project area flora. The undisturbed upland community areas will serve as seed sources for invasion of adjacent mined and reclaimed areas.

Fauna. Sequential clearing of mining blocks will allow migration of larger fauna away from active mining areas. However, adjacent habitat probably is at carrying capacity for the site; therefore, migration of larger fauna into these adjacent areas could result in more predation, disease, and a decrease in reproduction which would result in population loss. Smaller, less mobile species would also experience population losses.

Interim habitats created by excavation and extraction support a large number of species including several protected by the U.S. Fish and Wildlife Service and/or Florida Game and Fresh Water Fish Commission. For example, small mammal populations on mining and processing lands were found to be more abundant than those in adjacent flatwoods (Frohlich 1981). However, as these interim habitats mature, population levels generally decline.

Approximately 70 additional avifauna species (30% of the expected total) occur on the project site as a result of the various types of aquatic and wetland habitats created during mining and reclamation (EPA 1978). Legally protected species that utilize these interim habitats include the American alligator, wood stork, tricolored heron, snowy egret, little blue heron, southern bald eagle, and least tern.

Under Alternative B, which maximizes reserve recovery, the majority of the project area will be left in its present state, thus serving as biological reservoirs for species invasion and migration into adjacent areas of interim habitat types as well as reclaimed areas.

6.2.1.1.2 Matrix Transfer and Road Corridors

Matrix transfer lines and road corridors are required for movement of equipment and products. The corridors usually are constructed on mined lands, but due to the scattered nature of the reserves in the project area, some corridor construction will occur in areas not previously disturbed by mining.

Flora. Clearing vegetation for road and matrix slurry pipelines will affect vegetation communities along the proposed route. Possible rupture of the matrix slurry line and fugitive dust associated with vehicle traffic would impact vegetation in adjacent upland communities. However, these impacts are considered minimal and short-term because:

- corridor routes are usually located on previously disturbed areas and are moved frequently as mining proceeds;

- ° any rupture of matrix slurry lines would be immediately identified due to obvious loss of pumping pressures, resulting in shutdown of pumping activities until the rupture is repaired; and,

- ° fugitive dust is not a significant problem on the existing OXY mine areas and is not expected to be in the future.

Fauna. Construction of corridors for roads and pipelines would impact fauna by removal of vegetation, possible disruption of local migration and dispersal patterns, disturbance from noise, and possible isolation of habitat units. These impacts are also expected to be minor and short-term because of the reasons listed previously.

6.2.1.1.3 Waste Disposal Activities

Waste disposal activities include construction, utilization, and maintenance of waste clay settling areas, mudball disposal areas, and sand tailings disposal areas. Flora and fauna will be affected by associated activities including clearing, construction and maintenance of these facilities, and the risk of potential dike failures.

Flora. Impacts on flora as a result of clearing and construction are similar to those previously described for mining (Section 6.2.1.1.1). However, because the majority of these facilities are constructed on previously mined areas, impacts on upland communities are insignificant. A variety of interim habitats, including upland, wetland, and aquatic areas, will be created in association with waste disposal activities and invaded by various vegetation species.

A primary concern associated with settling basins is the potential for dike failure in which a large volume of clay could be discharged, destroying vegetation at the spill site. The likelihood of such an event is extremely remote, as foundation, soil conditions, and dike material are thoroughly inspected before and during construction. Dikes are continuously inspected and monitored during the active life of the waste clay disposal areas, and construction and maintenance of earthen dikes on the OXY project site are in accordance with regulations of the FDER (Ch. 17-9, FAC). Since the institution of this rule, no dike failures have occurred at waste clay settling areas.

Fauna. Impacts of waste disposal facilities contruction on fauna will be similar to those associated with clearing for mining activities (Section 6.2.1.1.1). A variety of interim habitats will be created which will support a diversity of fauna. Sand tailings areas provide much needed nesting habitat for the least tern, a threatened species, as well as killdeer, nighthawks, and black-necked stilts. The waste clay settling basins provide habitats for a diverse group of wetland and aquatic species. Approximately 70 additional avifauna species (30% of the expected total) occur on the OXY site primarily as a result of the aquatic habitats created during mining and reclamation. Existing waste clay settling areas with standing trees and snags provide rookery areas for wading birds. In 1977, the Florida Game and Fresh Water Fish

Commission estimated the following numbers of birds in an active waste clay settling area on the OXY project site (EPA 1978):

Species	No. of Pairs
Double-crested cormorant	250
Anhinga	150
Great egret	150
Cattle egret	4500-5000
Snowy egret	50
Little blue heron	200
Black-crowned night-heron	75
White ibis	2500
Green-backed heron	12

This is the largest colony of wading birds in the project area and within Hamilton County. Protected and economically important species observed utilizing interim habitat types created by waste disposal activities include the American alligator, southern bald eagle, peregrine falcon, tricolored heron, wood stork, river otter, raccoon, and bobcat.

6.2.1.1.4 Reclamation

Impacts of reclamation activities on upland communities include disturbance of interim habitats during reclamation, increased productivity of certain land use types, and net loss of upland community acreage.

Flora. Three reclamation types are utilized by OXY: land and lakes, elevated fill, and tailings fill (Section 3.3.10). Interim habitats and associated vegetation will be eliminated during the grading and contouring phases of reclamation. Appropriate planting and seeding techniques on the graded and contoured lands will result in the creation of a variety of habitat types similar to those existing in the project area. Overall, a more diverse landscape will be created with a slightly rolling topography of upland forest and agricultural communities interspersed with open waterbodies (lakes) and forested and non-forested wetlands.

Current reclamation projects at OXY indicate that native vegetation communities can be established and that the potential productivity of forestry and agricultural use is at least equal to that of existing conditions (Blue 1981, Gooding 1981). Evaluation of reclaimed areas indicates that their wildlife habitat value is potentially equal to that of existing upland systems (Section 3.3.10).

There will be a net loss of upland acreage due to the creation of lakes from voids left during the extraction of overburden and matrix; approximately 52% of the land and lakes will be wetlands and open water areas. However, aquatic habitats are presently limited in the project area, and those created as a result of mining and reclamation will be a valuable addition to the landscape of the area.

Fauna. Grading and contouring will disrupt interim habitats and consequently impact associated fauna; however, these will be short-term as reclamation will provide a more diverse landscape than that which presently exists, with habitat values potentially equivalent to existing conditions (Section 3.3.10). Thus, populations of terrestrial species will eventually stabilize. There will be a net loss of upland community acreage and terrestrial fauna associated with this acreage due to creation of lakes.

6.2.1.2 Proposed Mining Alternatives

Probable impacts on upland communities are similar for all mining alternatives with the exceptions of acreage affected and duration of mine life.

6.2.1.2.1 Alternative A: No Mining or Mine Support in Wetlands

Approximately 9849 (13.3%) acres of upland communities will be affected by mining and/or mine support facilities under this alternative, while 87% will remain undisturbed (Table 6.2-1). The upland communities will be sequentially affected over the life of the mines which is estimated to be 8-10 years. The percentage of each cover type to be disturbed ranges from 0% to 62.5%, with a mean of 15.7% disturbed. The major land use types to be disturbed under this alternative, as well as under Alternatives B, C, and D, include planted coniferous forest, clearcut areas, mixed forest, and mining and processing lands. These cover classes account for 8537 acres (87%) of the 9849 acres of upland communities to be mined and/or utilized for mine support facilities.

There will be an increase in aquatic and wetland habitats at the expense of upland habitats. Under Alternative A, approximately 7537 acres will be reclaimed as land and lakes, of which approximately 52% will be wetlands and open water. This will result in a net loss of approximately 3919 acres of upland communities (5.3% of total upland communities), but an increase in aquatic communities which are presently limited in the project area.

6.2.1.2.2 Alternative B: Mining All Wetlands Containing Reserves

Approximately 21,161 acres (28.5%) of the 74,191 acres of upland communities will be affected by mining and/or mine support facilities during the expected mine life of 21-26 years (Table 6.2-2). More acreage (7474 acres or 10% of the upland community) will be converted to lakes under this mining alternative than under Alternative A. No vegetation cover type will be eliminated under this mining alternative. The average percent of an individual cover type disturbed is 31.3% with the range being 0% to 79.1%.

6.2.1.2.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Under this mining alternative, 16,128 acres (21.7%) of the upland communities are proposed to be disturbed over a mine life of 14-18 years

Table 6.2-1. Extent of Upland Communities Disturbed Under Mining Alternative A.

Code*	Description	Existing Acreage	% Upland Community	% Total Project Site	Acreage Disturbed	% Cover Type
211	Row crops	3,976	5.4	4.0	349	8.8
212	Field crops	2,509	3.4	2.5	394	15.7
213	Improved pasture	1,302	1.8	1.3	40	3.1
222	Deciduous fruit orchard	1	<0.1	<0.1	0	0
231	Pecan orchard	1	<0.1	<0.1	0	0
242	Confined feeding operations	51	<0.1	<0.1	8	15.7
323	Scrub/brush rangeland	105	0.1	0.1	0	0
411	Pine flatwoods	3,935	5.3	3.9	372	9.4
422	Other hardwoods	87	0.1	<0.1	25	28.7
431	Mixed forest	12,399	16.7	12.4	1,080	8.7
441	Planted coniferous forest	24,861	33.5	24.8	3,688	14.8
451	Clearcut areas	9,195	12.4	9.2	2,709	29.5
741	Scraped areas	8	<0.1	<0.1	5	62.5
742	Dredge and fill areas	382	0.5	0.4	119	31.2
760	Mining and processing	15,379	20.7	15.4	1,060	6.9
	TOTAL	74,191	100.0	74.0	9,849	13.3

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

Table 6.2-2. Extent of Upland Communities Disturbed Under Mining Alternative B.

Code*	Description	Existing Acreage	% Upland Community	% Total Project Site	Acreage Disturbed	% Cover Type
211	Row crops	3,976	5.4	4.0	419	10.5
212	Field crops	2,509	3.4	2.5	623	24.8
213	Improved pasture	1,302	1.8	1.3	41	3.2
222	Deciduous fruit orchard	1	<0.1	<0.1	0	0
231	Pecan orchard	1	<0.1	<0.1	0	0
242	Confined feeding operations	51	<0.1	<0.1	8	15.7
323	Scrub/brush rangeland	105	0.1	0.1	83	79.1
411	Pine flatwoods	3,935	5.3	3.9	1,790	45.5
422	Other hardwoods	87	0.1	<0.1	35	40.2
431	Mixed forest	12,399	16.7	12.4	2,868	23.1
441	Planted coniferous forest	24,861	33.5	24.8	8,247	33.2
451	Clearcut areas	9,195	12.4	9.2	4,705	51.2
741	Scraped areas	8	<0.1	<0.1	5	62.5
742	Dredge and fill areas	382	0.5	0.4	258	67.5
760	Mining and processing	15,379	20.7	15.4	2,079	13.5
	TOTAL	74,191	100.0	74.0	21,161	28.5

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

(Table 6.2-3). As with Alternatives A and B, the majority of the upland community to be affected is planted coniferous forest, clearcut areas, mixed forest, and mining and processing lands. The proposed acreage converted to lakes (5744, <8% of upland community) is greater than in Alternative A but less than in Alternatives B and D. No vegetation community will be totally disturbed in the project area. The average disturbance to each cover type is approximately 18.6% with a range of 0% to 62.5%.

6.2.1.2.4 Alternative D: Mining In Areas Requiring Only ACOE Permits

Under this mining alternative, approximately 19,210 acres (25.9%) of the upland communities in the project area will be affected over a mine life of 18-25 years (Table 6.2-4). The total upland acreage to be converted to lakes (6573 acres, <9% of upland communities) is less than in Alternative B, but greater than in Alternatives A and C. The majority of affected upland community types include planted coniferous forests and clearcut areas (Table 6.2-4). No vegetation community will be eliminated from the project area. The average acreage of upland community types to be disturbed is 24.3% with a range of 0% to 62.5%.

Table 6.2-3. Extent of Upland Communities Disturbed Under Mining Alternative C.

Code*	Description	Existing Acreage	% Upland Community	% Total Project Site	Acreage Disturbed	% Cover Type
211	Row crops	3,976	5.4	4.0	377	9.5
212	Field crops	2,509	3.4	2.5	580	23.1
213	Improved pasture	1,302	1.8	1.3	27	2.1
222	Deciduous fruit orchard	1	<0.1	<0.1	0	0
231	Pecan orchard	1	<0.1	<0.1	0	0
242	Confined feeding operations	51	<0.1	<0.1	8	15.7
323	Scrub/brush rangeland	105	0.1	0.1	0	0
411	Pine flatwoods	3,935	5.3	3.9	871	22.1
422	Other hardwoods	87	0.1	<0.1	17	19.5
431	Mixed forest	12,399	16.7	12.4	1,845	14.9
441	Planted coniferous forest	24,861	33.5	24.8	7,439	29.9
451	Clearcut areas	9,195	12.4	9.2	3,602	39.2
741	Scraped areas	8	<0.1	<0.1	5	62.5
742	Dredge and fill areas	382	0.5	0.4	124	32.5
760	Mining and processing	15,379	20.7	15.4	1,233	8.0
	TOTAL	74,191	100.0	74.0	16,128	21.7

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

Table 6.2-4. Extent of Upland Communities Disturbed Under Mining Alternative D.

Code*	Description	Existing Acreage	% Upland Community	% Total Project Site	Acreage Disturbed	% Cover Type
211	Row crops	3,976	5.4	4.0	415	10.4
212	Field crops	2,509	3.4	2.5	624	24.9
213	Improved pasture	1,302	1.8	1.3	20	1.5
222	Deciduous fruit orchard	1	<0.1	<0.1	0	0
231	Pecan orchard	1	<0.1	<0.1	0	0
242	Confined feeding operations	51	<0.1	<0.1	8	15.7
323	Scrub/brush rangeland	105	0.1	0.1	0	0
411	Pine flatwoods	3,935	5.3	3.9	1,616	41.1
422	Other hardwoods	87	0.1	<0.1	33	37.9
431	Mixed forest	12,399	16.7	12.4	2,665	21.5
441	Planted coniferous forest	24,861	33.5	24.8	8,412	33.8
451	Clearcut areas	9,195	12.4	9.2	4,509	49.3
741	Scraped areas	8	<0.1	<0.1	5	62.5
742	Dredge and fill areas	382	0.5	0.4	237	62.0
760	Mining and processing	15,379	20.7	15.4	666	4.3
	TOTAL	74,191	100.0	74.0	19,210	25.9

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

6.2.2 Wetland Communities

Approximately 25,000 acres (25% of the project area) were classified into seven categories of wetlands (Table 6.2-5). Approximately one-third of these lands have identified phosphate reserves. The largest wetland category (51% of total wetlands acreage) is the cypress/swamp tupelo/bay association (type 6311). The wetlands on site are distributed among 1762 individual wetland units as follows:

Size Class (acres)	No. of Individual Wetlands	%	Approximate Acreage	%
<5	1,277	72	2,226	9
>5-10	198	11	1,484	6
>10-25	153	9	2,226	9
>25-50	74	4	2,474	10
>50-75	22	1	1,237	5
>75-100	8	<1	742	3
>100	30	2	14,346	58
TOTAL	1,762	100	24,735	100

Approximately 92% of the individual wetland units in the project area are small (<25 acres), hydrologically isolated and/or weakly periodically connected, and/or simplistic in vegetation structure (number of strata and zones) and diversity. The remaining 8% of the wetland units, which vary from 26 to 6400 acres and collectively account for the greatest acreage (approximately 76% of the total acreage), in general are weakly connected, primarily in response to sheetflow from runoff. These units typically have more complex structure and are more diverse than the smaller wetlands

The following sections address impacts on wetland community flora, fauna, and functional criteria which would potentially occur under all mining alternatives. No wetlands are proposed for mining or mine support activities under Alternative A. There will be, however, indirect impacts which may occur under this alternative, and these are discussed where appropriate.

6.2.2.1 Probable Impacts of Mining and Reclamation Activities

6.2.2.1.1 Mining

Wetland communities in the project area will be affected to some extent by mining activities regardless of the alternative selected. These activities include dewatering, site preparation, excavation of overburden and matrix, flow diversion, and construction of other facilities to support mining activities.

Flora. Preparation for mining begins with installation of drainage ditches to remove surface water and lower the water table in the mining

Table 6.2-5. Wetland Acreage by Florida Land Use and Cover Classification in the OXY Project Area.

Code*	Description	Acreage	% Total Wetlands	% Project Site
6110	Cypress	1,970	8.0	2.0
6211	Swamp tupelo	775	3.1	0.8
6212	Bayhead	1,322	5.3	1.3
6213	Scrub/shrub	1,314	5.3	1.3
6311	Cypress/swamp tupelo/ bay	12,633	51.1	12.6
6312	Swamp tupelo/bay/pine	6,291	25.4	6.3
6410	Emergent	430	1.8	0.4
	TOTAL	24,735	100.0	24.7

*Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

block. Wetland communities in adjacent areas may be affected by lowering local water tables, which could cause temporary stress on vegetation requiring moist and/or saturated soil conditions.

The majority (>92%) of the wetlands in the project area are small (<25 acres), hydrologically isolated or weakly/periodically connected, and receive direct rainfall and upland runoff as their primary sources of water. Because runoff from the mine area will be captured in the mine water management system (ditches), less water will reach adjacent wetland areas that historically received runoff from the mine area. The impacts of runoff diversion should be temporary and minor as wetlands periodically undergo water shortage during drought conditions. Based on observations by OXY's mine planners and field staff, drainage ditches do not typically have a significant effect on adjacent wetlands vegetation and water-holding capacity.

Clearing of the mine area will effectively eliminate all wetland vegetation. Marketable timber will be removed prior to final clearing. Harvesting of timber in wetlands occurs in the project area and is expected to continue whether wetlands are mined or not.

Reclamation (per requirements of Ch. 16C-16, FAC) occurs as soon as practically possible after mining to restore viable, productive wetland associations. Affected wetlands will be replaced on at least an acre-for-acre basis (Section 3.3.10), and no wetland community type will be completely eliminated under any of the four mining alternatives. For example, under Alternative B, which maximizes reserve recovery, over 60% of the wetlands in the project area will not be affected and a minimum of 47% of each type of wetland community will remain undisturbed. The vegetation species associated with these community types will remain a part of the project area flora and will also provide seed sources for invasion of adjacent communities and natural introduction of endemic wetland species on reclaimed wetlands.

Fauna. Sequential clearing of mine areas will allow migration of larger fauna away from active mining areas. However, the adjacent habitat is probably at carrying capacity for the area, and migration of larger fauna into adjacent wetland communities would increase populations in these communities. This increase in population could tax ecological resources and possibly lead to population declines due to competition for ecological resources (Section 6.2.1.1.1). Smaller, less mobile animals in the area being cleared would be eliminated. Construction of support facilities will have similar impacts on project area fauna.

Interim wetlands created as part of the mining process, such as waste disposal areas, are readily utilized by a number of wetland or aquatic species including legally protected species such as the American alligator, wood stork, tricolored heron, snowy egret, little blue heron, and southern bald eagle (Section 3.3.7). No wetland community type will be eliminated from the project area; thus, interim habitats such as active settling areas and reclaimed wetlands may be colonized by species from these undisturbed wetlands. There will, however, be some reduction in faunal populations due to habitat destruction.

6.2.2.1.2 Matrix Transfer and Road Corridors

For the most part, matrix transfer lines and road corridors are constructed on previously mined lands. However, due to the scattered nature of OXY reserves, some corridors may be constructed on land not previously mined.

Flora. Clearing of vegetation for corridors will have minimal impact on vegetation communities. The acreage involved is insignificant when compared to the area cleared for mining. Fugitive dust from vehicle traffic may impact adjacent wetlands units, but this impact is minor as evidenced by the existing facility. Rupture of a matrix transfer pipeline could result in discharge of slurry material into wetland units. However, the potential for this causing a significant impact is low, as any rupture of matrix lines would result in a pressure loss in the matrix pumping system which is constantly monitored. A major problem would be quickly detected and the pumps shut down before a large volume of material is released. Furthermore, the pipelines are placed within the mine boundary to the extent possible, so that any spilled material is confined to already disturbed areas. Impacts on flora from these activities are considered short-term and minimal as discussed for uplands (Section 6.2.1.1.2).

Fauna. Corridor activity impacts on wetlands fauna are similar to those discussed for upland fauna and are anticipated to be minor (Section 6.2.1.1.2).

6.2.2.1.3 Waste Disposal Activities

Activities associated with waste disposal include clearing, construction and maintenance of facilities, and creation of interim wetland habitat. To take advantage of the below-grade void left by mining, the majority of OXY's waste clay settling areas are planned for previously mined areas. To maintain ties between settling areas to allow gravity flow of the clays and return water, some additional lands will be incorporated into the adjacent settling area system. The majority of this area will be uplands and not subject to this EIS review; approximately 1500 acres will be in wetland areas.

Flora. Impacts on wetlands flora due to waste disposal will be limited to 1500 acres, considering that the majority of the disposal areas will be within mined areas. Placement of disposal facilities in unmined areas will eliminate the existing vegetation, and impacts will be similar to those discussed for mining (Section 6.2.2.1.1).

Creation of waste disposal facilities will provide interim land forms which are readily invaded by a variety of aquatic (open water), wetland, and upland species (Section 3.3.2.5). The potential for dam failure and discharge of a large volume of waste clay material is extremely remote due to sound and prudent design and construction practices in accordance with Ch. 17-9, FAC (Section 6.2.1.1.3). Since the 1971 revisions to this rule, no waste clay settling area dam failures have occurred.

Because of the special interest relative to settling areas in Swift Creek Swamp, associated impacts on this area are discussed below.

Portions of Swift Creek Swamp will be mined; these areas and the remaining unmined portions will be utilized for waste disposal (under Mining Alternatives B and D). This wetland unit has been logged repeatedly and has been subject to extensive drainage which has effectively dried up the swamp, as evidenced by the advanced oxidation of the organic substrate in many locations (Section 4.2.11). Swift Creek Canal, which presently bisects the swamp (Figure 4.2-1, Section 4.2.11), will be rerouted to the east and somewhat parallel to CR 137. It will reconnect to Swift Creek just north of Eagle Lake.

Reclamation plans propose utilizing elevated fill for restoration of viable, productive wetlands on an acre-for-acre basis, per requirements of Ch. 16C-16, FAC. The wetlands created will be hydrologically connected to each other as well as to Swift Creek. Water sources in these created wetlands will be direct rainfall and rainfall runoff from surrounding uplands. A computer simulation analysis indicated that a hydroperiod with a maximum inundation depth of 1-1.5 ft can be maintained with normal wet/dry cycles.

Fauna. Impacts of waste disposal area construction will be similar to those discussed for clearing for mining activities (Section 6.2.2.1.1). The interim wetland habitats created by invasion of wetland flora will provide habitat for many displaced faunal species and species invading from adjacent intact wetland units. Waste clay disposal areas provide habitat for a large group of wetland and aquatic species, in particular the avifauna of the site (Table 6.2-6). Inactive and active settling areas with standing trees and snags provide rookery areas for wading birds. In 1977, the FGFWFC estimated the following birds and numbers of pairs (in parentheses) in an active OXY settling area (EPA 1978): cattle egret (4500-5000), white ibis (2500), double-crested cormorant (250), little blue heron (200), anhinga (150), great egret (150), black-crowned night-heron (75), snowy egret (50), green-backed heron (12). This was the largest colony of wading birds in the project area and in Hamilton County.

Because approximately 63% of the wetlands on site will not be affected, and because a minimum of 47% of each wetland cover type will remain undisturbed under Alternative B, the wetlands fauna of the project area will not be eliminated. These undisturbed wetlands will serve as biological reservoirs for invasion and colonization of interim habitats and reclaimed wetlands.

6.2.2.1.4 Reclamation

Reclamation impacts on wetland communities include disturbance of interim communities during restoration, acre-for-acre replacement of wetlands disturbed, and an increase in diversity of wetland types.

Table 6.2-6. Avifauna Utilizing Active and Inactive Waste Clay Settling Areas at OXY.

Pied-billed grebe	Sharp-shinned hawk
Horned grebe	Cooper's hawk
White pelican	Red-shouldered hawk
Double-crested cormorant	Red-tailed hawk
American bittern	American kestrel
Anhinga	Peregrine falcon
Great blue heron	Common moorhen
Great egret	American coot
Snowy egret	Killdeer
Little blue heron	Greater yellowlegs
Tricolored heron	Lesser yellowlegs
Cattle egret	Least sandpiper
Black-crowned night-heron	Dunlin
White ibis	Dowitcher
Snow goose	Common snipe
Wood duck	Ring-billed gull
Green-winged teal	Mourning dove
American black duck	Belted kingfisher
Mallard	Northern flicker
Northern pintail	Eastern phoebe
Blue-winged teal	Tree swallow
Northern shoveler	American crow
Gadwall	Brown-headed nuthatch
American wigeon	House wren
Canvasback	American robin
Redhead	Gray catbird
Ring-necked duck	Loggerhead shrike
Common goldeneye	Yellow-rumped warbler
Bufflehead	Common yellowthroat
Hooded merganser	Savannah sparrow
Red-breasted merganser	Song sparrow
Ruddy duck	Swamp sparrow
Black vulture	Red-winged blackbird
Turkey vulture	Boat-tailed grackle
Bald eagle	Common grackle
Northern harrier	

Source: EPA 1978.

Flora. All wetlands affected in the project area will be replaced on an acre-for-acre basis in accordance with reclamation standards of Ch. 16C-16, FAC. Three reclamation types are utilized by OXY: land and lakes, elevated fill, and tailings fill (Section 3.3.10). Interim habitats created by mining and waste disposal activities will be eliminated during the grading and contouring phases of reclamation. Appropriate planting and seeding techniques on the graded and contoured land will create a variety of habitat types with an overall increase in diversity of wetland types (Section 3.3.10).

New wetland types to be created include littoral zones and zones of fluctuation in lake areas and forested and non-forested wetlands with strong hydrological connections to water courses. These are in addition to the forested and non-forested wetlands remaining undisturbed, accounting for approximately 63% (Alternative B) of the total wetlands currently existing in the project area.

Overall, a more diverse landscape will be created with a slightly rolling topography of upland forest and agricultural communities interspersed with open waterbodies (lakes) and forested and non-forested wetlands.

Fauna. Grading and contouring will disrupt interim habitats and consequently impact associated fauna; however, this will be short-term as reclamation will provide a more diverse landscape than that which presently exists. Reclamation will replace affected wetlands on an acre-for-acre basis with a variety of wetland types and interconnections (Section 3.3.10), resulting in more diverse wetland systems compared to present conditions. The overall impact is a possible decrease in populations of certain species, yet an overall increase in species diversity of the project area as compared to pre-mining conditions.

6.2.2.2. Probable Impacts on Wetlands Functions

6.2.2.2.1 Specific Functions

Specific functions attributed to wetlands were evaluated in the project area. These have been identified in Section 404 of the Clean Water Act (Public Law 92-500, as amended), President Carter's May 24, 1977 Executive Order on wetlands protection, and other statutory and administrative authorities (see Section 3.3.9.1 for example summaries). Wetland functions specified in the statutory and administrative authorities include:

- biological functions
- aquatic study areas, sanctuaries, and refuges
- hydrologic support
- shoreline protection
- storm and flood water storage
- groundwater recharge
- water quality enhancement

As wetlands are logged or cleared and either mined or utilized for mine support facilities, biological functions will decrease; however, the functions will not be lost from the project area, as more than 60% of the wetland acreage on site will be preserved even under Alternative B which maximizes reserve recovery. The approximately 37% of wetlands that will be affected will not be disturbed all at once but over the life of the mine, with reclamation occurring as soon as practically possible.

Interim wetland habitats created by mining and waste disposal activities will provide habitat for a large number of wetland and aquatic species (Sections 3.3.2.5, 6.2.2.1.1, and 6.2.2.1.3). Reclamation will actually increase the diversity of wetland types in the overall project area and possibly increase the biological functions value. For example: 1) some reclaimed wetlands will be hydrologically connected to other wetlands and surface water systems, providing a better opportunity for detrital transport and dispersal of floral and faunal resources to downstream systems; 2) habitat created in reclaimed wetland systems will support, within a relatively short period, many species indigenous to naturally occurring wetlands (Gilbert et al. 1981); 3) specifically designated "wildlife areas" (approximately 4700 acres) will be created as recommended by the FGFWFC (Section 3.3.10); and 4) creation of wetland areas along reclaimed lakes will increase littoral zone wetland areas, a limited habitat type in the geographical area, for fish and wildlife habitat.

No wetlands scheduled for mining or mine support facilities are administratively controlled as aquatic study areas, sanctuaries, and/or refuges. The FGFWFC does administer duck hunting on interim habitats (waste clay settling areas) created during waste disposal operations. Therefore, this wetland function will not be impacted by mining of wetlands, even under Alternative B, which maximizes reserve recovery. This function may be realized at the conclusion of reclamation under Alternative B, as specifically designated wildlife areas will be created, as recommended by the FGFWFC.

The hydrologic support functions of totally affected wetlands will be completely eliminated, and those of partially disturbed wetlands will be temporarily disrupted until reclamation has been completed. Acre-for-acre replacement of all disturbed wetlands is part of the conceptual reclamation plans (Section 3.3.10). Post-mining hydrologic periodicity values should improve because reclamation will increase the extent of hydrologically connected wetlands as compared to the existing condition where the majority of wetlands are hydrologically isolated or weakly/periodically connected.

The shoreline protection function is not presently being served to any significant degree in the project area but would apply to littoral zones or zones of fluctuation in reclaimed lake systems where the prevailing wind fetch is sufficient to generate wave action.

The storm and flood water storage function of wetlands will be eliminated or at least partially eliminated in affected wetland units during mining and reclamation. However, prudent water management techniques, presently practiced by OXY, will maintain this function within the overall drainage basins until reclamation has been completed. During mining, the mine cuts will act as storage areas. After mining, the reclaimed wetlands and lakes will serve this function. A comparison of pre- and post-mining tributary flows indicates no significant changes in flow regimes (Section 6.3). Acre-for-acre replacement of wetland acreage and subsequent revegetation, along with creation of lake systems, will result in greater storage capability for storm and flood waters than presently exists in the project area.

There are no significant recharge areas in the project area (Section 3.4.3), although some perched wetlands in upland areas may provide a minor localized recharge function where water discharges to the Surficial Aquifer when the groundwater table is below the level in the wetland. This function will be lost in these wetlands due to disruption of soil profiles in adjacent areas as well as elimination of the actual wetland. However, the impact to the project area will be minimal, as even under Alternative B only 30% of the total project area is proposed to be disturbed, and approximately 37% of the total existing wetlands will be affected. Reclamation activities will restore water tables in most areas to approximate pre-mining conditions (Section 6.5), with reclaimed wetlands having a groundwater recharge value similar to that of existing wetlands in the project area.

Hydrologically isolated or weakly/periodically connected wetlands may not appreciably provide a water quality enhancement function. Some of the larger wetlands are at least weakly connected and thus may provide this function to a greater degree than smaller wetlands. Loss of the filtration function in hydrologically isolated wetland units scheduled for mining will not make a significant change overall because: 1) over 63% of the wetlands in the project area will be preserved; 2) those that are not will be replaced on an acre-for-acre basis; 3) wetland acreage disturbed at any one time will be minimal compared to total wetland acreage, as mining proceeds on a sequential basis through mine life; and 4) reclamation will occur as soon as practically possible.

Reclaimed wetlands should provide a water quality enhancement function as well as or better than existing hydrologically isolated wetlands due to an increase in wetland contiguity, which will provide a flow-through system for filtering and nutrient uptake. All waters leaving the project area should meet all applicable Class III water quality standards for the propagation of fish and wildlife resources.

No significant historical or archaeological landmarks are within the areas of wetlands scheduled for disturbance.

None of the wetlands in the project area has a significant sport fishery value, and their contribution to Suwannee River fisheries is not significant as evidenced by organism and detrital transport to the Suwannee River from headwater areas (Sections 3.3.4.2.2 and 3.4.2.3.3). Reclaimed lake systems do provide significant sport fishing (Section 3.3.10.5). Lease of lands by private hunt clubs will be temporarily interrupted in mining areas until reclamation is completed.

Wetlands scheduled for mining will be logged for marketable timber prior to disturbance so that these resources will not be totally lost. Those trees not of marketable size will be cleared and thus lost. Forested wetlands will be replaced by planting to achieve a minimum survival rate of 200 trees/acre (Section 3.3.10).

Aesthetic values of scattered, forested wetlands, interspersed among upland forests, will be disrupted, and aesthetic values of large wetlands proposed for partial (Bee Haven Bay) or complete (Swift Creek Swamp) disturbance will be disrupted under Alternative B. Reclamation will produce a slightly rolling topography interspersed with wooded uplands, forested and non-forested wetlands, and lake systems, thus providing a greater diversity of habitat types than that which presently exists.

Habitat for certain rare and endangered species will be degraded or eliminated in affected wetlands (Section 6.2.6). Very large wetlands (>2000 acres) such as Bee Haven Bay, which support viable populations of species unique to wetlands, will be partially degraded by mining until vegetation is restored during reclamation activities. Interim habitats created by mining and waste disposal activities will continue to provide habitat for many rare and endangered species (Table 6.2-7). Conceptual reclamation plans include creation of more than 4500 acres of wildlife areas (Section 3.3.10). Creation of open water habitats and large contiguous wetland areas will provide habitat for some protected species (Sections 3.3.10.5 and 6.2.6).

6.2.2.2.2 Cumulative Impacts of Wetlands Mining

The cumulative impacts of wetlands mining were evaluated by pre-mining drainage areas. No wetlands are proposed for mining or mine support activities under Alternative A. Under the mining alternative that maximizes reserve extraction (Mining Alternative B), approximately 9264 acres (37%) of wetlands identified in the project area are proposed for mining or mine support activities. The percentage of wetlands to be affected within each pre-mining drainage area within the project boundary ranges from 0% (Cypress Creek) to 73% (Swift Creek), with average disturbance being 36% (Table 6.2-8 and Figure 6.2-1). Alternative C proposes disturbances to 2452 acres (10%) of the project area wetlands.

Disturbance of wetland acres within pre-mining drainage basins ranges from 0 to 44% (Table 6.2-9). Approximately 8601 acres of wetlands will be disturbed under Alternative D, with drainage basin wetland disturbance ranging from 0 to 69% (Table 6.2-10). Wetlands will not be eliminated from any drainage area within the project boundary. However, under Alternatives B and D, all wetland units will be disturbed or partially disturbed within the project boundary in Perimeter Area 5 (Figure 6.2-1).

Of the 1762 individual wetland units identified in the OXY project area, 728 are proposed for mining or mine support activities under Alternative B (Table 6.2-11). Under Alternatives C and D, 583 and 688 individual wetland units are proposed for mining or mine support activities. With

Table 6.2-7. Rare and Endangered Species Observed Utilizing Mining and Waste Disposal Interim Habitats.

Species	Status* Federal	Status* State
American alligator (*Alligator mississippiensis*)	T	SSC
Wood stork (*Mycteria americana*)	E	E
Southern bald eagle (*Haliaeetus l. leucocephalus*)	E	T
Peregrine falcon (*Falco peregrinus*)	E	E
Little blue heron (*Egretta caerulea*)		SSC
Snowy egret (*Egretta thula*)		SSC
Tricolored heron (*Egretta tricolor*)		SSC
Least tern (*Sterna albifrons*)		T

*Federal = FWS 1980.
State = Ch. 39-27.01-05, Rules of the Florida Game and Fresh Water Fish Commission.
E = Endangered T = Threatened SSC = Species of Special Concern

Source: EPA 1978.
OXY consultants.

Table 6.2-8. Total Wetland Acreage and Number of Individual Wetland Units Within Each Pre-Mining Drainage Area on the OXY Project Site (as of c. 1981) to be Disturbed Under Mining Alternative B.

Drainage Area*	Approx. Drainage Area Acreage	Total Wetland Acreage	% of Drainage Area	No. of Wetland Units	% of Total	Wetland Acreage Disturbed	%	No. of Wetland Units Disturbed (total and partial)	%
Camp Branch	4,603	1,096	24	160	9	772	70	122	76
Cypress Creek	143	9	6	8	<1	0	0	0	0
Four Mile Branch	1,887	387	21	53	3	252	65	33	62
Hunter Creek	14,973	2,736	18	242	14	295	11	56	23
Long Branch	2,374	223	9	68	4	113	51	40	59
Ratliff Creek	461	278	60	2	<1	69	25	1	50
Rocky Creek	18,690	9,462	51	333	19	1,731	18	51	15
Roaring Creek	13,539	2,689	20	240	14	1,834	68	155	65
Swift Creek	25,102	4,211	17	256	15	3,088	73	132	52
Sugar Creek	2,144	494	23	54	3	103	21	9	17
Perimeter Area 1	5,039	1,308	26	156	9	401	31	68	44
Perimeter Area 2	859	56	7	12	<1	32	57	3	25
Perimeter Area 3	1,725	172	10	40	2	52	30	6	15
Perimeter Area 4	3,505	708	20	49	3	214	30	18	37
Perimeter Area 5	423	121	29	4	<1	23	19	4	100
Perimeter Area 6	1,695	327	19	34	2	174	53	20	59
Perimeter Area 7	2,362	406	17	36	2	111	27	10	28
Perimeter Area 8	680	52	8	15	<1	0	0	0	0
TOTAL	100,204	24,735	25	1,762	100	9,264	37	728	41

*See Figure 6.2-1.

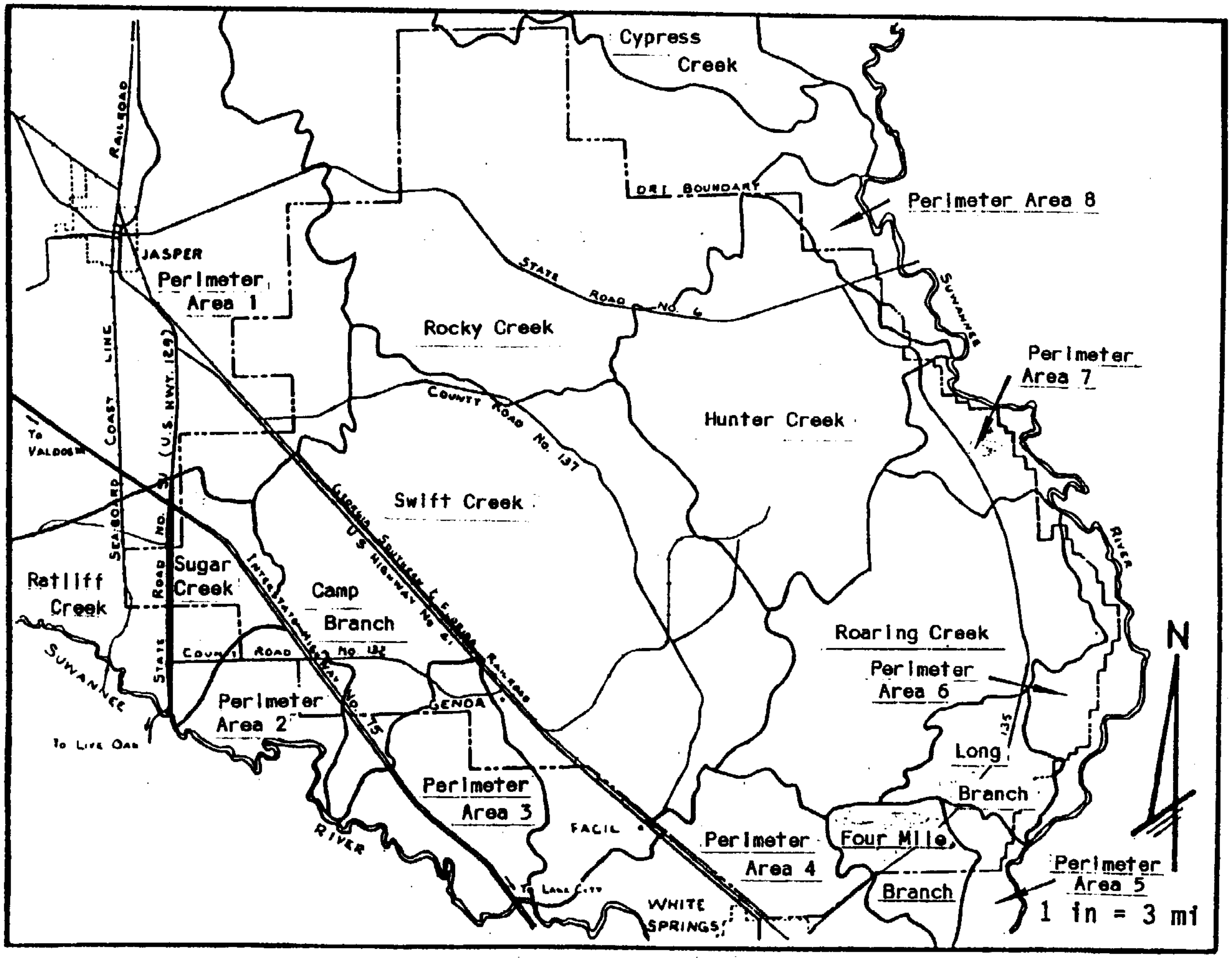

Figure 6.2-1. Pre-Mining Drainage Patterns.

Table 6.2-9. Total Wetland Acreage and Number of Individual Wetland Units Within Each Pre-Mining Drainage Area on the OXY Project Site (as of c. 1981) to be Disturbed Under Mining Alternative C.

Drainage Area*	Approx. Drainage Area Acreage	Total Wetland Acreage	% of Drainage Area	No. of Wetland Units	% of Total	Wetland Acreage Disturbed	%	No. of Wetland Units Disturbed (total and partial)	%
Camp Branch	4,603	1,096	24	160	9	346	32	108	68
Cypress Creek	143	9	6	8	<1	0	0	0	0
Four Mile Branch	1,887	387	21	53	3	97	25	29	55
Hunter Creek	14,973	2,736	18	242	14	221	8	48	20
Long Branch	2,374	223	9	68	4	98	44	35	51
Ratliff Creek	461	278	60	2	<1	0	0	0	0
Rocky Creek	18,690	9,462	51	333	19	76	<1	14	4
Roaring Creek	13,539	2,689	20	240	14	668	25	131	55
Swift Creek	25,102	4,211	17	256	15	424	10	101	39
Sugar Creek	2,144	494	23	54	3	94	19	8	15
Perimeter Area 1	5,039	1,308	26	156	9	200	15	67	43
Perimeter Area 2	859	56	7	12	<1	13	23	2	17
Perimeter Area 3	1,725	172	10	40	2	13	8	3	8
Perimeter Area 4	3,505	708	20	49	3	36	5	12	24
Perimeter Area 5	423	121	29	4	<1	16	13	2	50
Perimeter Area 6	1,695	327	19	34	2	123	38	20	59
Perimeter Area 7	2,362	406	17	36	2	27	7	3	8
Perimeter Area 8	680	52	8	15	<1	0	0	0	0
TOTAL	100,204	24,735	25	1,762	100	2,452	10	583	33

*See Figure 6.2-1.

Table 6.2-10. Total Wetland Acreage and Number of Individual Wetland Units Within Each Pre-Mining Drainage Area on the OXY Project Site (as of c. 1981) to be Disturbed Under Mining Alternative D.

Drainage Area*	Approx. Drainage Area Acreage	Total Wetland Acreage	% of Drainage Area	No. of Wetland Units	% of Total	Wetland Acreage Disturbed	%	No. of Wetland Units Disturbed (total and partial)	%
Camp Branch	4,603	1,096	24	160	9	733	67	118	74
Cypress Creek	143	9	6	8	<1	0	0	0	0
Four Mile Branch	1,887	387	21	53	3	217	56	32	60
Hunter Creek	14,973	2,736	18	242	14	273	10	53	22
Long Branch	2,374	223	9	68	4	97	43	31	46
Ratliff Creek	461	278	60	2	<1	69	25	1	50
Rocky Creek	18,690	9,462	51	333	19	1,731	18	51	15
Roaring Creek	13,539	2,689	20	240	14	1,451	54	148	62
Swift Creek	25,102	4,211	17	256	15	2,920	69	116	45
Sugar Creek	2,144	494	23	54	3	103	21	9	17
Perimeter Area 1	5,039	1,308	26	156	9	401	31	68	44
Perimeter Area 2	859	56	7	12	<1	32	57	3	25
Perimeter Area 3	1,725	172	10	40	2	52	30	6	15
Perimeter Area 4	3,505	708	20	49	3	214	30	18	37
Perimeter Area 5	423	121	29	4	<1	23	19	4	100
Perimeter Area 6	1,695	327	19	34	2	174	53	20	59
Perimeter Area 7	2,362	406	17	36	2	111	27	10	28
Perimeter Area 8	680	52	8	15	<1	0	0	0	0
TOTAL	100,204	24,735	25	1,762	100	8,601	35	688	39

*See Figure 6.2-1.

Table 6.2-11. Number of Wetland Units, by Size Class Interval, Proposed for Disturbance Under Each of the Four Mining Alternatives.

Size Class Interval (acres)	No. of Individual Wetland Units	Alternative A		Alternative B		Alternative C		Alternative D	
		No. Wetland Units Affected	%	No. Wetland Units Affected	%	No. Wetland Units Affected	%	No. Wetland Units Affected	%
<5	1277	0	0	456	36	445	35	445	35
>5-10	198	0	0	121	61	80	40	108	55
>10-25	153	0	0	73	48	58	38	63	41
>25-50	74	0	0	39	53	0	0	36	49
>50-75	22	0	0	12	55	0	0	16	73
>75-100	8	0	0	8	100	0	0	3	38
>100	30	0	0	19	63	0	0	17	57
Total	1762	0	0	728	41	583	33	688	39

the exception of the >75-100 acre size class, under Alternative B no size class will be completely affected by mining or mine support activities. Primary cumulative impacts associated with mining wetlands may include:

- shifts in populations of wetlands flora and fauna;
- changes in flood storage and storm detention/retention capacity;
- changes in contribution of detrital material to downstream systems (such as major tributaries and the Suwannee River);
- changes in water quality enhancement function; and
- changes in potential recharge to the Surficial Aquifer.

Populations of wetlands flora and fauna will be reduced but not eliminated from the project area, as the majority of wetland acreage and individual wetland units will not be affected under the mining alternative that maximizes reserve extraction. Even though reclamation will provide for acre-for-acre replacement of affected wetlands, populations may still be reduced after reclamation until systems mature. Population levels may shift (increases for some species and decreases for others), with an overall increase in species diversity due to creation of new wetland systems presently limited or not occurring in the project area.

The flood and storm storage/retention capacity of affected wetlands will be altered in the project area. This may impact flow regimes in major tributaries in the project area during mining. Flow regimes will be altered even if no wetlands are mined, as water is diverted from its natural drainage area to the mine water management system until post-reclamation. Post-reclamation flows will approximate pre-mining flows as required by Ch. 16C-16, FAC (Section 6.3). Impacts on ecological components of the project area aquatic systems are discussed in Section 6.2.3.

During mining, flow of detrital material from affected wetlands to downstream areas will be reduced, particularly in portions of tributaries that are hydrologically linked to wetland systems. Based on drift data (Sections 3.3.4.2 and 3.4.2.3), the majority of detrital material generally is utilized within the immediate area, with a small percentage transported downstream. Additionally, on a regional basis, the tributaries in the project area generally do not contribute significantly to the Suwannee River (Sections 3.3.4.2 and 3.4.2.3). At post-reclamation, reclaimed wetlands will be more strongly hydrologically connected to the existing wetlands, which may result in increased contributions of the project area tributaries to the Suwannee River.

Wetlands in the project area may provide a water quality enhancement function by nutrient uptake and filtering of overland runoff. This function will be eliminated in wetlands mined or used for mine support activities. The areas mined will be inside the mine water management system until post-reclamation. During mining, the runoff normally first received by wetlands will be collected in ditches and either used in the mining process or discharged through a permitted discharge into an on-site tributary. Discharge water will meet water quality permit criteria. At post-reclamation, the reclaimed wetlands will be able to provide a water quality enhancement function in a relatively short time.

The project area wetlands do not provide a significant groundwater recharge function. Although they probably serve a localized recharge and discharge function, on a regional scale, the elimination of this function in affected wetlands will not be significant. Reclaimed lands will be able to provide this function in the project area similar to existing conditions.

6.2.2.2.3 Wetlands Disturbance and Reclamation Schedule

Under Alternative A, no direct elimination of wetlands is proposed (Table 6.2-12). However, approximately 2071 acres of wetlands will be created under the reclamation plan to replace wetlands mined prior to January 1982. Alternative B, which maximizes reserve recovery, proposes disturbance of 9264 acres of wetlands, with reclamation restoring 11,335 acres. Alternatives C and D propose disturbance of 2452 acres and 8601 acres, respectively, with reclamation restoring 8221 acres of wetlands for Alternative C and 10,811 acres for Alternative D. These reclaimed acreages include wetlands mined prior to January 1982.

As of June 1983, OXY completed over 1200 acres of mandatory reclamation. However, no reclamation has been completed under the existing reclamation regulations (Ch. 16C-16, FAC). OXY's "Conceptual Reclamation Plan which must be approved prior to consideration of annual reclamation plans" was approved 20 March 1984. Therefore, OXY has not had time to complete any projects under the existing rules.

Previous rules did not require any wetlands reclamation. However, OXY has reclaimed some wetland areas (approximately 100 acres) in conjunction with the reclaimed lakes. These areas are still relatively young but appear to have good survival and growth (Section 3.3.10.6).

6.2.2.3 Proposed Mining Alternatives

6.2.2.3.1 Alternative A: No Mining or Mine Support in Wetlands

Under proposed Mining Alternative A, no reserves underlying wetlands will be mined and no mine support facilities will be placed in wetlands; therefore, no direct impacts on wetlands are anticipated. Mining in adjacent upland areas will indirectly affect the wetlands temporarily by: 1) reducing the drainage area, thereby decreasing surface water supply for lower areas, 2) lowering the water table and thereby decreasing the groundwater supply for lower areas, and 3) causing faunal migration. Other impacts which may affect wetlands include possible pipeline ruptures and dike failures.

Drainage. The majority, by number (>92%), of the wetlands in the project area are small (<25 acres), hydrologically isolated or weakly/periodically connected, and receive direct rainfall and upland runoff as their

Table 6.2-12. Schedule of Wetland Acres[1] to be Disturbed and Reclaimed for the Proposed Mining Alternatives.

Cover Type	Alternative A						
	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25	Yr 30	Total
DISTURBED							
Cypress (6110)	0	0	0	0	0	0	0
Swamp tupelo (6211)	0	0	0	0	0	0	0
Bayhead (6212)	0	0	0	0	0	0	0
Scrub/shrub (6213)	0	0	0	0	0	0	0
Cypress/swamp tupelo/bay (6311)	0	0	0	0	0	0	0
Swamp tupelo/bay/pine (6312)	0	0	0	0	0	0	0
Emergent (6410)	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	0
Cumulative summary	0	0	0	0	0	0	0
RECLAIMED							
Land and lakes[2]	436	643	253	0	0	0	1,332
Elevated fill[3]	26	131	582	0	0	0	739
Tailings fill[3]	0	0	0	0	0	0	0
Total	462	774	835	0	0	0	2,071
Cumulative summary[4]	462	1,236	2,071	2,071	2,071	2,071	2,071

Table 6.2-12 (Continued).

Cover Type	Alternative B						
	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25	Yr 30	Total
DISTURBED							
Cypress (6110)	17	77	53	125	220	0	492
Swamp tupelo (6211)	27	42	98	4	79	1	251
Bayhead (6212)	0	244	74	1	57	0	376
Scrub/shrub (6213)	0	50	64	117	0	0	231
Cypress/swamp tupelo/bay (6311)	675	1,065	1,372	949	429	21	4,511
Swamp tupelo/bay/pine (6312)	1,040	1,432	619	182	19	0	3,292
Emergent (6410)	10	34	44	14	9	0	111
Total	1,769	2,944	2,324	1,392	813	22	9,264
Cumulative summary	1,769	4,713	7,037	8,429	9,242	9,264	9,264
RECLAIMED							
Land and lakes[2]	240	395	497	427	620	255	2,434
Elevated fill[3]	119	331	1,122	1,029	2,812	1,174	6,587
Tailings fill[3]	0	343	820	705	213	233	2,314
Total	359	1,069	2,439	2,161	3,645	1,662	11,335
Cumulative summary[4]	359	1,428	3,867	6,028	9,673	11,335	11,335

Table 6.2-12 (Continued).

Cover Type	Alternative C						
	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25	Yr 30	Total
DISTURBED							
Cypress (6110)	0	1	1	181	0	0	183
Swamp tupelo (6211)	0	39	6	19	0	0	64
Bayhead (6212)	0	0	0	0	0	0	0
Scrub/shrub (6213)	0	2	10	0	0	0	12
Cypress/swamp tupelo/bay (6311)	634	473	527	196	0	0	1,830
Swamp tupelo/bay/pine (6312)	193	73	72	0	0	0	338
Emergent (6410)	1	10	14	0	0	0	25
Total	828	598	630	396	0	0	2,452
Cumulative summary	828	1,426	2,056	2,452	2,452	2,452	2,452
RECLAIMED							
Land and lakes[2]	280	408	671	457	82	0	1,898
Elevated fill[3]	70	230	732	1,224	369	0	2,625
Tailings fill[3]	0	0	0	0	0	0	0
Total	350	638	1,403	1,681	451	0	4,523
Cumulative summary[4]	350	988	2,391	4,072	4,523	4,523	4,523

Table 6.2-12 (Continued).

Cover Type	Alternative D						
	Yr 5	Yr 10	Yr 15	Yr 20	Yr 25	Yr 30	Total
DISTURBED							
Cypress (6110)	0	69	181	52	219	0	521
Swamp tupelo (6211)	0	29	146	144	0	0	319
Bayhead (6212)	24	25	245	138	2	0	434
Scrub/shrub (6213)	16	8	109	156	24	0	313
Cypress/swamp tupelo/bay (6311)	663	1,080	1,175	837	477	0	4,232
Swamp tupelo/bay/pine (6312)	933	772	225	551	140	0	2,621
Emergent (6410)	8	5	19	121	8	0	161
Total	1,644	1,988	2,100	1,999	870	0	8,601
Cumulative summary	1,644	3,632	5,732	7,731	8,601	8,601	8,601
RECLAIMED							
Land and lakes[2]	252	323	472	500	382	226	2,155
Elevated fill[3]	118	353	1,327	547	3,102	850	6,297
Tailings fill[3]	0	416	629	818	318	39	2,220
Total	370	1,092	2,428	1,865	3,802	1,115	10,672
Cumulative summary[4]	370	1,462	3,890	5,755	9,557	10,672	10,672

[1]Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.
[2]Wetlands portion (zone of fluctuation) of land and lakes reclamation type; includes approximately 117 acres of wetlands created in previous land and lakes reclamation.
[3]Wetlands portion of reclamation type.
[4]Includes acre-for-acre replacement of wetlands mined since 1975 and prior to January 1982.

primary sources of water. Because upland runoff will be captured in the mine water management system, less water will reach the nearby wetlands. This could impact floral and faunal resources of the wetland unit. Because mining is conducted on a sequential basis with reclamation following to restore local drainage areas, impacts should be short-term.

Water Table. Disruption of complex soil-water relationships of upland systems by mining may affect immediately adjacent wetlands through loss of stored water which could affect wetland vegetation. Alteration of the hydroperiod could create drier forest floor conditions, allowing more decay and oxidation of peaty material. Lowering of the water table for mining may slow growth of mature trees. These impacts should be minor, however, as wetlands occasionally undergo water shortage during drought conditions.

Faunal Migration. Mining adjacent upland areas will result in movement of fauna seeking refuge in wetland areas. This increase in the population of the wetland area could tax ecological resources and possibly lead to population declines due to competition for ecological resources. Although the populations would eventually stabilize, there would be a net loss of individual animals. Creation of interim wetland areas and permanent reclaimed wetland systems will result in a corresponding increase in wetlands flora and fauna.

Other potential impacts include spills from break or rupture of matrix slurry or other pipelines and possible settling area dike failures. The possibility of such impacts on wetlands is remote, as pipelines are usually constructed on previously disturbed areas and spills would be confined to the immediate area of the break; discovery of the break would be immediate due to loss of pumping pressure. The potential for dike failures, resulting in discharge of large volumes of waste clay, is also remote, as foundation, soil conditions, and dike material are thoroughly inspected before and during construction. Dikes are continuously inspected and monitored during the construction and active life of the waste clay disposal areas. Construction and maintenance of earthen dams on the OXY project site are in accordance with regulations of the FDER (Ch. 17-9, FAC).

6.2.2.3.2 Alternative B: Mining All Wetlands Containing Reserves

Under this mining alternative 37.4% (9264 acres) of wetlands in the project area is proposed for mining and/or mine support facilities, with a minimum of 47% of each cover type remaining undisturbed (Table 6.2-13). This will insure that flora and fauna unique to these cover types on 15,471 acres of wetlands will not be eliminated and will serve as biological reservoirs for invasion into adjacent interim habitats and reclaimed lands. Other areas to be excluded from mining are those stated in OXY's DRI application, which was reviewed and approved by the North Central Florida Regional Planning Council and Hamilton County Board of County Commissioners (Section 5.0). Areas excluded from mining are lands within 1) the 100-yr floodplain of the Suwannee River, 2) the

Table 6.2-13. Extent of Wetland Acreage Disturbed and Undisturbed under Mining Alternative B.

Code*	Description	Existing	Undisturbed	%	Disturbed	%
6110	Cypress	1,970	1,478	75.0	492	25.0
6211	Swamp tupelo	775	524	67.6	251	32.4
6212	Bayhead	1,322	946	71.6	376	28.4
6213	Scrub/shrub	1,314	1,083	82.4	231	17.6
6311	Cypress/swamp tupelo/bay	12,633	8,122	64.3	4,511	35.7
6312	Swamp tupelo/bay/pine	6,291	2,999	47.7	3,292	52.3
6410	Emergent	430	319	74.2	111	25.8
	TOTAL	24,735	15,471	62.6	9,264	37.4

*Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

floodplains of major creeks for at least 0.5 mi upstream from each creek's confluence with the Suwannee River, and 3) a 500-ft radius of any third-magnitude or larger spring or any major sinkhole (Figure 1.1-3, Section 1.1).

Wetlands to be disturbed under Alternative B include Swift Creek Swamp and Bee Haven Bay (Section 4.0), wetlands contiguous with stream channels to be mined in the upper reaches of the tributary streams, and hydrologically isolated wetlands of various size categories. Mining of wetlands contiguous to stream channels and headwater portions of stream systems themselves may locally impact detrital transport functions in the tributaries. Impacts on downstream systems and the Suwannee River will be insignificant as these headwater areas are not major contributors of detrital material to downstream systems (Sections 3.3.4.2.2 and 3.4.2.3.3). Contributions of detrital material to tributary main channel areas and the Suwannee River are primarily from streambank vegetation and floodplain areas. No mining will occur within the 100-yr floodplain of the Suwannee River nor in floodplains of major creeks for at least 0.5 mi upstream from each creek's confluence with the Suwannee River. These detrital sources will not be affected.

The specific functions served by the mined wetlands will be eliminated, while the functions of the remaining 15,471 acres of wetlands will remain. Functional values of partially mined wetlands will be reduced, with possible elimination of certain functions, depending on the degree of disturbance. Those wetlands remaining undisturbed may be temporarily affected, as discussed for Mining Alternative A (Section 6.2.2.3.1).

Conceptual reclamation plans provide for acre-for-acre replacement of disturbed wetlands; OXY's plans meet requirements of Ch. 16C-16, FAC, to provide for viable, functional wetland systems which potentially may be of higher value in specific functions than many of the naturally occurring wetlands on site (Section 3.3.10).

6.2.2.3.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Under proposed Alternative C, 9.9% (2452 acres) will be mined or disturbed, while 90.1% (22,283 acres) will be preserved (Table 6.2-14). Approximately 26.5% of the mineable wetlands would be mined or disturbed. Wetlands to be mined are all less than 25 acres in size, leaving those wetlands over 25 acres intact. No individual cover type will be reduced by more than 15%, thus insuring that flora and fauna unique to these cover types will continue to maintain viable populations and act as reservoirs for invasion and colonization of adjacent reclaimed wetland areas.

Impacts of mining will be similar to those previously discussed (Sections 6.2.2.1 and 6.2.2.2). The majority of the wetlands smaller than 25 acres are hydrologically isolated and are relatively simple in vegetation diversity and structure. Therefore, the impacts on wetlands communities of this mining alternative will not be as great as those anticipated for Alternative B. As for all the alternatives, impacts

Table 6.2-14. Extent of Wetland Acreage Disturbed and Undisturbed under Mining Alternative C.

Code*	Description	Existing	Undisturbed	%	Disturbed	%
6110	Cypress	1,970	1,787	90.7	183	9.3
6211	Swamp tupelo	775	711	91.7	64	8.3
6212	Bayhead	1,322	1,322	100.0	0	0
6213	Scrub/shrub	1,314	1,302	99.1	12	0.9
6311	Cypress/swamp tupelo/bay	12,633	10,803	85.5	1,830	14.5
6312	Swamp tupelo/bay/pine	6,291	5,953	94.6	338	5.4
6410	Emergent	430	405	94.2	25	5.8
	TOTAL	24,735	22,283	90.1	2,452	9.9

*Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

will be temporary, as reclamation plans require acre-for-acre replacement of viable wetland systems. Indirect impacts on those wetlands not proposed for mining or mine support facilities will be similar to those discussed for Alternative A (Section 6.2.2.3.1).

6.2.2.3.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Alternative D is similar to Alternative B but excludes wetlands that meet FDER jurisdictional criteria. These excluded wetlands are primarily those contiguous to stream channels. Therefore, no local impacts on detrital transport or downstream systems and the Suwannee River are anticipated. Under this mining alternative, 34.8% (8601 acres) of the total project area wetlands is proposed for mining or mine support facilities, while 65.2% (16,134 acres) will remain undisturbed (Table 6.2-15). Approximately 93% of the mineable wetlands would be mined or disturbed.

No more than 42% of any wetland cover type will be disturbed, thus insuring that flora and fauna unique to these cover types will continue to maintain viable populations for invasion and colonization of adjacent areas. Undisturbed areas will also serve as seed sources for reclaimed areas.

Impacts will be similar to those discussed previously (Section 6.2.2.2). Reclamation will provide acre-for-acre replacement of viable, functional wetland systems. Indirect impacts on those wetlands not proposed to be mined or utilized for mine support facilities will be minor and of relatively short duration as discussed for Mining Alternative A (Section 6.2.2.3.1).

Table 6.2-15. Extent of Wetland Acreage Disturbed and Undisturbed under Mining Alternative D.

Code*	Description	Existing	Undisturbed	%	Disturbed	%
6110	Cypress	1,970	1,449	73.6	521	26.4
6211	Swamp tupelo	775	456	58.8	319	41.2
6212	Bayhead	1,322	888	67.2	434	32.8
6213	Scrub/shrub	1,314	1,001	76.2	313	23.8
6311	Cypress/swamp tupelo/bay	12,633	8,401	66.5	4,232	33.5
6312	Swamp tupelo/bay/pine	6,291	3,670	58.3	2,621	41.7
6410	Emergent	430	269	62.6	161	37.4
	TOTAL	24,735	16,134	65.2	8,601	34.8

*Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

6.2.3 Aquatic Communities

Aquatic communities in the project area include canals, mine pits reclaimed to lakes, reservoirs, ponds, stream communities, and water areas within the mining and processing lands (e.g., reclaimed lakes, waste clay disposal areas). Aquatic communities other than those associated with stream communities and mining and processing lands account for approximately 590 acres (<1% of the project site) and are distributed among four land use and cover types:

Description	Acreage	% Aquatic Community	% Total Site
Canals	66	11.2	<0.1
Mine pits reclaimed to lakes	17	2.9	<0.1
Reservoirs	434	73.5	0.4
Ponds	73	12.4	<0.1
TOTAL	590	100.0	0.6

Twenty-one streams with approximately 341,457 linear ft of stream channel, exclusive of the Suwannee River, have a portion of their drainage basins in the project area (Table 6.2-16). Approximately 31,720 linear ft (9%) have mineable reserves. In their headwater reaches, these streams are primarily conveyances for water draining upland areas. Based on field studies conducted on major tributaries, no significant transport of drift organisms or detrital material to lower reaches of these tributaries is apparent (Sections 3.3.4.2.2 and 3.4.2.3.3). Most of the detrital material is from riparian vegetation which falls into the streams and is processed in place, with little movement downstream. The tributaries' contributions of detritus to the Suwannee River are limited primarily to their lower reaches near their confluences with the river.

Aquatic systems in the proposed mining area have been impacted at least locally by a variety of activities: roads, bridges, culverts, clearing, agricultural operations, and timbering. Most streams in the area are crossed several times by state, county, private, and logging roads. During the rainy season, turbid runoff from unpaved roads may enter streams at bridges and culverts. In addition, silvicultural activities can change water quality and quantity in area streams.

Aerial photography (c. 1979) and USGS topographic maps (7.5-minute quadrangles) show extensive drainage canals and ditches in the Roaring Creek, Rocky Creek, and Swift Creek drainage basins from silvicultural/ agricultural activities. Draining affects the functions of these and adjacent areas.

Drainage basins have also been altered either directly or by discharge from mining activities ongoing over much of the project area since about 1965. All of these activities have placed some stress on the ecology of the area and will continue to do so.

Table 6.2-16. Linear Feet of Stream Channels Occurring Wholly or Partially Within the Project Area.

Stream	Length (ft)[1]	% of Total	Linear Ft of Mineable Reserves
Camp Branch	29,900	8.8	2,300
Cypress Creek	14,200	4.2	0
Four Mile Branch	18,300	5.4	3,690
Hogans Branch	9,215	2.7	3,200
Hunter Creek	16,872	4.9	0
Jerry Branch	14,000	4.1	0
Long Branch	19,450	5.7	4,300
Poucher Branch	18,800	5.5	0
Ratliff Creek	13,400	3.9	0
Roaring Creek	32,450	9.5	17,900
Rocky Creek	35,900	10.5	0
Sal Marie Branch	28,000	8.2	0
Sugar Creek	3,200	0.9	0
Swift Creek[2]	37,370	10.9	330
Unnamed branch 1	7,400	2.2	0
Unnamed branch 2	13,400	3.9	0
Unnamed branch 3	11,000	3.2	0
Unnamed branch 4	3,000	0.9	0
Unnamed branch 5	3,000	0.9	0
Unnamed branch 6	8,800	2.6	0
Unnamed branch 7	3,800	1.1	0
TOTAL	341,457	100.0	31,720

[1]These measurements include the entire length of some streams that may be only partially within the 1974 DRI project boundary. Not included in these measurements are drainage ditches, side channels, and streams that do not flow directly into the Suwannee River, i.e., they may discharge into swamps.

[2]Does not include Swift Creek Canal.

Measures to collectively govern or monitor silvicultural and roadwork activities generally are inadequate and not subject to reclamation regulations; thus, the long-term biological integrity of an area may not be protected from development, agricultural, silvicultural, or other impacts. On the other hand, the phosphate industry must reclaim all mined areas to insure that the ecosystem will be restored on a long-term basis (Ch. 16C-16, FAC).

6.2.3.1 Impacts on the Suwannee River

The structure and function of rivers like the Suwannee River are maintained principally by organic and inorganic input of their headwaters and tributary streams, as well as internal processes. If significant changes occur in the input, the basic character of the river changes. The headwaters of the Suwannee River, which include the Okefenokee Swamp and other headwater wetlands in Georgia and many Florida tributaries, contribute dark, acidic, poorly-buffered waters. These conditions form the foundation for the biological components in the upper Suwannee River.

Many organisms, particularly macroinvertebrates, depend on terrestrially produced organic material for food and shelter (Cummins and Klug 1979). Mining uplands should not significantly alter the amount of organic detritus entering streams close to mine areas because the majority of the organic input to aquatic systems is from riparian vegetation or trees and shrubs close to the streams. In mine areas, a vegetation border will be left along all unmined waterbodies, except those stream reaches to be mined under Alternative B. Transport of material to downstream areas from upper reaches is not significant (Sections 3.3.4.2.2 and 3.4.2.3.3). Additionally, no mining under any alternative will occur within the 100-yr floodplain of the Suwannee River nor within floodplains of tributary streams for at least 0.5 mi upstream of the stream's confluence with the Suwannee River.

Contributions of organic material to the Suwannee River should not be altered significantly, as contributions of project area streams are relatively insignificant on a regional scale. Falling Creek, Robinson Creek, Little Creek, and Deep Creek have approximately the same discharge as streams draining the project area. Thus, it can be assumed that their organic contributions are similar. Any short-term alteration of organic input from several small streams draining the project area would be insignificant in terms of the overall dynamics of the project area. Additionally, major floodplain areas of the Suwannee River and tributaries for at least 0.5 mi upstream of the tributaries' confluence with the Suwannee River (potentially a major source of organic material for aquatic systems) will not be disturbed.

Physical and chemical characteristics of a stream typically change from its headwaters to its mouth (Hynes 1970). For most streams, these changes are gradual and occur over many miles. However, as a result of various surface and subterranean springs, particularly in the White Springs area, pH, hardness, and buffering capacity increase radically in the Suwannee River over a short distance (Bass and Hitt 1971).

Chemical characteristics of many rivers in the United States are fairly stable, fluctuating within fairly narrow ranges during normal periods of flow. However, for the upper/middle portions of the Suwannee River (beginning approximately at White Springs), the chemical characteristics fluctuate widely, depending on the relationship between input from tributaries, the Okefenokee Swamp, and surface and subterranean springs. Bass and Hitt (1971) and Cox (1970) explained the relationship between discharge and water chemistry in the Suwannee River. The wide-ranging chemical regime in this portion of the Suwannee River suggests that the biological community in the river is composed mainly of organisms that are tolerant of these extreme conditions. Any localized changes that may occur in the Suwannee River as a result of OXY mine water discharge represent only another dimension in an already extremely variable chemical environment (Section 3.4.2). Hence, the organisms inhabiting the Suwannee River are adapted to widely fluctuating conditions and should not be significantly impacted by stream discharges containing mine water effluent (Section 3.3.4).

The Florida Department of Environmental Regulation sampled macroinvertebrates throughout the Suwannee River, including stations both immediately above and below Hunter and Swift creeks for approximately two years beginning in February 1982 (Tables 6.2-17 through 6.2-20). Values above and below Hunter Creek for all macroinvertebrate parameters were equivalent (Table 6.2-18). Diversity below Hunter Creek was generally the same and always >75% of the values above Hunter Creek, indicating that the criteria for biological integrity, as defined in Chapter 17-3.121(7), FAC, were met (Table 6.2-19). More taxa were present below the confluence and diversity values were comparatively high, indicating a well-balanced community and good water quality.

The mean macroinvertebrate parameters for above and below Swift Creek, which has received both mine and chemical plant discharges since 1966, also were similar (Table 6.2-20). Mean diversity and number of taxa were equivalent above and below Swift Creek, but density was somewhat higher and equitability slightly depressed below Swift Creek (Table 6.2-18). However, the mean values for density are misleading. A set of samples collected below the confluence of Swift Creek for December 1982 had the second highest density recorded for the entire survey ($15,378/m^2$). If this value were omitted, mean density would be $1828/m^2$, which is similar to the value for samples collected above Swift Creek. Samples collected below Swift Creek were in compliance with the biological integrity rule [Ch. 17-3.121(7), FAC] 86% of the time. During 2 of the 14 sampling periods for which data were available, biological integrity was <75%. The data indicate that the Suwannee River below Swift Creek generally supports a diverse, abundant macroinvertebrate community which shows no significant signs of stress.

Additional evidence that the Suwannee River does not exhibit adverse effects below Swift Creek is provided by the Florida Game and Fresh Water Fish Commission. From 1969 to 1982 they sampled the fish community above and below the confluence of Swift Creek six times, utilizing a variety of techniques, including electrofishing, seines, and nets (FGFWFC 1982, 1983). They stated that "no consistent differences between the two sample stations are apparent" and found "no obvious

Table 6.2-17. Biological Sampling Stations for the FDER Suwannee River Outstanding Florida Water Study (FDER 1980).

Station 1	400 m upstream of Hunter Creek
Station 2	400 m downstream of Hunter Creek
Station 3	350 m upstream of Swift Creek
Station 4	300 m downstream of Swift Creek, above I-10 bridge
Station 5	1.6 km upstream of the Withlacoochee River
Station 6	1 km downstream of the Withlacoochee River, approximately 300 m upstream of the Florida Power Corporation's Suwannee River Plant intake canal
Station 7	3 km upstream of SR 250 bridge, near Dowling Park
Station 8	2.5 km upstream of SR 51 bridge, near Luraville
Station 9	5 km upstream of US 27 bridge, near Branford
Station 10	700 m upstream of SR 340 bridge, near Rock Bluff
Station 11	6 km downstream of New Pine Landing, adjacent to Manatee Springs State Park

Table 6.2-18. Summary of Macroinvertebrate Parameters for the Suwannee River Above and Below Hunter and Swift Creeks, February 1982-December 1983, FDER Outstanding Florida Water Study (FDER 1980).

Parameter ($\overline{x}$)	Above Hunter Creek	Below Hunter Creek	Above Swift Creek	Below Swift Creek
n	17	22	16	19
Diversity	3.35	3.24[1]	3.30	3.08[2]
No. of taxa	29.4	32.1	34.3	34.5
Density (no./m^2)	1859	2450	1453	2541
Equitability	0.54	0.42[1]	0.45	0.37[2]

Note: Values were generated from preliminary raw data obtained from FDER on computer tape. The raw data are subject to verification by FDER.

[1]n for this parameter was 19 because significantly <100 organisms were collected during 3 sampling periods.

[2]n for this parameter was 18 because significantly <100 organisms were collected during 1 sampling period.

Table 6.2-19. Diversity and Biological Integrity [Ch. 17-3.121(7), FAC] of Macroinvertebrate Samples from the Suwannee River Above and Below the Confluence of Hunter Creek (FDER Outstanding Florida Water Study, FDER 1980).

Sampling Date	Diversity Above Hunter Creek[1] (Station 1)	Diversity Below Hunter Creek[1] (Station 2)	Biological Integrity (% Change)	Compliance
1982				
Feb	3.47	2.72	78	+
Mar	3.62	3.53	98	+
Apr	3.48[2]	3.62	104	+
May	-[3]	4.11	-	
Jun	2.86	3.07	107	+
Jul	3.24	3.36	103	+
Aug	3.22	3.16	98	+
Sep	-	2.87[4]	-	
Oct	2.73	2.97	109	+
Nov	3.05	3.05	100	+
Dec	3.46	3.39	98	+
1983				
Jan	3.93[2]	3.13[2]	80	+
Feb	-	4.03	-	
Mar	3.37	3.62	107	+
Apr	3.87	3.88[4]	100	+
May	3.48	-	-	
Jun	2.99	3.67	123	+
Jul	3.54	3.36	95	+
Aug	2.95	1.58[2,3]	-[5]	
Sep	3.63	2.87	79	+
Oct	-	2.71	-	
Nov	-	2.84	-	
Dec	-	2.36	-	

Total in compliance = 15
% compliance = 100%

Note: Values were generated from preliminary raw data obtained from FDER on computer tape. The raw data are subject to verification by FDER.

[1]Based on a composite of 4 replicate samples unless otherwise indicated.
[2]Based on 3 replicates.
[3]Missing samplers.
[4]<100 organisms collected.
[5]Comparison invalid because only 3 organisms collected.

Table 6.2-20. Diversity and Biological Integrity [Ch. 17-3.121(7), FAC] of Macroinvertebrate Samples from the Suwannee River Above and Below the Confluence of Swift Creek (FDER Outstanding Florida Water Study, FDER 1980).

Sampling Date	Diversity Above Swift Creek[1] (Station 1)	Diversity Below Swift Creek[1] (Station 2)	Biological Integrity (% Change)	Compliance
1982				
Feb	3.28	2.87	88	+
Mar	3.00	2.52	84	+
Apr	3.58	2.88	80	+
May	-[2]	-	-	
Jun	3.60	3.44	96	+
Jul	2.81	2.85	1.01	+
Aug	3.54	3.40	96	+
Sep	3.49	3.36[3]	96	+
Oct	-	4.16	-	
Nov	3.50	3.39	97	+
Dec	3.32	1.68	51	
1983				
Jan	-	3.25	-	
Feb	-	3.51	-	
Mar	3.44	2.69	78	+
Apr	4.08	2.81	69	
May	4.09	-	-	
Jun	2.89	3.31	115	+
Jul	-	3.49	-	
Aug	2.49	2.97	119	+
Sep	-	-	-	
Oct	2.55	-	-	
Nov	-	3.26	-	
Dec	3.20	2.87	90	+

Total in compliance = 12
% compliance = 86%

Note: Values were generated from preliminary raw data obtained from FDER on computer tape. The raw data are subject to verification by FDER.

[1]Based on a composite of 4 replicate samples unless otherwise indicated.
[2]Missing samplers.
[3]<100 organisms collected.

trend since 1969." The FGFWFC concluded that the station below Swift Creek was similar to the station above Swift Creek and that "both sample locations are similar and reflect streams not degraded by impacts of man" (FGFWFC 1983). In a summary report, the FGFWFC reviewed data for six sampling periods from 1980 to 1983. They found that mean sport fish biomass below Swift Creek was nearly double the biomass found above Swift Creek (Krummrich and Kautz 1984).

6.2.3.2 Probable Impacts of Mining and Reclamation Activities

6.2.3.2.1 Mining

Aquatic communities in the project area will be affected by mining operations and temporary flow reductions in tributaries.

Periphyton. Mining will temporarily disrupt the structure and function of periphyton communities. Some permanent alterations, such as changes in species dominance, may result from the creation of more open water after reclamation. Population numbers and primary production will be impacted to some degree; however, periphyton are so widespread that permanent impacts are insignificant (Section 3.3.4.1.2).

Periphyton communities will also be affected by flow reductions in tributaries as a result of mining stream channels and decreases in drainage basin acreages. However, these impacts will be temporary, as reclamation will restore drainage basins and stream channels (Ch. 16C-16, FAC) and will result in a net increase in acreage of aquatic communities for all alternatives. Those areas not mined will serve as sources for colonization of reclaimed systems.

Phytoplankton. Mining impacts on phytoplankton will be similar to those described for periphyton, i.e., temporary reductions in populations and shifts in species dominance. In addition, nutrient-enriched waters entering the reclaimed lakes will contribute to periodic phytoplankton blooms. Reclamation activities will restore drainage basins and stream channels and create additional habitat.

Macroinvertebrates. The most obvious impacts on macroinvertebrates will result from mining reaches of stream channels. Under any alternative, no mining will occur within: 1) the 100-yr floodplain of the Suwannee River or 500 ft from the river, whichever is greater; 2) the floodplains of tributary streams for at least 0.5 mi upstream from each creek's confluence with the Suwannee River; and 3) a 500-ft radius of any third-magnitude or larger spring or any major sinkhole. Macroinvertebrate populations, reproductive cycles, and community structure and function will be temporarily disturbed in aquatic habitats, stream channels, and wetlands subject to mining. Hynes (1970) provided a short review of man's impacts on aquatic ecosystems when streams are directly altered. He concluded that operations within streams reduce the abundance and variety of flora and invertebrate fauna; however, substantial invertebrate colonization usually occurs within weeks. Morton (1977) concluded that direct burial of organisms and destruction of habitat were the two most obvious biological effects of dredging. Once the stream channel and surrounding basin are restored and some succession has taken place, a macroinvertebrate community will become reestablished within a short time. However, the community components may or may not be the same as those in the pre-mining stream.

Although vegetation will be removed from several drainage basins, riparian vegetation, one of the most important sources of organic material for stream food chains, will be left undisturbed along unmined aquatic ecosystems. Thus, macroinvertebrate communities on the project site should not be significantly impacted by loss of terrestrial vegetation in the upper reaches of affected streams.

Alterations in streamflow will result from mining stream channels and upland areas that are temporarily removed from the drainage basin. These changes are not expected to significantly impact the macroinvertebrate community, as macroinvertebrates inhabiting the streams presently experience varying environmental conditions including extreme ranges in flow conditions (Section 3.3.4.2.2).

Macroinvertebrates typically have short life cycles, produce abundant offspring, and rapidly colonize aquatic habitats. Once the reclamation process has begun, macroinvertebrates from adjacent habitats should colonize the various substrates in reclaimed areas through natural processes such as aerial dispersal of adult stages, drift, migration, and passive transport on other organisms. There may be shifts in community composition due to different substrates.

Fish. Mining impacts on fish communities are not expected to be significant. The fish communities on the project site and adjacent areas exhibit greatest density and diversity in the larger aquatic systems such as ponds, reclaimed lakes, main channel portions of streams, and the Suwannee River (Section 3.3.4.2.1). These areas will be least disturbed by mining. Mining in upper stream reaches will temporarily disturb the fish communities and reduce populations of headwater species. However, the fish communities in headwater reaches are generally poorly developed. Much of the area scheduled for mining has drainage ditches and small tributaries of other streams which generally support poor fish populations. These areas are usually occupied by smaller species with short life cycles which can reproduce and colonize rapidly under wide fluctuations in environmental conditions. Once reclamation has been completed, fish populations should become reestablished from unmined areas.

Mining within a drainage basin without discharge to the stream will result in a temporary reduction in flow. However, many fish species inhabiting small streams in the project area are adapted to a wide range of environmental and flow conditions (Section 3.3.4.2.1) and thus should not be significantly affected by mining. Under natural conditions, streams may flow rather swiftly or not at all, depending on the season. During particularly dry seasons, some portions of area streams may become desiccated for extended periods. For example, flows for Stations RO-2 and RO-5 on Roaring Creek and Station LB-2 on Long Branch had ranges of 0.2-22.1 cfs, 0-23.6 cfs, and 0-2.7 cfs, respectively, over an approximately 2.5-yr period (Section 3.4.2).

Data collected by OXY consultants in a 1982 survey (Section 3.3.4.2.1) showed that, despite wide-ranging flow conditions, the main channel areas of lower reaches of small streams near the confluence of the Suwannee River sustained significant fish communities. Therefore, if flow regimes are altered only minimally, associated impacts on fish communities should be minor. Additionally, creation of reclaimed lakes will increase fish populations and diversity in the project area (Section 3.3.10). These reclaimed lake areas provide fishing opportunities which, prior to mining, were limited in the project area. A survey conducted by Auburn University Fisheries and Allied Aquaculture staff indicated that during June and July 1981, approximately 4100 hours of fishing pressure resulted in removal of 1500 lb of fish from OXY reclaimed lakes (Boyd and Davies 1981). Additionally, in 1982 the FGFWFC removed approximately 6000 fingerling bass from Eagle Lake to stock lakes managed by the FGFWFC in Duval County.

Following is a comparison of fishing success as determined by creel surveys in OXY reclaimed lakes (Boyd and Davies 1981) and portions of the Suwannee River (Krummrich and Kautz 1984):

Location	Date	Fish/Hr
Reclaimed lakes	6/81 - 7/81	1.6
Suwannee River		
Upper	3/82 - 6/82	1.4
Middle	1971	2.0
Lower	2/83 - 6/83	1.7

6.2.3.2.2 Matrix Transfer and Road Corridors

Matrix transfer lines and road corridors typically are constructed in previously mined lands. However, due to the scattered nature of OXY reserves, some corridors may be constructed on land not previously mined. Potential impacts associated with these activities include actual construction (e.g., clearing and filling) and the possibility of pipe rupture. Impacts on periphyton, phytoplankton, macroinvertebrates, and fish will be similar to those discussed in Section 6.2.3.2.1, i.e., loss of some populations of these species from clearing and filling of aquatic habitats. Rupture of a matrix pipeline may result in spills in aquatic habitats, dramatically increasing turbidity, thus affecting those species in the water column and smothering substrate dwellers with spilled material. However, such impacts would be minimal, as corridor routes are usually located on previously disturbed areas and are moved frequently as mining proceeds; furthermore, any rupture of matrix slurry lines would be immediately identified due to obvious loss of pumping pressures, resulting in shutdown of pumping activities until the rupture is repaired.

6.2.3.2.3 Waste Disposal Activities

A primary concern with waste clay settling areas is the potential for dike failure which could result in the discharge of a large volume of clays into aquatic systems, destroying flora and fauna at the spill site and aquatic organisms downstream by water quality degradation and excessive sedimentation. Studies of spills indicated that approximately 90% of fish and most of the macroinvertebrates were eliminated by excessive sedimentation (Ware 1969). Although stream recovery can be rapid, community shifts may result due to substrate differences. The likelihood of dike failure is remote, as construction and monitoring are in accordance with Ch. 17-9, FAC, and no dike failure has been reported since the enactment of this rule.

Creation of interim aquatic habitat in waste disposal areas will primarily benefit vertebrate species, although flora and invertebrate fauna will receive limited benefit.

6.2.3.2.4 Water Discharges into Tributaries

OXY presently has permitted discharge points on two streams in the project area. Swift Creek receives water from reclaimed lakes, chemical processing, mine water, and runoff from natural areas. Hunter Creek receives only mine water and runoff from natural areas. Data for sampling stations in the project area provide an indication of the water quality that can be expected to be discharged into other streams, provided permits are obtained (Table 6.2-21). The values generally are in a range representing good quality water which should support diverse aquatic communities (Section 3.4.2).

The introduction of water from reclaimed lakes receiving chemical plant or beneficiation wastewater may cause an influx above background levels of phosphorus and nitrogen into receiving streams. However, an increase in nutrients did not appear to greatly alter the periphyton community in Hunter Creek or other streams receiving an increased nutrient level (Section 3.3.4.1.2). For example, centric and pennate diatoms were the dominant periphyton taxa for many unaffected streams, including the Suwannee River. These taxa were also prevalent or dominant in Hunter Creek and the canals leading from Eagle Lake and Altmans Bay. However, an influx of nutrients could contribute to increased biomass and a shift in community dominance for some streams.

Nutrient levels in water from reclaimed lakes not receiving process water from chemical plants or the beneficiation process should be similar to levels in natural runoff. The introduction of reclaimed lake water may alter stream conditions, thus contributing to changes in the macroinvertebrate community (Section 3.3.4.2.2). For example, in Eagle Lake Canal below the discharge of Eagle Lake, filter feeders (i.e., organisms that strain food resources from the water column), such as net spinning caddisflies (e.g., Cheumatopsyche) and the blackfly (Simulium), may become more prevalent because of the suspended organisms flowing out of the lake. However, this change would be limited to areas near the outfall of the lake.

A year-long study of various biological components in Hunter Creek indicated that the stream was not adversely impacted by the introduction of mine water (Sections 3.3.4.1 and 3.3.4.2). Diversity and abundance of algae, fish, and particularly macroinvertebrates in Hunter Creek were

Table 6.2-21. Mean Values of Selected Chemical Parameters for Hunter Creek, Eagle Lake, and Altmans Bay Canal, November 1979-March 1982 (Section 3.4.2, Tables 3.4-30 and 3.4-32).

	Stations Receiving Water from Reclaimed Lakes		Stations Receiving Mine Water Discharge		
Parameter	EL001-18	AB-3	HC-1	HC-2	HC-3
pH*	6.4(26)	6.5(26)	6.2(2)	5.0(29)	4.1(30)
Hardness (mg/l)	118(33)	134(32)	123(10)	106(44)	114(44)
Alkalinity (mg/l)	59.9(33)	49.5(32)	27.7(10)	28.0(43)	27.7(44)
Conductivity (µmhos/cm)	270(27)	330(27)	348(8)	262(37)	275(37)
Color (Pt-Co units)	231(33)	54(32)	156(10)	145(43)	137(44)
Total nitrogen (mg/l)	4.33(32)	3.49(31)	3.59(10)	2.56(43)	2.80(44)
Total phosphate (mg/l)	5.64(32)	5.64(32)	3.12(9)	2.10(43)	2.08(43)

*Mean based on hydrogen ion concentration.

Note: Number in parentheses indicates number of samples.

comparable to values for "unaffected" aquatic systems in the area. The number of taxa and drift density in Hunter Creek for August 1981 and February 1982 were within the ranges of values for tributaries that do not receive mine water discharge (Section 3.3.4.2.2). Furthermore, drift was sampled for an entire 24-hr period during August 1981 and was found to be representative of normal macroinvertebrate patterns. A recent survey of Hunter, Roaring, and Rocky creeks showed that only Hunter Creek supports a significant mussel community (OXY consultants unpubl. data 1982). The presence of mussels in Hunter Creek is at least partially attributable to relatively stable water levels and favorable chemical characteristics of the water. As filter feeders, many mussel species are sensitive to pollution; their presence generally indicates no acute toxicity in the stream. Data from Hunter Creek suggest that the introduction of mine water to other area streams will not adversely affect the function of the aquatic community (Section 3.3.4).

6.2.3.2.5 Reclamation

Interim aquatic habitats will be disturbed during the grading and contouring phases of reclamation. Creation of lake systems, both flow-through and isolated, will provide a net increase in aquatic habitat over what presently exists. These reclaimed aquatic habitats support a diverse group of aquatic flora and fauna (Sections 3.3.4 and 3.3.10).

The reaches of stream channels that are mined (Alternative B) will be restored (Section 3.3.10); the lower reaches, where aquatic communities are more prevalent and more structured (Section 3.3.4), will not be mined. These areas, as well as many other undisturbed aquatic habitats, will act as colonizing sources for the newly reclaimed systems.

6.2.3.3 Mining Alternatives

6.2.3.3.1 Alternative A: No Mining or Mine Support in Wetlands

Under Alternative A, only 10 acres (1.7%) of the aquatic communities on site will be affected. No wetlands or stream channels will be mined under this alternative; thus, impacts on aquatic resources will be minimal (Sections 6.2.3.1 and 6.2.3.2). Reclamation will increase the extent of aquatic communities in the project area by creating approximately 3919 acres of lakes, both isolated and flow-through. Reclaimed lakes support diverse flora and fauna and will contribute to the overall diversity of the aquatic communities in the project area.

6.2.3.3.2 Alternative B: Mining All Wetlands Containing Reserves

Impacts on aquatic communities will be greatest for this mining alternative, compared to Alternatives A, C, and D, because portions of the upper reaches of several stream channels will be mined. Under this alternative, 67 acres (11.4%) of the aquatic communities in the project area will be mined. Additionally, 31,720 linear ft (approximately 9%) of stream channel upper reaches will be mined (Table 6.2-22). However, this alternative will result in creation of the greatest extent of additional aquatic communities. Reclamation will create approximately 7474

Table 6.2-22. Number of Linear Feet of Stream Channel Disturbed by the Mining Process under Alternative B.[1]

Stream	Total Length	Undisturbed		Disturbed	
		Ft	%	Ft	%
Camp Branch	29,900	27,600	92.3	2,300	7.7
Cypress Creek	14,200	14,200	100.0	0	0
Four Mile Branch	18,300	14,610	79.8	3,690	20.2
Hogans Branch	9,215	6,015	65.3	3,200	34.7
Hunter Creek	16,872	16,872	100.0	0	0
Jerry Branch	14,000	14,000	100.0	0	0
Long Branch	19,450	15,150	77.9	4,300	22.1
Poucher Branch	18,800	18,800	100.0	0	0
Ratliff Creek	13,400	13,400	100.0	0	0
Roaring Creek	32,450	14,550	44.8	17,900	55.2
Rocky Creek	35,900	35,900	100.0	0	0
Sal Marie Branch	28,000	28,000	100.0	0	0
Sugar Creek	3,200	3,200	100.0	0	0
Swift Creek[2]	37,370	37,040	99.1	330	0.9
Unnamed branch 1	7,400	7,400	100.0	0	0
Unnamed branch 2	13,400	13,400	100.0	0	0
Unnamed branch 3	11,000	11,000	100.0	0	0
Unnamed branch 4	3,000	3,000	100.0	0	0
Unnamed branch 5	3,000	3,000	100.0	0	0
Unnamed branch 6	8,800	8,800	100.0	0	0
Unnamed branch 7	3,800	3,800	100.0	0	0
TOTAL	341,457	309,737	90.7	31,720	9.3

[1]These measurements include the entire length of some streams that may be only partially within the 1974 DRI project boundary. Not included in these measurements are drainage ditches, side channels, and streams that do not flow directly into the Suwannee River, i.e., they may discharge into swamps.

[2]Does not include Swift Creek Canal which will also be mined and reclaimed.

acres of isolated and flow-through lake systems, similar to existing lake systems in the project area, which support a diverse assemblage of flora and fauna (Sections 3.3.4 and 3.3.10).

6.2.3.3.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Approximately 18 acres (3.1%) of the aquatic communities in the project area will be mined. No portions of stream channels will be mined under this alternative and impacts on other aquatic systems will be minimal (Sections 6.2.3.1 and 6.2.3.2). Reclamation will create 5744 acres of lake systems in the project area--a net increase in aquatic habitat.

6.2.3.3.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

This alternative includes mining 23 acres (3.9%) of the aquatic communities in the project area. No stream channels will be mined; however, wetlands not under FDER jurisdiction (per Ch. 17-4, FAC) will be mined. FDER jurisdiction includes those wetlands immediately adjacent to and/or hydrologically connected to stream systems. Impacts on aquatic resources are anticipated to be minimal (Sections 6.2.3.1 and 6.2.3.2).

6.2.4 Forestry and Agricultural Resources

6.2.4.1 Alternative A: No Mining or Mine Support in Wetlands

Existing forestry resources (active silviculture) account for approximately 34,056 acres (34%) of the 100,000-acre project site. This includes planted pine (type 441) and clearcut areas in various stages of site preparation (type 451). Under Alternative A, approximately 6397 acres (19%) of the 34,056 acres will be affected by mining and mine support activities (Table 6.2-23). Timber on the planted pine acres will be harvested prior to mining. Based on evaluations of the silvicultural potential of existing reclaimed lands (Gooding 1981), impacts should be limited to short-term unavailability of the land mined and/or disturbed until reclamation is complete. The forestry productivity of reclaimed land is of at least equivalent value to that of native soils in the project area.

Approximately 791 acres (10%) of the 7945 acres of agricultural land will be disturbed by mining and mine support facilities. According to the definition and final ruling on prime farmland (Federal Register 31 January 1978), <50 acres of agricultural lands on the project site are considered prime and unique farmland (Section 3.3.5.3). However, no actual locations were identified due to the lack of certified soil maps for Hamilton County. Therefore, potential impacts are assumed to be minimal due to the small acreage and the probability that these lands are not included within the mining or support facility areas for Alternative A. An evaluation of the forage potential of reclaimed lands indicates productivity is similar to that in natural areas (Blue 1981).

6.2.4.2 Alternative B: Mining All Wetlands Containing Reserves

Approximately 12,952 acres (38%) of silvicultural lands will be disturbed by mining and mine support facilities (Table 6.2-23). Pine timber will be harvested prior to mining. Additionally, cypress is occasionally logged in the project area. It is anticipated that the 9153 acres of forested wetlands proposed for mining and mine support facilities will be harvested for marketable cypress. Therefore, this resource will not be lost.

Of the 7945 acres of agricultural land, 1174 acres (15%) are proposed to be mined or utilized for mine support activities. As for Mining Alternative A, impacts on the forestry and agricultural resources of the project site will be short-term, as mining will occur over a 20-yr period and reclamation plans include returning a substantial portion of the post-mining land use to these activities (Section 3.3.10). Comparisons of forestry productivity on reclaimed areas and natural areas indicate that reclaimed areas have as good or better forestry productivity than natural areas (Gooding 1981). Comparison of pre- and post-mining soils in other areas also indicates the potential for as good or better productivity for agricultural and forestry activities on reclaimed soils (EPA 1981).

Table 6.2-23. Acreages of Forestry and Agricultural Lands to be Disturbed Under the Mining Alternatives.

Code*	Description	Project Acreage	Alternative A Disturbed Acreage	Alternative A %	Alternative B Disturbed Acreage	Alternative B %	Alternative C Disturbed Acreage	Alternative C %	Alternative D Disturbed Acreage	Alternative D %
211	Row crops	3,976	349	8.8	419	10.5	377	9.5	415	10.4
212	Field crops	2,509	394	15.7	623	24.8	580	23.1	624	24.9
213	Improved pasture	1,302	40	3.1	41	3.2	27	2.1	20	1.5
222	Deciduous fruit orchard	1	0	0	0	0	0	0	0	0
231	Pecan orchard	1	0	0	0	0	0	0	0	0
242	Confined feeding operations	51	8	15.7	8	15.7	8	15.7	8	15.7
323	Scrub/brush rangeland	105	0	0	83	79.1	0	0	0	0
441	Planted coniferous forest	24,861	3,688	14.8	8,247	33.2	7,439	29.9	8,412	33.8
451	Clearcut areas	9,195	2,709	29.5	4,705	51.2	3,602	39.2	4,509	49.0
TOTAL		42,001	7,188	17.1	14,126	33.6	12,033	28.7	13,988	33.3

*Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

6.2.4.3 Alternative C: Mining Only Small Isolated or Weakly/ Periodically Connected Wetlands Containing Reserves

Under Mining Alternative C, approximately 12,921 acres (38% of the forested areas (types 441 and 451) will be mined or used for mine support facilities which is similar to Mining Alternative B (Table 6.2-23). These areas are anticipated to be harvested of marketable timber prior to mining. An additional 2427 acres of forested wetlands will be harvested of marketable cypress.

Approximately 992 acres (13%) of existing agricultural lands are proposed for mining and mine support facilities. Impacts associated with forestry and agricultural resources under this mining alternative are similar to those discussed for Alternatives A and B, i.e., temporary loss of use, but productivity of at least equal value for forestry and agricultural resources after reclamation.

6.2.4.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Under Mining Alternative D, approximately 11,041 acres (32%) of forestry resources are proposed for mining and mine support activities (Table 6.2-23). It is anticipated that all marketable timber will be harvested prior to disturbance to avoid complete loss of this existing resource. An additional 8440 acres of forested wetlands will be harvested of marketable cypress. Agricultural resources will be impacted by the temporary loss of 1067 acres (13% of existing resources). Impacts associated with this alternative are similar to those previously discussed.

6.2.5 Game and Migratory Wildlife

A significant portion of the project area is under private lease from local hunt clubs. Hunting is also conducted on the 25,972-acre Cypress Creek Wildlife Management Area north of CR 6 and on portions of the Suwannee River Mine. Major game species are the white-tailed deer and feral hog. Only about 3200 acres (12%) of the 25,972-acre Cypress Creek Wildlife Management Area are within the OXY project boundary. None of this land is scheduled for mining or mine-related activities under any of the proposed mining alternatives.

Puddle ducks and diving ducks are hunted primarily on open waterbodies at the Suwannee River Mine; thus, duck hunting activity will not be adversely affected by additional mining. In fact, reclaimed lands, particularly land and lakes, will benefit these species by providing additional habitat presently limited in the geographical area. Creation of these aquatic systems has resulted in a net increase in the number of bird species (30% of the expected total) occurring in the project area (EPA 1978).

Only 13% of the approximately 235 bird species expected to occur in the area are non-migratory (EPA 1978). The remainder are either transients or winter or summer residents. Migratory species primarily utilize man-made open water habitats in the area, e.g., settling areas, mine pits, and, most significantly, reclaimed lakes. Thus, any adverse impacts to these species would be relatively minor and short-term as reclamation activities will create more open water habitats than presently exist in the geographical area.

6.2.6 Rare and Endangered Species

6.2.6.1 Flora

Federally Protected Species. Only one federally-protected plant species is believed to occur in the project area based on past studies (EPA 1978). Chapman's rhododendron (*Rhododendron chapmanii*) was believed to have been observed along Rocky, Swift, and Roaring creeks, and Camp Branch, as well as wetland habitats (EPA 1978). This species was not observed during field investigations for this project. Under Mining Alternative A, this species would not be directly impacted, as only upland areas will be mined. Under Alternatives B, C, and D, individuals of this species may be directly impacted by mining in wetlands and stream areas. However, over 60% of the wetlands on site will be preserved under Mining Alternative B, which involves mining of the most acreage. Therefore, mining will not eliminate this species from the area flora, regardless of the mining alternative.

State Protected Species. Several species of plants protected as endangered or threatened under Section 581.185, FS, occur in the project area. The stated intent of Section 581.185, FS, is to "...provide an orderly and controlled procedure for restricting harvesting of native flora from the wilds, thus preventing wanton exploitation or destruction of Florida native plant populations." This restriction applies to the majority of the species observed in the project area. Their distribution is primarily associated with hardwood and mixed forests (types 621 and 631) and pine flatwoods (type 411). Much of the upland habitat in the project area has been cleared, logged, and/or intensively managed for forestry. The wetland habitat types have also been disturbed by burning, logging, and draining, which have reduced the value of these areas for protected species. No species of orchids or hollies listed in Section 581.185, FS, were observed in the project area during the vegetation studies. Fern species observed included a spleenwort (*Asplenium platyneuron*) and a chain fern (*Woodwardia areolata*).

Three species listed by the Florida Committee on Rare and Endangered Plants and Animals (FCREPA) potentially occurring in the project area were not encountered during the vegetation studies (Section 3.3.7). Species listed by FCREPA are not afforded any legal protection.

The listed species would not be significantly impacted by any of the mining alternatives, as species distributions include both uplands and wetlands and, even under Alternative B, over 60% of the wetlands and 71% of the uplands (types 411, 422, and 431) will be preserved.

6.2.6.2 Fauna

Federally Protected Species. Of the nine species that are federally protected or are under review for federal protection and that potentially occur in the project area, only four were actually observed: the American alligator, wood stork, southern bald eagle, and peregrine falcon (Section 3.3.7). The eastern indigo snake and Suwannee cooter are likely to occur but were not actually observed. The short-tailed snake, red-cockaded woodpecker, and gray bat also were not observed and probably do not occur in the project area due to lack of suitable habitat (Section 3.3.7).

The American alligator is protected as threatened under federal law and as a species of special concern by the State of Florida. It has been observed in the project area mostly in waste clay settling areas, abandoned mine pits, reclaimed lakes, and in the Suwannee River. No significant waterbodies are scheduled for mining under any of the mining alternatives, with the exception of some tributary stream areas under Alternative B (Section 2.2). Mining under any of the alternatives will benefit this species, as most of the population in the project area occurs in areas which have previously been mined or are part of the mining operations (waste clay settling areas), and reclamation activities will create additional habitat for this species.

The wood stork is protected as endangered under both federal and state law. This species has been observed feeding and roosting in waste clay settling areas and mine pits. No rookeries of this species have been observed in the project area or in Hamilton County (Colonial Bird Register 1981). The individuals observed in the project area are believed to be non-breeding or post-breeding wanderers. Impacts on this species as a result of the proposed mining alternatives should be positive, as observed use has been exclusively in mine and reclaimed areas. Although wood storks use wetlands, streams, and rivers for feeding, they have not been observed in these habitats in the project area. Mining and reclamation under Alternatives B, C, and D would result in additional habitat similar to that presently used by wood storks for feeding and roosting areas. However, there would be a temporary reduction in habitat from wetlands mining.

The southern bald eagle is protected as threatened by the State of Florida and endangered by the U.S. Fish and Wildlife Service. The status is different because southern bald eagle populations have been less severely impacted in Florida than those in areas outside of Florida (Hammerstrom et al. 1975, Peterson and Robertson 1978). This species has been observed feeding and roosting in the Suwannee River Mine clay waste settling areas (Section 3.3.7). The individuals observed were in immature plumage; however, no nesting sites are known in the project area (pers. comm. Steve Nesbitt, Florida Game and Fresh Water Fish Commission). Impacts of mining under any of the proposed alternatives may be somewhat beneficial as the species appears to be using mine and reclaimed areas rather than adjacent naturally vegetated areas.

Only two peregrine falcons have been recorded in the project area at waste clay settling areas on the Suwannee River Mine. Both were probably transients. Peregrine falcons do not breed in Florida, but some do winter in the state. The species' optimal habitat is in coastal areas where there are suitable roosting sites and abundant food resources (water birds). The clay settling areas and other open waterbodies created by mining and reclamation activities normally support large populations of water birds (Sections 3.3.2 and 3.3.10), thereby offering this species a valuable food resource. Impacts on this species from mining and reclamation under any of the proposed alternatives appear to be somewhat beneficial in terms of providing additional food resources.

The eastern indigo snake is protected as a threatened species by federal law and by the State of Florida. Although not observed in the project area, this species has a large range and uses a variety of habitat types and is believed to occur on site. However, the paucity of sightings may indicate that population levels are low. Its preferred habitat is believed to be mesic hammock and floodplain areas along streams and rivers (Kochman 1978). This species may be impacted under Mining Alternative B, as some areas along streams will be mined. However, due to its large range and low population levels and the fact that no mining, under any alternative, will occur within the 100-year floodplain of the Suwannee River, the impact on this species is anticipated to be minimal.

The Suwannee cooter is presently under review for protection by the U.S. Fish and Wildlife Service and is protected as a species of special concern by the State of Florida. Although this species has not been observed in the project area, previous studies have reported it on the Suwannee River (NFWL 1978, EPA 1978). Populations in the upper Suwannee River are presumed to be low due to limited aquatic vegetation. No mining within the 100-year floodplain of the Suwannee River is proposed under any of the mining alternatives and no significant changes to the water quality of the Suwannee River by discharges which would affect this species will occur. Therefore, impacts associated with mining will be negligible for this species.

It is unlikely that the short-tailed snake, red-cockaded woodpecker, and gray bat occur in the project area due to lack of suitable ecological requirements such as nesting habitats; therefore, mining under any of the proposed alternatives will not impact these species.

State Protected Species. Of the 22 potentially-occurring species protected by the State of Florida, 11 were actually observed in the project area (Section 3.3.7). These included four species also protected by federal law in addition to the gopher tortoise, Florida sandhill crane, little blue heron, snowy egret, tricolored heron, least tern, and Florida black bear. The eastern indigo snake, Suwannee cooter, southeastern kestrel, Sherman's fox squirrel, and Atlantic sturgeon may also occur but have not been observed in the area. The geographical distributions of the gopher frog, Florida mouse, and Suwannee bass include the project area, but these species are not likely to occur due to lack of suitable ecological requirements.

The gopher tortoise, protected as a species of special concern by the State of Florida, has been observed in high pinelands in the Swift Creek basin and along the natural levees of the Suwannee River. This species will not be impacted by any of the mining alternatives, as the proposed mining activities do not include areas where gopher tortoises have been sighted.

The Florida sandhill crane, protected by the State of Florida as a species of special concern, has been observed flying over the project area. However, there is no evidence of nesting, feeding, or roosting by this species in the project area. It is unlikely that this species maintains a viable population in the project area, and impacts due to mining under any of the proposed alternatives would be unlikely.

The little blue heron, snowy egret, and tricolored heron are protected by the State of Florida as species of special concern. These species have been observed along settling areas on the Suwannee River Mine. Colonies were quite large and included 460 little blue heron, 140 snowy egrets, and 90 tricolored herons. A few individuals have also been observed in non-mining areas such as along roadside ditches, streams,and agricultural ponds and in cypress heads and bayheads along the Suwannee River. Minimal impacts are anticipated on these species as a result of mining activities under any of the four mining alternatives. There will be some loss of wetlands habitat under Alternatives B, C, and D; however, based on observed populations, the open water/marsh habitats created as a result of mining and reclamation are favored over naturally vegetated areas by all of these species.

The Florida black bear is afforded protection as a threatened species by the State of Florida. Population levels throughout the state are extremely low with the exception of the nearby Apalachicola and Osceola National Forests where hunting is allowed by the Florida Game and Fresh Water Fish Commission. Florida black bears have been reported in the northern portion of the project area. Mining under any of the proposed alternatives will result in loss of habitat for this species. However, the impacts should be short-term, as reclamation efforts specifically address "wildlife areas," designed in cooperation with the Florida Game and Fresh Water Fish Commission.

The least tern, protected as a threatened species by the State of Florida, has been observed nesting on sand tailings areas of the Suwannee River Mine. Three colonies were reported to have successfully nested (Colonial Bird Register 1981). This species historically has nested on coastal beaches, but loss of habitat and human disturbance have eliminated many of the Florida colonies, while others have shifted nesting to rooftops and sand tailings areas of phosphate mines in north and central Florida (Fisk 1978). Mining activities under any of the proposed alternatives would not adversely impact this species; rather, the species would benefit from creation of sand tailings areas.

The southeastern kestrel is protected by the State of Florida as a threatened species. This subspecies has not been observed on the site; however, the northern migratory subspecies has been observed in the project area. The southeastern kestrel is non-migratory, and attempts at observations during times when the northern subspecies should not be present have failed to document its occurrence in the project area; however, the species may occur there in limited numbers. Preferred habitat consists of open fields and thinly wooded areas. Impacts as a result of any of the proposed mining alternatives would be minimal.

Sherman's fox squirrel is designated a species of special concern in the State of Florida. It is also considered a game species, and hunting is allowed during regular hunting seasons. This species has not been observed in the project area, but it may occur in high pineland areas and along the natural levees of the Suwannee River. If this species does occur, population levels are probably extremely low and individuals would be expected in areas presently occupied by the gopher tortoise. None of these areas is scheduled for mining under any of the proposed mining alternatives.

The Atlantic sturgeon is protected as a species of special concern by the State of Florida. This species was not collected during any field studies, but adult sturgeon are believed to spawn in shoal areas between Ellaville and White Springs (Huff 1975). Mining under any of the proposed alternatives will not adversely impact this species.

The Suwannee bass, protected as a species of special concern, has not been found in the upper Suwannee River but rather in the lower Suwannee River including the lower Ochlockonee, Santa Fe, and Ichetucknee rivers. No adverse impacts are anticipated for this species as a result of any of the proposed mining alternatives. Mining and beneficiation discharges into the Suwannee River will not affect this species in the lower reaches of the Suwannee River.

The Florida mouse and Florida gopher frog are protected by the State of Florida as threatened and of special concern, respectively. They have not been observed in the project area and their occurrence is doubtful due to lack of suitable habitat. The most likely areas of occurrence are in gopher tortoise burrows. Because areas containing the gopher tortoise are not scheduled for mining under any of the proposed alternatives, no adverse impacts are anticipated for these species.

6.2.6.3 Summary

Impacts on legally protected species occurring or potentially occurring in the project area are, for the most part, minimal under all proposed mining alternatives and in many cases may be beneficial. For example, mining and reclamation activities will create open water areas used by the American alligator, wood stork, little blue heron, snowy egret, and tricolored heron. Creation of sand tailings habitat as part of the mining process will also benefit the least tern.

Populations of legally protected flora in the project area may be reduced. The Florida black bear, as well as other terrestrial species, may experience habitat loss, but the overall impact will be minimal as OXY proposes to provide wildlife areas (as specified by the Florida Game and Fresh Water Fish Commission) in its reclamation design which should benefit these species. The U.S. Fish and Wildlife Service has also concurred that proposed mining will not significantly affect threatened and endangered species in the project area (consultation with the U.S. Army Corps of Engineers pursuant to Section 7 of the Endangered Species Act of 1973, as amended; Section 3.3.7).

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6.3 Surface Water Quantity

Hydrology impacts were not addressed for each of the mining alternatives due to the 1) difficulties associated with establishing drainage divides under each set of mining plans, 2) continually changing position of the divides as the mining area expands each year, 3) effects of unpredictable manual control of the mine water levels on flows in receiving streams, 4) uncertainty of where mine wastewater can be discharged in the future, and 5) lack of impacts on the Suwannee River even under the most extreme case of no discharges to the river from OXY's operations.

Item 5 above is based on the fact that if all water from OXY's entire project area of approximately 100,000 acres could somehow be removed, the annual average flow in the Suwannee River would be decreased by only 7% (112 cfs) at Suwannee Springs based on USGS drainage area and flow data. Obviously, this cannot happen; therefore, the most adverse impact would be considerably less than the 7% change. As discussed in Section 6.3.2, actual flows to the Suwannee River during mining should be similar to pre-mining flows.

During mining, hydrological impacts on small streams in the area will depend largely on whether or not OXY is allowed to discharge to additional streams. If they are not, then some of the water normally reaching non-discharge streams will be diverted to other drainage basins. Depending on the percentage of the area removed, flows could be dramatically reduced in several of these streams (Section 6.3.2).

After reclamation is completed, the area draining to each stream will closely approximate the pre-mining acreage. Therefore, the quantity of water reaching the streams will be similar. Streams that receive a significant portion of their flow via reclaimed lakes will have reduced peak flows, and the duration of low flow periods will be shortened (Section 6.3.3). The long-term net impact of mining and subsequent reclamation should be considered positive. The lakes will reduce flooding potential and periods of low flow which are typically stressful to aquatic organisms.

Water Quantity Impact Modeling. The HSPF model was used to assess impacts on surface water hydrology under pre-mining, baseline, and post-mining conditions. The area modeled included the Suwannee River watershed from Benton to Suwannee Springs, Florida and seven small drainage areas--Rocky Creek, Hunter Creek, Roaring Creek, Long Branch, Four Mile Branch, Swift Creek, and Camp Branch--which will be influenced by mining and post-mining activities. The surface runoff of these small drainage areas was simulated by the PERLND module of HSPF. The PERLND module was calibrated using Rocky Creek hydrological data and verified using Deep Creek hydrological data (Section 3.4.1). Streamflow routing in the Suwannee River was simulated by the RCHRES module of HSPF. The combined PERLND and RCHRES module application was calibrated and verified using flow data at White Springs. The calibration and verification results under baseline conditions are shown in Table 3.4-7 and Figures 3.4-10 through 3.4-12 (Section 3.4.1); the pre-mining model results are shown in Table 3.4-8 and Figures 3.4-13 through 3.4-15 (Section 3.4.1).

Removal of vegetative cover, overburden material, and matrix and disposal of waste products from processing the matrix will change the soil characteristics and consequently modify the pre-mining land surface conditions. Other mining-related activities, such as clearing, ditching, and construction of roads, pipelines, powerlines, and dragline walking paths, will also change the land surface and subsurface conditions. These changes may affect evapotranspiration, infiltration, interception, and interflow. After completion of the mining operation, OXY will reclaim the mined area in various manners which may alter the pre-mining hydrology. Therefore, the surface hydrology under pre-mining conditions, baseline conditions, and post-mining conditions was investigated to evaluate the hydrological and water quality impacts on the Suwannee River and tributary drainage areas during and after mining.

Sensitivity Analysis. Selected model (PERLND) parameters (Table 3.4-6, Section 3.4.1) were changed to reflect the reclaimed land forms and soil conditions. In order to help determine the magnitude of the changes in parameters, a sensitivity analysis was run to determine which parameters should receive the most attention and how sensitive the model was to changes in the parameters. The sensitivities of 16 model input parameters were tested. Each parameter was allowed to vary within a range of expectancy in the neighborhood of the final value from the calibration/verification procedure (Table 6.3-1). The sensitivity analysis was conducted under the assumption that the drainage area has the same land surface area as the Roaring Creek basin (13,744 acres).

An initial simulation was performed using the previously calibrated parameter values; its results were considered as the basic conditions for comparison. Only one parameter was changed from the calibrated value to one extreme of the specified variation range. The process was repeated for every model parameter. Results of the sensitivity analysis (Table 6.3-2) indicated that maximum flow is most sensitive to changing of infiltration (INFILT), upper zone nominal storage (UZSN), interflow (INTFW), active groundwater recession (AGWRC), and length of overland flow (LSUR). Mean flow is most sensitive to changing of deeper zone percolation (DEEPFR), active groundwater recession (AGWRC), upper zone nominal storage (UZSN), lower zone ET (LZETP), and lower zone nominal storage (LZSN). Therefore, great care was exercised when determining these sensitive parameters for different land surface conditions.

6.3.1 Pre-Mining and Baseline Conditions

The hydrology of the Suwannee River and tributary drainage areas under pre-mining and baseline conditions (as of January 1981) was simulated and discussed in detail in Sections 3.4.1.6 and 3.4.1.7, respectively.

6.3.2 Impacts During Mining

The impacts during mining were addressed by examining the impacts on a small stream, Roaring Creek, during the period of its maximum impact from mining under Alternative B, Mining All Wetlands Containing Reserves. Additionally, the impact on the Suwannee River during mining was examined using a water balance approach (Hayes et al. 1980).

Table 6.3-1. Range of Parameter Values Used for Sensitivity Analysis.

Parameters*		Calibrated Value	Minimum	Maximum
LZSN		5.3	4.3	6.3
INFILT		0.15	0.1	0.3
SLSUR		0.0024	0.001	0.004
AGWRC		0.94	0.85	0.995
INFEXP		2.0	1.5	2.5
INFILD		2.0	1.7	1.4
DEEPFR		0.12	0.05	0.2
BASETP		0.08	0.05	0.12
AGWETP		0.45	0.40	0.50
CEPSC		0.25	0.15	0.35
UZSN		1.2	0.6	1.8
INTFW		2.0	1.5	2.5
FOREST		0.5	0.30	0.70
IRC		0.9	0.85	0.95
LSUR		800	400	1200
NSUR		0.35	0.25	0.45
LZETP	J	0.4	0.5	0.3
	F	0.4	0.5	0.3
	M	0.4	0.5	0.3
	A	0.5	0.6	0.4
	M	0.7	0.8	0.6
	J	0.8	0.9	0.7
	J	0.8	0.9	0.7
	A	0.8	0.9	0.7
	S	0.8	0.9	0.7
	O	0.7	0.8	0.6
	N	0.6	0.7	0.5
	D	0.4	0.5	0.4

*Defined in Table 3.4-6, Section 3.4.1.

Table 6.3-2. Results of Sensitivity Analysis for Flow (Q).

Parameter*	Value	Q mean (cfs)	Q max (cfs)	s-Q (cfs)
Calibrated flow	-	18.25	871.5	35.00
LZSN	6.3	17.85	891.5	34.47
	4.3	18.75	853.1	35.67
INFILT	0.1	18.61	1158.0	39.49
	0.3	17.72	450.6	30.30
SLSUR	0.001	18.24	746.6	33.99
	0.004	18.25	942.4	35.69
INFEXP	1.5	18.17	852.7	34.09
	2.5	18.32	919.1	35.97
INFILD	1.4	18.31	854.1	34.73
	1.7	18.29	858.7	34.81
DEEPFR	0.05	19.46	883.3	36.24
	0.20	16.88	857.8	33.59
BASETP	0.05	18.45	847.2	34.56
	0.12	18.01	902.1	35.49
AGWRC	0.85	18.94	839.6	38.64
	0.995	15.94	1125.0	30.90
AGWETP	0.40	18.28	864.4	34.85
	0.50	18.21	878.0	35.15
CEPSC	0.15	18.39	853.5	34.84
	0.35	18.12	889.0	35.10
UZSN	0.6	19.52	1022.0	37.85
	1.8	17.53	773.6	32.95
INTFW	1.5	18.15	1067.0	37.24
	2.5	18.31	717.1	33.82
IRC	0.85	18.26	907.8	37.97
	0.95	18.22	835.3	30.78
LZETP (JAN)	0.5	17.67	847.3	34.45
	0.3	18.98	896.4	35.70
LSUR	400	18.26	1061.0	37.03
	1200	18.24	755.8	34.05
NSUR	0.25	18.25	964.6	35.93
	0.45	18.24	800.1	34.39

*Defined in Table 3.4-6, Section 3.4.1. Only one parameter was changed among the calibrated parameter set for each run (Table 3.4-6).

6.3.2.1 Small Stream Drainage Systems

In order to estimate the maximum impact to the Suwannee River tributary drainage systems in the project area, the impact on the Roaring Creek drainage area was investigated during the period of maximum disturbance. This drainage area is moderately sized and is typical of project area drainage basins in terms of its physiographic characteristics. Roaring Creek is also a potential site for future mine discharges. When the Roaring Creek drainage area is under maximum mining influence, only 1606 acres of the drainage area will remain outside the hydrologic influence of the Suwannee River Mine (Figure 6.3-1).

The HSPF model was used to simulate the area shown in Figure 6.3-1 with the calibrated PERLND module. The scenario was studied with and without the mine discharges. These discharges, when applied, were assumed to be equivalent to the present mine discharges to Hunter Creek. Figure 6.3-2 shows the results of several model runs for various conditions. In addition to cumulative frequency curves for baseline and natural conditions, curves are also shown for cases where the mine has affected most of the drainage area (and left only 1606 acres totally unaffected), both with and without mining discharges.

It is evident that the mining operations will temporarily have a significant impact on Roaring Creek if planned mining occurs and OXY is not allowed to discharge to Roaring Creek (Figures 6.3-2 through 6.3-4). If there are no mining discharges, the flows will be severely reduced from baseline levels. Approximately 40% of the time the flow will be 0. If mining discharges are allowed, the impact will be much less--only about 5% of the flows will be 0. There will be more low level flows and fewer high level flows. Other drainage areas such as Long Branch, Four Mile Branch, and Camp Branch will experience the situation shown by curve C in Figure 6.3-2. Rocky Creek will be affected less because a much smaller percentage of its drainage area is proposed for mining.

The biological impacts associated with the loss of flow to the small creeks are discussed in Section 6.2.3.

6.3.2.2 Suwannee River

Mining impacts on the hydrology of the Suwannee River were addressed using a mass balance approach as opposed to a continuous simulation modeling approach. The HSPF model was not used to address water quantity during mining because of the variability in the way OXY operates their mine water system and the inability to predict where and when water could be discharged from the system, as future discharges are dependent on NPDES permitting by the EPA and FDER.

OXY presently discharges mine water at three points. The Suwannee River Mine discharges mine wastewater through NPDES points 001-7 (outfall from Altmans Bay to Swift Creek) and 002 (outfall to Hunter Creek). The Swift Creek Mine discharges from several outfalls, all of which enter Eagle Lake which discharges through NPDES point 001-18.

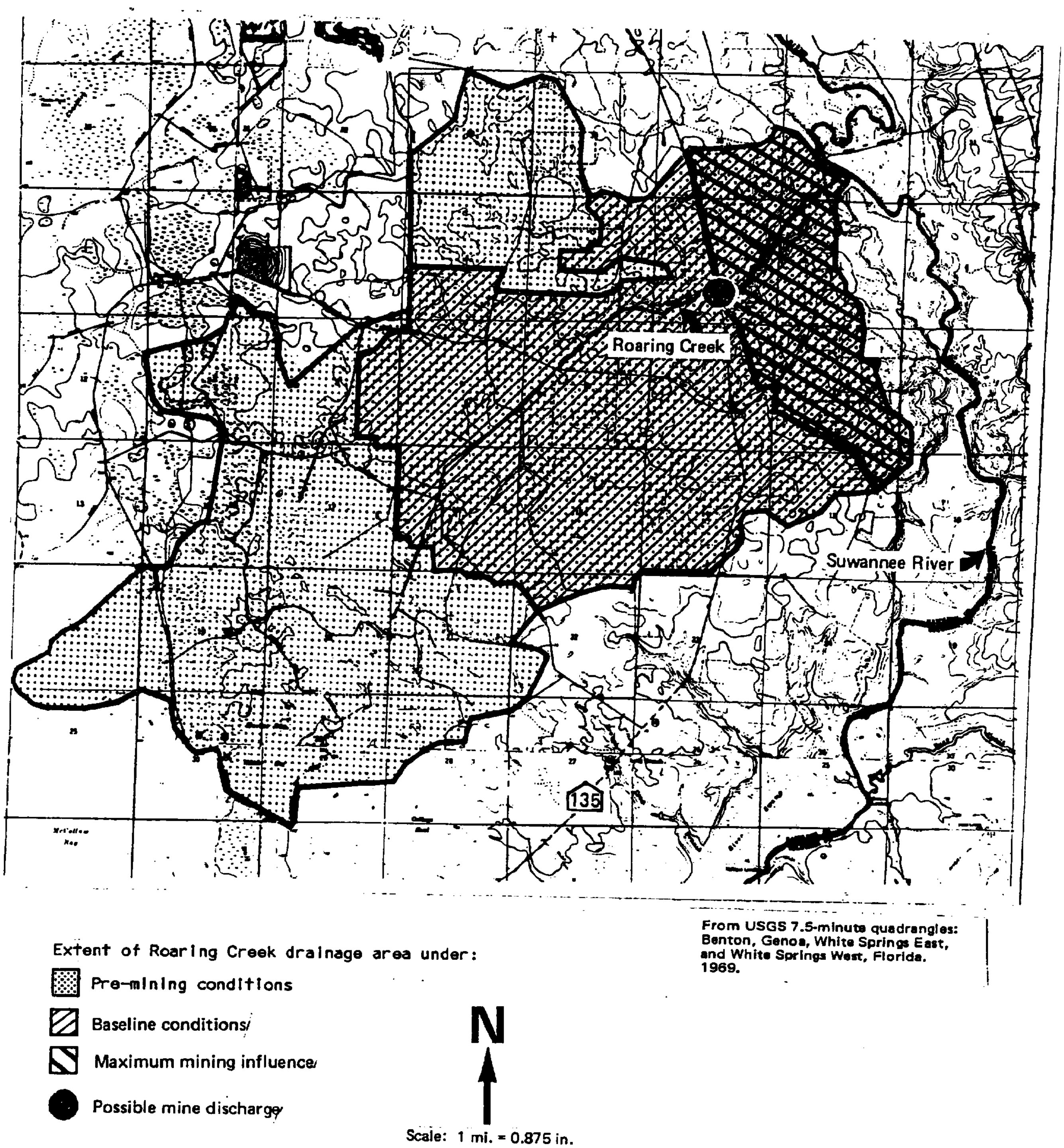


Figure 6.3-1. Roaring Creek Drainage Area Under Pre-Mining, Baseline, and Mining Conditions.

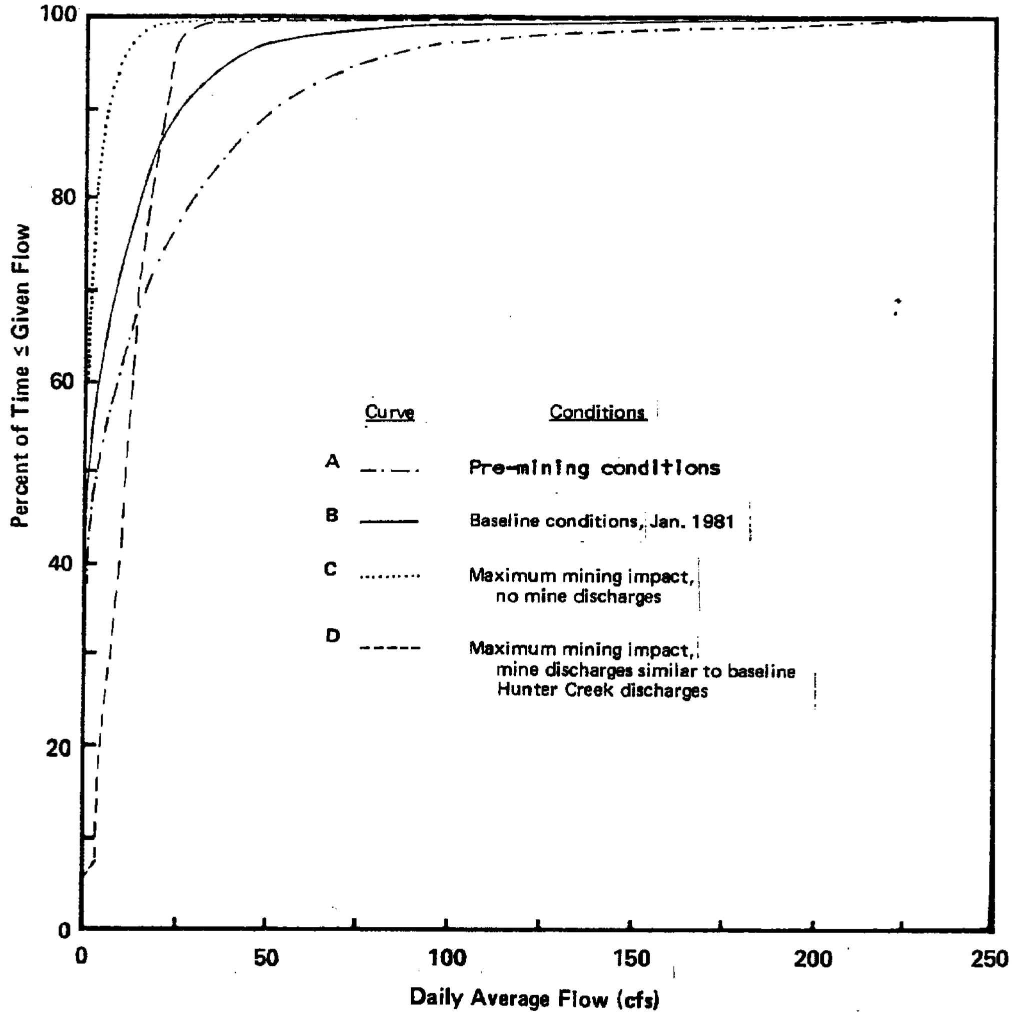


Figure 6.3-2. Maximum Mining Impact on a Small Stream Drainage Area, Simulation Period October 1959-September 1979.

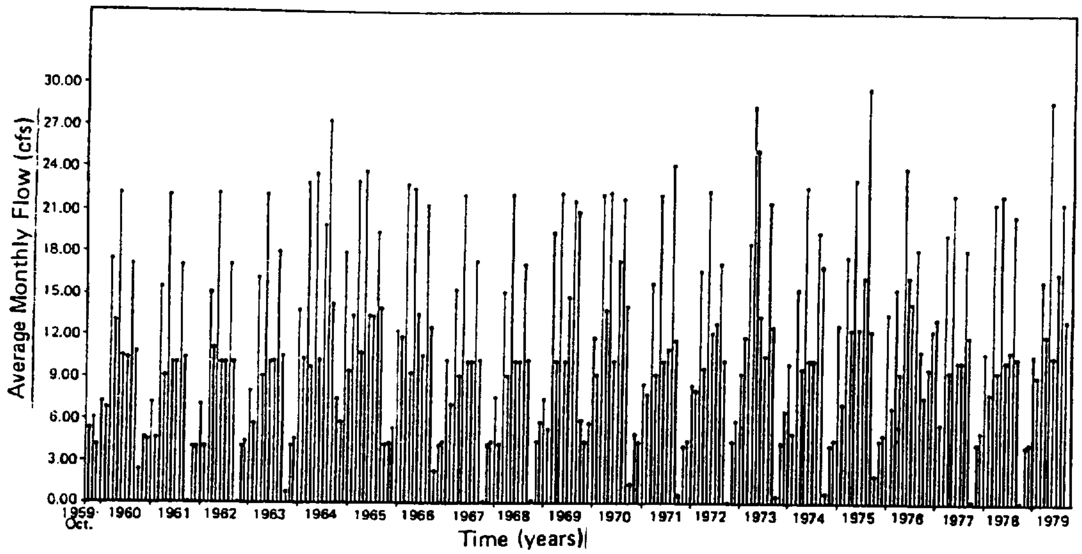


Figure 6.3-3. Monthly Average Flows, Roaring Creek, Maximum Mining Impact (with Mine Discharges); Simulation Period October 1959-September 1979.

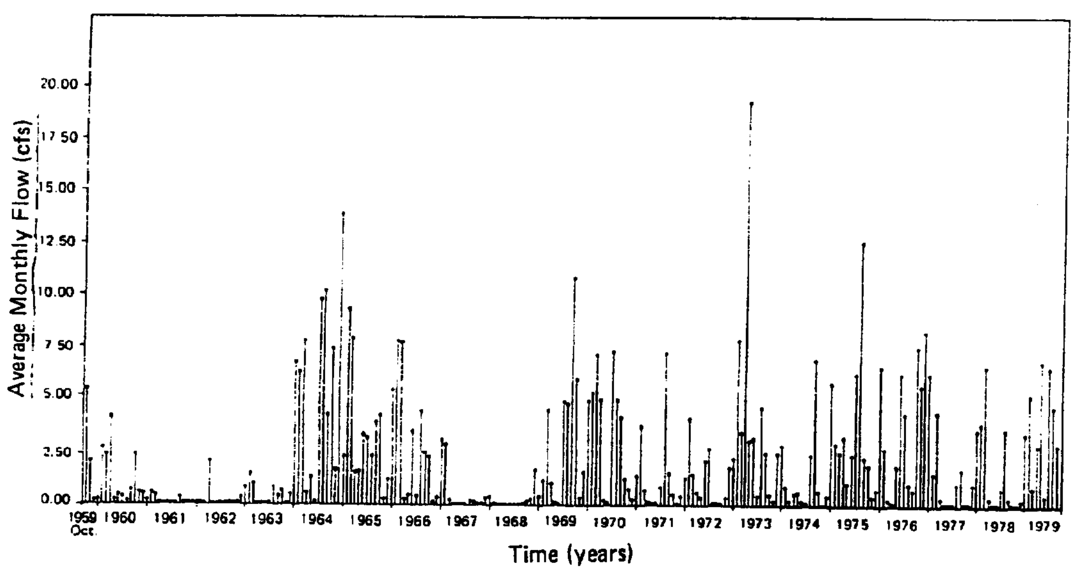


Figure 6.3-4. Monthly Average Flows, Roaring Creek, Maximum Mining Impact(No Mine Discharge); Simulation Period October 1959-September 1979.

Due to the lack of additional permitted outfalls on other creeks, water from several of the other creeks' drainage systems must be diverted to Swift and/or Hunter creeks. The diversion obviously causes increased flow in the receiving stream and decreased flow in the affected creek. The magnitude of the change in flow is largely dependent on the percent of drainage area removed from the affected creek.

Regardless of the actual point of discharge, the same total amount of water will reach the Suwannee. If new NPDES discharge points are not permitted, the majority of the discharge from mining areas would have to be discharged via Swift Creek. Therefore, flow normally entering the Suwannee River upstream of White Springs would be diverted from that portion of the river. This would not have a significant impact because the streams comprise a relatively low percentage of the Suwannee River flow and not all of the streams would be affected at the same time. The lower sections of the streams, which are more deeply incised and receive baseflow, would experience less flow impacts. Additionally, diversion would be temporary because the original stream drainage areas will be restored after mining and reclamation as required by Ch. 16C-16, FAC.

During mining, the total amount of water entering the Suwannee River is not expected to change from present conditions. OXY is not planning any new plants or significant increases in the design operating rates of their current operations. Therefore, deep well withdrawals are not expected to increase, nor are significant changes in evapotranspiration or recharge expected. Therefore, the same amount of water should reach the Suwannee River. However, different percentages of the drainage area will have been affected by OXY operations.

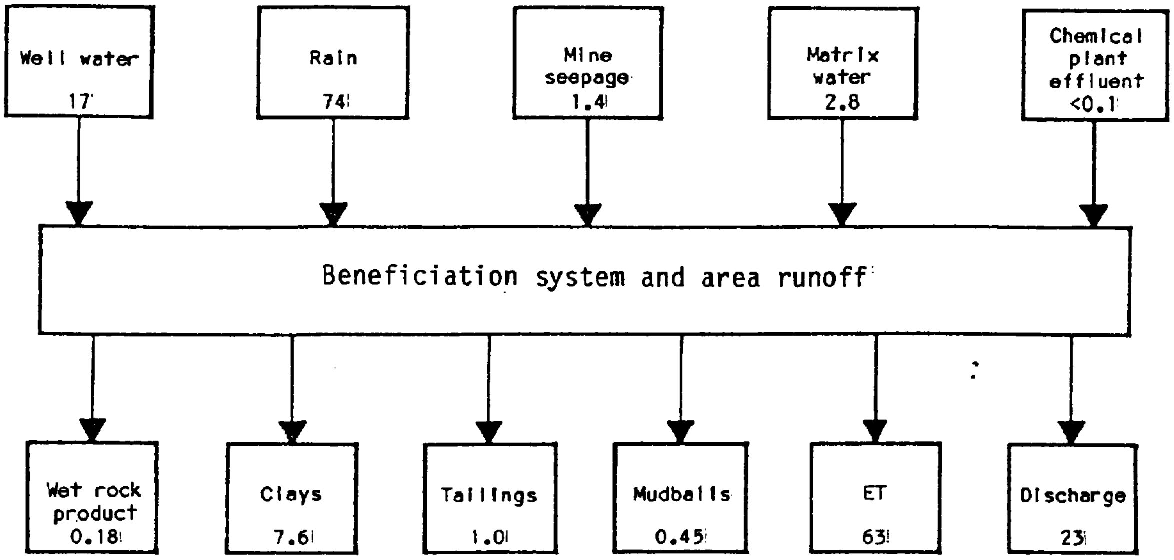
As the mining areas increase each year, a larger drainage area comes under the influence of the mining operations. The rainfall which falls within the boundary of the perimeter ditching used to prevent turbid runoff from entering unpermitted wetlands or streams is either routed through one of OXY's reclaimed lakes or incorporated into the mine water system and used in the mining process. Neither of these options would affect the quantity of water discharges. Inspection of the water balances for the two mines demonstrates that water lost in the beneficiation process is replaced by deep well withdrawals (Figure 6.3-5).

6.3.3 Post-Mining Conditions

Simulating surface runoff under post-mining conditions is more difficult than under pre-mining conditions because after reclamation the drainage area will consist of more varied land surfaces. Seven land use categories were used for post-mining simulation:

1) water area associated with reclaimed lakes
2) land area associated with reclaimed lakes
3) tailings fill type reclaimed lands
4) elevated fill type reclaimed lands
5) natural areas, discharging into lakes
6) natural areas, discharging into small streams
7) natural areas, discharging into the Suwannee River

Suwannee River Mine



Swift Creek Mine

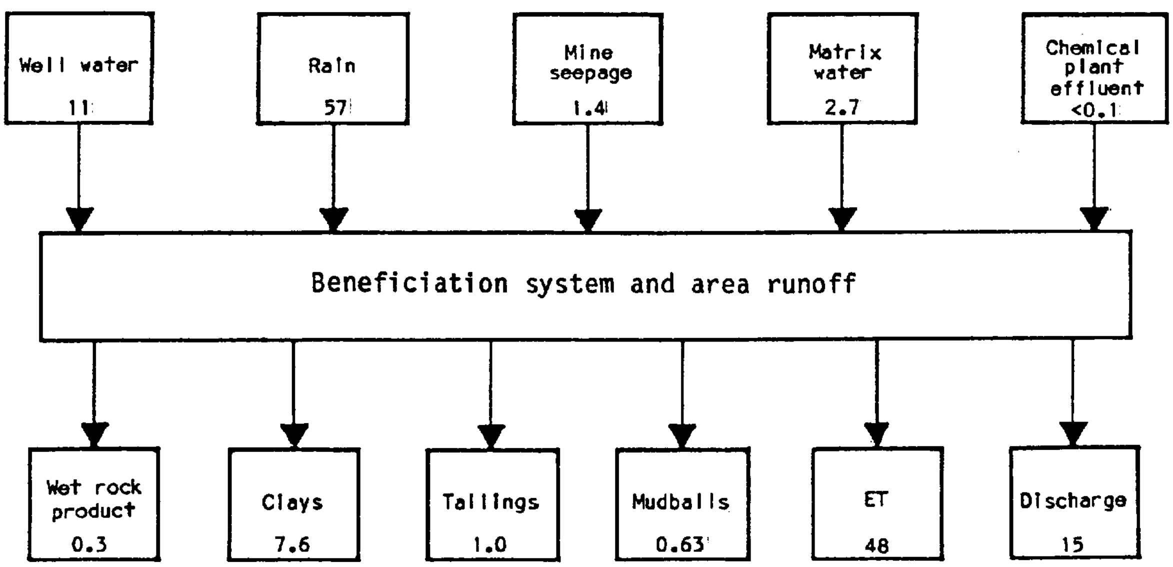


Figure 6.3-5. Schematic Flow Sheet and Estimated Water Balance (mgd) for OXY Mine Operations.

A schematic diagram of the surface runoff is depicted in Figure 6.3-6. Runoff from categories 1 through 5 will discharge into the lakes and then will be routed through a discharge structure, such as an overflow weir, and flow into small streams. The runoff from category 6 will discharge directly into streams without routing through lakes and discharge structures. The streamflow from each small drainage area and runoff from natural areas will discharge into the corresponding Suwannee River reaches. The drainage areas of each land use category were measured and calculated according to the conceptual reclamation plans and the existing land use distribution (Tables 6.3-3 and 6.3-4).

The configuration of the reclaimed lakes has an important effect on the hydrology under post-mining conditions because it determines the lake's storage capacity. Each lake is divided into four areas: zone of fluctuation, littoral zone, transition zone, and the deep zone (Table 6.3-5). The land slope above the zone of fluctuation is 4:1. Based on the design specifications, the depth-area-volume relationship was calculated for each reclaimed lake in each small drainage area.

The discharge structure at the lake outlet was assumed to be a rectangular overflow weir. The width of the discharge weir was designed so that the range of water level fluctuation in the lake will not exceed 5 ft. The top of the rectangular weir was set at the lake operating level, which is the upper edge of the fluctuation zone. The width and elevation of the discharge structure for each drainage area are presented in Table 6.3-6. The following rectangular weir formula was used in discharge calculation:

$$Q = 3.33\ Lh^{3/2}$$

where Q = discharge in cfs
L = weir width in ft, and
h = water level above top of weir in ft.

To demonstrate the effects of weir width on drainage area hydrology, weir width at Roaring Creek basin reclaimed lake was changed from 8 ft to 12 ft. Table 6.3-7 indicates that the increase in weir width increases peak discharge, decreases maximum lake level, but has an insignificant effect on mean flow and mean water level. Figures 6.3-7 and 6.3-8 are time series plots of simulated runoff and lake level using a 12 ft overflow weir.

To simulate surface runoff under post-mining conditions, a set of HSPF parameter values was determined for each land use category. The original parameter values, calibrated for undisturbed areas, were revised to account for the physical changes caused by mining and reclamation. The primary changes from the original land surface configuration to the reclaimed configuration are as follows:

1) greater infiltration (i.e., more porous soil matrix)

2) less deeper zone loss for elevated fill

3) lower interflow for elevated fill

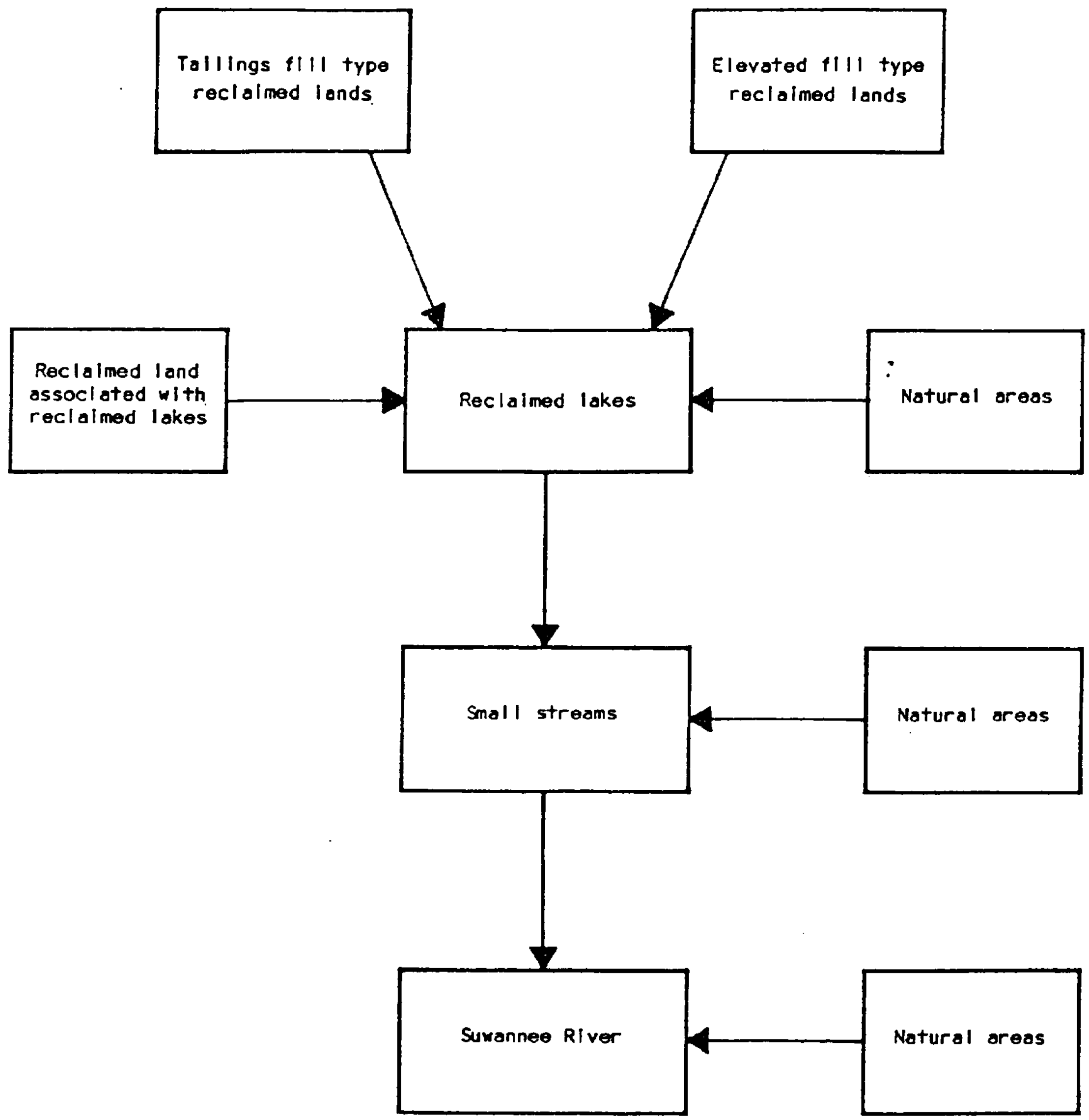


Figure 6.3-6. Schematic Diagram of Surface Water Runoff as Simulated by the HSPF Model.

Table 6.3-3. Acreages of Land Use Categories for Each Small Drainage System Under Post-Mining Conditions.

Land Use Code*	Rocky Creek No.10	Hunter Creek No.20	Roaring Creek No.30	REACHES No.40	No.50	Swift Creek No.60	Camp Branch No.70
1	1,714	376	1,595	LB 533 FB 480	0	1,190	622
2	1,461	333	1,595	LB 554 FB 480	0	1,190	415
3	0	117	1,005	0	0	2,584	2,080
4	0	5,321	5,661	0	0	7,130	0
5	15,288	6,653	3,002	LB 1,324 FB 40	0	9,506	2,271
6	33,181	1,635	1,943	LB 503 FB 1,931	0	4,445	847
7	10,422	8,627	101,496	63,173	34,036	28,928	11,890
TOTAL	62,066	23,062	116,297	69,017	34,036	54,973**	18,125

*1-Reclaimed lakes.
2-Reclaimed land near lakes.
3-Tailings fill.
4-Elevated fill.
5-Natural areas, discharging into lakes.
6-Natural areas, discharging into small streams.
7-Natural areas, discharging into the Suwannee River.

**919 acres cooling pond/gypsum stack not included in modeling because it is a completely recycled system with a negative water balance and therefore no discharge.

Table 6.3-4. Post-Mining Reclamation Acres Within Project Boundary.

Drainage Area	Land and Lakes[1]	Tailings Fill[2]	Total Elev. Fill[3]	Total Reclaimed	Unmined/Not Reclaimed	Total Post-Mining	Pre-Mining
Camp Branch	1,037	2,080	-	3,117	2,271	5,388	4,539
Swift Creek	2,380	2,584	7,130	13,013[4]	11,736	24,749	25,273
Four Mile Branch	960	-	-	960	904	1,864	1,864
Long Branch	1,087	-	-	1,087	1,324	2,411	2,411
Roaring Creek	3,190	1,005	5,661	9,856	4,602	14,458	13,744
Hunter Creek	709	117	5,321	6,147	7,938	14,085	14,930
Rocky Creek	3,175	-	-	3,175	15,288	18,463	18,624
Other	2,776	1,524	-	4,300	14,282	18,582	18,615
Total	15,314	7,310	18,112	41,655	58,345	100,000	100,000
% of total reclamation	37	18	43				

[1]Includes 941 acres reclaimed prior to January 1982.
[2]Includes 944 acres reclaimed prior to January 1982.
[3]Includes 6,658 acres unmined but reclaimed.
[4]Includes 919 acres cooling pond/gyp stack (2% of total reclamation).

Note: Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

Table 6.3-5. Statistics of Land and Lakes Reclamation by Drainage Area.

Drainage Area	Total Acres[1]	Land Acres	Water		Zone of Fluctuation		Littoral Zone		Transition Zone		Deep Zone	
			Acres	Depth (ft)	Acres	Depth (ft)	Acres	Depth (ft)	Acres	Depth (ft)	Acres	Depth (ft)
Camp Branch	1,037	415	622	15	156	1	93	4	112	17	261	27
Swift Creek	2,380	1,190	1,190	10	393	1	238	4	381	17	178	25
Four Mile Branch	960	480	480	11	168	1	96	4	120	17	96	27
Long Branch	1,087	554	533	12	187	1	112	4	176	21	58	33
Roaring Creek	3,190	1,595	1,595	12	526	1	319	4	510	20	240	33
Hunter Creek	709	333	376	18	94	1	56	4	134	22	92	38
Rocky Creek	3,175	1,461	1,714	13	429	1	326	4	360	17	599	25
Other	2,776	1,360	1,416	11	481	1	283	4	340	16	312	26
Total	15,314	7,388	7,926	13($\bar{x}$)	2,434	1($\bar{x}$)	1,523	4($\bar{x}$)	2,133	18($\bar{x}$)	1,836	29($\bar{x}$)
% of total area	-	48	52		-		-		-		-	
% of high water surface area	-	-	100		31[2]		19		27		23	

[1]Includes 941 acres of land and lakes reclamation type reclaimed prior to January 1982.
[2]16% wetland over entire area (15,314 acres).

Note: Includes both mandatory and nonmandatory reclamation lands and assumes that nonmandatory lands will be reclaimed under Chapter 378, FS, and Chapter 16C-17, FAC.

Table 6.3-6. Discharge Structure Configuration.

Drainage Area	Weir Width (ft)
Rocky Creek	10
Hunter Creek	8
Roaring Creek	8
Long Branch	3
Four Mile Branch	3
Swift Creek	12
Camp Branch	10

Table 6.3-7. Effects of Weir Width on Roaring Creek Hydrology (Reclaimed Condition).

Parameter	Weir Width	
	8 ft	12 ft
Q max	169.1	182.7
Q mean	19.28	19.32
s_Q	21.35	22.54
Z max	35.73	35.26
Z mean	33.48	33.31
Z min	31.87	31.83
s_Z	1.22	1.17

Q = flow (cfs).

Z = lake level (ft).

s = standard deviation.

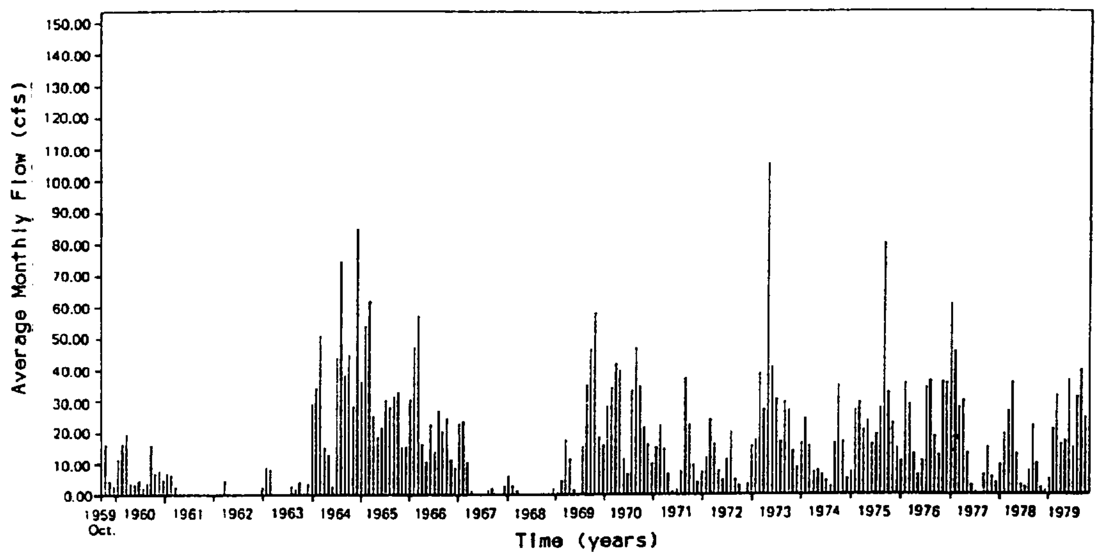


Figure 6.3-7. Monthly Average Flows, Roaring Creek; Reclaimed Conditions; Simulation Period October 1959-September 1979.
Note: Discharge Weir Width = 12 ft.

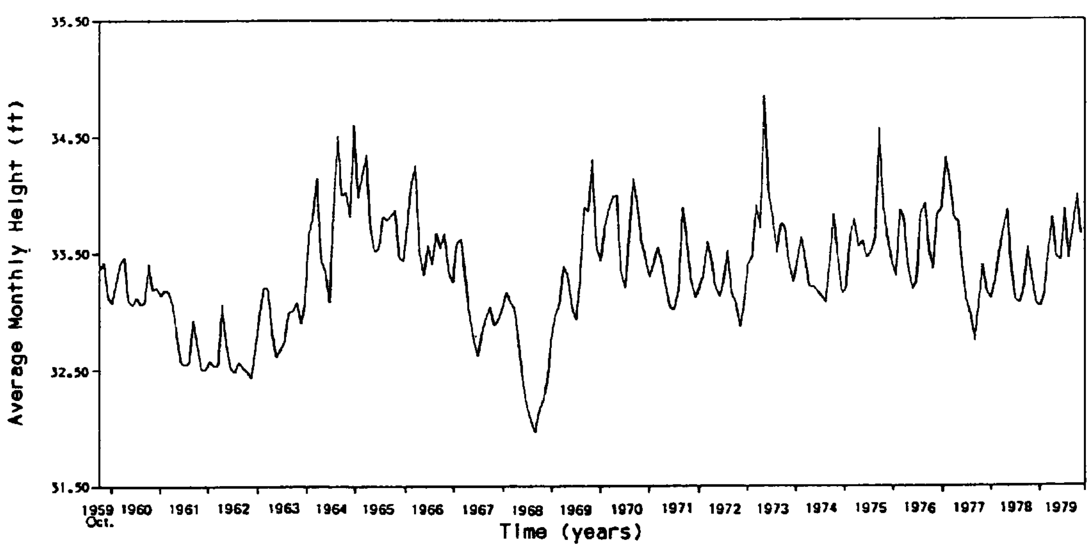


Figure 6.3-8. Reclaimed Lake Elevation, Roaring Creek; Simulation Period October 1959-September 1979.
Note: Discharge Weir Width = 12 ft.

4) lower surface roughness

5) steeper overland flow slopes for lake drainage

6) less overland flow lengths for lake drainage

7) nominally less storage capacity in the upper soil zone for lake drainage (i.e., higher moisture content)

8) nominally more water in the lower soil zone for tailings and elevated fill (i.e., greater soil depth) and less water for lake drainage (i.e., smaller depth and less moisture retention capacity).

The general changes are reflected in the values shown in Table 6.3-8.

A plot of the time series of simulated monthly average surface runoff of Roaring Creek under post-mining conditions demonstrates the variation and range of flows which can be expected after reclamation (Figure 6.3-9). The surface runoff simulation for all drainage areas under post-mining conditions is summarized in Table 6.3-9. Figure 6.3-10 shows an example of the time series plots of the reclaimed lake level fluctuation for Roaring Creek. This illustrates that the wetland areas in the "zone of fluctuation" will be periodically inundated. The simulated lake level is summarized in Table 6.3-10 for each of the drainage areas. The simulated monthly average flows of the Suwannee River at White Springs and Suwannee Springs are shown in Figures 6.3-11 and 6.3-12.

A comparison of pre-mining and post-mining results indicates that reclamation does not significantly change mean flows (Table 6.3-11). The maximum change in average flow of all small stream drainage areas was <2 cfs due to reclamation effects; therefore, the impact on the Suwannee River water budget is quite small. Peak discharge, however, is reduced because the reclaimed lakes serve as flow regulators, i.e., the large fluctuation in land surface runoff is damped by lake storage.

The effects of mining and reclamation on streamflow are illustrated by the duration curves under pre-mining, baseline, and post-mining conditions for each small drainage area (Figures 6.3-13 through 6.3-19). Mining activities have not affected Rocky Creek, Long Branch, or Four Mile Branch drainage basins under baseline conditions; therefore, the duration curves under baseline conditions coincide with the pre-mining duration curves. Baseline mining activities have changed the pre-mining drainage basin areas of Roaring Creek and Camp Branch; however, there is no mine discharge issuing into them; therefore, mining caused the duration curves to be stretched or compressed horizontally, depending on the increase or decrease in the drainage area (Figures 6.3-15 and 6.3-19). Although Hunter Creek and Swift Creek receive mine discharge, their drainage basin sizes were also changed by mining activities. The duration curves were not only stretched/compressed horizontally, they were also shifted down near the low flow region, primarily because the year-round mine discharge reduced the probability of extremely low flows.

Table 6.3-8. HSPF Parameter Values Used for Post-Mining Conditions.

Parameter*		Lake Drainage	Tailings Fill	Elevated Fill	Natural Areas
LZSN		4.0	7.1	7.1	5.3
INFILT		0.3	0.5	0.5	0.15
SLSUR		0.125	0.001	0.001	0.0024
INFEXP		2.0	2.0	2.0	2.0
INFILD		2.0	2.0	2.0	2.0
DEEPFR		0.12	0.12	0.01	0.12
BASETP		0.08	0.08	0.08	0.08
AGWETP		0.45	0.45	0.45	0.45
CEPSC		0.15	0.15	0.15	0.15
UZSN		0.8	1.2	1.2	1.2
INTFW		2.2	2.0	1.1	2.0
IRC		0.9	0.9	0.9	0.9
NSUR		0.25	0.25	0.25	0.3
LSUR		400	800	800	800
AGWRC		0.94	0.94	0.995	0.94
LZETPM	J	0.35	0.35	0.35	0.4
	F	0.35	0.35	0.35	0.4
	M	0.35	0.35	0.35	0.4
	A	0.45	0.45	0.45	0.5
	M	0.60	0.60	0.60	0.7
	J	0.70	0.70	0.70	0.8
	J	0.70	0.70	0.70	0.8
	A	0.70	0.70	0.70	0.8
	S	0.70	0.70	0.70	0.8
	O	0.60	0.60	0.60	0.7
	N	0.50	0.50	0.50	0.6
	D	0.35	0.35	0.35	0.4

*Defined in Table 3.4-6, Section 3.4.1.

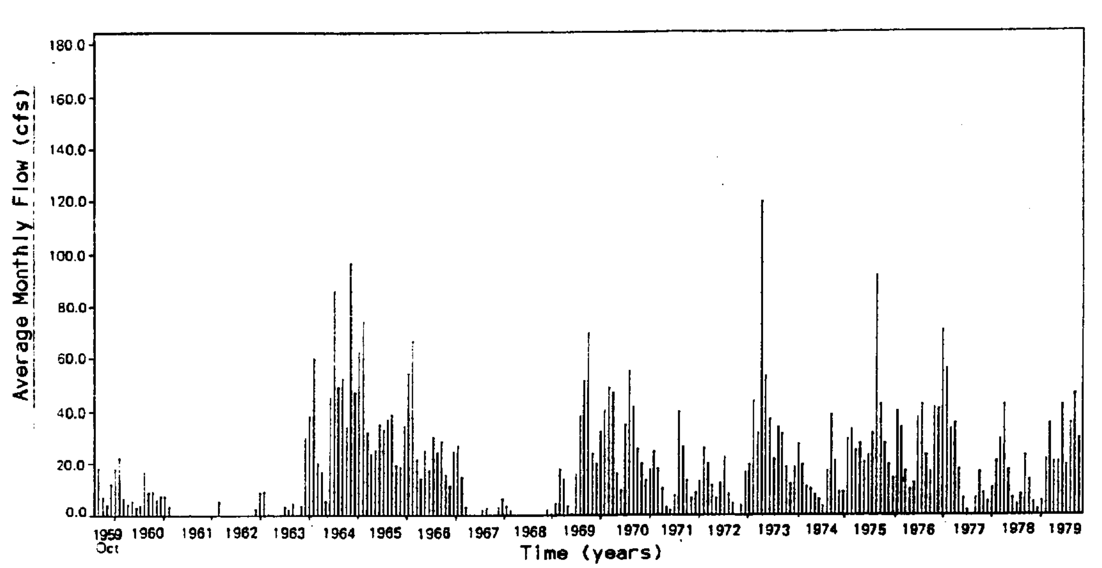


Figure 6.3-9. Monthly Average Flows, Roaring Creek, Reclaimed Conditions; Simulation Period October 1959-September 1979.
Note: Discharge Weir Width = 8 ft.

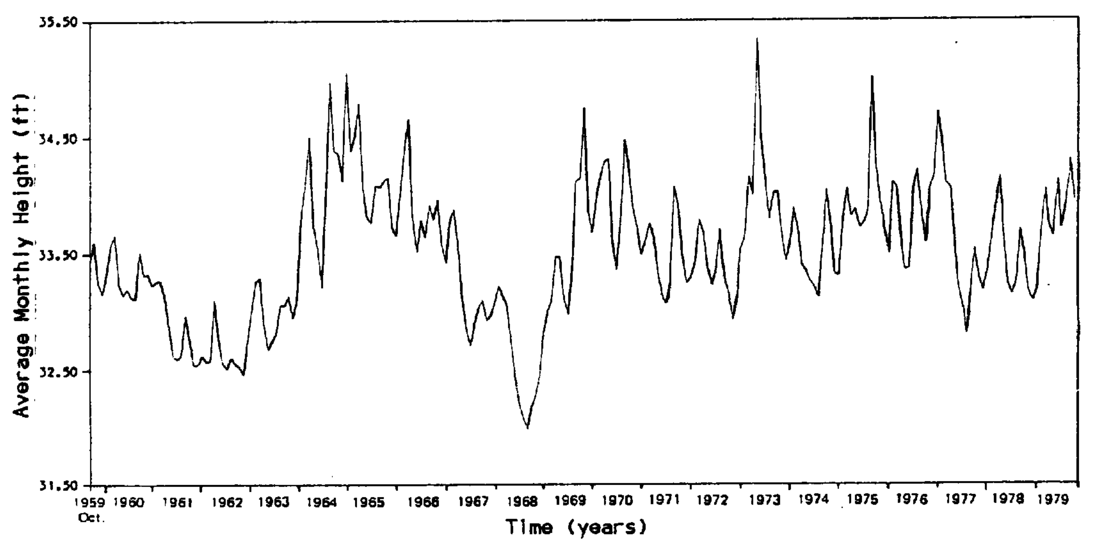


Figure 6.3-10. Reclaimed Lake Elevation, Roaring Creek; Simulation Period October 1959-September 1979.
Note: Discharge Weir Width = 8 ft.

Table 6.3-9. Summary of Surface Runoff Simulation Under Post-Mining Conditions.

Drainage Area	Q mean (cfs)	Q max (cfs)	$s_{\overline{Q}}$ (cfs)
Rocky Creek	68.4	2,169	108.8
Hunter Creek	18.9	252.3	25.1
Roaring Creek	19.3	169.1	21.4
Long Branch	3.9	41.5	5.2
Four Mile Branch	3.9	127.5	6.5
Swift Creek	34.1	405.2	43.8
Camp Branch	8.1	93.7	10.8
Suwannee River at White Springs	2,219	37,990	2,994
Suwannee River at Suwannee Springs	2,360	39,390	3,136

Table 6.3-10. Water Level and Fluctuation of Reclaimed Lakes.

Drainage Area	Overflow Depth* (ft)	Outfall Width (ft)	Lake Depth (ft)		
			Min.	Mean	Max.
Rocky Creek	25	10	24.27	25.56	28.88
Hunter Creek	38	8	36.87	38.48	41.85
Roaring Creek	33	8	31.87	33.48	35.73
Long Branch	33	3	31.67	33.17	35.11
Four Mile Branch	27	3	25.42	26.93	28.24
Swift Creek	25	12	23.85	25.53	28.75
Camp Branch	27	10	25.85	27.40	30.23

*Depth at which flow from lake begins.

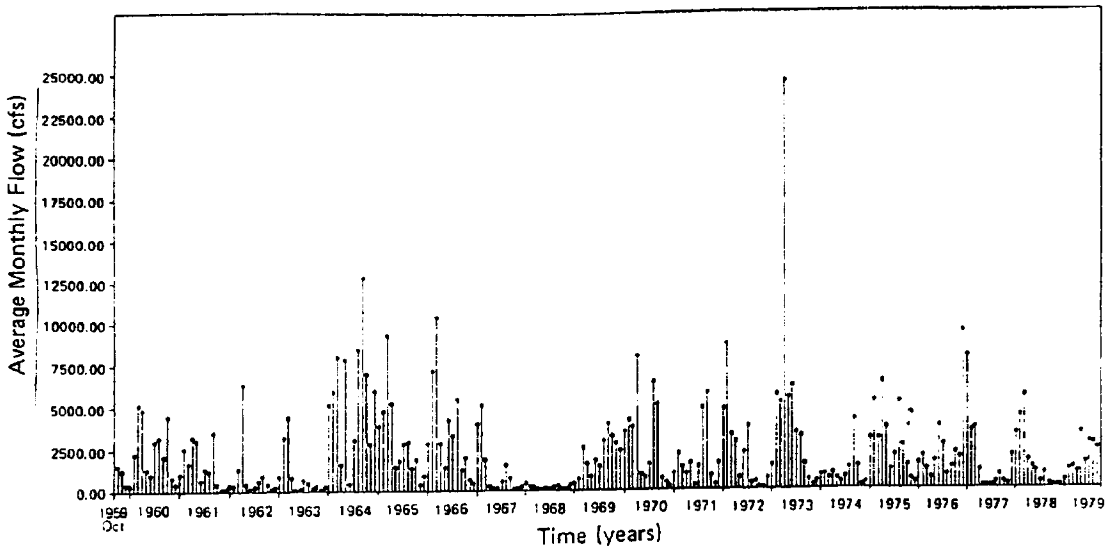


Figure 6.3-11. Monthly Average Flows, Suwannee River at White Springs, Reclaimed Conditions; Simulation Period October 1959-September 1979.

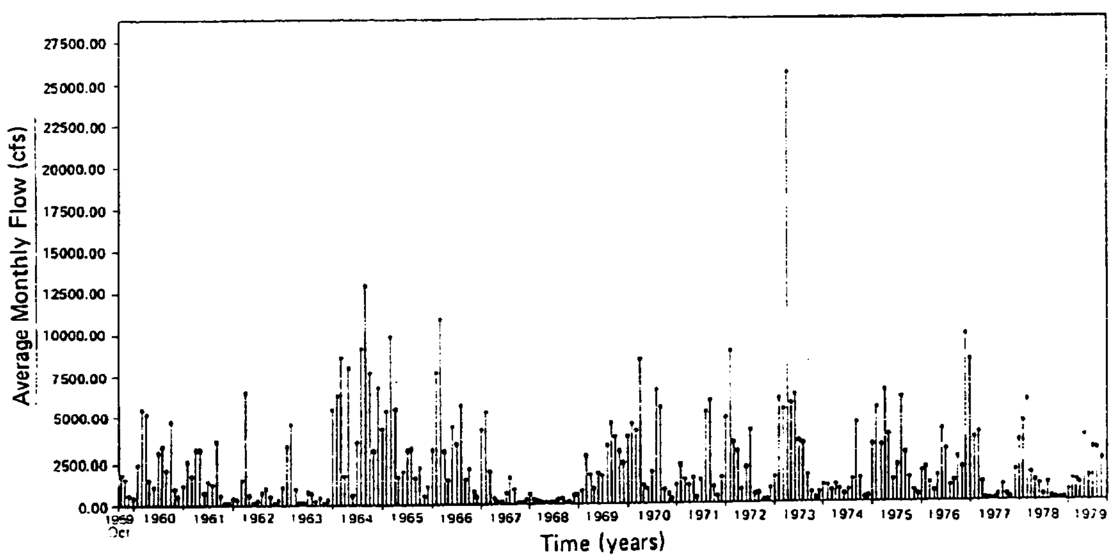


Figure 6.3-12. Monthly Average Flows, Suwannee River at Suwannee Springs, Reclaimed Conditions; Simulation Period October 1959-September 1979.

Table 6.3-11. Flow Statistics for Small Drainage Areas.

	Pre-Mining Conditions				Post-Mining Conditions			
Drainage Area	Acres	Q mean (cfs)	Q max (cfs)	s (cfs)	Acres	Q mean (cfs)	Q max (cfs)	s (cfs)
Rocky Creek	51,806	68.8	3,285	131.9	51,645	68.4	2,169	108.8
Hunter Creek	15,280	20.3	968.9	38.9	14,435	18.9	252.3	25.1
Roaring Creek	13,744	18.3	871.5	34.4	14,801	19.3	169.1	21.4
Long Branch	2,913	3.9	184.7	7.4	2,913	3.9	41.5	5.2
Four Mile Branch	2,931	3.9	185.9	7.5	2,931	3.9	127.5	6.5
Swift Creek	27,134	36.0	1720.6	69.1	26,964	34.1	405.2	43.8
Camp Branch	5,499	7.3	348.7	13.9	6,235	8.1	93.7	10.8
Suwannee River at White Springs	1,606,859	2,219	38,260	3,011	1,606,816	2,219	37,990	2,994
Suwannee River at Suwannee Springs	1,714,760	2,362	39,730	3,166	1,714,869	2,360	39,390	3,136

s = standard deviation.

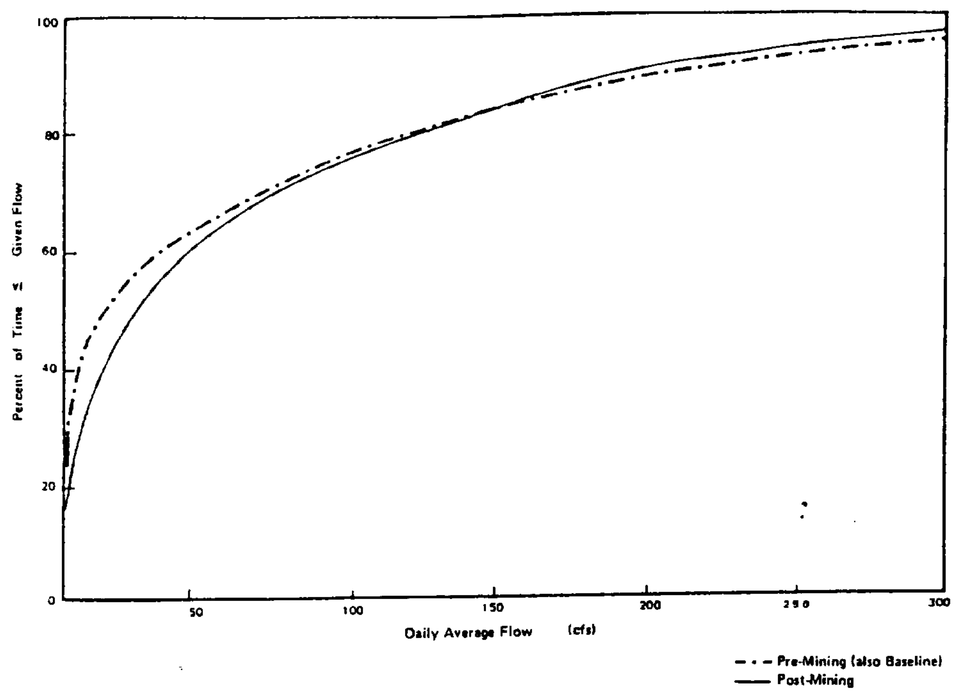


Figure 6.3-13. Cumulative Frequency Analysis for Rocky Creek Under Pre-Mining, Baseline, and Post-Mining Conditions.

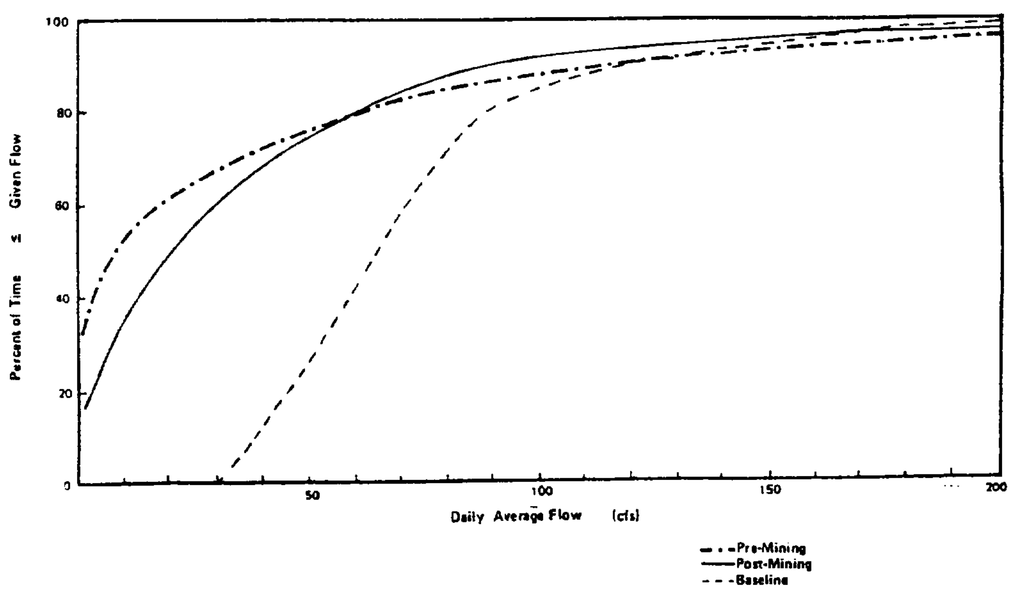


Figure 6.3-14. Cumulative Frequency Analysis for Swift Creek Under Pre-Mining, Baseline, and Post-Mining Conditions.

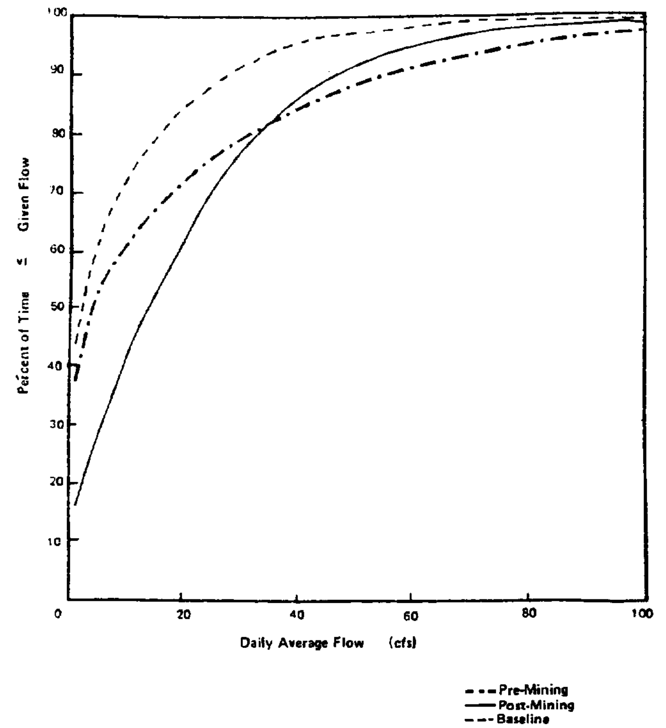


Figure 6.3-15. Cumulative Frequency Analysis for Roaring Creek Under Pre-Mining, Baseline, and Post-Mining Conditions.

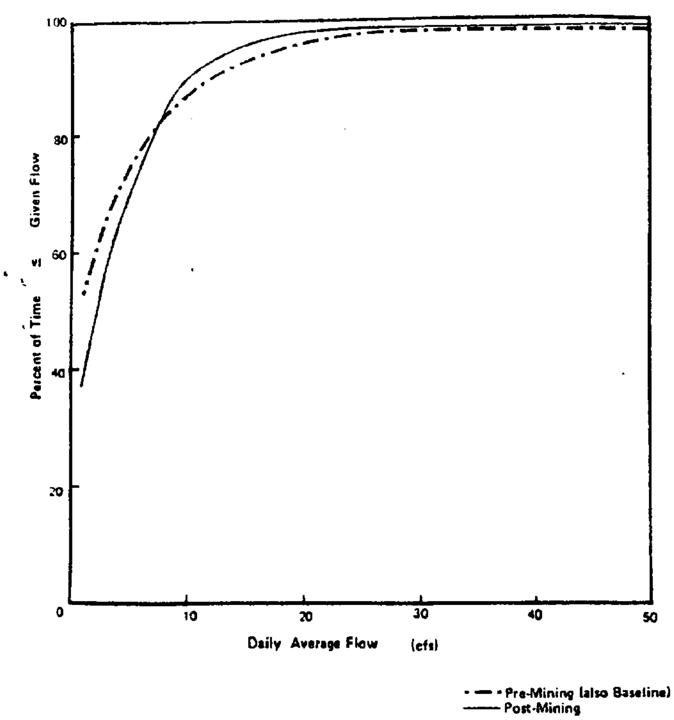


Figure 6.3-16. Cumulative Frequency Analysis for Long Branch Under Pre-Mining, Baseline, and Post-Mining Conditions.

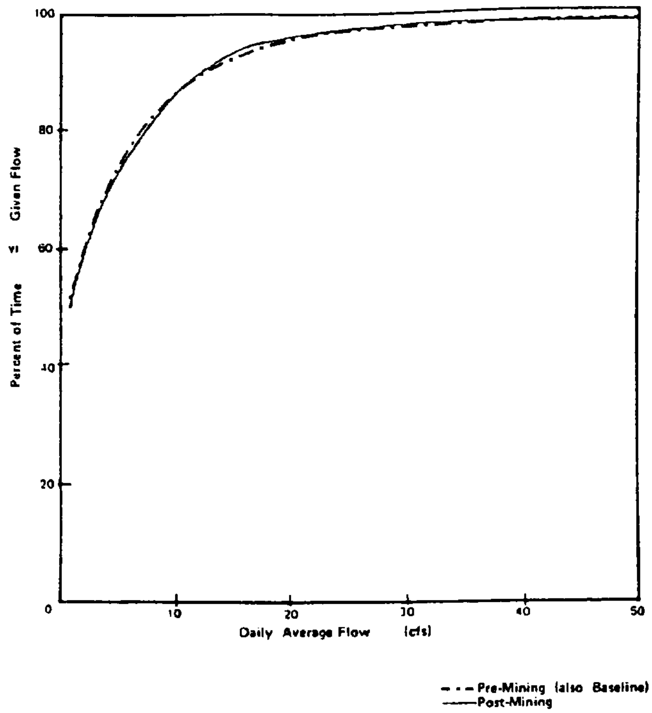


Figure 6.3-17. Cumulative Frequency Analysis for Four Mile Branch Under Pre-Mining, Baseline, and Post-Mining Conditions.

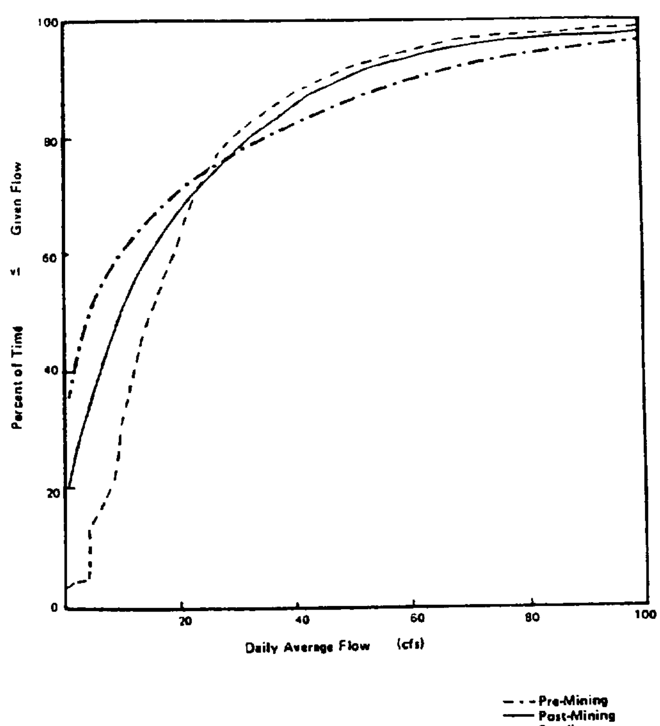


Figure 6.3-18. Cumulative Frequency Analysis for Hunter Creek Under Pre-Mining, Baseline, and Post-Mining Conditions.

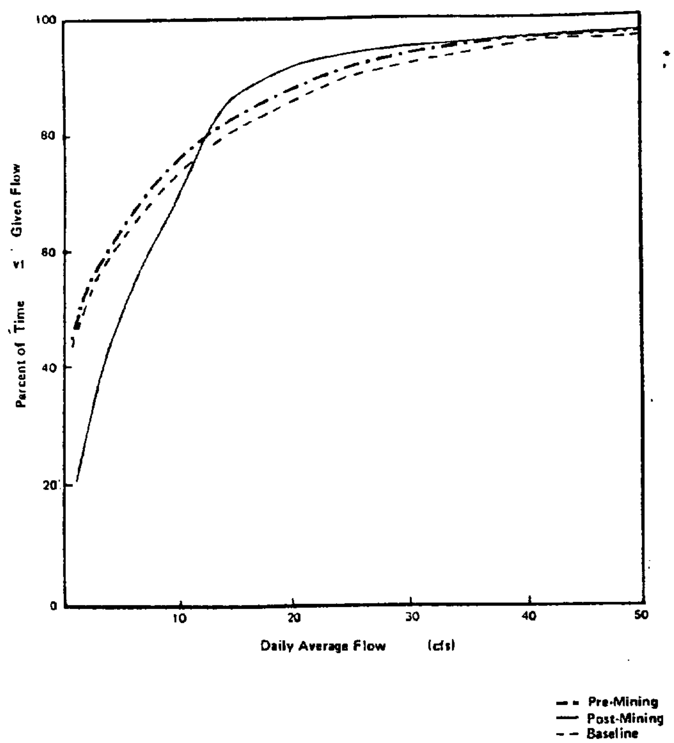


Figure 6.3-19. Cumulative Frequency Analysis for Camp Branch Under Pre-Mining, Baseline, and Post-Mining Conditions.

Reclamation will cause the duration curves to be lowered near the low flow region and to be raised at the high flow region, as shown in every small drainage area. The reclaimed lakes function as flow regulators--they absorb peak storm discharge, and the retained stormwater is released slowly even during part of the dry season. Therefore, the probabilities of extended low flow and extremely high flow are reduced. The flow-regulating effects can be visualized by pre-mining and post-mining hydrographs showing 10-year storms (Figures 6.3-20 and 6.3-21). The first storm occurred on 17 July 1964, with 33 hours duration, 9.76 in rainfall, and a maximum intensity of 3.23 in/hr. The second storm occurred on 3 December 1964, with 36 hours duration, 9.73 in rainfall, and a maximum intensity of 2.15 in/hr. Under post-mining conditions, peak discharge was significantly reduced and the recession rate was also reduced. These storms were extreme events; therefore, the difference in peak highs is more dramatic than in typical storm events.

A flood discharge analysis was performed using a Log-Pearson Type III method (Table 6.3-12). Compared with flood discharge under pre-mining conditions (Table 3.4-11, Section 3.4.1), reclamation reduced the 50-year flood flow in the small drainage areas by 39-84%. Table 6.3-13 shows the simulated yearly maximum daily average flows for Roaring Creek and the Suwannee River at White Springs under pre-mining and post-mining conditions. These data indicate the impacts related to the storage provided by the reclaimed lakes.

The Suwannee River flow was not significantly affected by either mining activities or reclamation because the flow disturbances caused by mining or reclamation are small compared with the total runoff. The duration curves for the Suwannee River at White Springs and Suwannee Springs are shown in Figures 6.3-22 through 6.3-25. There was no perceptible difference among pre-mining, baseline, and post-mining conditions.

The results of the runoff simulation under post-mining conditions indicate that reclamation will decrease flood discharge and shorten the dry period. Both effects are beneficial in terms of hydrology and water quality, because a reduction in peak flow will reduce flood damage and pollutant washoff; on the other hand, reduction of the low flow probability will provide more water during the dry season which will lessen the stress on aquatic organisms.

6.3.4 Literature Cited

Hayes, R.J., K.A. Popko, and W.K. Johnson. 1980. Guide manual for preparation of water balances. Hydrologic Engineering Center, U.S. Army Corps of Engineers, Davis, CA. 71 pp.

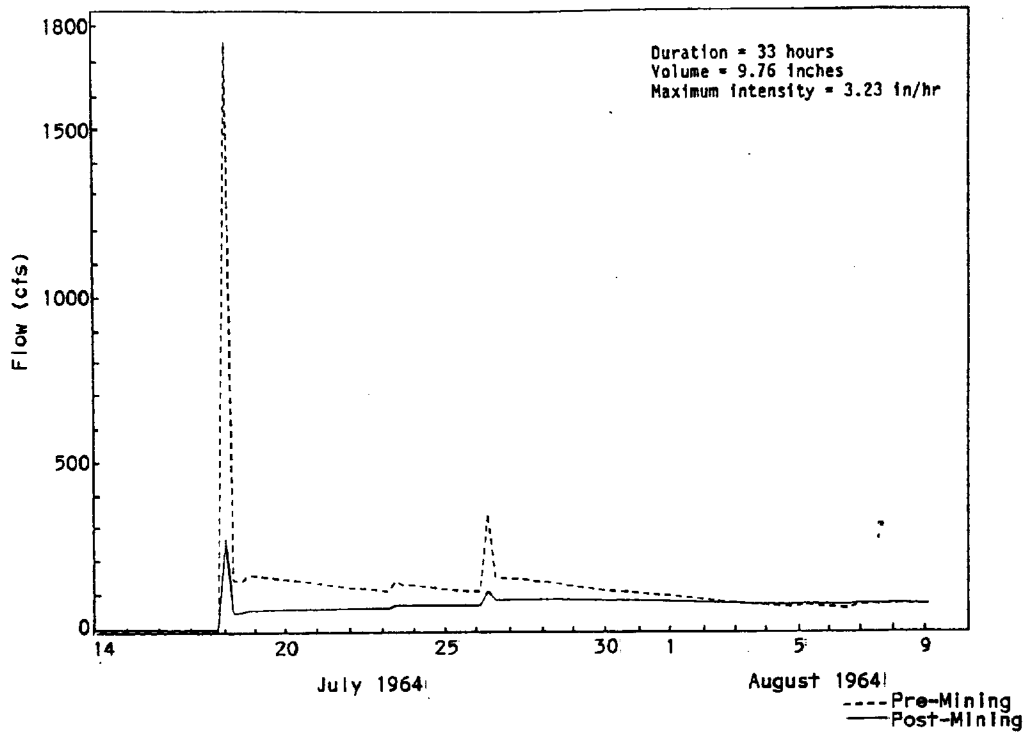


Figure 6.3-20. Roaring Creek Storm Hydrograph (7/17/64).

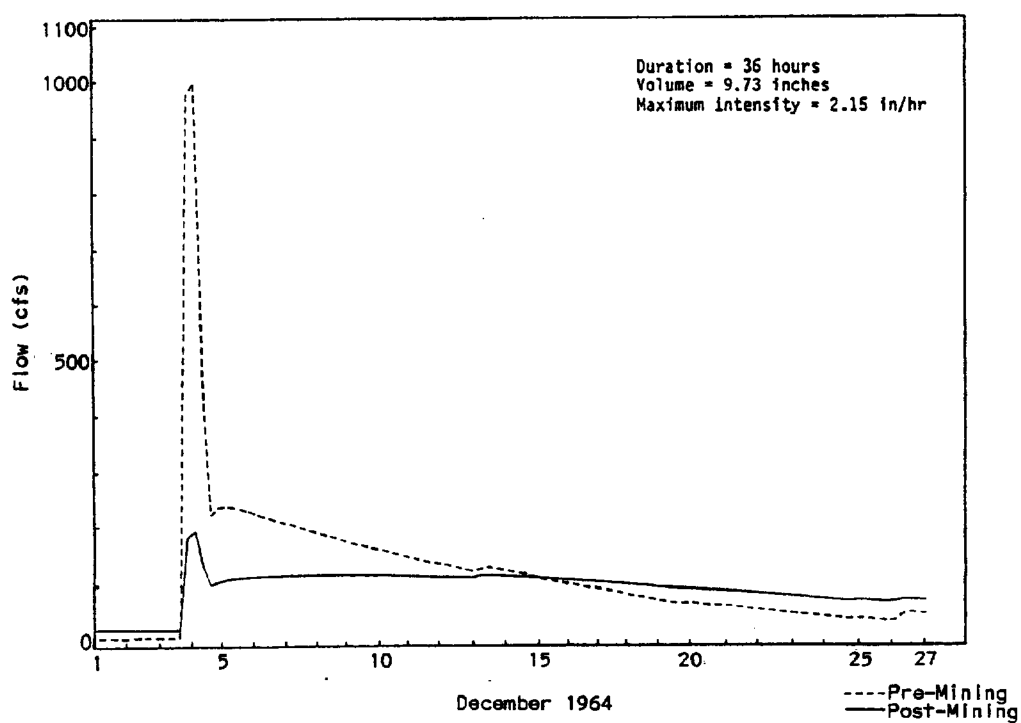


Figure 6.3-21. Roaring Creek Storm Hydrograph (12/3/64).

Table 6.3-12. Flood Discharge Analysis Under Post-Mining Conditions.

Drainage Area	Flood Flow (cfs)					
	2*	5*	10*	25*	50*	100*
Rocky Creek	374	861	1,270	1,856	2,328	2,821
Hunter Creek	79	163	226	308	370	430
Roaring Creek	59	116	157	211	250	287
Long Branch	16	31	38	44	46	47
Four Mile Branch	26	64	95	139	173	207
Swift Creek	129	261	357	482	575	665
Camp Branch	30	61	84	112	132	151
Suwannee River at White Springs	9,745	15,403	18,033	20,300	21,433	22,223
Suwannee River at Suwannee Springs	10,244	16,149	18,889	21,249	22,428	23,250

*Return period in years.

Table 6.3-13. Yearly Maximum Daily Average Flows (cfs).

Year	Roaring Creek		Suwannee River at White Springs	
	Pre-Mining	Reclaimed	Pre-Mining	Reclaimed
1	98	36	6,425	6,443
2	42	23	7,266	7,268
3	44	10	9,393	9,354
4	26	14	5,926	5,899
5	562	117	22,219	22,215
6	492	139	11,806	11,904
7	151	91	12,147	12,254
8	48	38	6,738	6,727
9	8	8	710	709
10	813	151	12,955	10,885
11	872	169	12,447	12,408
12	107	46	8,216	8,262
13	64	31	9,537	9,486
14	334	157	38,260	37,995
15	122	48	5,540	5,223
16	445	122	10,326	10,349
17	139	62	6,617	6,444
18	271	84	10,546	10,601
19	115	56	6,802	6,717
20	131	63	5,237	5,028
Mean	244	73	10,456	10,309
Std. Dev.	260	52	7,843	7,798
Return Period (years)				
2	144	59	9,897	9,745
5	380	116	15,649	15,403
10	611	157	18,324	18,033
25	990	211	20,629	20,300
50	1,335	250	21,781	21,433
100	1,730	287	22,585	22,223

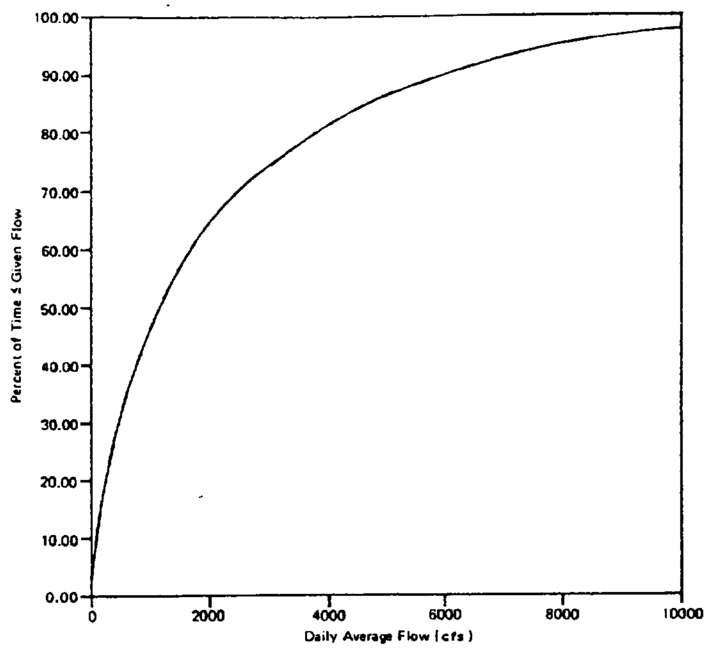


Figure 6.3-22. White Springs Under Reclaimed Conditions; Simulation Period October 1959-September 1979.

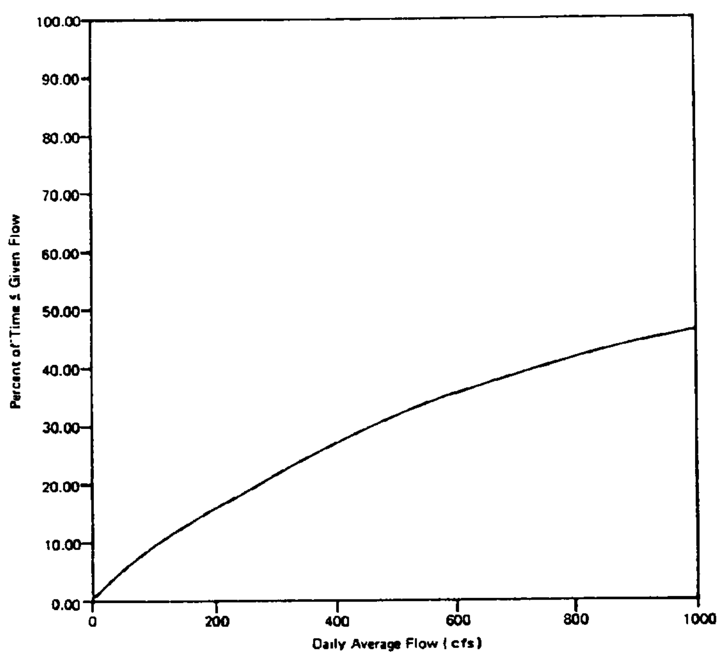


Figure 6.3-23. White Springs Under Reclaimed Conditions; Simulation Period October 1959-September 1979 (expanded scale for low flow).

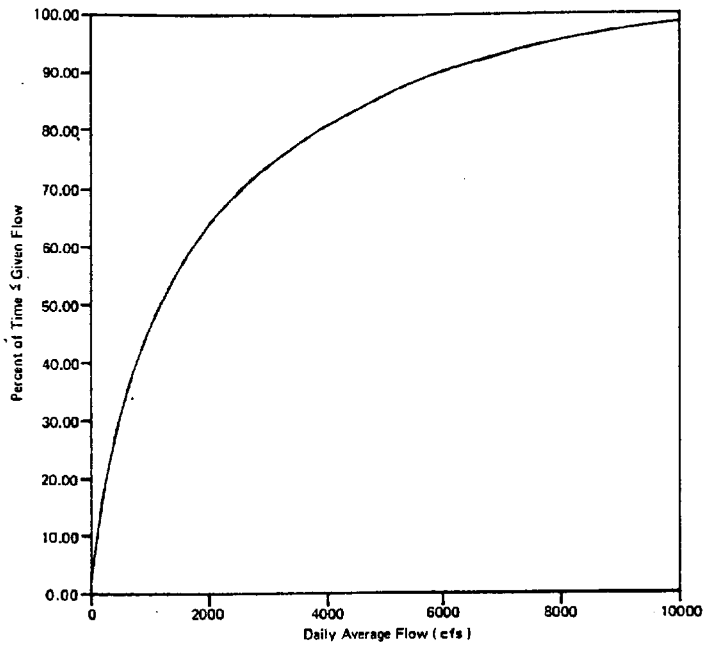


Figure 6.3-24. Suwannee Springs Under Reclaimed Conditions; Simulation Period October 1959-September 1979.

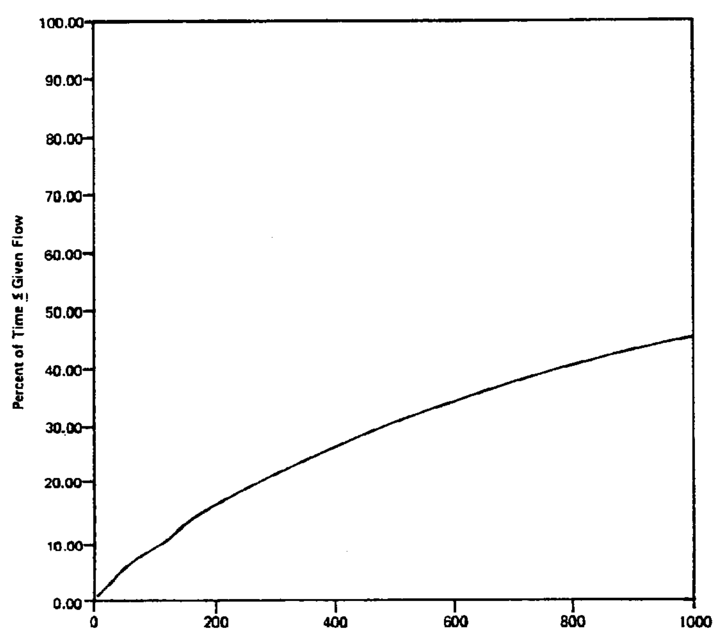


Figure 6.3-25. Suwannee Springs Under Reclaimed Conditions; Simulation Period October 1959-September 1979 (expanded scale for low flow).

6.4 Surface Water Quality

6.4.1 Impacts During Mining

OXY's mining operations have the potential to affect water quality in the following ways:

1) discharge of mine process wastewater
2) discharge of disturbed area runoff
3) diversion of surface flows from streams
4) matrix line ruptures
5) failure of waste clay settling area dikes
6) discharge from reclaimed lakes

6.4.1.1 Discharge of Mine Process Water

OXY presently has mining outfalls which discharge water to Swift Creek and Hunter Creek. OXY plans to obtain NPDES permit modifications to allow for future mining discharges to additional streams in the area. The discharges will be similar in quality to their present discharges as reflected in data collected on Hunter Creek and Altmans Bay, which discharges to Swift Creek (Section 3.4.2). The discharges contain overflow from OXY's settling areas, runoff from disturbed mining areas and natural areas within the mine perimeter ditching, surficial groundwater, water from dewatering of the mine pits, and tailings water (water used to transport sand tailings to a reclamation site).

Regardless of the mining alternative selected, the discharges to Swift and Hunter creeks will continue until mining operations cease. The level of wetlands mining will affect only the duration of these discharges and not the quality. Therefore, no additional water quality impacts on Swift or Hunter creeks due to mining are anticipated.

It is impossible to predict which new creeks would receive mining discharges in the future as a result of NPDES permitting procedures; several new discharge points will be needed regardless of whether wetlands are mined. Impacts of new discharges will be thoroughly evaluated through the NPDES permitting procedure at both the state and federal levels. Therefore, the impacts relative to new discharge points are not addressed as part of this wetlands mining process.

6.4.1.2 Discharge of Disturbed Area Runoff

As OXY's mine operations expand, more area will be included within the perimeter ditching system and more drainage area will be isolated from the various creeks because rainfall runoff from disturbed areas must be discharged through permitted NPDES outfalls. OXY proposes to apply for permits to allow discharge of this type water to the creeks to which it naturally flowed.

Suspended solids might be appreciably elevated in the disturbed area runoff which could cause turbidity problems if not adequately clarified prior to discharge. Also, the ditching system will pick up flow from the water table aquifer which will increase the dissolved solids content and conductivity. However, these increases would probably be minor due to the relatively low percentage of the flow derived from water table seepage. Even if the dissolved solids content increases appreciably, it would not cause a significant impact.

The water will be routed to a reclaimed lake prior to release. Lake systems could change the character of the runoff water to some extent by allowing time for phytoplankton communities to develop. This may result in a shift in pH from that of a relatively poorly buffered and acidic surface drainage to a slightly higher pH discharge. This would be a positive change because organisms are normally more severely stressed by low pH waters.

Runoff from cleared areas could be less "stained" due to the absence of vegetation and the rapidity with which drainage ditches remove the water, thus decreasing the time water is in contact with organic matter and litter, which impart the brownish color to the water.

6.4.1.3 Diversion of Surface Flow from Streams

During mining, the mine area must be isolated from its drainage area with perimeter ditches to avoid turbid runoff to a stream or wetlands not permitted for disturbance. Isolation of a portion of a stream's drainage area decreases flow within the stream.

Water diverted from the various drainage areas will be routed to either Swift Creek or Hunter Creek. The amount of diverted surface runoff will eventually accumulate to a point that the receiving creeks will experience flooding and increased scour due to higher flow velocities; however, this will not appreciably affect water quality. The increased flow will also dilute historical nutrient concentrations, but will not significantly change the present water quality of these two streams.

The water quality impact due to the expected reduced flow in the streams from which the flows are diverted will be negligible. The lower sections of the tributaries, which are deeply incised below the water table, will continue to receive baseflow from groundwater, and the relative percentage of groundwater in the streams will increase. This should not have a significant effect on water quality relative to the stream's ability to support fish and aquatic organisms, unless the flow is reduced so much that there is not enough water present to sustain aquatic communities.

To assess the effects of diverting headwater drainage from tributaries, limited pre- and post-diversion data from Roaring Creek were compared (Table 6.4-1). Pre-diversion data for Roaring Creek (RO-2), which were collected prior to any major mining activity within the drainage area, were published in the Swift Creek Chemical Complex EIS (EPA 1978). The major drainage activity was completed in 1981. Data collected in 1982-1983 were used to characterize post-diversion water quality.

Table 6.4-1. Summary of Roaring Creek (RO-2) Water Quality Data, Before and After Drainage Diversion.

Parameter	Pre-Drainage Diversion[1]		Post-Drainage Diversion[2]	
	Min.	Max.	Min.	Max.
Alkalinity as $CaCO_3$ (mg/l)	0	70	0	79
Total hardness as $CaCO_3$ (mg/l)	22	49	8	82
pH, field	5.6	7.0	2.9	6.7
Fluoride (mg/l)	0.2	1.1	0.07	0.45
Total phosphate as P (mg/l)	0.5	1.6	0.02	0.94
Dissolved oxygen (mg/l)	3.7	13.2	2.4	11.0
Total suspended solids (mg/l)	1.0	14.0	0.33	8.0
Total dissolved solids (mg/l)	60	128	89	183
Ammonia as N (mg/l)	0.02	1.15	0.01	0.21
Nitrate/nitrite as N (mg/l)	0.06	0.60	0.01	0.19
Total organic nitrogen as N (mg/l)	0.06	1.65	0.51	1.87

[1]Based on 8 samples collected July 1977-February 1978.

[2]Based on 13 samples collected January 1982-March 1983.

Although the sample sizes are small and differ for the two periods, there does not appear to be a major difference between pre- and post-diversion water quality. Maximum values for total hardness and total dissolved solids were greater after diversion of the drainage. This is expected as reduced surface water input results in less dilution of groundwater input. Therefore, diversion of drainage from one stream to another should not cause any water quality impacts on the streams or on the Suwannee River.

6.4.1.4 Matrix Line Ruptures

OXY has operated slurry pumping systems for 18 years without any significant matrix line ruptures. A rupture would result in an immediate pressure loss in the matrix pumping system which is constantly monitored. Thus, a major problem would be quickly detected and the pumps shut down before a large volume of material is released. The likelihood of a major water quality impact is further reduced because of the limited amount of contact the matrix lines have with a creek. The lines are placed within the mine boundary to the extent possible; thus, any spilled material is confined to the mine site.

Due to these factors, the probability of matrix line ruptures having a significant impact on area streams is very low, and because of the distance of matrix lines from the Suwannee River, no impact on the river should occur.

6.4.1.5 Failure of Waste Clay Settling Area Dikes

The likelihood of dike failure is remote, as foundation, soil conditions, and dike material are thoroughly inspected and monitored during the construction and active life of waste clay settling areas. The construction and maintenance of earthen dams for settling areas are in accordance with FDER regulations (Ch. 17-9, FAC), and no failures have occurred at waste clay settling areas since the 1971 revisions to this rule. Thus, the potential for any impacts on either the area streams or the Suwannee River is remote.

6.4.1.6 Water Quality of Reclaimed Lakes

As part of their reclamation process, OXY will construct approximately 7900 acres of lakes within the project area. Approximately 30% (2400 acres) of these lake systems will consist of reclaimed forested wetlands which will add detrital material to the lakes, thus contributing a brownish stain to the lake water. Based on historical data from OXY's reclaimed lakes and old phosphate lakes in central Florida, water quality within all the lakes should be good, but it will vary depending on the type of input the lakes receive. Reclaimed lakes presently in existence are used as a final "polishing" step in OXY's water system. Some of the reclaimed lakes to be built in the future will be tied into this system and will receive water from the chemical and beneficiation operations. Some of the lakes will receive mine-related discharge in addition to natural area runoff, and still others will receive only disturbed area runoff or perhaps runoff from reclaimed lands and natural areas.

Lakes Receiving Chemical/Beneficiation Discharges. Eagle Lake provides an excellent example of the type water quality that can be expected in reclaimed lakes receiving both chemical and beneficiation discharges in addition to natural area runoff (Tables 3.4-32, 3.4-33, and 3.4-34, Section 3.4.2). Even though the lake would be classified as eutrophic based on nutrient concentrations, the lake has not experienced the type problems typically attributed to eutrophic lakes, such as excessive aquatic weeds, oxygen depletions, and fish kills. The lack of problems in reclaimed lakes is probably due to: 1) a relatively large drainage area input to the lakes, thus providing periodic turnover of lake water, 2) varied water depths, and 3) a lack of oxygen-demanding waste within the lake and lake input. Eagle Lake's good water quality is evidenced by the excellent fishing provided and the lack of parasites and disease noted in the fish (Boyd and Davies 1981).

Eagle Lake typically meets all applicable state and federal water quality standards and effluent guidelines. Table 3.4-35 (Section 3.4.2) identifies the parameters that exceeded state Class III water quality standards at the outfall from the lake. The mercury, alkalinity, and dissolved oxygen variances from the Class III standards are background-related and should not be attributed to the lakes themselves or process-related discharges (Tables 3.4-21 and 3.4-29, Section 3.4.2). The un-ionized ammonia exceedances are related to the higher pH in the lakes which increases the percentage of total ammonia in un-ionized form and ammonia from processing operations. The exceedances have not caused any problems with the aquatic communities within the lake. The fishery within the lake is very productive and heavily utilized by the general public.

In conclusion, the processing operations will continue to discharge to reclaimed lakes regardless of the mining alternative selected, and water quality impacts on reclaimed lakes due to wetlands mining will be negligible.

Lakes Receiving Mine Discharge. Water quality within reclaimed lakes receiving only mining-related discharge is represented by that in Altmans Bay and Section 13 Lake (Tables 3.4-32, 3.4-33, and 3.4-34, Section 3.4.2). Water entering the lakes may come from one or more of the following sources:

- overflow from the waste clay settling system
- runoff from sand tailings disposal
- barge water from active mine pits
- runoff from disturbed areas
- runoff from natural areas draining through reclaimed lakes

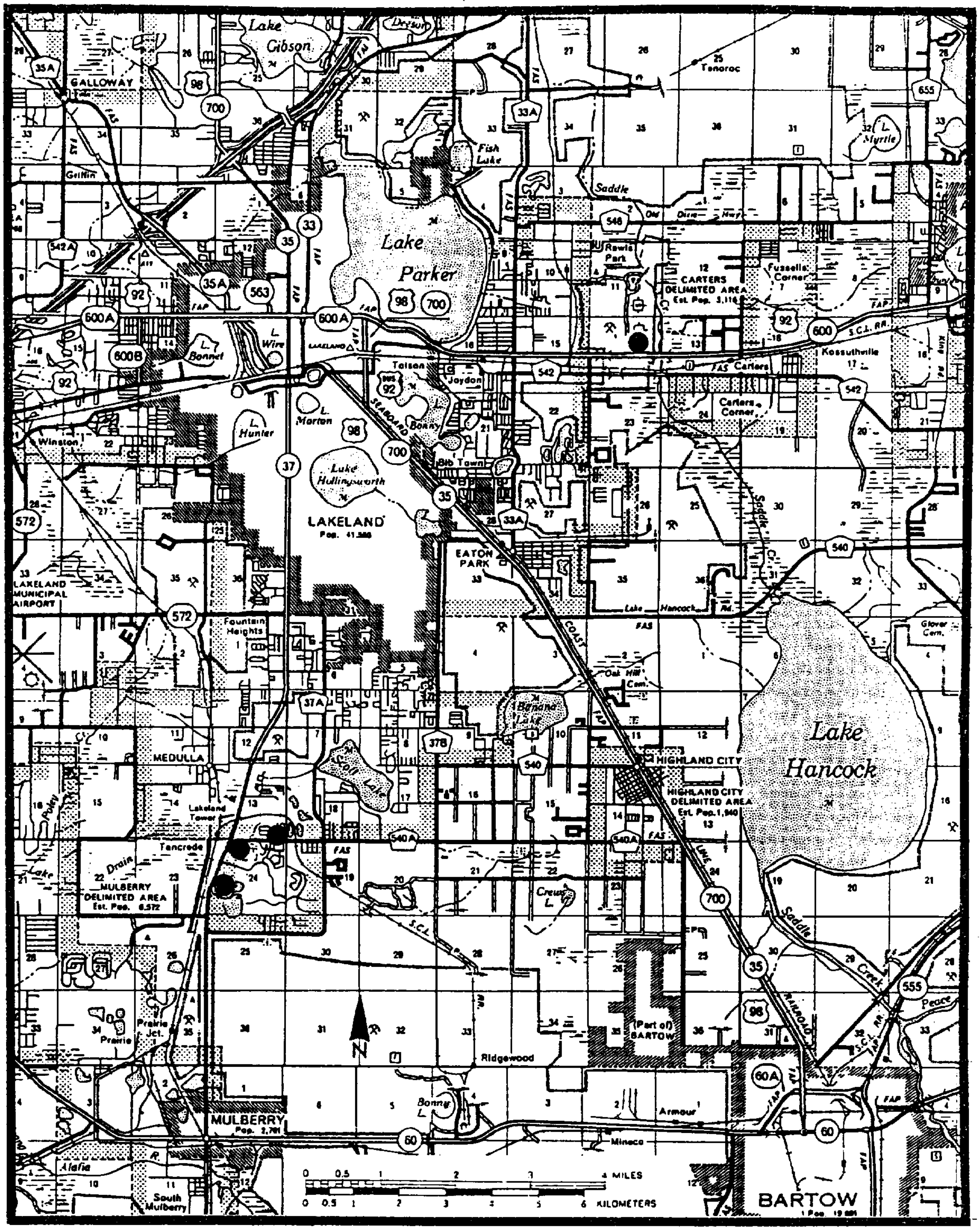
Altmans Bay and Section 13 Lake historically have had good water quality and continue to support good fish populations. The lakes typically meet all applicable water quality standards (Table 3.4-35, Section 3.4.2). The few alkalinity exceedances are related to the naturally low pH of the swamp and pine drainage. Ammonia is elevated in the lakes due to natural conditions and the ammonia used in processing operations. Wetlands mining will not increase this level and should therefore have no additional impact. The ammonia levels have not resulted in any fish kills within the reclaimed lakes.

Some low dissolved oxygen values were due to a relatively high percentage of the lake being covered by mats of water hyacinths, which occur in many natural lakes and streams in Florida. The periods of low dissolved oxygen have not caused fish kills, and no significant water quality impacts have been experienced. In these lakes and other types of reclaimed lakes, deeper portions of the lakes may periodically experience low dissolved oxygen. However, this is not expected to be a problem, as there are more than adequate areas of the lakes with good dissolved oxygen levels, as evidenced by the good fishing in abandoned and reclaimed mine pits.

Lakes Receiving Only Rainfall and Runoff. The third type of reclaimed lake which will be constructed are lakes which will receive only rainfall and rainfall runoff from reclaimed or natural areas. OXY has no reclaimed lakes on the site which could be used to characterize reclaimed lake water quality without the influence of process discharges. All of their reclaimed lakes are used to insure that all water leaving their property meets all applicable water quality standards. Even when the lakes are used in the final treatment of process wastewater, the discharges of the reclaimed lakes typically meet all applicable water quality permit limits and standards and provide excellent fishing opportunities. Exceptions may occur due to background conditions or a temporary upset which could cause a particular parameter such as pH, turbidity, or suspended solids to deviate from the standard.

Examples of nutrient levels in reclaimed lakes not receiving process waters can be drawn from the central Florida area. Four reclaimed lakes without current phosphate discharges were sampled (Figure 6.4-1, Table 6.4-2). The data indicate lower phosphate, sulfate, fluoride, and nitrogen levels than in OXY's reclaimed lakes now used as part of their treatment system (Table 3.4-32, Section 3.4.2). The central Florida reclaimed lakes have a higher pH than would be expected in OXY's reclaimed lakes which probably is due to the low percentage of wetlands and/or pine areas within their drainage areas. OXY's reclaimed lakes should have a lower pH due to drainage from undisturbed and reclaimed wetlands and pine areas. The influence of this drainage is evidenced by the brownish color of the water and a pH below 7.0, even with mine discharge. However, this is not to say that the water quality characteristics in OXY's reclaimed lakes will mimic those of the undisturbed wetlands. For example, planktonic communities within the lakes and the increased alkalinity will cause the pH of the lakes to be higher than that normally found in wetlands.

Water quality of reclaimed lakes will vary depending on their input. Those lakes not receiving a high percentage of their water from wetlands and/or pine areas will probably have water quality similar to that shown in Table 6.4-2. The lakes will be more autotrophic and their discharges will provide more primary production (e.g., phytoplankton) to the receiving streams. From a biological standpoint, this should benefit instream aquatic communities by increasing productivity and providing a pH more suitable for most aquatic organisms (Boyd 1979).



● - Old Phosphate Lake

Taken from Polk County DOT map

Figure 6.4-1. Location of Old Florida Phosphate Lakes Sampled for Water Quality.

Table 6.4-2. Water Quality of Lakes in Previously Mined Areas in Polk County, Sampled March 1982.

Parameter	Reclaimed Lake Behind Raffles	Lake Christina	CR 540A Reclaimed Lake	Saddle Creek
Depth (ft)	16	18	19	18
Transparency, secchi disk (ft)	1.6	2.4	2.6	4.0
pH	9.0	8.5	8.7	8.2
Temperature (°C)	21	21	20	22
Dissolved oxygen (mg/l)	11	8.2	10	8.7
Conductivity (µmhos/cm at 25°C)	280	200	155	345
Chlorophyll a (mg/m^3)	23.48	ND	12.88	33.07
Total suspended solids (mg/l)	12.67	6.6	5.0	3.0
Total dissolved solids (mg/l)	168	151	113	220
Turbidity (JTU)	25.0	15.0	15.0	12.0
Fluoride (mg/l)	0.66	0.66	0.52	0.84
Sulfate (mg/l)	8.57	0	0.38	42.52
Total phosphate as P (mg/l)	0.96	0.71	0.06	0.42
Orthophosphate as P (mg/l)	0.72	0.64	0	0.31
Ammonia nitrogen as N (mg/l)	0.30	0.40	0.20	0.24
Nitrite/nitrate as N (mg/l)	0.06	<0.02	<0.02	<0.02
Organic nitrogen as N (mg/l)	1.60	0.60	0.87	0.39
Total nitrogen as N (mg/l)	1.96	1.02	1.09	0.65
BOD_5 (mg/l)	12.94	4.78	6.48	3.02
Total organic carbon as C (mg/l)	13.4	9.9	10.3	17.5

ND = not detectable.

Because relatively large areas drain to the reclaimed lakes, periodically flushing the lakes, the lake water quality should begin to reflect the characteristics of the water flowing into it after cessation of mining and reclamation. Due to the relatively high percentage of wetlands and planted pine areas that will drain to the lakes after reclamation is completed, the water quality of the lakes should be typical of that found in soft, brown water, tannic lakes. The nutrient levels in the lakes will begin to decline after the processing input ceases and as lower nutrient water begins to flush the lakes. The lake sediments contain phosphate which may be gradually released over time; however, as additional sedimentation occurs, the sediments with relatively high phosphate levels will be buried and the phosphate will be immobilized (tied up) permanently.

6.4.1.7 Impacts on the Suwannee River

During mining, impacts on the Suwannee River should remain relatively constant and not change appreciably from those presently experienced under baseline conditions. Wetlands mining will not increase the nutrient loadings to the Suwannee River except to the extent that it extends OXY's operations over time. The majority of the nutrient loadings discharged from OXY's operations come from the beneficiation and chemical processing operations. These operations are not expected to increase in capacity or number due to wetlands mining. All four mining alternatives are based on normal operation of the plants until the reserves are expended, so their effects on nutrient levels should remain relatively constant until shutdown of the plants.

Impacts on the Suwannee River should also be relatively constant regardless of the points at which nutrients enter the river; that is, regardless of the number of discharge points, the same total amount or loading of nutrients and other parameters should reach the river because the same amount of rainfall-related water must be discharged. However, the relative amounts carried by a particular stream may differ.

Based on these considerations, the magnitude of water quality impacts on the Suwannee River can be estimated by examining the impact that OXY's current mining discharge to Hunter Creek has on the river (Section 3.4.2.3). In 1980, the Suwannee River was redesignated as an Outstanding Florida Water. In its report in support of the redesignation, FDER found that after approximately 15 years of operation, the Suwannee River water quality was among the best in the state (FDER 1980).

6.4.2 Post-Reclamation Impacts

After mining ceases and reclamation is completed, water quality in the Suwannee River, area tributaries, and unaffected and reclaimed wetlands should approximate pre-mining characteristics.

6.4.2.1 Reclaimed Wetlands

The majority (63%) of wetlands within the OXY project area are not proposed for mining, even under Alternative B. Water quality within these undisturbed areas should not change. Therefore, a minimum of 15,500 wetland acres not proposed for disturbance will be available to provide the same water quality function after mining as they did prior to mining.

It is expected that the reclaimed wetlands will modify water quality in varying degrees, depending on their maturity. For example, when initially planted, forested wetlands will not be able to provide humic and tannic acids or color to the water until the organic matter in the litter accumulates. However, the surrounding pine flatwoods and unmined wetlands will continue to provide this function.

The newly established wetlands may provide more of a water purification function than the older wetlands due to the rapid growth of the young plants. Direct rainfall and rainfall runoff from surrounding areas will be the only water that reclaimed wetlands will receive after cessation of mining and completion of reclamation. Therefore, water quality within the reclaimed wetlands should meet all FDER Class III water quality standards.

6.4.2.2 Reclaimed Lakes

After the process-related discharges to the reclaimed lakes cease and reclamation is complete, water quality in the reclaimed lakes should begin to reflect the characteristics of their drainage. Flow into the lakes will begin to flush the lakes with low phosphate waters, and release of phosphate from the lake sediments will decrease with time. Thus, the water quality of the reclaimed lakes will be that characteristic of lakes receiving only rainfall and runoff from reclaimed and natural areas (Section 6.4.1.6).

6.4.2.3 Streams

After reclamation is complete, there will be approximately the same amount of area draining to each creek as prior to mining. Flows within the streams will be similar to pre-mining flows (Section 6.3). Water quality within the area streams will be controlled largely by drainage type (Table 6.4-3). Those streams receiving the highest percentage of their drainage from reclaimed lakes will have the greatest potential for change in water quality.

Impacts on stream water quality will be greatest under Alternative B because more area will be disturbed and reclaimed. However, ≥50% of all stream drainage areas will be left undisturbed by mining, with the exception of Roaring Creek. Water quality impacts could result from mining and reclamation of the upper reaches of stream channels under Alternative B; however, <10% of the stream channels will be disturbed or mined and reclaimed. The lower sections of the streams will not be disturbed in any case. The potential water quality impacts of stream reclamation are related to differences in water depths, flow velocities, and substrates between pre- and post-reclamation streams. As the actual design of the reclaimed streams is not known at this point, it is difficult to predict impacts on water quality. The changes in land forms and the increased percentage of lakes within a stream's drainage may

Table 6.4-3. Reclamation Types by Major Creek System As a Percentage of Post-Mining Drainage Basins.[1]

	Reclaimed Lakes				Tailings Fill		Elevated Fill		Undisturbed	
	Land		Water							
	acres	%	acres	%	acres	%	acres	%	acres	%
Camp Branch	415	7	622	10	2,080	33	0	0	3,118	50
Swift Creek[2]	1,190	5	1,190	5	2,584	10	7,130	27	13,951	53
Four Mile Branch	480	16	480	16	0	0	0	0	1,971	67
Long Branch	554	19	533	18	0	0	0	0	1,826	63
Roaring Creek	1,595	11	1,595	11	1,005	7	5,661	38	4,945	33
Hunter Creek	333	2	376	3	117	1	5,321	37	8,288	57
Rocky Creek	1,461	3	1,714	3	0	0	0	0	48,470	94

[1]Excludes acreage reclaimed in unnamed tributaries.

[2]Acreages do not reflect an additional 919 acres of reclaimed cooling pond and gypsum stack; i.e., total reclaimed acreage for the Swift Creek drainage basin is 13,013 acres.

cause slightly higher nutrient levels in the streams due to the gradual release of nutrients tied up in bottom sediments and sediments from reclaimed lakes which have received nutrients from processing operations. However, the permitting process should insure that all state water quality standards will be met in the streams after completion of mining and reclamation.

Long Branch and Four Mile Branch will have approximately 16-18% of their drainages in reclaimed lakes (Table 6.4-3); approximately 35% of the lake area will be reclaimed as forested wetlands. These changes should not cause any significant adverse impacts on the streams because the water that will overflow from the reclaimed lakes will be of good quality.

The potential for water quality changes at the mouth of Rocky Creek is low, as the majority of this drainage basin is outside of the project area. The total Rocky Creek post-mining drainage area will be approximately 51,645 acres. Only 6% of the drainage will be affected by mining, and the remaining 94% of the area will continue to produce the same quality water it always has, which will dominate the water quality of the stream.

Concentrations of parameters normally associated with phosphate operations will decrease after the cessation of mining and reclamation, and the streams will begin to reflect the characteristics of the drainage. Over half of the Swift Creek drainage area and about one-third of the Hunter Creek drainage area will not be affected by mining operations. These areas will continue to contribute the same type water to the streams. The reclaimed lands and lakes will produce good quality water; thus, the water quality should improve within these streams which have historically received discharges from processing operations.

6.4.2.4 The Suwannee River

Water quality within the Suwannee River should not be significantly changed by discharges from OXY's reclaimed lands. The relative annual volume of water flowing into the Suwannee River after reclamation will closely approximate pre-mining amounts (Section 6.3). Runoff from reclaimed areas should yield good quality water relatively low in nutrients. Over half of the project area will not be disturbed, including over 60% of the wetlands on site. Therefore, only about 2% of the Suwannee River's drainage as measured at Suwannee Springs will be affected.

An example of a "worst case" situation demonstrates the potential effect of changes in phosphate levels on water quality within the Suwannee River and shows the effect OXY should have on water quality in the river after mining. It is assumed that a "worst case" situation would include the following conditions: 1) all flow from the major named streams in the OXY project area have phosphate levels of 1.0 mg/l; 2) their combined projected post-reclamation annual flows are approximately 157 cfs; 3) the phosphate level in the Suwannee River is approximately 0.2 mg/l (Table 3.4-14, Section 3.4.2); and 4) annual average flow in the river is 2360 cfs. Under these conditions, the increase in phosphate levels in the Suwannee River at Suwannee Springs, as a result of contributions from major streams in the OXY project area, would be only 0.05 mg/l. The average phosphate level at Suwannee Springs during November 1979-March 1982 (Table 3.4-14) was approximately 10X higher than the predicted 0.25 mg/l phosphate level in this example, and no problems were reported even at this level.

6.4.3 Literature Cited

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Florida Department of Environmental Regulation (FDER). 1980. The proposed redesignation of the Suwannee River between State Road 6 (Hamilton and Columbia counties) and Suwannee Springs (Hamilton and Suwannee counties) as an "Outstanding Florida Water." Rept. to the Env. Reg. Comm., Fla. Dept. of Env. Reg., Tallahassee.

U.S. Environmental Protection Agency (EPA). 1978. Draft environmental impact statement for proposed issuance of a new source National Pollutant Discharge Elimination System permit to Occidental Chemical Company Swift Creek Chemical Complex, Hamilton County, Florida. Resource Document Vols. I-IV. U.S. EPA Region IV, Atlanta. EPA-904/9-78-012-A,B,C,D.

6.5 Groundwater

All mining and reclamation operations must comply with Florida water quality and quantity regulations. Chapter 373, FS, provides for management and storage of surface waters, works of the District, consumptive use of water, regulation of wells, and water level and flow management. The Suwannee River Water Management District (SRWMD) is in the process of implementing rules and regulations under this legislation.

Chapter 403, FS, provides for regulation of surface and groundwater quality. Chapters 17-3 and 17-4, FAC, provide water quality standards and permitting requirements and procedures governing discharges to both surface water and groundwater. Groundwater within a permitted zone of discharge must be free from all contaminants in concentrations which:

1) are harmful to soil organisms responsible for treatment or stabilization of the discharge;
2) are carcinogenic, mutagenic, teratogenic, or toxic to human beings;
3) are acutely toxic to aquatic organisms within surface water affected by the groundwater;
4) pose a serious danger to public health, safety, or welfare;
5) create or constitute a nuisance; and
6) impair the reasonable and beneficial use of adjacent waters.

Beyond the permitted zone of discharge, water in potable water use aquifers must meet primary and secondary drinking water standards for public water systems or contain constituents in concentrations no greater than representative background conditions. Unless otherwise exempted, any installation discharging into groundwater shall establish and implement an acceptable groundwater monitoring program.

6.5.1 Potential Impact Areas

The mining alternatives were evaluated in terms of their impacts on the following groundwater-related issues:

- deep well withdrawal,
- recharge to the Floridan Aquifer,
- groundwater table levels,
- baseflow to streams, and
- groundwater quality.

6.5.1.1 Deep Well Withdrawal

Water withdrawal from the Floridan Aquifer causes drawdowns within a cone of depression around the pumping center(s). Future mining operations are projected to withdraw approximately 28 mgd on an average annual basis for each of the four mining alternatives. Therefore, the difference between alternatives is limited to differences in the duration of pumping and not in the magnitude of pumping. Essentially all of this water is withdrawn from the Floridan Aquifer. The Surficial Aquifer supplies minimal amounts of water only for rural domestic use, with a typical well yielding 4-10 gpm. The Secondary Artesian Aquifer is not important for industrial use because of its low transmissive properties (SRWMD unpubl. data 1983).

The magnitude and duration of drawdowns in any aquifer can be quantified by the non-equilibrium equation (Todd 1964). Drawdowns are directly related to pumping rate and duration, and they are inversely related to transmissivity, storage coefficient, leakance, and distance from well withdrawal (Section 3.4.3).

Impacts of OXY mining associated with deep well withdrawals from the Floridan Aquifer were discussed by the USGS (Miller et al. 1978), based on a 30 mgd average annual withdrawal:

> Long-term records from an observation well in Jennings, a well 3.5 miles west of White Springs, a well in Lake City, and a well near Valdosta, Georgia, have not shown any pronounced long-term water-level decline if climatic variations are taken into account. Therefore, based on these records, a significant regional decline of the Floridan's potentiometric surface has not resulted from the 30 mgd of pumpage for the OXY Hamilton County phosphate industry operations. This pumpage probably has been balanced by either an increase in recharge to the Floridan from vertical leakage or from capture of stream flow, or both.

The water pumped is derived from a combination of sources, including upgradient flow captured from within the Floridan Aquifer, natural and induced vertical leakage through the confining beds, changes in storage within the limits of the cone of depression, and capture of part of the groundwater discharge to, and induced inflow from, the Suwannee River.

Part of the capture of groundwater flow to the Suwannee River theoretically could result in reduced spring flow. However, the effect of pumpage on the flow of the Suwannee River, if any, would not be detectable. The pumping area centers are more than 3 mi away from the river. Based on the Floridan Aquifer characteristics, no drawdown at this distance is expected. The potentially reduced contribution from spring discharge would be more than offset by the additional streamflow to the Suwannee River from dewatering of the Surficial Aquifer during mining and from surface water outflow from a portion of the pumped deep water withdrawals entering the surface water drainage systems after reuse in the mining and beneficiation operations.

The decline of the Floridan potentiometric surface resulting from the pumpage would increase local leakage to the Floridan Aquifer. The increase in leakage would be greatest near the pumping centers, where drawdowns are at a maximum, and would diminish away from the centers as drawdowns diminish. For the Osceola National Forest, the USGS reported that the area within a 100-ft radius of the pumping centers (pumping rate = 6000 gpm) would have leakage changed from 1.0 to 1.55 in/yr (Miller et al. 1978). At 10,000 ft from the pumping centers, the average leakage would change from 1.0 to 1.16 in/yr. The anticipated average annual pumpage rate at each of the two mines is about 10,000 gpm. However, even with the higher pumping rates, the higher aquifer transmissivity in the OXY area results in less drawdown at a given distance away from the pumping center than reported by Miller et al. (1978). Therefore, over the 100,000-acre OXY project area, the change in leakage to the aquifer would be less in magnitude but over a larger cone of depression than in the Osceola National Forest.

The impacts of deep well withdrawal are assessed for each alternative by comparing the duration of the mining periods for each alternative (Section 6.5.2). The magnitude of drawdowns is not significant enough to warrant further discussion.

6.5.1.2 Recharge to the Floridan Aquifer

Natural recharge rates are estimated to be 0.1-0.7 in/yr over most of the project area. Changes in leakance, head difference, and surface area as a result of mining should be considered in assessing impacts. The leakance value for the primary confining beds within the Hawthorn Formation will not be altered by any of the alternatives. Therefore, the head difference changes and the areal extent of the head difference changes are the only factors that differ among alternatives.

During the mining operation, deep well withdrawals within the cone of depression increase the head difference between the water table and potentiometric surface of the Floridan Aquifer. Conversely, within the actual mining areas the head difference decreases between aquifers because the water table is lowered during the mining operation. The lowered water table in the active mining area could decrease the recharge rate by as much as 50%. The area affected by mine cut dewatering is expected to be approximately 1000 acres per year (or about 1% of the project area) and will be approximately the same area and magnitude for each alternative. The net effect of this mine cut dewatering within the Surficial Aquifer will be a decrease in the annual average recharge to the Floridan Aquifer of <0.025 mgd. However, the increased recharge to the Floridan Aquifer within the project area as a result of the deep well pumping is estimated at 1.5 mgd, based on best available data. Thus, for the project area as a whole, under any of the mining alternatives, there will be a slight increase in local recharge to the Floridan Aquifer of <1.5 mgd during mining compared to pre-mining conditions. This slight increase in local recharge to the Floridan Aquifer over the project area (100,000 acres) will not have a significant impact on the groundwater resources. The impact will be approximately the same for each of the alternatives, differing only in the duration of the impact.

6.5.1.3 Groundwater Table Levels

The primary impact to the water table of the Surficial Aquifer occurs as a result of subsurface drainage associated with the mining operations. The magnitude of drawdown adjacent to a mine cut or dewatering ditch depends on the following factors:

- ° Distance away from the mine cut or ditch;
- ° Depth below existing land surface to the water level in the cut or ditch;
- ° Aquifer transmissivity and storage coefficient;
- ° Duration of lowered water table;
- ° Recharge during lowered water table period;
- ° Mitigating measures, if any, to induce recharge to adjacent areas or reduce outflow from the area; and
- ° Areal extent of, vertical distribution within, and leakage through relatively tight layers within the Surficial Aquifer.

The following summary of water table impacts associated with mining and beneficiation operations is based, in part, on a USGS report (Miller et al. 1978).

Dewatering operations during mining will lower the local water table elevation in the Surficial Aquifer. However, once excavation and dewatering cease and reclamation is complete, the water table elevation will recover to a new position controlled by the changed topography and permeability of the Surficial Aquifer. The magnitude of the configuration change from that of the nearly flat and relief-free water table existing before mining depends largely on the amount of change in relief of the land surface and the post-reclamation surface drainage network. If the drainage network is not significantly changed, the primary controlling factor will be the amount of change in relief. Another contributing factor is the stratification, thickness, and permeability of the redeposited material.

The water table is at or within a few feet of the land surface throughout the pre-mining area. After reclamation, the depth to the water table might be increased to perhaps 5-10 ft below land surface beneath the mounds or ridges in the land and lakes areas. In those areas where excavation and backfill operations leave the land surface depressed compared to pre-mining conditions, the depth to the water table will probably decrease from what it is now, at least during part of the year. Where the permeability of the backfill materials is lower than the natural deposits and the topography is similar to pre-mining conditions, the water table will stand at somewhat higher elevations after reclamation than before mining. When the backfill is adjacent to more pervious soils, the water table will be controlled primarily by the rate of evapotranspiration.

Figure 6.5-1 shows the near-surface groundwater system as it relates to Swift Creek Swamp. Typically, a 5-15 ft thick layer of various combinations of muck, sand, and silty sand overlies a 15-25 ft thick layer of clayey, silty sand to sandy clay. This clayey layer acts as a semi-confining layer within the Surficial Aquifer. It has a permeability, where intact, between 10^{-6} and 10^{-8} cm/sec. However, there is some evidence that this layer is not always intact. At several locations at the Swift Creek and Suwannee River mines, the measured gradients and the estimated recharge to the Floridan Aquifer of 0.1-0.7 in/yr indicate a permeability for this layer of approximately 10^{-6} cm/sec. The phosphate matrix, which in places has a relatively high transmissivity, is below

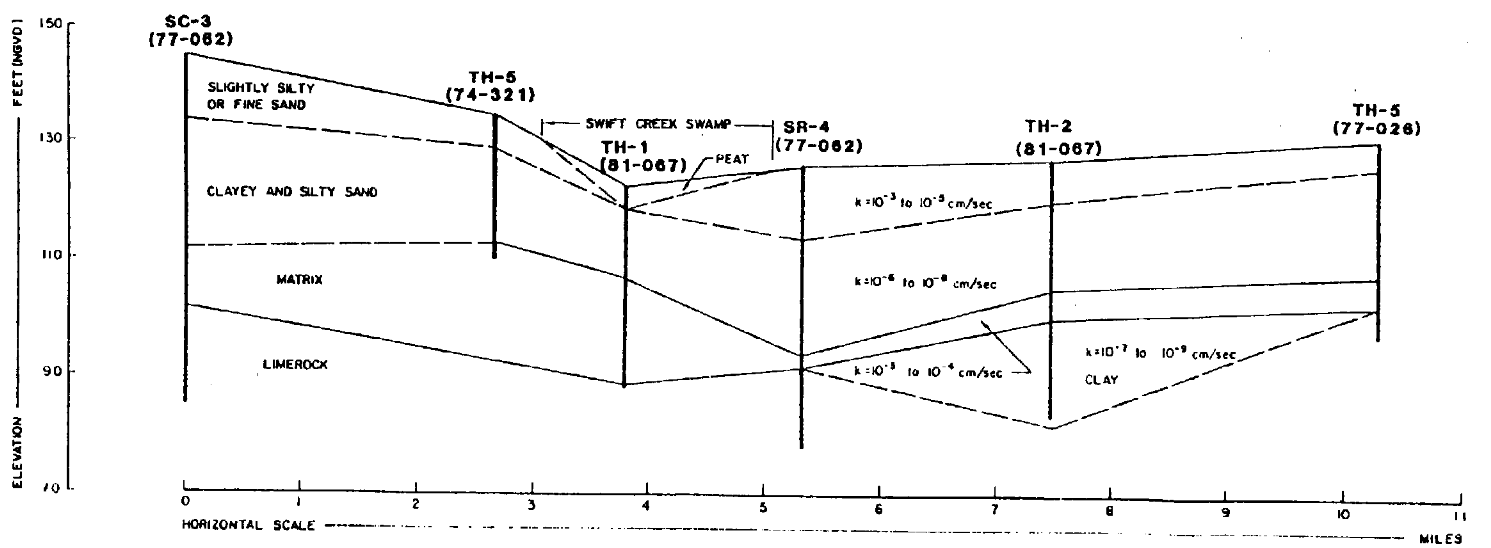

Figure 6.5-1. Swift Creek Swamp Surficial Aquifer System. (See Figure 3.1-10, Section 3.1.3.3, for location of transect.)

this clayey layer. The relatively impermeable beds of the Hawthorn Formation, which comprise the principal confining layer above the Floridan Aquifer, underlie the matrix.

The Surficial Aquifer is composed, in descending order, of a surficial sand and organic layer, a relatively thick clayey layer, and a permeable matrix zone. The clayey layer, which divides the Surficial Aquifer into two subsystems, mitigates the potential drawdown impacts to surface water systems which could occur if the aquifer were homogeneous.

The clayey layer is evident in all borings and probings performed in the project area. This clayey layer, together with a surface muck layer, tends to mitigate the drawdown impacts associated with gravity drainage adjacent to the mine cuts. In some places, the organic soils of the wetlands rest directly on these clayey deposits, while in other areas the thin surface sands separate the wetlands and the clayey materials. There are no cases known in which wetlands are in direct contact with the permeable matrix deposits. Based on a permeability of 10^{-6} cm/sec for the clayey layer and assuming the matrix layer has been dewatered, i.e., the hydraulic gradient across the clayey layer is approximately 1, water could move vertically through the clayey materials at a rate of approximately 0.003 ft/day (1.1 ft/yr), which is small in comparison to sand systems.

The USGS made the following statements about the groundwater impacts associated with seepage from a phosphatic clay waste storage settling pond on the OXY property (pers. comm. USGS, Tallahassee, 1983):

> The earthen dike and slime pond will leak to some extent, however small, but the leakage would be diluted by rainfall, especially in the upper part of the Surficial Aquifer. The Surficial Aquifer is of relatively low permeability, and the hydraulic gradients outward from the perimeter ditch are relatively low, with gradients of about 1 ft/mi. Under these conditions, no leakage from the slime pond or perimeter ditches was detected in the Surficial Aquifer in this investigation.

The potential for impacts associated with subsurface drainage adjacent to mining operations is directly related to the total acreage of mined lands (Section 6.5.2). Therefore, the number of acres of mined lands will be compared for each alternative.

Even though no known adverse drawdown impacts have been identified as a result of present mining operations, there are mitigative measures that can be taken, should adverse impacts become evident (Section 10.2).

6.5.1.4 Baseflow to Streams

The groundwater contribution to streamflow consists of two parts: 1) interflow, which represents water in temporary groundwater storage released to a stream shortly after a rainfall runoff event, and 2) baseflow, which represents long-term groundwater seepage to a stream from upland areas.

Because of the flat hydraulic gradients from the upland areas toward the stream channels and the shallow nature of the stream channels throughout most of the project area, neither interflow nor baseflow are major contributors to streamflow in the areas affected by mining and waste disposal operations. Neither mining nor waste disposal operations are expected to significantly affect the interflow component of streamflow. Even though baseflow is not considered a major contribution to streamflow, mining could affect this baseflow contribution because during dewatering (drainage) of the Surficial Aquifer prior to and during mining operations, groundwater normally in storage will be released to surface waters. This water will increase the groundwater contribution, and hence flow, to surface waters which are permitted for discharge of mine waters.

Presently, water from mining operations is discharged to Swift Creek or Hunter Creek drainage areas. Therefore, baseflow to streams in other drainage areas will decrease during the mining operation from a reduction in drainage areas and reversal of hydraulic gradients. This reversal causes groundwater to move to the lower base levels, such as mine cuts, instead of the shallow natural channels of existing streams. If OXY were permitted to discharge mine drainage water to the stream nearest the mining operation, the groundwater contribution to tributary streams generally will increase and there will be no drastic reductions in streamflow.

During mining in stream segments not receiving drainage water, under Alternative B, the periods of baseflow will be significantly reduced. In fact, for at least some of the stream segments in close proximity to dewatering areas, baseflow will probably cease while water levels are depressed below the streambed.

Because all of the alternatives include upland mining in all of the various drainage areas and because the amount of land impacted by mining in any year remains relatively constant, the difference in impacts between alternatives is, as for many other issues, related to the duration of mining.

Waste clay disposal operations are generally expected to slightly decrease the baseflow contribution to streamflow. The embankments surrounding most of the existing and proposed waste clay disposal areas are designed to minimize seepage out of the settling areas. In addition, the waste clay itself, after consolidation, has a relatively low permeability. Consequently, little seepage is expected from most of the existing and proposed waste clay disposal areas either during or after mining operations cease. Water that would normally enter the streams as baseflow may still reach the stream via surface runoff. The impact of waste clay disposal operations on baseflow to streams is related to the size and location of the waste disposal areas with respect to potentially impacted streams (Section 6.5.2).

6.5.1.5 Groundwater Quality

No water quality change is expected in the Secondary Artesian and Floridan aquifers for any of the alternatives as a result of mining or post-reclamation conditions. Water quality changes in the Surficial Aquifer will be subtle. Levels of dissolved constituents in the process water are expected to be between those in the Surficial and Floridan aquifers. Therefore, some changes in the dissolved constituents in the baseflow of the streams during mining operations are expected. In the upper reaches of the tributary streams, the baseflow will have somewhat greater hardness during mining operations. Once the water reaches the Hawthorn Formation or Suwannee Limestone of the Floridan Aquifer in the lower reaches of the tributary streams, as illustrated for Swift Creek in Figure 6.5-2, and from below the mouth of Roaring Creek in the Suwannee River, the level of dissolved constituents in the baseflow of the stream will approach that in the Floridan Aquifer. The water quality in the Suwannee River below White Springs will not be altered by the contribution of deep well withdrawals in the mining discharge.

The water quality in Swift and Hunter creeks also will not be altered by the contribution of deep well withdrawals under any of the proposed mining alternatives, as these streams presently receive deep well withdrawal water from uplands mining and beneficiation operations.

After reclamation, the water quality characteristics of baseflow in the Surficial Aquifer stream segments will be more mineralized than under pre-mining conditions but will not exceed the mineralization characteristics of Floridan Aquifer water.

The USGS made the following statements about water quality impacts associated with seepage from a phosphatic clay waste storage settling pond studied on the OXY property (pers. comm. USGS, Tallahassee, 1983):

> Relatively elevated concentrations of phosphorus, sulfate, trace elements, and radioisotopes, associated with the solid phase of the phosphate slimes, are effectively trapped in the slime material, but some material may solubilize after settling and percolate through the bottom of the slime pond. Some of the perimeter-ditch water and slime-pond water has undoubtedly migrated into the upper Surficial Aquifer, even though this movement was undetectable in this study due to the dilution by rainfall, the similar water quality of the background groundwater, and the potential sources of contamination of the nearby inactive slime pond and perimeter ditches. No contaminants appear to have reached the lower part of the Surficial Aquifer. None has, or probably ever will, reach the Floridan Aquifer. No threat to any aquifer used for public water supply is evident.

Water quality analyses for mine process water and water squeezed from the waste clay indicate that, except for slightly elevated levels of fluoride, these waters meet FDER groundwater standards (Ch. 17-3 and 17-4, FAC) (Palm 1983). Consequently, impacts associated with groundwater seepage from mining operations are limited to potential increases in hardness within the Surficial Aquifer.

Water quality issues pertaining to the Surficial Aquifer and the tributary streams are discussed in Section 6.5.2.

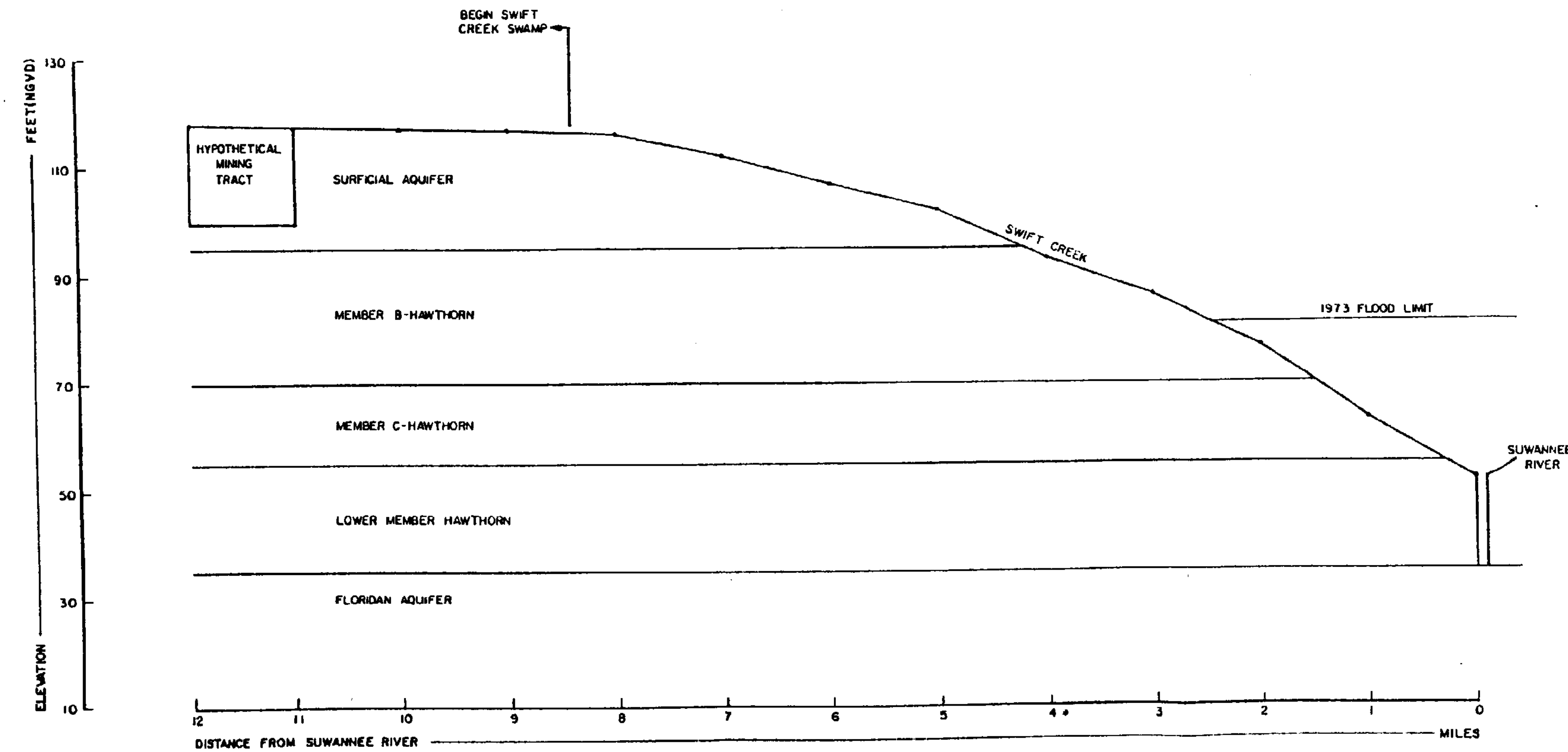

Figure 6.5-2. Generalized Swift Creek Groundwater Section.

6.5.2 Impacts of Mining Alternatives

6.5.2.1 Alternative A: No Mining or Mine Support in Wetlands

Groundwater impacts for Alternative A during mining are not significant. Impacts after reclamation would be insignificant in comparison with pre-mining conditions. Reasons for the relatively low level of impact for this alternative are basically related to the small area of disturbance in comparison to the total project area (approximately 9.8% of the project area would be affected by mining and mine support activities).

6.5.2.1.1 Mining

During mining, groundwater impacts are associated with: 1) deep well withdrawals, 2) mine cut dewatering, 3) seepage from process water ditches, and 4) waste disposal areas.

Deep Well Withdrawal. Deep well withdrawal is approximately the same for each of the alternatives, varying only in the duration of withdrawal (Section 6.5.1.1). For Alternative A, the duration of withdrawal is approximately 8-10 years.

Mine Cut Dewatering. Mine cut dewatering results in lowering of the groundwater table in the vicinity of the mine cuts. The amount of land potentially impacted by water table drawdowns adjacent to mining areas is related to the total acreage of mined lands during a given period. For Alternative A, the total acreage of lands to be mined is 9183 acres (with an additional 701 acres to be utilized for mine support) or 9.2% of the project area. The quantity of water involved in the dewatering operation for both mines will be about 4000 gpm (9 cfs) and is approximately equal for all of the alternatives, varying only in the duration of the activity.

Seepage from Process Water. Seepage from process water ditches has the potential for increasing baseflow to streams that are permitted to receive discharges, which at present include Swift and Hunter creeks. Tributaries receiving water from the dewatering operation will have flows higher than during pre-mining conditions. In the tributaries not receiving water from the dewatering operation and where active mining is ongoing, flow will be lower because baseflow periods will be shorter and less surface water will reach the stream as the mining block is removed from its original drainage area. However, the total baseflow contribution to the Suwannee River from the tributaries will be increased. This increased groundwater contribution will not represent a significant percentage of the total flow in the river except possibly during low flow periods. The USGS reports that the 10-year, 7-day low flow on the Suwannee River at the U.S. 41 bridge is only 10 cfs (Hughes 1981). The average flow of the Suwannee River at this location is 1861 cfs.

Seepage from Waste Clay Disposal Areas. Waste clay disposal areas at the Swift Creek Mine are located within the upland area adjacent to the west boundary of Swift Creek Swamp. The elevated fill areas at the Suwannee River Mine are located within the upland areas several miles to the east and south of Swift Creek Swamp and west of Hunter and Roaring creeks.

Baseflow to Hunter and Roaring creeks is not expected to be decreased significantly as a result of the elevated fill areas. Baseflow to the upper reaches of Swift Creek, i.e., to Swift Creek Swamp, is expected to be decreased by about 30% as a result of the elevated fill areas adjacent to the west boundary of Swift Creek Swamp. However, this is not considered a significant impact because seepage to this area even under pre-mining conditions is limited in magnitude due to the flat hydraulic gradients, shallow incisement, and relatively low permeability found in the semi-confining clayey layer which separates the surface drainage from the pervious units of the Surficial Aquifer.

Groundwater Quality. The water quality of the baseflow in the tributary streams receiving process water discharges and seepage from waste disposal areas, at least in the reaches of the streams where the bottom of the stream is above the top of the Hawthorn Formation, probably will be changed during the mining operation. These waters will have a tendency toward greater hardness and possibly higher pH.

6.5.2.1.2 Post-Reclamation

In the project area, the most transmissive unit in the Surficial Aquifer is the phosphate matrix; consequently, in areas where mining occurs, a major portion of the Surficial Aquifer will be removed. In areas reclaimed as elevated fill, the Surficial Aquifer will be replaced with waste phosphatic clay and cast overburden capped either with mudballs or sand tailings. The sand tailings cap, which will be approximately 10 ft thick, will replace some of the hydraulic characteristics of the Surficial Aquifer. In areas reclaimed as sand tailings fill, the sand tailings portion of the replacement aquifer will have even better hydraulic characteristics than the existing aquifer (e.g., higher transmissivity). The remainder of the mined areas will be reclaimed as land and lakes. Because the land portion of these areas will consist of overburden spoil materials, these land areas will not have a highly productive Surficial Aquifer. Nonetheless, the lake portions of these areas compensate for this factor so that the water storage characteristics of the area will probably be significantly increased through land and lakes reclamation.

6.5.2.2. Alternative B: Mining All Wetlands Containing Reserves

Groundwater impacts for this mining alternative are similar to those described for Alternative A (Section 6.5.2.1). Because of the large acreage involved and the longer duration (21-26 years) of mining activities, this alternative has the highest potential for cumulative groundwater impacts, with the greatest impacts occurring during mining.

6.5.2.2.1 Mining

Deep Well Withdrawal. Deep well withdrawals will be 28 mgd on an average annual basis, with 43 mgd to be used as a maximum on a daily basis for Alternatives A and B. However, for Alternative A, the withdrawals would be for only 8-10 years while for Alternative B the withdrawals would be for 21-26 years.

Mine Cut Dewatering. Impacts associated with dewatering the Surficial Aquifer and removal and partial replacement of the Surficial Aquifer during reclamation, as discussed for Alternative A, are also applicable here. These impacts are not significantly different from those of Alternative A except that they would occur over a larger area (25,899 acres mined) and for a longer period of time.

Seepage from Process Water. Impacts of seepage from process water are similar to those discussed for Alternative A. The permeable unit of the Surficial Aquifer will be removed and replaced with waste clay beneath approximately twice as much land area as for Alternative A.

Seepage from Waste Clay Disposal Areas. Waste clay disposal areas at the Swift Creek Mine are located within the upland areas adjacent to the west boundary of Swift Creek Swamp and cover a large portion of the swamp itself. Drainage from the areas above the present swamp is rerouted around the eastern boundary of the disposal areas. The waste disposal areas at the Suwannee River Mine are located in the same areas described for Alternative A, with additional areas located in the upland areas between and approximately 1 mi north of Roaring Creek and 1 mi south of Hunter Creek. The waste clay fill areas at the Suwannee River Mine are not expected to have a significant impact on baseflow to Roaring and Hunter creeks. Baseflow to the upper reaches of the rerouted Swift Creek is expected to be decreased by approximately 40% as a result of the waste clay areas adjacent to the western bank of the rerouted creek. A reach of stream within the Camp Branch drainage area will also be rerouted under this alternative.

Groundwater Quality. Depending on the depth of the rerouted reaches of Camp Branch and Swift Creek, groundwater may be discharged that normally would not have entered the streams. However, once the stream-groundwater system comes to a new equilibrium, the groundwater-related changes resulting from the construction should not be detectable if the stream length is not significantly changed.

6.5.2.2.2 Post-Reclamation

Post-reclamation impacts are similar to those discussed under Alternative A, with the exception of the larger extent of reclaimed lands.

6.5.2.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

The total area to be mined for Alternative C is 16,746 acres or approximately 16.7% of the project area over a mine life of 14-18 years. The only significant groundwater impacts will occur during mining and will be similar in scope to those discussed for Alternative A.

6.5.2.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Under Alternative D, mining will occur over 18-25 years with approximately 24,157 acres or 24.2% of the project area proposed for mining. Impacts during mining will be the only significant groundwater impacts;

impacts will be greater than under Alternative C, but slightly less than under Alternative B.

6.5.3 Literature Cited

Hughes, G.H. 1981. Low-flow frequency data for selected stream-gaging stations in Florida. USGS Water Resources Investigations 81-69.

Miller, J.A., G.H. Hughes, R.W. Hull, J. Vecchioli, and P.R. Seaber. 1978. Impact of potential phosphate mining on the hydrology of Osceola National Forest, Florida. USGS Water Resources Investigations 78-6.

Palm, G.F. 1983. Groundwater data acquisition program. Submitted to Florida Department of Environmental Regulation, Groundwater Section.

Todd, D.K. 1964. Groundwater hydrology. John Wiley and Sons, Inc. New York.

6.6 Air Quality

The probable impact of phosphate rock mining on ambient air quality is a localized, temporary increase in total suspended particulate matter levels as a result of land clearing operations, wind erosion of barren land, reclamation activities, and vehicular traffic on unpaved mine roads. Based on visual observations, the vehicular traffic on mining roads is the greatest source of fugitive particulate matter emissions associated with phosphate rock mining activities.

During the period 1979 through 1982, total suspended particulate matter levels were measured at seven monitoring sites in the vicinity of OXY operations while mining was actively conducted at both the Swift Creek and the Suwannee River mines (Section 3.5). These data show a long-term, area-wide geometric mean total suspended particulate matter concentration of 36 $\mu g/m^3$. Annual geometric mean total suspended particulate matter levels at individual monitoring sites ranged from 23 to 52 $\mu g/m^3$. The annual ambient air quality standard for total suspended particulate matter developed by EPA and adopted by the FDER is 60 $\mu g/m^3$.

The annual second-high 24-hour total suspended particulate matter level at individual monitoring sites generally was 80-90 $\mu g/m^3$. The highest second-high total suspended particulate matter level measured at any time during the four-year monitoring period was 139 $\mu g/m^3$. The 24-hour total suspended particulate matter standard developed by EPA and adopted by the FDER is 150 $\mu g/m^3$, not to be exceeded more than once per year.

No significant changes in total suspended particulate matter levels are expected in the area of Hamilton County occupied by OXY as a result of future mining and reclamation activities. These levels, for both the annual and the 24-hour time periods, are below ambient air quality standards developed by EPA and adopted by FDER. Levels would be similar in upland and wetland areas; thus, levels of total suspended particulate matter for the various mining alternatives would differ only as a factor of the length of mine life.

6.7 Radiation

During the mining of phosphate rock and subsequent reclamation of mined land, the naturally occurring profile of radiological characteristics in the soil is altered. The undisturbed profile normally shows low activity at the surface, a gradual increase and then a more rapid increase in activity with depth, and the highest activity in or just above the phosphate matrix.

In order to gain access to the phosphate matrix, the overlying topsoil, sand, and other strata are first removed. These overlying materials, collectively known as overburden, are stored in previously mined cuts and are subsequently used for land reclamation activities or for the construction of waste clay settling areas. Other materials used in the reclamation of mined lands are waste materials from the beneficiation of phosphate matrix. These materials include clays, sand tailings, and mudballs.

In the following sections the effects of mining and reclamation on the radiological characteristics of the OXY mining area are examined. In summary, it can be stated that mining and reclamation will alter the radiological profile and that the result will be an increase in the near-surface concentration of Ra-226 and an increase in terrestrial gamma radiation. For each of the four alternative mining plans, the relative changes in near-surface Ra-226 and terrestrial gamma levels are quantified and compared with radiological guidelines to assess the relative impact of each alternative. In no case will the increased Ra-226 or terrestrial gamma radiation levels exceed levels in existing mined and reclaimed lands at the OXY site, and in no case will those levels exceed guidelines established for Ra-226 and terrestrial gamma radiation.

The effects of each mining alternative and reclamation on airborne and waterborne radioactivity are also examined in the following sections. Airborne radioactivity is considered qualitatively because impacts will be short-term and are not related to the various alternative mining plans. Potential radiological impacts on both surface water and groundwater are evaluated. Some differences among various alternatives will occur and are assessed quantitatively on an area-wide basis, with specific comments provided on maximum expected impacts.

Biological uptake of radionuclides was evaluated qualitatively and determined not to be related to specific mining alternatives.

In assessing the potential radiological impacts of the proposed mining alternatives, it must be recognized that regardless of whether a permit is issued for the mining of wetlands, OXY may mine phosphate reserves in uplands. This radiological assessment is therefore made on the basis of the number of wetland acres that will be mined and reclaimed, not on the basis of whether mining will occur or not occur.

Another important factor to consider in the evaluation of the mining plans is that OXY has been mining in the Hamilton County area since

1965. During this period of time, mining and reclamation plans have been developed that adequately control the radiological impact of phosphate mining. This fact is adequately demonstrated by the radiological measurements made in previously mined areas, measurements that are used to assess the impacts of future mining. These measurements demonstrate that mining will not result in unacceptable radiological impacts as measured by established radiological guidelines and standards. It is reasonable to expect that continuation of mining can be accomplished with the same results.

6.7.1 Probable Radiological Impacts of Mining and Reclamation

The natural profile of radioactivity, which shows an increasing level of radioactivity with depth, will be altered by mining and reclamation. The degree of alteration will depend on the reclamation practices and the materials used for reclamation. The alterations may result in changes in the concentrations of radionuclides in the soil, terrestrial gamma radiation levels, levels of radioactivity in surface water and groundwater, and levels of airborne radioactivity.

Measurements made at sites previously mined and reclaimed by OXY have shown that, following mining and reclamation, the radiation profile becomes more or less uniform with depth. As a result, the near-surface (0-6 ft) radioactivity will generally be higher than it was before mining. The increase in the near-surface radioactivity will result in increases in terrestrial gamma radiation and in the near-surface Ra-226 concentration. The increased levels, however, will be well below guidelines for these parameters established by the Florida Department of Health and Rehabilitative Services (HRS), EPA, and the International Commission on Radiation Protection (ICRP).

6.7.1.1 Radionuclide Levels

Because only physical processes are involved in the mining operation, little change can be expected in the equilibrium of the uranium series. As a result, Ra-226 data can be used to represent the distribution of other radionuclides in the uranium series, and changes in Ra-226 concentrations can be used as a measure of assessing changes in concentrations of radionuclides in the soil as a result of mining and reclamation.

Table 6.7-1 includes several Ra-226 concentration measurements for the existing north Florida mining areas derived from field measurements and calculations conducted during three periods since 1978 (EPA 1978, Ardaman and Associates, Inc. 1981, and data from this study). The Ra-226 levels for overburden and reclaimed areas can be considered representative of levels that will exist in similar land types after mining. Data identified as Item 8 (Table 6.7-1) are utilized to define baseline levels of Ra-226 while those defined as Items 13, 14, and 15 are used to define the Ra-226 levels in various types of reclaimed lands.

In the reclamation of clay settling areas, it is planned to cap most of the settled clay with a minimum of 6 ft of sand tailings. The depth of

Table 6.7-1. Background and Post-Reclamation Soil Ra-226 Concentrations in the OXY Project Area.

Item	Sample Description	Ra-226 Conc. (pCi/g)	Reference
	<u>Background Samples</u>		
	Surface		
1	Topsoil	0.5	(1)
2	0-1 ft composite	0.3	(2)
3	Surface soil	0.4	(3)
	Near-Surface		
4	Completely overburden composite (calculated)	3.6	(1)
5	0-6 ft soil composite	0.6	(2)
6	0-6 ft soil composite (average)	1.0	(1)
7	Completely mixed overburden (calculated)	1.9	(3)
8	0-6 ft wetlands composite	1.1	(3)
	<u>Post-Reclamation Samples</u>		
	Surface		
9	0-1 ft overburden composite	3.7	(2)
10	0-1 ft land composite from land and lakes reclamation area	6.7	(2)
	Near-Surface		
11	0-6 ft overburden composite	4.7	(2)
12	0-6 ft mudball composite	18.6	(2)
13	0-6 ft land composite from land and lakes reclamation area	6.8	(2)
14	Sand tailings with thin layer of clay overburden or mudballs (calculated)	3.8	Calculated mix with 90% sand tailings
15	0-6 ft overburden composite	4.2	Average of Items 4, 7, 9, and 11

(1) EPA 1978.
(2) Ardaman and Associates, Inc. 1981.
(3) Data from this study.

the sand tailings over the clay settling area is important in determining the 0-6 ft composite Ra-226 concentration because at the OXY site the sand tailings have a Ra-226 concentration of 3.2 pCi/g while the clays have a higher concentration. Approximately 30% of the clay settling areas (normally near the center of the area) will be left uncapped as wetlands. Appropriate consideration will be given to this acreage in the impact analysis.

To provide a better growing medium, the reclamation plan calls for the addition (up to 10%) of either overburden material, mudballs, or a thin layer of waste clay to the sand cap. This technique helps provide rapid stabilization of the surface soil and the prevention of surface water runoff (with suspended solids containing greater than natural levels of radioactivity). The addition of these materials to the sand tailings will, however, increase the average Ra-226 level in the surface soils from about 2.9 pCi/g to a calculated level of 3.8 pCi/g (Item 14, Table 6.7-1).

6.7.1.2 Gamma Radiation Levels

The redistribution of radioactivity in the soil after mining and reclamation also alters the terrestrial gamma radiation level. The terrestrial gamma radiation is a direct measure of the gamma radiation level at the ground surface and an indirect measure of the surface soil (0-1 ft depth) radioactivity. The background terrestrial gamma radiation level over uplands at the OXY site was found to average 5.2 μR/hr and over wetland areas was found to be 4.4 μR/hr (Section 3.7.6). Terrestrial gamma radiation levels have also been measured at several reclaimed areas at the OXY site and are summarized in Table 6.7-2. Data identified as Items 4, 5, and 6 are used to assess mining and reclamation impacts. For reclaimed areas such as the lake fraction of the land and lakes areas and the wetland fraction of reclaimed clay settling areas, a terrestrial gamma level of 3.5 μR/hr, resulting from cosmic radiation, was utilized.

6.7.2 Methods of Assessing the Radiological Impact of Mining and Reclamation

The alteration of the radioactivity profile brought about by mining and reclamation will result in an increase in the near-surface concentration of Ra-226 (Section 6.7.2.1), an increase in terrestrial gamma radiation (Section 6.7.2.2), potential changes in levels of radioactivity in surface water and groundwater (Section 6.7.2.3), and potential changes in levels of airborne radioactivity (Section 6.7.2.4). The concentration of Ra-226 in the near-surface soil is of concern primarily because of the formation of the decay product radon (Rn-222) and the emanation of this radioactive gas into the atmosphere. Terrestrial gamma radiation is of concern because it is a direct measure of the radiation at the ground-surface and an indirect measure of near-surface soil radioactivity.

Applicable radiation standards were reviewed in Section 3.7.1 (Table 3.7-1). This review included proposed EPA and HRS standards, neither of

Table 6.7-2. Terrestrial Gamma Radiation Levels Over Existing Reclaimed Areas at OXY.

Item	Type of Land	Gamma (μR/hr)	Reference
1	Reclaimed area	8.4	EPA 1978
2	Reclaimed area	7.8	EPA 1978
3	Reclaimed area	8.5	EPA 1978
4	Land and lakes (reclamation land)	13.7	Ardaman and Associates, Inc. 1981
5	Overburden cap	11.1	Ardaman and Associates, Inc. 1981
6	Tailings over clay	11.7	Ardaman and Associates, Inc. 1981
7	Overburden only	13.3-14.7	Calculated
8	Wet areas, including lakes	<4.4	Ardaman and Associates, Inc. 1981; EPA 1978

which has been adopted, as of March 1984. Based on this review, a decision was made to use the proposed HRS standards as a point of reference, as they were developed based on conditions existing in Florida and upon recommendation of the ICRP.

In 1980, after the Florida Department of Natural Resources (FDNR) published reclamation requirements (Item 18, Table 3.7-1), the HRS was required to prepare "Applicable Radiological Standards" (Item 19, Table 3.7-1). The draft HRS regulations, as proposed in 1980, addressed terrestrial gamma radiation and soil Ra-226 concentrations.

In March 1983, the State Health Officer of Florida appointed a Committee on Radiation Standards. This committee published a draft report entitled, "Environmental Radiation Protection Standards" on 19 January 1984. In general, the committee adopted the basic recommendation outlined in the Recommendations of the International Commission on Radiation Protection (ICRP Publ. 26, Para. 119-126). This primary guideline stipulates a maximum effective whole body dose equivalent to 500 mrem in any one year to any individual in the general public.

Because it is not feasible to measure the radiation dose received by members of the general public, the HRS committee reviewed pathways of exposure and allocated fractions of the 500 mrem/yr dose to definable pathways. The committee then established secondary exposure-based guidelines (secondary guidelines) that limit the exposure to individuals to the extent that the primary guideline for radiation dose is not exceeded. In some cases, the HRS committee went a step further and established tertiary exposure-based guidelines (tertiary guidelines) that can be used as alternatives to the secondary guidelines. The standards proposed by the HRS committee are summarized in Table 6.7-3.

The most restrictive secondary guideline proposed by HRS, related to mining activities, is the limit on the terrestrial gamma radiation increase for lands that are to have unrestricted post-mining use. The proposed secondary guideline for terrestrial gamma radiation is 20 μR/hr above the pre-mined terrestrial gamma radiation level for unrestricted post-mining use of the land. In addition to the secondary guideline, a tertiary guideline to limit external radiation exposure has been proposed by HRS. This guideline, setting the near-surface Ra-226 concentration at 3.0 pCi/g above pre-mined levels for unrestricted post-mining use, is based on an established correlation between terrestrial gamma radiation levels and soil Ra-226 levels.

In addition to the HRS guidelines, site-specific guidelines have been developed for the OXY site by combining HRS guidelines with site-specific background radiation measurements (Table 6.7-3).

The mining alternatives considered by OXY address land areas to be mined, land areas impacted by mining, and land areas that have been previously mined and are to be reclaimed under the various alternatives. The relationship among these land types does not lend itself to simple before-and-after radiological analysis. For example, under Alternative A, 9183 acres will be mined and 701 additional acres will be used for

Table 6.7-3. Summary of Radiological Standards Proposed by the Florida Dept. of Health and Rehabilitative Services Committee on Radiation Standards and Site-Specific Standards.

Site-Specific Guidelines for OXY Site	Tertiary Guideline[1]	Secondary Guideline[2]	Pathway	Primary Guideline[3]
Near-surface Ra-226 conc. of 20 pCi/g (background + 3 pCi/g)	HRS Ra-226 increase in near-surface soil of 3 pCi/g	HRS terrestrial gamma radiation increase of 20 μR/hr above background	External exposure	The ICRP recommended an allowable whole body equivalent dose of 500 mrem/yr to any individual in the general public. This includes the dose expected from nuclear power plants (0.03 mrem/yr) and the doses from consumer products (smoke alarms, watch dials, etc.) estimated to be 3 mrem/yr. Excluded from this dose are contributions from the healing arts (medical uses) and occupational exposure. These contributions are either addressed by other standards or considered not applicable to the general public. The primary dose of 500 mrem/yr, minus the small fraction attributed to nuclear power plants and consumer products, has been apportioned to the various pathways to which the general public can be expected to be exposed. Secondary and tertiary guidelines were then established to limit exposure to levels that will assure that the primary dose-related guideline is not exceeded.
External gamma radiation level 24.4 - 25.2 μR/hr (background + 20 μR/hr)				
Potable water standard of 5 pCi/l Ra-226	EPA drinking water standard of 5 pCi/l[4]	ICRP annual intake of 20 pCi/day of Ra-226	Ingestion (primarily Ra-226)	
Daily intake from foodstuff of 10 pCi/day Ra-226	Intake from foodstuff (crops, fish, etc.) limited to 10 pCi/day[4]			
Inhalation exposure of 0.011 working levels (background + 0.01 working levels)		HRS exposure to 0.01 working levels in addition to background	Inhalation (primarily Rn-222 decay products)	

[1]Tertiary guidelines were established as a means to assure compliance with secondary guidelines.
[2]Secondary exposure or concentration-based guidelines were established as a means to assure compliance with the primary dose-related guidelines.
[3]Primary guideline of 500 mrem/yr maximum whole body dose established by the International Commision on Radiation Protection (ICRP).
[4]Drinking water standard based on intake of 2 liters per day of water with 5 pCi/l Ra-226 (10 pCi/day intake); intake remaining for other foodstuffs is 10 pCi/day to satisfy secondary guideline of 20 pCi/day annual average intake.

support facilities; a total of 18,496 acres will be reclaimed. Approximately 9300 of these acres have been previously mined and, thus, are unrelated to the 9183 acres to be mined under Alternative A.

The FDNR regulations and HRS radiation guidelines apply to the difference between the virgin state of the lands and the final reclaimed state regardless of when the lands were mined. The reclaimed acreage, therefore, was used to analyze the radiological impacts of the four mining alternatives.

6.7.2.1 Changes in Soil Radium Levels

The concentration of Ra-226 in the 0-6 ft soil layer is an important radiological characteristic of an area, as the decay of Ra-226 is responsible for the Rn-222 flux from the surface of the soil and, hence, the contribution of Rn-222 to the atmosphere or to structures built on the land.

The Ra-226 concentration in the 0-6 ft layer of soil, multiplied by the area of land represented by that concentration and other related factors, is equal to the total Ra-226 content of the 0-6 ft soil layer in a defined area. This can be represented mathematically as:

$$C = \sum_{i=1}^{n} (c_i)(d_i)(t)(A_i)(k1)(k2)$$

where:

- C = Ra-226 concentration in the 0-6 ft soil layer of the mining site (pCi/g),
- i = each of the specific land types that will exist after reclamation,
- c_i = Ra-226 concentration in the 0-6 ft soil layer for land type i (pCi/g),
- d_i = bulk density of the soil for land type i (g/ft^3),
- t = thickness of the soil strata (ft) which in this case is 6 ft,
- A_i = area of land type i (acres),
- $k1$ = conversion factor (ft^2/acre), and
- $k2$ = conversion factor (c_i/pCi).

As the second, third, fifth, and sixth terms in the equation are constant, the average soil Ra-226 concentration can be represented by the simplified equation:

$$C = \sum_{i=1}^{n} (c_i)(A_i)(K)$$

where:

$$K = (k1)(k2)(t)(d_i)$$

This concentration, which will be referred to as the Ra-226 parameter, is proportional to the soil Ra-226 concentration and the area involved. This parameter was used to evaluate area-wide changes in one of the radiological characteristics affected by mining.

Because the average Ra-226 concentration in each land type has been established for the OXY area (Table 6.7-1) and the acreages involved in each mining alternative are known, the Ra-226 parameter can be calculated for pre-mined and reclaimed areas under each mining alternative. In addition, an "allowable" Ra-226 parameter can be calculated by multiplying the OXY site-specific Ra-226 guideline in Table 6.7-3 (20 pCi/g) by the total land area reclaimed under each mining alternative.

The change in the Ra-226 parameter between pre-mined and reclaimed states represents the change in the near-surface Ra-226 content of the soil, while the allowable Ra-226 parameter provides a comparison of pre- and post-mining Ra-226 levels with the proposed HRS guideline. The allowable Ra-226 is utilized only to demonstrate the relative impact of each mining alternative, fully recognizing that no reclaimed land areas will have Ra-226 levels in excess of the 20 pCi/g guideline established for the OXY site, based on a proposed HRS guideline. It should also be recognized that no land areas will have Ra-226 levels that will exceed levels currently existing in reclaimed areas at the OXY site.

6.7.2.2 Terrestrial Gamma Radiation

The redistribution of radioactivity in the soil after mining and reclamation will alter terrestrial gamma radiation levels as it modified soil Ra-226 concentrations. The HRS secondary gamma guideline of 20 μR/hr over background (Table 6.7-3) was used to establish a proposed allowable gamma radiation guideline for the OXY site. The background terrestrial gamma radiation level was found to average 5.2 μR/hr over upland areas and 4.4 μR/hr over wetland areas at the OXY site (Section 3.7.6). Thus, the proposed allowable terrestrial gamma radiation guideline for the OXY mining area will range between 24.4 and 25.2 μR/hr for reclaimed areas.

Typical gamma radiation levels for various types of reclaimed lands in the OXY mining area have been measured and all have been found to be less than 24.4-25.2 μR/hr, generally less than half of these levels. The measured levels, which will be typical of levels over lands OXY reclaims in the future, have been used to calculate a gamma parameter which will provide a quantitative measure of the change in terrestrial gamma radiation levels for different mining alternatives and a comparison of altered gamma levels with the HRS secondary guideline.

The gamma parameter is defined as the summation of the products of land area (acres) and the gamma radiation level (μR/hr) that exists over that particular type of land. The development of this parameter is analogous to the development of the Ra-226 parameter described in Section 6.7.2.1.

6.7.2.3 Waterborne Radioactivity

There is a potential for changes in radioactivity in water resulting from the various mining alternatives. Changes of concern are changes in levels of dissolved radionuclides, rather than the suspended fractions, as the dissolved fractions can be assimilated by the biological media if present in surface water and can be ingested by humans if present in surface water or groundwater. Measurements in areas where OXY has previously mined and reclaimed indicate no elevated levels of radionuclides in surface water or groundwater, demonstrating that mining practices employed by OXY adequately protect water quality. These practices, which are typical of practices employed by the industry for over ten years, will be employed during all future OXY mining to insure that surface water and groundwater will continue to be protected.

6.7.2.3.1 Surface Water

Gross beta, gross alpha, and Ra-226 concentrations were found to be low in three categories of surface waters on the OXY site: 1) waters of unaffected areas, 2) waters impacted to some extent by runoff from mined and/or reclaimed areas, and 3) recirculating waters and reclaimed lakes (Section 3.7.8). The data indicated, however, a trend toward increasing concentrations of radioactivity in waters as one progressed from waters in unaffected areas to the reclaimed lakes.

The surface water data for the unaffected areas yielded a background Ra-226 level of 0.15 pCi/l (Table 3.7-21, Section 3.7.8). The concept of distribution coefficients (Table 3.7-26, Section 3.7.8) describes the relationship between Ra-226 concentrations in various land types and associated surface waters. Hence, these coefficients can be used to estimate the Ra-226 concentration of surface runoff and lakes after reclamation, taking into account the change in land type distribution brought about by mining and reclamation. The change in activity between background levels and the reclaimed state, once quantified, can be used to evaluate the relative impacts of the various mining alternatives.

In order to compare the mining alternatives, an average surface water Ra-226 concentration for each alternative can be defined as:

$$SW = \frac{\sum_{i=1}^{n} [C_i A_i k3/Kd_i]}{\sum_{i=1}^{n} A_i}$$

where:

SW = weighted surface water concentration of Ra-226 (pCi/l)

C_i = Ra-226 concentration in the 0-1 ft soil layer of land type i (pCi/g),

Kd_i= distribution coefficient for land type i (ml/g),

k3 = conversion factor (10^3 ml/l),

A_i = area of land type i (acres), and

i = the particular land type.

The maximum impact is considered to be demonstrated by the distribution coefficient of 10,000 ml/g for recirculating waters and reclaimed lakes (Table 3.7-26). Thus, the above equation reduces to:

$$SW = \frac{0.1 \sum_{i=1}^{n} C_i A_i}{\sum_{i=1}^{n} A_i}$$

Only two values for C_i will be utilized: 3.7 pCi/g for elevated fill and tailings areas and 6.7 pCi/g for land and lake areas.

The background concentration of Ra-226 in water and the concentration following reclamation for each mining alternative can be evaluated by comparison to a guideline for soil and terrestrial gamma radiation. The level of Ra-226 in water selected for this comparison is the 5.0 pCi/l drinking water standard established by EPA.

6.7.2.3.2 Groundwater

Radioactivity in groundwater is more complex than in surface water as the mechanisms that produce various levels of naturally occurring radionuclides in groundwater are not well known. The chemical and physical state of the strata, the chemical and physical state of the water (both the interstitial and that moving within the void spaces), and the concentrations of radionuclides within the solid phase all play an important role in the solubility of individual species in groundwater.

A number of factors have indicated extreme insolubility of most of the individual radionuclides. These factors include the measured equilibrium of the series in natural strata, observed equilibrium of the uranium series in clays, tailings, and rock following the extreme environment of the beneficiation plant, and well-established low chemical solubility coefficients of certain of the species. Levels of radioactivity in groundwater are, however, generally higher than levels in surface water (Section 3.7.8).

For the purpose of evaluating levels of radioactivity in groundwater, the average baseline concentration of Ra-226 will be taken as 0.94 pCi/l in the Surficial Aquifer and 0.30 pCi/l in the Floridan Aquifer, both based on measured values. The levels of activity in the waters of deep aquifers are thought to be dictated by the concentrations of radionuclides in the deeper Hawthorn formations and are thought to be relatively unaffected by activities in the near-surface strata. For the planned mining operations, there is a very low probability that any alternative will result in a significant increase in deep aquifer concentrations of radionuclides.

There is a greater potential for an increase in levels of radioactivity in the near-surface groundwater formations. For the purposes of developing a relative impact assessment, the following assumptions are made for evaluating the change in Ra-226 in the Surficial Aquifer: 1) the maximum distribution coefficient is 60,000 ml/g (because observed levels of radioactivity in groundwaters are generally 6X that of surface waters), 2) after reclamation, the major contribution to the Surficial Aquifer will be the reclaimed lakes (weighted by 2X the acreage), and 3) the baseline value for Ra-226 in the Surficial Aquifer is 0.94 pCi/l. These "worst case" assumptions and the procedure outlined for evaluating Ra-226 levels in surface water will be used to predict a maximum weighted average Ra-226 concentration in the Surficial Aquifer for each mining alternative. It is further assumed that other radionuclides in the uranium series will behave similar to Ra-226, as discussed in previous sections.

6.7.2.4 Airborne Radioactivity

Because present mining activities have been observed to have no significant impact on airborne particulate matter levels, it follows that any future mining, either in wetlands or uplands, will have no significant impact on either total airborne particulate matter or on airborne radioactive particles.

Potential impacts of mining on airborne radioactivity include changes in the concentration of radioactive particles, resulting from the entrainment of fugitive dust particles in the air, and changes in the concentration of Rn-222, a noble gas, in the atmosphere. The latter change would result if the near-surface soil levels of Ra-226 were significantly increased. Ambient air measurements at the OXY site have shown that the mining activities presently practiced have no significant impact on ambient particulate matter levels; the measured levels approach background levels in the state (Section 3.5).

The impact of mining on Rn-222 concentrations is potentially of more concern because of the modified radioactivity profile in the soil and the increase in Ra-226 in the near-surface soil of most reclaimed lands. The effect of changes in the Rn-222 concentration is addressed by guidelines for soil Ra-226 levels, as the Ra-226 levels are more easily measured (Section 6.7.2.1).

6.7.2.5 Radionuclide Uptake by Crops

Radiological uptake in crops is a function of many parameters, including the chemical nature of the radionuclide, soil characteristics, the concentration of the radionuclide in the topsoil, the crop type, the calcium concentration of the soil, and the demand for divalent cations by the crop. For naturally occurring radionuclides, the characteristics of the system tend to discriminate against uptake.

The data in Section 3.7.9 demonstrate little radionuclide uptake by aquatic species and crops; hence no evidence exists that would predict significant transport of naturally occurring radionuclides found in reclaimed areas to man.

6.7.2.6 Occupational Exposures

The potential for occupational exposures in the mining of phosphate has been addressed by Prince (1977). Specific data for the north Florida area were evaluated during the preparation of the EIS for the Swift Creek Chemical Complex at OXY (EPA 1978). Mining and wet rock operations, including dragline areas, beneficiation plants, wet rock storage piles, and tunnels, were investigated. Levels of airborne radioactivity associated with mining activities were all below applicable occupational exposure standards. Continued mining at OXY will not change the conclusion of the earlier investigation--that occupational radiation exposure is not a problem.

6.7.3 Mining Alternatives

Mining under Alternative A may proceed regardless of the approval for mining wetlands, as Alternative A addresses only the mining of uplands. The impacts of this alternative, therefore, are the baseline against which the impacts of the other mining alternatives are to be measured.

Several environmental modifications will result from all of the mining alternatives. First, the near-surface radioactivity will be changed. In the virgin condition, the radioactivity is low at the surface and increases to just above, or within the mineable matrix. After reclamation, the final radiation profile will be more or less uniform with depth. Reclamation can therefore be expected to increase near-surface radioactivity, terrestrial gamma radiation, and radon flux from the soil surface. Second, surface water and shallow groundwaters will be in contact with near-surface materials of higher radioactivity. Third, the overall impact is altered by the mix of land types that existed before mining and that will exist after reclamation.

The assignment of radiological parameters to each alternative is an attempt to demonstrate the relative overall impacts of each alternative. Specific impacts are normally not manifest until some future action, e.g., after a home and water well are placed on a specific piece of land or an area is used for a pasture or other agricultural use. Regardless of the altered distribution of radionuclides after mining and reclamation, the near-surface levels of radionuclides and other radiological parameters will be below levels established by applicable guidelines and standards and below levels in many natural lands.

6.7.3.1 Alternative A: No Mining or Mine Support in Wetlands

Environmental impacts are discussed with respect to the near-surface concentration of Ra-226, terrestrial gamma radiation, and surface and groundwater levels of radioactivity. Short-term impacts from airborne radioactivity, uptake by crops, and occupational radiation exposure are negligible and do not require further discussion (Sections 6.7.2.4 through 6.7.2.6).

Near-Surface Radioactivity. The Ra-226 parameters were calculated for the 18,496 acres of reclaimed area using the Ra-226 concentrations for the various land types discussed in Section 6.7.2.1 and the land type distributions existing prior to mining and after reclamation. These Ra-226 parameters are compared to the OXY site-specific guideline for Ra-226 concentration in near-surface soil (Table 6.7-3):

Description of Condition (18,496 acres reclaimed)	Radium Parameter (pCi-acre/g)
Pre-mining or virgin state	20,300
Reclaimed land (average)	97,000
OXY site-specific guideline	370,000

As a point of reference, the radium parameter for 18,500 acres of central Florida reclaimed overburden ranges up to 133,000 pCi-acre/g.

Terrestrial Gamma Radiation. Gamma parameters were calculated for the mining areas for pre-mined and post-mined land type distribution. A gamma parameter was also calculated for the mining area using the OXY site-specific guideline for terrestrial gamma radiation (Table 6.7-3):

Description of Condition (18,496 acres reclaimed)	Gamma Parameter (μR-acre/hr)
Pre-mining or virgin state	96,200
Reclaimed land (average)	185,900
OXY site-specific guideline	460,000

In general, the natural background terrestrial gamma radiation level for central Florida is about 7 μR/hr. Mined and reclaimed areas often have terrestrial gamma radiation levels twice the background level. Thus, the 18,496 acres, if in central Florida, would have a reclaimed gamma parameter of about 260,000 μR-acre/hr.

Surface Water Radioactivity. The predicted weighted surface water Ra-226 concentration for Alternative A compares to the background level and the EPA drinking water standard as follows:

Description of Condition (18,496 acres reclaimed)	Surface Water Ra-226 (pCi/l)
Pre-mining or virgin state	0.15
Reclaimed land (average)	0.49
Drinking water standard	5.00

The increase in the surface water concentration of Ra-226 resulting from mining and reclamation produces a concentration that is in the range of other natural waters in the U.S. and is 16X lower than the standard for drinking water.

Groundwater Radioactivity. The maximum predicted Surficial Aquifer Ra-226 level after mining and reclamation can be compared to the unmined levels and the EPA drinking water standard as follows:

Description of Condition (18,496 acres reclaimed)	Groundwater Ra-226 (pCi/l)
Pre-mining or virgin state	0.97
Reclaimed land (average)	3.0
Drinking water standard	5.0

The predicted increase in the Surficial Aquifer water concentration of Ra-226 is about threefold; however, the maximum level is only 60% of the drinking water standard.

For both the calculation of Ra-226 in surface water and the shallow aquifer, no credit has been given for dilution with non-impacted waters of lower activity. The predicted impacts, therefore, represent worst-case conditions.

6.7.3.2 Alternative B: Mining All Wetlands Containing Reserves

Near-Surface Radioactivity. For Alternative B, the Ra-226 parameter, a measure of the amount of Ra-226 in the 0-6 ft soil layer, was estimated using the Ra-226 concentrations for various land types discussed in Section 6.7.1.1 and the land type distributions prior to mining and after reclamation. The Ra-226 parameters are compared to the site-specific OXY guideline for Ra-226 concentration in near surface soils (Table 6.7-3):

Description of Condition (38,851 acres reclaimed)	Radium Parameter (pCi-acre/g)
Pre-mining or virgin state	42,700
Reclaimed land (average)	198,400
OXY site-specific guideline	777,000

Terrestrial Gamma Radiation. The gamma parameter, as described in Section 6.7.2.2, was calculated for the mining area both under pre-mined conditions and after reclamation. A gamma parameter was also calculated for the mining area using the OXY site-specific guidelines for terrestrial gamma radiation levels (Table 6.7-3):

Description of Condition (38,851 acres reclaimed)	Gamma Parameter (μR-acre/hr)
Pre-mining or virgin state	190,000
Reclaimed land (average)	394,000
OXY site-specific guideline	967,000

Surface Water Radioactivity. The predicted maximum weighted surface water Ra-226 concentration for Alternative B compares to the background condition and the EPA drinking water standard as follows:

Description of Condition (38,851 acres reclaimed)	Surface Water Ra-226 (pCi/l)
Pre-mining or virgin state	0.15
Reclaimed land (average)	0.48
Drinking water standard	5.00

The increased surface water concentration of Ra-226 is within the range of concentrations found in other natural waters in the U.S. and 10X lower than the EPA standard for drinking water.

Groundwater Radioactivity. The maximum predicted Surficial Aquifer Ra-226 concentration for Alternative B can be compared to unmined conditions and the EPA drinking water standard as follows:

Description of Condition (38,851 acres reclaimed)	Groundwater Ra-226 (pCi/l)
Pre-mining or virgin state	0.97
Reclaimed land (average)	2.90
Drinking water standard	5.00

The predicted increase in the Surficial Aquifer water concentration of Ra-226 is at most threefold; however, these "worst-case" levels have not been observed in other mined areas. Also, the predicted levels are much lower than the EPA drinking water standard of 5 pCi/l.

For both the surface water and shallow aquifer Ra-226 concentration calculations, no credit has been given for dilution with non-impacted waters of lower activity.

6.7.3.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Near-Surface Radioactivity. Ra-226 parameters were calculated for the mining areas using the Ra-226 concentrations for the various land types as discussed in Section 6.7.2.1 and the land type distributions prior to mining and after reclamation. These Ra-226 parameters are compared to the parameter representing the OXY site-specific guideline for Ra-226 concentration in the surface soil (Table 6.7-3):

Description of Condition (26,890 acres reclaimed)	Radium Parameter (pCi-acre/g)
Pre-mining or virgin state	29,600
Reclaimed land (average)	140,800
OXY site-specific guideline	537,800

Terrestrial Gamma Radiation. Changes in the terrestrial gamma radiation level were evaluated by calculating the gamma parameter for mining areas under pre-mined conditions and post-reclamation conditions. The gamma parameter was also calculated using the OXY site-specific guideline for terrestrial gamma radiation levels (Table 6.7-3):

Description of Condition (26,890 acres reclaimed)	Gamma Parameter (μR-acre/hr)
Pre-mining or virgin state	130,800
Reclaimed land (average)	272,000
OXY site-specific guideline	672,000

Surface Water Radioactivity. The predicted maximum surface water Ra-226 concentration for Alternative C compares to the background level and the EPA drinking water standard as follows:

Description of Condition (26,890 acres reclaimed)	Surface Water Ra-226 (pCi/l)
Pre-mining or virgin state	0.15
Reclaimed land (average)	0.49
Drinking water standard	5.00

The increase in the surface water concentration of Ra-226 results in a level that is in the range of other natural waters in the U.S. and is 10X lower than the EPA standard for drinking water.

Groundwater Radioactivity. The Alternative C maximum Ra-226 concentration for the Surficial Aquifer can be compared to unmined conditions and the EPA drinking water standard as follows:

Description of Condition (26,890 acres reclaimed)	Groundwater Ra-226 (pCi/l)
Pre-mining or virgin state	0.97
Reclaimed land (average)	3.0
Drinking water standard	5.0

As with the previous two mining alternatives, there is a predicted maximum increase in the Ra-226 concentration in the Surficial Aquifer of about 3X. The predicted level, which is below the drinking water standard, is a "worst-case" level that has not been observed in existing mining areas.

6.7.3.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Near-Surface Radioactivity. The increase in radioactive materials in the near-surface soil is evaluated by calculating the Ra-226 parameter for mining areas under pre-mined and post-reclamation conditions. Also, a radium parameter representing the OXY site-specific guideline for allowable Ra-226 concentrations in near-surface soil was calculated:

Description of Condition (36,298 acres reclaimed)	Radium Parameter (pCi-acre/g)
Pre-mining or virgin state	39,900
Reclaimed land (average)	187,700
OXY site-specific guideline	726,000

Terrestrial Gamma Radiation. Gamma parameters were calculated for the mining areas to evaluate the impact on terrestrial gamma radiation levels resulting from mining and reclamation activities under Alternative D. A gamma parameter was also calculated using the OXY site-specific guideline for terrestrial gamma radiation levels (Table 6.7-3):

Description of Condition (36,298 acres reclaimed)	Gamma Parameter (μR-acre/hr)
Pre-mining or virgin state	172,700
Reclaimed land (average)	368,000
OXY site-specific guideline	903,000

Surface Water Radioactivity. Because the area of land affected under Alternative D falls between that affected under Alternatives B and C, it follows that the impact of Alternative D will be similar to the impacts predicted for Alternatives B and C.

Groundwater Radioactivity. Because the area of land affected under Alternative D falls between that affected under Alternatives B and C, it follows that the impact of Alternative D will be similar to the impacts predicted for Alternatives B and C.

6.7.4 Conclusions and Summary

The magnitude of the radiological impacts resulting from the four mining alternatives will be identical to the radiological impacts that have resulted from previous OXY mining. These impacts are well within applicable guidelines and proposed standards and are similar in magnitude to naturally occurring levels of radioactivity in other areas of the U.S. Only the extent of the impacts will vary under the four mining alternatives, the maximum extent of impact occurring with mining of the maximum number of acres (Alternative B). Mining under Alternative A will occur regardless of whether a permit is issued for wetlands mining, as Alternative A addresses only uplands mining. The radiological impacts to be addressed, therefore, are those resulting from the increased extent of the radiological impacts of the other mining alternatives.

In this evaluation it was found that the radiological impacts of the four mining alternatives were not proportional to the affected land areas under each alternative. Table 6.7-4 demonstrates the relative radiological impacts resulting from Mining Alternative A. The radium parameter of reclaimed lands represents an approximately four-fold increase in the near-surface radioactivity. The gamma parameter in Alternative A is 93% higher than pre-mining background levels, i.e., the average terrestrial gamma radiation level over the reclaimed lands will be about 2X the level over virgin lands. The third column in Table 6.7-4 illustrates that the radiological parameters of reclaimed lands will be well within all site-specific radiological guidelines derived from EPA and proposed HRS standards.

Table 6.7-5 compares the additional benefits (additional acreages of mined reserves) and the increased impacts for the three mining alternatives that involve wetlands mining. All benefits and impacts are measured against the baseline alternative (Alternative A). The first set of data in Table 6.7-5 summarizes the increase in acreage of mineable land. This is considered the benefit. The second set of data illustrates the relative impacts of each wetlands mining alternative. Clearly, each wetlands mining alternative produces an increase in the extent of the radiological impact over the impact resulting from Alternative A; however, the increases are not proportional to the additional reserves made available under Alternatives B, C, and D.

Alternative B results in the mining of all available reserves, 183% more acreage than Alternative A. On an absolute scale, this alternative has the greatest impact. The analysis in Table 6.7-5, however, indicates that the increase in benefit (from A to B) is greater than the increase in the radiological impact parameters (radium and gamma), i.e., Alternative B allows for mining about 3X more reserves than Alternative A but produces only about 2X the impact. The impacts on surface water and groundwater are similar for Alternatives A and B.

Alternative C results in the mining of about 82% more land than Alternative A; however, the Ra-226 and gamma impacts show only a 45-46% increase over those of Alternative A. The impacts on surface water and groundwater are similar.

Alternative D results in the mining of 163% more reserves than in Alternative A; however, the impact parameters (Ra-226 and gamma) are only doubled (94-97% increase) over those in Alternative A. Surface water and groundwater impacts are similar.

It is apparent that the extent of the radiological impact is not proportional to the number of acres mined and reclaimed. Thus, from a radiological point of view, there is no justification for not using Alternative B once the decision to mine under Alternative A is made.

In summary, the findings of this impact analysis are:

1) All radiological parameters are predicted to be well within applicable standards and guidelines.

Table 6.7-4. Summary of Radiological Conditions Produced by Mining Under Alternative A.

Radiological Parameter	Percent Increase over Natural State[1]	Percent of Site-Specific Guidelines[2,3]
Ra-226 in soil	380	26
Terrestrial gamma	93	40
Ra-226 in surface water	230	10
Ra-226 in groundwater (surficial)	210	60

[1]Calculated by:

(Reclaimed level - Background level) x 100/Background level

[2]Calculated by:

(Reclaimed level/Guideline) x 100

[3]Guidelines for Ra-226 in soil and terrestrial gamma radiation are based on proposed HRS standards. Guideline for surface water and groundwater is EPA drinking water standard.

Table 6.7-5. Summary of Radiological Impacts of Alternatives B, C, and D Relative to Alternative A.

Parameter	Percent Increase Over the Level in Alternative A*		
	Alternative B	Alternative C	Alternative D
Benefit			
Mineable areas	183	82	163
Impacts			
Ra-226 in soil	104	45	94
Terrestrial gamma	111	46	97
Ra-226 in surface water	No change	No change	No change
Ra-226 in ground-water	No change	No change	No change

*Calculated by:

(Alternative X impact - Alternative A impact) x 100/Alternative A impact

2) For every mining alternative and radiological parameter, there are increases in the extent of radiological impacts due to mining and subsequent reclamation.

3) Alternative A results in mining of the least acreage and therefore results in the radiological impact of the least extent. Alternative A will proceed regardless of approval for mining wetlands, as this alternative addresses only uplands mining.

4) Alternative B results in the mining and reclamation of the greatest acreage and therefore produces the radiological impact of the greatest extent.

5) On a relative scale, using mineable acreage as a measure of benefit and the changes in various radiological parameters and total land affected as the impact, mining Alternatives B, C, and D have a measureably lower impact per units of benefit than the baseline plan of Alternative A. Mining under either Alternative B, C, or D produces about equal environmental impact per unit of mineable resource.

6.7.5 Literature Cited

Ardaman and Associates, Inc. 1981. Radiation survey: Suwannee River and Swift Creek mines, Occidental Chemical Company, Hamilton County, Florida. Unpubl. report.

Prince, R.J. 1977. Occupational radiation exposure in the Florida phosphate industry. M.S. thesis, University of Florida, Gainesville.

U.S. Environmental Protection Agency (EPA). 1978. Draft environmental impact statement for proposed issuance of a new source National Pollutant Discharge Elimination System permit to Occidental Chemical Company Swift Creek Chemical Complex, Hamilton County, Florida. Resource Document Vols. I-IV. U.S. EPA Region IV, Atlanta. EPA-904/9-78-012-A,B,C,D.

6.8 Historical and Archaeological Resources

Based on the cultural resource assessment of the OXY project site and agency review of the area for archaeological site occurrence and significance, no adverse impacts on the historical and archaeological resources of the project site are predicted for any of the proposed alternatives.

The Florida Division of Archives, History and Records Management (FDAHRM) reviewed the OXY project area for locations of known archaeological sites in the vicinity of the project area and locales likely to contain presently unrecorded sites based on known site distribution. In their 23 October 1981 review letter, they recommended that such areas be subjected to a systematic archaeological site assessment survey. The letter further stated that the remainder of the tract covered by the permit has "only a low to moderate site occurrence potential, and the proposed mining activities in those areas are deemed unlikely to affect any sites listed, or eligible for listing, on the National Register of Historic Places, and may therefore proceed without further involvement with this agency." In accordance with these guidelines, all designated locales were subjected to field survey and assessed for historical importance (Section 3.8).

Thirteen new archaeological sites were discovered during the survey. Based on the findings of the field survey and testing, none of the sites or cultural resources is considered eligible for listing on the National Register on the basis of archaeological, historical, or architectural significance as specified by the criteria for inclusion on the National Register. Based on investigations of similar sites nearby, the OXY sites represent a common type archaeological site of which there are more intact examples elsewhere (pers. comm., Calvin Jones, Staff Archaeologist, FDAHRM). Due to their lack of cultural significance and their disturbed condition, none of the sites investigated is recommended for preservation or impact mitigation.

6.9 Socioeconomics

In accordance with the original long-term plans for the Hamilton County complex, 30,587 acres are proposed to be mined or disturbed including 9264 acres of ACOE-defined wetlands, over 21-26 years (Alternative B). If unable to proceed as planned, operations will be curtailed at the complex. Prohibition of wetlands mining (Alternative A) will decrease the life of the Hamilton County operation.

The company's original development plans were initiated in 1964, and the bulk of their phosphate reserves was acquired by 1975. The reserves are scheduled to support the Suwannee River Chemical Complex, constructed in 1966, and the Swift Creek Chemical Complex, constructed in 1979.

6.9.1 An Overview of Socioeconomic Impacts

Continued operation of the Hamilton County complex is of significance to the economy of Hamilton, Columbia, and Suwannee counties in northeast Florida as well as the State of Florida. For example, approximately 24% of all jobs in the three-county area are attributable directly or indirectly to OXY as are 36% of the total salary and wage incomes.

Socioeconomic impact evaluations are normally concerned with new facilities, the introduction of new employment, the subsequent increase that these jobs cause to population growth, and the resultant increased demands on public services such as education, public safety, health, and welfare, which ultimately have an impact on the public tax structure and social climate of the area. In contrast, this evaluation concerns an ongoing operation, and no alternative is anticipated to significantly increase employment.

The impacts presented here were computed using the methodology discussed in Section 3.9.1 developed by Burford and Katz (1977, 1981, 1985).

The mining and chemical processing operation employs 2150 workers at full employment and directly adds about $48,200,000 per year (in 1982 dollars and not including fringe benefits of about 30% of payroll) to the earned income of the three counties of immediate impact and other counties in north Florida. From the input-output model used in this study, it is estimated that each direct job at OXY's facilities adds 3.66 additional full-time equivalent indirect and induced jobs in Florida; 1.99 of these additional jobs are located within Columbia, Hamilton, and Suwannee counties (Tables 3.9-7 and 3.9-9, Section 3.9). In addition, for each dollar of direct salaries resulting from the OXY operation, an additional 2.68 dollars of indirect and induced income is generated in Florida. Approximately 1.09 dollars of this indirect and induced income is earned by people living within the three-county area, and the other 1.59 dollars is earned by people throughout Florida.

Under Alternative A, no wetlands would be mined or used for mine support activities. Thus, only those areas designated as uplands and containing reserves presently owned or leased by OXY will be mined (about 9183 acres). At full operating schedules under this alternative, all reserves currently identified as economic to mine will be depleted in 6 years at the Suwannee River Mine and 8 years at the Swift Creek Mine.

Under Alternative B, a total of 25,899 acres will be mined, including the 9183 acres in Alternative A and ACOE-defined wetlands. Under this alternative, mining of the Suwannee River Mine is expected to be completed in approximately 19 years and the Swift Creek Mine in approximately 24 years, assuming full production.

Based on engineering and economic studies, a loss of reserves under Alternative A will force a total shutdown of the mines and chemical complexes approximately 13-16 years early. Early mine-out of phosphate reserves will idle the fertilizer complexes unless phosphate raw material is purchased from some other location. However, even if 4 million tons were available in the marketplace, the anticipated additional cost of transportation and processing of purchased phosphate rock required for the fertilizer operation would erode the cash contribution made by these products. It is expected that this competitive disadvantage would force shutdown of all facilities.

6.9.2 Summary of Statewide and Local Impacts

The following economic impacts of the Hamilton County complex (Tables 3.9-7 and 3.9-9, Section 3.9) were computed based on direct annual OXY impacts on income of $48,200,000, on taxes of $15,400,000, revenues to Florida firms of $90,000,000, and full employment of 2150 (all dollar amounts are in 1982 dollars and cover direct, indirect, and induced impacts):

Total Annual Florida Impacts

1) On full-time equivalent jobs to Florida citizens - 10,023.

2) On incomes to Florida residents - $177,300,000.

3) On state taxes - $31,500,000.

4) On local taxes - $14,900,000.

5) On revenue to Florida firms - $348,500,000. This is net revenue to firms, excluding state and local taxes and salaries and wages. It represents that part of revenue which is used to purchase supplies, equipment, and materials, and for capital investments and profits.

6) Total on the State of Florida (excluding OXY sales) - $572,200,000. It should be noted that the methodology used is subject to a maximum error of about $50,000,000 in this estimate.

Total Annual Local Impacts

1) On full-time equivalent jobs for the residents of Columbia, Hamilton, and Suwannee counties - 6067 or about 24% of all employment in the three counties in 1980.

2) On incomes to the residents of Columbia, Hamilton, and Suwannee counties - $95,100,000 or some 28% of all earned income in the three counties in 1981 (36% of wage and salary income).

3) On local taxes in Columbia, Hamilton, and Suwannee counties - $6,200,000 or about 32% of all local government revenues in the three counties in the 1981-1982 fiscal year.

4) On revenue to local firms in Columbia, Hamilton, and Suwannee counties - $156,800,000. It represents the total revenues of area firms which result from OXY's operations, excluding salary and wage payments and state and local taxes.

5) Total on Columbia, Hamilton, and Suwannee counties (excluding OXY sales) - $276,300,000.

Under Alternative B, these levels of positive economic impacts can be expected to continue until the Suwannee River Mine is depleted 20 years in the future. At that time, the level of impact will be scaled back somewhat for approximately another 5 years. Under Alternative A, the present level of positive economic impacts can be expected to continue for only about 6-7 more years at full operation. The net result will be a loss of the measurable economic contribution outlined above for a period starting in about 7 years.

Thus, estimates from the input-output model used in the study are that Alternative A will result in a net loss (compared to Alternative B) of $2,352,808,000 in direct, indirect, and induced income to Florida residents, which includes $1,261,980,000 in income to residents of Columbia, Hamilton, and Suwannee counties. It would cost Florida residents 133,000 labor-years of work, including 80,510 labor-years of work for residents of Columbia, Hamilton, and Suwannee counties. As a result, it would cost Florida a total economic loss of $7,593,090,000, including a loss for Columbia, Hamilton, and Suwannee counties of $3,666,500,000.

The State of Florida would lose $418,005,000 in tax collections, and county and municipal governments would lose $197,723,000, including $82,274,000 in taxes to the county and city governments in Columbia, Hamilton, and Suwannee counties.

Other economic factors not considered above are:

- Revenues of >$130,000,000 a year to out-of-state firms and the feedback effects of those revenues through their expenditures in Florida.

- Capital improvement outlays of approximately $20,000,000 per year.

- Employee fringe benefits of about 30% of payroll and the multiplier effects of these on the economy (e.g., medical insurance payments to local medical firms and hospitals).

- Loss of potential retirement benefits.

- Federal taxes paid by OXY and those resulting from indirect and induced economic impacts and the feedback effects of federal expenditures in Florida.

- Economic effects of outmigration, reduced property values, and financial stress in the area.

- Increased costs of unemployment compensation, welfare payments, and social services.

- Loss of an export product for the U.S., thus negatively impacting the national balance of trade and decreasing the export volume in the Port of Jacksonville.

Based on these projections and the following detailed analyses, selection of the most restrictive alternative will create significant adverse economic impacts.

Under Alternative B, it is anticipated that mining will stop at the Suwannee River Mine after about 19 years and will continue at the Swift Creek Mine for an additional 5 years. Thus, shutdown of the operation will be phased to mitigate negative impacts. In addition, after mining and reclamation are completed, some level of activity will continue either in agriculture or redeveloping the land for other uses such as housing, given the projections for the north Florida area.

If Alternative B is chosen, many who now work at OXY will reach retirement age before the mines and plant are shut down. Many or perhaps most of these will remain after retirement, and these income impacts will not be lost in the area.

According to middle level population projections prepared by the Bureau of Economic and Business Research at the University of Florida, population of the three-county area is expected to increase from about 66,500 in 1980 to 96,400 in 2000 and 110,200 in 2010 (Table 6.9-1). Thus, it is projected that total employment in the three counties will grow from 26,300 in 1980 to about 42,000 in 2000 and 49,000 in 2010. Therefore, whereas OXY's direct employment represents about 8.2% of the total three-county employment in 1980, it will represent only 5.1% in 2000 and 4.4% in 2010. Similarly, while OXY's total employment impact of 6067 jobs represents 23% of all 1980 jobs in the area, it will represent about 16% of the projected jobs in 1990, 14% of the projected jobs in 2000, and 12% of the projected jobs in the year 2010. This means that the longer the facility is in operation, the less will be the negative impact at mine-out and the longer the economic benefits will be received.

Table 6.9-1. Projected Population and Employment in Columbia, Hamilton, and Suwannee Counties.

	Population				Employment
	Columbia	Hamilton	Suwannee	Three Counties	Three Counties
1975	30,900	8,800	19,700	59,400	23,000
1980	35,400	8,800	22,300	66,500	26,300
1985	39,600	8,800	25,800	74,200	30,000
1990	44,100	8,800	29,100	82,000	34,000
1995	48,400	9,100	32,100	89,600	38,000
2000	52,300	9,200	34,900	96,400	42,000
2010	59,800	10,500	39,900	110,200	49,000

Source: Florida Statistical Abstract 1983. Employment projections by Economic and Industrial Research, Inc. based on historical relation to population.

6.9.3 Analysis of the Alternatives

Of the four alternatives, Alternative B will have the greatest positive economic impact on Florida and the three-county impact area. Alternative A will have the most negative economic impacts.

Alternative C (Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves) will result in shutdown of the OXY operations approximately 6.5-7.5 years earlier than Alternative B, and Alternative D (Mining in Areas Requiring Only ACOE Permits) will result in shutdown approximately 1.0-2.5 years earlier than Alternative B.

The positive economic impacts of all four Alternatives are shown in Table 6.9-2, and the net negative impacts of Alternatives A, C, and D relative to Alternative B are shown in Table 6.9-3.

Each year of full operation of the complex stimulates approximately $572 million in total economic activity in Florida, including about $276 million in the three-county impact area. This results in about $177.7 million in income to people in Florida, including $95.1 million in income to people who live within Columbia, Hamilton, and Suwannee counties. Approximately $45 million of OXY's direct payroll is included within this $95.1 million, but about $50 million results from the extra business stimulated by OXY and the expenditures of this $45 million within the three counties.

In addition, each year of full operation of the facilities results in over 10,000 full-time equivalent jobs (over 6000 in Columbia, Hamilton, and Suwannee counties), $31.5 million of state tax collections ($13.9 million paid directly by OXY), and $14.9 million in county and city tax collections throughout Florida ($6.2 million to Columbia, Hamilton, and Suwannee counties).

Alternative B would result in an equivalent of about 20 additional years of full operation of the complex from 1984 (Table 6.9-2). The complex would actually operate at full capacity less than 20 years but could be anticipated to operate at a reduced level for several more years. This would mean that the total impact of Alternative B on Florida and the three-county area over the remainder of the lifetime of the complex would be:

Alternative B Impacts	Statewide	Three Counties
Jobs (labor-years)	200,159	121,158
Revenues to Florida firms	$6,951,522,000	$3,131,292,000
Incomes to people	3,548,670,000	1,899,150,000
State taxes	629,055,000	363,454,000
County and municipal taxes	297,553,000	123,814,000
Total impact	$11,426,800,000	$5,517,710,000

Table 6.9-2. Total Direct, Indirect, and Induced Measurable Positive Economic Impacts of Four Alternatives.

Type of Impact	Statewide	Local
Annual Impacts		
Jobs (labor-years)	10,023	6,067
Revenues to Florida firms	$348,500,000	$156,800,000
Incomes to people	177,300,000	95,100,000
State taxes	31,500,000	18,200,000
Local taxes	14,900,000	6,200,000
Total impact	$572,200,000	$276,300,000
Alternative A: Equivalent to approx. 7 Years of Full Operation		
Jobs (labor-years)	67,154	40,649
Revenues to Florida firms	$2,332,270,000	$1,050,560,000
Incomes to people	1,190,590,000	637,170,000
State taxes	211,050,000	121,940,000
Local taxes	99,830,000	41,540,000
Total impact	$3,833,740,000	$1,851,210,000
Alternative B: Equivalent to approx. 20 Years of Full Operation		
Jobs (labor-years)	200,159	121,158
Revenues to Florida firms	$6,951,522,000	$3,131,292,000
Incomes to people	3,548,670,000	1,899,150,000
State taxes	629,055,000	363,454,000
Local taxes	297,553,000	123,814,000
Total impact	$11,426,800,000	$5,517,710,000
Alternative C: Equivalent to approx. 13.5 Years of Full Operation		
Jobs (labor-years)	135,311	81,905
Revenues to Florida firms	$4,699,350,000	$2,116,800,000
Incomes to people	2,398,950,000	1,283,850,000
State taxes	425,250,000	245,700,000
Local taxes	201,150,000	83,700,000
Total impact	$7,724,700,000	$3,730,050,000
Alternative D: Equivalent to approx. 18.5 Years of Full Operation		
Jobs (labor-years)	185,426	112,240
Revenues to Florida firms	$6,439,850,000	$2,900,800,000
Incomes to people	3,287,450,000	1,759,350,000
State taxes	582,750,000	336,700,000
Local taxes	275,650,000	114,700,000
Total impact	$10,585,700,000	$5,111,550,000

Table 6.9-3. Total Negative Impact of Selecting Alternatives A, C, or D Rather than Alternative B.

Type of Impact	Statewide	Local
Alternative A: Equivalent to approx. 13 Years of Full Operation		
Jobs (labor-years)	133,000	80,510
Revenues to Florida firms	$4,691,282,000	$2,080,732,000
Incomes to people	2,358,080,000	1,261,980,000
State taxes	418,005,000	241,514,000
Local taxes	197,723,000	82,274,000
Total impact	$7,593,090,000	$3,666,500,000
Alternative C: Equivalent to approx. 6.5 Years of Full Operation		
Jobs (labor-years)	64,849	39,254
Revenues to Florida firms	$2,252,202,000	$1,014,495,000
Incomes to people	1,149,720,000	615,297,000
State taxes	203,805,000	117,754,000
Local taxes	96,403,000	40,114,000
Total impact	$3,702,130,000	$1,787,660,000
Alternative D: Equivalent to approx. 1.5 Years of Full Operation		
Jobs (labor-years)	14,734	8,918
Revenues to Florida firms	$511,707,000	$230,496,000
Incomes to people	261,219,000	139,797,000
State taxes	46,305,000	26,754,000
Local taxes	21,903,000	9,114,000
Total impact	$841,134,000	$406,161,000

By contrast, selection of Alternative A would mean that the complex would continue for an equivalent of approximately 7 years of full operation. Thus, under Alternative A, the total impact of the complex over this shorter lifetime would be:

Alternative A Impacts	Statewide	Three Counties
Jobs (labor-years)	67,154	40,649
Revenues to Florida firms	$2,332,270,000	$1,050,560,000
Incomes to people	1,190,590,000	637,170,000
State taxes	211,050,000	121,940,000
County and municipal taxes	99,830,000	41,540,000
Total impact	$3,833,740,000	$1,851,210,000

This means that under Alternative A, Florida and the three-county impact area would experience a net loss of the benefits of approximately 13 years of full operation of the complex. Table 6.9-3 summarizes these losses for Alternatives A, C, and D relative to Alternative B.

For example, if Alternative A is chosen, the net economic loss to Florida and the three-county area would be:

Difference (A vs B)	Statewide	Three Counties
Jobs (labor-years)	133,000	80,510
Revenues to Florida firms	$4,619,282,000	$2,080,732,000
Income to people	2,358,080,000	1,261,980,000
State taxes	418,005,000	241,514,000
County and municipal taxes	197,723,000	82,274,000
Total negative impact	$7,593,090,000	$3,666,500,000

For local area perspective, a total loss of $3,666,500,000 is equivalent to cessation of all business in the area for almost 4 years (Table 6.9-4). Similarly, it would be equivalent to 100% unemployment in the three counties for approximately 3 years and the loss of all local government revenues and earned incomes of all people for approximately 4 years.

6.9.4 Impacts on Individual Counties

Without more detailed information it is not possible to evaluate precisely what the impacts of the alternatives will be on individual counties. One approach would be to allocate the total impacts proportionally to the place of residence of OXY's employees. This, however, would understate the impact that would be felt by Columbia County and overstate the effects on Hamilton County. It is more likely that the impact would be felt approximately in proportion to the total economic activity in the three counties. Columbia County, being the commercial hub of the area, would be expected to feel a larger share of the total impacts than the proportion of OXY employees living there would indicate.

Table 6.9-4. Economic Losses to the Three-County Area Compared to Current Levels.

Type of Impact	Alternatives (Total over Period of Loss)			Annual Actual Current Levels*
	A	C	D	
Jobs (labor-years)	80,510	39,254	8,918	25,763
Revenues to Florida firms	$2,080,732,000	$1,014,495,000	$230,496,000	-
Incomes to people	1,261,980,000	615,297,000	139,797,000	332,680,000
Local taxes	82,274,000	40,114,000	9,114,000	19,168,000
Total impact	$3,666,500,000	$1,787,660,000	$406,161,000	$1,005,146,000

*The sales and income data are for 1981 and employment is for 1980. The local tax is really local government revenue from all sources (not just taxes) for fiscal year 1981-1982.

Thus, whichever alternative is selected, the impacts will be of about equal relative magnitude in all three counties. Hamilton County is more directly affected than either of the other counties in terms of local tax collections. But the other two, especially Columbia County, will be more heavily affected in absolute terms with respect to sales of businesses, income, and employment.

6.9.5 Other Impacts

6.9.5.1 Retail and Service Businesses

Losses in business, especially under Alternatives A and C, will be certain to result in a weakening of retail and service businesses in the area unless the loss of the OXY operation can be replaced by another employer.

6.9.5.2 Housing

The estimated loss of the large share of jobs in the area will result in a sharp increase in the number of housing units for sale or rent as people move out of the area in search of jobs. The increased supply of housing on the market relative to demand will likely decrease residential property values and make housing difficult or impossible to sell or rent at any price. Thus, many people will lose much of the equity that they have acquired in their homes, possibly even selling them for a loss.

6.9.5.3 Financial Institutions

Workers generally maintain a level of debt commensurate with their earning power. A large-scale layoff will affect their timely repayments of installment and consumer loans, as well as home mortgages. Also, reduced time and demand deposits are anticipated. No single major financial institution that might be significantly affected by a large-scale layoff has been identified, except the local federal credit union which has $2.5 million of outstanding loans to OXY employees.

6.9.5.4 Social Institutions

An early shutdown of the complex and the resultant financial stress on a large number of families caused by widespread and possibly long-term unemployment in the area undoubtedly will adversely impact the social service institutions in the area. In addition to substantial increases in unemployment compensation payments that will have to be made, there will be the need to help find suitable alternative employment or perhaps provide relocation assistance, welfare payments, and possibly personal counseling services for some families.

6.9.5.5 Population

Significant outmigration of people from the three-county area can also be expected. This is especially true among the managerial and professional people in the higher income groups and people employed in businesses which will be adversely affected by removal of OXY from the local economy.

Generally, professional and managerial people are likely to be more mobile than are the other occupational groups in the community because it is less likely that they will be able to find suitable alternative employment in the area, and it is more likely that they will find it easier to obtain similar employment in other regions of the country.

Thus, the three-county impact area is likely to lose many people who have relatively high incomes, pay above-average taxes, maintain higher-than-average accounts with various financial institutions, and spend more with local businesses than the average family in the area. The loss of these people will have significant long-term economic effects on the area.

6.9.5.6 Education

School-age children of the families leaving the area to search for employment elsewhere will represent a loss of students to the local school systems which in turn will lead to a decrease in state aid. It is also likely that, as a result of reductions in school enrollments, there will be fewer jobs for teachers.

6.9.5.7 Duval County

Other than Columbia, Hamilton, and Suwannee counties, Duval County will be impacted more heavily than any other area in Florida. There are two important reasons for this. First, because Jacksonville is the largest metropolitan area in north Florida and is the primary trading and distribution center for northeast Florida and southeast Georgia, much of the indirect and induced income, employment, and business impacts which are felt in Florida outside of the three-county area of primary impact will be felt there.

The second and more direct reason for OXY's unique impacts on Duval County is that OXY ships >2.1 million tons of cargo annually through the Port of Jacksonville. Although no attempt is made here to measure the value of this impact on Duval County, it is clear that there are additional direct and indirect impacts on the Jacksonville economy.

6.9.5.8 Other Florida Counties

About 5% of OXY's employees live in counties in north Florida other than Columbia, Hamilton, and Suwannee counties; thus, about 5% of the statewide direct employment and income impacts are felt in those counties. In addition, some part of the statewide indirect and induced impacts are also felt in those counties. With information currently available, it is not possible to measure these impacts with any great degree of precision.

6.9.6 Effects on International Balance of Payments and Balance of Trade

Most of the product of OXY's north Florida complex is currently exported. In addition to OXY's shipments to the Soviet Union in exchange for nitrogen fertilizers and potash, OXY's sales in the international market amount to approximately $100 million per year. While this amount is a small part of total U.S. exports, its loss would further impact the negative balance of trade situation faced by the United States (Table 6.9-5).

6.9.7 Literature Cited

Burford, R.L. and J.L. Katz. 1977. Regional input-output multipliers without a full I-O table. Annals of Regional Science.

Burford, R.L. and J.L. Katz. 1981. A method for estimation of input-output multipliers when no I-O model exists. Annals of Regional Science.

Burford, R.L. and J.L. Katz. 1985. Shortcut formulas for output, income, and employment multipliers. Annals of Regional Science (July 1985).

Table 6.9-5. U.S. Foreign Transactions in Billions of Current Dollars.

Year	Exports Minus Imports	Payments Minus Receipts
1980	8.3	1.5
1981	26.0	4.1
1982	17.4	-8.3
1983	-9.0	-34.6
1984*	-45.2	-69.6

*First quarter at annual rate.

Source: Survey of Current Business, U.S. Department of Commerce.

6.10 Recreation and Natural Resources of the Suwannee River

Recreation and natural resource features of the Suwannee River will not be impacted under any of the four proposed mining alternatives. No mining or mine support facilities will be conducted within the Suwannee River or its 100-year floodplain. Current discharges from mining and processing activities into tributaries of the Suwannee River have not had a significant impact on the recreational features of the river. No significant changes in water quality, which would potentially impact recreation and natural resource features, are anticipated under any of the proposed mining alternatives.

7.0 UNAVOIDABLE ADVERSE ENVIRONMENTAL IMPACTS

7.1 Physiographic Characteristics

7.1.1 Alternative A: No Mining or Mine Support in Wetlands

Unavoidable adverse impacts on physiography anticipated from this mining alternative include potential erosion and dust from unvegetated disturbed areas and local dramatic changes in topography and soil characteristics. Erosion and dust problems will be temporary and minor. Erosion runoff from exposed mine areas and overburden piles will be collected in perimeter ditches and adjacent mine pits and will be clarified before entering surface water courses. Dust will not have a significant adverse impact on the area because of the infrequency of high winds (Section 3.2.3). The dramatic topographic changes immediately following mining will also be temporary, as reclamation of the land to approximate pre-mining contours, per Ch. 16C-16, FAC, will begin as soon as practically possible. Changes in soil characteristics of reclaimed areas are not expected to adversely impact the productivity of the soil for silvicultural or agricultural activities (Blue 1981, Gooding 1981). However, engineering characteristics of soils, such as stability for foundations, will be adversely impacted in those areas where elevated fill areas are reclaimed. Therefore, the areas are likely to remain as "green space" rather than being developed into residential areas. Local post-mining land use will be primarily silviculture, as it is currently.

Drainage basin sizes will change as portions are included within the mine water management areas. This will impact stream flows until the drainage area is reclaimed. Pursuant to Ch. 16C-16, FAC, the drainage pattern will be restored to the greatest extent possible.

7.1.2 Alternative B: Mining All Wetlands Containing Reserves

Impacts associated with mining under this alternative are similar to those discussed for Mining Alternative A (Section 7.1.1), with the addition of mining wetlands containing reserves. However, mining will be phased so that not all wetlands will be mined at one time, and wetlands will be created through reclamation activities (Section 3.3.10). Portions of some streams are also proposed for mining and relocation; this will impact aquatic resources due to changes in stream slope, sinuosity, and substrate. Reclamation of stream courses, as presented in the conceptual plans (Section 3.3.10), should minimize impacts to aquatic resources.

7.1.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

Adverse environmental impacts on physiographic characteristics associated with this mining alternative are similar to impacts associated with

Mining Alternatives A and B. The extent of overall land to be disturbed is greater than for Alternative A, but less than for Alternative B.

7.1.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

Adverse environmental impacts associated with this alternative are similar to impacts associated with Mining Alternatives A and B. The extent of land to be disturbed is greater than that disturbed under Alternatives A and C but less than that disturbed under Alternative B.

7.2 Ecology

7.2.1 Upland Communities

Unavoidable impacts on upland communities include reductions in flora and fauna populations due to clearing of vegetation and subsequent mining. However, clearing and mining are gradual processes, and reclamation will follow, with reestablishment of vegetative cover and invasion of flora and fauna from adjacent areas. The majority of naturally occurring vegetation will not be eliminated from the project site, ensuring that local seed sources of native species are available for invasion of reclaimed lands. At post-mining, there will be a net loss in acreage of upland communities and associated flora and fauna due to creation of lake systems. Reclamation conceptual plans for restoring upland communities focus on agriculture, wetlands, forestry, and wildlife resources in accordance with Ch. 16C-16, FAC (Section 3.3.10). Unavoidable impacts are similar for all four proposed mining alternatives; however, the amount of upland community disturbed, mine life, and net loss of upland community vary for each alternative (Table 7.2-1).

7.2.2 Wetland Communities

Unavoidable impacts on wetland communities are similar to those on uplands; in disturbed areas there will be reductions in flora and fauna populations due to clearing of vegetation and subsequent mining. However, clearing and mining are gradual processes, and reclamation will reestablish wetlands on an acre-for-acre basis per requirements of Ch. 16C-16, FAC. The majority of naturally-occurring wetland vegetation will not be disturbed even under Mining Alternative B, which maximizes known reserve recovery (Table 7.2-2). This will insure that local seed sources of native flora and fauna will be maintained for invasion and colonization of reclaimed lands.

Under Alternative A, no wetlands will be mined or utilized for mine support facilities. The greatest impacts will be experienced under Alternative B. Portions of Swift Creek Swamp are scheduled for mining, and these acres and the remainder of this wetland unit will be utilized for storage of waste clays. Reclamation plans call for this area to be reclaimed as forested wetlands. Approximately 1391 acres (21.7%) of the 6404-acre wetland unit known as Bee Haven Bay will be mined and reclaimed. Reclamation will be by cover type on an acre-for-acre basis.

Table 7.2-1. Comparison of Upland Community Impact Statistics for Proposed Mining Alternatives.

Mining Alternative	Upland Community Affected	% Upland Community	% Project Area	Reclaimed Lake Acreage*	% Upland Community	% Project Area	Mine Life (years)	
							Suwannee River	Swift Creek
A	9,849	13.3	9.8	3,919	5.3	3.9	8	10
B	21,161	28.5	21.1	7,474	10.1	7.5	21	26
C	16,128	21.7	16.1	5,744	7.7	5.7	14	18
D	19,210	25.9	19.2	6,573	8.9	6.6	18	25

*Excludes 452 acres of lakes reclaimed prior to January 1982.

Table 7.2-2. Comparison of Wetland Community Impact Statistics for Proposed Mining Alternatives.

Cover Type*		Existing Acreage	Acres Disturbed by Mining Alternatives							
			A		B		C		D	
			Acres	%	Acres	%	Acres	%	Acres	%
6110	Cypress	1,970	0	0	492	25.0	183	9.3	521	26.4
6211	Swamp tupelo	775	0	0	251	32.4	64	8.3	319	41.2
6212	Bayhead	1,322	0	0	376	28.4	0	0	434	32.8
6213	Scrub/shrub	1,314	0	0	231	17.6	12	0.9	313	23.8
6311	Cypress/swamp tupelo/ bay	12,633	0	0	4,511	35.7	1,830	14.5	4,232	33.5
6312	Swamp tupelo/bay/pine	6,291	0	0	3,292	52.3	338	5.4	2,621	41.2
6410	Emergent	430	0	0	111	25.8	25	5.8	161	37.4
	TOTAL	24,735	0	0	9,264	37.4	2,452	9.9	8,601	34.8

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

Functional values attributed to wetlands will be lost in those wetlands mined and adversely impacted in those wetlands that are partially disturbed (Section 6.2.2.2.1). These functions will not be totally restored until the reclaimed wetland systems mature. Primary cumulative impacts associated with mining wetlands include shifts in populations of wetlands flora and fauna, reduction in flood storage and storm detention/retention capacity, reduction in contribution of detrital material to downstream systems, reduction in water quality enhancement functions, and reduction in local recharge to groundwater (Section 6.2.2.2.3). However, these impacts may be minimized by proper mine management, reclamation procedures, and mitigative measures (Section 6.2.2.2.2). Under Alternative C, only those wetlands less than 25 acres in size containing reserves will be mined. Under Alternative D, only wetlands requiring ACOE permits will be disturbed.

7.2.3 Aquatic Communities

Mining of aquatic habitats will result in temporary reductions in associated flora and fauna. However, only a small percentage (<12%) of this habitat will be disturbed under any mining alternative (Table 7.2-3). The addition of new habitats due to mining activities, such as canals, settling areas, pits, ditches, and recirculation channels, will aid in mitigating the temporary loss of aquatic habitats. The addition of such habitats during mining and the creation of reclaimed lakes after mining will result in a net increase in aquatic habitats under all mining alternatives (Table 7.2-1). Perhaps the greatest impact on stream communities will be the mining of upper reaches of several tributary channels under Alternative B (Section 6.2.3.3.2). Only 9.3% of the stream channels in the area will be mined and only under Alternative B. Mining portions of stream channels will impact those individuals of flora and fauna occurring there. These stream channels will be reclaimed to provide lotic habitats.

In those streams not receiving mine water discharge, there will be a temporary reduction in streamflow as portions of the basin are mined and water diverted through the mine water management system. Reclamation will restore the drainage basins to approximately their original areas.

The extent to which streamflow will be altered is related to the area of the drainage being mined and would be greatest for Alternative B. A reduction in streamflow could cause a reduction in aquatic habitat and a concomitant reduction in the number of aquatic inhabitants. However, flow regimes for most Florida streams are extremely wide-ranging, and many aquatic organisms are adapted to these conditions. Maintenance of a base hydrologic level in area streams can be insured by discharging water to those streams whose drainage basins would be affected. The basic structure and function of all aquatic systems disturbed by mining will be restored for all mining alternatives; however, there will be shifts in populations of flora and fauna.

7.2.4 Forestry and Agricultural Resources

Unavoidable adverse environmental impacts are similar for all mining alternatives under consideration. The magnitude varies according to the

Table 7.2-3. Comparison of Aquatic Community Impact Statistics for Proposed Mining Alternatives.

Cover Type*	Existing Acreage	Acres Disturbed by Mining Alternatives A		B		C		D	
		Acres	%	Acres	%	Acres	%	Acres	%
513 Canals	66	2	3.0	43	65.2	0	0	12	18.2
521 Mine pits	17	0	0	15	88.2	0	0	0	0
531 Reservoirs	434	0	0	0	0	10	2.3	5	1.2
561 Ponds	73	8	11.0	9	12.3	8	11.0	6	8.2
TOTAL	590	10	1.7	67	11.4	18	3.1	23	3.9

*Based on Florida Land Use and Cover Classification System (Fla. Dept. of Admin. 1976).

amount of land proposed to be mined or disturbed by mine support facilities. Unavoidable impacts include a gradual but temporary decrease in acreage of productive forestry and agricultural land during incremental mining and reclamation. Reclamation will restore productive forestry and some agricultural operations on reclaimed lands (Blue 1981, Gooding 1981). There may be a net loss of these lands due to the net loss of uplands, some of which will be converted to lake systems as a result of reclamation. There is also the potential unavoidable loss of timber which may not be marketable at the time of clearing and thus would be lost; however, all marketable timber will be harvested.

7.2.5 Game and Migratory Wildlife

Unavoidable impacts under the proposed mining alternatives include temporary decreases in populations of large game species (e.g., white-tailed deer) as a result of mining. There will also be a decrease in land available for private lease by local hunt clubs, depending on the intended uses of the land after mining.

Populations of migratory species dependent on wetland and terrestrial habitats will temporarily decline due to mining; however, reclamation activities are planned to restore terrestrial and wetland habitats equivalent to the acreages mined, and creation of new and more diverse habitats during reclamation should increase populations of many species.

7.2.6 Rare and Endangered Species

7.2.6.1 Flora

Populations of legally protected species will be gradually reduced as a result of mining. However, the listed flora will not be eliminated from the project area as not all lands within the approximately 100,000 acres will be mined. Only approximately 30% of the project area will be affected under Mining Alternative B, and this will be sequential over a 20-yr period. Acreage not scheduled for mining or mine support facilities will be left in its natural state to ensure survival of listed species.

7.2.6.2 Fauna

Populations of some legally protected species will be reduced by mining; however, past studies have documented that populations of many species may increase (NFWL 1978, EPA 1978). Population reductions will not be dramatic, because mining is a gradual process and reclamation will be active and ongoing. Final reclamation plans (Section 3.3.10) provide for establishment of wildlife areas which will be readily invaded by populations in adjacent unmined areas. Considering the areas already mined and/or affected by previous mining activities and the additional acreage to be affected, only about 30% of the project area is scheduled for mining or mine support facilities under the alternative proposing mining of the most acreage (Alternative B).

7.3 Surface Water Quantity

Unavoidable environmental impacts on surface water quantity resources for all mining alternatives include: 1) reductions in drainage basins in areas affected by mining, 2) increased flows in streams receiving discharges, and 3) decreased flows in streams not receiving discharges. As mining progresses in drainage basins, runoff will be diverted into the mine water management system for discharge into one of the two presently permitted streams (Swift and Hunter creeks). This will increase flows in streams receiving discharge and decrease flows in streams draining affected drainage areas.

Increased flows may result in some bed load movement, altering substrate conditions for aquatic biological resources. Decreased flows may also affect aquatic communities, particularly if flow is reduced to zero during certain portions of the year. However, the overall contribution of water to the Suwannee River will remain the same, as water is simply being diverted and not lost. There may actually be a slight increase in the amount of water contributed to the Suwannee River due to dewatering of the Surficial Aquifer in mine areas.

Pursuant to requirements of Ch. 16C-16, FAC, drainage basins will be reclaimed to approximate pre-mining acreages. Based on computer simulations of pre- and post-mining mean flows, the maximum change in average flow of all small stream drainage areas will be <6% due to reclamation effects (Section 6.3). Impacts on the Suwannee River water budget as a result of mining and reclamation will be minor.

7.4 Surface Water Quality

During mining, adverse impacts on water quality include possible turbidity problems, if water is not adequately clarified prior to discharge, and increases in dissolved solids content from increased Surficial Aquifer contribution to surface waters; however, these impacts are considered minor. Water will be routed to a settling basin, such as a reclaimed lake, prior to discharge to allow sufficient time for settling of the suspended solids. Increases in dissolved solids will be relatively small, as a relatively low percentage of the flow will be derived from water table seepage. A shift in pH to a slightly higher level may result in waters routed to settling basins where phytoplankton communities develop; however, this change is considered insignificant.

Presently, OXY discharges to two permitted streams, Swift and Hunter creeks. OXY plans to obtain NPDES permit modifications to allow for future mining discharge to additional streams in the area which, if permitted, would result in altered chemical nature of the streams. This type impact on a new stream will be subject to a thorough evaluation through the NPDES permitting procedure at both the state and federal levels and thus will not be addressed as part of this wetlands mining process.

7.5 Groundwater

7.5.1 Alternative A: No Mining or Mine Support in Wetlands

No unavoidable adverse impacts on groundwater are anticipated after reclamation. Two unavoidable groundwater impacts during mining are: 1) lowering of the water table adjacent to a mining operation, and 2) decrease in baseflow for tributaries not receiving groundwater from the dewatering operation. The magnitude of the impacts will depend on the local, site-specific hydrogeological system, climatological factors, possible mitigative measures, and water use practices. Existing design principles have been effective in mitigating potential adverse groundwater impacts. Possible mitigative measures are discussed in Section 10.0.

The cumulative unavoidable adverse impacts will be less for this alternative than for Alternatives A, B, or C. Baseflow to the upper reaches of Swift Creek is expected to be reduced by approximately 30% as a result of elevated fill areas adjacent to the west boundary of Swift Creek Swamp.

7.5.2 Alternative B: Mining All Wetlands Containing Reserves

The discussion under Mining Alternative A is also applicable here. The potential impacts associated with lowering the water table for Alternative B, although they occur for a considerably longer duration than for Alternative A, may not be as significant with respect to adjacent wetlands because Alternative B includes mining of the adjacent wetlands overlying reserves.

Because approximately 2.8X as much area will be mined under Alternative B than under Alternative A, a greater potential exists for a tributary stream to have a reduction in baseflow contribution as a result of dewatering operations. Baseflow to the upper reaches of Swift Creek is expected to be reduced by approximately 40% as a result of the elevated fill areas adjacent to the west boundary of the rerouted reach to Swift Creek.

All of the adverse environmental impacts can mostly, if not totally, be avoided in selected, important areas if necessary, through potential mitigative measures (Section 10.0).

7.5.3 Alternative C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves

The quantity of water involved in mine cut dewatering for Alternative C is approximately 1.8X as much as the quantity involved in Alternative A but 0.7X as much as the quantity involved in Alternative B. Overall, the cumulative adverse impacts probably will be closer to those described for Alternative A than to those for Alternative B. No impacts from stream relocations or use of Swift Creek Swamp for a settling area are involved in this alternative.

7.5.4 Alternative D: Mining in Areas Requiring Only ACOE Permits

The quantity of water and the area involved with mine cut dewatering for this alternative are approximately 2.6X as much as for Alternative A and 0.9X as much as for Alternative B. Overall, the cumulative adverse impacts probably would be more similar to the impacts described for Alternative B than to those described for Alternative A.

7.6 Air Quality

The only unavoidable adverse impact on ambient air quality associated with phosphate rock mining and subsequent land reclamation is a temporary increase in total suspended particulate matter levels in the vicinity of the mining activities as a result of land clearing operations, wind erosion, reclamation activities, and vehicular traffic. The increase will be temporary, and total suspended particulate matter levels will return to area-wide background levels when reclamation is completed. Air quality monitoring for total suspended particulate matter during 1979-1982, when both the Swift Creek and Suwannee River mines were active, indicated that even the temporary impacts associated with mining and reclamation activities did not threaten ambient air quality standards.

7.7 Radiation

For all mining alternatives, there will be increases in radiological parameters as a result of mining and subsequent reclamation (Section 6.7). Alternative A involves mining of the least acreage and will result in the least radiological impact. Alternative A will proceed regardless of approval for mining wetlands, as this alternative addresses only upland mining. Alternative B will result in the mining and reclamation of the greatest acreage and therefore will produce the greatest radiological impact. On a relative scale, using mineable acreage as a measure of benefits and the changes in various radiological parameters and total land affected as the impact, Mining Alternatives B, C, and D will have measureably lower impacts per units of benefit than Alternative A. Mining under Alternatives B, C, and D produces about equal environmental impacts per units of mineable resources.

The magnitude of the radiological impacts resulting from the four mining alternatives will be identical to those that have resulted from previous OXY mining. The increased levels of radioactivity are well within applicable guidelines and proposed standards and are similar in magnitude to naturally occurring levels of radioactivity in other areas of the United States.

7.8 Historical and Archaeological Resources

Based on the cultural resource assessment of the OXY project area and agency review of the area for archaeological site occurrence and significance, no adverse impacts on the historical and archaeological resources of the project area are predicted for any of the proposed alternatives.

7.9 Socioeconomics

There are no adverse impacts resulting from any of the four proposed mining alternatives. Of the alternatives considered, Alternative A would have the greatest adverse economic impact on the area and Alternative B would have the most positive economic impact on the area. Alternatives C and D would result in economic impacts intermediate to A and B.

7.10 Literature Cited

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8.0 RELATIONSHIP BETWEEN SHORT-TERM USE AND LONG-TERM PRODUCTIVITY

8.1 Physiographic Characteristics

A slight increase in productivity of silvicultural and agricultural land uses may be realized with reclaimed soils and land forms. An evaluation of reclaimed areas for silviculture indicated that yields (cords/acre) at a rotation age of 25 years are expected to be slightly higher for pines managed on reclaimed land than on native soils (Gooding 1981). An evaluation of agricultural/forage production indicated that reclaimed overburden has an equivalent productive capacity, with possibly less maintenance cost, than natural undisturbed soils (Blue 1981). The relationship between the short-term use and potential slight increase in productivity of silvicultural and agricultural lands is similar for all mining alternatives; the only difference is in the acreage to be reclaimed (Table 8.1-1).

Long-term productivity of the area will be affected by the creation of lake systems which are presently limited in the geographical area. The lakes will provide habitat for fish and wildlife, including endangered species, and support recreational activities (hunting and fishing). All four mining alternatives include land and lakes reclamation, though acreages vary (Table 8.1-1).

8.2 Ecology

8.2.1 Upland Communities

Enhancement of long-term productivity by the short-term disturbance of upland communities will be realized by 1) creating lake systems and associated marsh areas at post-mining, 2) increasing the overall landscape diversity, and 3) maintaining or slightly increasing productive value for forestry and agricultural activities.

Lakes and associated marsh areas will be created as part of the reclamation process for all mining alternatives (Table 8.2-1). These lakes are typically irregular in shape with varying depths. Lakes are constructed per Ch. 16C-16, FAC, and incorporate a variety of habitats:

Zone	Estimated Percent of Water Surface Area
Zone of fluctuation	30
Littoral zone	20
Transition zone	27
Deep water zone	23

Table 8.1-1. Acreages of Reclamation Types By Mining Alternative.[1]

Mining Alternative	Land and Lakes	Elevated Fill	Tailings Fill	Total Reclaimed[2]
A: No Mining or Mine Support in Wetlands	7,537	9,062	1,897	18,496
B: Mining All Wetlands Containing Reserves	14,373	18,112	6,366	38,851
C: Mining Only Small Isolated or Weakly/ Periodically Connected Wetlands Containing Reserves	11,046	12,262	3,582	26,890
D: Mining in Areas Requiring Only ACOE Permits	12,640	17,492	6,166	36,298

[1]Based on mining and reclamation after 1982; includes lands that would be reclaimed under the non-mandatory reclamation program (Ch. 16C-17, FAC).

[2]Excludes 941 acres of land and lakes and 944 acres of tailings fill reclaimed prior to January 1982 and 919 acres of cooling ponds/gypsum stacks.

Table 8.2-1. Acreages of Lake Systems Created Under the Proposed Mining Alternatives.

Mining Alternative	Land and Lakes	Lakes*
A	7,537	3,919
B	14,373	7,474
C	11,046	5,744
D	12,640	6,573

*Based on an average of 52% of land and lakes systems being wetlands and open water; excludes 452 acres of lakes reclaimed prior to January 1982.

These lakes are considered productive habitat for fish and wildlife (Section 3.3.10). A study conducted by Auburn University Fisheries and Allied Aquaculture staff found that in a 2-month period, over 4000 fisherman hours resulted in a total catch of 1500 lb on OXY reclaimed lakes (Boyd and Davies 1981).

The Florida Game and Fresh Water Fish Commission has utilized reclaimed lakes as a source of fingerling bass for stocking other lakes in north Florida. This agency also manages duck hunting on mined and reclaimed aquatic systems. According to the FGFWFC, hunter success ratios in reclaimed areas were comparable, or better than, those recorded in other areas of the state, including other game management areas.

Under all proposed mining alternatives, reclamation will increase the topographic and habitat diversity. The generally low relief site presently interspersed with wetlands will still retain this character, but areas of slightly rolling topography interspersed with lakes and associated wetlands systems will also be present. This increased habitat diversity will result in increased species diversity. The reclaimed lakes will support stable, viable populations of game fish and other types of fish. Additionally, the increase (30% of expected total) realized in avifauna from past mining and reclamation activities will be maintained and enhanced as a result of the new reclamation activities.

The productive capability of reclaimed upland systems for forestry and agriculture will be similar to existing systems. A comparison of productivity on reclaimed and natural soils indicated that reclaimed soils supported viable, productive land uses and slightly higher yield of commercial forest species (Blue 1981, Gooding 1981).

8.2.2 Wetland Communities

There will be a loss of productivity and functional values associated with wetlands proposed for mining or disturbance. Long-term productivity will be enhanced by creation of lake systems and associated marshes, thus increasing the overall landscape diversity of wetland communities and providing a productive habitat which is presently limited in the geographical area. Approximately 27% of the water surface area of reclaimed lakes will be in a transition zone and 20% in littoral zone. The transition zone is considered wetland acreage and will be vegetated with wetland species per Ch. 16C-16, FAC (Section 3.3.10). The acreage of the transition zone for each alternative is as follows:

Mining Alternative	Lake Surface Area (acres)	Transition Zone (acres)
A	3919	1058
B	7474	2018
C	5744	1551
D	6573	1775

Various types of forested and non-forested wetlands will also be created as part of the reclamation process and will contribute to the overall diversity of wetland types.

8.2.3 Aquatic Communities

Reclaimed lakes are an integral part of OXY's mine plan and will be constructed for all mining alternatives. Once mining operations cease, the reclaimed lakes will no longer receive water from the mining processes. At present, there are few lakes in the proposed mining area. The existing reclaimed lakes, Eagle Lake and Altmans Bay, provide habitat for many aquatic species, including a variety of fish (Boyd and Davies 1981), and the irregular shorelines provide a large and valuable area of land/water ecotone.

Long-term aquatic productivity and habitat diversity will be enhanced by the addition of lakes to the area. The reclaimed lakes will provide habitat for species that may have been sparse in the streams and wetlands prior to mining activities, such as game fish, lentic macroinvertebrates, and species associated with lake margins and littoral zones such as reptiles, amphibians, wading birds, and macroinvertebrates. The lakes will support high rates of primary and secondary productivity which should represent a net increase over pre-mining productivity. The littoral zone of the reclaimed lakes is considered as wetlands replacement but the open water area is not. Hence, the addition of reclaimed lakes represents a real increase in aquatic habitat for all mining alternatives.

The chemical and physical nature of the streams receiving mine water discharge may be altered to some degree, but after mining ceases, the streams will begin to revert to their original characteristics. Both primary and secondary production will increase in lakes and streams as a result of increased nutrient concentrations.

There should be no significant interruption of productivity in aquatic ecosystems for Alternative A. Only 1.7% of the aquatic ecosystems and no new streams will be impacted for this alternative, and any variation in the rate or pattern of production would probably fall within the range of natural variation. Reclamation and the addition of reclaimed lakes will insure that aquatic ecosystem production will be greater than or equal to pre-mining conditions.

For Alternative B, the greatest amount of aquatic and wetland habitat will be disturbed as compared to Alternatives A, C, and D. Some impacts on short-term productivity are expected for this alternative, but there may not be significant interruption of overall production because nearly 90% of the aquatic habitat will remain relatively undisturbed. To compensate for the disturbance of wetlands and aquatic ecosystems during the mining process, an area equal to the amount of disturbed habitat will be reclaimed in addition to the littoral zone and the open water area of reclaimed lakes. Once succession is completed, species composition and community structure should be similar to pre-mining conditions. While the productivity patterns of these areas will be interrupted on a short-term basis, the reclamation process will insure that these patterns will be reestablished or enhanced on a long-term basis.

The headwater aquatic systems and small isolated wetlands to be mined under Alternatives C and D represent the lowest quality aquatic habitat in the project area. Although these areas may have a fairly high rate of primary production, secondary production and habitat use by aquatic species are probably lower than in larger wetlands. During the successional stages after reclamation, primary and secondary production may exceed pre-mining conditions. Once restoration and succession are complete in aquatic ecosystems and their drainage basins, productivity should be similar to or surpass pre-mining conditions.

8.2.4 Forestry and Agricultural Resources

Long-term productivity of forestry and agricultural resources can be achieved assuming post-mining land use is comparable to pre-mining land use. Productive silvicultural and agricultural operations are possible on reclaimed lands, and recent studies indicate equivalent forestry productivity of natural areas and reclaimed lands (Blue 1981, Gooding 1981).

8.2.5 Game and Migratory Wildlife

Under all four proposed mining alternatives, open waterbodies and marsh areas will be created as part of the reclamation process. Local populations of many migratory species, particularly diving ducks and puddle ducks, will increase as a result of the increased habitat available. Open waterbodies are sparse in this area; thus, creation of this habitat type will increase the local species diversity of both migratory and game species in the area.

8.2.6 Rare and Endangered Species

8.2.6.1 Flora

Although plants occurring in areas proposed for mining will be lost, the listed species will not be eliminated from the project site nor will the regional status of these species be altered by mining as proposed under all four alternatives, as even under Alternative B, which maximizes reserve recovery, only 30% of the project area will be affected.

8.2.6.2 Fauna

Long-term productivity of some listed species observed on site will be enhanced under the proposed mining alternatives, particularly for those species which utilize aquatic areas, such as the American alligator, little blue heron, snowy egret, and tricolored heron. Habitat for the least tern, typically a coastal beach-nesting species, has been created by past mining activities and used by this species for successful nesting, thereby enhancing regional populations.

8.3 Surface Water Quantity

Mining and reclamation will result in temporary disturbance of on-site tributaries, drainage basins, and flows. No significant impacts are anticipated for the Suwannee River. Post-mining flows in the tributaries should not be significantly different from pre-mining flows, with the maximum change in average flows being <2 cfs. Peak discharge will be reduced because reclaimed lakes will serve as flow regulators, i.e., the large fluctuation in land surface runoff will be damped by lake storage. Therefore, the probabilities of both extremely low flow and extremely high flow are reduced. Reduction in peak flow will reduce flood damage and pollutant washoff whereas reduction of low flow probabilities will provide more water during the dry season which should lessen the stress on aquatic organisms under the extremely wide ranging flow conditions which presently exist for the majority of the tributaries. Additional benefits from the creation of lake systems include recreational benefits of hunting and fishing currently realized on existing reclaimed lake systems.

8.4 Surface Water Quality

Presently, OXY discharges mine waters and water from their chemical and beneficiation processes to two permitted streams. If additional NPDES permits are granted for discharging mine waters to other streams on site, their chemical composition would change slightly. There may be a slight reduction in detrital input to the on-site tributaries and possibly to the Suwannee River as a result of mining upper reaches of some streams; however, this is considered insignificant on a regional scale. There will be no increase in the amount of nutrient loadings to the Suwannee River as a result of any alternatives.

After reclamation, water quality of the area should improve above that which presently exists due to shutdown of chemical and beneficiation operations and their discharges. Reclaimed lakes, which are connected to water courses, will be autotrophic, and discharges to streams will provide greater primary production (e.g., phytoplankton) to the receiving streams, thus benefitting downstream ecological systems. Reclaimed lakes will also enhance water quality by acting as detention/retention areas for filtering nutrients and allowing settling of suspended solids from adjacent surface runoff.

8.5 Groundwater

No relationship exists between short-term use of the Surficial Aquifer and enhancement of long-term productivity. Increased baseflow to the streams could positively enhance long-term productivity of the surface water system. The intermittent tributary streams would have the potential for more continuous flow and the tendency for both increased hardness and pH of the water. These relationships are similar for all four mining alternatives.

8.6 Air Quality

Total suspended particulate matter levels will temporarily increase as a result of mining and reclamation activities but will return to background levels once reclamation is completed. Because total suspended particulate matter levels during active mining and reclamation activities are less than levels established by federal and state air quality standards, neither the long-term nor short-term productivity of the area will be affected by air quality impacts.

8.7 Radiation

Increases in Ra-226 concentrations in the near-surface soil and terrestrial gamma radiation are long-term effects of mining. Increases in airborne particulate radioactivity and occupational hazards are associated with mining and reclamation activities and have been determined to be negligible impacts. The impacts of these latter exposures are further reduced after reclamation. There is no enhancement of long-term productivity with respect to radiation and radioactivity.

8.8 Historical and Archaeological Resources

No significant archaeological sites occur in the project area and no adverse impacts are predicted for any of the proposed alternatives.

8.9 Socioeconomics

Continuation of mining under Alternative B will provide continued primary and secondary employment opportunities. Tax revenues generated by the mines will more than pay for the community service requirements of OXY employees. Continued mining in the project area will sustain OXY's contributions to the long-term economic growth of Columbia, Hamilton, Suwannee, and Duval counties.

If Alternative A is selected over Alternative B, the three-county region will experience annual losses over a period of almost 14 years of 6067 jobs, incomes to local citizens of $95.1 million, sales of local businesses of $215.5 million, and taxes to county and municipal governments of $6.2 million. For perspective, this loss will be roughly equivalent to the loss of all jobs in the three counties for approximately 3 years, a loss of all sources of earned income to everyone in the area for approximately 4 years, a complete loss of sales of businesses in the three counties for almost 3 years, and loss of all revenues to the county and city governments in the three counties for slightly over 4 years.

These quantifiable losses to the area imply, but do not include:

- Revenues of >$130,000,000 a year to out-of-state firms and the feedback effects of those revenues through their expenditures in Florida.
- Capital improvement outlays of approximately $20,000,000 per year.

- Employee fringe benefits of about 30% of payroll and the multiplier effects of these on the economy (e.g., medical insurance payments to local medical firms and hospitals).

- Loss of potential retirement benefits.

- Federal taxes paid by OXY and those resulting from indirect and induced economic impacts and the feedback effects of federal expenditures in Florida.

- Economic effects of outmigration, reduced property values, and financial stress in the area.

- Increased costs of unemployment compensation, welfare payments, and social services.

- Loss of an export product for the U.S., thus negatively impacting the national balance of trade and decreasing the export volume in the Port of Jacksonville.

8.10 Literature Cited

Blue, W.G. 1981. Occidental Chemical Company's proposed land forms: their forage productivity potential and usefulness for agriculture. Report prepared for Occidental Chemical Agricultural Products, Inc., White Springs, FL. 8 pp.

Boyd, C.E. and W.D. Davis. 1981. Occidental Chemical Company lakes: their limnology and potential for fish and wildlife. Unpubl. report prepared for Occidental Chemical Agricultural Products, Inc., White Springs, FL. 88 pp.

Gooding, J.W. 1981. A report addressing phosphate mine reclamation, their soils, and potential for practicing forest management on such land forms. Report prepared for Occidental Chemical Agricultural Products, Inc., White Springs, FL. 11 pp.

9.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

9.1 Physiographic Characteristics

Irreversible and irretrievable commitments of resources include extraction and processing of phosphate rock and loss of upland areas to lake systems as a result of reclamation activities. To the extent that lakes will occupy 4-7% of the project area after reclamation, land area will be lost which could have been used for silviculture or agriculture (Table 9.1-1).

9.2 Ecology

9.2.1 Upland Communities

Irreversible and irretrievable commitments of resources include the loss of individual fauna due to disturbance of upland communities, upland habitat loss from creation of lake systems, and loss of vegetation not harvested on affected lands. However, the loss of upland habitat will be mitigated by the creation of new habitat types which are limited in the present geographical area (Table 9.2-1) and which support fish, wading birds, ducks, amphibians, and some reptiles and mammals. There will also be minor losses of agricultural and forestry lands.

9.2.2 Wetland Communities

Portions of the wetland communities will be disturbed under Alternatives B, C, and D. However, the majority of wetland acreage will be left undisturbed (Section 6.2.2.3). Wetlands disturbed under all alternatives will be reclaimed on an acre-for-acre basis and will therefore represent only a temporary loss. There will be a loss or decrease in value of functions in those wetlands disturbed. These functions will be gradually restored as the reclaimed wetland systems mature. There will be a loss of habitat and individual flora and fauna during the mining process, but a number of species will be able to utilize interim wetland habitats created during the mining and waste disposal processes (Section 6.2). These losses will be mitigated by the acre-for-acre replacement of wetland communities as part of the proposed reclamation plans (Section 3.3.10).

9.2.3 Aquatic Communities

Although the reclamation process will not be completed immediately after mining, mining activities will not involve irreversible and irretrievable commitments of aquatic resources. The functions provided by the wetlands and aquatic systems scheduled for mining and the floral and

Table 9.1-1. Approximate Acreages of Land and Lakes Systems for the Four Mining Alternatives.

Mining Alternative	Land/Lakes (acres)	Lakes* (acres)	% of Project Area Converted to Lakes*
A: No Mining or Mine Support in Wetlands	7,537	3,919	3.9
B: Mining All Wetlands Containing Reserves	14,373	7,474	7.4
C: Mining Only Small Isolated or Weakly/Periodically Connected Wetlands Containing Reserves	11,046	5,744	5.7
D: Mining in Areas Requiring Only ACOE Permits	12,640	6,573	6.6

*Wetlands and open water; excludes 452 acres of lakes reclaimed prior to January 1982.

Table 9.2-1. Extent of Upland Communities Converted to Aquatic Systems Under the Proposed Mining Alternatives.

Mining Alternative	Land and Lakes Acreage	Lake Acreage*	% Upland Community	% Project Area
A	7,537	3,919	5.3	3.9
B	14,373	7,474	10.1	7.5
C	11,046	5,744	7.7	5.7
D	12,640	6,573	8.9	6.6

*Based on an average of 52% of land and lakes systems being wetlands and open water; excludes 452 acres of lakes reclaimed prior to January 1982.

faunal communities they support will be altered to varying extents under the four alternatives, but will be replaced by reclamation. Several functions will be increased by a combination of restored aquatic systems, wetlands, and reclaimed lakes. The flora and fauna will return as succession progresses, and community composition and structure should be similar to pre-mining conditions.

Lakes created by the reclamation/mitigation process represent a permanent alteration of habitat. However, the lakes will provide habitats that were sparse or absent prior to mining. In addition, the reclaimed lakes will be far more productive in terms of secondary and tertiary production and provide greater diversity in biotic communities than many of the aquatic systems presently in the area.

9.2.4 Forestry and Agricultural Resources

Other than the loss of unmarketable timber due to clearing for mining and/or mine support facilities, no irreversible or irretrievable commitments of resources are expected under any of the proposed mining alternatives.

9.2.5 Game and Migratory Wildlife

Because the process of mining removes their habitat, some individuals of game and migratory species, particularly those not associated with open water systems, will be lost. However, the loss should not be significant, as mining is a gradual process with reclamation following as soon as is practically possible. The creation of a more diverse landscape will enhance populations of many species.

9.2.6 Rare and Endangered Species

9.2.6.1 Flora

Some individuals of listed species will be lost as a result of mining; however, the majority of habitat presently on site will not be mined, so that populations of these species can be maintained. There should be no change in their regional status as a result of mining under any of the proposed alternatives.

9.2.6.2 Fauna

Some individuals of listed species will be lost as a result of mining; however, protected species will remain as part of the fauna of the project area, as the majority of the project area will not be mined. No change in their regional status will result from mining under any of the proposed alternatives. Many species populations will be enhanced as a result of habitats created by mining and reclamation (Section 6.2.6).

9.3 Surface Water Quantity

There will be no irreversible or irretrievable commitments of surface water resources as a result of mining and reclamation.

9.4 Surface Water Quality

There will be no irreversible or irretrievable commitments of surface water quality as a result of mining and reclamation.

9.5 Groundwater

The Surficial Aquifer water and Floridan deep well water that drain from the project area to the Suwannee River during the mining operation will be replaced after mining by rainfall runoff from other parts of the drainage area, groundwater inflow, and recharge. Therefore, this water use is not considered an irreversible commitment of resources.

The physical change in the Surficial Aquifer in mined-out areas could be considered an irreversible and irretrievable commitment of a resource. In waste clay disposal areas (9.2% of the project area), the transmissive zones of the Surficial Aquifer (matrix) would be removed and replaced with a relatively tight, non-productive unit. In those areas where the waste clay is capped with sand tailings, the sand cap partially mitigates this impact. In sand tailings reclamation areas (1.9% of the project area), a more transmissive unit replaces the existing Surficial Aquifer.

9.6 Air Quality

The probable impact of phosphate mining and reclamation activities on ambient air quality will be minor temporary increases in total suspended particulate matter levels. Once land reclamation has been completed, total suspended particulate matter levels will return to normal background levels. As a result, there will be no irreversible or irretrievable impact on air quality.

9.7 Radiation

The uranium in the matrix is lost unless uranium recovery is practiced in the chemical plant. For this north Florida facility there is no economic incentive for uranium recovery.

9.8 Historical and Archaeological Resources

There will be no irreversible or irretrievable commitments of historical and archaeological resources as a result of mining under any of the proposed alternatives.

9.9 Socioeconomics

At 1981 consumption rates, the United States could provide phosphate for the entire world for 39 years, assuming that no other country produces phosphate and that the reserve base (reserves, marginal reserves, and part of the demonstrated subeconomic resources) becomes economic to mine. The U.S. phosphate industry could also continue the current production rate for domestic consumption and exports for 24 years using only reserves and for the next 106 years using the reserve base (estimated on 1300 million metric tons of U.S. reserves; 5700 million metric tons U.S. reserve base; a U.S. 1981 production rate of 53 million metric tons; and a world production rate of 146 million metric tons). This does not include vast quantities that cannot be mined and processed with present technology, but could be with higher prices and new technological developments (U.S. Bureau of Mines 1981).

OXY's reserves total 95.8 million metric tons and are 7.4% of U.S. reserves and 0.7% of world reserves. Florida reserves are 550 million metric tons, or 42.3% of U.S. reserves and 3.9% of world reserves. The U.S. phosphate rock reserves are 9.3% of the world reserves (Table 9.9-1).

Under Alternative B, OXY could mine their reserves of 95.8 million metric tons of phosphate concentrate (100%); under Alternative A, 38% would be mined; Under Alternative C, 66%; and under Alternative D, 95%. This represents an irreversible and irretrievable loss of reserves; however, the magnitude of this loss is difficult to quantify as data are not available for evaluating future domestic needs and availability.

9.10 Literature Cited

U.S. Bureau of Mines. 1981. Information Circular 8850.

U.S. Environmental Protection Agency (EPA). 1981. Draft Environmental Impact Statement, Mobil Chemical Company South Ft. Meade Mine, Polk County, Florida. EPA, Region IV, Atlanta.

U.S. General Accounting Office. 1979. Phosphates: a case study of a valuable, depleting mineral in America. Report by the Comptroller General to the Congress, EMD-80-21.

Table 9.9-1. Phosphate Rock Reserves (U.S. Bureau of Mines 1981).[1]

Description	Reserves[2] (million metric tons)	% U.S. Reserves	% World Reserves
OXY North Florida rock reserves[3]			
Suwannee River Mine	53.9		
Swift Creek Mine	41.9		
Total	95.8	7.37	0.68
Florida phosphate rock reserves	550	42.3	3.93
U.S. phosphate rock reserves	1,300		9.29
World phosphate rock reserves	14,000		

[1]Mineral commodity profiles, phosphate rock, Bureau of Mines, United States Department of the Interior, 1983.

[2]Costs less than $30 per metric ton.

[3]Occidental Chemical Agricultural Products, Inc. reserves as of January 1, 1981. Suwannee River Mine at 2.1 mm STPY for 22 years to January 1, 2003 and Swift Creek Mine at 2.2 mm STPY for 27 years to January 1, 2008.

10.0 MEANS TO MITIGATE ADVERSE ENVIRONMENTAL IMPACTS

10.1 Erosion Control and Sedimentation

Erosion and sedimentation can be effectively controlled by:

- recontouring and revegetation of bare soil as quickly as possible;
- reducing the velocity and controlling the flow of runoff;
- detaining runoff on site to trap sediments; and
- releasing runoff safely to downstream areas.

All of these practices are currently used by OXY in existing operations through reclamation activities and mine water management systems.

10.2 Induced Recharge

Induced recharge to the Surficial Aquifer can be an effective way to limit the horizontal distance from a mine cut influenced by dewatering. Induced recharge is the process of discharging water to an area between the mine cut and the adjacent wetland or surface waterbody, or directly to the adjacent wetland or surface waterbody. The recharge can be from a number of sources, such as deep well withdrawals, pumped waters from the dewatering operation, or surface drainage diverted to an area from the same or adjacent drainage areas. The recharge can be injected into the aquifer in a number of ways, such as direct discharge to the potentially affected wetland or surface waterbody, discharge into a surface ditch system, or discharge into shallow wells. As the recharge areas could be considered a point source discharge, this process would be subject to permitting requirements, which could limit the use of induced recharge as a viable mitigation alternative.

10.3 Addition of Water Control Facilities

Water level control structures to limit outflows and drainage conveyance systems to transfer water are used for inducing recharge to the Surficial Aquifer either by bringing water into an area or retaining water that normally would be discharged from an area.

10.4 Air Quality

The impact of phosphate rock mining and associated activities on ambient air quality is mitigated by hydraulically transporting the phosphate matrix from the mine to the beneficiation plant, by hydraulically transporting tailings from the beneficiation plant back to the mined-out areas, and by reclamation practices that will minimize wind erosion of barren lands.

10.5 Ecology

In all of the proposed alternatives, mining will be conducted as an incremental process with reclamation occurring as soon as is practically possible. This will result in disturbing a limited amount of acreage at any one time rather than disturbing the entire community proposed to be mined under each alternative. The various communities in the project area will not be eliminated from the area under any of the proposed mining alternatives (Section 6.2). Therefore, no vegetation community and associated flora and fauna and/or land use will be completely eliminated from the project area. The undisturbed portions of the communities will function as biological reservoirs for seeding and colonization of adjacent reclaimed areas.

There will be a net loss of upland acreage as a result of mining and reclamation, but this will be mitigated by the creation of ecologically productive lake systems which can also be used for fishing and hunting. The conceptual reclamation plans (Section 3.3.10) will mitigate environmental impacts on ecological resources by focusing on restoration of streams, acre-for-acre replacement of wetlands, creation of productive land uses, such as agriculture and silviculture, as well as specially-designated wildlife areas, and revegetation of all lands mined and/or utilized for mine support activities under the proposed mining alternatives.

10.6 Socioeconomics

The negative impacts of selection of Alternative A instead of Alternative B cannot be fully mitigated. If Alternative A is selected, its negative impacts will begin to be felt in approximately 6 years and its full impact felt in approximately 8 years.

It is possible that, given this time for planning, the impacts might be softened through a coordinated effort of governments, chambers of commerce, and other entities to develop assistance programs.

Some of the negative impacts on individuals could perhaps be softened by a relocation assistance program, perhaps at the state level, to help those who are displaced by this alternative to 1) find suitable employment elsewhere; 2) dispose of their homes in a depressed market; and 3) buy new homes in a new location.