United States
Environmental Protection
Agency

Region 4
345 Courtland Street, NE
Atlanta, GA 30365

EPA

Environmental Impact Statement

CF Mining Corporation
Hardee Phosphate Comp
Hardee County, Florida

Supplemental Information

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

REGION IV
345 COURTLAND STREET
ATLANTA, GEORGIA 30365

SUPPLEMENTAL INFORMATION DOCUMENT

FOR

CF MINING CORPORATION
HARDEE PHOSPHATE COMPLEX II
DRAFT ENVIRONMENTAL IMPACT STATEMENT

MARCH 1988

CF INDUSTRIES
SUPPLEMENTAL INFORMATION DOCUMENT
TABLE OF CONTENTS

Section

1.0 INTRODUCTION

1.1 DESCRIPTION OF PROPOSED PROJECT 1-1
1.2 REQUIREMENT FOR EIS PREPARATION 1-4
1.3 STATUS OF OTHER PERMITTING REQUIREMENTS 1-6

1.3.1 CONSUMPTIVE USE OF WATER PERMIT 1-7
1.3.2 APPLICATION FOR DEVELOPMENT APPROVAL/ DEVELOPMENT OF REGIONAL IMPACT 1-8
1.3.3 HARDEE COUNTY MINING AND EARTH MOVING ORDINANCE AND ZONING VARIANCE 1-9

1.4 THE SUPPLEMENTAL INFORMATION DOCUMENT 1-9

2.0 CF INDUSTRIES' PROPOSED ACTION 2-1

2.1 DRAGLINE MINING OPERATION 2-1

2.1.1 DEPOSIT GEOLOGY 2-1
2.1.2 LAND CLEARING 2-1
2.1.3 PRESERVED AREAS 2-5
2.1.4 DRAGLINE CROSSINGS 2-7
2.1.5 PHOSPHATE MINING 2-11
2.1.6 DRAINAGE BASIN MINING SEQUENCE 2-14

2.1.6.1 DOE BRANCH 2-14
2.1.6.2 PLUNDER BRANCH 2-16
2.1.6.3 COON'S BAY BRANCH 2-17
2.1.6.4 TROUBLESOME CREEK 2-17
2.1.6.5 SHIRTTAIL BRANCH 2-18
2.1.6.6 BRUSHY CREEK 2-19
2.1.6.7 HORSE CREEK 2-19
2.1.6.8 LETTIS CREEK 2-20
2.1.6.9 SUMMARY 2-20

2.2 SLURRY MATRIX TRANPORT 2-23

2.2.1 GENERAL DESCRIPTION 2-23
2.2.2 PIPELINE CROSSING OF WETLANDS 2-25

2.3 MATRIX PROCESSING 2-25

2.3.1 PLANT LOCATION 2-25
2.3.2 PLANT DESCRIPTION SUMMARY 2-26
2.3.3 WASHER SECTION 2-30
2.3.4 SIZING SECTION 2-33
2.3.5 FLOTATION AREA 2-33
2.3.6 WET ROCK STORAGE 2-36
2.3.7 PHOSPHATE PRODUCT DISPOSITION 2-38
2.3.8 PLANT CONSTRUCTION 2-38
2.3.9 ENERGY REQUIREMENTS AND OPERATING PERSONNEL 2-39
2.3.10 REAGENT, FUEL, AND LUBRICANT STORAGE 2-40

2.4 WASTE SAND AND CLAY DISPOSAL PLAN 2-43

2.4.1 INTRODUCTION 2-43
2.4.2 SAND/CLAY MIX PROCESS 2-45
2.4.3 INITIAL SETTLING AREAS 2-45

TABLE OF CONTENTS
(Continued, Page 2 of 7)

Section			Page
	2.4.4	SAND/CLAY MIX AND DISPOSAL AREAS	2-46
	2.4.5	SAND/CLAY WASTE DISPOSAL PLANNING	2-47
	2.4.6	TAILINGS	2-51
	2.4.7	SUMMARY	2-52
2.5	MINE WATER USE PLAN		2-52
	2.5.1	PROCESS WATER REQUIREMENTS	2-52
	2.5.2	BENEFICIATION PROCESS REAGENT REQUIREMENTS	2-54
	2.5.3	WATER RECIRCULATION SYSTEM	2-55
	2.5.4	CONSUMPTIVE USE-GROUND WATER WITHDRAWALS	2-58
	2.5.5	OTHER WELLS	2-61
	2.5.6	MAXIMUM WELL PUMPAGE	2-62
	2.5.7	MINE PIT DRAINAGE	2-62
	2.5.8	SURFACE WATER RUNOFF	2-63
	2.5.9	WATER DISCHARGE	2-64
		2.5.9.1 CF INDUSTRIES' PROPOSED WATER DISCHARGE PLAN	2-65
		2.5.9.2 ADDITIONAL WATER DISCHARGE ALTERNATIVES	2-68
2.6	RECLAMATION PLAN		2-69
	2.6.1	OBJECTIVES	2-69
	2.6.2	PHYSICAL RECLAMATION OF LANDFORMS	2-71
		2.6.2.1 SAND/CLAY MIX AREAS	2-73
		2.6.2.2 SAND TAILINGS FILL AREAS WITH OVERBURDEN CAP	2-76
		2.6.2.3 LAND-AND-LAKES	2-76
		2.6.2.4 OVERBURDEN FILL AREAS AND DISTURBED NATURAL GROUND	2-82
	2.6.3	WETLAND AND STREAM CHANNEL RECLAMATION	2-82
		2.6.3.1 WETLANDS	2-82
		2.6.3.2 STREAMS	2-84
	2.6.4	REVEGETATION	2-84
		2.6.4.1 EXPERIMENTAL TEST PLOTS	2-84
		2.6.4.2 IMPROVED PASTURE	2-90
		2.6.4.3 FORESTED UPLANDS	2-91
		2.6.4.4 FORESTED WETLANDS	2-93
		2.6.4.5 NON-FORESTED WETLANDS	2-94
	2.6.5	RECLAMATION SEQUENCE	2-94
	2.6.6	POST-RECLAMATION TOPOGRAPHY	2-95
	2.6.7	POST-RECLAMATION LAND USE	2-104

TABLE OF CONTENTS
(Continued, Page 3 of 7)

Section			Page
	2.7 REFERENCES: CF INDUSTRIES' PROPOSED ACTION		2-106
3.0	AIR RESOURCES		3-1
	3.1 THE AFFECTED ENVIRONMENT		3-1
	3.1.1	INTRODUCTION	3-1
	3.1.2	REGIONAL METEOROLOGY	3-3
		3.1.2.1 METEOROLOGICAL DATA SOURCES	3-3
		3.1.2.2 TEMPERATURE	3-3
		3.1.2.3 PRECIPITATION	3-3
		3.1.2.4 WIND DIRECTION AND SPEED	3-6
		3.1.2.5 ATMOSPHERIC STABILITY	3-6
	3.1.3	APPLICABLE AIR QUALITY REGULATIONS	3-12
		3.1.3.1 AMBIENT AIR QUALITY STANDARDS (AAQS)	3-12
		3.1.3.2 PREVENTION OF SIGNIFICANT DETERIORATION (PSD)	3-12
		3.1.3.3 NON-ATTAINMENT AREAS	3-14
		3.1.3.4 EMISSION STANDARDS	3-15
	3.1.4	AREAWIDE EMISSION SOURCES	3-15
		3.1.4.1 PARTICULATES	3-15
		3.1.4.2 FLUORIDES	3-17
		3.1.4.3 NITROGEN OXIDES	3-17
	3.1.5	AMBIENT AIR QUALITY DATA	3-17
		3.1.5.1 TOTAL SUSPENDED PARTICULATES	3-22
		3.1.5.2 SULFUR DIOXIDE	3-22
		3.1.5.3 FLUORIDES	3-22
	3.2 NOISE		3-23
	3.2.1	SOUND MEASUREMENT	3-23
	3.2.2	REGULATORY GUIDELINES	3-24
	3.2.3	EXISTING NOISE ENVIRONMENT	3-28
		3.2.3.1 EXISTING ENVIRONMENT	3-28
		3.2.3.2 PROJECTED ENVIRONMENT WITHOUT THE PROPOSED PROJECT	3-28
	3.3 REFERENCES: AIR RESOURCES		3-33

TABLE OF CONTENTS
(Continued, Page 4 of 7)

Section			Page
4.0	GEOTECHNICAL RESOURCES		4-1
	4.1 THE AFFECTED ENVIRONMENT		4-1
		4.1.1 REGIONAL DESCRIPTION	4-1
		4.1.1.1 GEOMORPHOLOGY	4-1
		4.1.1.2 SOLUTION FEATURES	4-1
		4.1.1.3 STRATIGRAPHY	4-1
		4.1.1.4 STRUCTURAL GEOLOGY	4-3
		4.1.1.5 SEISMICITY	4-6
		4.1.2 SITE-SPECIFIC DESCRIPTION--GEOLOGY	4-6
		4.1.2.1 EOCENE SERIES	4-6
		4.1.2.2 OLIGOCENE SERIES	4-10
		4.1.2.3 MIOCENE SERIES	4-10
		4.1.2.4 PLIOCENE TO RECENT--UNDIFFERENTIATED CLASTICS	4-11
		4.1.3 SITE-SPECIFIC DESCRIPTION--SOILS	4-12
		4.1.3.1 METHODS OF INVESTIGATION	4-15
		4.1.3.2 DESCRIPTION OF SOILS	4-15
	4.2 REFERENCES: GEOTECHNICAL RESOURCES		4-23
5.0	RADIATION		5-1
	5.1 THE AFFECTED ENVIRONMENT		5-1
		5.1.1 REGIONAL DESCRIPTION	5-1
		5.1.1.1 URANIUM, RADIOISOTOPES AND EXPOSURE	5-2
		5.1.1.2 RADIOISOTOPES AND PHOSPHATE DEPOSITS	5-5
		5.1.1.3 BACKGROUND RADIATION	5-8
		5.1.2 SITE-SPECIFIC DESCRIPTION	5-9
		5.1.2.1 EXTERNAL GAMMA RADIATION	5-9
		5.1.2.2 SURFACE MATERIALS	5-11
		5.1.2.3 SUBSURFACE MATERIALS	5-11
		5.1.2.4 GROUND WATER	5-18
		5.1.2.5 SURFACE WATER	5-19
	5.2 REFERENCES: RADIATION		5-25
6.0	GROUND WATER		6-1
	6.1 THE AFFECTED ENVIRONMENT		6-1

TABLE OF CONTENTS
(Continued, Page 5 of 7)

Section			Page
	6.1.1	REGIONAL DESCRIPTION--QUANTITY	6-1
	6.1.2	SITE-SPECIFIC DESCRIPTION--QUANTITY	6-8
		6.1.2.1 SHALLOW AQUIFER	6-12
		6.1.2.2 SECONDARY ARTESIAN AQUIFER	6-17
		6.1.2.3 FLORIDAN AQUIFER	6-22
		6.1.2.4 RECHARGE AND WATER MOVEMENT	6-32
		6.1.2.5 SUMMARY	6-33
	6.1.3	REGIONAL DESCRIPTION--QUALITY	6-39
		6.1.3.1 SHALLOW AOUIFER	6-41
		6.1.3.2 SECONDARY ARTESIAN AQUIFER	6-41
		6.1.3.3 FLORIDAN AQUIFER	6-42
	6.1.4	SITE-SPECIFIC DESCRIPTION--QUALITY	6-46
		6.1.4.1 DATA COLLECTION	6-46
		6.1.4.2 DATA ASSESSMENT	6-48
		6.1.4.3 SUMMARY	6-62
	6.2	REFERENCES: GROUND WATER	6-65
7.0	SURFACE WATER		7-1
	7.1	THE AFFECTED ENVIRONMENT	7-1
	7.1.1	REGIONAL DESCRIPTION--QUANTITY	7-1
	7.1.2	SITE-SPECIFIC DESCRIPTION--QUANTITY	7-4
		7.1.2.1 BASIN DESCRIPTIONS	7-4
		7.1.2.2 DATA COLLECTION	7-7
		7.1.2.3 DATA ASSESSMENT	7-9
	7.1.3	REGIONAL DESCRIPTION--QUALITY	7-20
		7.1.3.1 HORSE CREEK	7-20
		7.1.3.2 PEACE RIVER	7-24
	7.1.4	SITE-SPECIFIC DESCRIPTION--QUALITY	7-27
		7.1.4.1 DATA COLLECTION	7-27
		7.1.4.2 DATA ASSESSMENT	7-28
		7.1.4.3 SUMMARY	7-67
	7.2	REFERENCES: SURFACE WATER	7-70
8.0	AQUATIC ECOLOGY		8-1
	8.1	THE AFFECTED ENVIRONMENT	8-1
	8.1.1	REGIONAL DESCRIPTION	8-1

TABLE OF CONTENTS
(Continued, Page 6 of 7)

Section			Page
	8.1.2	SITE-SPECIFIC DESCRIPTION	8-2
		8.1.2.1 HORSE CREEK	8-4
		8.1.2.2 BRUSHY CREEK	8-4
		8.1.2.3 SHIRTTAIL BRANCH	8-5
		8.1.2.4 DOE BRANCH	8-5
		8.1.2.5 PLUNDER BRANCH	8-6
		8.1.2.6 COON'S BAY BRANCH	8-6
	8.1.3	METHODOLOGY	8-6
		8.1.3.1 PHYTOPLANKTON	8-7
		8.1.3.2 PERIPHYTON	8-7
		8.1.3.3 BENTHIC MACROINVERTEBRATES	8-7
		8.1.3.4 FISH	8-8
	8.1.4	COMMUNITY ANALYSIS	8-8
		8.1.4.1 PHYTOPLANKTON	8-8
		8.1.4.2 PERIPHYTON	8-14
		8.1.4.3 BENTHIC INFAUNA	8-15
		8.1.4.4 EPIFAUNA	8-19
		8.1.4.5 FISH	8-25
	8.1.5	SUMMARY	8-27
	8.2	REFERENCES: AQUATIC ECOLOGY	8-168
9.0		TERRESTRIAL ECOLOGY	9-1
	9.1	THE AFFECTED ENVIRONMENT	9-1
	9.1.1	REGIONAL DESCRIPTION	9-1
	9.1.2	SITE-SPECIFIC DESCRIPTION	9-2
		9.1.2.1 VEGETATION AND WILDLIFE	9-2
		9.1.2.2 WETLAND/DRAINAGE UNIT DESCRIPTIONS	9-46
		9.1.2.3 WETLANDS CLASSIFICATION	9-55
		9.1.2.4 THREATENED AND ENDANGERED SPECIES	9-74
		9.1.2.5 RECREATIONALLY AND COMMERCIALLY IMPORTANT WILDLIFE	9-85
	9.2	REFERENCES: TERRESTRIAL ECOLOGY	9-87
10.0		SOCIOECONOMICS	10-1
	10.1	THE AFFECTED ENVIRONMENT	10-1
	10.1.1	POPULATION, INCOME AND EMPLOYMENT	10-1
		10.1.1.1 POPULATION	10-1
		10.1.1.2 INCOME	10-3

TABLE OF CONTENTS
(Continued, Page 7 of 7)

Section		Page
	10.1.1.3 EMPLOYMENT	10-5
	10.1.1.4 PROJECTIONS	10-7
10.1.2	LAND USE	10-9
	10.1.2.1 LAND USE IN HARDEE COUNTY	10-9
	10.1.2.2 ON-SITE LAND USE	10-12
	10.1.2.3 PRIME AND UNIQUE FARMLAND	10-16
10.1.3	TRANSPORTATION	10-17
	10.1.3.1 HIGHWAY TRANSPORTATION	10-17
	10.1.3.2 RAIL TRANSPORTATION	10-20
	10.1.3.3 WATER TRANSPORTATION	10-21
	10.1.3.4 AIR TRANSPORTATION	10-21
10.1.4	COMMUNITY SERVICES AND FACILITIES	10-21
	10.1.4.1 HOUSING	10-21
	10.1.4.2 SCHOOLS	10-23
	10.1.4.3 FIRE PROTECTION	10-23
	10.1.4.4 POLICE PROTECTION	10-26
	10.1.4.5 HEALTH SERVICES	10-26
	10.1.4.6 RECREATION	10-27
	10.1.4.7 PUBLIC UTILITIES	10-28
10.1.5	PUBLIC FINANCE	10-30
10.1.6	CULTURAL RESOURCES	10-34
	10.1.6.1 OVERVIEW	10-34
	10.1.6.2 ON-SITE RESOURCES	10-36
10.1.7	VISUAL RESOURCES	10-37
10.2	REFERENCES: SOCIOECONOMICS	10-39

APPENDIX A--GROUND WATER QUALITY MONITORING DATA
APPENDIX B--SURFACE WATER QUALITY MONITORING DATA

LIST OF TABLES

Table		Page
2.1.1-1	Physical Composition of the Phosphate Ore	2-2
2.1.5-1	Existing and Post-Reclamation Land Use	2-13
2.3.10-1	Reagent Tankage Requirements	2-42
2.4.4-1	Summary of Sand/Clay Mix Data	2-48
2.6.1-1	Acreage to be Disturbed and Preserved	2-70
2.6.2-1	Landforms Remaining After Mining	2-72
2.6.5-1	Reclamation Sequence for Sand/Clay Landfills	2-96
2.6.5-2	Proposed Reclamation Schedule	2-103
2.6.6-1	Existing and Post-Reclamation Drainage Areas	2-105
3.1.2-1	Monthly and Annual Average Temperatures (°F) at Wauchula and the Proposed CF Mine Site	3-4
3.1.2-2	Monthly and Annual Average Rainfall (inches) at Wauchula and the Proposed CF Mine Site	3-5
3.1.3-1	Federal and State of Florida AAOS and Allowable PSD Increments (ug/m^3)	3-13
3.1.4-1	Summary of Point and Area Source Emissions in Study Area	3-16
3.1.5-1	Summary of 24-Hour Total Suspended Particulate Matter Concentrations Measured on the CF Industries Site, 1976-1981	3-18
3.1.5-2	Ambient Sulfur Dioxide Concentrations Measured on the CF Industries Site, 1976-1981	3-20
3.1.5-3	Ambient Fluoride Concentrations Measured on the CF Industries Site, 1976-1981	3-21
3.2.2-1	Yearly Average Equivalent Sound Levels Requisite to Protect the Public Health and Welfare	3-25
3.2.2-2	Federal Highway Administration Design Noise Level/ Land Use Relationships	3-27
3.2.3-1	1975 Generalized Land Use in Hardee County	3-29
3.2.3-2	Typical Values of Yearly Day-Night Average Sound Level for Various Residential Neighborhoods Where There are No Well-Defined Sources of Noise Other Than Usual Transportation Noise	3-31
4.1.3-1	Characteristics of Site Soils	4-17
4.1.3-2	Hydraulic Conductivity Values for Soils of the Site	4-21
5.1.1-1	Representative Radium-226 Concentrations in Central Florida Phosphate Area Environment	5-7
5.1.2-1	Maximum External Gamma Radiation Dosage Encountered on CF Property	5-12

LIST OF TABLES
(Continued, Page 2 of 6)

Table		Page
5.1.2-2	External Gamma Radiation Measured by TLDs on CF Property From Third Quarter 1981 Through Second Quarter 1982	5-13
5.1.2-3	Radium-226 Analyses of Top Soil, Pasture Grass Samples, and Stream Sediments Collected From the CF Industries Property	5-15
5.1.2-4	Radium-226 Analyses of Core Samples Collected From the CF Industries Property	5-16
5.1.2-5	Summary of Ground Water Ra-226 Average Gross Alpha Data for the CF Site	5-20
5.1.2-6	Summary of Radium-226 Concentration in Surface Water, January 1976 Through March 1981	5-21
5.1.2-7	Summary of Radium-226 Concentration in Surface Water From July 1981 Through June 1982	5-22
5.1.2-8	Summary of Gross Alpha Concentration in Surface Water From July 1981 Through June 1982	5-23
6.1.1-1	Geohydrologic Characteristics of the Lithological Units	6-2
6.1.2-1	Shallow Aquifer Hydrologic Characteristics	6-13
6.1.2-2	Inventory of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Site	6-34
6.1.2-3	Summary of Aquifer and Confining Bed Characteristics	6-40
6.1.3-1	Median Values and Ranges of Water Quality Characteristics for Hardee County	6-43
6.1.4-1	Results of Split Sampling Conducted by CF/ESE on Three Wells, October 1981	6-47
6.1.4-2	Location and Description of Existing Wells Drilled by CF Mining Corporation	6-49
6.1.4-3	Mean Concentrations of Water Quality Data Collected from Shallow Aquifer Wells from July 1981 Through June 1982	6-50
6.1.4-4	Mean Concentration of Water Quality Data Collected From Secondary Artesian Aquifer From July 1981 Through June 1982	6-54
6.1.4-5	Mean Concentration of Water Ouality Data Collected From Floridan Aquifer From July 1981 Through June 1982	6-57
6.1.4-6	Summary of Ground Water Quality Data Collected During 1975 Pump Tests	6-58
7.1.1-1	Summary of Pertinent Data From USGS Stations in the Region	7-2
7.1.2-1	Annual Range of Discharges Recorded on Streams Draining CF Property, January 1976 Through March 1982	7-10
7.1.2-2	Drainage Areas and Average Flows for Each Surface Water Sampling Station	7-12
7.1.2-3	Monthly Rainfall on CF Property, July 1981 Through June 1982	7-13
7.1.2-4	Summary of Instantaneous Flows Measured at Surface Water Stations	7-19

LIST OF TABLES
(Continued, Page 3 of 6)

Table		Page
7.1.3-1	Comparison Summary of Selected Water Quality Parameters Along Horse Creek	7-22
7.1.3-2	Summary of Water Quality Data for Horse Creek Near Arcadia (USGS Station 02297310)	7-23
7.1.3-3	Summary of Water Quality Data for Peace River at Zolfo Springs (USGS Station 02295637)	7-25
7.1.3-4	Comparison Summary of Water Quality Data Along Peace River	7-26
7.1.4-1	Surface Water Quality Parameters	7-29
7.1.4-2	Summary of Water Quality Data Collected at WQ-11 and WQ-9 From July 1981 Through September 1981	7-32
7.1.4-3	Summary of Water Quality Data Collected at Station WQ-6	7-33
7.1.4-4	Summary of Water Quality Data Collected on Brushy Creek Downstream of Complex II	7-34
7.1.4-5	Summary of Water Quality Data Collected At Station MCC-12	7-35
7.1.4-6	Summary of Water Quality Data Collected at WQ-10 and WQ-8, July 1981 Through June 1982	7-39
7.1.4-7	Summary of Water Quality Data Collected at WQ-5, July 1981 Through June 1982, and WQ-12, July 1981 Through September 1981	7-40
7.1.4-8	Summary of Water Quality Data Collected at WQ-5 by CF Industries	7-41
7.1.4-9	Summary of Water Quality Data Collected at WQ-1 and WQ-7, September 1981 through June 1982	7-45
7.1.4-10	Summary of Water Quality Data Collected at WQ-1 by CF Industries	7-46
7.1.4-11	Summary of Water Quality Data Collected at WQ-7 by CF Industries	7-47
7.1.4-12	Summary of Water Quality Data Collected at WQ-4, September 1981 through June 1982	7-48
7.1.4-13	Summary of Water Quality Data Collected at WQ-4 by CF Industries	7-49
7.1.4-14	Summary of Water Quality Data Collected at WQ-2 and WQ-3, September 1981 through June 1982	7-50
7.1.4-15	Summary of Water Quality Data Collected at WQ-2 by CF Industries	7-51
7.1.4-16	Summary of Water Quality Data Collected at WQ-3 at CF Industries	7-52
7.1.4-17	Summary of Water Quality Data Collected at WQ-13 and WQ-14, September 1981 through June 1982	7-57
7.1.4-18	Summary of Water Quality Data Collected at Stations SW-11 and MCC-5	7-60
7.1.4-19	Summary of Violations of Class III Standards Observed During EIS Monitoring	7-61
7.1.4-20	Summary of Violations of Class III Standards Measured in Streams Draining CF Property	7-63
7.1.4-21	Summary of Water Quality Data Collected from CF's Mine Recirculation System at Stations MDW-1 and MDW-2	7-66
7.1.4-22	Summary of Chemical Analyses Performed on Stream Sediment Samples	7-68

LIST OF TABLES
(Continued, Page 4 of 6)

Table		Page
8.1.4-1	Presence/Absence Matrix of Phytoplankton Taxa Identified from CF Complex II Site, July 1981	8-28
8.1.4-2	Presence/Absence Matrix of Phytoplankton Taxa Identified from CF Complex Site II, August 1981	8-30
8.1.4-3	Presence/Absence Matrix of Phytoplankton Taxa Identified from CF Complex II Site, September 1981	8-32
8.1.4-4	Presence/Absence Matrix of Phytoplankton Taxa Identified from CF Complex II Site, October 1981	8-34
8.1.4-5	Presence/Absence Matrix of Phytoplankton Taxa Identified from CF Complex II Site, February 1982	8-36
8.1.4-6	Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981	8-39
8.1.4-7	Phytoplankton Abundance, Number of Taxa, Species Diversity, Richness and Evenness Indices for CF Hardee Complex II Sampling Stations	8-47
8.1.4-8	Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981	8-49
8.1.4-9	Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981	8-57
8.1.4-10	Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981	8-65
8.1.4-11	Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982	8-73
8.1.4-12	Presence/Absence Matrix of Periphyton Taxa Identified from CF Complex II Site, July 1981	8-85
8.1.4-13	Presence/Absence Matrix of Periphyton Taxa Identified from CF Complex II Site, August 1981	8-87
8.1.4-14	Presence/Absence Matrix of Periphyton Taxa Identified from CF Complex II Site, September 1981	8-89
8.1.4-15	Presence/Absence Matrix of Periphyton Taxa Identified from CF Complex II Site, October 1981	8-91
8.1.4-16	Presence/Absence Matrix of Periphyton Taxa Identified from CF Complex II Site, February 1982	8-94
8.1.4-17	Presence/Absence Matrix of Benthic Infaunal Taxa Identified from CF Complex II Site, July 1981	8-97
8.1.4-18	Presence/Absence Matrix of Benthic Infaunal Taxa Identified from CF Complex II Site, August 1981	8-98
8.1.4-19	Presence/Absence Matrix of Benthic Infaunal Taxa Identified from CF Complex II Site, September 1981	8-100
8.1.4-20	Presence/Absence Matrix of Benthic Infaunal Taxa Identified from CF Complex II Site, October 1981	8-102
8.1.4-21	Presence/Absence Matrix of Benthic Infaunal Taxa Identified from CF Complex II Site, February 1982	8-103
8.1.4-22	Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981	8-104

LIST OF TABLES
(Continued, Page 5 of 6)

Table		Page
8.1.4-23	Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981	8-109
8.1.4-24	Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981	8-114
8.1.4-25	Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, October 1981	8-120
8.1.4-26	Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, February 1982	8-123
8.1.4-27	Shannon-Weaver Diversity (H'), Margalef's Species Richness (Y), and Pielou's Evenness(E) Indices for Benthic Infauna Identified from CF Complex II Site, July 1981 to February 1982	8-126
8.1.4-28	Presence/Absence Matrix of Benthic Epifaunal Taxa Identified from CF Complex II Site, July 1981	8-128
8.1.4-29	Presence/Absence Matrix of Benthic Epifaunal Taxa Identified from CF Complex II Site, August 1981	8-130
8.1.4-30	Presence/Absence Matrix of Benthic Epifaunal Taxa Identified from CF Complex II Site, September 1981	8-134
8.1.4-31	Presence/Absence Matrix of Benthic Epifaunal Taxa Identified from CF Complex II Site, October 1981	8-139
8.1.4-32	Presence/Absence Matrix of Benthic Epifaunal Taxa Identified from CF Complex II Site, February 1981	8-143
8.1.4-33	Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981	8-146
8.1.4-34	Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981	8-151
8.1.4-35	Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981	8-156
8.1.4-36	Shannon-Weaver Diversity, Margalef's Species Richness, and Pielou's Evenness Indices Calculated for Hester-Dendy Multiplate Samplers	8-161
8.1.4-37	Species Presence/Absence Matrix by Transect and Habitat, Mitchell Hammock, February 1982	8-162
8.1.4-38	Presence/Absence Matrix of Fish and Amphibians Identified from CF Complex II Site, August 1981 to February 1982	8-167
9.1.2-1	Legend, Acreages, and Percentages for CF Industries Hardee Phosphate Complex II Proposed Mine Site Vegetation Map	9-3
9.1.2-2	Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-7

LIST OF TABLES
(Continued, Page 6 of 6)

Table		Page
9.1.2-3	Amphibians and Reptiles Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-30
9.1.2-4	Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-32
9.1.2-5	Terrestrial Mammal Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-38
9.1.2-6	EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-62
9.1.2-7	Summary of EPA Category Acreages by Creek/Drainage for CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-68
9.1.2-8	Threatened or Endangered Plant Species Which May Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-76
9.1.2-9	Status of Endangered (E), Threatened (T), and Species of Special Concern (S) Wildlife Species Whose Ranges Include the CF Industries Hardee Phosphate Complex II Proposed Mine Site	9-79
10.1.1-1	Population and Growth Rates for Hardee County, the Central Florida Region, and Florida	10-2
10.1.1-2	Per Capital Income on a Place-of-Residence Basis, 1975-1982	10-4
10.1.1-3	Estimated Average Monthly Employment in Hardee County and the Region by Industrial Sector, 1982	10-6
10.1.1-4	Population Projections for the State, Region, and Hardee County	10-8
10.1.2-1	1975 Generalized Land Use in Hardee County	10-10
10.1.2-2	Present On-Site Land Use	10-13
10.1.3-1	Annual Average Daily Traffic Counts for Points on Major Highways in Hardee County, 1983 and 1984	10-19
10.1.4-1	Housing Characteristics for Year-Round Housing Stock in the Region	10-22
10.1.4-2	Building Permit Activity, Number of New Housing Units Authorized	10-24
10.1.4-3	Hardee County School District--Selected Characteristics	10-25
10.1.5-1	Revenues and Expenditures of County Governments in Region--Fiscal Year 1982-1983	10-31
10.1.5-2	Revenues and Expenditures of Municipal Governments in Hardee County--Fiscal Year 1982-1983	10-32
10.1.5-3	Millage Rates for Hardee County and Municipalities	10-33

LIST OF FIGURES

Figure		Page
1.1-1	General Location of Central Florida Phosphate District and the CF Industries Existing Hardee Phosphate Complex I and Proposed Hardee Phosphate Complex II	1-2
1.1-2	Proposed Hardee Phosphate Complex II	1-3
2.1-1	Initial Start-Up Areas for Plant Construction, Waste Disposal, and Mining	2-4
2.1-2	CF Industries' Proposed Preservation Areas (Category I-A Wetlands)	2-6
2.1-3	Perimeter Ditch Around Preserved Wetlands	2-8
2.1-4A	Conceptual Dragline Crossing at Horse Creek Section 32, T33S, R23E	2-9
2.1-4B	Conceptual Dragline Crossing at Horse Creek Section 32, T33S, R23E	2-10
2.1-5	Dragline Mining Sequence	2-15
2.1-6	Watershed Disturbed Acreage vs. Undisturbed and Reclaimed Acreage (for those Watersheds > 1,000 acres)	2-21
2.1-7	Total Tract Disturbed Acreage vs. Undisturbed and Reclaimed Acreage	2-22
2.2-1	Schematic Flow Diagram for Slurried Matrix Transport	2-24
2.3-1	Location of Plant Site Alternatives	2-27
2.3-2	Location of Plant Site 1	2-28
2.3-3	General Plant Layout	2-29
2.3-4	Generalized Process Flowsheet	2-31
2.3-5	Schematic of Washer Section	2-32
2.3-6	Schematic of Sizing Section	2-34
2.3-7	Schematic of Flotation Plant Area	2-35
2.3-8	Schematic of Wet Rock Storage Area	2-37
2.3-9	Reagent Area of Beneficiation Plant	2-41
2.4-1A	Waste Disposal Plan	2-49
2.4-1B	Waste Disposal Plan	2-50
2.5-1	Mine Water Balance (Daily Average)	2-53
2.5-2	Conceptual Waste Disposal and Water Recirculation Plan for Initial Start-Up	2-56
2.5-3	Typical Production Well	2-60
2.6-1	Reclamation of Sand/Clay Mix Areas	2-75
2.6-2	Reclamation of Sand Tailings Fill Areas	2-77
2.6-3	Conceptual Land-and-Lakes Reclamation	2-78
2.6-4	Post-Reclamation Land Use: Complex II, Eastern Section	2-80
2.6-5	Post-Reclamation Land Use: Complex II, Western Section	2-81
2.6-6	Pre-Mining Topography and Drainage Boundaries: Complex II, Eastern Section	2-85
2.6-7	Pre-Mining Topography and Drainage Boundaries: Complex II, Western Section	2-85
2.6-8	Post-Reclamation Topography: Complex II, Eastern Section	2-87
2.6-9	Post-Reclamation Topography: Complex II, Western Section	2-88
2.6-10	Reclamation Sequence Year 10: Complex II, Eastern Section	2-97
2.6-11	Reclamation Sequence Year 10: Complex II, Western Section	2-98

LIST OF FIGURES
(Continued, Page 2 of 3)

Figure		Page
2.6-12	Reclamation Sequence Year 21: Complex II, Eastern Section	2-99
2.6-13	Reclamation Sequence Year 21: Complex II, Western Section	2-100
2.6-14	Reclamation Sequence Year 27: Complex II, Eastern Section	2-101
2.6-15	Reclamation Sequence Year 27: Complex II, Western Section	2-102
3.1-1	CF Air and Meteorological Monitoring Stations	3-2
3.1-2	Five Year (1971-1975) Annual Average Wind Rose for the NWS Station at TIA	3-7
3.1-3	Five Year (1971-1975) Seasonal Average Wind Roses for the NWS Station at TIA	3-8
3.1-4	Annual Average Wind Rose for the CF Site, 1981	3-9
3.1-5	Seasonal Average Wind Roses for the CF Site, 1981	3-10
3.2-1	Transportation Facilities in Hardee County	3-30
3.2-2	Examples of Outdoor Day-Night Sound Level in dB (RE 20 Micropascals) Measured at Various Locations	3-32
4.1-1	Physiographic Features in Site Region	4-2
4.1-2	Generalized Stratigraphic Column	4-4
4.1-3	Regional Structural Features	4-5
4.1-4	Summary of Site Geology	4-7
4.1-5	Isopach Map Showing Thickness of Material Between Ore Zone and Hawthorn Limestone	4-13
4.1-6	Generalized Cross Section of Upper Stratigraphy on Complex II	4-14
4.1-7	Reconnaissance Soil Survey Map of Site	4-16
5.1-1	Uranium-238 Decay Series	5-4
5.1-2	Average Uranium Concentrations as U_3O_8 Typical Central Florida Phosphate District Profile	5-6
5.1-3	Location of Environmental Monitoring Stations	5-10
5.1-4	Locations of Core Borings, Soils Samples, and Pasture Grass Samples Collected on CF Property	5-14
6.1-1	Seasonal Fluctuations of the Floridan Aquifer Potentiometric Surface in a USGS Well	6-5
6.1-2	Potentiometric Surface of Floridan Aquifer, May 1981	6-6
6.1-3	Potentiometric Surface of Floridan Aquifer, September 1981	6-7
6.1-4	Stratigraphic Column, Deep Floridan Test Well	6-10
6.1-5	Location of Hydrologic Data Collection Stations	6-11
6.1-6	Hydrograph of Shallow Aquifer Well SA-17 on CF Complex II, January 1976 Through June 1982	6-15
6.1-7	Hydrographs of Shallow Aquifer Wells on CF Property, July 1981 Through June 1982	6-16
6.1-8	Potentiometric Surface of Shallow Aquifer in September 1981	6-18
6.1-9	Potentiometric Surface of Shallow Aquifer in May 1982	6-19
6.1-10	Hydrographs of Secondary Artesian Aquifer Wells on CF Property, July 1981 Through June 1982	6-21

LIST OF FIGURES
(Continued, Page 3 of 3)

Figure		Page
6.1-11	Summary of Flowmeter Data Indicating Depths of Principal Water-Bearing Zones at the DF Well	6-24
6.1-12	Hydrograph of Floridan Aquifer Well LF-4 on CF Complex II, February 1976 Through June 1982	6-29
6.1-13	Hydrographs of Floridan Aquifer Wells on CF Complex II, July 1981 Through June 1982	6-31
6.1-14	Location of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Area	6-38
6.1-15	Depth to Base of Potable Water Zone in Floridan Aquifer, 1975	6-44
7.1-1	Peace River Drainage Basin	7-3
7.1-2	Drainage Basin Areas on Complex II Property	7-5
7.1-3	Location of Hydrologic Data Collection Stations	7-8
7.1-4	Hydrograph of Average Daily Flow at Station WQ-3 (Payne Creek) Exiting CF Industries Property, June 1981 Through June 1982	7-15
7.1-5	Hydrograph of Average Daily Flow at Station WQ-4 (Gum Swamp Branch), Entering CF Property From June 1981 Through June 1982	7-16
7.1-6	Hydrograph of Average Daily Flow at Station WQ-7 (Hickey Branch) Exiting CF Property, June 1981 Through June 1982	7-17
7.1-7	Hydrograph of Average Daily Flow at Station WQ-11 (Horse Creek), August 1981 Through June 1982	7-18
7.1-8	Locations of Regional Water Quality Stations	7-21
7.1-9	Locations of Point Source Discharges on Complex I	7-53
8.1-1	Aquatic Ecology Sampling Station Locations	8-3
9.1-1	Vegetation Map	9-4
9.1-2	Wetland/Drainage Study Units	9-47
9.1-3	Wetlands Delineation Map	9-60
10.1-1	On-Site Cultural Features	10-14
10.1-2	Transportation Facilities in Hardee County	10-18

1.0 INTRODUCTION

1.1 DESCRIPTION OF PROPOSED PROJECT

CF Industries, Inc. (CF) currently owns and operates phosphate mining and beneficiation facilities, known as the Hardee Phosphate Complex I Mine, in northwest Hardee County, Florida. These existing operations were initiated in 1978 and are planned to continue through 1997. Approximately one million tons per year of phosphate rock are currently being processed at this mine.

CF is proposing to develop and operate a new phosphate mine and beneficiation facilities on a 14,994-acre site in Hardee County just south of its existing mining operation. The proposed operation will be referred to as the Hardee Phosphate Complex II Mine. Figure 1.1-1 shows the general location of CF's existing mine and the proposed mine. The proposed mine site is located east of Horse Creek and south of State Road 62. The site is rectangular in shape, extending about 10 miles in a east-west direction and about 2.5 miles north-south. Figure 1.1-2 presents a more detailed view of the proposed mine site, including CF's planned locations for the beneficiation plant and the 300-acre site planned for the initial clay settling area.

According to CF's proposed Plan of Action, construction of the beneficiation plant, adjoining storage and settling areas, and initial clearing and site preparation activities at the proposed mine are scheduled to begin in 1988, with mining commencing in 1989. The mining operations will be designed to produce approximately 2 million tons per year of phosphate rock during the first phase of mining, utilizing a single dragline operation. During the second phase (beginning about 1997) and for the remainder of the projected 27-year life of the mine, the operation will be expanded to 4 million tons per year with the addition of a second dragline. The phosphate rock produced from this new facility would replace CF's rock supply currently provided by another phosphate mining company under two long-term contracts with expiration dates in 1984 and 1988, respectively.

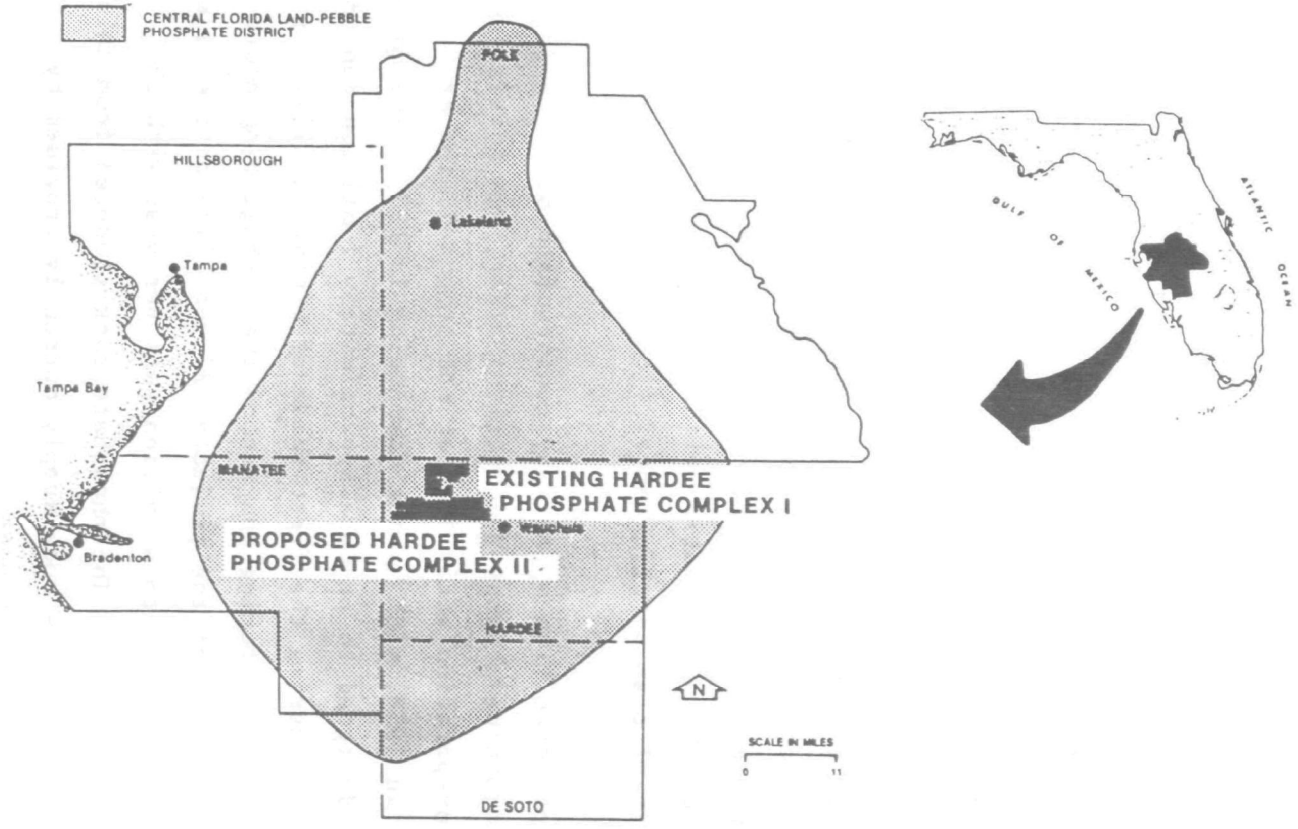
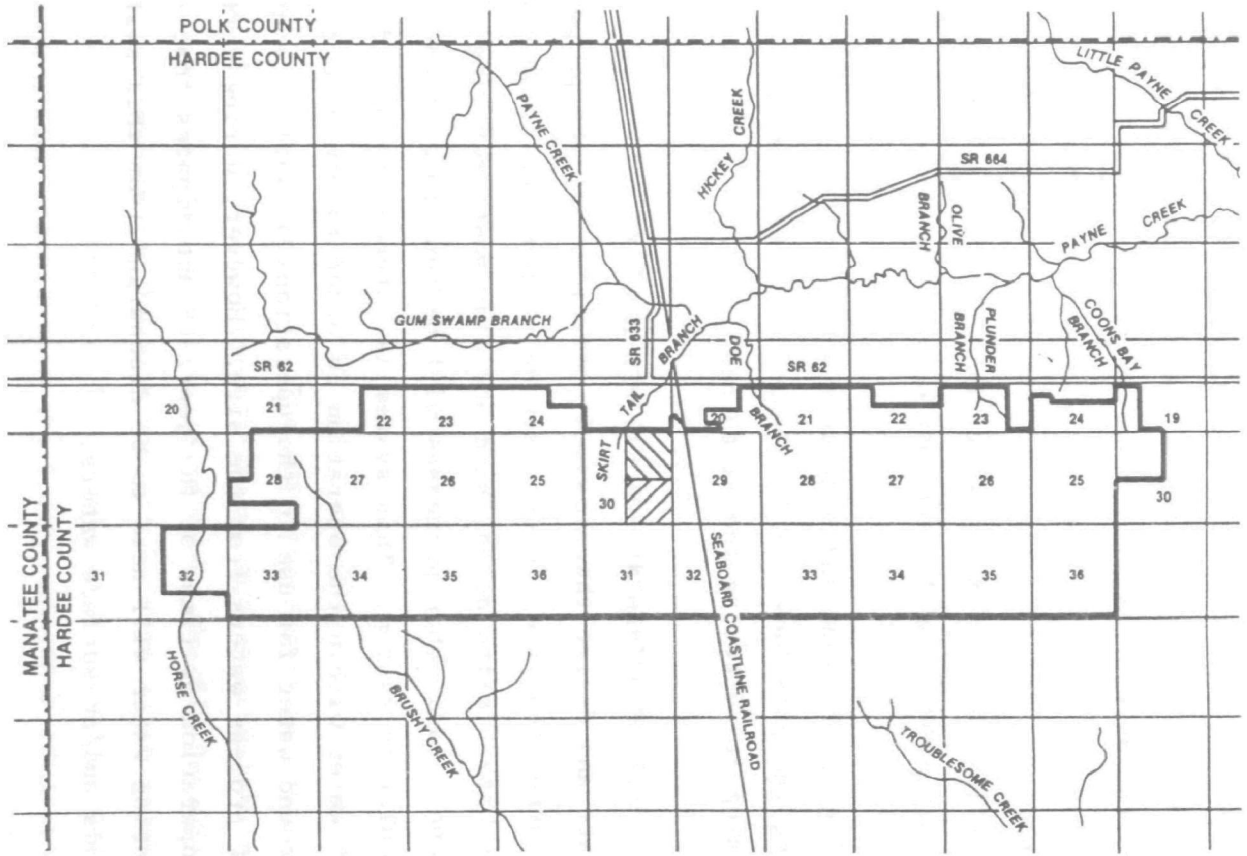


Figure 1.1-1
GENERAL LOCATION OF CENTRAL FLORIDA PHOSPHATE DISTRICT AND THE CF INDUSTRIES EXISTING HARDEE PHOSPHATE COMPLEX I AND PROPOSED HARDEE PHOSPHATE COMPLEX II

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II



SOURCES: CF INDUSTRIES, 1981.
ESE, 1984.

Figure 1.1-2
PROPOSED HARDEE PHOSPHATE COMPLEX II

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

The proposed operations will involve mining and processing methods which are commonly used in the extraction and processing of phosphate ore in the Central Florida Land-Pebble Phosphate District. Major phases of the proposed operation will include:

1. Clearing and preparing the site for operations and constructing the processing plant, initial settling areas, well fields, water and wastewater control and recirculation systems, transportation systems, and other ancillary operations;
2. Extracting the phosphate ore-bearing matrix by electric-powered dragline;
3. Transporting the matrix to the central processing plant;
4. Physically separating the phosphate ore from the sand and clay wastes;
5. Disposing of the sand and clay wastes;
6. Shipping the phosphate ore from the facility by rail; and
7. Reclaiming or restoring the disturbed areas.

1.2 REQUIREMENT FOR EIS PREPARATION

CF plans to locate and design the proposed operations for the proposed mine in such a manner that the process wastewater generated from mine dewatering, phosphate beneficiation, sand and clay waste settling, surface water runoff, and other processes will be contained in an extensive recirculation system. This system is intended to provide for maximum reuse of water within the operation in order to minimize the withdrawal of ground water for use in the operations as well as minimize the discharge of process waters from the site. However, during certain periods of the operation or times of the year, CF anticipates that some of the recirculating water will need to be discharged from this system to nearby wetlands and/or surface waters.

The U.S. Environmental Protection Agency (EPA), Region IV, has determined that due to these wastewater discharges, the proposed CF mining operations at the Hardee Phosphate Complex II mine will constitute a "new source" discharge facility under Section 306 of the Federal Clean

Water Act of 1977 (FCWA), as amended. As a new source facility, the proposed CF operations are subject to the National Pollutant Discharge Elimination System (NPDES) new source effluent limitations and permit requirements under Section 402 of the FCWA. Also, it is possible that the proposed operations will be subject to the dredge and fill permit requirements of the U.S. Army Corps of Engineers (COE) under Section 404 of the FCWA. The issuance of a NPDES permit by EPA and/or a dredge and fill permit by COE may represent major federal actions, significantly affecting the quality of the human environment. Therefore, prior to issuance, permit approvals may be subject to the requirements of the National Environmental Policy Act of 1969 (NEPA) requiring preparation of a detailed Environmental Impact Statement (EIS).

EPA Region IV has determined that the proposed CF phosphate mining and processing operations represents a new source and major federal action significantly affecting the quality of the human environment under NEPA. Therefore, as a prerequisite to granting the NPDES permits, a detailed, site-specific EIS on the proposed CF phosphate mining operation in Hardee County, Florida, must be prepared.

EPA Region IV accepted the lead agency responsibility for preparation of this Environmental Impact Statement.

The EIS document is prepared as an assessment of the impacts of the proposed mining operation. The EIS includes an investigation and evaluation of the environmental issues and alternatives associated with the proposed operation. In this process, the EIS provides a vehicle for public and agency involvement and establishes a framework for assessment of project-related issues. The result is a logical, orderly decision-making process upon which EPA and other regulatory agencies can base their decisions regarding the issuance of applicable permits and approvals.

In order to expedite the EIS preparation process, EPA and CF elected to comply with the NEPA requirements by a "Third Party" consultant

arrangement. Under this arrangement, EPA (as lead federal agency) and CF (as applicant for federal permit approval) entered into a Memorandum of Understanding (MOU) whereby CF engaged and retained at its expense, an independent Third Party consultant acceptable to EPA, for the preparation of the detailed EIS. EPA retained responsibility for content of the EIS and therefore, direct supervision, review, and approval of all work performed by the Third Party consultant. Also, under this arrangement, other concerned regulatory agencies (such as COE) served as cooperating agencies, reviewing and commenting on the EIS to EPA as the lead agency.

Environmental Science and Engineering, Inc. (ESE) was approved by EPA to serve as CF's Third Party consultant. ESE's role involved the assimilation and analysis of all environmental data for the EIS. All work products generated by ESE were submitted simultaneously to EPA and CF for review. Any technical changes in these work products requested by CF required EPA approval. Any technical direction given to ESE by EPA which was beyond the scope of work defined in ESE's contract with CF had to be approved by CF prior to commencing of work efforts. During the project, EPA, CF, and ESE interacted freely with one another as a team.

1.3 STATUS OF OTHER PERMITTING REQUIREMENTS

In addition to the previously discussed requirements, CF was responsible for performing environmental studies for fulfilling certain other federal, state, and local requirements and conditions needed to obtain applicable permits and regulatory approvals, prior to initiation of the proposed operations at the Hardee Phosphate Complex II mine.

CF initiated the environmental permitting program for its Hardee County phosphate operations in the mid-1970s by conducting studies on both the existing mine and proposed mine sites. These studies involved mining, reclamation, hydrology, geology, air quality, radiation, aquatic and terrestrial ecology, water quality, socioeconomics, and archaeology. To date, the results of these studies have been used primarily by

CF Industries to fulfill the following three key regulatory requirements:

1. Consumptive Use Permit--Approved by the Southwest Florida Water Management District (SWFWMD) on March 10, 1976;
2. Application for Development Approval/Development of Regional Impact (ADA/DRI)--Approved Development Order issued by Hardee County, June 30, 1976; and
3. Mineral Extraction Permit and Zoning Variance Approval--Approved by Hardee County, June 30, 1976.

These previously completed requirements, which have received favorable governmental approvals, involved all the lands which CF owned and planned to mine in Hardee County. Therefore, the regulatory approvals of these three requirements covered both the existing mine and the proposed mine site. The following sections briefly describe these previously completed regulatory requirements.

1.3.1 CONSUMPTIVE USE OF WATER PERMIT

Under the Florida Water Resources Act of 1972, Chapter 373, Florida Statutes, regional water management districts are charged with the responsibility of regulating water usage in the state. The regional district with jurisdiction in the proposed mining area is Southwest Florida Water Management District (SWFWMD). Under Chapter 16J-2, Florida Administrative Code (FAC), SWFWMD requires a permit for the consumptive use of water if the withdrawal during any single day is to exceed one million gallons. Since the CF mining operations required water amounts in excess of these threshold limits, a SWFWMD Consumptive Use of Water Permit was required.

In 1975, CF conducted extensive aquifer pump tests on the proposed site to determine the effects of an average annual withdrawal of 15.74 million gallons of water per day from four production wells and a surface reservoir, and a maximum daily withdrawal of 20.20 million gallons per day.

Based on the results of these studies, CF prepared and submitted an Application for Consumptive Use permit to SWFWMD on January 2, 1976. After reviewing the application, SWFWMD granted CF a permit for the consumptive use of ground and surface water in the amount cited above, subject to certain terms and conditions. Thus, CF fulfilled the requirements and obtained a Consumptive Use Permit for SWFWMD for its operations.

1.3.2 APPLICATION FOR DEVELOPMENT APPROVAL/DEVELOPMENT OF REGIONAL IMPACT

According to Rule 22F-2.06, FAC, if a mining operation will disturb more than 100 acres per year or consume more than 3 million gallons per day (mgd) of water, the operation will be presumed to be a Development of Regional Impact (DRI). In addition, under Chapter 380, Florida Statutes, the developer proposing to construct the DRI project must prepare an Application for Development Approval (ADA) which includes a comprehensive assessment of the regional impacts that the proposed development will have on the environment. This DRI application is reviewed, and recommendations or approvals are made by various state, regional, and local agencies. However, the DRI application must be ultimately approved by the local government (usually the county) prior to beginning construction.

The CF mining operations required preparation of an ADA/DRI which needed approval of Hardee County. The regional planning council responsible for reviewing and making recommendations to the county concerning the accuracy and sufficiency of the information in the ADA/DRI and its approval was the Central Florida Regional Planning Council (CFRPC).

As part of its environmental permitting program, CF had an ADA/DRI with special studies appendices prepared which was submitted to Hardee County on June 30, 1976. After review of the ADA/DRI, Hardee County adopted Development Orders which approved the CF application, subject to certain conditions. Thus, CF fulfilled the requirements of the ADA/DRI from Hardee County.

1.3.3 HARDEE COUNTY MINING AND EARTH MOVING ORDINANCE AND ZONING VARIANCE

Under County Ordinance No. 73-6, Amendment No. 1, Hardee County requires that a permit for Mineral Extraction be obtained for proposed mining operations within its boundaries. In addition, the county requires a zoning variance be applied for and obtained to classify proposed mine lands as M-1, Mining and Earth Moving District.

In order to fulfill the requirements of the mining ordinance, CF had a Mining and Reclamation Master Plan prepared in conjunction with the ADA/DRI. The master plan was submitted to Hardee County with the ADA/DRI on June 30, 1976, for review and was approved by the county subject to the same conditions as the ADA/DRI. CF also applied for and was granted the necessary zoning variance by the county for its phosphate mining operations.

1.4 THE SUPPLEMENTAL INFORMATION DOCUMENT

Primary inputs for EIS preparation include (1) the environmental data collected and the analyses performed in conjunction with previous permitting efforts for the existing and proposed CF mining operations, and (2) the data from CF's environmental monitoring program at the mine sites in Hardee County. ESE was responsible for verifying the technical quality of these data prior to use in the EIS. In addition, since CF modified the mining and reclamation plans which were included in the ADA/DRI and Master Mine Plan, ESE was responsible for reassessing and/or updating the potential impacts of the proposed operations as well as feasible alternatives to the proposed operations.

This Supplemental Information Document (SID) has been prepared to supplement the Environmental Impact Statement for CF's Hardee Phosphate Complex II mine. It includes, by technical discipline, findings of fact and substantive data and analyses to support the evaluations and impact assessments within the EIS. This SID contains the technical data base developed from field observations, laboratory investigations,

mathematical models and analyses, and previously existing data. The SID includes a description of the Proposed Action and data for the following technical disciplines:

- Air Resources
- Geotechnical Resources
- Radiation
- Ground Water
- Surface Water
- Aquatic Ecology
- Terrestrial Ecology
- Socioeconomics

Each technical section of this SID is supported by a bibliography of reference materials used to develop the data base for the EIS.

2.0 CF INDUSTRIES' PROPOSED ACTION

2.1 DRAGLINE MINING OPERATION

2.1.1 DEPOSIT GEOLOGY

The Ore-Bearing Zone (Matrix) on CF Industries' Hardee County tract constitutes part of the Bone Valley and Hawthorn Formations, deposited between 2-15 million years ago when shallow seas inundated much of the Florida Peninsula during the Miocene and Pliocene epochs. The matrix, averaging 23.7 feet in thickness, is covered by an overburden of quartz sand, clay, gravel, and a thin layer of topsoil. This overburden has an average thickness of 15.4 feet. An underlying bedrock unit is composed of various limestones overlaid by bedclays. The matrix varies both in composition and in distribution over the tract, typical for phosphorite ore bodies in Hardee County.

The ore zone is characterized by phosphate pebbles and fine phosphatic sand dispersed in a nonphosphatic, sandy clay. The percentage breakdown of this zone is illustrated in Table 2.1.1-1. Only about 20 percent phosphate product is present in the matrix material, the remainder being regarded as waste materials. The primary phosphate mineral is collophane, a calcium magnesium fluorapatite that contains small amounts of other minerals.

In comparison to the phosphate ore being mined in Polk and Hillsborough Counties, CF Industries' ore is of lower grade and has finer sized particles. However, both the phosphate product and the clay/sand by-product content of this ore are typical of ore deposits found throughout the Southern District. The total reserves of phosphate rock product which would be recoverable by CF Industries in this project amount to 97.0 million short tons.

2.1.2 LAND CLEARING

Early construction, including receipt and erection of the dragline, was approved by the EPA. Clearing of existing vegetation for this approved activity was accomplished as follows:

Table 2.1.1-1. Physical Composition of the Phosphate Ore

	Percent
Phosphate (Pebble)	8.51
Phosphate (Concentrate)	10.97
Waste Clay	19.38
Waste Sand	61.14
TOTAL	100.00

Source: CF Industries, 1983.

- Dragline assembly areas;
- Powerline (construction power);
- Partial rail spur; and
- Access road.

Prior to mining, land clearing will be required for construction of the initial clay settling areas, the initial mining areas, and the powerline and pipeline right-of-ways. Land clearing for the initial settling areas will begin as near to the start of construction as feasibly possible and will require approximately 460 acres of clearing. Two hundred thirty-two (232) acres are planned for the first year of mining; however, CF expects to clear only 80 acres initially, most of which will be completed prior to construction of the initial settling areas (Figure 2.1-1).

As mining progresses, acreage will gradually be cleared ahead of the actual mining operation. The average acreage being cleared at any given time will be about 80 acres, but this figure can vary depending on the type of land to be cleared and the time of year. During the dry season, clearing will generally be limited to preparing 3 to 6 months of work area in advance of the dragline, unless the area to be mined is heavily vegetated. In the case of pine flatwoods-palmetto rangeland, clearing must be initiated several months prior to mining to allow complete removal of any woody material that might interfere with the mining process. In such areas, it will also be desirable to clear sufficient land for two to three months mining prior to the onset of the rainy season. When necessary, vegetation on land to be mined will be burned. Such open burning would be conducted according to the applicable rules and regulations (Florida Administrative Code, Chapter 17-5, Open Burning and Forest Protection Fires; and Chapter 51-2, Rural Open Burning). These rules specify that:

- Open burning be conducted in a manner, under conditions, and within certain periods that will reduce or eliminate the deleterious effect of air pollution caused by open burning.

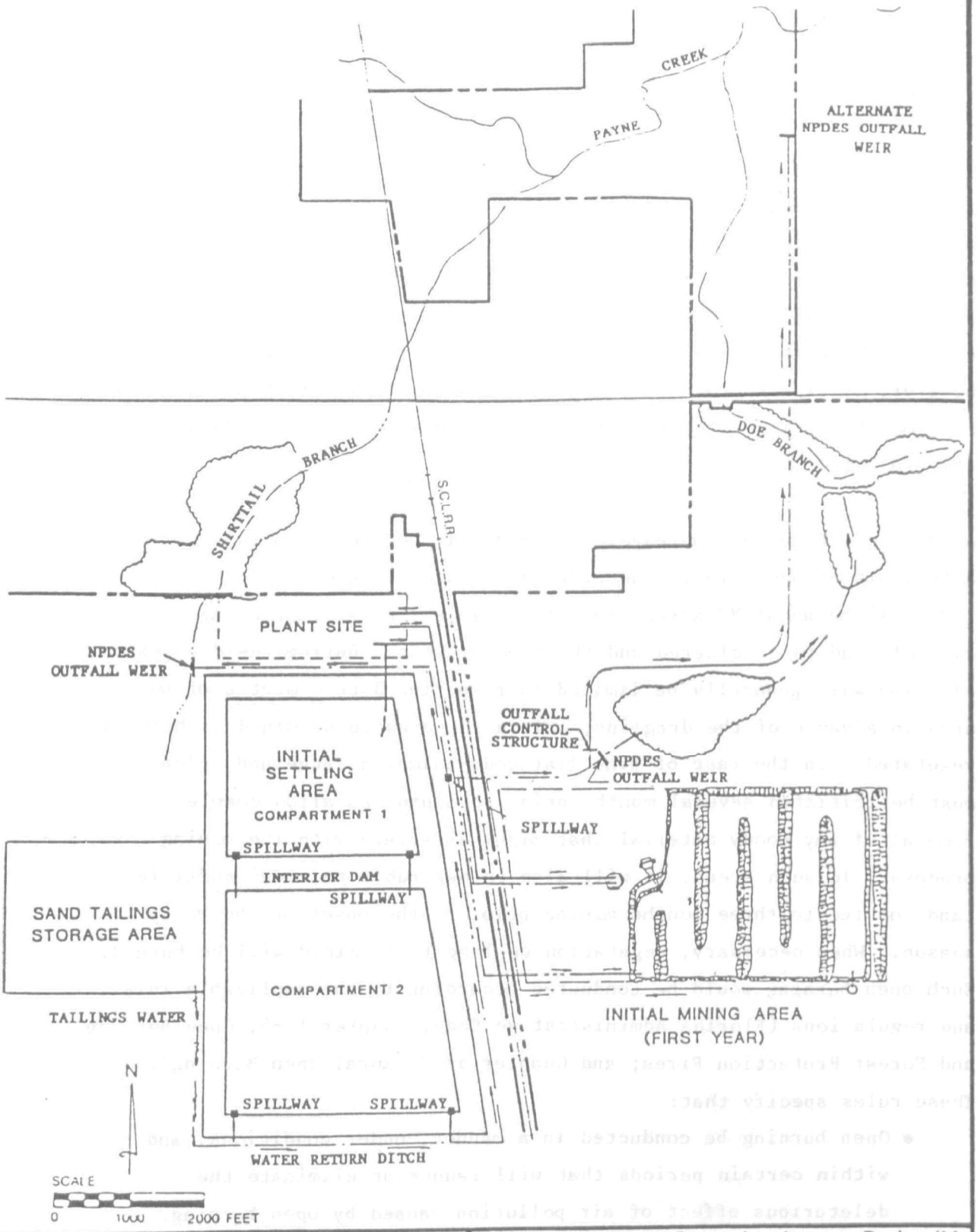


Figure 2.1-1
INITIAL START-UP AREAS FOR PLANT CONSTRUCTION, WASTE DISPOSAL AND MINING
SOURCE: CF INDUSTRIES, INC.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

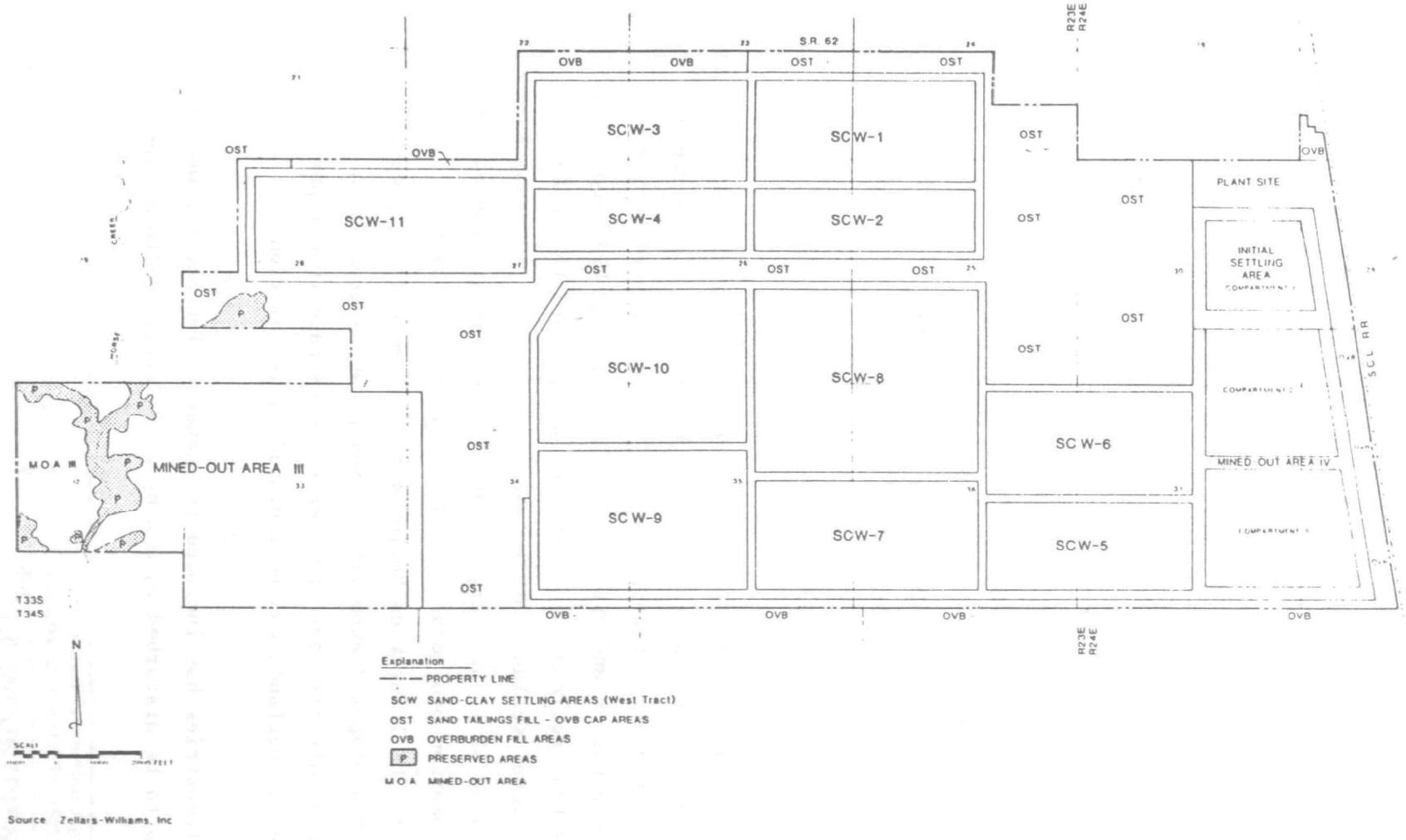
- Open burning may be conducted only between the hours of 9:00 a.m. and one hour before sunset, or upon direct permission of the Division of Forestry for other hours of the day.
- The size, moisture content, and composition of the refuse piles shall be such so as to minimize air pollution and ensure that all burning will be completed within the allowable time period.

2.1.3 PRESERVED AREAS

The areas to be preserved from mining occupy approximately 69 acres and consist of all but 2 acres of the wetlands designated as Category I-A by the EPA. These proposed preserved wetlands are located in the far western portion of the site and are contiguous with Horse Creek (Figure 2.1-2). The two acres of Category I-A wetlands to be disturbed will be needed for the proposed dragline crossing (see Section 2.1.4). Category I-A wetlands are mainstem stream wetlands that are considered by the EPA to provide important environmental functions and which should be preserved and protected from mining.

In addition to the Category I-A wetlands, there are approximately 695 acres of Category I-C and I-D wetlands on the site. These are headwater and special concern wetlands that are also considered by the EPA as worthy of preservation and protection. However, the EPA recognizes the possibility that reclamation technology may proceed to the extent that fully functional wetlands may be restored. The Florida phosphate industry, including CF Industries, is currently working on approximately 35 wetland reclamation projects (Florida Institute of Phosphate Research, 1983a). CF Industries believes that these ongoing projects, together with CF's proposed experimental revegetation program on an existing sand/clay mix disposal area, will demonstrate that important functional roles of wetlands can be replaced by reclamation.

Therefore, CF Industries has included the Category I-C and I-D wetlands within the area to be disturbed by mining activities. Although the mine



Source: Zellars-Williams, Inc

Figure 2.1-2
CF INDUSTRIES' PROPOSED PRESERVATION AREAS (CATEGORY I-A WETLANDS)

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

plan and waste disposal plan were developed to include all Category I-C and I-D wetlands, CF understands the EPA's position on the mining of these wetlands. Mining will not be allowed within the boundaries of any of the Category I wetlands unless and until the EPA reconsiders the categorization or value of these wetlands based upon the proven recreation of functional hardwood swamp communities and large wetland systems. CF believes that it can successfully demonstrate a viable, functional restoration program sufficient to receive EPA approval to mine these areas in the future. A description of the EPA's wetland categorization system, as applied to the wetlands on-site, is presented in Section 9.1.2.3.

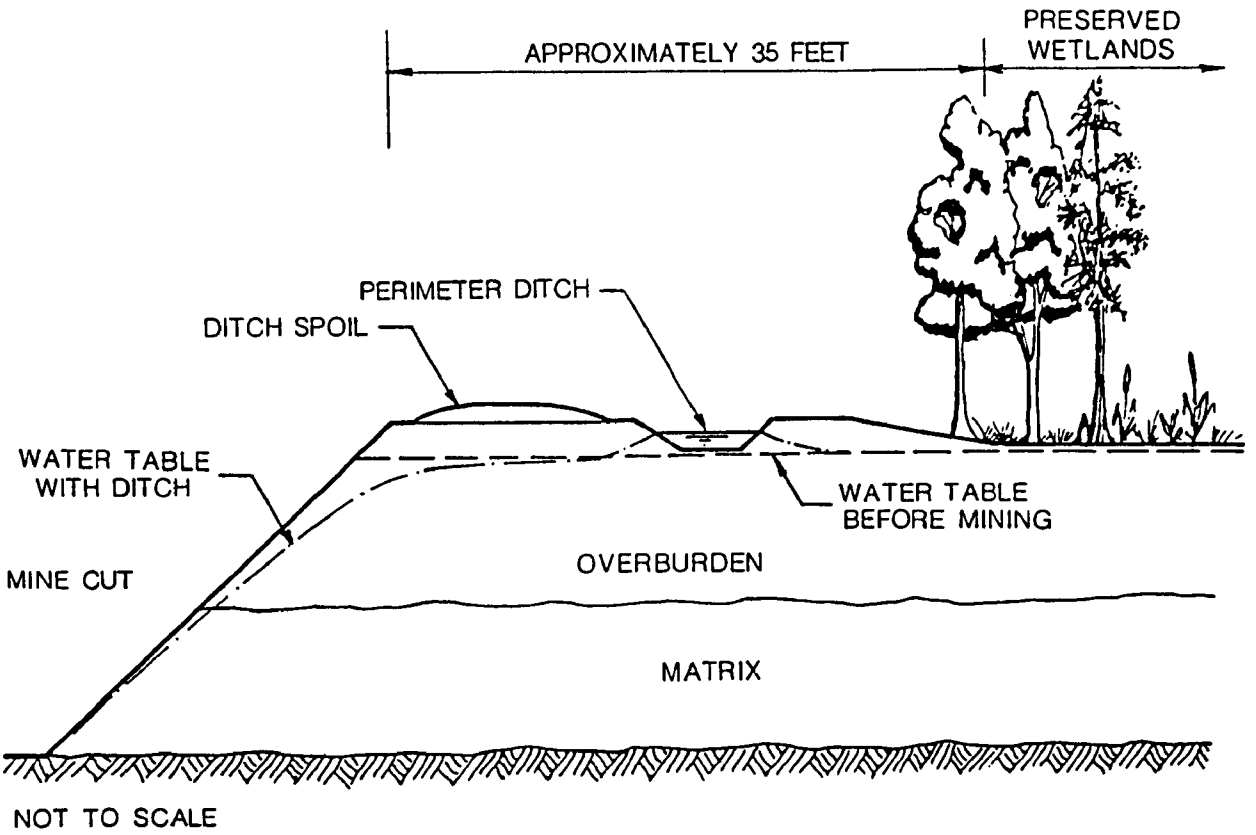
The Category I-A wetlands that are to be preserved will also be protected from the indirect effects of mining. A perimeter ditch will be constructed around all preserved wetlands when adjacent lands are being mined. The water level in this ditch will be maintained at or above the average water table elevation, which should prevent potential drawdown of the water table within the wetland (Figure 2.1-3.).

The mined land adjacent to these preserved wetlands will be reclaimed to land-and-lakes (see Section 2.6.2.3) by grading and contouring the remaining spoil piles. This type of reclamation can be completed in a short period of time (approximately two years), which will also reduce the potential effects of mining.

2.1.4 DRAGLINE CROSSINGS

In mine year 20, the dragline mining the west tract will cross the Horse Creek Category I-A area. This dragline relocation will require an access corridor across two areas of Horse Creek, located in Township 33S, Range 23E, Section 32 (Figures 2.1-4A and 2.1-4B). The corridor will be constructed during the dry season when Horse Creek is likely to be at minimum or no flow conditions. Topography specific to this area requires minimal grading to establish the corridor. Approximately two acres will be disturbed for the planned corridor.

The corridor will be the only link between the east and west side of Horse Creek during all phases of mining activities, including



NOTE: Water level in ditch maintained at or above average water table elevation.

Source: Gurr & Associates, Inc.

Figure 2.1-3
PERIMETER DITCH AROUND PRESERVED WETLANDS

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Draft Environmental Impact Statement

CF INDUSTRIES
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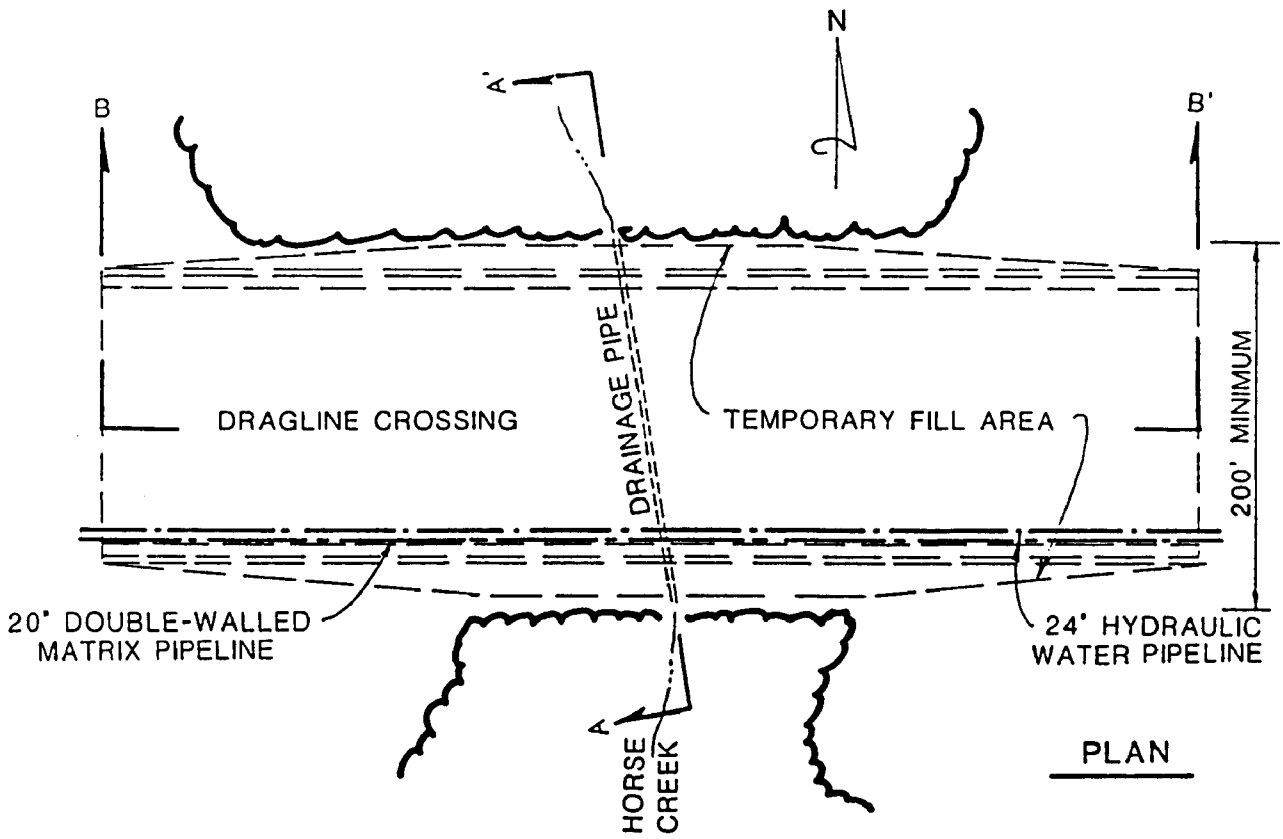
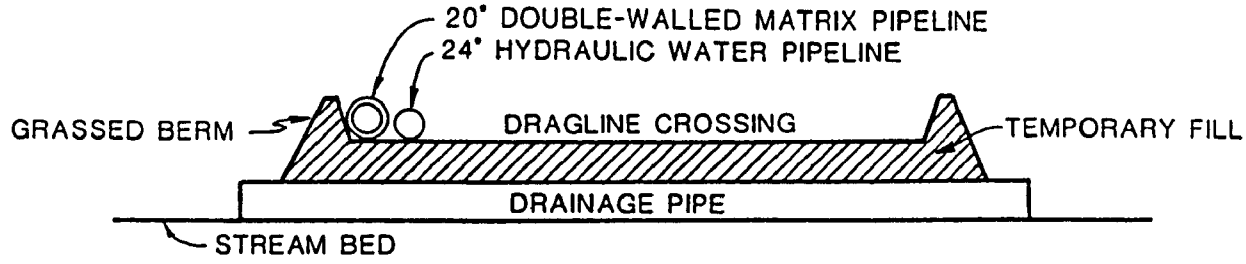
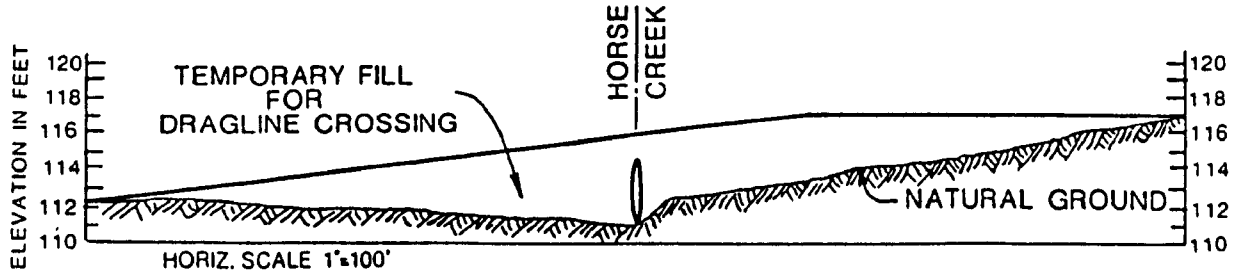




SECTION A-A'



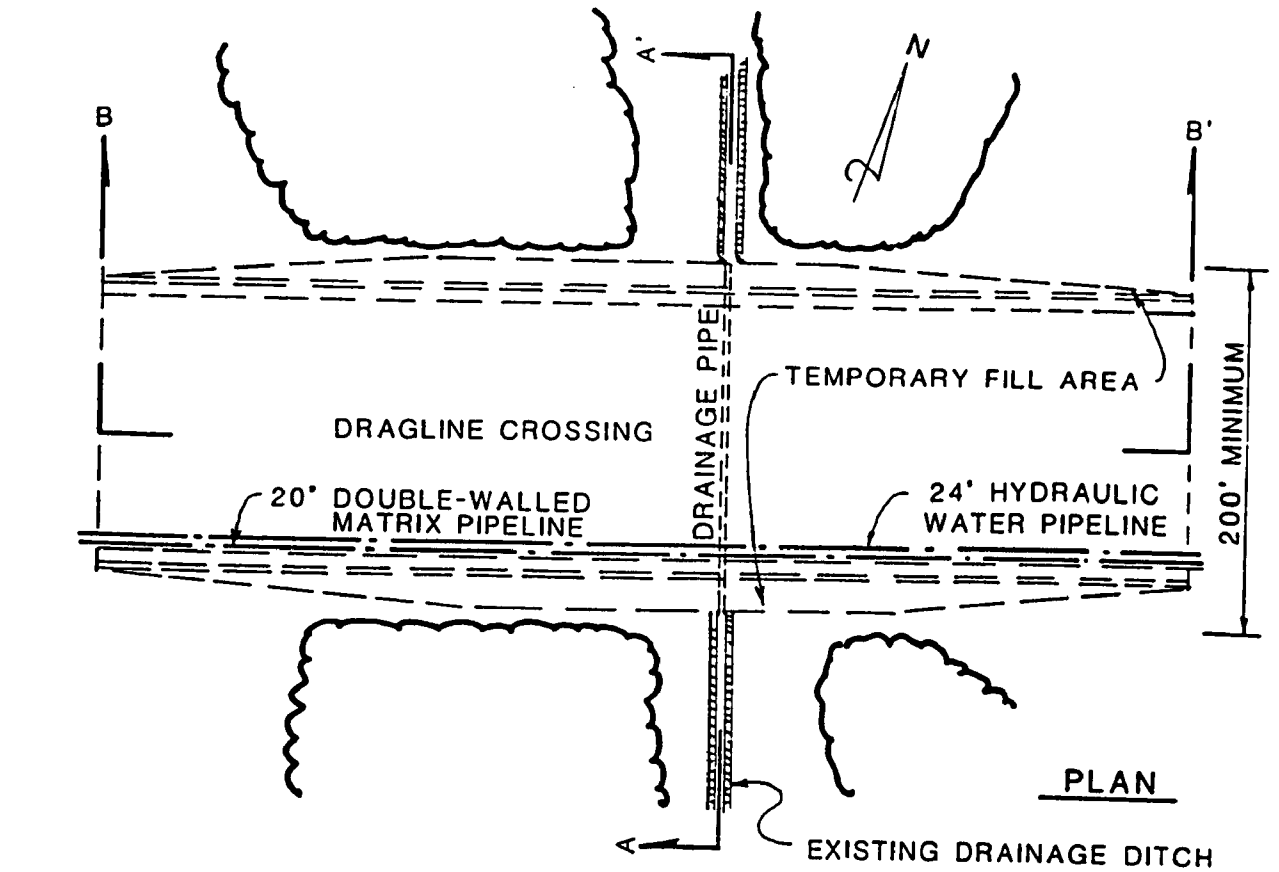
SECTION B-B'

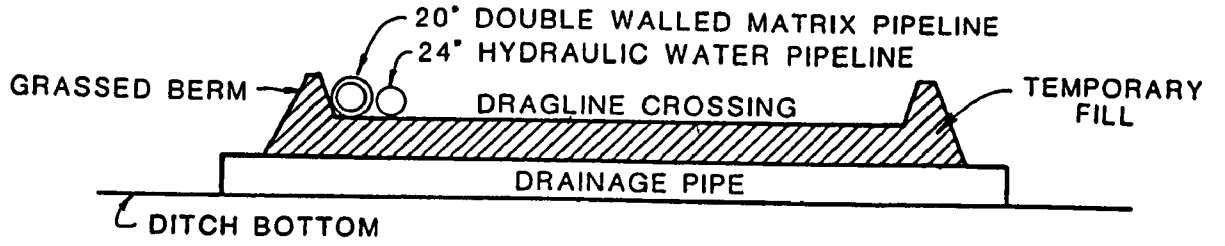
Zellars-Williams, Inc.

Figure 2.1-4A
CONCEPTUAL DRAGLINE CROSSING AT HORSE CREEK SECTION 32, T33S, R23E

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II





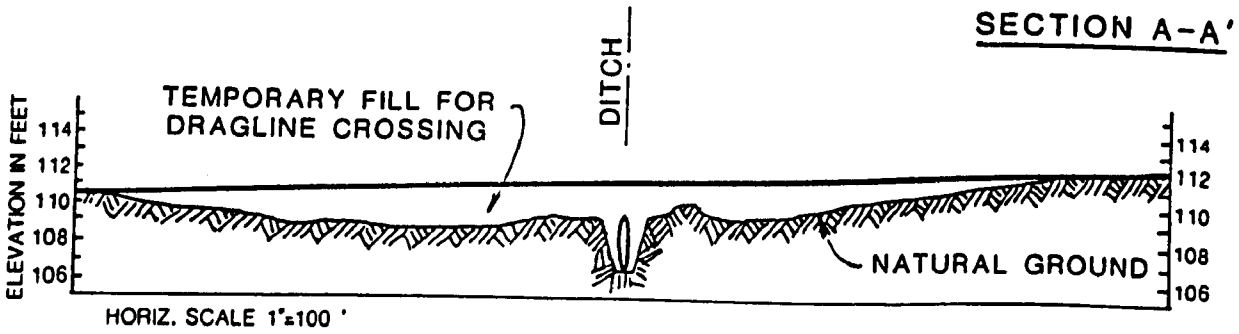


Figure 2.1-4B
CONCEPTUAL DRAGLINE CROSSING AT HORSE CREEK SECTION 32, T33S, R23E

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

reclamation. It will contain a double-cased matrix pipeline and hydraulic water pipeline (Figures 2.1-4A and 2.1-4B) necessary for mining and ore transportation. The double-cased matrix pipeline will extend beyond the corridor limits in the east-west direction to protect the area against any accidental leakage, thus protecting the "preserved area" of Horse Creek. In addition to the double-cased matrix pipeline, a berm will be constructed on both edges of the corridor and grasses will be established on all graded or constructed areas to prevent erosion and turbid runoff into the creek. The corridor will be maintained and monitored by CF until the final dragline crossing in mine year 21 and the removal of the pipelines and reclamation activities are completed on the west side of Horse Creek.

After the dragline has returned over the stream and the crossing location is no longer needed, the fill will be removed and the area will be graded to approximately original elevations. A layer of organic soil borrowed from a wetland to be mined will be spread over the area after final grading to encourage natural revegetation.

A short-lived herbaceous species such as rye or millet will be planted over the reclaimed area to stabilize the soils and minimize erosion. Where wooded wetland systems have been disturbed, native and locally grown trees will be planted at a density of a least 400 seedlings per acre. Trees to be planted will include species such as red maple, sweetgum, sweet bay, laurel oak, and water oak. Where herbaceous wetland systems have been disturbed, the organic soil layer is expected to provide revegetation similar to the disturbed marshes. The likelihood of successful revegetation in the reclaimed area is high because of the existing floodplain forest immediately adjacent upstream of the proposed stream crossing. This existing floodplain forest will provide a good seed source for a wide variety of wetland plant species.

2.1.5 PHOSPHATE MINING

Within the central Florida phosphate industry, the conventional procedure for mining phosphate ore consists of stripping away the

overburden and removing the phosphate matrix with draglines. The CF Hardee Phosphate Complex II project would initially employ a single dragline with bucket capacity of 55 cubic yards. In mining year 8, a second dragline of similar capacity would be added to provide additional excavation capabilities to support an expanded beneficiation facility.

Typical dragline operations include the development of a series of mining cuts with the overburden from the initial cut being placed on adjacent mine land. As successive cuts are made, each varying from 250 to 300 feet wide and 50 to 70 feet deep, overburden material is placed in adjacent cuts previously mined. Leach zone material would be placed near the base of the mining cut, then covered with overburden to minimize any naturally occurring radiation from uranium concentrations. The ore is placed in a matrix well, where it is slurrified for transport to the beneficiation plant. As the mining operation proceeds, the matrix well and ore transport equipment are advanced along the direction of mining with the dragline. Electrical power for the operation of the dragline and the matrix slurry equipment is provided by portable cables extended from a pole line approximately 2,000 to 3,000 feet to this equipment.

The proposed mining operations would result in an average annual excavation of approximately 12.3 million cubic yards of overburden and 16.2 million cubic yards of phosphate matrix when two draglines are in operation. The average density (dry basis) of these materials is approximately 1.25 short tons/cubic yard. In a drained condition, they would contain about 75 to 85 percent solids.

During the planned mine life of 27 years, the proposed mine operation would disturb approximately 14,925 acres or 99 percent of the site. Table 2.1.5-1 shows the acreage of each vegetation type to be disturbed by the mining operation.

Table 2.1.5-1. Existing and Post-Reclamation Land Use

Land Use Code*	Type	Existing Acres	%	Proposed Disturbance Acres	%	Post-Reclamation Acres	%
211	Row Crops	13.1	0.09	13.1	0.09	--	--
212	Field Crops	44.1	0.29	44.1	0.30	--	--
213	Improved Pasture	1310.3	8.74	1310.3	8.78	6659	44.41
231	Orange Grove	2.6	0.02	2.6	0.02	--	--
321	Palmetto Prairie	6957.2	46.40	6957.2	46.61	--	--
411	Pine Flatwoods	732.7	4.89	732.7	4.91	1500.	10.00
422	Other Hardwoods	2354.8	15.70	2354.8	15.78	1900	12.67
520	Lakes	--	--	--	--	1055	7.04
621	Freshwater Swamp	1239.9	8.27	1194.8	8.00	1410	9.40
641	Freshwater Marsh	2339.3	15.60	2315.4	15.51	2470	16.47
	TOTAL	14994	100.00	14925	100.00	14,994	99.99

* Based on Florida Land Use and Cover Classificaton System (Florida Department of Administration, 1976).

Source: CF Industries, 1984.

The planned sequence of mining is illustrated in Figure 2.1-5. Existing land use patterns would continue on reserve land until those lands are scheduled for mining. Approximately 69 acres would remain undisturbed. CF's mining sequence has been developed through the use of a computer model which simulates the mining and processing of the entire mineable deposit on an annual basis. The base data for this program came from the prospect drilling results and the preliminary design of the mining and processing equipment. The dragline would follow a sequence which balances production and grade requirements and facilitates water recirculation, waste disposal and reclamation activities. If production and sales requirements change, the length of the mine operation may also be changed.

2.1.6 DRAINAGE BASIN MINING SEQUENCE

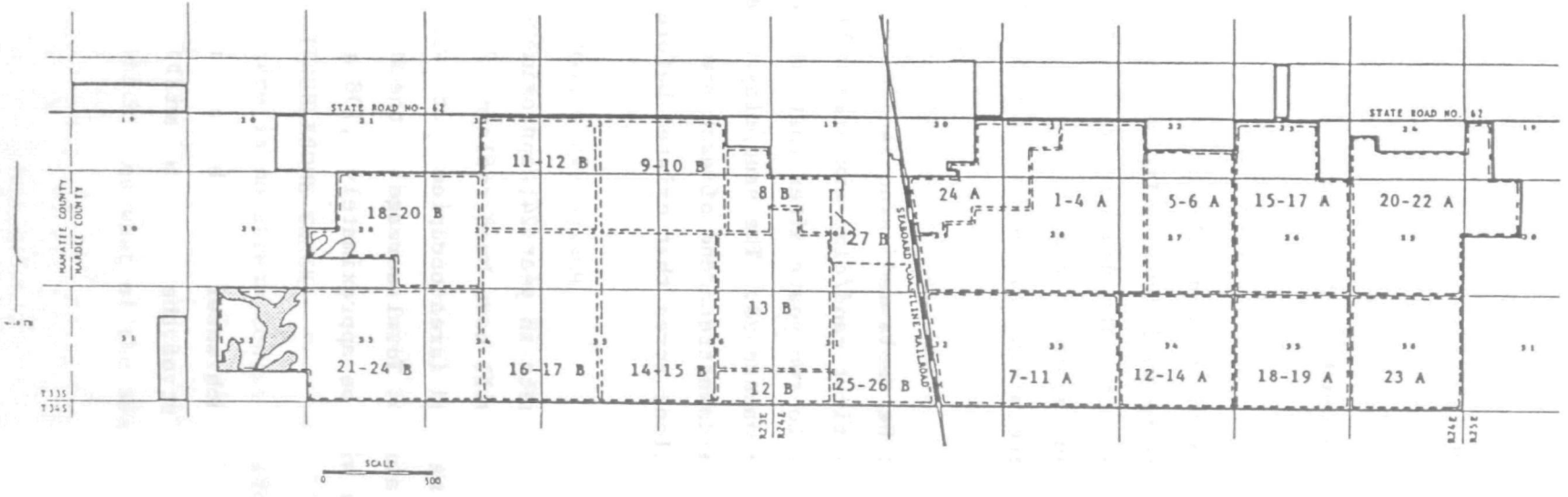
Mining and reclamation events in each system are described in the following discussion. Mining years and reclamation features are given. The sequencing of mining activities is shown in Figure 2.1-5.

2.1.6.1 DOE BRANCH

The plant site and initial settling area (ISA) lie partly in the Doe Branch watershed. Construction of the plant site and ISA will impact approximately 5 percent of the Doe Branch watershed for the life of the mine. Most of this area will be reclaimed to the Doe Branch watershed at the completion of mining.

Mining in the watershed occurs from year 1 through year 24. At no time during the mining will there be less than 45 percent of the watershed area in an undisturbed or reclaimed state.

The first year of mining will begin just west of the main stream of Doe Branch and proceed west. In year 2 the dragline will cross Doe Branch and begin mining in Section 21. Reclamation of a stream course will be undertaken in the area mined just west of the main stream. The



LEGEND

A - Dragline I

B - Dragline II

1-4 - Mining Years

- Preserved Areas

SOURCE: CF Industries

Figure 2.1-5
DRAGLINE MINING SEQUENCE

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

reclamation will be complete in time to receive the flow from the main stream before it is scheduled for mining in the latter part of year 3. The upstream area of Doe Branch in Section 33 will serve as a seed source for the reclaimed stream course until the upstream area is mined in year 9. The area immediately downstream of the reclaimed stream course will serve as a buffer to minimize impacts of mining and reclamation activities. This downstream segment is not scheduled for mining until year 24.

From year 3 mining will progress to the east until Section 27 is mined in year 6. At this time, the dragline will move to the western half of Section 32 and begin mining to the east. The dragline will leave the Doe Branch watershed in year 14, and again in year 18 before returning to Section 21 in year 24 to complete mining in the Doe Branch watershed and the east half of Complex II.

The majority of the watershed will be reclaimed using sand/clay mix technology (see Section 2.4). The first sand/clay mix area will be reclaimed in year 10 and every one to two years after that another sand/clay area will be reclaimed in the watershed. The sand/clay areas will include wetland reclamation at the downstream end of each area. At the completion of reclamation, the wetland acres that existed before mining will exist after reclamation.

When mining in the watershed is complete in year 24, approximately 75 percent of the Doe Branch watershed will have been reclaimed. By year 29, all but 5 percent of the watershed (area occupied by the ISA and plant site) will have been reclaimed. Total acreage in the Doe Branch watershed following reclamation will be approximately 4,708 acres.

2.1.6.2 PLUNDER BRANCH

The major portion of the Plunder Branch watershed will be mined from year 14 through year 23. A small part of the watershed will be mined in years 5 and 6.

The first mining in the stream course occurs in year 14. The west fork of Plunder Branch will be mined by year 17. Reclamation of approximately 220 acres of the watershed in Sections 23 and 26 will be reclaimed using sand tailings and overburden. This reclamation will be completed by year 19 and will include wetland acreage which will serve as a buffer to downstream areas as runoff from the reclaimed sand/clay mix areas discharges to the system.

The majority of the Plunder Branch watershed acreage upstream of the aforementioned 220 acres will be reclaimed using the sand/clay mix technique. The majority of the wetland acreage associated with the watershed will be reclaimed as a part of the sand/clay reclamation.

In year 23, when the watershed is mined out, all but 14 percent of the watershed on-site will be out of service. However, due to the sand/clay reclamation, by year 26 this percentage will increase to 45 percent. By year 29, there will be 72 percent of the watershed contributing to the Plunder Branch system.

When reclamation is complete, there will be approximately 5 percent less acreage than existed in the pre-mining watershed, or a total of 2,266 acres.

2.1.6.3 COON'S BAY BRANCH

The 259 acres of the Coon's Bay Branch watershed on-site will be mined in years 19 and 20. This watershed will be reclaimed using sand tailings and overburden. There will be a total of 188 acres reclaimed in the watershed. Reclamation will be complete by year 23.

2.1.6.4 TROUBLESOME CREEK

Although there is no stream course on-site in the Troublesome Creek watershed, there is approximately 550 acres of watershed area. The initial settling area will occupy the majority of the 234 acres of this watershed which lies west of the Seaboard Coast Line Railroad. The

316 acres east of the railroad will be mined from year 7 through year 12, and again in year 23.

Reclamation will be completed in year 20 in Section 33 when a sand/clay mix area is reclaimed; in year 26, when a land-and-lakes area in Section 36 is reclaimed; and in years 28 and 29, when the southern portions of the ISA are reclaimed. The Troublesome Creek watershed on-site will total approximately 840 acres upon completion of reclamation.

The impacts downstream of the mining and reclamation activities can be effectively controlled since there is no recognized stream channel on-site. The wetlands associated with the watershed will be reclaimed to at least the pre-mining acreage.

2.1.6.5 SHIRTTAIL BRANCH

Part of the Shirttail Branch watershed will be occupied by the plant site, the ISA, and the sand tailings storage pile, all in Section 30, Range 24 East. Mining will begin in the watershed in year 8 and continue into year 15. The last mining in the watershed will occur in year 27.

Reclamation in year 11 will return approximately 235 acres of the watershed to service, and an additional 230 acres will be reclaimed by year 15. Sand tailings and overburden reclamation will be used to reclaim the 465 acres. The watershed area reclaimed in years 18 and 19 will be sand/clay mix areas.

The section of the watershed scheduled for mining in year 27 contains wetlands and a stream channel which will serve as a seed source for earlier downstream reclamation and a buffer to activities upstream. When this area is mined, sufficient time will have elapsed to have a reclaimed functioning stream and wetland system to provide a seed source and buffer area for the associated mining and reclamation activities.

2.1.6.6 BRUSHY CREEK

The Brushy Creek watershed will first be impacted by mining activities in year 9. The mining in this watershed is sequenced so that mining occurs over a 15-year span. The mining and reclamation schedule is such that at least 32 percent of the watershed will be in service at any one time.

The mining of the easternmost headwaters of Brushy Creek will take place from year 11 through year 18. During this time, downstream impacts to Brushy Creek will be buffered by the downstream segment in Section 34. Reclamation of the sand/clay disposal areas planned for this headwater region will begin in year 20 and continue through year 31. The reclamation design includes a complex of swampland, marsh, wetlands, and upland mixed forests to be reclaimed as part of the sand/clay system and will comprise the reclaimed watershed for the eastern portion of Brushy Creek.

The upper headwater area of Brushy Creek is scheduled for mining in year 18 through year 20. Approximately 268 acres of this headwater area will be reclaimed within two years of the completion of mining activities in this part of the watershed. The downstream portion of Brushy Creek in Section 34 is scheduled for mining in years 23 and 24. Reclamation of this stream segment will be complete in years 26 and 27 when sand tailings fill overburden cap is used to return the area to near original contours.

Upon completion of the stream course reclamation in year 27, approximately 67 percent of the mined watershed will have been reclaimed. In year 34, the total watershed will be reclaimed to a total of 3,636 acres.

2.1.6.7 HORSE CREEK

The main stream of Horse Creek and the adjacent wetlands are not scheduled for mining. The watershed of Horse Creek on-site is scheduled for mining in year 18 and years 20 through 22. Reclamation

will commence immediately following the completion of mining operations with the majority of the watershed being reclaimed to land-and-lakes.

The reclamation proposed will return the watershed to service in a short period of time. The post-reclamation watershed acreage will be 728 acres.

2.1.6.8 LETTIS CREEK

Mining will begin in the Lettis Creek watershed, which has no distinct stream channel on-site, in year 12 and continue through year 15. Mining will again occur in the watershed when the southern portion of the ISA is mined in years 24 through 26.

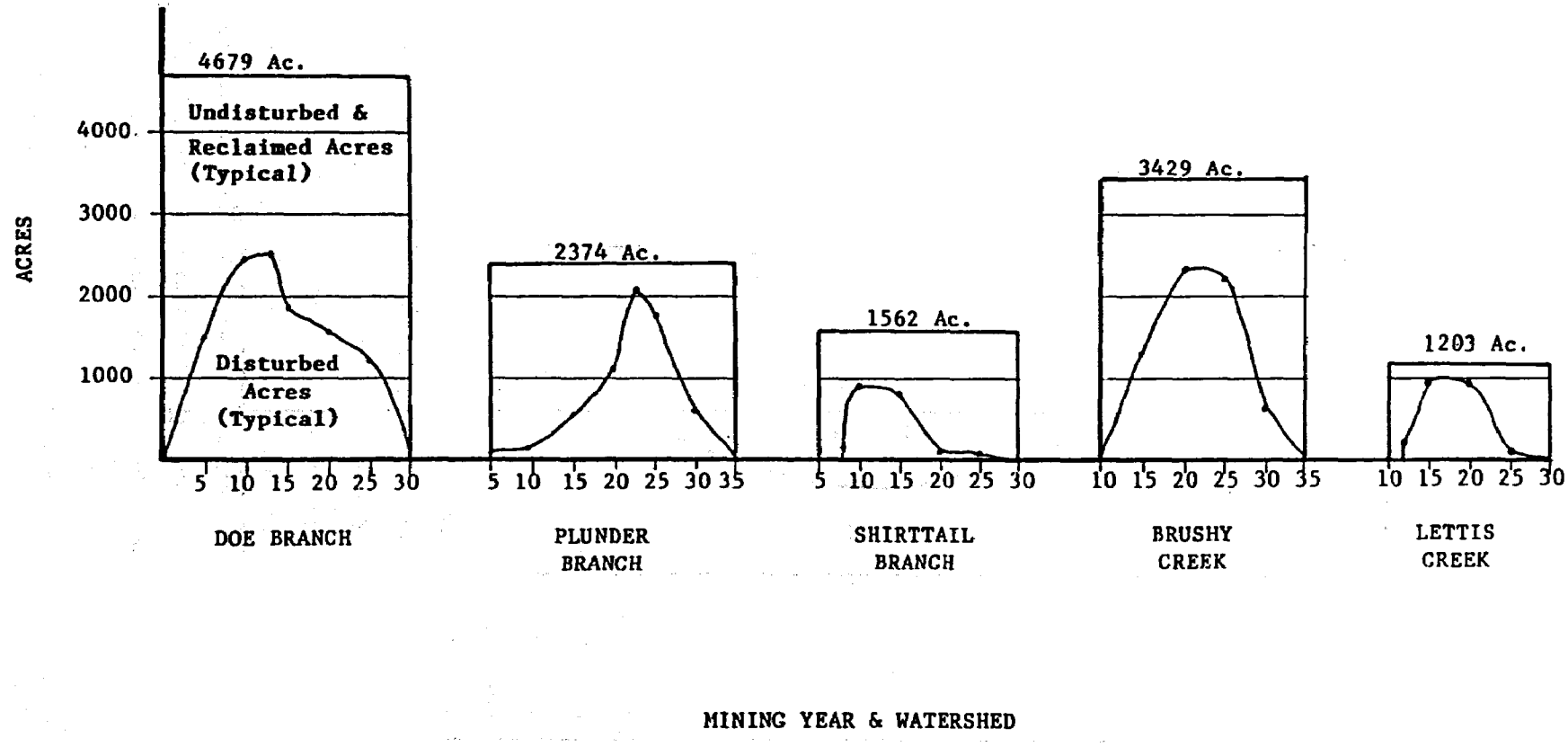
All areas except the area under the ISA, which will be land-and-lakes, will be reclaimed sand/clay mix areas. The first reclamation will occur in year 22 and, by year 29, the watershed reclamation will be complete.

The watershed acreage following reclamation will be almost the same as the pre-mining acreage. The reclamation plan will replace wetlands in the watershed with ones similar to those existing prior to mining to minimize downstream impacts.

2.1.6.9 SUMMARY

The ratio of disturbed land to undisturbed and reclaimed land within a given watershed is expected to be kept at a minimum. Figures 2.1-6 and 2.1-7 show the overall impact for the five largest watersheds and for the total site. For the majority of time, the mining plan and the reclamation schedule result in no more than 50 percent of any one watershed being in a disturbed state. For the total site, that percentage would be 40 percent.

The relatively short-term disturbances to the watershed acreages on the Complex II site are not anticipated to result in negative downstream



SOURCE: CF Industries

Figure 2.1-6
WATERSHED DISTURBED ACREAGE VS. UNDISTURBED AND RECLAIMED ACREAGE (FOR THOSE WATERSHEDS>1000 ACRES)

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Draft Environmental Impact Statement

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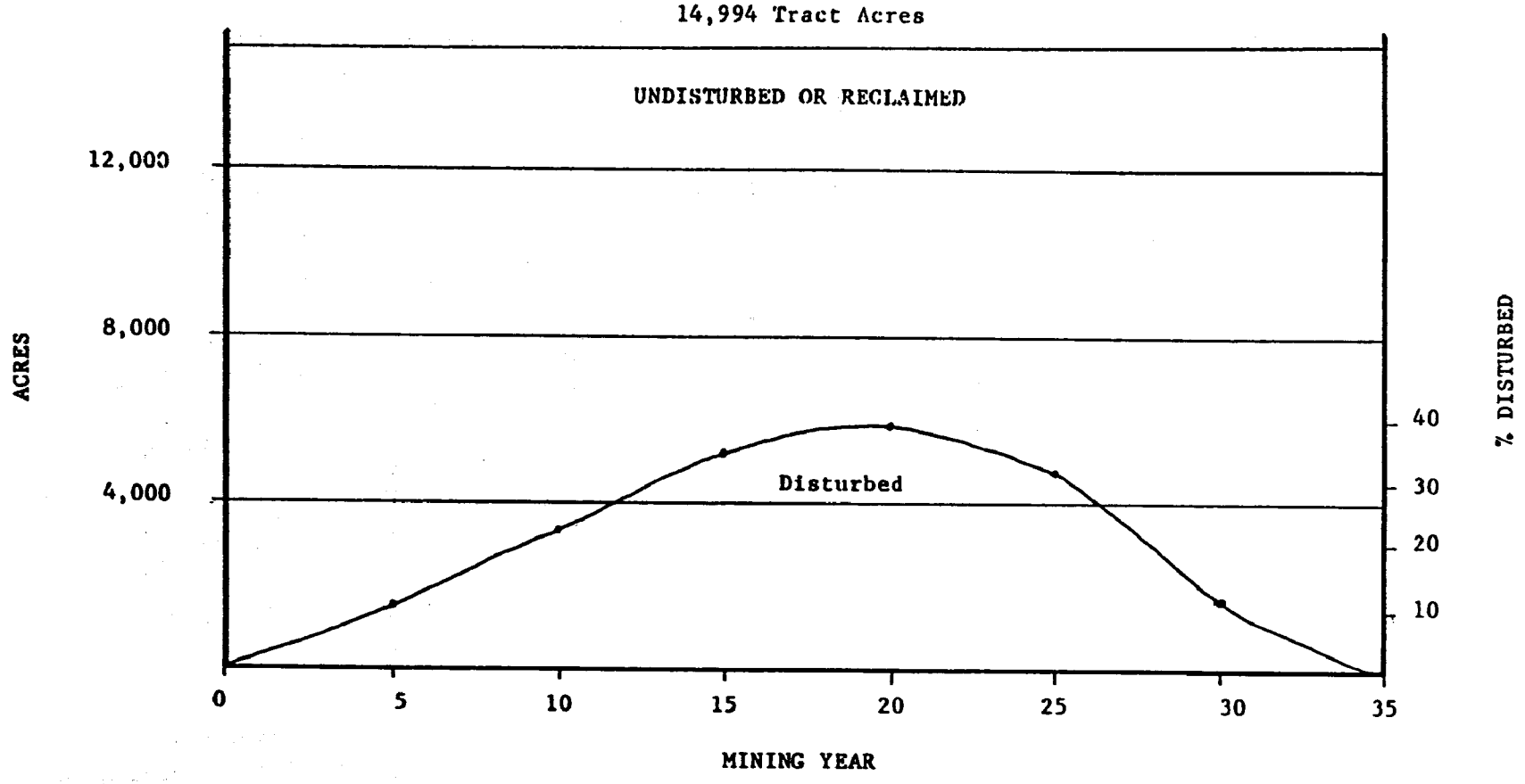
Hardee Phosphate Complex II



SOURCE: CF Industries

Figure 2.1-7
TOTAL TRACT DISTURBED ACREAGE VS. UNDISTURBED AND RECLAIMED ACREAGE

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

impacts. With reclamation, the return of the pre-mining function of the watershed is expected.

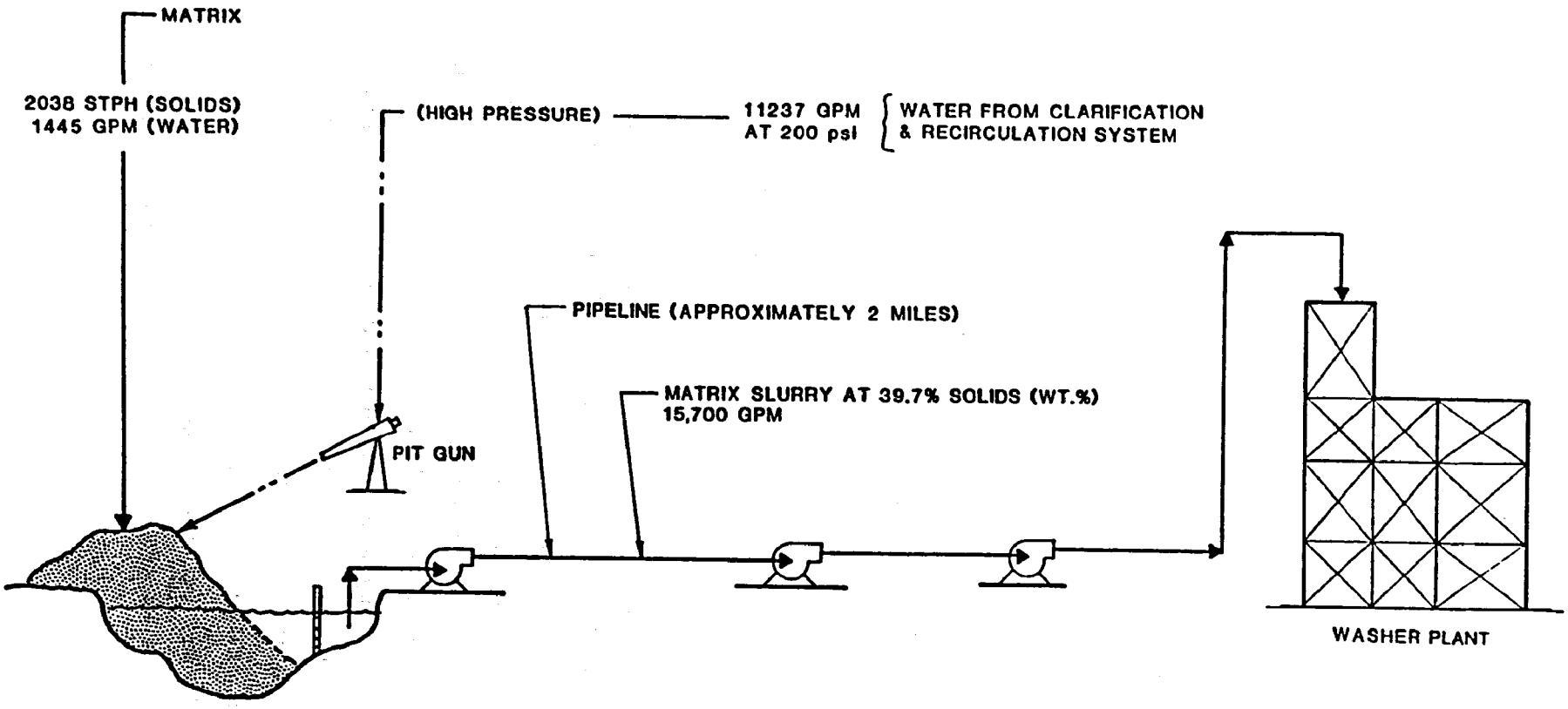
There are several other positive aspects of CF's mining and reclamation plan relative to the watersheds. First, land clearing ahead of mining will be minimized to reduce the potential of the runoff from creating water quality or water quantity problems downstream. Second, reclamation will incorporate a diversity of land forms in a pattern designed to provide wetland systems for water quality benefits to runoff and stream flow. Another positive aspect is the rate of reclamation. Although initially large land areas will be tied up in sand/clay mix areas, reclamation of the site is expected to be complete eight years after the last mining occurs.

2.2 SLURRY MATRIX TRANSPORT

2.2.1 GENERAL DESCRIPTION

CF's current plans for transporting matrix involve the matrix slurry transport system, presently used at most existing Florida phosphate mines. Slurry pumping is a proven technology, extremely flexible, relatively inexpensive compared to other methods, and environmentally acceptable.

In the system illustrated in Figure 2.2-1, matrix placed into the matrix well is mixed with water sprayed under "high pressure." Approximately 11,000 gallons/minute of water is required to break down the clay and sand matrix into a slurry which can then be pumped. The source of this water will be clarified and recycled water from the water recirculation ditch which receives water from the initial settling area (ISA), pit dewatering, and area drainage. Approximately 6,000 horsepower pumping capability is then needed to transfer the matrix solids and transport water from the matrix well to the top of the beneficiation plant, assuming an average pumping distance of 10,000 feet. The density of the slurry must also be properly maintained. Pumping at less than optimum density (e.g., 35 to 40 percent solids) would not transfer the required



NOTE: APPROXIMATELY 300 GPM OF SEAL WATER WILL ALSO BE ADDED TO THE PUMPS AND WILL GENERALLY BE ADDITIVE TO THE ABOVE FLOW. THIS WATER WILL COME FROM THE HIGH PRESSURE WATER LINE AND FROM ADJACENT RECIRCULATION WATER CANALS.

Source: Zellars-Williams, Inc.

Figure 2.2-1
SCHEMATIC FLOW DIAGRAM FOR SLURRIED MATRIX TRANSPORT

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

tonnage, and pumping at excessive density can overload the pump motors and/or plug the system. The turbulent washing and scrubbing action of the high pressure water pumps and pipeline all contribute to the processing sequence which follows, for the matrix must be broken apart and diluted with water to remove the waste clay and silica sand.

2.2.2 PIPELINE CROSSING OF WETLANDS

Proper planning has minimized the need for numerous crossings of wetland areas with pipelines as mining proceeds throughout the tract. The matrix slurry transport system presents the potential for pipeline leaks which could cause increased turbidities in wetland water course areas should the matrix slurry escape from the containment line. However, the possibility of this occurrence is minimized by the use of preventive maintenance practices such as pipeline inspection and rotation along with the implementation of certain safeguard systems. These systems would include double walled pipes and a low pressure shutoff system with cutoff valves installed at both sides of the pipeline stream crossing to assist in controlling a pipeline leak at these points.

At the Horse Creek crossing (see Figure 2.1-4A), the matrix pipeline will also be underlain by temporary fill across the stream channel which will have grassed berms on both edges of the corridor to prevent erosion and turbid runoff into the creek should a leak or heavy rains occur.

2.3 MATRIX PROCESSING

2.3.1 PLANT LOCATION

The CF Industries' beneficiation plant and support facilities will occupy approximately 60 acres. This site (Section 30, Township 33 South, Range 24 East) is located one-half mile south of the town of Ft. Green Springs, in Hardee County, Florida. In selecting this particular location for this phosphate beneficiation plant, several

sites were investigated with the following objectives carefully considered:

- Minimize disturbing environmentally sensitive areas;
- Minimize the consumption of energy used in the movement of water, ore, and waste products;
- Minimize the cost of transportation facilities (roads and railroad), and utility construction;
- Minimize fill and ensure the site is all upland; and
- Minimize phosphate reserve loss.

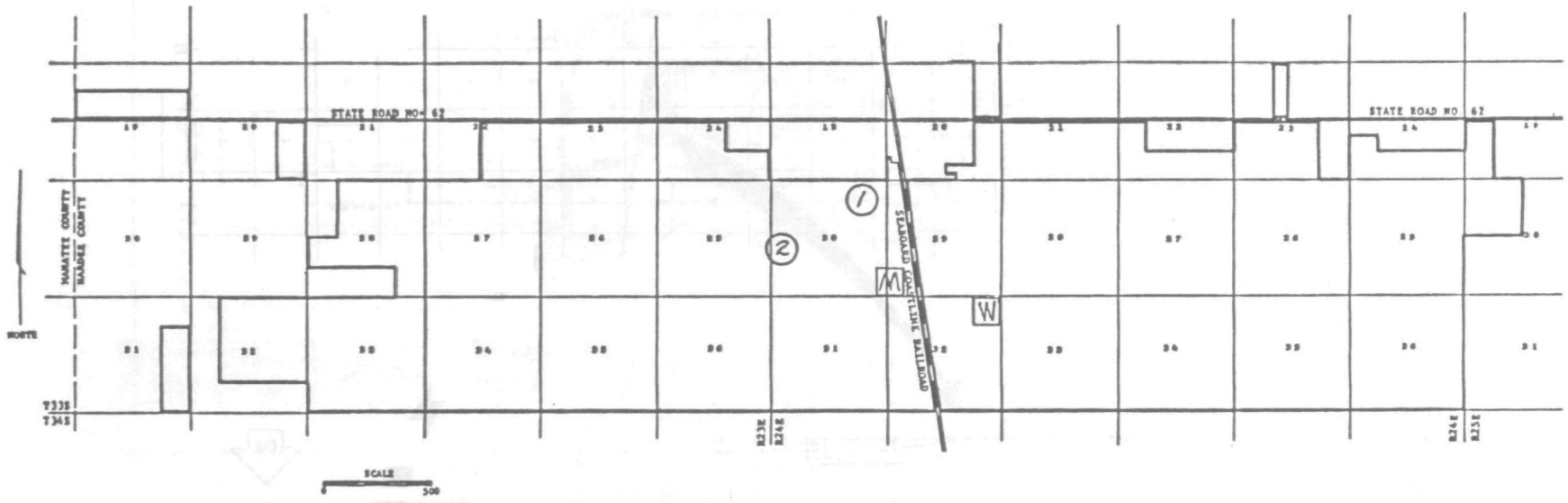
Of the various sites considered, Sites 1 and 2 (Figure 2.3-1) were the most promising in meeting most of the objectives mentioned above.

Site 1 (Figure 2.3-2) was finally chosen over Site 2 in that it was closer to the centroid of ore and waste disposal; one mile closer to rail and power facilities; and had favorable topography (Site 2 is located in the drainage basin of Shirttail Branch).

2.3.2 PLANT DESCRIPTION SUMMARY

CF proposes to use mining and processing procedures common to the Florida Phosphate Industry. Therefore, Figure 2.3-3, which depicts the general layout of the plant, is characteristic of Florida phosphate beneficiation plants. The matrix will be slurried and pumped from the mine to the beneficiation plant. There the matrix will undergo the conventional beneficiation process, consisting of separating the clays and fines from the pebble-sized product in the washer and feed preparation areas before being transferred to the flotation plant for processing to recover the final phosphate concentrate.

CF's facilities are planned to have a nominal capacity of 2,000,000 short tons per year of phosphate rock product. Wet phosphate rock will be stored according to product classification in a storage area with a 1,000,000 short ton capacity. Product load-out facilities and a railroad marshalling yard will be located nearby. On-site water will be provided by facilities located in the plant hydraulic station.



SOURCE: CF Industries

Figure 2.3-1
LOCATION OF PLANT SITE ALTERNATIVES

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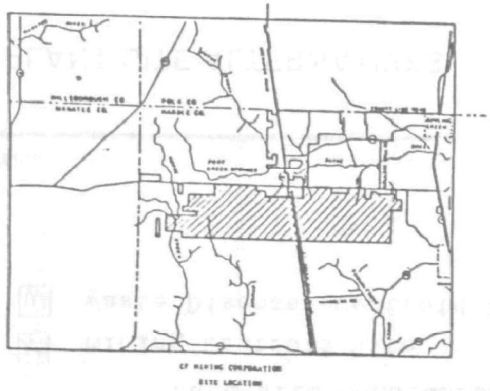
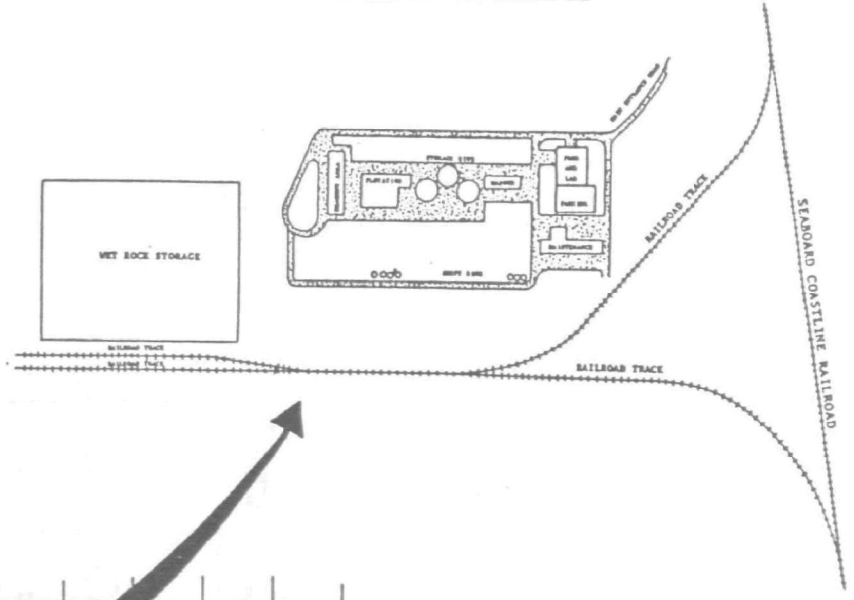
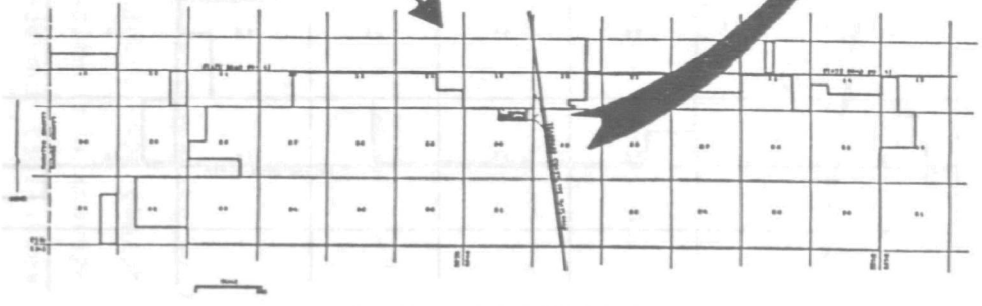
Hardee Phosphate Complex II



PLANT FACILITIES





PLANT SITE LOCATION

SOURCE: CF Industries

Figure 2.3-2
LOCATION OF PLANT SITE 1

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Hardee Phosphate Complex II

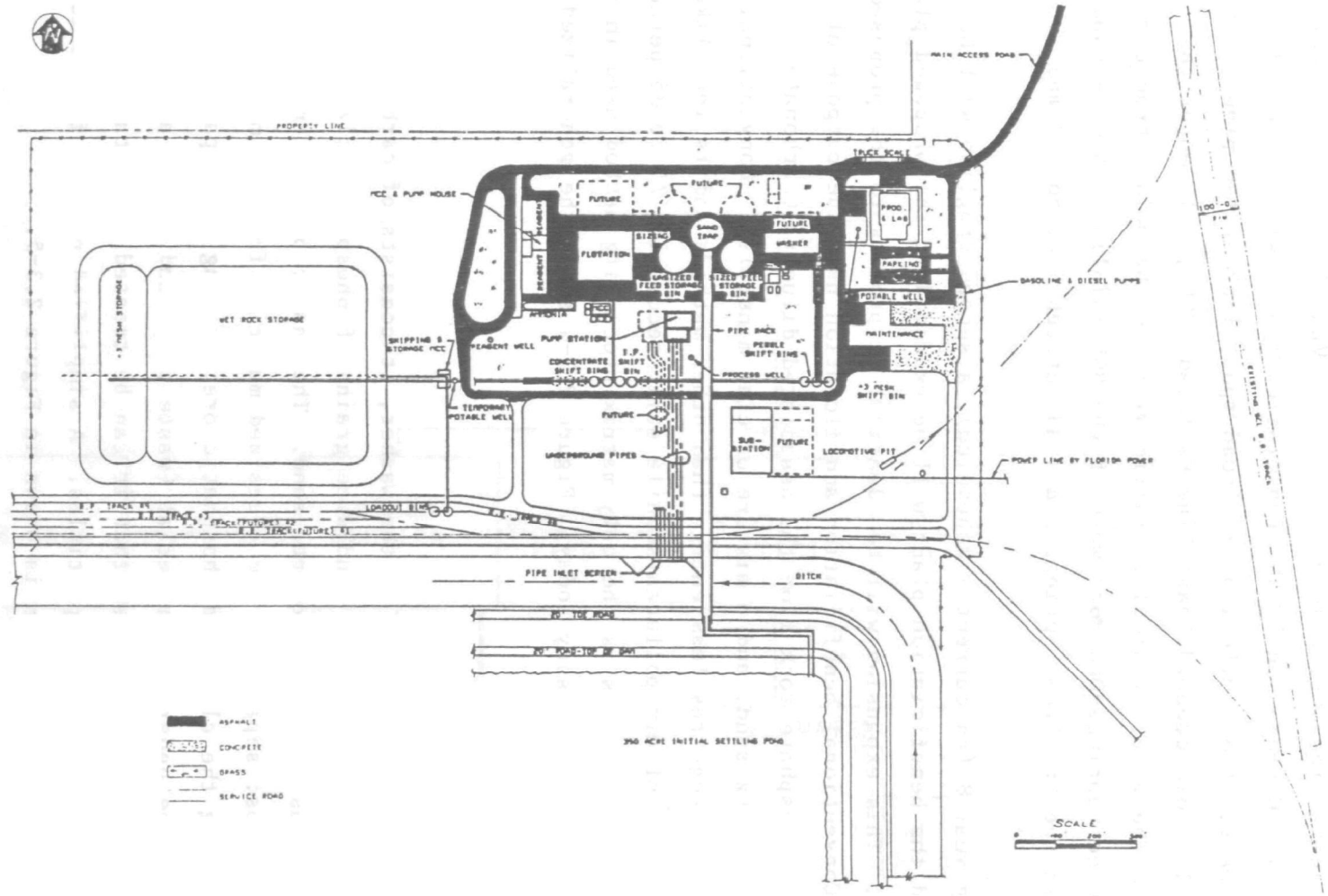

Figure 2.3-3
GENERAL PLANT LAYOUT

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CF INDUSTRIES
Hardee Phosphate Complex II

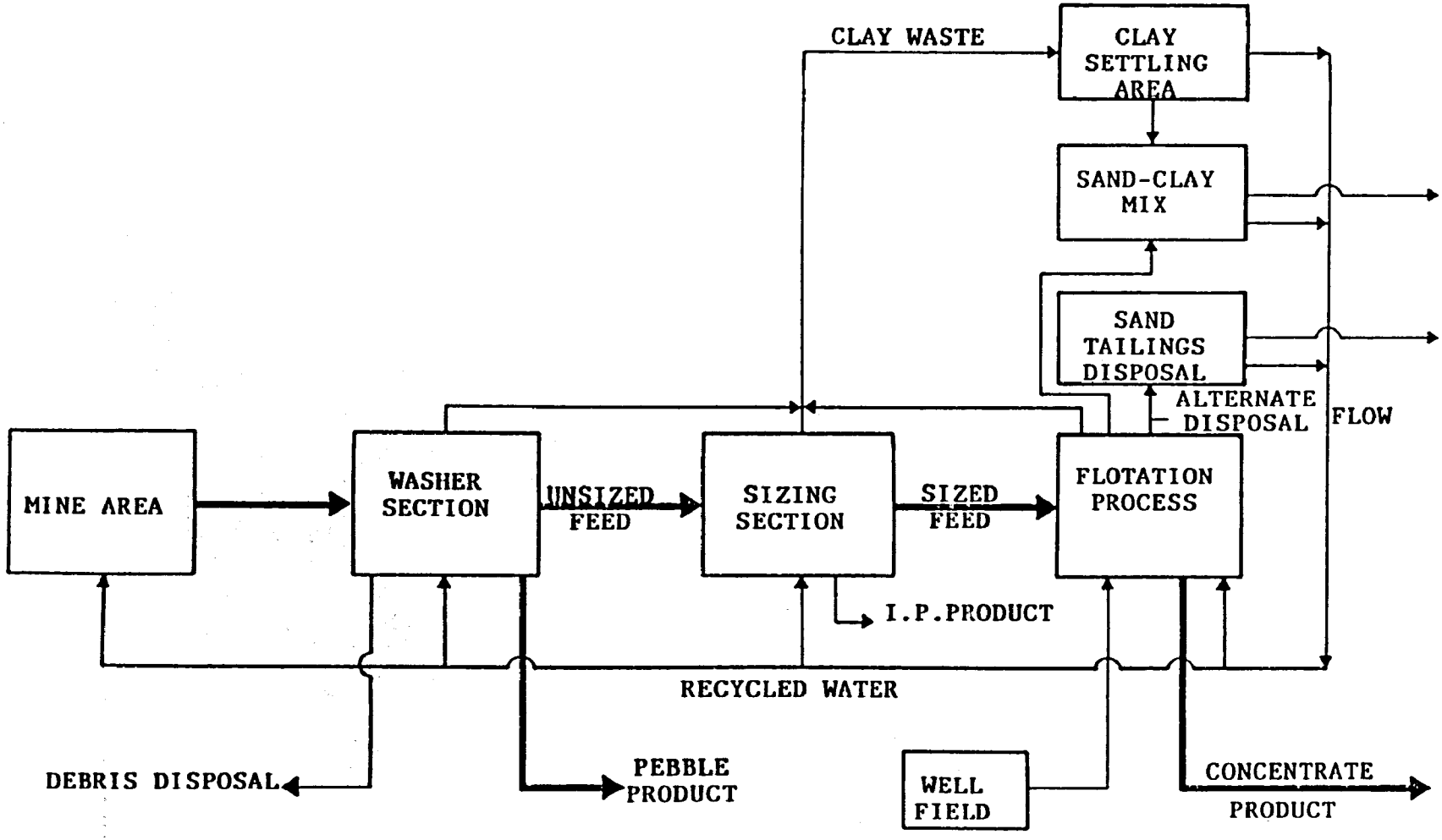
Miscellaneous operation support facilities, including the office, laboratory, and parking area, will be located within the plant site area.

Electric power lines (tied into the existing Vandolah-Ft. Green Springs, Florida Power Corporation 69 kV transmission lines) will enter the plant from the east. A one-mile long railroad spur, linking the plant with the main line of Seaboard Coast Line Railroad (SCL), will enter the plant from the east. Vehicular traffic will use the main entrance road off Ft. Green Springs-Ona Road west of the SCL mainline. A mine road will cross the Ft. Green Springs-Ona Road between Sections 29 and 30.

In mining year 8 (as currently scheduled), a second dragline will be added and the beneficiation plant will be expanded at the proposed plant location. This expansion will be identical in process to the proposed plant. Conventional beneficiation and flotation have the purpose of separating phosphate rock from the associated diluents (carbonate minerals, quartz sand, and a mixture of clay minerals). Conventional beneficiation requires less energy than other methods and is less likely to be a source of air pollutants while still recovering 75 to 85 percent of the phosphate. This is the only matrix processing method used in the Florida phosphate industry today. Figure 2.3-4 shows the generalized flow process.

2.3.3 WASHER SECTION

When the matrix is received at the washer, it consists of carbonate minerals, phosphate pebble, sand-size grains of phosphate, clay particles of various sizes, and quartz sand. The washer process involves a number of steps: separating the oversized material from the matrix; disaggregating the clays and phosphatic ore; washing and separating the pebble from the undersized material (waste clays and feed); and separating the sand-size material so that it can be treated by flotation to recover the fine phosphate particles. A simplified process flowsheet for a typical washer section is shown in Figure 2.3-5.



SOURCE: CF Industries

Figure 2.3-4
GENERALIZED PROCESS FLOWSHEET

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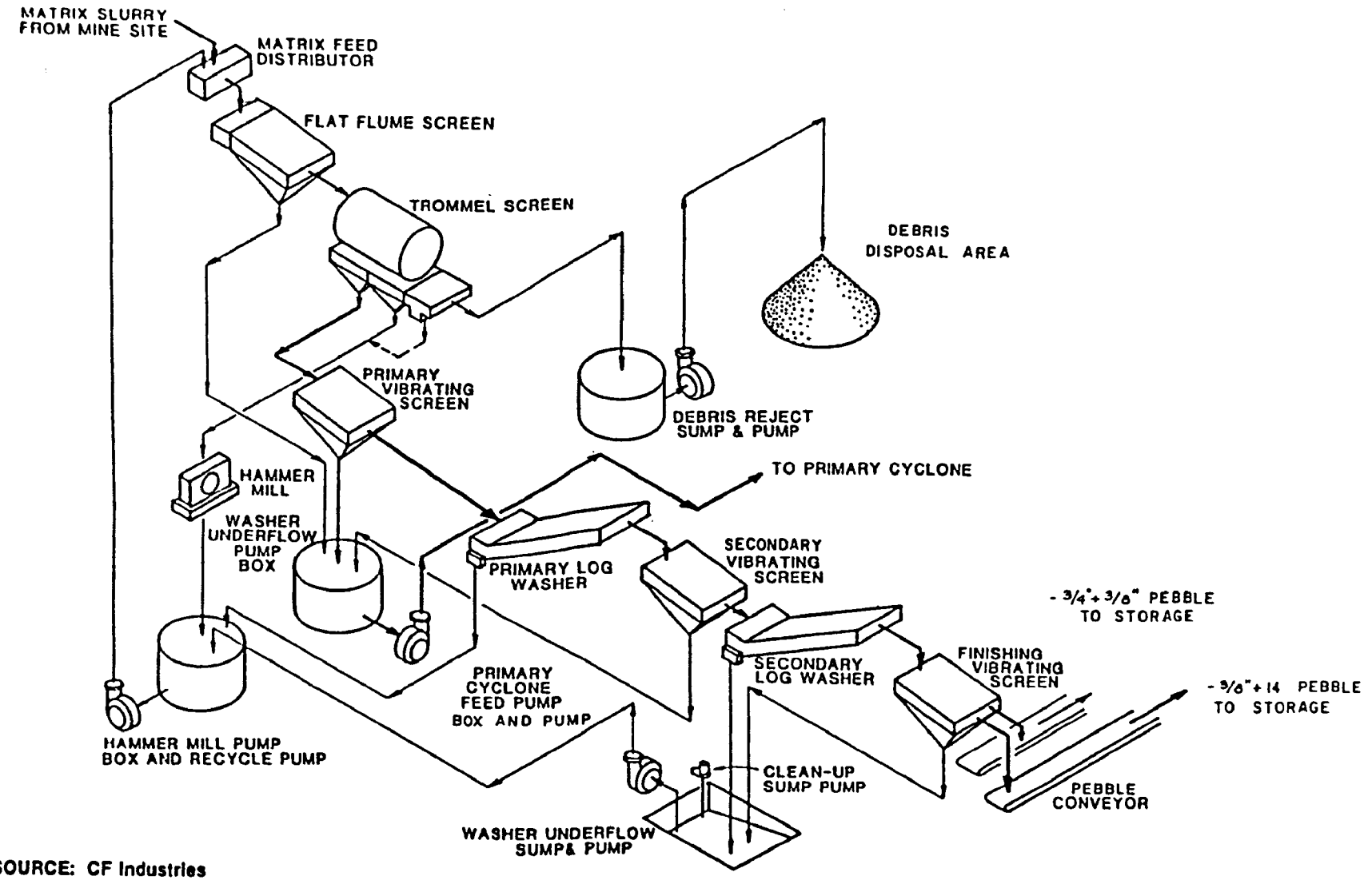
Hardee Phosphate Complex II



SOURCE: CF Industries

Figure 2.3-5
SCHEMATIC OF WASHER SECTION

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Hardee Phosphate Complex II

Matrix pumped in from the mine discharges into the matrix receiving box, located atop the washer structure. This receiving box has nine hydraulically operated gates which allow distribution of the matrix to the three trains of the washer section.

2.3.4 SIZING SECTION

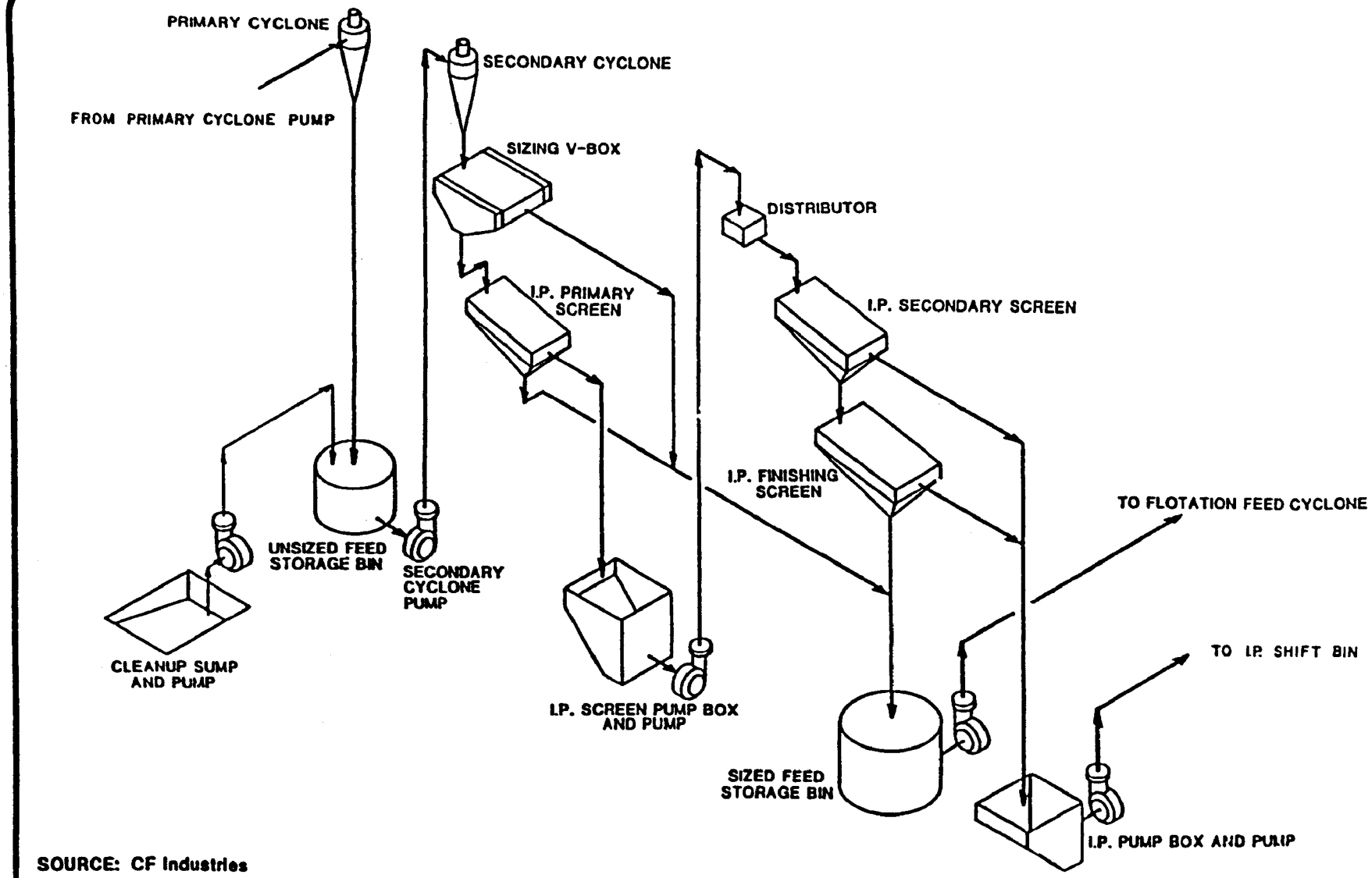
The sizing of coarse intermediate product (IP) begins when the material is pumped from the washer area to the primary cyclone. The -14 mesh material produced by the washer is pumped to the primary desliming cyclones. These cyclones remove the bulk of the -150 mesh material present in the feed stream as an overflow stream, which flows by gravity to the settling pond. The cyclone underflow flows by gravity to the unsized feed storage bin. The unsized feed material is then pumped to a secondary cyclone for removal of additional amounts of -150 mesh material (see Figure 2.3-6 for a schematic of the sizing section).

From this point the material reports to a sizing box and on to subsequent primary and secondary screens, if needed. Further processing divides the material for transport to the intermediate product shift bin or for additional subsequent processing in the flotation feed cyclone.

2.3.5 FLOTATION AREA

Sized feed, or float feed, is pumped from the sizing section to the flotation plant (Figure 2.3-7). There the feed is subjected to a standard Florida phosphate double flotation process consisting of three major processing steps designed to produce concentrate and sand tailings:

- A rougher (fatty acid) flotation circuit to achieve high recovery of phosphate, with bulk rejection of sand tailings;
- Collection and cleaning of initial concentrates prior to cleaner flotation; and



SOURCE: CF Industries

Figure 2.3-6
SCHEMATIC OF SIZING SECTION

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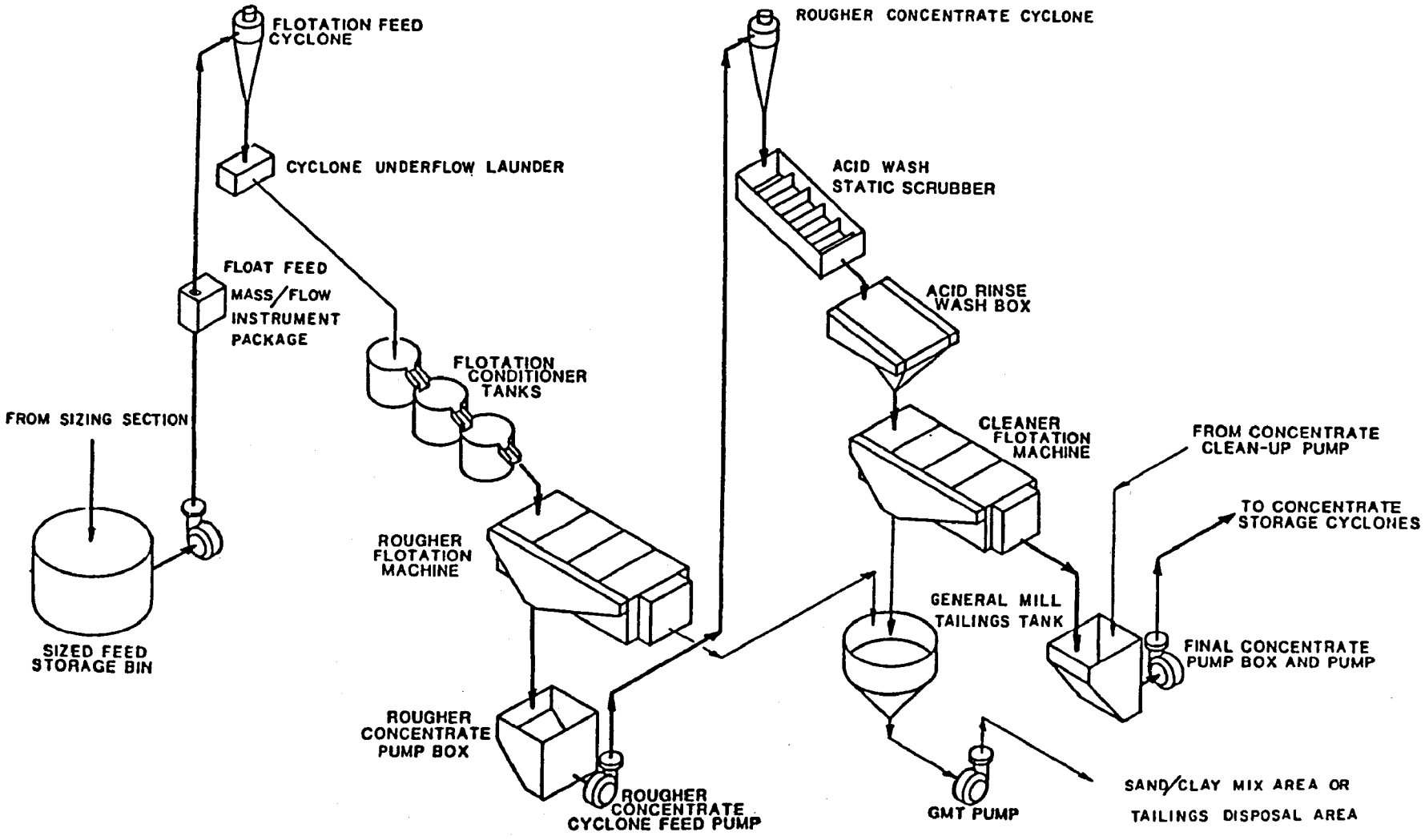
Hardee Phosphate Complex II



SOURCE: CF Industries

Figure 2.3-7
SCHEMATIC OF FLOTATION PLANT AREA

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Hardee Phosphate Complex II

- Cleaner (amine) flotation - a second stage of flotation to further concentrate the product.

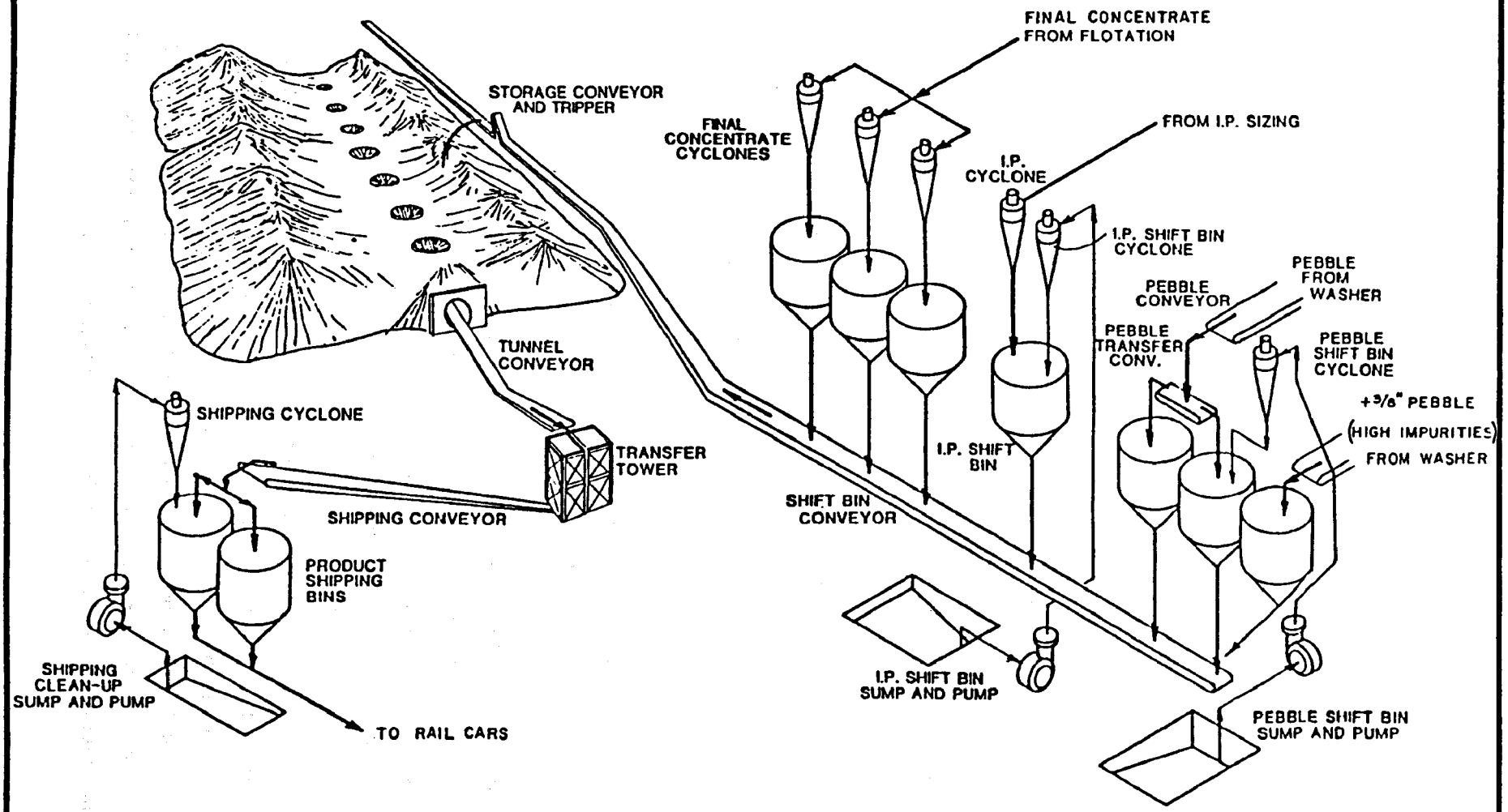
The flotation area is divided into two identical, independent sections called trains, each of which is composed of a bank of float feed cyclones, rougher flotation machines, acid scrubbers, acid wash boxes, and cleaner flotation machines. A common final concentrate pump and a common sand tailings pump are set on-grade for disposition of each material.

The final concentrate pump delivers the final concentrate to a pair of cyclones over one of three concentrate dewatering shift bins and then to the wet rock storage pile. The GMT pump and a booster pump deliver the rougher and cleaner tailings to the disposal area or to the sand/clay mix area.

2.3.6 WET ROCK STORAGE

After beneficiation, the wet rock pebble, IP, and concentrate are loaded from the shift bins via conveyor to the storage pile. The product is dumped, by means of a conveyor, into piles according to size, BPL (bone phosphate lime) grade, Fe, Al and MgO (iron, aluminum and magnesium oxide) content, and other factors. This short-term storage area (Figure 2.3-8) will contain rock with a moisture content between 12 and 16 percent. Drainage from the area will be collected and returned to the beneficiation plant circuit. Since these products are sorted, conveyed and shipped wet, they should pose no particulate air pollution problems.

The wet rock is then transferred by conveyor belts to the rail car loading facility. Wet rock is loaded into rail cars for shipment to the CF chemical plants located in Bartow or Plant City.



SOURCE: CF Industries

Figure 2.3-8
SCHEMATIC OF WET ROCK STORAGE AREA

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Hardee Phosphate Complex II

2.3.7 PHOSPHATE PRODUCT DISPOSITION

The phosphate rock resulting from this expansion will be utilized by CF's Plant City and Bartow phosphate complexes to replace an existing rock supply contract. The phosphate rock resulting from the second expansion would also be utilized by CF's two phosphate complexes to replace rock from contracts with other mining companies and rock supply provided by Hardee Complex I.

2.3.8 PLANT CONSTRUCTION

CF anticipates construction for their proposed mining and beneficiation plant to be completed within 19 months, allowing 2 months for land clearing, 3 months for grading and excavation, and 14 months for plant construction. CF plans to employ approximately 200 workers for this construction, drawing on the local labor pool to the greatest extent possible. During peak periods, the number of workers may increase to 400.

A projected 750 to 1,000 KVA will be required during the construction period to meet all electrical power needs for lighting, pumps, welding, etc. These needs will be met by 1,000 KVA service at the mine site. In addition, 150 gal/day gasoline and 250 gal/day diesel oil will be consumed by heavy equipment and will be provided by the responsible construction contractor. Energy demand can be expected to fluctuate greatly during the construction period.

Lubricants and fuels to service vehicles will be stored in small, stationary or portable containers above ground and in a location in keeping with vehicle fuel and lubricant requirements. These containers will be maintained by the vehicle owners.

During the construction phase, perimeter ditches will be installed to collect runoff from the plant site area. Dam construction areas will also be enclosed by perimeter ditches to intercept runoff. In the plant site area, all areas not permanently surfaced will be landscaped and revegetated. Access road shoulders, powerline right-of-ways, and pipeline corridors will be graded and revegetated.

During the construction, compliance with Article IV-Mining Ordinance, Hardee County Land Development Code will minimize adverse impacts to air quality. Dust or smoke emissions from heavy machinery, vehicular travel, and open burning will be effectively controlled. Roads within the plant area will be paved to minimize particulate pollution.

The capital cost for the CF mine and beneficiation plant is estimated at $129,000,000 (1981 dollars).

2.3.9 ENERGY REQUIREMENTS AND OPERATING PERSONNEL

The beneficiation plant's electrical energy needs are projected to be 18MW. The mine and slurry transport system will require approximately 13MW. The highest anticipated requirements are predicted at 38MW. CF is served by FPC on Rate Schedule IST 1-Interruptable General Service, Time of Use. This schedule provides that FPC may elect to curtail power service to CF's operation during critical load periods.

CF has continued to investigate and implement energy conservation concepts and through the engineering phase of the plant design will continue this practice. Metering devices will be installed to continually monitor individual load centers in order to evaluate energy demand to accomplish effective conservation practices. Power factor control will be implemented as required in order to maintain a desirable power factor.

It is estimated that 400 gal/day of gasoline and 100 gal/day of diesel fuel will also be employed during plant operation.

Operating personnel required for the mine and beneficiation plant at startup will be 139. That total will increase to 301 with the proposed expansion in mine year 8, which happens to coincide with the depletion of Complex I reserves. This increase will be largely filled by personnel from the Complex I mine.

2.3.10 REAGENT, FUEL, AND LUBRICANT STORAGE

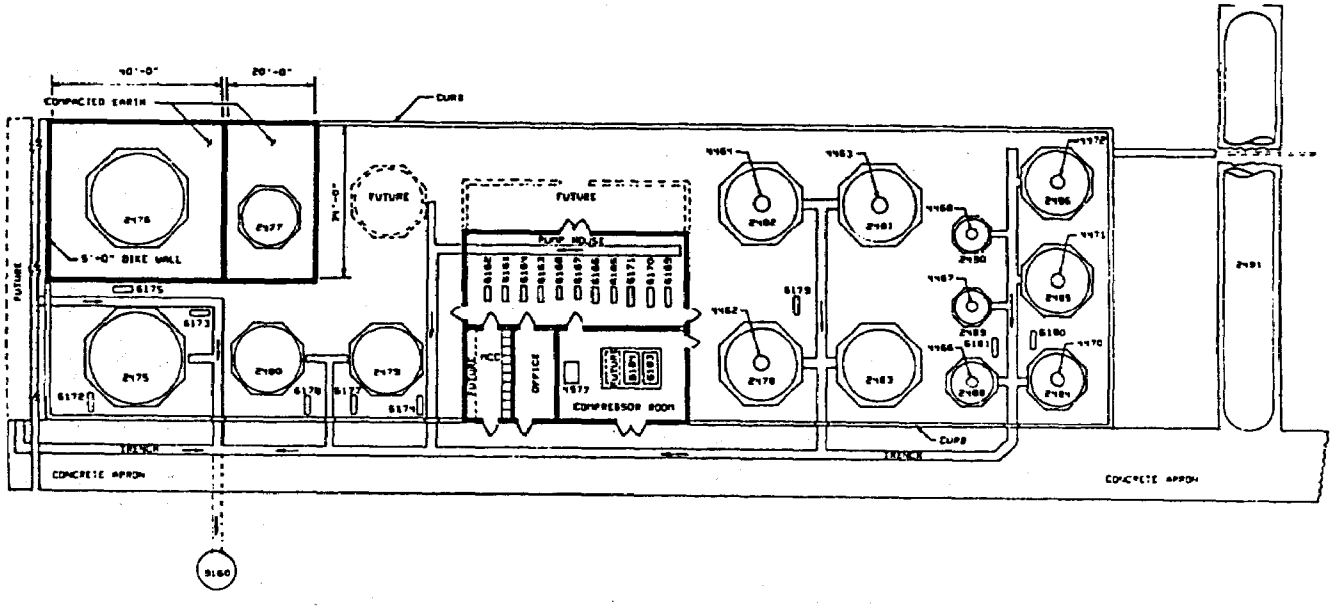
The reagent area of the beneficiation plant is diagrammed in Figure 2.3-9. As shown, the area contains bulk reagent storage tanks, mix/use storage tanks in which the concentrated reagents are mixed with other reagents or diluted to useable concentrations, reagent truck unloading pumps, reagent transfer pumps which move reagents from the bulk storage tanks to the mix/use tanks, reagent feed pumps which pump the reagents into the point of use in the flotation processes, the instrument air compressor/dryer package, and an oil separator/skimmer package.

CF's above-ground reagent and underground fuel tankage requirements are specified in Table 2.3.10-1. All reagents are delivered by tank trucks. The reagents, with the exception of ammonia, are stored in vertical, cylindrical, closed top, carbon steel tanks. These tanks are vented to the atmosphere; the No. 5 fuel oil and the kerosene tank vents are equipped with flame arrestors to preclude open flame or electric arcs from igniting the fumes in the vapor spaces of these tanks.

Ammonia is stored in a horizontal, cyclindrical, carbon steel pressure vessel, designed for a working pressure of 250 psig, and having appropriate pressure relief valving.

The No. 5 fuel oil tank and the kerosene tanks are set within individual, concrete-walled areas for fire protection purposes and for emergency spill containment. These two areas have valved sumps for manual, controlled release of water accumulation to the reagent area drainage system.

The bulk reagent tanks are fitted with level gages visible from the truck unloading pumps, while the mix/use tanks are fitted with high level switches that shut off pumps or valves supplying reagent to their respective tanks.



EQUIPMENT LIST

6175	FUEL OIL TRANSFER PUMP
6177,6178	FATTY ACID/FUEL OIL MIX/USE PUMP
6161,6162	FATTY ACID/FUEL OIL FEED PUMP
6179	AMINE ACETATE TRANSFER PUMP
6165,6166	3% AMINE ACETATE FEED PUMP
6169,6170	SULFURIC ACID FEED PUMP
6173	FATTY ACID TRANSFER PUMP
6172	FATTY ACID UNLOAD PUMP
6174	FUEL OIL/KEROSENE UNLOAD PUMP
6171	I.P. TRIPLEX REAGENT PUMP
6180	BULK I.P. AMINE TRANSFER PUMP
6181	DEPRESSANT TRANSFER PUMP
6163,6164	FUEL OIL FEED PUMP
6167,6168	KEROSENE FEED PUMP
4462	AMINE ACETATE STORAGE TANK AGITATOR
4463,4464	AMINE ACETATE MIX/USE TANK AGITATOR
4470	BULK I.P. AMINE STORAGE TANK AGITATOR
4471,4472	I.P. AMINE MIX/USE TANK AGITATOR
4466	BULK DEPRESSANT TANK AGITATOR
4467,4468	DEPRESSANT MIX/USE TANK AGITATOR
2431	AMMONIA STORAGE TANK
2476	#5 FUEL OIL STORAGE TANK
2475	FATTY ACID STORAGE TANK
2478	AMINE ACETATE STORAGE TANK
2477	KEROSENE STORAGE TANK
2481,2482	3% AMINE ACETATE MIX/USE TANK
2483	SULFURIC ACID STORAGE TANK
2479,2480	FATTY ACID/FUEL OIL MIX/USE TANK
2484	BULK I.P. AMINE STORAGE TANK
2485,2486	I.P. AMINE MIX/USE TANK
2488	BULK DEPRESSANT TANK
2489,2490	DEPRESSANT MIX/USE TANK
6183,6184	INSTRUMENT AIR COMPRESSOR PACKAGE
4977	INSTRUMENT AIR DRYER PACKAGE
9160	OIL SKIMMER PACKAGE

Figure 2-3-9
REAGENT AREA OF BENEFICIATION PLANT

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

Table 2.3.10-1. Reagent Tankage Requirements

	Gallons*	(Diameter x Height) Size
Reagent Area Tankage (Above Ground)		
Ammonia Storage Bullet	90,000(+-)	11'Ø x 135'
No. 5 Fuel Oil Bulk Tank	50,700	20'Ø x 21'
Fatty Acid Bulk Tank	50,700	20'Ø x 21'
Amine Acetate Bulk Tank	31,820	16'Ø x 21'
Kerosene Bulk Tank	16,900	12'Ø x 21'
Amine Mix/Use Tanks (2 tanks)	31,820 (ea)	16'Ø x 21' (ea)
Sulfuric Acid Bulk Tank	31,580	16'Ø x 21'
Fa/FO Mix Use Tanks (2 tanks)	25,935	14'-6" x 21' (ea)
IP Amine Bulk Tank	7,820	11' x 12'
IP Amine Mix/Use Tanks (2 tanks)	13,800 (ea)	14' x 12' (ea)
Bulk Depressant Tank	5,830	9'-6" x 12'
Depressant Mix/Use Tanks (2 tanks)	5,710 (ea)	7'Ø x 12'
Fuel Tankage (Underground)		
Gasoline Storage	10,000	10'6" x 24'8"
Diesel Storage	10,000	10'6" x 24'8"

* Net working volume to overflow.

Source: DMC, 1979.

The reagent tanks, other than the ammonia storage bullet, are fitted with vent, overflow, and drain connectors, all directed to the reagent area drainage system. In addition, all pump leakage is directed to this same drainage system.

The reagent area drainage system consists of an area concrete slab and trenches which direct all runoff or spillage through an oil separator. This separator removes the water insoluble oil phase from the area drainage. This material can then be reclaimed to a fatty acid/fuel oil mix use tank. The water phase drains, via open swales, to the beneficiation plant water recirculation system.

The reagent area is lighted to appropriate industrial standards to allow for mixing of reagents at night and to allow for the monitoring of the area for spillage.

Gasoline and diesel fuel are stored in underground tanks and vented to the atmosphere according to standard API practice.

Lubricant oil is stored in drums in a building near the maintenance building. A Spill Prevention Control and Countermeasure (SPCC) Plan will be prepared for the reagent fuel and lubricant storage area to conform with regulations specified in 40 CFR 112.

2.4 WASTE SAND AND CLAY DISPOSAL PLAN

2.4.1 INTRODUCTION

The CF ore body is composed of a mixture of non-uniform size phosphate pellets, disbursed in a matrix of silts, clays, and coarser grained sand particles. Since sand and clay have no economic importance to the operator, the only resource for which the proposed mine and beneficiation facility is being planned to recover is the phosphate value occurring in the -3/4 inch to +150 mesh size range. Consequently,

all sand and clay removed from the processed ore will be disposed of as waste materials throughout the life of the proposed Complex II project. CF estimates that mining and processing ore from the Complex II site will continue for at least 27 years before the existing phosphate resource becomes exhausted. During this time, approximately 97 million short tons (s.t.) of clay and 305 million s.t. of sand tailings (CF Industries, 1983) will be generated and disposed of at various locations prepared to receive the materials within the Complex II boundaries. Disposing of sand and clay wastes for use as backfill and reclamation materials for mined and disturbed lands is one of the primary objectives of the CF waste disposal plan.

The waste disposal method selected by CF is sand/clay mixing. Several factors were considered in reaching a decision on the method of waste disposal to be employed at the Complex II mine. From a materials handling perspective, the mix reduces the equipment, energy, and manpower requirements when compared with traditional practices of handling sand and clay separately. Also, higher total percent solids and increased consolidation rates have been observed from tests using the sand/clay mix technique (Ardaman & Associates, 1982). Both features offer positive incentives to the operator to pursue sand/clay mixing as the primary waste disposal method. Sand/clay mix also offers enhanced potential for reclamation over conventional clay settling areas. The increased dewatering potential of the sand/clay mix also allows for lower dams than typically constructed in conventional disposal systems.

Accumulation of information on the operational aspects of the sand/clay mix technique started in 1980 when CF began a production scale test with sand/clay mix as the waste disposal technique. CF initiated the program to honor its commitment to the Hardee County Board of County Commissioners to investigate new technology that might eliminate long-term conventional clay settling systems. Encouraging test results from work completed at the Complex I sand/clay mix site and the favorable sand to clay ratio of the Complex II ore have directed CF to commit to

this method as the primary waste disposal technique for subsequent reclamation at the Complex II mine site. The details of the waste disposal plan are discussed in the following section.

2.4.2 SAND/CLAY MIX PROCESS

Sand-clay mix refers to a process in which sand and clay components, separated during mining and beneficiation, are recombined into a suitable mix for disposal in a mined area. In the CF mix process, the waste clay generated from the beneficiation processes is routed to a containment area for storage and subsequent consolidation to higher percent solids. When clay consolidation reaches the 12 to 18 percent range, it is removed by dredge and pumped to a mix tank where mixing with dewatered sand tailings from the beneficiation plant takes place (Ardaman & Associates, 1982). The sand/clay mixture is then pumped from the mix tank to a designated disposal site. Disposal areas are designed to receive sand-clay mix over mined lands to final fill elevations that consolidate to within approximately 2-3 feet above the original average pre-mining elevation by the end of the reclamation period.

2.4.3 INITIAL SETTLING AREAS (ISA)

An above-ground settling area is necessary to receive diluted clay slurries for storage and consolidation to use in sand-clay mixing. To satisfy this requirement, CF plans only one above-ground settling area to be subdivided into three compartments. Designated as the Initial Settling Area, or ISA, the structure is necessary for the successful execution of the sand/clay process. The ISA receives low-percent (i.e., 2 to 5 percent) solids clay slurries originating at the beneficiation plant and contains them until the desired 12 to 18 percent solids are reached for sand/clay mixing. The design of the ISA, in available storage volume (acre-feet), must be commensurate with the peak demands of the total system. In other words, storage capacity must equal clay production and consolidation requirements as they develop to the maximum operating demands of the project. On this basis, the ISA has been designed to ultimately provide 20,000 acre-feet of storage volume. This requires ISA dam walls to be constructed 40 feet above the average

existing grade and encompass 760 surface acres (580 acres storage; 180 acres dam construction) at its maximum size.

During the last three mining years, 563 acres of the ISA will be mined and reclaimed. At the conclusion of all mining activities, the mix technique will be used to remove the clays in the remaining section by mixing with stored sand tailings, and the dam walls contoured to near natural grade.

2.4.4. SAND/CLAY MIX AND DISPOSAL AREAS

The design and construction of dams required for the impoundment of clay and sand/clay wastes will comply with all provisions of Chapter 17-9 of the Florida Administrative Code. A professional engineer, registered in Florida and experienced in earthen dam design, will be responsible for the design of all retention dams built on the property.

When construction is complete, the dam faces will be planted in grasses to inhibit wind and water erosion. The vegetative cover will be mowed as necessary to allow visual inspection of the dam surface at all times.

An inspection plan for all dams will adhere strictly to the provisions of Article IV Hardee County Mining Regulations of the Hardee County Land Development Code, and Chapter 17-9 of the Florida Administrative Code.

All dams will be inspected daily by a CF employee who has been instructed by the design engineer. A monthly report, including a copy of the daily inspections, will be submitted to Hardee County. The design engineer or another comparably qualified engineer will make annual inspections of all the retention dams on the property. The engineer will submit his findings in writing to the Florida Department of Environmental Regulation. A copy of this report and any corrective action required will be forwarded to Hardee County.

Sand/clay mix disposal areas must first be constructed over mined lands before filling can proceed. The disposal sites are constructed using available overburden for earthen dams. Dams are engineered for safety and utility in the same manner as conventional settling areas. The design heights above pre-mining grades are a function of the ultimate thickness of the sand/clay mix required to consolidate to the desired final elevations for reclamation. This is accomplished with sand/clay mixes stored behind dams that average 14.7 feet above pre-mining average grades for the Complex II area. Each mix area has been planned to reach the desired final topography for reclamation by storing only those quantities of sand/clay mix required to achieve this objective.

Table 2.4.4-1 shows average dam heights above grade and final grades of the reclaimed areas after capping the sand/clay mix with materials from the surrounding dams.

Figures 2.4-1A and 2.4-1B present a plan view of all areas required to contain the sand/clay mix and overburden/tailings for the east and west sectors of Complex II.

2.4.5 SAND/CLAY WASTE DISPOSAL PLANNING

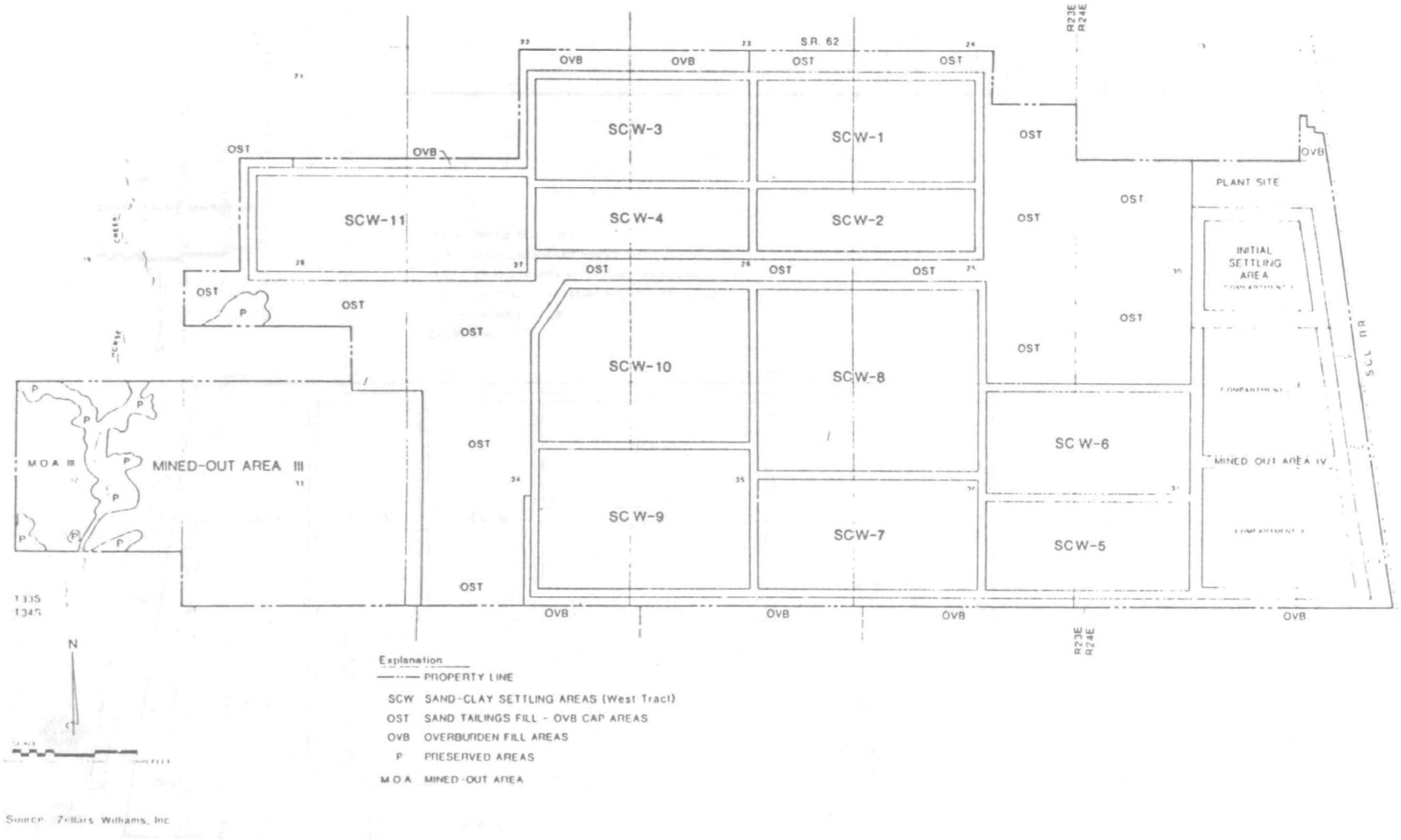
Many basic assumptions supporting the CF sand/clay waste disposal plan were developed from actual field tests conducted by CF at its Complex I mine site. The progress of the CF sand/clay technique has been monitored by Ardaman & Associates, Inc. under a grant from FIPR (Ardaman & Associates, Inc., 1982). A recent grant has been awarded to Ardaman & Associates, Inc. by FIPR to continue monitoring the CF sand/clay mix technique. Some of the major conclusions resulting from that sampling and monitoring program are:

- Consolidation of the sand/clay mix during the filling and resting periods within the 2-year study resulted in an average percent clay solids of 34 percent at the end of the study period.
- Computer simulations of the filling sequence for the west compartment of the reclamation area using laboratory

Table 2.4.4-1. Summary of Sand/Clay Mix Data

Sand/Clay Area Designation	Sand/Clay Acres	Dam Height Above Grade (Ft.)	Total Acre/ft.	Clay MM Tons	Clay Height (ft.)	Final Surface Height Above Natural Grade With Cap (ft.)
E-1	187	18.8	6,749	2.67	49	2.8
E-2	308	13.8	5,626	2.22	28	2.3
E-3	426	17.4	14,749	5.83	43	2.4
E-4	292	15.1	7,203	2.85	34	2.3
E-5	220	17.7	8,576	3.39	45	2.4
E-6	330	18.3	13,334	5.27	47	2.4
E-7	330	18.8	13,463	5.32	49	2.4
W-1	356	13.5	7,203	2.85	27	2.3
W-2	223	14.3	5,645	2.23	31	2.3
E-8	350	22.1	19,024	7.51	63	2.6
W-3	343	13.3	7,134	2.82	26	2.2
W-4	191	12.2	3,162	1.25	22	2.2
E-9	329	18.1	11,960	4.72	46	2.5
W-5	307	11.2	4,184	1.65	18	2.2
W-6	326	11.2	4,690	1.85	18	2.1
E-10	366	19.1	15,820	6.25	50	2.3
W-7	381	13.1	7,798	3.08	25	2.2
E-11	240	17.0	7,604	3.00	42	2.5
W-8	550	13.6	12,107	4.78	28	2.2
E-12	324	15.4	8,788	3.47	35	2.3
W-9	450	12.5	8,247	3.26	23	2.2
E-13	421	13.9	10,118	4.00	29	2.2
E-14	276	15.3	8,383	3.31	35	2.2
W-10	467	12.8	8,976	3.55	24	2.1
W-11	410	14.3	9,776	3.86	31	2.3
E-15	680	14.6	16,747	6.62	31	2.2
TOTAL/AVERAGE	9083	14.7	247,066	97.61	34	2.3

Source: CF Industries, 1982.



Source: Zellars Williams, Inc

Figure 2.4-1A
WASTE DISPOSAL PLAN

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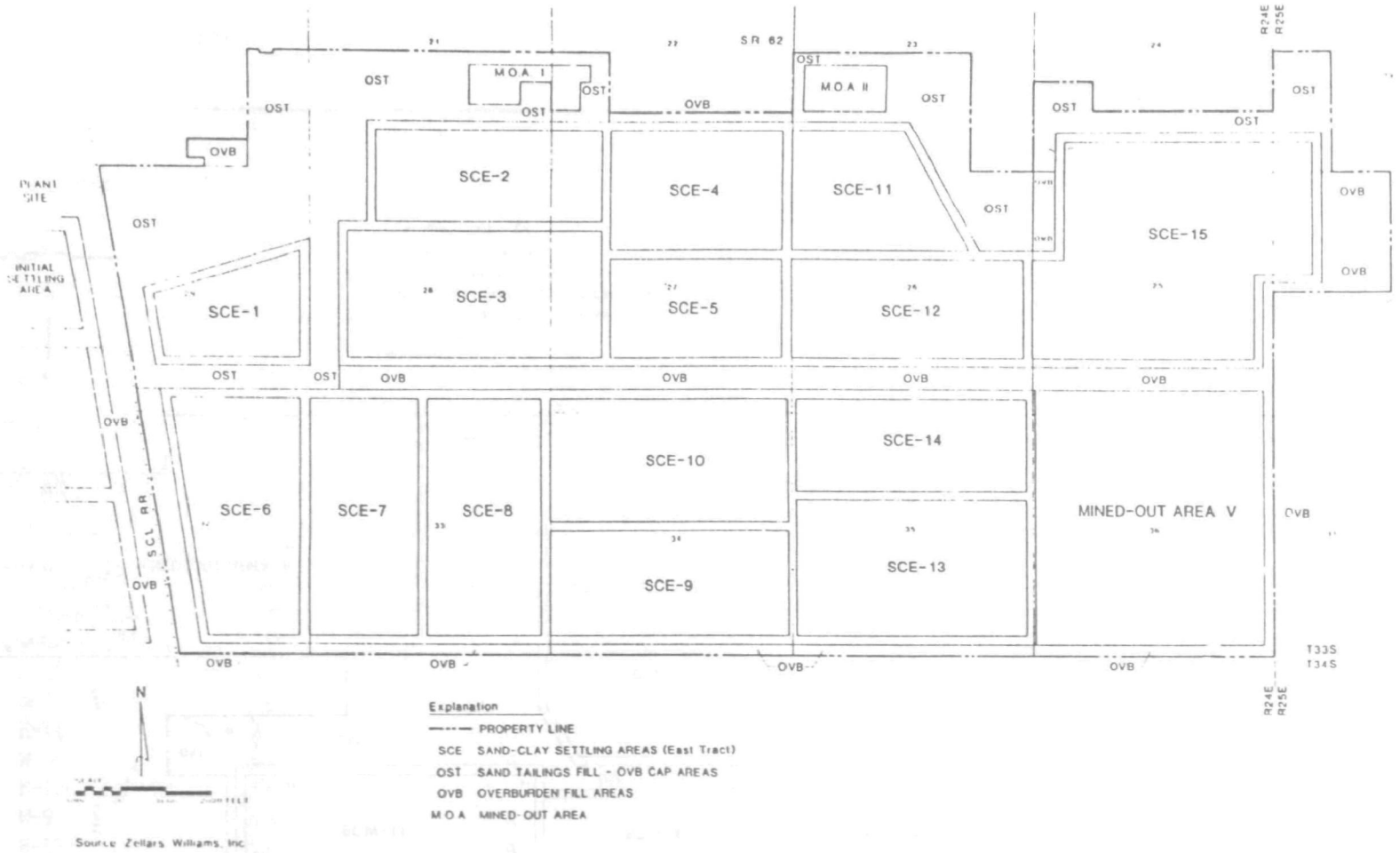
Hardee Phosphate Complex II



Source: Zellars Williams, Inc.

Figure 2.4-1B
WASTE DISPOSAL PLAN

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consolidation properties show reasonable agreement between calculated and observed values.

Land use planning for sand/clay disposal areas was the subject of a paper prepared by CF for presentation at a FIPR symposium on "Reclamation and the Phosphate Industry" (Florida Institute of Phosphate Research, 1983). In addition to the physical properties of sand/clay mix consolidation and waste disposal advantages inherent with the method, the paper also evaluated the vegetative support and water retention qualities of sand/clay as applied to land reclamation. In essence, nutrient analysis of the sand/clay and overburden soils show higher nutrient content in the sand/clay soil than in the overburden. The combination of the sand/clay mix and the overburden soils used for capping should provide a desirable growing medium for a variety of vegetation. Soil permeability is lower in sand/clay than typical overburden soils which would be an advantage in wetland restoration. The sand/clay mix soils may be enhanced for other types of vegetation by increasing sand to clay ratios and/or overburden caps placed over the sand/clay mix areas.

2.4.6 TAILINGS

Some mined areas will be backfilled with sand tailings that are not used in the sand/clay mix program. These areas are shown on Figures 2.4-1A and 2.4-1B. The tailings may be pumped directly from the beneficiation plant to the reclamation site or temporarily stored at a stockpile area for later use.

Tailings provide an excellent material for backfilling. Therefore, sand tailings and overburden will be used to construct a permanent right-of-way to relocate the existing FPC 230KV transmission line which passes through the east sector of Complex II. Other tailings and overburden quantities are designated for restoring certain stream channels and other mined out areas of the property.

Revegetation over tailings usually requires a 6-inch to 12-inch overburden cap to retain moisture and provide some nutrients for plant growth. CF plans to cap the tailings acres with overburden to establish a suitable base for subsequent revegetation and to reduce the effects of wind erosion.

2.4.7 SUMMARY

In total, over 60 percent of Complex II will be composed of sand/clay mix areas at the conclusion of mining. Assumptions used in sand/clay disposal planning were primarily the results of actual field tests conducted by CF at its Complex I mine site. An important consideration for the plan was predicting consolidation rates for reclamation. Consolidation rates for 2:1 sand/clay mix ratios, stacked 40 feet, will attain 40.9 percent clay solids 5 years after filling (Ardaman & Associates, Inc., 1983). Each CF sand/clay area has been designed to consolidate 2 to 3 feet above the pre-mining average grade approximately 5 years after filling.

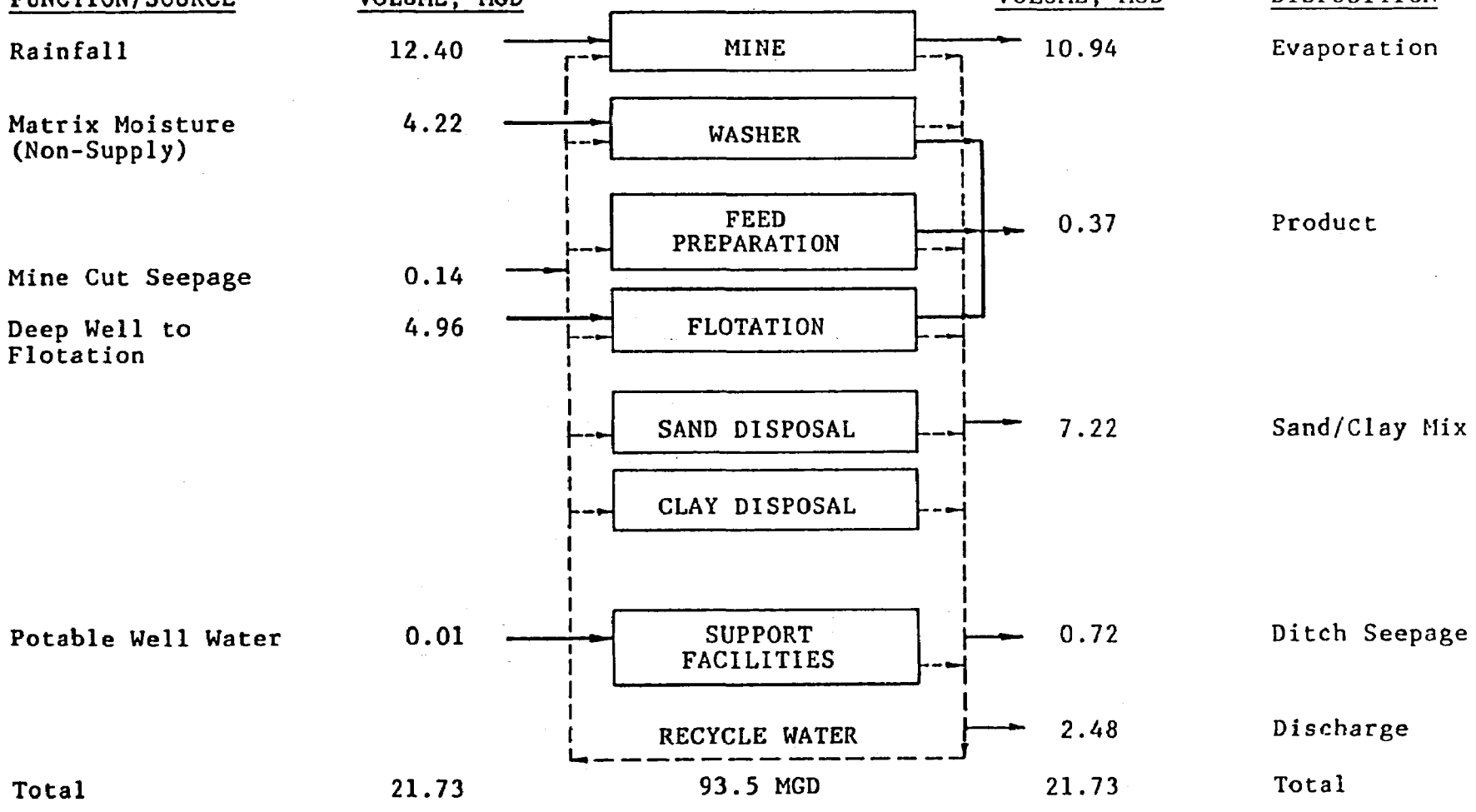
Other waste disposal consists of tailings and overburden at selected sites over the property, graded to approximate pre-mining contours.

One above-ground settling area will be required to contain diluted clay slurries until percent solids reach the 12 to 18 percent range. Clays will be removed from this structure, and its dams will be reduced to meet abandonment and reclamation requirements at the conclusion of mining.

2.5 MINE WATER USE PLAN

2.5.1 PROCESS WATER REQUIREMENTS

Water is an essential ingredient in many of CF Industries' phosphate mining operations. Figure 2.5-1 presents the key water uses for the mine as planned by CF, including the respective sources and final



Source: Ardaman & Associates

Figure 2.5-1
MINE WATER BALANCE
(DAILY AVERAGE)

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CF INDUSTRIES
Hardee Phosphate Complex II

disposition of the water. Recycled water is used extensively as a medium in many processes to reduce the overall consumptive use of water. Matrix transport and process water is used as follows:

- Ore Transportation - Recycled water is required to slurry the matrix as a medium for transporting the matrix to the beneficiation plant.
- Washer and Sizing Sections - Recycled water is used in the washing process to separate pebble, sand, and clay size fractions.
- Rougher Flotation - Recycled water is used in the rougher flotation circuit to dilute the float feed in the rougher flotation machines.
- Amine Flotation - Deepwell water is used in the amine flotation circuit for feed dilution. Recycled water may be used as an alternative based upon water quality and flotation considerations.
- Waste Disposal - Recycled water and water from the flotation circuits is used as a medium for transporting waste clays and sand tailing from the beneficiation plant to disposal area.

2.5.2 BENEFICIATION PROCESS REAGENT REQUIREMENTS

Several reagents are utilized during the feed preparation and flotation processes of the beneficiation plant. These reagents include ammonia (caustic may be considered as a substitute to using ammonia as a neutralizing reagent), fatty acid, fuel oil, amines, kerosene, and sulfuric acid. The reagents are used in dilute quantities to separate phosphate rock from sand particles in the flotation circuits, thus achieving the desired level of phosphate rock recovery.

The reagents used and their expected dilution ratio in the flotation discharge water, assuming the reagents pass through the flotation circuit without chemically reacting, follow:

REAGENT	AVERAGE USAGE GAL/DAY	DILUTION RATIO
Ammonia	3,075	9,821:1
Fatty Acid	6,111	4,942:1
Fuel Oil	5,225	5,780:1
Amines	909	33,223:1
Kerosene	21	1,438,095:1
Sulfuric Acid	2,306	13,096:1

Flotation discharge waters then mix with other discharge streams from the beneficiation process where the majority of these reagents react forming chemically insoluble complexes and precipitates. In addition, most reagents have an affinity for clay particles. Consequently, as the float circuit discharge waters mix with water containing clay, the opportunity for further reaction takes place. As a result of these chemical reactions and the subsequent settling out of clay particles in the disposal areas, only trace concentrations of the reagents are expected to end up in the plant process recycle water.

2.5.3 WATER RECIRCULATION SYSTEM

CF plans to recycle water to the greatest extent possible for use in plant operations. The mine water recirculation system proposed (Figure 2.5-2) will recycle 93.5 mgd, which is projected to be adequate for the required uses. Since mining and beneficiation processes operate with a fixed water usage to production rate ratio, demand is fairly

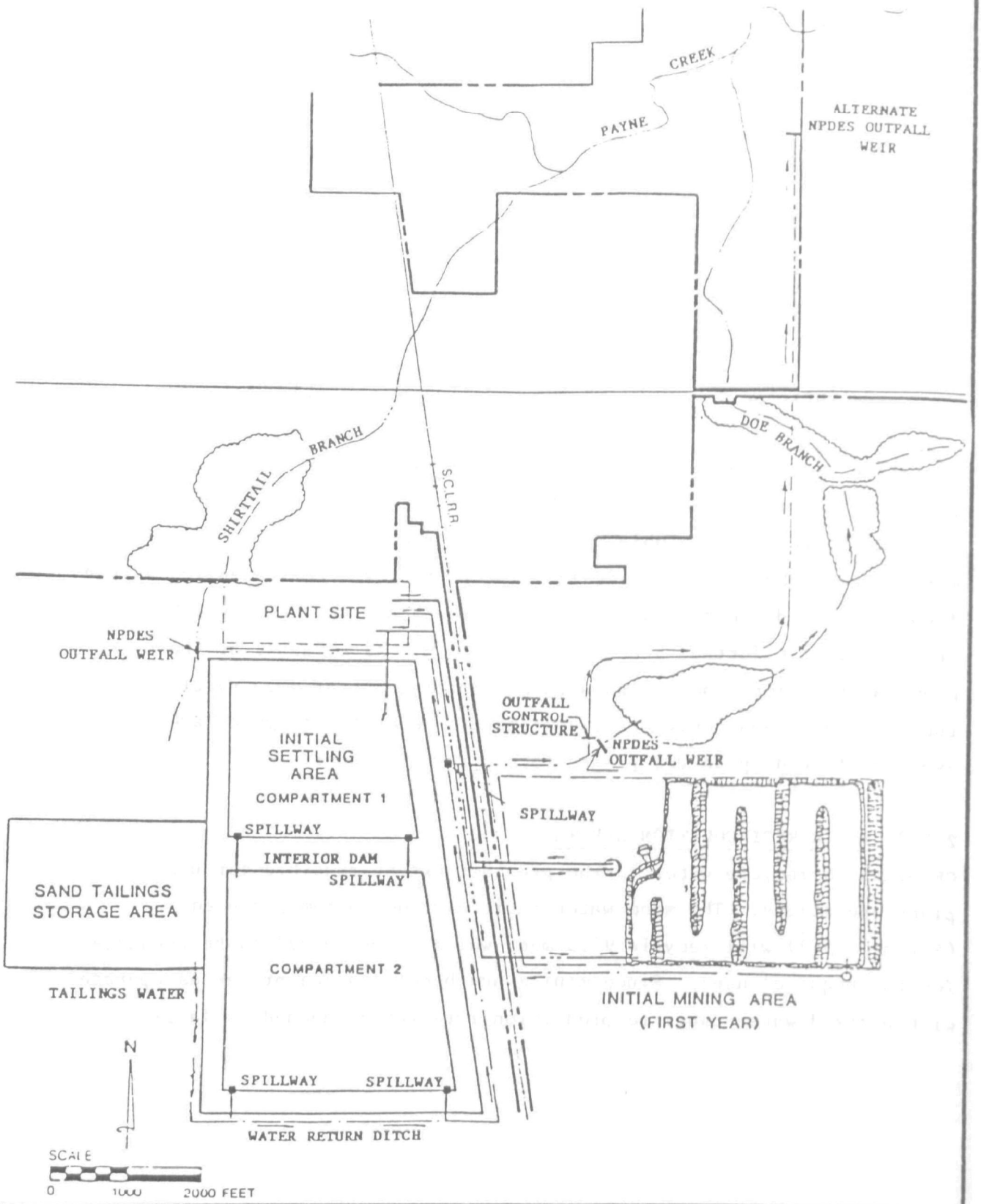

Figure 2.5-2
CONCEPTUAL WASTE DISPOSAL AND WATER RECIRCULATION PLAN FOR INITIAL START-UP
SOURCE: CF INDUSTRIES, INC.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

constant. Therefore, no significant fluctuations in water usage are expected.

Seasonal variation in rainfall and evaporation rates can affect the recirculation system's water supply; however, annual rainfall within the region is 55 inches as opposed to the annual evaporation rate of 48 inches. This difference of 7 inches is considered as a make-up water supply source when it can be collected. Chapter 17-9 of the Florida Administrative Code limits the rate at which the water level in any active settling area can be raised or lowered. This limits the variable holding capacity of any pond, thus making it impossible to recover all the net rainfall available during wet periods. Close control and management of the pond system can provide for rainfall recovery of approximately 70 percent.

This excess can be used during the pre-filling of the ISA in the initial year of mining to provide a surplus to the system and help offset system losses. A seasonal deficit can result if the reservoir's capacity is insufficient to collect enough rainfall during the wet season to counter-balance shortages during the dry season; or if the catchment area is insufficient to offset the loss between rainfall and evaporation rates. During the dry season, this deficit due to evaporation can increase system losses. As planned, the system's surge capacity should aid in eliminating these seasonal changes. If necessary, well water can be drawn as make-up during the dry season. Conversely, during the rainy season, if the accumulation of rainfall and runoff in the system exceed the storage capacity, discharges may be necessary.

The major water loss from the recirculation system is entrainment in the waste clays. CF's use of sand/clay mix for waste disposal has the advantage of more rapid dewatering resulting in increased water recycling and a lower rate of water loss due to entrainment. The process, however, has not been thoroughly tested for all types of clay. Consequently, the degree of success for water recovery is not known.

Minor losses from the water recirculation system are identified in CF's mine water balance (Figure 2.5-1).

2.5.4 CONSUMPTIVE USE - GROUND WATER WITHDRAWALS

On April 7, 1976, CF Mining Corporation was issued a Consumptive Use Permit (CUP) from the Southwest Florida Water Management District (SWFWMD) for its Hardee Phosphate Mining Complex. This permit was originally based on a three phase development plan - two mining operations (Hardee Complex I and Hardee Complex II) and a proposed phosphate chemical processing plant. Expiring in late 1981, this permit authorized an average water withdrawal of 15.74 million gallons per day and a maximum withdrawal of 20.2 million gallons per day.

CF applied for and received renewal CUP No. 203669 from SWFWMD on January 6, 1982. Water use projections for this permit were based on efficient water use at Hardee Complex I and the implementation of the plan to construct a beneficiation plant at Complex II. Consequently, CF proposed decreased average and maximum withdrawal rates from the original CUP. A comparison between the original and the renewal consumptive water use permits is shown below:

	Original CUP		Renewal CUP	
	MGD/Max.	MGD/Avg.	MGD/Max.	MGD/Avg.
Authorized Water Consumption	20.20	15.74	10.57	7.85

This comparison shows a reduction of almost 50 percent in overall water consumption from the original permit. The renewal CUP permit, under which CF currently operates, has an expiration date of January 5, 1988.

The permitted wells designated for Hardee Complex II will be located in the vicinity of the beneficiation plant site (Figure 2.3-2). These wells collectively should yield approximately 5.0 million gallons per day for total plant operations.

Current plans indicate a need for ground water withdrawal to provide a primary source of clean water for the amine flotation circuit and to offset water losses from the recirculation system.

The projected material balance and ground water withdrawals were developed using 86 percent solids in the shipped phosphate rock, 80 percent solids in the sand tailings and 18 percent solids in the waste clays. Colloidal entrainment was calculated considering a deduction for the water that is in the matrix when it is moved and ends up in the waste clay.

Water will be required before the actual initiation of mining for use as potable construction water and for pre-filling the ISA. The tendency of the clays to gradually release water necessitates pre-filling at the outset of operations, although this water will eventually be recovered from the clays over time. The water level in the ISA will be maintained at an elevation sufficient to provide rapid flow return to the plant water pool for plant start-up.

CF proposes to drill two 24-inch production wells (designated Well No. D and E) to a depth of approximately 1,200 feet into the Avon Park Limestone (Figure 2.5-3). In addition, two smaller wells (designated Well No. F and G) will be developed to supply the operation's domestic and potable water needs.

Wells permitted for Hardee Complex II are described below:

Well No. D: 24-inch diameter, 1,200 foot depth--to be used as the main production well for ground water supply to the flotation plant.

Well No. E: 24-inch diameter, 1,200 foot depth--to be used for fresh water dilution in mixing reagents. Casing sized to accommodate production well pump in the event of a production well failure.

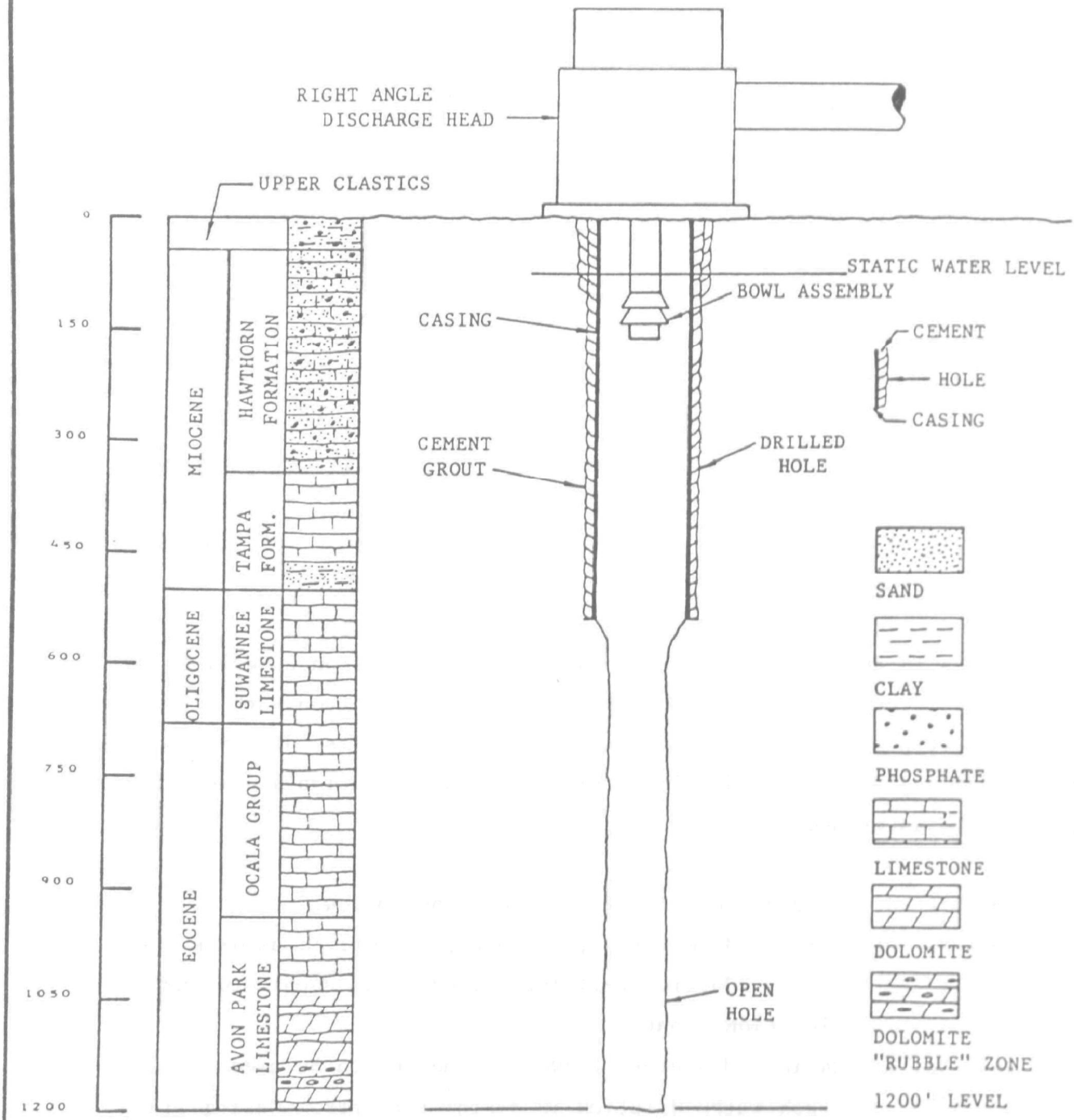

Figure 2.5-3
TYPICAL PRODUCTION WELL

SOURCE: CF INDUSTRIES, INC.

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Hardee Phosphate Complex II

Well No. F: 8-inch diameter, 1,200 foot depth--to be used as domestic water well.

Well No. G: 4-inch diameter, 500 foot depth--proposed to be used as a potable water supply during construction.

CF has accepted and agreed to comply with the renewal CUP's operational conditions. To maintain compliance with the permit, CF will minimize drawdown impacts to the Floridan and water-table aquifers, perform the required ground water level and water quality monitoring, and prepare the necessary monthly pumpage reports.

2.5.5 OTHER WELLS

A total of 25 monitor wells are located at the CF's Hardee Phosphate Complex II. These include: a deep well with a depth of 1,702 feet; 6 lower Floridan wells with depths ranging from 950 to 1,200 feet; 4 upper Floridan wells to depths of between 375 and 433 feet below ground surface; and 14 shallow aquifer wells ranging in depth from 35 to 66 feet below ground surface. The wells were installed as part of the study for the consumptive-use application required by SWFWMD and to meet the ground water monitoring regulations established by Hardee County.

As mining progresses, 9 of the 25 wells will be eliminated. These include 4 lower Floridan wells, 2 uppper Floridan wells, and 3 wells from the shallow aquifer.

State regulations require that appropriate well abandonment procedures must be followed. These procedures have been established to prevent drainage of upper aquifer waters to lower aquifers through poor well abandonment techniques. Floridan Aquifer wells will be abandoned in accordance with the rules of the Department of Environmental Regulation, Chapter 17-21, "Rules and Regulations Governing Water Wells in Florida." The abandonment procedure would involve sealing the well from the bottom to the top with neat cement grout. Shallow aquifer wells would be

physically removed as the sand is stripped and phosphate matrix is removed.

2.5.6 MAXIMUM WELL PUMPAGE

Maximum well pumpage is expected to occur during the pre-filling of the settling pond (ISA). Estimates call for well water to be pumped at the maximum capacity of 4,400 gpm for 90 days, the time required to fill the ISA. However, due to a possible need to curtail withdrawal during the dry season (to comply with SWFWMD regulations), the actual pumping time may vary.

2.5.7 MINE PIT DRAINAGE

The dragline method for mining requires a relatively dry pit, consequently mine pit dewatering is necessary to effectively recover the maximum quality and quantity of phosphate matrix. CF plans to pump at a rate of approximately 2,000 gpm to maintain the desired pit water level elevation. Should this pumping rate fail to lower the water level to acceptable limits, the use of additional dewatering pumps, the placement of cast spoil against the sidewall, the use of well points for groundwater withdrawal, or other methods may be used to reduce seepage through the pit wall.

Since the matrix underlies the surficial sands containing the surficial aquifer, maintaining the desired water level in the pit results in the temporary and localized lowering of the water table in the vicinity of the mine cut.

The degree to which this lowering of the water table or drawdown may cause undesirable effects is a function of aquifer hydraulic properties, the geometry of the mine cut, and the length of time dewatering continues at each location. Water table drawdown impacts are site-specific, short-term, and should result in no permanent water table changes.

If drawdown impacts do become excessive at the property boundaries, CF will draw upon the latest mining and engineering techniques in minimizing or eliminating the problem. These techniques include back filling mine cuts along property boundaries and, when necessary, digging rim ditches between the open mine pits and property boundaries. Through the maintenance of the water level in these ditches, a recharge area would be created preventing the current water table elevation from declining beyond the boundary of the ditch.

2.5.8 SURFACE WATER RUNOFF

At present, surface water runoff at the proposed site is distributed to on-site streams and can primarily be attributed to rainfall occurrences. Factors which influence the water discharge to each stream are soil permeability, vegetative cover, land gradient, and drainage area. CF's planned water recirculation system (including the active waste disposal areas, the clear water pond, and the recirculation ditches) will reduce this runoff by retaining a portion of the rainfall for use in the recirculation system.

Planned post-mining reclamation activities within portions of each watershed are expected to return the flow characteristics of most downstream drainage systems back to approximate pre-mining streamflow conditions. Balancing pre- and post-mining watershed conditions will be accomplished by plans which include the creation of lakes and wetlands, and increasing the surface storage capacity at the site. In addition, the drainage basin of each stream on the mining tract will be restored to approximately its pre-mining size. Some of the major components of Hardee Complex II's drainage system during the operating and post-operating phases are illustrated in Figures 2.6-6, 2.6-7, 2.6-8, and 2.6-9.

During periods of excessive rainfall, expected during June, July, August, and September, water which exceeds the system's water handling design capacity will be discharged via CF's NPDES permitted outfalls.

The water balance planned for the CF project uses retention capacity and recirculation efficiency to determine the make-up water needs of the development. The design of the recirculating water system (Figure 2.5-2) allows for the segregation of process recirculation water within the system from the overload flow outside of the system. The ISA will be designed to contain a 25-year storm rainfall event (defined as having 9.63 inches of rainfall in a 24-hour period) and release 12 inches of water in a 24-hour period. The size of each area predicates a minimum number and size of release structures. The preliminary locations of these spillways are shown in Figure 2.5-2.

The northern section of the ISA will have two discharge structures located in the south end and discharging into the second section. There will also be a spillway in the southeast corner of the northern section which will discharge into the circulation ditch. Water which is given up by the waste clay will decant further in the second section and will be discharged into the extension of the water circulation ditch through two discharge structures. The water circulation ditch west of the SCL railroad will be connected to the east-west ditch east of the railroad through a controlled discharge structure. This will provide for the necessary make-up water to the mine for matrix pumping.

Recirculated water will pass through the ISA into the recirculation ditch along the southern and eastern boundaries of the ISA, and report to the mine (as required) and the plant through the northern ditch to the hydraulic station.

2.5.9 WATER DISCHARGE

CF's objective to achieve a balanced wastewater disposal program can be realized by minimizing the frequency and volume of wastewater discharged while maintaining its quality and the water quality of the receiving waters.

To minimize the frequency and volume of discharge, CF plans to recycle/recirculate as much water stored in the interconnecting ditches and

ponds as possible. As a result of these efforts, discharges of treated process wastewater should typically occur during the rainy season at times when accumulated rainfall and runoff exceed the storage capacity of the settling ponds and recirculating water system. This should occur primarily during the months of June, July, August, and September.

Major inputs to the recirculating water system will include clarified water from the settling areas, mine-cut dewatering water, and stormwater from in and around the plant complex. As water inputs to the recirculating water system exceed that amount required for matrix pumping and plant operations, occasional intermittent discharges will result.

To maximize reuse of water and minimize both ground water withdrawal and discharge of process waters, CF may incorporate other water conservation practices into its operation if proven successful through site-specific experimentation. One such practice that CF may experiment with is the use of recirculating water in lieu of freshwater in the flotation circuit of the beneficiation plant. If successful, freshwater will be reduced, decreasing this input to the overall plant water balance.

The proposed water balance (Figure 2.5-1) specifies that an average of 2.48 mgd is expected to be discharged on a daily basis. Reduction of this rate depends on how successful or unsuccessful CF is in the utilization of other water conservation efforts. Success with any experimental water use practice is highly dependent on site-specific conditions including matrix composition, clay settling, plant design, and material utilization.

2.5.9.1 CF INDUSTRIES' PROPOSED WATER DISCHARGE PLAN

Each water management alternative evaluated provides its own positive and negative impacts. CF proposes to discharge to surface waters either directly or via wetlands. CF's primary discharge of clarified water is expected from the recirculation system into Shirttail Branch and/or Doe

Branch. An alternative surface water discharge point is also proposed into Payne Creek. Discharge to Payne Creek is expected to be via pipe and open ditch into wetlands by sheetflow. The surface water discharge outfall locations selected for utilization are illustrated in Figure 2-5.2. Payne Creek wetlands discharge outfall will be an alternative discharge location and will be used as the operation requires and as permitted by receiving water characteristics.

Discharge of clarified treated process water to receiving waters will be required during or after the rainy season when accumulated rainfall and runoff exceed the storage capacity of the water recirculation management system.

Discharge outfall locations at Shirttail Branch and Doe Branch were selected primarily due to their proximity to the plant site and because direct discharge to other surface waters offered no particular environmental advantage. With the exception of Horse Creek, all other water receiving systems are similar, characterized as having headwater systems with large wetland complexes, relatively flat elevations, low stream gradients and mild stream velocities. These systems flow primarily for short periods of time following the occurrence of rainfall. No individual system appears to demonstrate an advantage over any other from either a functional, operational, or environmental standpoint. Horse Creek was not considered for discharge since its location is approximately 5 miles from the proposed plant complex.

To utilize the Payne Creek wetlands discharge outfall, excess water will be pumped through a pipeline across Doe Branch by low-pressure water pumps. Beyond Doe Branch, there will be enough head and capacity to carry this water through a ditch system where water will flow by gravity to the discharge weir adjacent to the Payne Creek floodplain.

Once the water is in the ditch system, it will flow downhill to a sheetflow control pond. The water will then overflow a grass-covered discharge sill developing sheetflow into the floodplain paralleling Payne Creek. There will be no discharge structures within Waters of the State associated with these items.

The discharged water will overflow this grassed, earthen bank, and flow into Payne Creek wetlands. The pond overflow will be designed to keep exit velocity low. Once the effluent enters the floodplain, the existing heavy growth or vegetation should retard the movement of the water within the floodplain and limit the effluent velocity (to 2 feet per second or less).

In reviewing local and regional stream water quality data, it can be expected that during certain conditions most streams will exceed one or more Class III water quality standards. Water quality data for Doe Branch and Shirttail Branch have shown exceedences for alkalinity, dissolved oxygen, cadmium, mercury, iron, zinc, and pH. Water quality data for Payne Creek have shown exceedences for dissolved oxygen, cadmium, mercury, and zinc. Higher than normal metal concentrations are most likely the result of increased metal solubility caused by natural acidic and low oxygen level stream water quality conditions. Although violations of water quality standards may occur in these systems under certain conditions, they most likely reflect ambient/natural background conditions and are not the result of effluent water quality impacts. If a comparison between the expected concentrations of the concerned parameters in the proposed receiving stream and CF's treated process discharge water are evaluated, it can be shown that the receiving streams may actually experience a net positive improvement in overall water quality. CF's proposed discharge is not expected to contribute to or cause violations of Class III water quality standards.

As originally filed, CF Industries' Application for Development Approval called for the construction of two surface water outfalls that would

discharge clarified water to either Doe Branch and/or Shirttail Branch. It was determined that, from an environmental standpoint, it would be desirable to provide an alternate discharge outfall into a perennial system. It was decided as described previously that this discharge outfall will sheetflow across wetlands into Payne Creek just north of Hardee Phosphate Complex II. The utilization of this outfall into Payne Creek will increase the flexibility of operation if the experimental use of recycled water in lieu of fresh water in the flotation plant causes the effluent water quality to exceed Florida's Class III water quality standards. If this were to occur, surface water discharges could be limited in Shirttail Branch and Doe Branch. Since, at this point in time, the quality of the process water could not be guaranteed to meet regulatory standards on a continuous basis, the use of these intermittent streams as receiving bodies could be restricted. If water quality standards are exceeded, the use of Shirttail Branch and Doe Branch will be dependent on each having sufficient volume and flow to provide the necessary mixing and dilution to meet water quality objectives.

If the above scenario were to occur, CF would weigh the positive benefits of using recycled water against the resultant problems that elevated levels of certain water quality standards could have on receiving waters. Once these benefits and impacts were evaluated, CF would either decide to continue using recycled water, necessitating a request to FDER for a mixing zone, or to cease the experimental use of recycled water in lieu of fresh water in the flotation plant.

2.5.9.2 ADDITIONAL WATER DISCHARGE ALTERNATIVES

Since, as proposed, a positive water balance is projected, an acceptable method to discharge wastewater will be required. After an assessment of water discharge alternatives, discharge to surface water either directly or via wetlands was selected as the preferred option for CF. Comments regarding other alternatives evaluated are presented below.

Connector Wells

A ground water discharge method was precluded from use since an adequate head differential between the bottom of the mine cuts and the deeper aquifers does not exist at all locations. However, connector wells are potentially feasible, from a technical perspective, to discharge water from the surficial aquifer to the deeper aquifers. More detailed studies may be needed to determine the feasibility of connector wells on the site.

Deepwell Injection

A ground water discharge technique was rejected because the high initial capital cost cannot be justified when compared to other alternatives. This technique also has the potential risk of causing aquifer contamination.

Zero Discharge

CF's proposed projected positive water balance precludes zero discharge. In an attempt to comply with no discharge, other negative factors such as increased settling areas, higher dams, impacts on post-mining contouring and reclamation, and future land use potential would all require further consideration.

2.6 RECLAMATION PLAN

2.6.1 OBJECTIVES

The present land use of CF Industries' Complex II mine site is primarily palmetto prairie, freshwater marsh, and hardwood forest (Table 2.1.5-1). All of the mine site is designated as mining in Hardee County's Comprehensive Plan (Adley and Associates, Inc., 1980). Approximately 14,925 acres of the site will be disturbed by mining and related activities (Table 2.6.1-1). The areas to be preserved consist of the U.S. EPA Category I-A wetlands (Figure 2.1-2).

The reclamation plan for the site is designed to meet the intent of Florida DNR's mine reclamation rules (Chapter 16C-16) and the goals of

Table 2.6.1-1. Acreage to be Disturbed and Preserved

Description		Acres
Areas to be Disturbed		
Mining Operations		14,647
Plant Site		60
Set Backs from Roads and Property Line*		218
	Subtotal	14,925
Areas to be Preserved†		
Category I-A Wetlands Contiguous with Horse Creek		69
	Subtotal	69
AREA OF MINE SITE	TOTAL	14,994

* The set backs may be disturbed by access roads, utility corridors, temporary storage of overburden, perimeter ditching and related mining activities.

† This acreage does not include strips around preserved wetlands or oddly shaped areas that may not be accessible with the dragline. Two acres of Category I-A wetlands will be disturbed by a dragline crossing.

Source: CF Industries, 1984.

Hardee County's Comprehensive Plan and Hardee County Land Development Code (Article IV). Specific objectives of the reclamation plan are to restore the disturbed lands to beneficial uses that are compatible with adjacent land uses and consistent with future land use plans; enhance or restore as nearly as practicable the natural functions of the existing important habitats, water and lands on the site; eliminate safety hazards; minimize erosion and siltation effects of water leaving the property; and eliminate the visual impacts of mining. To achieve these goals, all of the disturbed wetland and forest acreage will be replaced and the majority of the remaining disturbed lands will be reclaimed to improved pasture. CF's innovative sand/clay waste disposal technique is an important aspect of the reclamation program since it reduces the amount of conventional clay settling areas required, allows reclamation to near original grade, and produces reclaimed soils that are suitable for future agricultural uses.

2.6.2 PHYSICAL RECLAMATION OF LANDFORMS

The land use capabilities and reclamation plans for the mined areas are closely related to the types of landforms created by the waste disposal plan. The acreage of each landform remaining after mining and waste disposal is delineated in Table 2.6.2-1 and is summarized below:

Landform	Acreage
Sand/Clay Mix Areas	9,083
Sand Tailings Fill Areas with Overburden Cap	2,213
Mined Out Areas for Land-and-Lakes	2,399
Overburden Fill Areas and Disturbed Natural Ground	1,230

The location of these various landforms is shown on Figures 2.4-1A and 2.4-1B. The proposed physical restoration of these landforms is discussed in the following sections.

Table 2.6.2-1. Landforms Remaining After Mining

Landforms*	Acres	Percentage of Site†
Sand/Clay Mix Areas		
E-1	187	
E-2	308	
E-3	426	
E-4	292	
E-5	220	
E-6	330	
E-7	330	
E-8	350	
E-9	329	
E-10	366	
E-11	240	
E-12	324	
E-13	421	
E-14	276	
E-15	680	
W-1	356	
W-2	223	
W-3	343	
W-4	191	
W-5	307	
W-6	326	
W-7	381	
W-8	550	
W-9	450	
W-10	467	
W-11	410	
Subtotal	9,083	60.9
Mined Out Areas for Land-and Lakes		
MOA-1	44	
MOA-2	44	
MOA-3	922	
MOA-4	684	
MOA-5	705	
Subtotal	2,399	16.1
Sand Tailings Fill Areas With Overburden Cap	2,213	14.8
Overburden Fill Areas and Disturbed Natural Ground	1,230	8.2
TOTAL DISTURBANCE	14,925	100.00

* See Figures 2.4-1A and 2.4-1B for location.
† Total site area is 14,994 acres.

Source: CF Industries, 1984.

2.6.2.1 SAND/CLAY MIX AREAS

CF Industries has been experimenting with the sand/clay waste disposal technique since 1980. This particular technique significantly reduces the time needed for stabilization of the waste clays and will allow more rapid reclamation of these lands than could be accomplished with conventional clay settling areas. This technique also allows waste disposal materials placed above-grade to settle at- or near grade, thereby eliminating the need for high dams and allowing reclamation to be completed close to original contours. Based on the favorable results of this experimental disposal technique, sand/clay mix will be the predominant waste disposal method to be used on the site. Additional discussion of CF's experimental waste disposal technique is provided in Section 2.4.

The sand/clay mix will be pumped to 26 storage areas that will occupy 9,083 acres or 60.9 percent of the site (Figures 2.4-1A and 2.4-1B). The sand/clay mix will be pumped at approximately 30-35 percent total solids with a dry weight sand/clay ratio of approximately 2:1. At the time of placement, the clay solids will be 12 to 18 percent. The storage areas will be filled to an average height of 10 feet above original grade and a maximum of 5 feet below the top of the dikes. The mix will undergo an initial period of rapid subsidence and dewatering, reaching approximately 30 percent clay solids at the completion of filling, followed by a prolonged period of gradual consolidation and further subsidence. Over a period of approximately 5 years after filling, the sand/clay mix is expected to consolidate to an average of approximately 41 percent clay solids. This level of consolidation with surface crust development is expected to be sufficient to support agricultural machinery (Garlanger, 1984).

The natural slope of the sand/clay mix is approximately one foot drop across 1,000 feet of disposal area. Therefore, the decant end or downslope portion of the storage area will be wetter and subject to

ponding. Differential settling will also produce a slightly undulating surface. The surface level of the storage area after subsidence is designed to average approximately two feet above natural grade.

After the desired level of consolidation is achieved, the surrounding dams and any protruding overburden spoil piles will be graded over and will partially cap the sand/clay mix areas (Figure 2.6-1). It is expected that the volume of overburden within the surrounding dams and remaining spoil piles could provide a two to four inch cap for the sand/clay mix areas. However, the thickness and extent of the cap will vary with the aereal coverage of the disposal area. Naturally occurring low areas within each sand/clay disposal area are not planned to be capped and would be retained as low areas for wetland reclamation. Additional grading and contouring will provide the necessary basins and drainage channels for the wetland reclamation program.

The sand/clay mix and overburden soils used for capping are expected to have good potential for a variety of land uses, including improved pasture, forestry, cropland and wetlands (Zellars-Williams, Inc., 1978; Keen and Sampson, 1983). The sand content should improve tillage and aeration problems that are common with clay soils. The content of silt and clay provide water and nutrient retention and natural fertility. The increased moisture retention capacities of the sand/clay mix have the potential for causing high water levels or ponding. This effect would favor the reclamation of wetlands and should not preclude reclamation of improved pasture. This increased soil moisture, however, may limit the types of crops that may be grown on the sand/clay mix soils. Supplemental grading, drainage and the overburden cap on portions of the disposal areas would increase the range of cropping possibilities.

Since the objectives of the reclamation plan include reclamation of disturbed wetlands and productive agricultural uses, the majority of the sand/clay mix areas will be reclaimed to wetlands and improved pasture. Revegetation methods are described in Section 2.6.4.

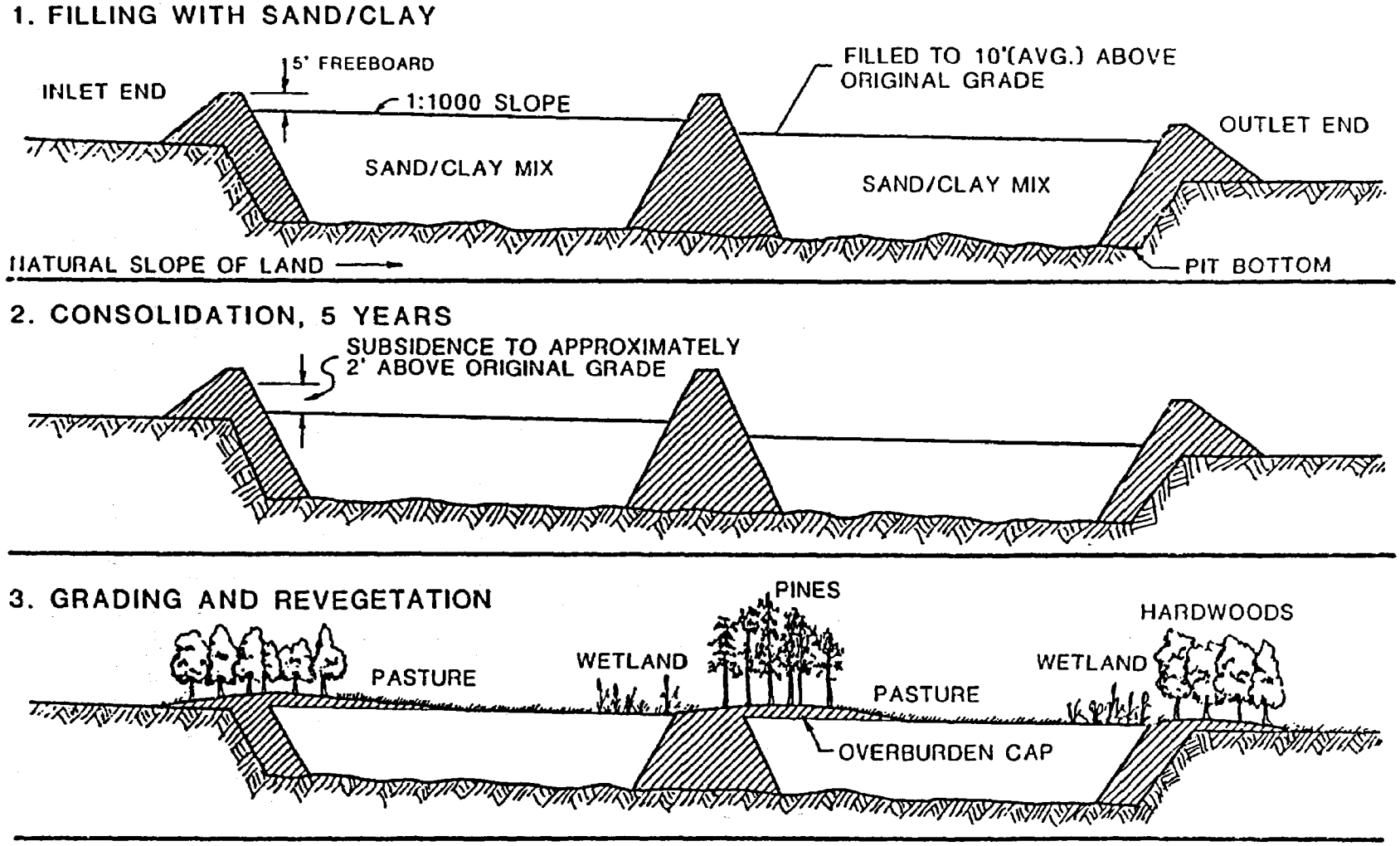

Figure 2.6-1
RECLAMATION OF SAND/CLAY MIX AREAS

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On the average, the sand/clay storage areas will be filled in approximately one year. Drying and consolidation to approximately 41 percent clay solids will require approximately 5 years. Final grading and revegetation will require an additional 2 years. Therefore, complete reclamation of the sand/clay storage areas will be completed in approximately 7 years after filling is completed.

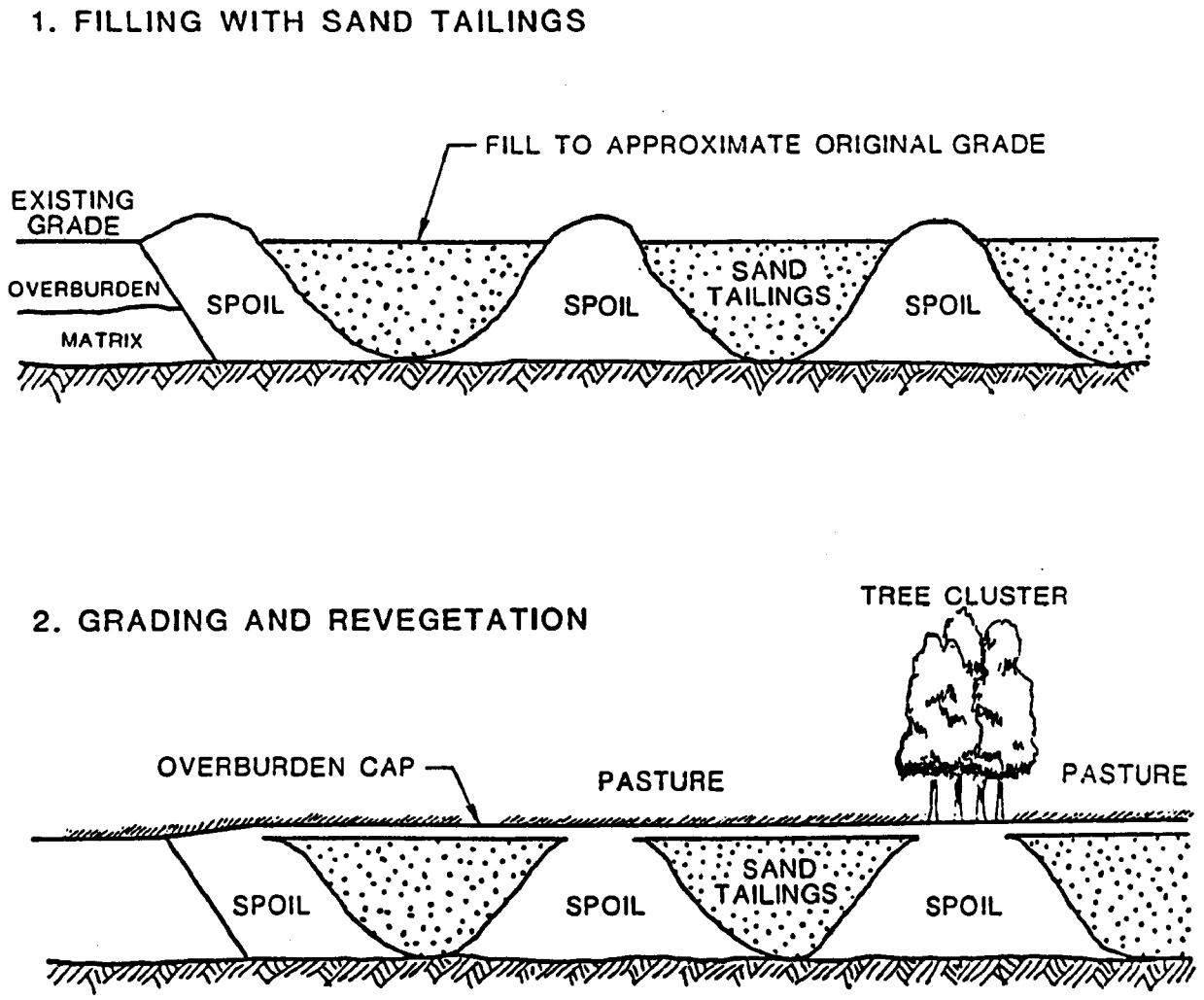
2.6.2.2 SAND TAILINGS FILL AREAS WITH OVERBURDEN CAP

Sand tailings will be deposited in mine cuts and will occupy a total of 2,213 acres (Figures 2.4-1A and 2.4-1B). The mine cuts will be backfilled with sand tailings to approximately natural grade and capped with approximately 6 to 12 inches of overburden (Figure 2.6-2). The overburden cap will provide a soil cover that will have improved agricultural characteristics compared to the infertile sand tailings. Sand tailings capped with overburden have good potential for improved pasture, forestry, citrus, cropland, and residential/industrial construction (Zellars-Williams, Inc., 1978). Recent experimental plantings have also shown that sand tailings with no overburden cap are suitable for a variety of forage grasses (Mislevy and Blue, 1981). It is planned to reclaim the capped sand tailings fill areas primarily to improved pasture, wetlands and upland forest.

Since sand tailings dewater rapidly and have good bearing capacity, capping with overburden can begin almost immediately after filling is complete. Final grading and revegetation will be completed within approximately 2 years after filling.

2.6.2.3 LAND-AND-LAKES

Lakes will be constructed in five mined out areas on the site (Figures 2.4-1A and 2.4-1B). Sand tailings or sand/clay mix will not be available for reclaiming these areas, therefore, reclamation will consist primarily of grading the remaining spoil piles followed by revegetation. A conceptual diagram of the land-and-lakes reclamation is shown on Figure 2.6-3. The planned surface water area within each



Source: Gurr & Assoc., Inc.

Figure 2.6-2
RECLAMATION OF SAND TAILINGS FILL AREAS

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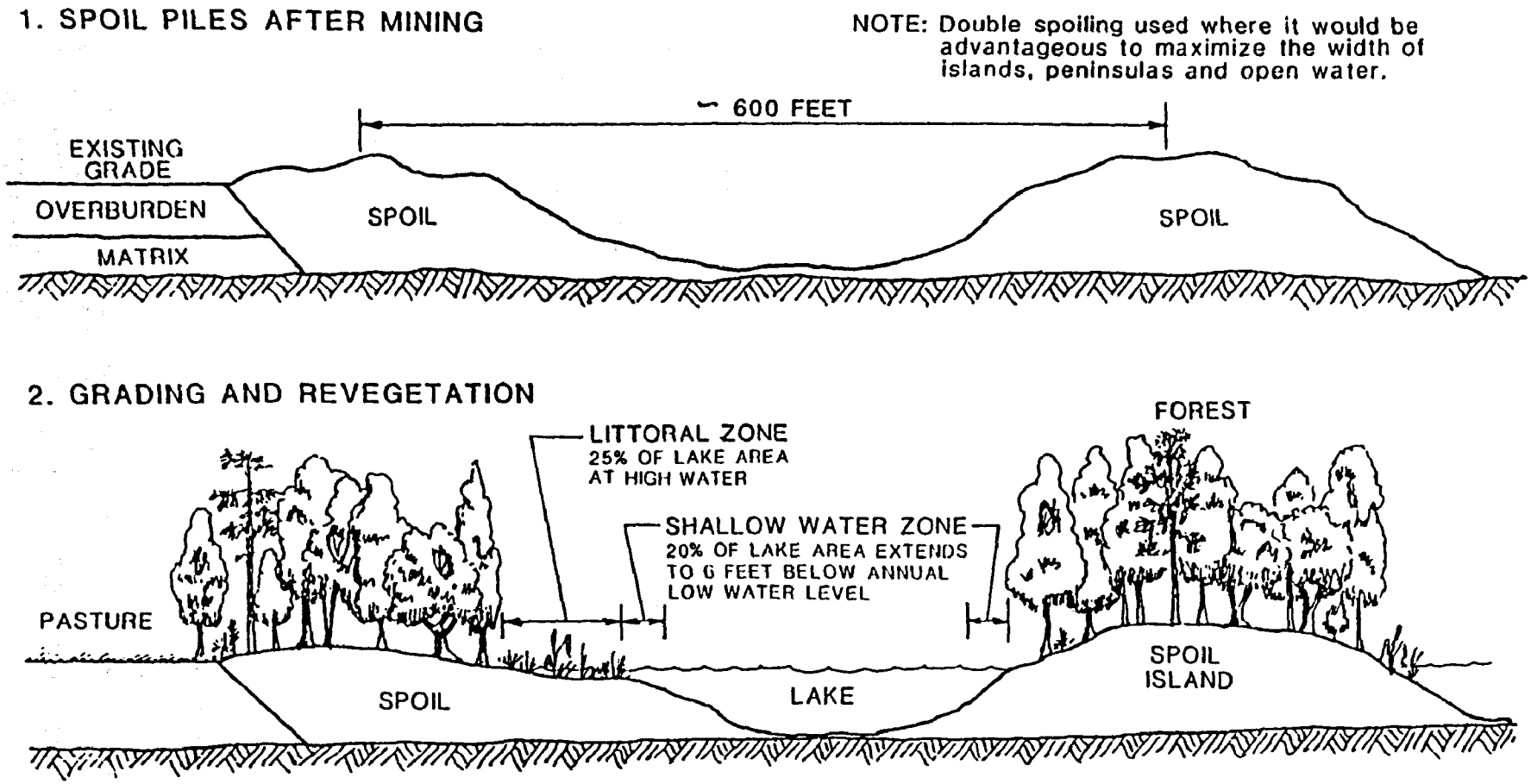

Figure 2.6-3
CONCEPTUAL LAND-AND-LAKES RECLAMATION

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Hardee Phosphate Complex II

mined-out area is based on several variables, including the thickness of overburden and matrix, a restored water table, plus using the remaining spoil to create necessary shoreline slopes required by the Florida Department of Natural Resources mine reclamation rules (Chapter 16C-16). Presented below is the estimated design surface area of land and water in each mined out area. It should be noted that up to 25 percent of the lake area may be used for wetland reclamation.

	Estimated Design Acreage		
Mined Out Area	Land	Lake & Wetland*	Total
I	0	44	44
II	0	44	44
III	271	651	922

	Estimated Design Acreage		
Mined Out Area	Land	Lake & Wetland*	Total
IV	276	408	684
V	385	320	705

* Area shown on Figures 2.6-4 and 2.6-5 may vary slightly.

Suggested lake shapes are shown on Figures 2.6-4 and 2.6-5; however, the actual size and shape of the lakes will depend on variables such as the remaining spoil pile configuration, direction of mine cuts and the void space available. These lake shapes include islands that provide refuge for waterfowl and wading birds, a variety of sizes and shapes for aesthetics, and peninsulas for increased shoreline length and access points.

Double spoiling will be utilized in the larger mined out areas where it would be advantageous to maximize the width of islands, peninsulas and open water. A variety of shoreline slopes will be created but at least 25 percent of the lake areas at high water will consist of a littoral water zone for emergent vegetation and habitat for a variety of wildlife. A shallow water zone will also be constructed that will occupy 20

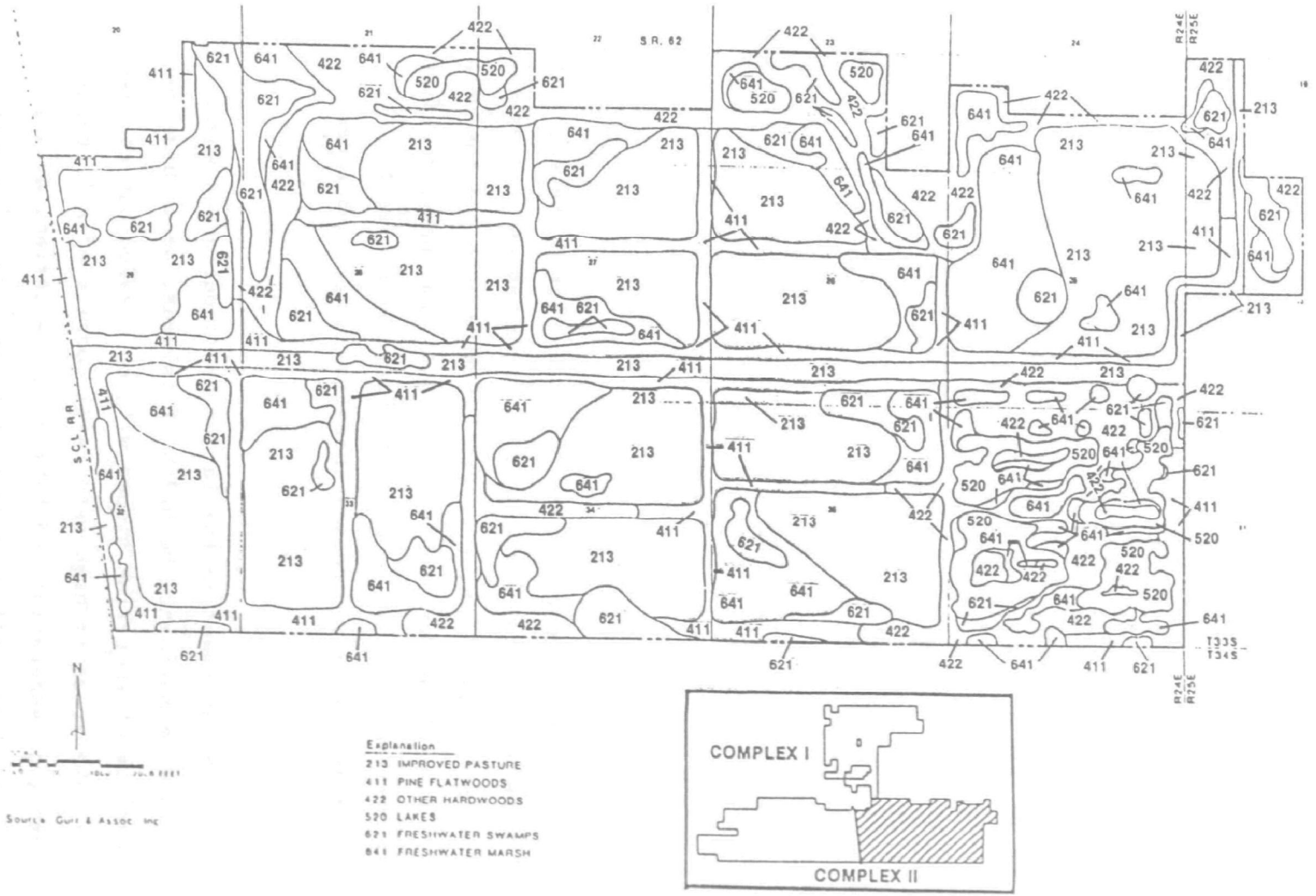

Figure 2.6-4
POST-RECLAMATION LAND USE:
COMPLEX II, EASTERN SECTION

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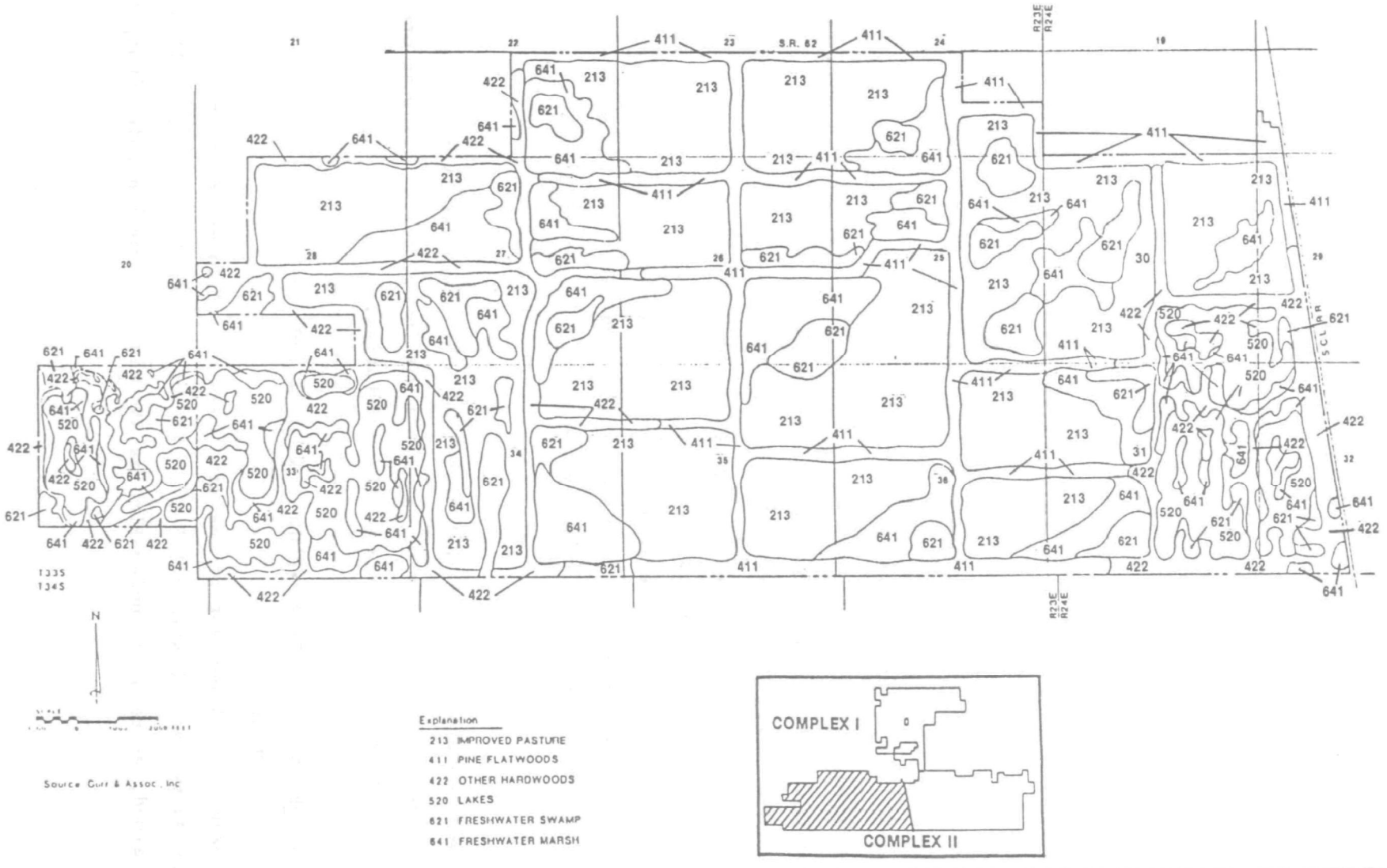

Figure 2.6-5
POST-RECLAMATION LAND USE:
COMPLEX II, WESTERN SECTION

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percent of the lake area. This shallow water zone shall extend to a depth of 6 feet below annual low water levels and shall have shoreline slopes no steeper than 4:1 (Figure 2.6-3).

It is planned to reclaim the land surrounding the lakes to pine flatwoods and hardwoods (Figure 2.6-4 and 2.6-5). Management of these lands will be primarily for recreation and wildlife habitat.

Reclamation of the land-and-lakes areas will require approximately 2 years, allowing one year for grading and one year for revegetation.

2.6.2.4 OVERBURDEN FILL AREAS AND DISTURBED NATURAL GROUND

The mined and disturbed areas to be reclaimed with overburden fill will occuby 1,230 acres, not including the overburden fill to be used in reclaiming the land-and-lakes areas or capped sand tailings fill areas. These areas are primarily located along the property boundary and also include the plant site and Initial Settling Area, Compartment I (Figure 2.1-1). The unmined areas along the property boundary may be disturbed for utility corridors, access roads, pipelines, recirculating water ditches and other related mining activities. These mined and disturbed lands will be reclaimed to approximately natural grade and will have good potential for a variety of land uses, including improved pasture, forestry, citrus, cropland and residential/industrial construction.

Reclamation of overburden fill areas can begin immediately after mining. These areas will generally be reclaimed within two years, allowing one year for grading and one year for revegetation.

2.6.3 WETLAND AND STREAM CHANNEL RECLAMATION

2.6.3.1 WETLANDS

Approximately 24 percent of the site consists of forested and non-forested wetlands (Table 2.1.5-1). All of this wetland acreage will be reclaimed, as required under Florida DNR mine reclamation rules (Chapter

16C-16). Although the topography of the reclaimed site will be within 2 or 3 feet of original grade, it will not be possible to restore all of the wetlands to their original shape and location. Several large mined out areas will need to be reclaimed to land-and-lakes, and each sand/clay mix disposal areas will have a slightly higher elevation near its inlet, which would be more suitable for upland land uses.

A conceptual plan depicting the location of reclaimed wetlands is shown on the post-reclamation land use map (Figures 2.6-4 and 2.6-5). This conceptual land use map shows the planned reclaimed wetland acreage and the intended distribution of wetlands over the entire property. It should be noted, however, that the actual shape and location of the reclaimed wetlands will likely be different than that shown on the drawing. For instance, the wetlands reclaimed at the low end of each sand/clay mix disposal area are typically shown as one large contiguous unit with a fairly smooth boundary. Differential settling in the disposal areas may create several separate low areas with very irregular boundaries which can be an advantage since they would provide more edge effect between habitat types. Naturally occurring irregular boundaries are not planned to be recontoured. The only natural low areas that would probably be recontoured and/or filled would be the occurrence of many small depressions throughout the sand/clay disposal areas which might significantly hamper future agricultural activities. This recontouring would not reduce the planned acreage of reclaimed wetlands.

Approximately 25 to 30 percent of each sand/clay mix area is planned to be reclaimed as wetlands. This acreage will be created primarily by raising the elevation of the outlet drain after consolidation and by retaining a portion of the perimeter dike along the lower end of the disposal area. Approximately 20 percent of the land-and-lakes areas will be reclaimed as wetlands. Most of the wetlands in those areas will be created by grading and contouring the required littoral zone within the lakes. The remainder of the reclaimed wetland acreage will be distributed within the areas to be reclaimed with sand tailings and

overburden. Wetlands within these areas will be principally graded or excavated in low areas and along planned drainageways. Revegetation of wetlands is discussed in Section 2.6.4.

2.6.3.2 STREAMS

The mine plan for the Hardee Phosphate Complex II includes the mining of several small ephemeral tributaries and portions of some named streams. The named streams that will be partially mined are Shirttail Branch, Plunder Branch, and Coon's Bay Branch. These streams also have several ephemeral tributaries that will be mined. The other ephemeral streams to be mined on the site are tributaries of Horse Creek, Brushy Creek, Lettis Creek and Doe Branch. The location of these streams and their existing drainage basin boundaries are shown on Figures 2.6-6 and 2.6-7.

CF is planning to mitigate the environmental effects of mining these streams through the following measures: reclamation of all adjacent disturbed lands; reclamation of all disturbed main stream channels to their approximate original grade; approximate restoration of original drainage basin area; and implementation of certain precautionary measures to prevent degradation of downstream waters. The reclaimed drainage basin boundaries and drainage patterns are shown on Figures 2.6-8 and 2.6-9.

CF is currently mining and reclaiming portions of Hickey Branch at the existing Hardee Phosphate Complex I operation, approximately 3 miles north. It is anticipated the reclamation of this stream will provide relevant experience and design parameters for construction of the stream channels on the proposed mine site.

2.6.4 REVEGETATION

2.6.4.1 EXPERIMENTAL TEST PLOTS

The combination of the sand/clay mix and the overburden soils used for capping provide a promising media for a variety of vegetation. However,

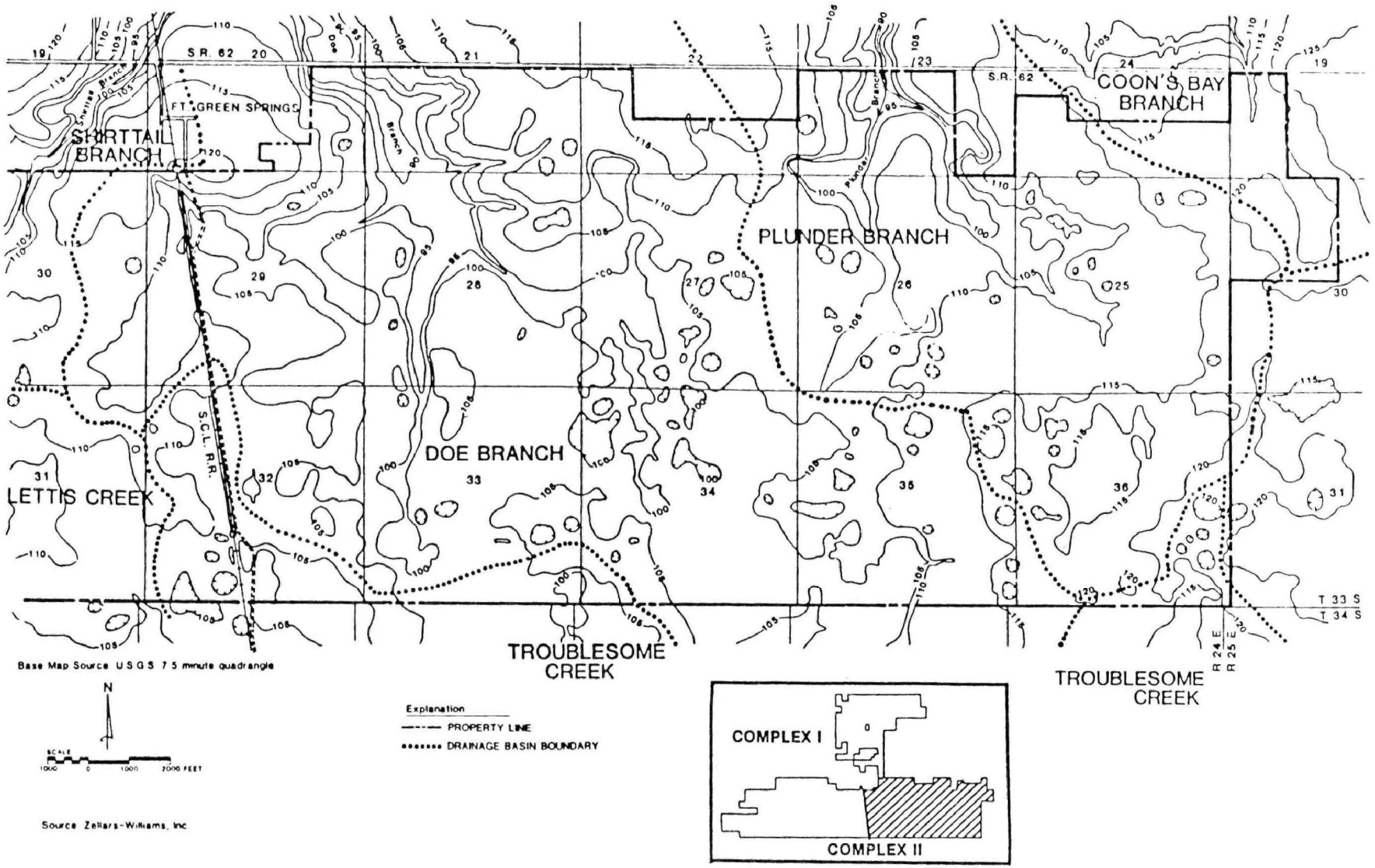

Figure 2.6-6
PRE-MINING TOPOGRAPHY AND DRAINAGE BOUNDARIES:
COMPLEX II, EASTERN SECTION

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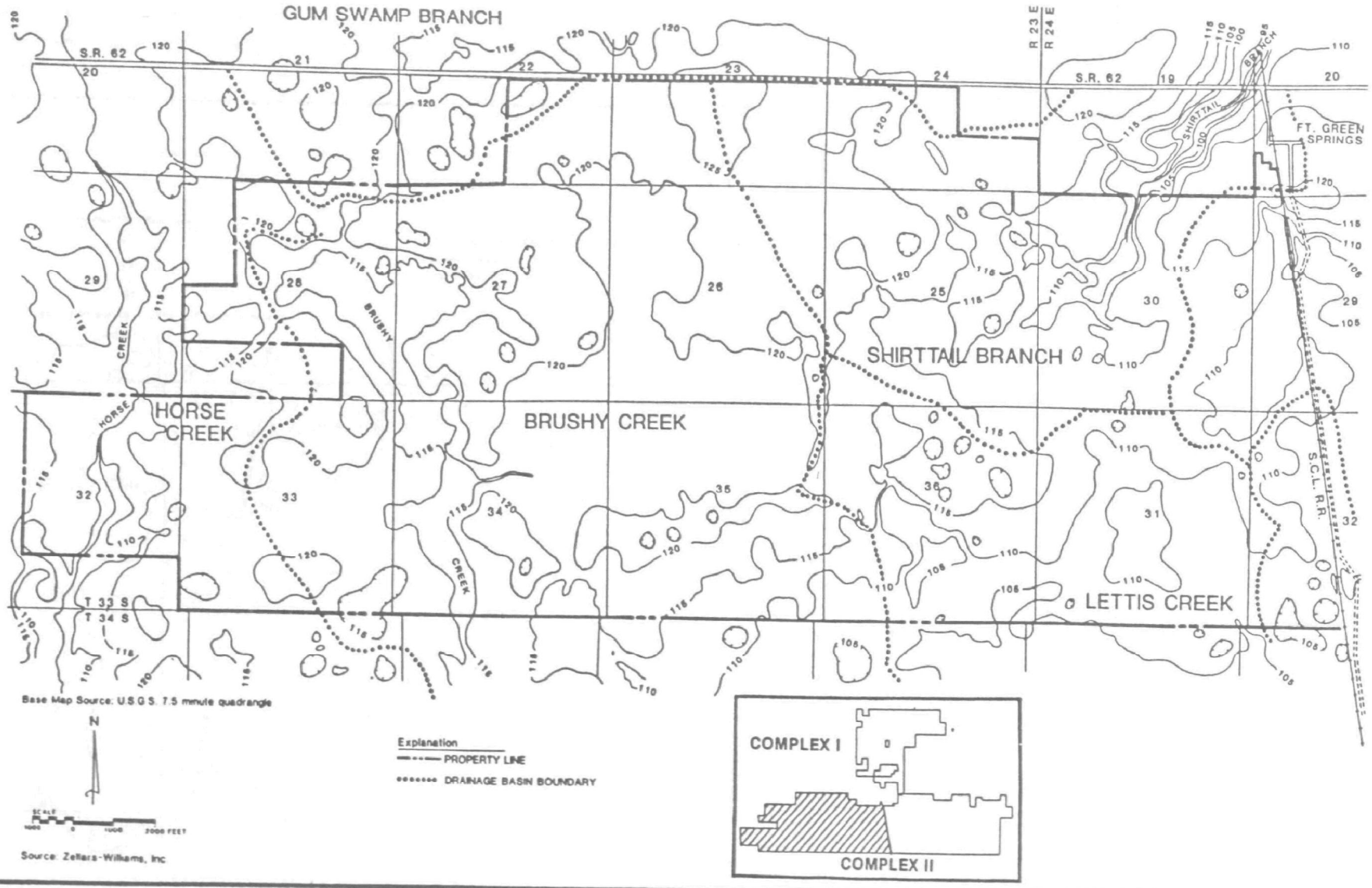

Figure 2.6-7
PRE-MINING TOPOGRAPHY AND DRAINAGE BOUNDARIES: COMPLEX II, WESTERN SECTION

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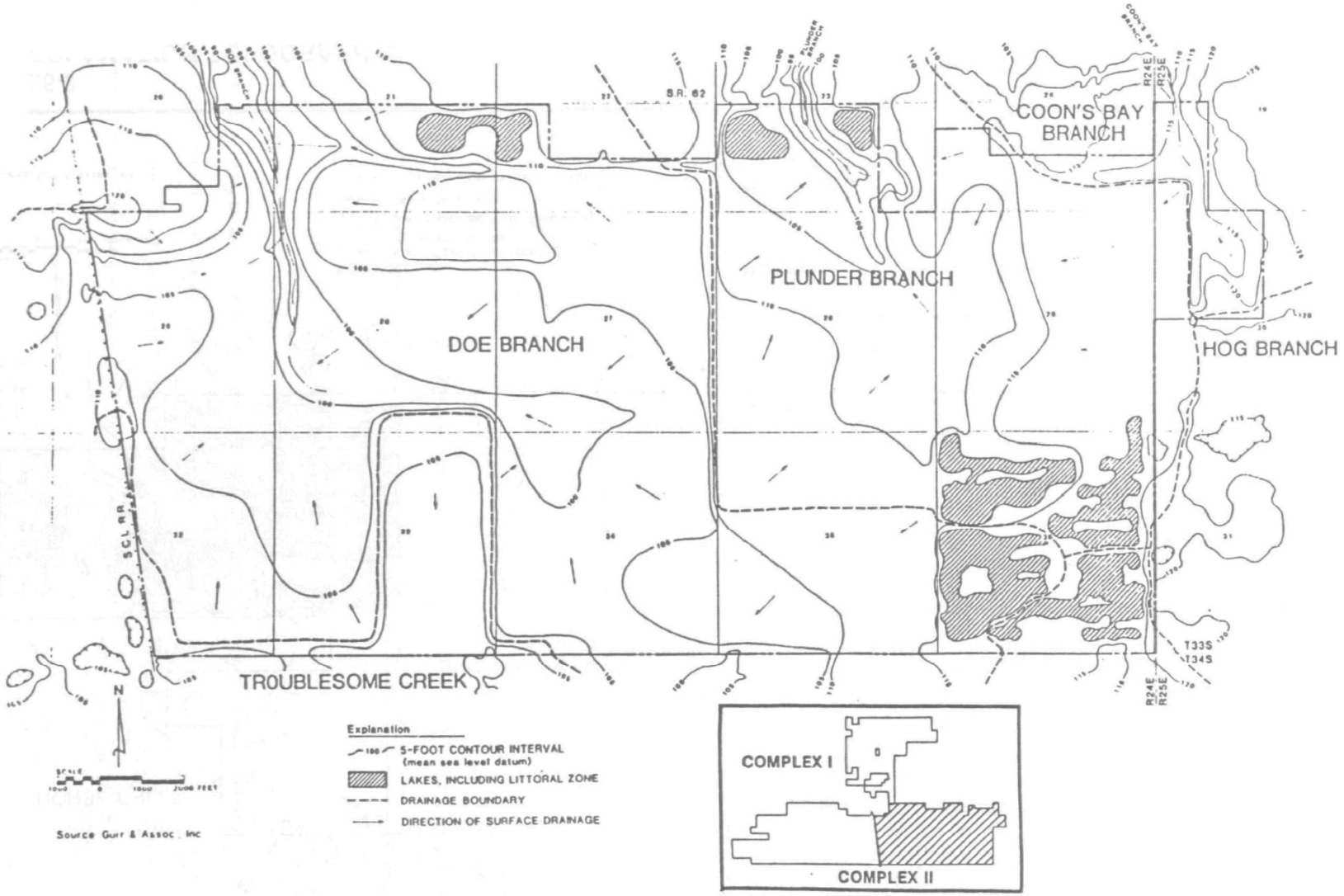

Figure 2.6-8
POST-RECLAMATION TOPOGRAPHY:
COMPLEX II, EASTERN SECTION

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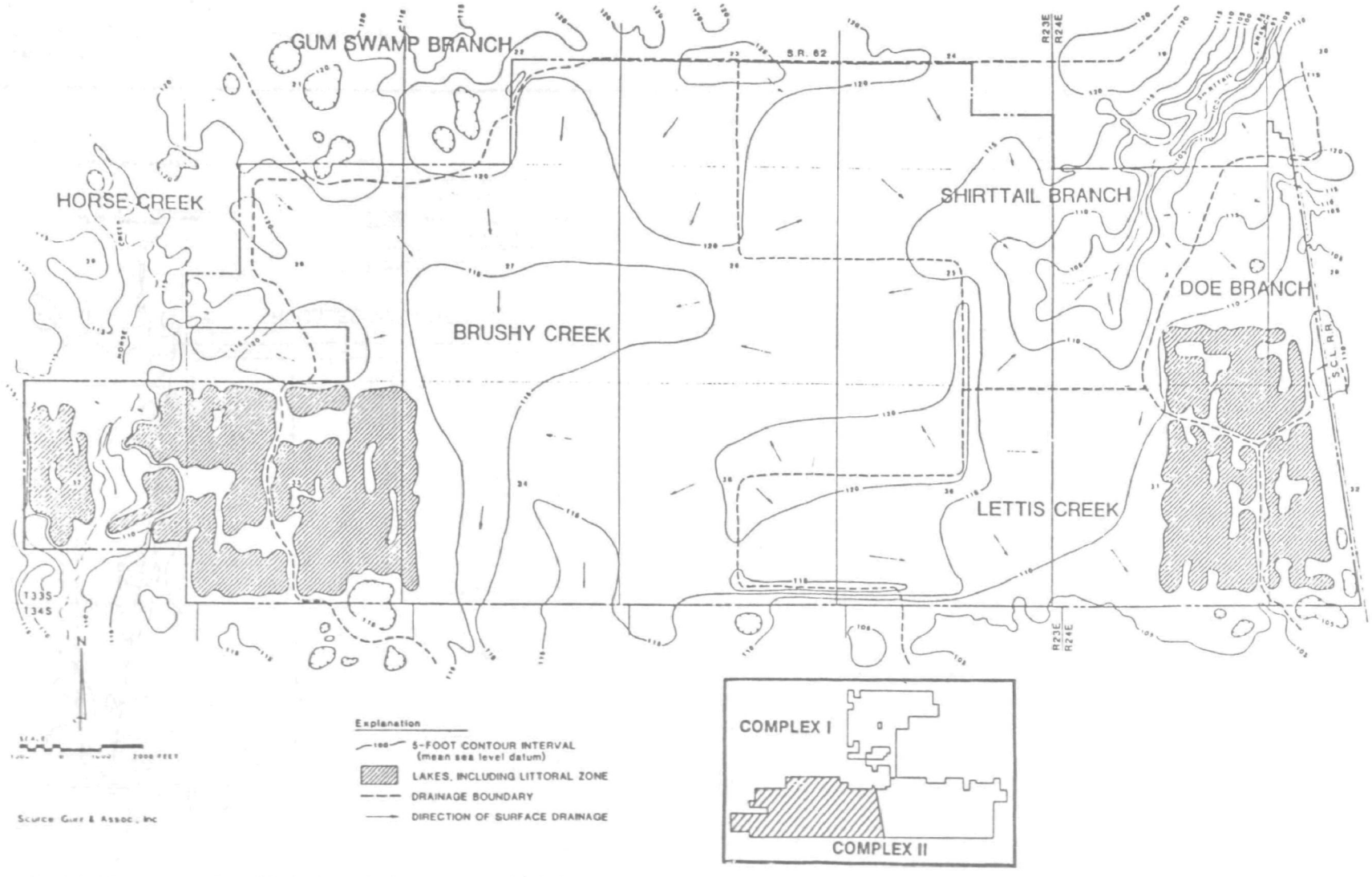

Figure 2.6-9
POST-RECLAMATION TOPOGRAPHY: COMPLEX II, WESTERN SECTION

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Draft Environmental Impact Statement

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Hardee Phosphate Complex II

the suitability of these mine soils for various agricultural crops and native vegetation has not been well established through field experience (Robertson, 1984). Therefore, CF Industries is planning an experimental revegetation program on an existing sand/clay disposal area at their Hardee Phosphate Complex I. The results of this test program and other similar research in the Florida phosphate industry will be used to determine the most suitable agricultural and native species to be planted on the sand/clay soils.

The existing sand/clay mix test area encompasses approximately 140 acres and is located in Section 7, Township 33S, Range 24E, 0.5 miles south of CF's Hardee Phosphate Complex I plant site. Filling of this sand/clay disposal area began in October, 1980 and was completed in September, 1983. The construction of this disposal area and the characteristics of the sand/clay mix are very similar to that to be used on the Complex II mine site.

It is planned to test a variety of upland and wetland revegetation techniques on the sand/clay mix test area. Personnel at the University of Florida Extension Service, Soil Conservation Service, University of Florida Center for Wetlands, Florida Division of Forestry, and other qualified agencies or individuals are planned to be consulted in designing the experimental plantings. Since the majority of the Complex II site will be reclaimed to wetlands, forest land, and agricultural uses, the emphasis of the experimental revegetation program will be on reclamation of these vegetation types.

CF Industries is also conducting an experimental wetland reclamation project at the Hardee Complex I, approximately 0.5 miles north of the plant site. This wetland project site is approximately 15 acres and has been constructed on sand tailings and overburden fill that has been capped with one foot of sand/clay mix. The area is planned to be reclaimed as a hardwood swamp. Specific objectives of the project are:

(1) test the success of various combinations of species diversity, (2) test the effectiveness of an artificial hardpan to perch water, (3) test the benefit of various topsoil applications, and (4) test effectiveness of water control. It is expected that the results of this project will also be of value in reclamation of wetlands at the Complex II mine site.

Presented in the following sections are CF's current revegetation plans for the Complex II mine site. The actual species to be planted and planting methods may be changed in later years to reflect the results of the experimental revegetation program and reclamation research currently being conducted in the phosphate industry (Florida Institute of Phosphate Research, 1983b).

2.6.4.2 IMPROVED PASTURE

Improved pasture will be planted as the initial vegetative cover on approximately 6,659 acres of the reclaimed site. This initial planting of forage grasses will be established on portions of all upland landforms and would be the dominant vegetation type on the reclaimed site (Table 2.1.5-1 and Figures 2.6-4 and 2.6-5).

Improved pasture was chosen as the dominant post-reclamation land use for the following reasons: (1) reclaimed grazing land is in demand among local cattlemen and is a productive agricultural use for mined lands (Hawkins, 1983; Miller, 1983); (2) planting of forage crops is an excellent method of stabilizing reclaimed soils and preventing erosion; (3) the establishment of pasture sods is an excellent means of encouraging the development of organic matter content of soils which improves tillage properties, aeration, nutrient retention and moisture retention (Zellars-Williams, Inc., 1980); and (4) improved pasture is a vegetation type that can be easily cleared and converted to cropland or alternative uses if desired.

The forage species to be planted will contain a rapidly germinating annual grass that will quickly provide an initial ground cover (where erosion control is important), a long-lived perennial legume and one or two long-lived perennial grasses for the permanent vegetative cover. Inclusion of a legume is intended to reduce the need for refertilization with nitrogen since legumes are nitrogen fixing plants.

The particular grass and legume species to be planted will be carefully selected to match the characteristics of the surface soil type. Unless experimental plantings or additional research in the phosphate industry identifies more suitable forage varieties, the species to be planted will be those currently used in reclamation programs and suggested by the Soil Conservation Service (1977) or County Extension Service. Recommended seeding mixtures vary with the season in which they will be planted and with the drainage characteristics of the soil. Permanent grasses that are typically planted are Ona stargrass, improved bermuda grasses, and bahia grasses such as Pensacola, Paraguay, and Argentine. Clover, hairy indigo, and aeschynomene are recommended legumes; rye grass and millet are recommended temporary grasses.

A seedbed for all pasture areas will be prepared through final grading or heavy discing. Lime and fertilizer will be applied according to soil test recommendations.

All improved pasture will be protected from grazing until the forage plantings are firmly established. Replanting and possibly refertilization will be conducted where initial revegetation fails or where survival is poor.

2.6.4.3 FORESTED UPLANDS

Approximately 3,400 acres of reclaimed uplands, occupying 23 percent of the site, will be revegetated as forest land. These forested areas will be planted primarily within the land-and-lakes areas, along the reclaimed dams of the sand/clay mix areas, and as greenbelts along the

property boundary. The greenbelts and contiguous forested strip plantings would provide habitat for wildlife, corridors for wildlife movement, eventual shade for cattle and would also serve as an aesthetic break in the landscape.

The forested uplands will consist of approximately one-half mixed hardwood plantings and one-half coniferous plantings (Table 2.1.5-1 and Figures 2.6-4 and 2.6-5). The ratio of hardwood forest area to coniferous forest area was decreased from that which currently exists on the site because the coniferous species are expected to be more marketable in the future. The site also probably contained much more coniferous forest prior to logging in the early 1900's.

The hardwood forest areas will be planted with a variety of native tree species such as laurel oak, live oak, dogwood and sweetgum. Blackgum, water oak, and red maple or other suitable species would be planted adjacent to lowland areas or along drainages where the soil may be more poorly drained. The actual composition of planted seedlings will depend on the availability of various species from the State Forestry Department and commercial nurseries. Bare root, potted or containerized seedlings will be planted in a random pattern to yield an initial density of 400 trees per acre in order to ensure a final density of 200 trees per acre.

The coniferous forest land will be planted and managed to eventually resemble a pine flatwoods community rather than a commercial pine plantation. South Florida slash pine and longleaf pine seedlings will be hand-planted in a random pattern at a density of 400 trees per acre in order to ensure a final density of 200 per acre. Efforts will be made to establish native understory species such as gallberry, wire grass and small scrub oaks.

A ground cover of short-lived herbaceous species will be planted on reclaimed forest land where erosion and sediment control is important,

such as along reclaimed stream channels. The selection of herbaceous species and timing of planting will be done carefully to reduce the potential problem of competition between the tree seedlings and ground cover. Eradication of agressive volunteer species or replanting of seedlings may be required to achieve a final density of 200 trees per acre. All forested areas will be protected from grazing until they are firmly established.

2.6.4.4 FORESTED WETLANDS

Approximately 1,410 acres of freshwater swamp will be reclaimed on the site (Table 2.1.5-1 and Figures 2.6-4 and 2.6-5). Most of these freshwater swamps will be contiguous with the reclaimed stream channels and reclaimed freshwater marshes.

A variety of revegetation techniques for wetlands are currently being tested in the Florida phosphate industry (FIPR, 1983a). Although many projects are only a few years old, the results of several techniques are encouraging. It is expected that additional research will suggest even more effective approaches by the time CF begins to reclaim its first wetland (in approximately mine year 5). CF's current plan for reclaiming wetlands will consist primarily of creating a topography with frequently saturated soils, providing a favorable hydroperiod, spreading a layer of organic mulch borrowed from another wetland, and tree planting.

The freshwater swamps will be planted with a variety of native tree and shrub species such as red maple, black gum, water hickory, sweet bay, water ash, sweetgum, buttonbush, dahoon and wax myrtle. Bare root, potted or containerized seedlings will be planted by hand in a random pattern to yield an initial density of 400 trees per acre in order to ensure a final density of 200 trees per acre. Planting herbaceous species for erosion control and maintenance of newly established vegetation will be similar to that described for the upland hardwood forest.

2.6.4.5 NON-FORESTED WETLANDS

Approximately 2,470 acres of freshwater marsh will be reclaimed on the site. The number of reclaimed marshes will be less than the number presently on the site but the total acreage reclaimed will be increased by 131 acres. Most of these marshes will be reclaimed in the lower portions of the reclaimed sand/clay mix areas (Figures 2.6-4 and 2.6-5). These lower wet areas will occur at the outlet end of the storage areas and in areas of differential settling. Additional basins and channels will be excavated if needed to create the proposed acreage of reclaimed wetlands.

The current revegetation plan for these marshes is to spread a mulch borrowed from another wetland that is dominated by desireable native wetland vetetation. This technique has been shown to be a successful revegetation method for marshes on several mine sites in central Florida (Carson, 1983; Clewell, 1981; Conservation Consultants, 1981). CF's experimental revegetation plots and further research by others may provide additional successful revegetation techniques that may be incorporated.

2.6.5 RECLAMATION SEQUENCE

Reclamation will lag several years behind the mining schedule because of the time required for dam construction, filling the mining cuts with waste materials, consolidation of the sand/clay mix, grading and contouring, and revegetation. The total time period for mining and reclamation ranges from 3 to 4 years for overburden and sand tailings areas, to 10 years for sand/clay mix areas. Presented below is a summary of the projected time requirements for mining and reclamation of a typical parcel to be mined in any given year.

	Overburden Fill, Land-and-Lakes, Sand Tailings Fill	Sand/Clay Mix
Mining	1 year	1 year
Dam Constructon	--	0-1 year

Filling	0-1 year	1 year
Consolidation	--	5 years
Grading & Contouring	1 year	1 year
Revegetation	1 year	1 year
	3-4 years	10 years

The reclamation sequence for each sand/clay disposal area is presented in Table 2.6.5-1.

Mining of the proposed tract is expected to require approximately 27 years. Reclamation of all mined lands will be completed within eight years after mining ends. The progress of mining and reclamation activities across the property at years 10, 21, and 27 is shown on Figures 2.6-10 through 2.6-15. The proposed reclamation schedule for the tract for each year is presented in Table 2.6.5-2.

2.6.6 POST-RECLAMATION TOPOGRAPHY

An objective of the reclamation plan is to restore the land surface elevations to approximate original grade, to the greatest extent practical. All of the site is planned to be reclaimed within 2 to 3 feet of original grade, with the exception of the mined-out areas to be reclaimed as lakes.

Sand/clay mix areas will be gently sloping flat areas with low areas near the outlet and randomly occurring depressions which are a result of differential settling. The retaining dams will be graded towards the interior and will provide a thin cap of overburden material in a band around each disposal area. The areas between sand/clay mix areas will be graded flat in cross-sections and will be at approximate pre-mining slopes and elevations. Several of the reclaimed stream channels will be established in these areas.

The post-reclamation drainage area boundaries will vary slightly from existing boundaries because of the location of the sand/clay mix areas (Figures 2.6-8 and 2.6-9). However, total acreage of each drainage

Table 2.6.5-1. Reclamation Sequence for Sand/Clay Landfills

Sand/Clay Mix Areas	Acreage	Year Filling Begins	Year Filling Completed	Year Reclamation Completed
E-1	187	2	3	10
E-2	308	3	5	12
E-3	426	5	7	14
E-4	292	7	8	15
E-5	220	8	9	16
E-6	330	9	10	17
E-7	330	10	11	18
W-1	356	11	11	18
W-2	223	11	12	19
E-8	350	12	13	20
W-3	343	13	13	20
W-4	191	13	14	21
E-9	329	14	15	22
W-5	307	15	15	22
W-6	326	15	16	23
E-10	366	16	17	24
W-7	381	17	18	25
E-11	240	18	19	25
W-8	550	18	20	27
E-12	324	20	21	28
W-9	450	21	21	28
E-13	421	21	22	29
E-14	276	22	23	30
W-10	467	23	24	31
W-11	410	24	26	33
E-15	680	26	28	35
TOTAL	9,083			

Source: CF Industries, 1983.

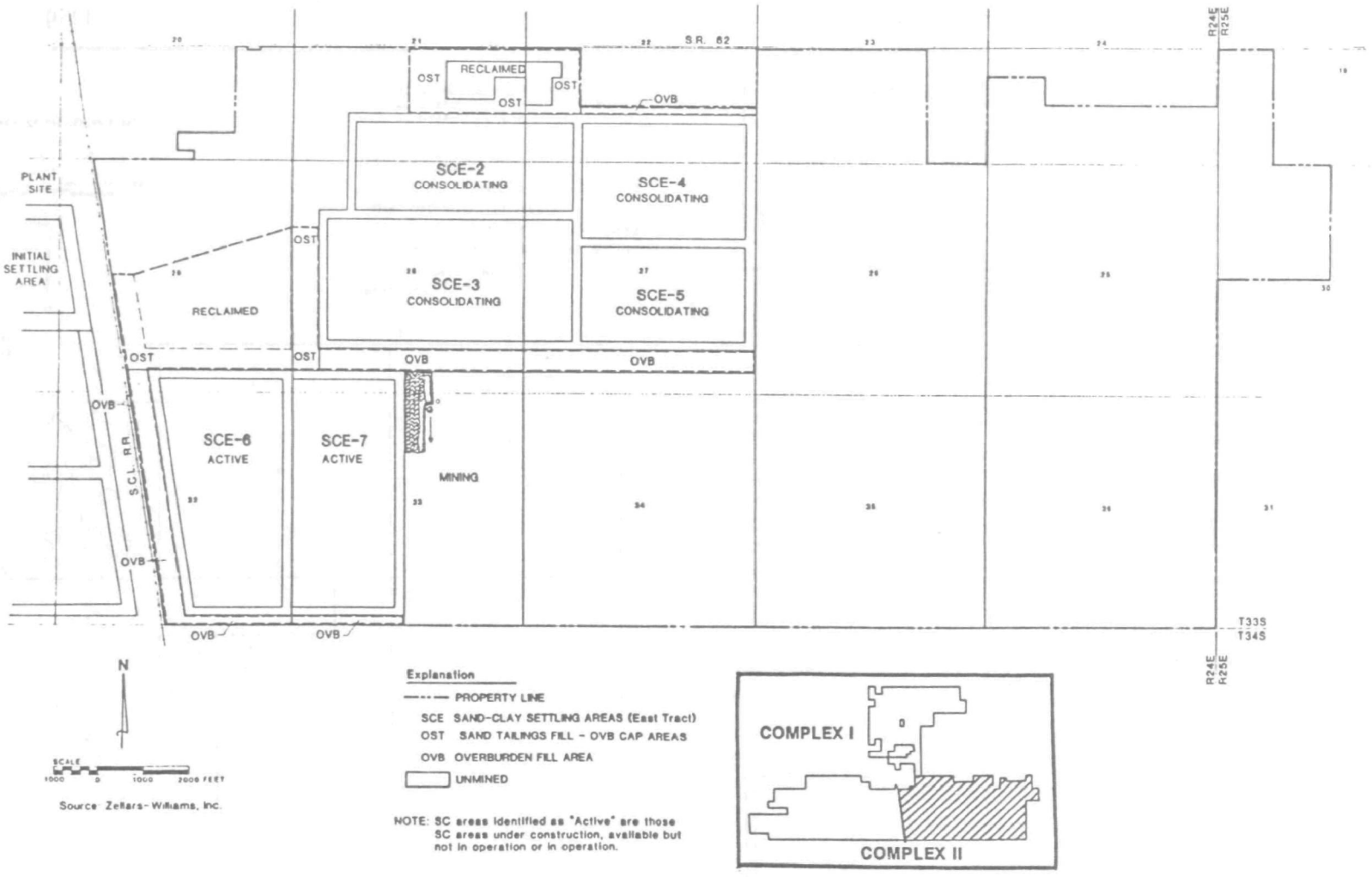

Figure 2.6-10
RECLAMATION SEQUENCE YEAR 10:
COMPLEX II, EASTERN SECTION

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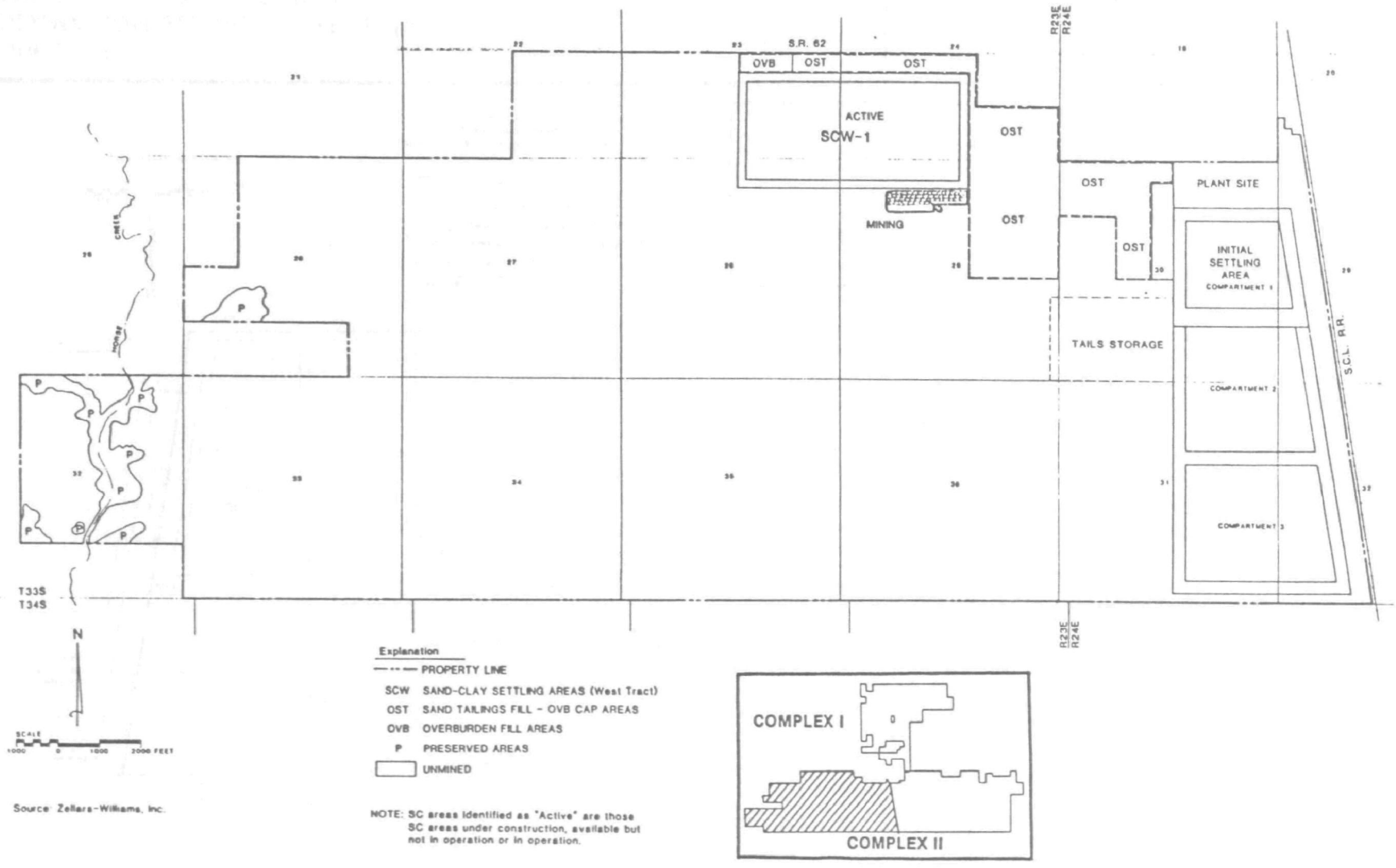
Hardee Phosphate Complex II



Source: Zellars-Williams, Inc.

NOTE: SC areas identified as "Active" are those SC areas under construction, available but not in operation or in operation.

Figure 2.6-11
RECLAMATION SEQUENCE YEAR 10: COMPLEX II, WESTERN SECTION

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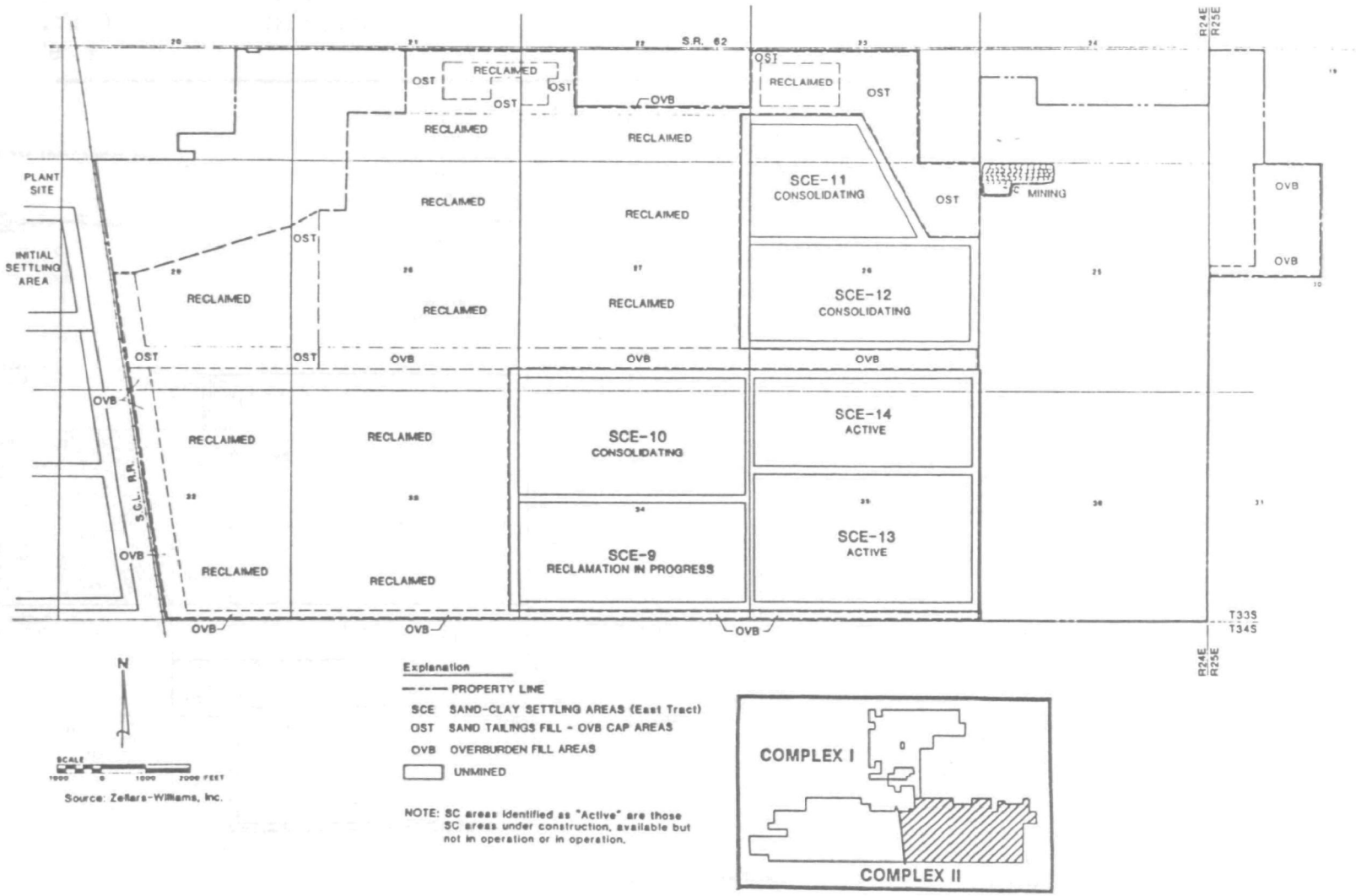

Figure 2.6-12
RECLAMATION SEQUENCE YEAR 21: COMPLEX II, EASTERN SECTION

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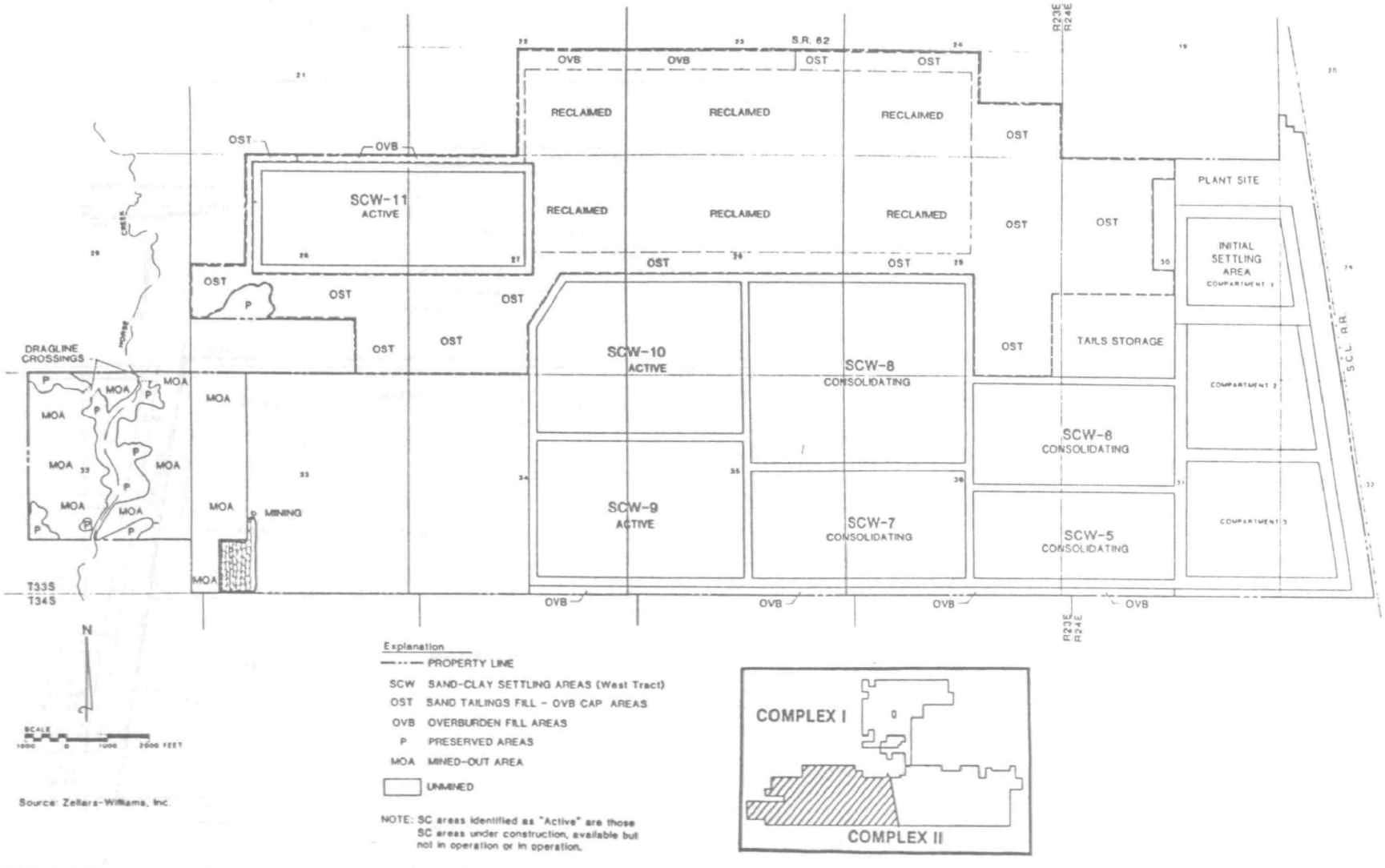

Source: Zellars-Williams, Inc.

Figure 2.6-13
RECLAMATION SEQUENCE YEAR 21: COMPLEX II, WESTERN SECTION

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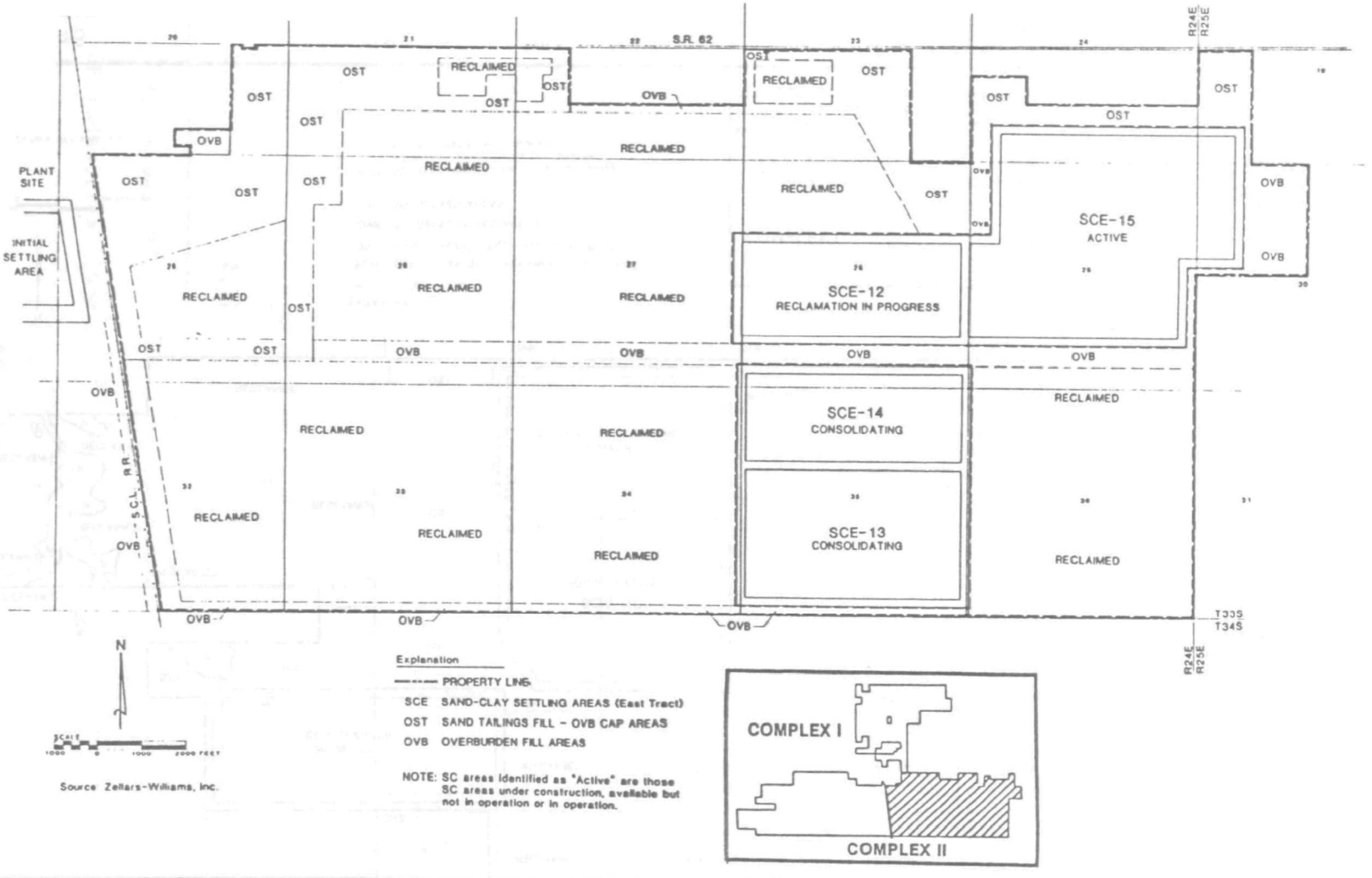

Figure 2.6-14
RECLAMATION SEQUENCE YEAR 27
COMPLEX II, EASTERN SECTION

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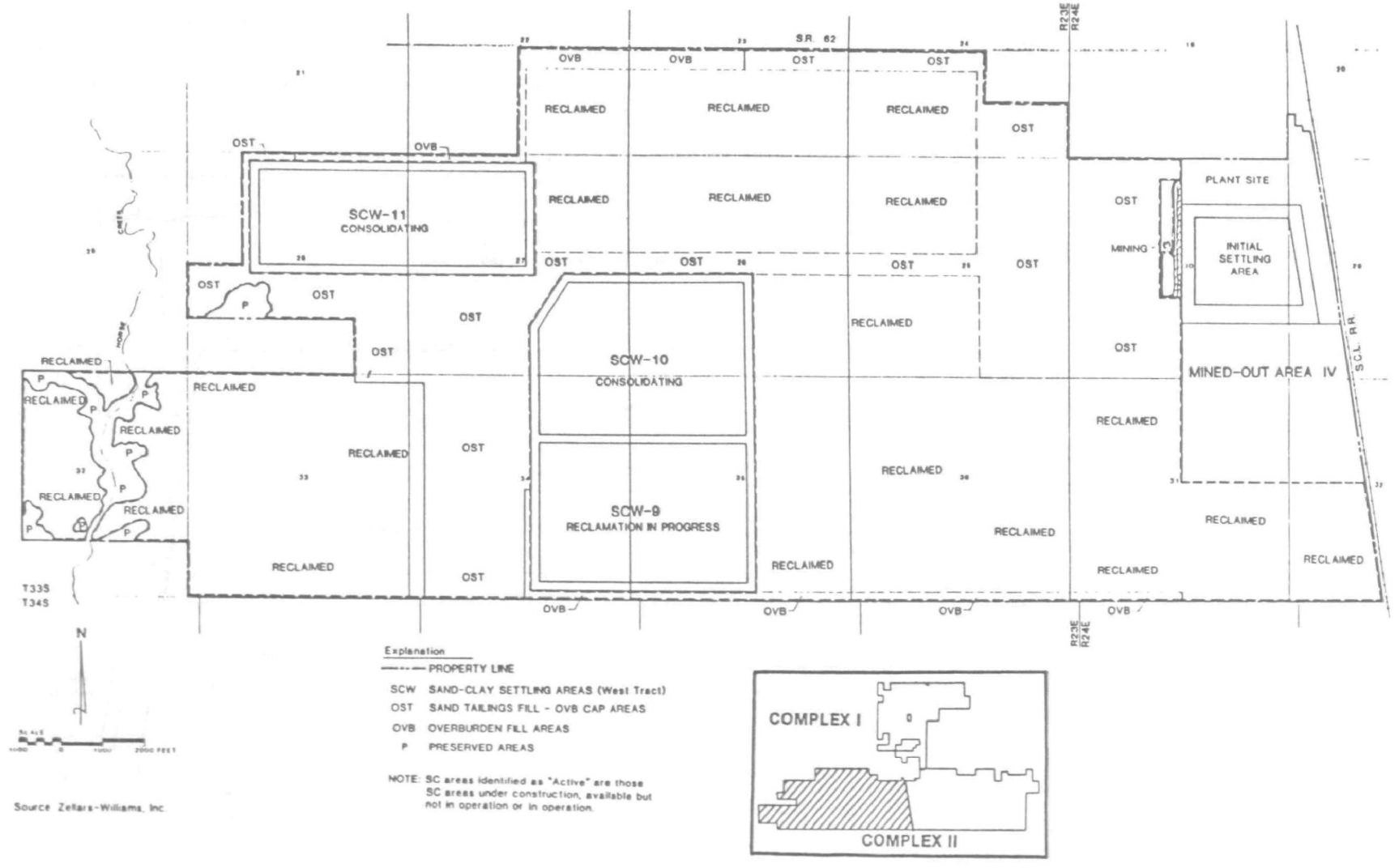

Source Zellars-Williams, Inc.

Figure 2.6-15
RECLAMATION SEQUENCE YEAR 27
COMPLEX II, WESTERN SECTION

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Table 2.6.5-2. Proposed Reclamation Schedule

Mine Year*	Types of Reclamation and Acres Completed: Sand/Clay Landfill	Tailings Landfill	Land & Lakes Area	Overburden	Total
1	0	0	0	0	0
2	0	0	0	0	0
3	0	90	0	0	90
4	0	111	44	0	155
5	0	0	0	22	22
6	0	0	0	35	35
7	0	0	0	30	30
8	0	0	0	39	39
9	0	0	0	61	61
10	187	374	0	21	582
11	0	12	0	9	21
12	308	105	0	6	419
13	0	0	0	48	48
14	426	59	0	53	538
15	292	72	0	95	459
16	220	40	19	24	303
17	330	106	25	0	461
18	686	37	0	42	765
19	223	50	0	85	358
20	693	108	0	0	801
21	191	128	0	110	429
22	636	242	25	10	913
23	326	0	376	28	730
24	366	0	457	69	892
25	621	0	769	0	1390
26	0	646	110	0	756
27	550	0	229	0	779
28	774	0	345	88	1207
29	421	33	0	95	549
30	276	0	0	200	476
31	467	0	0	60	527
32	0	0	0	0	0
33	410	0	0	0	410
34	0	0	0	0	0
35	680	0	0	0	680
TOTAL	9,083	2,213	2,399	1,230	14,925

* Mining ends in year 27.

Source: CF Industries, 1984.

basin will be approximately equal to pre-mining conditions (Table 2.6.6-1).

2.6.7 POST-RECLAMATION LAND USE

Agriculture will be the predominant land use of the reclaimed site, occupying approximately 6,700 acres or 44 percent of the total property (Table 2.1.5-1 and Figures 2.6-4 and 2.6-5). This economic use is compatible with adjacent properties and is consistent with the goals and policies of the Hardee County Comprehensive Plan. All of agricultural land will be initially planted as improved pasture, although it is anticipated that these lands would also be suitable for a variety of agricultural crops and other land uses. CF's planned experimental test plots would evaluate a variety of crops that may be planted in later years.

The remainder of the reclaimed site will consist primarily of forest lands and wetlands (Table 2.1.5-1 and Figures 2.6-4 and 2.6-5). These vegetation types currently occupy approximately 45 percent of the site and provide valuable environmental functions, such as maintaining water quality of downstream waters and providing habitat for a variety of wildlife. Therefore, all of the existing acreage of forest lands and wetlands will be replaced and will actually be increased by approximately 10 percent.

The only existing land use type that will be significantly reduced in acreage through mining and reclamation is the palmetto prairie. This vegetation type will be largely replaced by improved pasture which will provide much better forage for cattle. Palmetto competes with forage grasses and is commonly eradicated on cattle ranges. Therefore, this vegetation type may have eventually been cleared on the CF property even if the site were not mined.

Table 2.6.6-1. Existing and Post-Reclamation Drainage Areas

Drainage Area	Acres	
	Existing	Post-Reclamation
Doe Branch	4,679	4,708
Plunder Branch	2,374	2,266
Coon's Bay Branch	259	188
Troublesome Creek	552	840
Hog Branch	23	11
Shirttail Branch	1,562	1,378
Lettis Creek	1,203	1,182
Brushy Creek	3,429	3,636
Horse Creek	795	728
Gum Swamp Branch	118	57
TOTAL ACREAGE OF SITE	14,994	14,994

Source: ESE, 1983.

2.7 REFERENCES: CF INDUSTRIES' PROPOSED ACTION

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3.0 AIR RESOURCES

3.1 THE AFFECTED ENVIRONMENT

3.1.1 INTRODUCTION

The proposed mine and beneficiation plant at the CF Industries Hardee Phosphate Complex II site will be located a few miles northwest of Wauchula in Hardee County, Florida. The proposed activities have the potential to generate air emissions during the initial construction as well as during the 27-year life of the mining operation. These emissions may be fairly insignificant since actual processing of the phosphate ore will be done at an existing off-site plant. Activities which may result in the production of emissions include:

1. Initial land clearing and preparation (particulates from earth-moving and combustion products due to open burning and heavy equipment traffic);
2. The mining process (particulates); and
3. Increased vehicular activity.

These sources are relatively minor in magnitude or occur infrequently for a short duration.

In order to assess the potential impact of the proposed mine and beneficiation plant, baseline conditions for meteorology and air quality must be assessed. An air quality and meteorological monitoring program was implemented by CF in September of 1975. The program included a weather station, 7 rainfall stations, 8 fixed air monitoring stations, and 5 mobile air monitoring stations. The mobile stations were operated in 1976 and 1977 and have been discontinued due to the remoteness of the area from existing operations and the low pollutant levels recorded. The station locations are illustrated in Figure 3.1-1.

This section presents a description of the local meteorology of the site area, applicable air quality regulations, existing and planned emission sources which may impact the site area, and air quality measurements obtained at the Hardee Phosphate Complex II site. Based on existing and gathered information, estimated baseline air quality levels are presented.

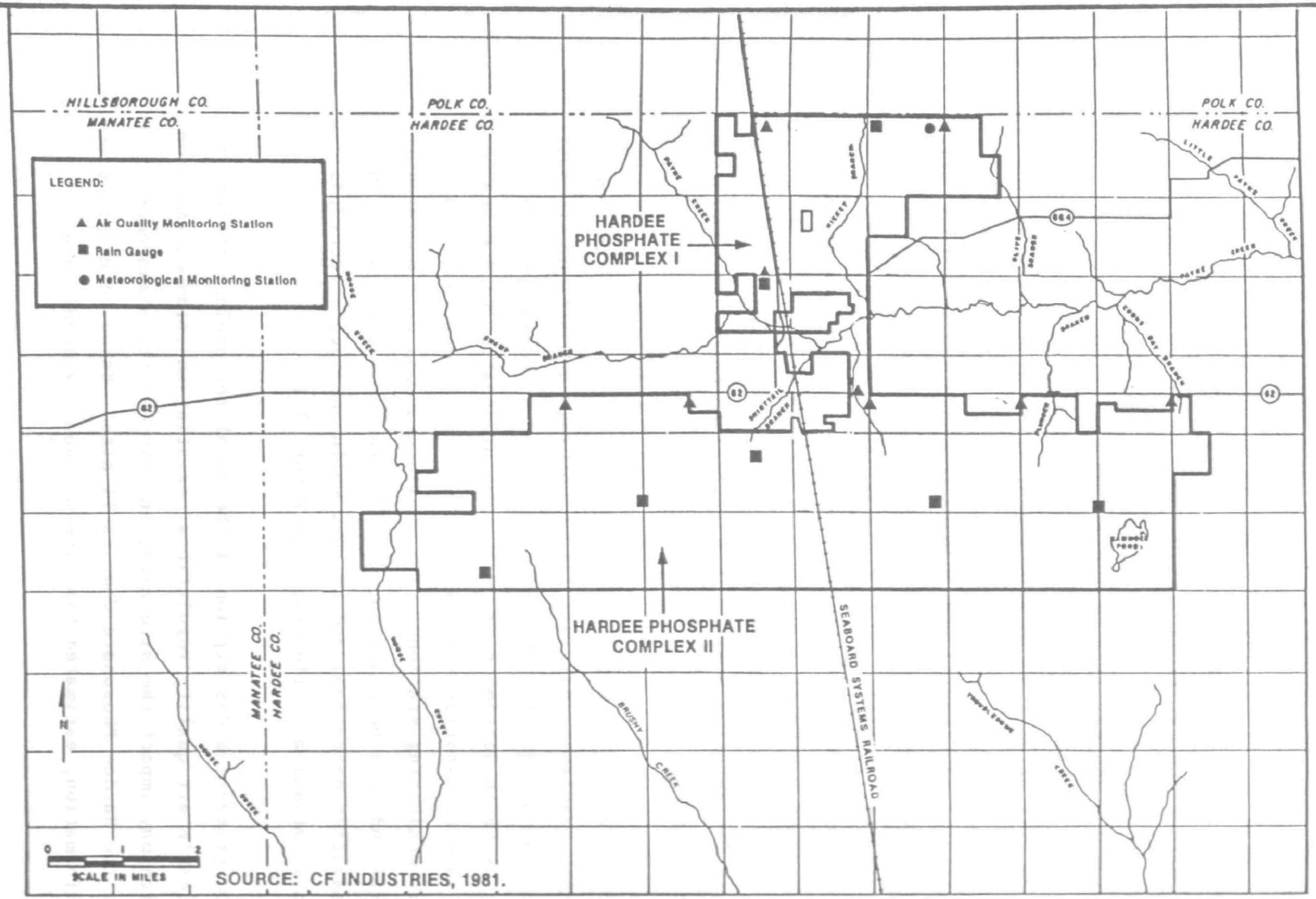

Figure 3.1-1
CF AIR AND METEOROLOGICAL MONITORING STATIONS

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Hardee Phosphate Complex II

CF SID 08/25/85 rev.

3.1.2 REGIONAL METEOROLOGY

The Hardee Phosphate Complex II site has a relatively sub-tropical climate which is typical of central Florida. Winters are generally quite mild and dry, with occasional cold fronts from the north. Summers are hot and humid, with fairly regular afternoon thunderstorms. Central Florida is characteristically humid as a result of frequent rainfall, warm temperature, and occasional cloud cover. Humidity levels are usually highest in the early morning and lowest in the afternoon. Tropical storms accompanied by heavy rains may occur in the summer and early fall. Tornadoes may be associated with some thunderstorms and tropical disturbances.

3.1.2.1 METEOROLOGICAL DATA SOURCES

The nearest weather station to the Hardee Phosphate Complex II site recording temperature and precipitation is located about 2 miles north of Wauchula, Florida. Table 3.1.2-1 shows the monthly and annual average temperature recorded in Wauchula and at the CF site. Wauchula records are based upon observations taken from 1941 to 1970. CF data are for 1981.

3.1.2.2 TEMPERATURE

The 30-year annual average temperature in Wauchula is 72.4°F. The maximum monthly average temperature (81.6°F) occurs in August, whereas the minimum monthly average temperature (61.8°F) occurs in January. For the CF site, the annual average temperature for 1981 was 68°F, with a maximum monthly average temperature of 80°F occurring in July and August and a minimum monthly average temperature of 56°F occurring in February and December.

3.1.2.3 PRECIPITATION

Monthly and annual average rainfall data from Wauchula during the period from 1941 to 1970 and the Hardee Phosphate Complex II site for 1981 are shown in Table 3.1.2-2. The annual average rainfall in Wauchula is

Table 3.1.2-1. Monthly and Annual Average Temperatures (°F) at Wauchula and the Proposed CF Mine Site

Period	Wauchula (1941-1970)	CF Site (1981)
January	61.8	NA*
February	63.1	56
March	67.1	58
April	72.1	68
May	76.6	70
June	80.2	78
July	81.3	80
August	81.6	80
September	80.2	75
October	74.7	74
November	67.4	64
December	62.7	56
Annual	72.4	68

* NA - Not available.

Sources: NOAA, 1973.
CF, 1981.

Table 3.1.2-2. Monthly and Annual Average Rainfall (inches) at Wauchula and the Proposed CF Mine Site

Period	Wauchula (1941-1970)	CF Site (1981)						
		1	2	3	4	5	6	7
January	2.20	0.42	0.45	0.79	0.73	0.71	0.69	0.65
February	2.79	2.72	3.31	4.23	4.21	4.55	4.47	3.85
March	3.39	1.68	1.28	1.22	1.33	1.42	1.12	1.07
April	2.85	2.16	0.00	0.00	0.00	0.00	0.00	0.00
May	3.99	3.54	9.04	4.12	5.52	4.45	2.94	2.07
June	8.66	4.95	6.87	7.72	5.40	1.93	6.06	6.47
July	9.04	4.57	4.49	5.41	9.64	8.24	7.21	5.01
August	7.48	12.79	10.88	6.09	10.65	10.31	12.68	8.11
September	7.88	3.60	5.06	8.16	3.97	3.20	3.83	4.77
October	3.05	0.05	0.23	0.79	1.27	0.73	0.50	0.28
November	1.63	0.76	0.97	0.83	0.47	0.85	0.67	0.37
December	1.70	0.74	1.30	0.91	0.71	0.65	0.87	0.66
Annual	54.66	37.94	43.88	40.27	43.90	37.04	41.04	33.31

Sources: NOAA, 1973.
CF, 1981.

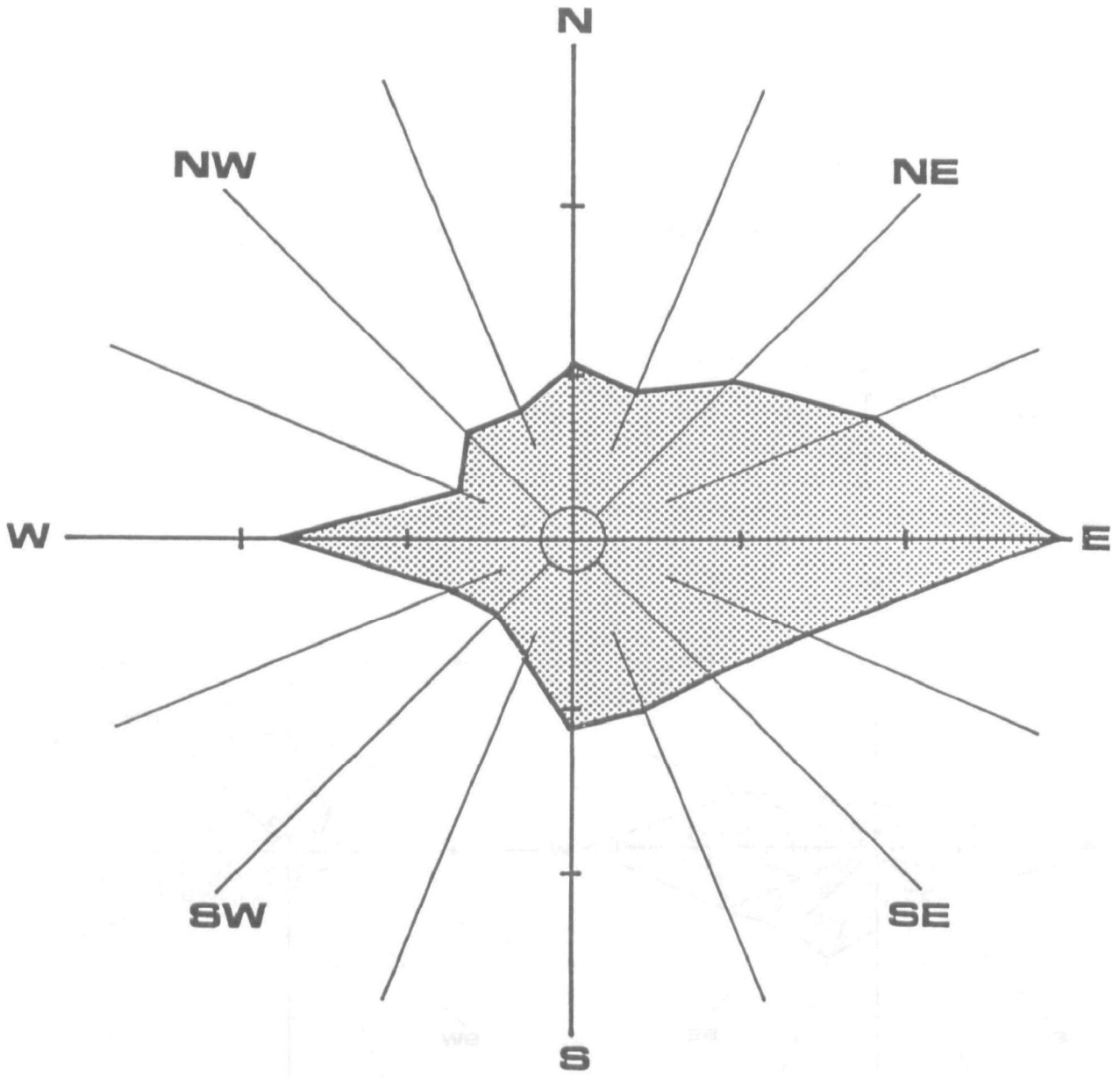
54.7 inches, whereas the maximum monthly rainfall occurs in July, with 9.04 inches, and the minimum monthly rainfall occurs in November with 1.63 inches. For the stations at the CF site, the annual average rainfall for 1981 ranged from approximately 33 to 44 inches, with maximum monthly rainfall occurring in August, and minimum monthly rainfall occurring in April for most of the stations.

3.1.2.4 WIND DIRECTION AND SPEED

Winds in central Florida are dominated by the sub-tropical conditions that produce easterly and southerly winds. The most common winds on an annual basis in this area are between northeast and south. Five-year (1971-1975) annual and seasonal average wind roses for Tampa International Airport (TIA) are presented in Figures 3.1-2 and 3.1-3, respectively. The National Weather Service station at TIA is the nearest to the site and the most representative primary weather station for which long-term weather data are available. Annual average and seasonal average wind roses for 1981 for the CF site are illustrated in Figures 3.1-4 and 3.1-5, respectively. As shown in these figures, the annual average wind directions measured at both sites reflect strong easterly and westerly components. The annual average wind directions measured at the NWS station at TIA are predominantly from the east-northeast through east- southeast and west, whereas those at the CF site are from the north through east-northeast, southeast, and west. The differences in wind directions measured between the two sites can be attributed in part to the relative locations of the sites with respect to the Gulf of Mexico and the Atlantic Ocean, and the non-coincident time periods for which wind data were available for comparisons.

3.1.2.5 ATMOSPHERIC STABILITY

Atmospheric stability is an evaluation of the dispersive capacity of the atmosphere and is used to determine the potential concentration of pollutants. Turner (1964) developed stability classes which range from A (very unstable) to F (stable). As the atmosphere becomes more stable, its dispersive capacity decreases and the dissipation of pollutants is reduced. The relative frequency of occurrence of each stability class at the NWS station at TIA, based on 43,824 hourly



SCALE: 1 inch = 5%

SOURCE: NOAA, 1975.

Figure 3.1-2
FIVE YEAR (1971 — 1975) ANNUAL AVERAGE WIND ROSE FOR THE NWS STATION AT TIA

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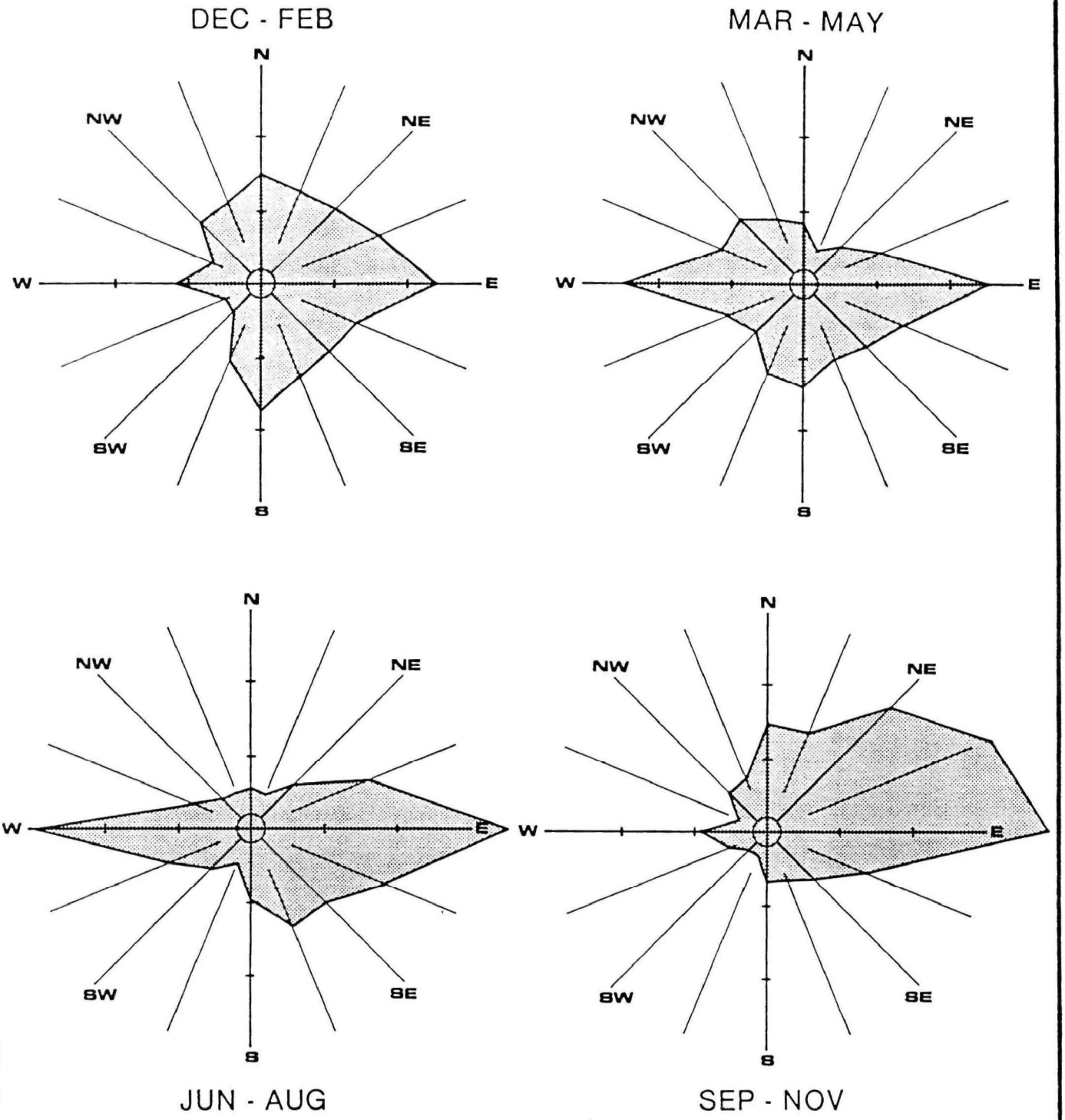

SOURCE: NOAA, 1975.

Figure 3.1-3
FIVE YEAR (1971 — 1975) SEASONAL AVERAGE WIND ROSES FOR THE NWS STATION AT TIA

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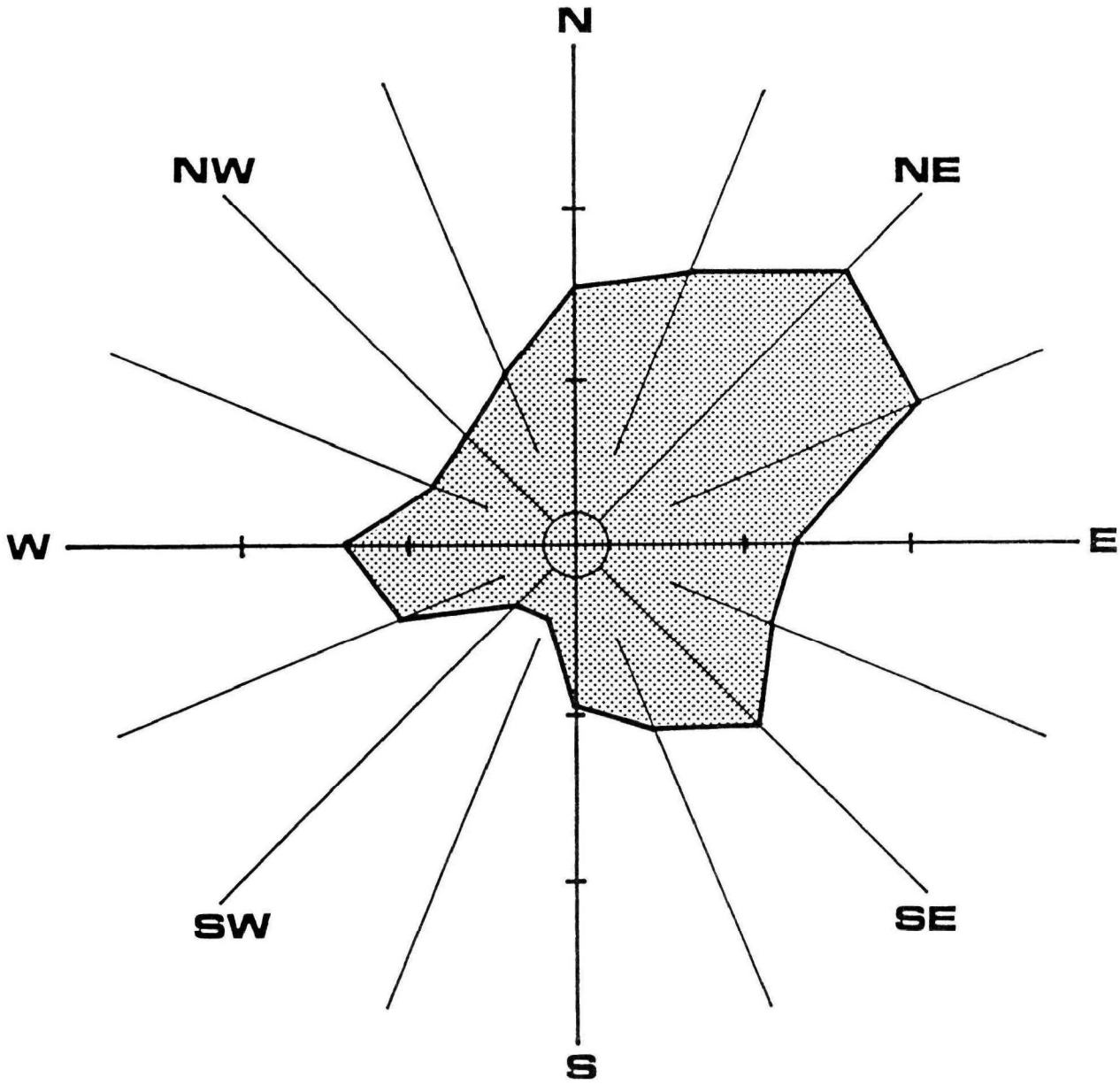

SCALE: 1 inch = 5%

SOURCE: CF INDUSTRIES QUARTERLY REPORTS, 1981.

Figure 3.1-4
ANNUAL AVERAGE WIND ROSE FOR THE CF SITE, 1981

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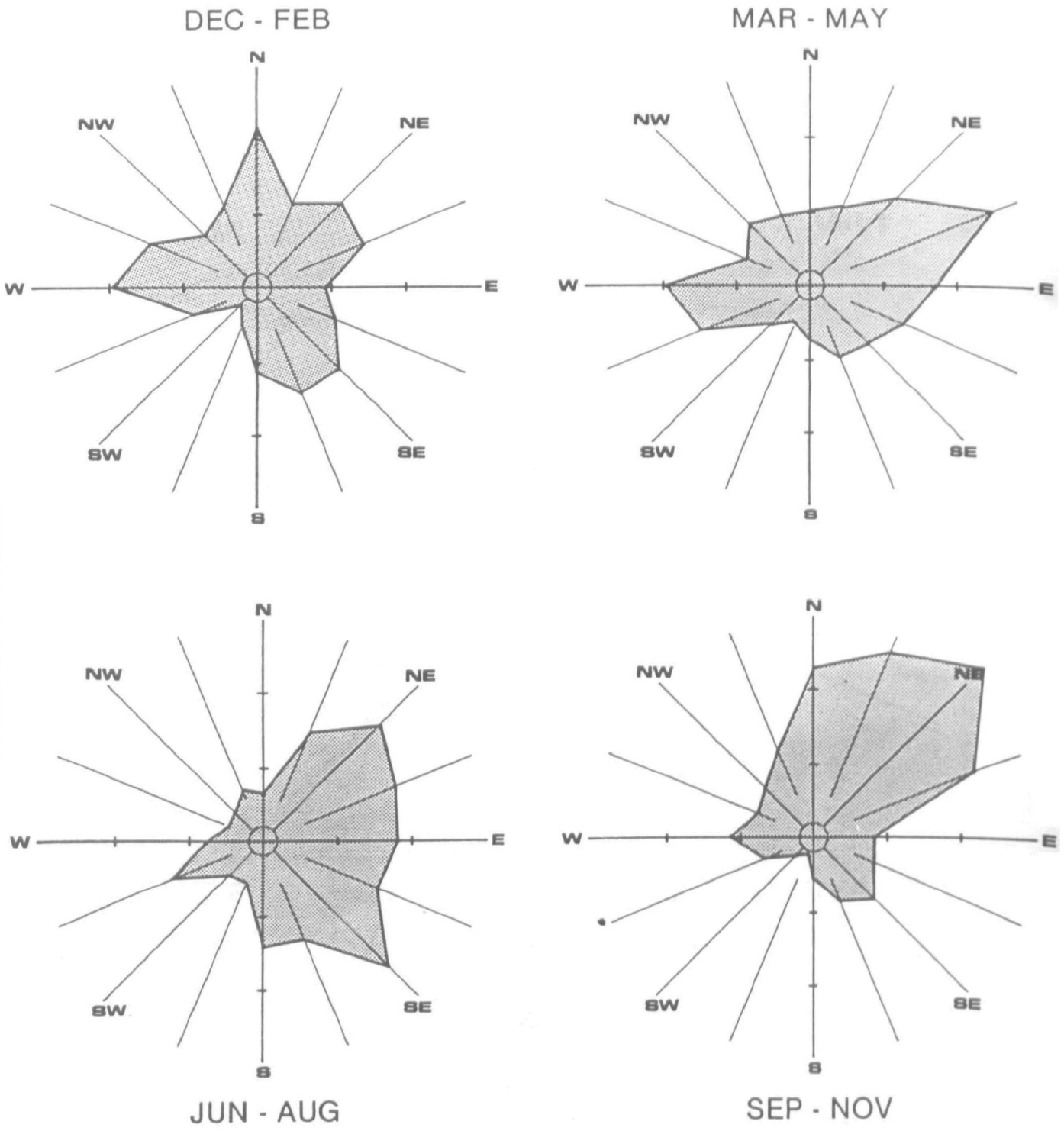

SOURCE: CF INDUSTRIES QUARTERLY REPORTS, 1981.

Figure 3.1-5
SEASONAL AVERAGE WIND ROSES FOR THE CF SITE, 1981

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CF INDUSTRIES
Hardee Phosphate Complex II

observations over a 5-year period from 1971 to 1975 (NOAA, 1975), is presented in the following list:

Stability Class	Frequency of Occurrence
A - very unstable	0.4 percent
B - moderately unstable	6.0 percent
C - slightly unstable	15.6 percent
D - neutral	37.8 percent
E,F - slightly stable, stable	40.2 percent

Conditions at the Hardee Phosphate Complex II site are expected to be similar to the conditions experienced at Tampa, due to the proximity of the two sites. Slightly lower wind speeds and a slight increase in unstable conditions (A,B,C) may be expected at the CF site due to its inland location compared to the NWS station at TIA.

Atmospheric temperature inversions alter the dispersive and mixing capacity of the atmosphere and limit the volume of air into which emitted pollutants can mix. The most frequent inversions occurring at the site are due to the radiative cooling of the surface on clear and calm nights, called nocturnal or radiation inversions. The most severe radiation inversions occur during the fall and winter, but are usually dissolved by surface heating shortly after sunrise.

Other types of inversions that occur at the site are due to frontal systems and subsidence inversions. A frontal system may cause a build-up of pollutant concentrations for a few hours, but these systems are experienced infrequently and only during the late fall or winter when cooler air masses invade the state. A subsidence inversion is formed when a stationary high pressure area causes air at high levels to slowly descend, creating an upper air inversion. Unlike nocturnal inversions which are broken up by sunshine, subsidence inversions, resulting from high pressure areas, may persist for days. A study by Holzworth (1972) showed that occurrences of mixing heights of less than 1,500 meters on at least 2 to 5 consecutive days with wind speeds of less than

4.0 meters per second, representative of stagnation conditions, are expected infrequently near the site. Stagnation conditions lasting at least 2 consecutive days occurred about 9 times, whereas stagnation conditions lasting at least 5 days did not occur over a 5-year period. Stagnation estimates are based on data collected at Tampa, the nearest NWS station to the proposed site included in the Holzworth study.

3.1.3 APPLICABLE AIR QUALITY REGULATIONS

3.1.3.1 AMBIENT AIR QUALITY STANDARDS (AAQS)

Federal and State of Florida AAQS applicable to the proposed project site are shown in Table 3.1.3-1. Pollutants for which AAQS have been set are termed "criteria" pollutants. Federal AAQS were set by EPA to protect the public health and welfare (i.e., animals, vegetation, soils, materials, etc.) with an adequate margin of safety.

Florida AAQS are equal to or, in the case of sulfur dioxide, more stringent than federal AAQS. EPA promulgated secondary annual and 24-hour sulfur dioxide AAQS in 1971, but revoked these standards in 1973. The State of Florida, however, retained these secondary standards as the state AAQS.

3.1.3.2 PREVENTION OF SIGNIFICANT DETERIORATION (PSD)

The Clean Air Act was amended in August 1977 (Public Law 95-95) to incorporate provisions for PSD. Final PSD regulations were promulgated by EPA in August 1980 (45 FR 52735) and require that state implementation plans be revised to include requirements which will prevent significant deterioration of air quality in areas which meet the ambient air quality standards. Major new sources and major modifications are required to undergo PSD review. A new source is termed major if it has the potential to emit 100 tons per year or more of any regulated pollutant and belongs to one of 28 specified source categories, or if it has the potential to emit 250 tons per year or more of any regulated pollutant.

Table 3.1.3-1. Federal and State of Florida AAQS and Allowable PSD Increments (ug/m^3)

Pollutant	Averaging Time	Federal AAQS		State of Florida AAQS	PSD Increment Class		
		Primary Standard	Secondary Standard		I	II	III
Suspended Particulate Matter	Annual Geometric Mean	75	60	60	5	19	37
	24-Hour Maximum*	260	150	150	10	37	75
Sulfur Dioxide	Annual Arithmetic Mean	80	N/A	60	2	20	40
	24-Hour Maximum*	365	N/A	260	5	91	182
	3-Hour Maximum*	N/A	1,300	1,300	25	512	700
Carbon Monoxide	8-Hour Maximum*	10,000	10,000	10,000	—	—	—
	1-Hour Maximum*	40,000	40,000	40,000	—	—	—
Hydrocarbons	3-Hour Maximum* (6 to 9 A.M.)	160	160	160	—	—	—
Nitrogen Dioxide	Annual Arithmetic Mean	100	100	100	—	—	—
Ozone	1-Hour Maximum†	235	235	235	—	—	—
Lead	Calendar Quarter	1.5	1.5	1.5	—	—	—

* Maximum concentration not to be exceeded more than once per year.
† The standard is attained when the average number of calendar days per year on which the standard level is exceeded is less than one.

Sources: EPA, 1981 (40 CFR, Part 50).
EPA, 1982 (40 CFR, Part 52).
DER, 1982 (Ch 17-2, FAC).

Florida DER was granted federal PSD review authority by EPA on November 22, 1983 (Federal Register). As a result, federal PSD permits are now issued by Florida DER. EPA has previously determined that the CF Industries Hardee Phosphate Complex II does not require a PSD permit.

Florida DER has also promulgated state PSD regulations which are nearly identical to the federal PSD regulations. The proposed CF Complex II would not require a state PSD permit under these regulations.

3.1.3.3 NON-ATTAINMENT AREAS

EPA has promulgated a list of areas of the country which are not currently meeting federal AAQS (EPA, 1981, 40 CFR, Part 81). These areas are termed non-attainment areas and require special stringent permitting conditions for new sources which are located in or have the potential to significantly impact these areas.

Non-attainment areas for the federal AAQS for PM, SO_2, ozone and NO_2 which are in the vicinity of the CF site are as follows:

- PM--the nearest non-attainment area for PM is described as "that portion of Hillsborough County which falls within the area of a circle having a centerpoint at the intersection of US 41 and State Road 60 and a radius of 12 km" (43 FR 8962). The boundary of this area is approximately 45 km northwest of the CF site.
- SO_2--the nearest non-attainment area for SO_2 is described as being "the northwest corner of Pinellas County." This area is approximately 100 km from the CF site.
- Ozone--the nearest non-attainment area for ozone is designated as being all of Hillsborough County, its borders being 6-8 km from the CF site. Florida DER has requested that Hillsborough County be redesignated as an attainment area for ozone.
- NO_2--Florida is currently unclassified for NO_2.

The proposed plant site, therefore, is in an area designated as attainment or unclassifiable for all pollutants.

3.1.3.4 EMISSION STANDARDS

All sources of pollution are required to meet state and federal emission standards. For the proposed mining operation and beneficiation plant, no federal or state emission standards apply. However, according to FAC, Chapter 17-4.23(1)(d), all new sources must use the best and latest technology in order to be granted an operating permit. Fugitive particulate matter must be minimized through reasonable precautionary measures [FAC, Chapter 17-2.610(3)]. New stationary air pollution sources must complete an air pollutant source construction permit application (FAC, Chapter 17-4.03) and receive a construction permit before construction of the facility can begin.

3.1.4 AREAWIDE EMISSION SOURCES

Current emission sources in the central Florida region are summarized by EPA (1978) in the Central Florida Phosphate Industry Areawide Impact Assessment Study, which includes emission information for Hillsborough, Polk, Manatee, Hardee, Sarasota, DeSoto, and Charlotte Counties. Information from this report is reproduced in Table 3.1.4-1.

3.1.4.1 PARTICULATES

Dust and particulates are produced by phosphate mining and production activicies. Hillsborough County is responsible for 39.1 percent (20,774 metric tons per year) of all particulate emissions in the 7-county study area. Polk County produces 36.4 percent (19,326 metric tons per year) of all particulate emissions. The remaining counties have small contributions to the areawide particulate levels and have little or no phosphate activity.

Sulfur dioxide is mainly produced by electric utility operations in central Florida but is also associated with phosphate processing. Eighty-two percent (241,344 metric tons per year) of the SO_2 emissions

Table 3.1.4-1. Summary of Point and Area Source Emissions in Study Area

County	Metric Tons Per Year			
	1974		1976	
	Particulates	SO_2	Particulates	SO_2
Charlotte				
Area sources	1,835	141	1,862	147
Point sources	32	40	32	40
DeSoto				
Area sources	1,644	65	1,656	67
Point sources	29	85	29	85
Hardee				
Area sources	2,556	72	2,572	73
Point sources	37	114	37	114
Hillsborough				
Area sources	12,382	2,559	12,865	2,695
Point sources	29,358	267,620	7,909	238,649
Manatee				
Area sources	3,091	326	3,121	348
Point sources	399	746	614	5,593
Polk				
Area sources	10,983	841	11,199	901
Point sources	31,125	119,010	8,127	45,080
Sarasota				
Area sources	2,806	328	2,901	349
Point sources	115	175	115	175
TOTAL				
Area sources	35,297	4,332	36,176	4,580
Point sources	61,095	387,790	16,863	289,736
All sources	96,392	392,122	53,039	294,316

Overall, the ambient levels of dust and SO_2 are expected to increase in the 7-county study area between 1976 and 2000. The 1976 fluoride emissions by the phosphate industry were reported to be 315 metric (346 short) tons. This level is not expected to change much before 2000.

Source: EPA, 1978.

produced in the EPA 7-county study area are from Hillsborough County. Most of these emissions can be attributed to electric generating facility point sources. Polk County comprises 15.6 percent (45,981 metric tons per year) of the total areawide SO_2 emissions. Very little SO_2 is emitted in Hardee, Manatee, Sarasota, DeSoto, and Charlotte Counties.

3.1.4.2 FLUORIDES

Fluoride emissions are produced from phosphate processing. It is estimated that 315 metric tons of fluoride emissions were generated by the phosphate industry in central Florida in 1976 (EPA, 1978). These levels are expected to remain fairly constant in the ensuing 20 years.

3.1.4.3 NITROGEN OXIDES

Nitrogen oxide emissions are a by-product of fossil fuel combustion and are related to fuel-burning activities. Point source emissions are produced primarily from electric power generating facilities and phosphate plants in central Florida.

3.1.5 AMBIENT AIR QUALITY DATA

As discussed in Section 3.1.1, CF has gathered ambient air monitoring data at the Hardee Phosphate Complex II site since September 1975. The locations of the air monitoring stations are shown in Figure 3.1-1. Tables 3.1.5-1 through 3.1.5-3 summarize the collected ambient data for total suspended particulate matter (TSP), sulfur dioxide (SO_2), and gaseous fluorides (F), respectively, for the years 1976 through 1981. These data are from the fixed CF monitoring stations, Stations AQ-1 through AQ-8. Data from the mobile monitoring stations AQ-9 through AQ-13, are not presented because these data were collected intermittently and over only a 1.5-year period in 1976 and 1977.

Effective January 1, 1986, CF modified its ambient air quality monitoring program after generating a 10-year data base. In this revised program, the ambient air is monitored at Station AQ-2. This station monitors for TSP and is located at Hardee Phosphate Complex I in the general area of mining activity.

Table 3.1.5-1. Summary of 24-Hour Total Suspended Particulate Matter Concentrations Measured on the CF Industries Site, 1976-1981

Station	Year	Number of Observations	Concentrations (ug/m^3) Highest 24-Hour	Second Highest 24-Hour	Geometric Mean
AQ-1	1976	56	289	99	31
	1977	61	160	114	29
	1978	60	95	75	28
	1979	60	165	96	35
	1980	60	81	70	35
	1981	60	240	133	44
AQ-2	1976	54	99	83	27
	1977	59	146	110	25
	1978	58	67	62	28
	1979	58	96	72	31
	1980	60	105	69	27
	1981	61	97	89	30
AQ-3	1976	58	73	71	30
	1977	59	294	100	31
	1978	60	103	80	24
	1979	57	114	78	26
	1980	56	131	84	35
	1981	59	125	124	55
AQ-4	1976	56	84	64	25
	1977	60	118	66	27
	1978	57	107	87	31
	1979	58	144	97	33
	1980	58	80	80	38
	1981	61	127	112	33
AQ-5	1976	58	61	55	24
	1977	59	76	60	25
	1978	60	88	55	24
	1979	58	87	57	25
	1980	61	59	56	30
	1981	61	111	73	30
AQ-6	1976	57	88	59	28
	1977	59	210	101	28
	1978	60	70	65	27
	1979	60	69	67	30
	1980	58	67	67	31
	1981	61	86	84	31

Table 3.1.5-1. Summary of 24-Hour Total Suspended Particulate Matter Concentrations Measured on the CF Industries Site, 1976-1981 (Continued, Page 2 of 2)

Station	Year	Number of Observations	Concentrations (ug/m^3) Highest 24-Hour	Second Highest 24-Hour	Geometric Mean
AQ-7	1976	57	76	70	27
	1977	57	82	67	26
	1978	59	75	68	30
	1979	58	81	73	33
	1980	60	134	107	39
	1981	59	110	96	48
AQ-8	1976	57	97	97	31
	1977	58	93	60	29
	1978	60	207	101	28
	1979	61	144	64	32
	1980	59	71	70	34
	1981	61	80	76	34

Source: CF Industries, 1976-1981.

Table 3.1.5-2. Ambient Sulfur Dioxide Concentrations Measured on the CF Industries Site, 1976-1981

Period	Annual Average Concentration (ug/m^3)							
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6	AQ-7	AQ-8
1976	29	21	13	19	25	16	15	15
1977	14	15	13	14	13	14	14	14
1978	14	16	13	15	14	15	14	15
1979	15	15	13	16	15	17	15	14
1980	14	13	13	14	14	13	13	13
1981	13	13	13	14	14	14	13	13

Source: CF Industries, 1976-1981.

Table 3.1.5-3. Ambient Fluoride Concentrations Measured on the CF Industries Site, 1976-1981

Period	Annual Average Concentration (ug/m^3)							
	AQ-1	AQ-2	AQ-3	AQ-4	AQ-5	AQ-6	AQ-7	AQ-8
1976	0.9	0.7	0.9	0.8	0.8	0.7	0.7	0.7
1977	0.7	0.6	0.8	1.1	0.9	1.1	0.7	0.7
1978	1.6	1.0	1.0	1.1	1.3	0.7	1.5	0.4
1979	1.0	1.2	0.8	0.6	0.8	0.5	0.7	0.6
1980	0.5	0.5	0.4	0.6	0.4	0.4	0.4	0.3
1981	0.4	0.5	0.4	0.4	0.4	0.4	0.4	0.4

Source: CF Industries, 1976-1981.

3.1.5.1 TOTAL SUSPENDED PARTICULATES

Table 3.1.5-1 shows that data recovery for TSP was acceptable for all stations and all years. Data were collected on a once-every-sixth-day schedule, resulting in about 60 observations per year. Annual geometric mean TSP levels are generally low for all stations for most years and reflect background, rural TSP levels.

All TSP annual geometric means are less than 35 ug/m^3 except for Stations AQ-1 and AQ-3 in 1981; Station AQ-4 in 1980; and Stations AQ-7 in 1980 and 1981. All annual geometric means are less than the Florida AAQS of 60 ug/m^3. Over the 6-year monitoring period, five 24-hour concentrations in excess of the 150 ug/m^3 Florida AAQS were recorded. The causes of the high values are not known, and judging from the remainder of the data base, can be attributed only to local phenomena such as agricultural operations, open burning, or forest fires. The Florida 24-hour AAQS for TSP can be exceeded once per year at each monitoring station, and the data show that the second highest 24-hour observation at each station was below the 150 ug/m^3 level. Therefore, no violations of the TSP standard were recorded over the monitoring period.

3.1.5.2 SULFUR DIOXIDE

Table 3.1.5-2 presents SO_2 data measured at the CF Hardee Chemical Complex II site. The maximum annual average concentration recorded at any of the eight stations was 29 ug/m^3, which is about 50 percent of the Florida annual SO_2 AAQS of 60 ug/m^3. Annual averages for most years are less than 20 ug/m^3, reflective of rural air quality conditions.

3.1.5.3 FLUORIDES

Ambient fluoride data from the CF site are presented in Table 3.1.5-3. Annual average concentrations range from 0.3 ug/m^3 to 1.6 ug/m^3, with most averages being less than 1.0 ug/m^3. No AAQS exist for F in the State of Florida.

3.2 NOISE

3.2.1 SOUND MEASUREMENT

The human ear perceives sound between frequencies of 16 and 20,000 Hertz. One important characteristic of the human ear is that throughout its range of perception, sounds of equal pressure level at different frequencies are not perceived equally. Sounds of low and high frequencies are not heard as easily as sounds in the mid-range. A commonly used weighting scale, which nearly approximates the response of the human ear, is the A scale. A sound level meter measures the A scale by electronically attenuating low and high frequency sounds.

The unit of measure in acoustics is the decibel (dB), defined as:

$$dB = 10 \log PA^2/PR^2$$

where PA is the measured sound pressure level, and
PR is a reference level (in this case, 20 micropascals).

Guidelines for environmental noise are defined in terms of the A scale and are expressed as one of the following statistical measures (EPA, 1974).

1. L_{10}--the sound level which is exceeded 10 percent of the time during a measurement period.
2. L_{50}--the sound level which is exceeded 50 percent of the time during a measurement period.
3. $L_{eq}(24)$--the sound level equal in cumulative energy to all time-varying noise produced during a 24-hour period.
4. L_{dn}--the equivalent sound level for day (7 a.m.-10 p.m.) and night (10:00 p.m.-7:00 a.m.) in which the equivalent night time level has been biased by the addition of 10 decibels.

EPA (1974) also presents the following information on the nighttime weighting factor:

> The choice of the 10 dB nighttime weighting in the computation of L_{dn} has the following effect: In low noise level environments below L_{dn} of approximately 55 dB, the natural drop in L_{dn} values is approximately 10 dB, so that daytime and nighttime levels contribute about equally to L_{dn}. However, in high noise environments, the night noise levels drop relatively little from their daytime values. In these environments, the nighttime weighting applies pressure towards around-the-clock reduction in noise levels if the noise criteria are to be met.

3.2.2 REGULATORY GUIDELINES

EPA has published noise levels requisite to protect the public against hearing loss or activity interference for various land use categories (EPA, 1974) (see Table 3.2.2-1). Sound levels are given as $L_{eq}(24)$ and $L_{dn}(24)$ and are yearly averages on an energy basis. These values are for long-term exposures and take into consideration the cumulative effects of noise. Requisite noise levels have been set to protect the public against hearing loss such that 96 percent of the population will not experience a hearing threshold shift of more than 5 dBA at 4,000 Hertz in 40 years of continual exposure.

In addition to EPA's published guidelines, the U.S. Department of Transportation has published Design Noise level criteria based upon land use (U.S. Federal Highway Administration, 1976) (see Table 3.2.2-2). Highway noise has long been recognized as a major contributor to environmental noise, thus, the suggested criteria, based on L_{10}'s, have been developed for various land use categories.

Table 3.2.2-1. Yearly Average* Equivalent Sound Levels Requisite to Protect the Public Health and Welfare

Land Use	Measure	INDOOR			OUTDOOR		
		Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects**	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects**
1 Residential with Outdoor Space and Farm Residences	L_{dn}	45		45	55		55
	$L_{eq}(24)$		70			70	
2 Residential with No Outside Space	L_{dn}	45		45			
	$L_{eq}(24)$		70				
3 Commercial	$L_{eq}(24)$	†	70	70 ††	†	70	70 ††
4 Inside Transportation	$L_{eq}(24)$	†	70	†			
5 Industrial	$L_{eq}(24)$***	†	70	70 ††	†	70	70 ††
6 Hospitals	L_{dn}	45		45	55		55
	$L_{eq}(24)$		70			70	
7 Educational	$L_{eq}(24)$	45		45	55		55
	$L_{eq}(24)$***		70			70	
8 Recreational Areas	$L_{eq}(24)$	†	70	70 ††	†	70	70 ††

Table 3.2.2-1. Yearly Average* Equivalent Sound Levels Requisite to Protect the Public Health and Welfare (Continued, page 2 of 2)

Land Use	Measure	INDOOR			OUTDOOR		
		Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects**	Activity Interference	Hearing Loss Consideration	To Protect Against Both Effects**
9 Farm Land and General Unpopulated Land	$L_{eq}(24)$				†	70	70 ††

* Refers to energy rather than arithmetic averages.

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

** Based on lowest level.

†† Based only on hearing loss.

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

NOTE: Explanation of identified level for hearing loss. The exposure period which results in hearing loss at the identified level is a period of 40 years.

Source: U.S. Environmental Protection Agency, 1974.

Table 3.2.2-2. Federal Highway Administration Design Noise Level/Land Use Relationships

Land Use Cacegory	Design Noise Level - L_{10}*	Description of Land Use Category
A	60 dBA (Exterior)	Tracts of lands in which serenity and quiet are of extraordinary significance and serve an important public need, and where the preservation of those qualities is essential if the area is to continue to serve its intended purpose. Such areas could include amphitheaters, particular parks or portions of parks, or open spaces which are dedicated or recognized by appropriate local officials for activities requiring special qualities of serenity and quiet.
B	70 dBA (Exterior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, picnic areas, recreation areas, playgrounds, active sports areas, and parks.
C	75 dBA (Exterior)	Developed lands, properties or activities not included in categories A and B above.
D	Variable	For requirements on undeveloped lands see paragraph 5a(5) and (6), Federal Highway Administration policy and procedure manual.
E	55 dBA (Interior)	Residences, motels, hotels, public meeting rooms, schools, churches, libraries, hospitals, and auditoriums.

*L_{10} represents the level which can be exceeded no more than 10 percent of the time.

Source: U.S. Federal Highway Administration, 1976.

3.2.3 EXISTING NOISE ENVIRONMENT

3.2.3.1 EXISTING ENVIRONMENT

Hardee County is predominatly rural and depends upon agriculture as its economic mainstay. Table 3.2.3-1 provides information on land use in Hardee County. The proposed site, the Hardee Phosphate Complex II, has primarily open rangeland, improved pasture, and forest land uses. Property surrounding the site is rural agricultural and is very sparsely populated. The nearest muncipality to the site is Wauchula, the county seat, about 2 miles away. No major noise sources are currently located within the site or in the near vicinity. The property is traversed by the Seaboard Coast Line (SCL) Railroad, and bounded on the north by SR 62. U.S. Highway 17 is located roughly 2.5 miles east of the site. These transportation facilities are currently the most significant anthropogenic noise sources in proximity to the site. Figure 3.2-1 illustrates transportation facilities in Hardee County.

Table 3.2.3-2 and Figure 3.2-2 describe characteristic sound levels for various land use types. From these sources, monitoring information from similar locations, and previous phosphate EIS's, ambient L_{dn} noise levels at the CF site can be expected to be between 40 and 50 dBA. Higher levels could be experienced during periods of heavy traffic on SR 62, when the SCL railroad passes, and during periods of increased wildlife activity.

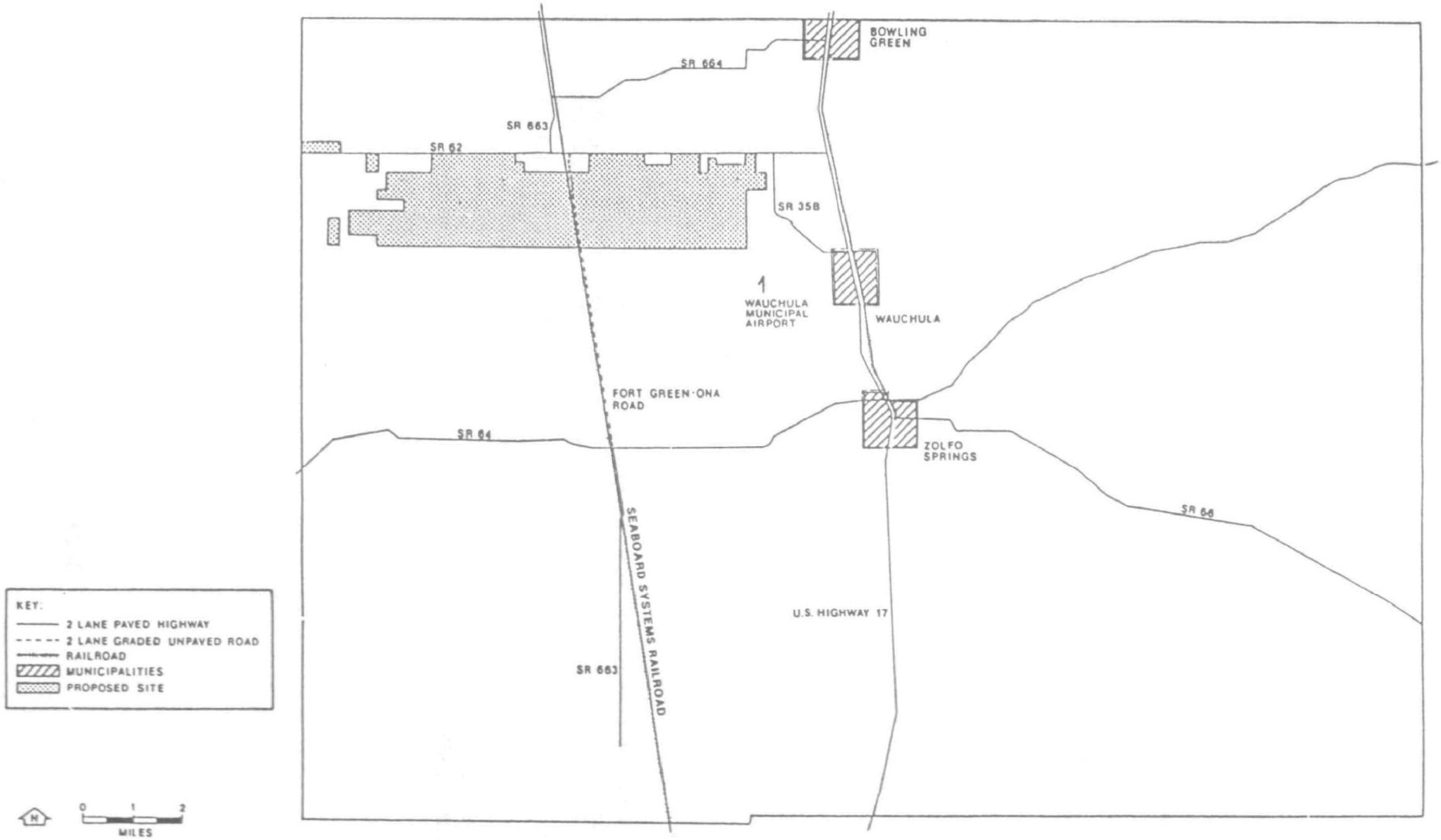
3.2.3.2 PROJECTED ENVIRONMENT WITHOUT THE PROPOSED PROJECT

The projected noise levels at the CF site can be expected to increase slightly without the proposed project due to increased vehicular and rail activity stimulated by future phosphate mining operations a few miles south of the site in Central Hardee County. The major population growth corridor in Hardee County lies along U.S. 17 between Bowling Green and Zolfo Springs and may contribute to somewhat higher on-site noise levels from increased anthropogenic activity (e.g., additional traffic on U.S. 17 and SR 62).

Table 3.2.3-1. 1975 Generalized Land Use in Hardee County

Land Use Category	Area (Acres)	Percent of County
Urban or Built-Up		
Residential	3,507	0.87
Commercial and Services	293	0.07
Industrial	166	0.04
Transportation, Communications, and Utilities	566	0.14
Other Urban or Built-Up Areas	68	0.02
Agricultural Land		
Cropland and Pasture	102,971	25.54
Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	69,120	17.14
Rangeland	144,723	35.89
Forest Land	11,299	2.80
Water	948	0.24
Wetland	69,412	17.22
Barren Land		
Strip Mines, Quarries, and Gravel Pits	--	--
Other Barren Land	128	0.03
COUNTY TOTAL	403,201	100.00

Sources: EPA, 1978.
ESE, 1982.



SOURCE: FDOT, 1975.

Figure 3.2-1
TRANSPORTATION FACILITIES IN HARDEE COUNTY

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

Table 3.2.3-2. Typical Values of Yearly Day-Night Average Sound Level for Various Residential Neighborhoods Where There Are No Well-Defined Sources of Noise Other Than Usual Transportation Noise

Description	Population Density (People/Sq Mi)	L_{dn} - dB
Rural (undeveloped)	20	35
Rural (partially developed)	60	40
Quiet Suburban	200	45
Normal Suburban	600	50
Urban	2,000	55
Noisy Urban	6,000	60
Very Noisy Urban	20,000	65

Source: National Academy of Science, 1977.

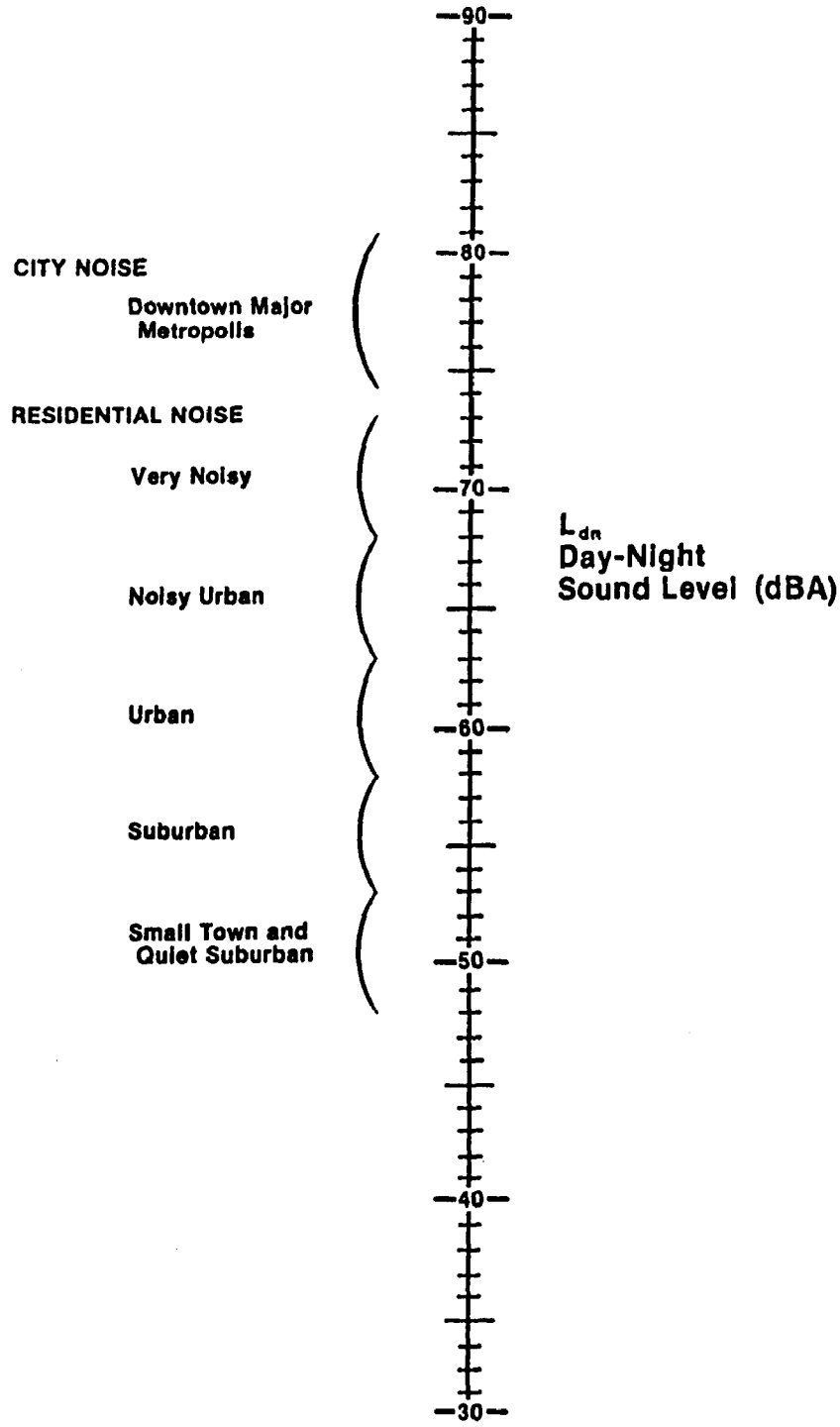

Figure 3.2-2
EXAMPLES OF OUTDOOR DAY-NIGHT SOUND LEVEL IN dB (RE 20 MICRO-PASCALS) MEASURED AT VARIOUS LOCATIONS

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3.3 REFERENCES: AIR RESOURCES

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4.0 GEOTECHNICAL RESOURCES

4.1 THE AFFECTED ENVIRONMENT

4.1.1 REGIONAL DESCRIPTION

4.1.1.1 GEOMORPHOLOGY

The project site is located in northwestern Hardee County, Florida, within the Polk Upland region of the mid-peninsula physiographic zone as described by White (1970) (see Figure 4.1-1). The Polk Upland is a broad, slightly dissected, marine terrace, ranging in elevation from 100 to 150 feet above mean sea level (msl). It is bordered on the north by the Western Valley and the Lake Upland, and on the east by the Lake Wales Ridge. Several miles south of the site the terrain is the gently sloping, nearly undissected DeSoto Plain ranging in elevation from 30 to 100 feet msl. To the west lies the Gulf Coastal Lowlands.

Except for the Winter Haven, Lakeland, and Lake Henry ridges which rise from its surface in the northeastern part, the Polk Upland is a broad area of low topographic relief. Both the uplands and the lowlands appear to have been eroded to their present elevations from a paleo-highland.

4.1.1.2 SOLUTION FEATURES

The occurrence of solution features varies throughout the region and is restricted by the thickness of overburden over solution-prone limestones and the depth of the potentiometric surface. The thick layer of solution-resistant clastic sediments (White, 1970) above the Hawthorn formation and the occurrence of a near-surface water table in the region of the mine site combine to reduce the potential for sinkhole development.

4.1.1.3 STRATIGRAPHY

The basement rocks in Florida consist of both crystallines and sediments. The crystalline rocks range from granites to basalt flows and pyroclastics, while the sediments are primarily unmetamorphosed to very weakly metamorphosed noncalcareous shales and sandstones (Applin

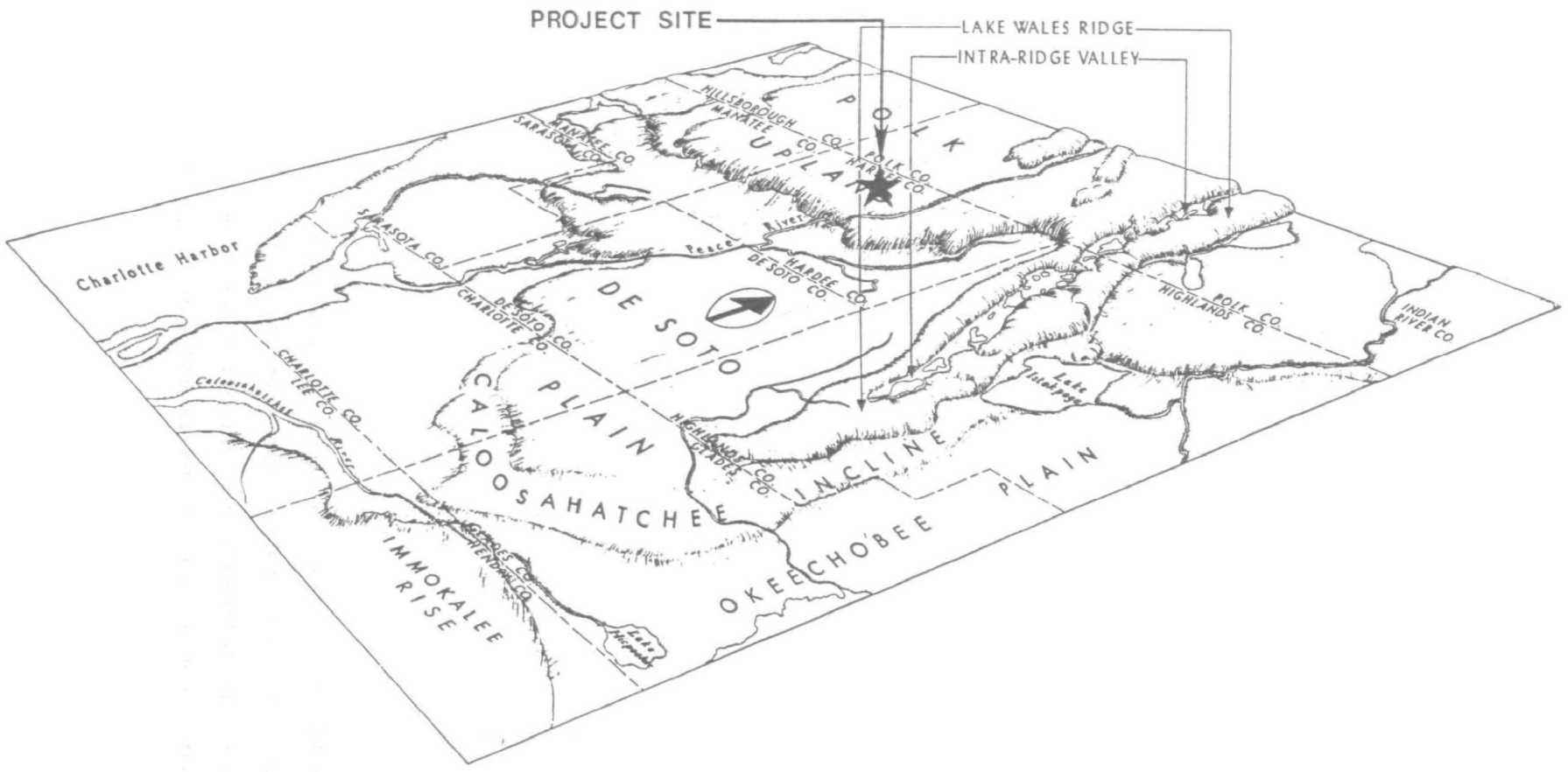

Figure 4.1-1
PHYSIOGRAPHIC FEATURES IN SITE REGION

SOURCE: WHITE, 1970.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

and Applin, 1944). The basement rocks are pre-Cretaceous in age (Figure 4.1-2). They are overlain by a wedge of Cretaceous and Cenozoic sediments. This wedge thickens from about 4,300 feet in southeastern Georgia to nearly 12,000 feet in Southern Peninsula Florida.

Throughout Florida the Cretaceous and overlying Cenozoic section consists primarily of shallow-water marine carbonates and evaporites, claystones and partially cemented to uncemented sands, silts, and clays. Cenozoic strata are the only units which were encountered during previous investigations conducted on the property.

4.1.1.4 STRUCTURAL GEOLOGY

Regional structural features that have influenced the geology at the project area are the South Florida Basin, the Kissimmee Faulted Flexure, and the Ocala Uplift (Figure 4.1-3). The South Florida Basin is a downwarp structure that plunges westward toward the Gulf of Mexico with its axis trending east-west. Sediments within the basin are Mesozoic and Cenozoic in age and have a gentle dip to the southwest. The basin subsided slowly from Jurassic to Middle Eocene. During this time, the environment of the basin was essentially that of a shallow to deep shelf supporting carbonate and evaporitic cyclic deposition. The Kissimmee Faulted Flexure is a local, fault-bounded tilted and rotated block of Eocene or Oligocene age extending down the Florida Peninsula in Orange, Osceola, and Lake Counties. The regional structural feature that has the most significant effect on the project site is the Ocala Uplift, a gentle, local anticlinal structure.

The Ocala Uplift centers around outcrops of the Ocala Group (Upper Eocene) and Avon Park Limestone (Late Middle Eocene) in Citrus, Dixie, and Levy Counties on the West Coast of the peninsula. Where exposed, the uplift is about 230 miles long and 20 miles wide. Fracturing and faulting of the Tertiary rocks is associated with the development of the uplift (Vernon, 1951).

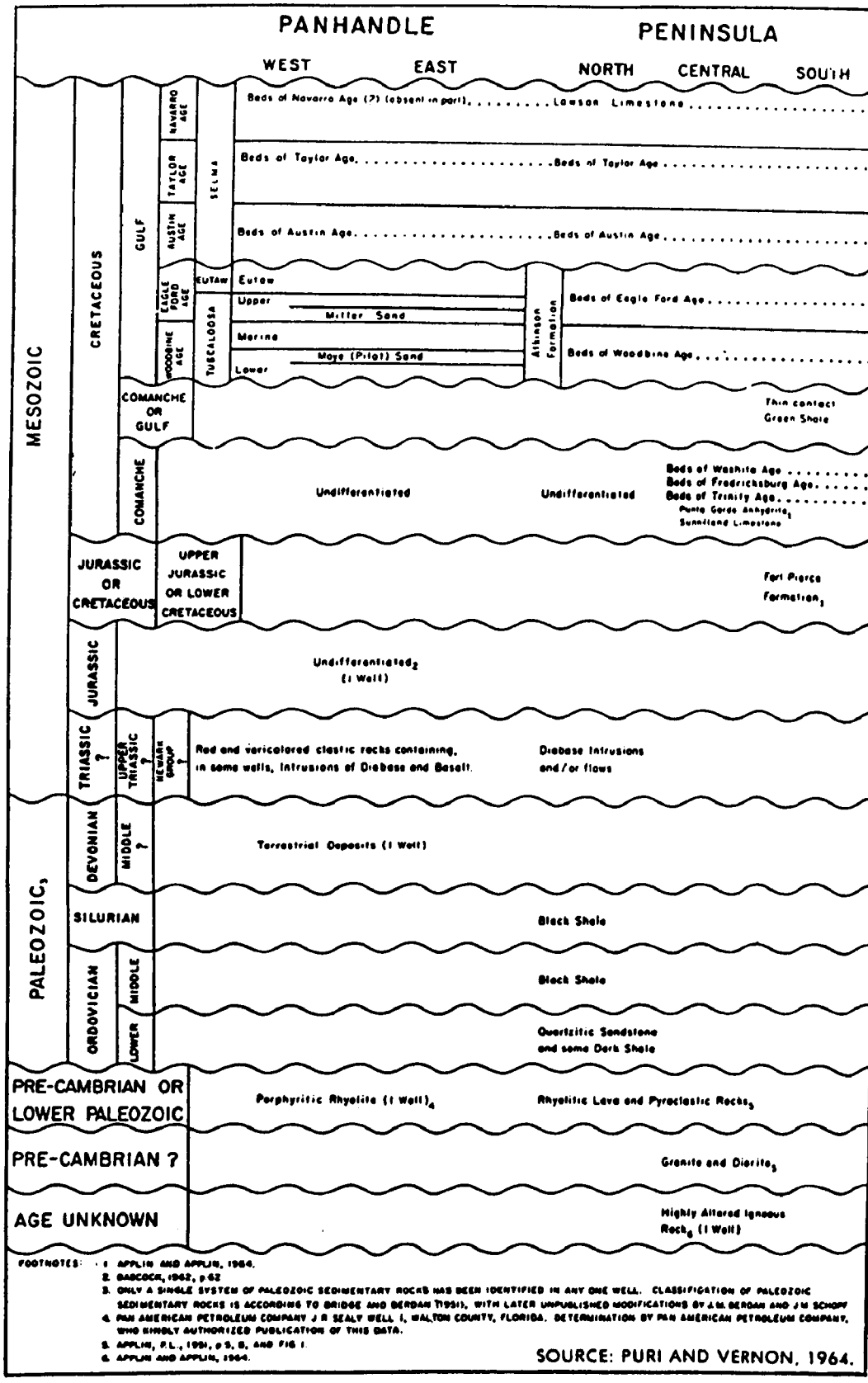

Figure 4.1-2
GENERALIZED STRATIGRAPHIC COLUMN

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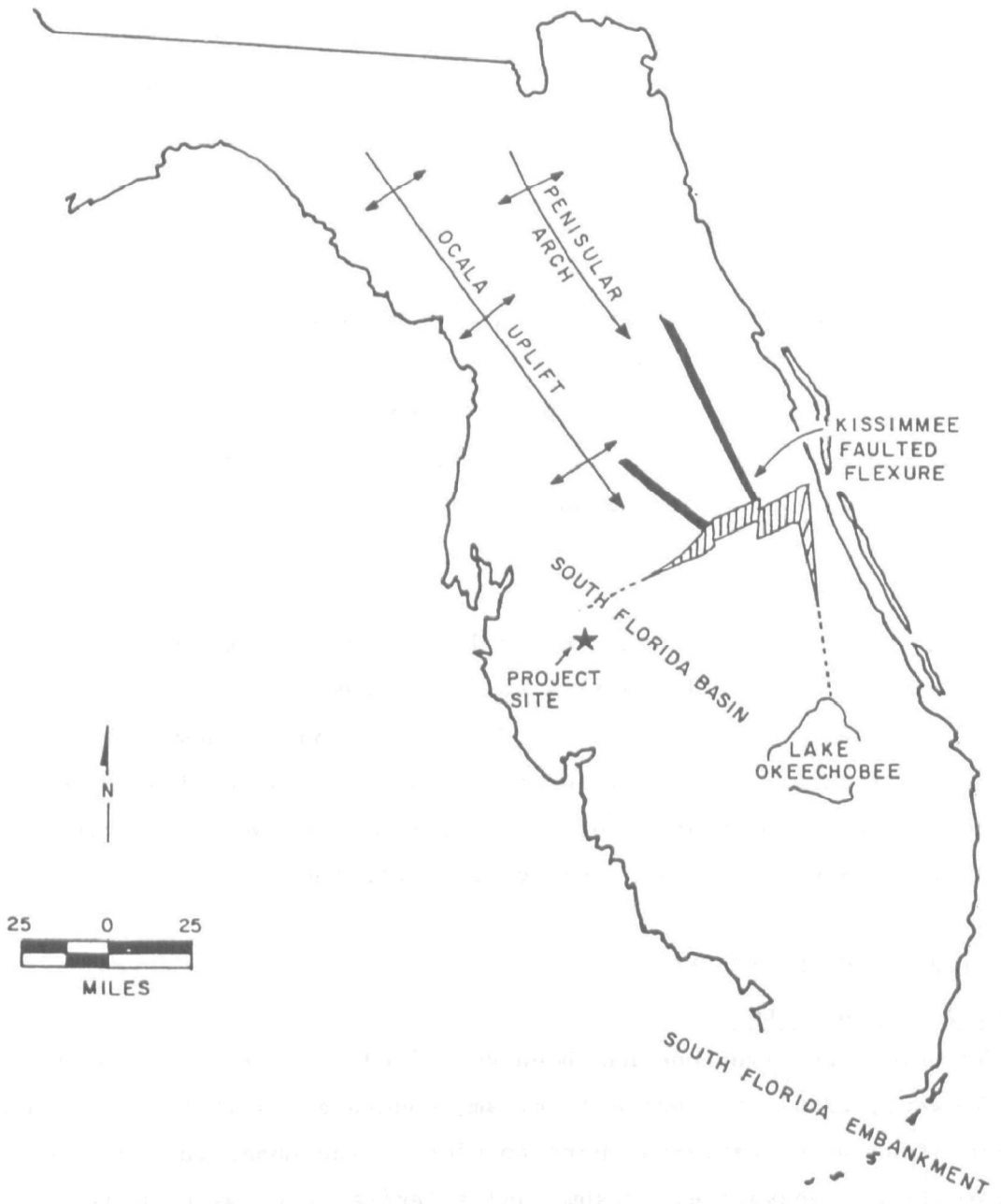

SOURCE: CF DRI.

Figure 4.1-3
REGIONAL STRUCTURAL FEATURES

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4.1.1.5 SEISMICITY

Very low seismic activity has historically characterized the State of Florida. In modern times few significant events which occurred within the state have been recorded. Stover et al. (1979) reported that the maximum intensity of events known to have occurred within the state was recorded at Modified Mercalli (mm) intensity V. There is little chance that events of stronger intensity will be observed in Florida.

4.1.2 SITE-SPECIFIC DESCRIPTION--GEOLOGY

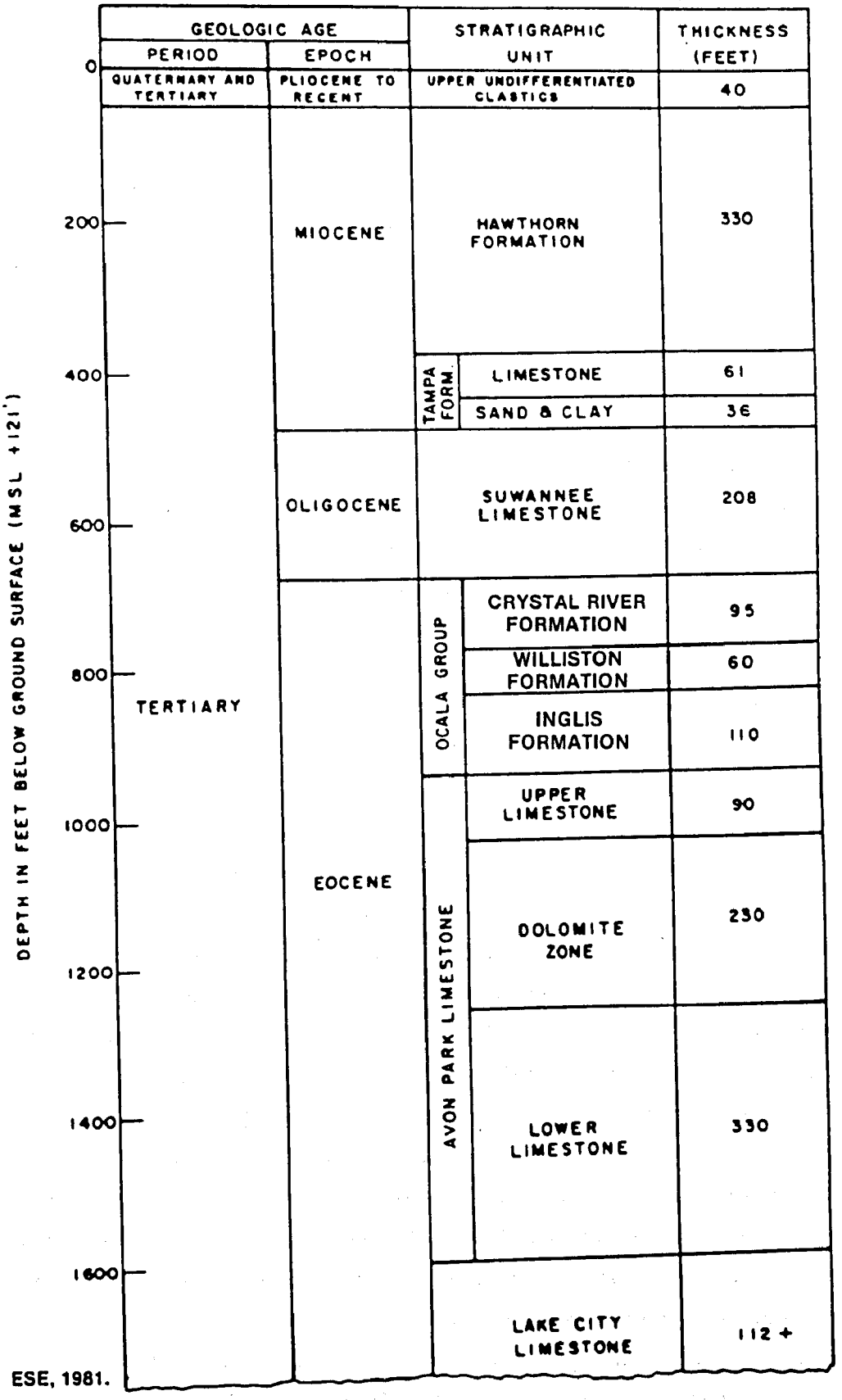
The geologic formations penetrated during the drilling phase of previous on-site investigations range in age from Eocene to Recent. In ascending order, the formations encountered are: the Lake City Limestone, Avon Park Limestone and Ocala Group of Eocene age; the Suwannee Limestone of Oligocene age; the Tampa and Hawthorn Formations of Miocene age; and undifferentiated clastic deposits ranging in age from Pliocene to Recent.

In the following sections, regional and site characteristics of the individual geologic formations have been taken from the CF DRI descriptions. A general Stratigraphic Section is shown for the site area in Figure 4.1-4. A literature review and an evaluation of both the geologic and geophysical logs from four on-site wells (ranging from 948 to 1,702 feet deep) were used to delineate the formations.

4.1.2.1 EOCENE SERIES

Lake City Limestone

The Lake City Limestone has been described in nearby Polk County (Stewart, 1966) as a white to cream, moderately soft to hard chalky limestone with scattered chert nodules in the upper part of the formation. Anhydrite, gypsum, and selenite occur as nodules throughout the formation. The continuity of lithic material from the Lake City Limestone into the overlying Avon Park Limestone suggests that the contact is transitional. Average thickness of the Lake City Limestone in Polk County is 419 feet.



SOURCE: ESE, 1981.

Figure 4.1-4
SUMMARY OF SITE GEOLOGY

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At the CF Industries site in northwestern Hardee County, the Lake City Limestone consists of medium brown to very light brown, moderately soft to indurated fossiliferous limestone. Dolomite also is present scattered throughout the upper part of the formation. The contact between the Lake City Limestone and the overlying Avon Park Limestone at a depth of about 1,590 feet was based on the occurrence of abundant nodules of evaporite minerals at that depth. Thickness of the Lake City Limestone at the project site is a minimum of 110 feet.

Avon Park Limestone

In Polk County, the Avon Park Limestone is a dark brown to cream, very hard to soft, granular to chalky to finely crystalline, highly fossiliferous limestone (Stewart, 1966). Within the limestone section there is normally a dolomite zone ranging from 80 to 135 feet thick which occurs from 57 to 220 feet below the top of the formation. Wilson (1975) provides a similar lithic description for the Avon Park Limestone in Hardee and DeSoto Counties and gives thicknesses ranging from 200 to 470 feet for the entire formation and a minimum of 150 feet for the dolomite zone.

In northwestern Hardee County at the project site, the entire thickness of the Avon Park Limestone was penetrated by the Deep Floridan Test Well. The formation consists of three lithic types. The upper unit is a very light brown, very fine grained to coarse grained, dense crystalline to coarse grained bioclastic limestone approximately 90 feet thick between depths of 940 to 1,030 feet below ground surface. The middle unit is a dark yellowish brown to light yellowish brown, fine to medium grained, crystalline and highly indurated dolomite approximately 230 feet thick between depths of 1,030 and 1,260 feet below ground level. Within the dolomite unit at depths between 1,130 and 1,160 is a dark, granular, gravel-like dolomite "rubble" zone. This zone, also described by Stewart (1966) in Polk County, contains abundant solution features and fractures commonly lined by coarse to fine well-developed crystals. The basal unit of the Avon Park Limestone is dominantly limestone and very similar to the underlying Lake City Limestone except

for an absence of evaporite material. Total thickness of the Avon Park Limestone at the project site is about 650 feet.

Ocala Group

In Polk County, the Ocala Group as described by Stewart (1966) includes three formations. In ascending order these are: (1) the Inglis formation; (2) the Williston formation, and (3) the Crystal River formation.

The Inglis formation in Polk County is a white to cream to dark brown, generally hard to very hard, granular, partially to highly dolomitized, highly fossiliferous limestone with local soft chalky zones. This member is 75 feet thick in parts of Polk County (Stewart, 1966). At the CF Industries site in northwestern Hardee County, the lithology of the Inglis formation is similar to that described by Stewart in Polk County. The Inglis unconformably overlies the Avon Park Limestone and is present between depths of 830 and 940 feet below ground surface. Total thickness of the Inglis is about 110 feet.

Overlying the Inglis formation in Polk and Hardee Counties is the Williston formation which consists of white to cream to brown, generally soft, coarse limestone with coquina of foraminifera set in a chalky, calcite matrix (Stewart, 1966). The lower 5 to 15 feet are usually harder than the rest of the member due to dolomitization. Thickness of the Williston in Polk County ranges from 10 to 100 feet and averages about 30 feet. At the CF Industries site in Hardee County, the Williston formation was observed between depths of 770 to 830 feet for a thickness of about 60 feet.

The Crystal River formation as described by Stewart (1966) and as observed at the project site in Hardee County is a white to tan, medium grained to chalky limestone with large foraminifera common. The thickness in the project area is about 95 feet between depths of 675 and 770 feet below ground surface.

4.1.2.2 OLIGOCENE SERIES

Suwannee Limestone

In nearby Polk County, the Suwannee Limestone which overlies the Ocala Group is a white to cream or tan, generally very soft, granular, detrital limestone which is generally very pure. It contains abundant bryozoa, small mollusks and large echinoids (Stewart, 1966).

In northwestern Hardee County, the Suwannee Limestone is a white to very light brown limestone with fine to coarse grained carbonate grains in a carbonate matrix. Echinoid fragments are common. Wilson (1975) states that the contact between the Suwannee Limestone and the overlying Tampa Limestone can often be identified on gamma logs by the marked decrease of gamma-ray intensity in the Suwannee Limestone. This was observed on gamma logs from the Deep Floridan Test Hole at about 467 feet below ground surface. The thickness of the Suwannee Limestone at the project site is, therefore, about 208 feet.

4.1.2.3 MIOCENE SERIES

Tampa Formation

Stewart (1966) describes the Tampa formation in Polk County as a calcareous clay with occasional beds of white to gray sandy limestone. Wilson (1975) uses the name Tampa Limestone and describes an upper limestone which he does not differentiate from limestone in the overlying Hawthorn formation and a lower sand and clay unit.

In the Deep Floridan Test Well at the CF Industries project site, the Tampa formation was observed between depths of 370 and 467 feet below ground surface. The formation consists of two units. These are an upper limestone unit and a lower sand and clay unit. The upper contact with the Hawthorn formation is determined on the basis of a distinct lithic change from a sandy, clayey, phosphatic limestone of the Hawthorn formation to a relatively pure, slightly sandy and slightly phosphatic, fossiliferous limestone of the Tampa formation. This contact was observed in drill cutting and on gamma logs and occurs at about 370 feet below ground surface. The thickness of the limestone

unit is 61 feet at the Deep Floridan Test Well. The lower unit of the Tampa formation is a dark greenish gray sandy clay. The upper few feet of the clay are silicified. The top of the lower unit is placed at 431 feet below ground surface which indicates a thickness of 36 feet for the sand and clay and a total of 97 feet for the Tampa formation at the project site.

Hawthorn Formation

Overlying the Tampa formation is the Hawthorn formation which has been described by Stewart (1966) in Polk County as consisting of interbedded sandy limestones and sandy clays which are not individually distinctive. The clays are soft, sandy, phosphatic and usually a gray to dark bluish or greenish gray. The limestone beds are light cream to yellow or tan, very hard to soft, very sandy, clayey and phosphatic.

In the Deep Floridan Test Well, the Hawthorn formation was observed between depths of 43 to 370 feet below ground surface. The formation consisted of yellowish gray grading to medium gray to very light gray, fine gained, indurated to very soft, pure to abundantly phosphatic and sandy limestone. The clay content increased with depth becoming very clayey in the lower portion. Chert also occurs scattered through the lower portion.

4.1.2.4 PLIOCENE TO RECENT - UNDIFFERENTIATED CLASTICS

Wilson (1975) divides the material above the Hawthorn limestone into three units: a phosphatic unit, a shell and sand unit, and an upper sand unit. The combined thickness of these average 40 feet in DeSoto and Hardee Counties.

At the CF Industries site in northwestern Hardee County, the combined thickness of the undifferentiated clastics is variable as is the thickness or presence of the individual units. In the Deep Floridan Test Well, 43 feet of light gray to yellowish gray, phosphatic sandy clay was observed overlying the Hawthorn limestone. The average

thickness over the project area is approximately 32 feet. The results of exploratory drilling on the property have been summarized by CF in Figure 4.1-5 which shows the thickness between the base of the ore zone and the top of the limestone.

Because of the extensive geologic information available from previous studies, on-site geologic investigations for the EIS were limited to a series of six shallow core borings (approximately 50 feet deep) drilled in the study area. As shown in Figure 4.1-6, a general geologic cross section of the upper undifferentiated clastics on Complex II was developed from these borings.

4.1.3 SITE-SPECIFIC DESCRIPTION--SOILS

A detailed description of the soils on the CF property was developed in the Application for Mineral Extraction (1976) and the CF DRI (1976). The following section has been taken from these sources and discusses the entire CF property, and does not differentiate between Complex I (the existing mine) and Complex II (the study area). The maps included also show both Complex I and Complex II undisturbed, even though Complex I is presently an active mining area.

The site area is characterized by low topographic relief, localized depressional marshes, and frequent occurrence of swamps. Along the more developed streambeds, slopes increase to 4 and 5 percent.

The surficial soils (the top 60 to 80 inches) can be divided into three basic groups which correspond closely to vegetative types and landforms. These are: soils formed on the broad upland flats; soils near and around the marshes and swamps; and those formed in the marshes and swamps.

The high amount of rainfall in the site area causes intensive leaching of the surficial soils. As a result, the soils are generally acidic and often contain layers of organic matter and clay which have translocated

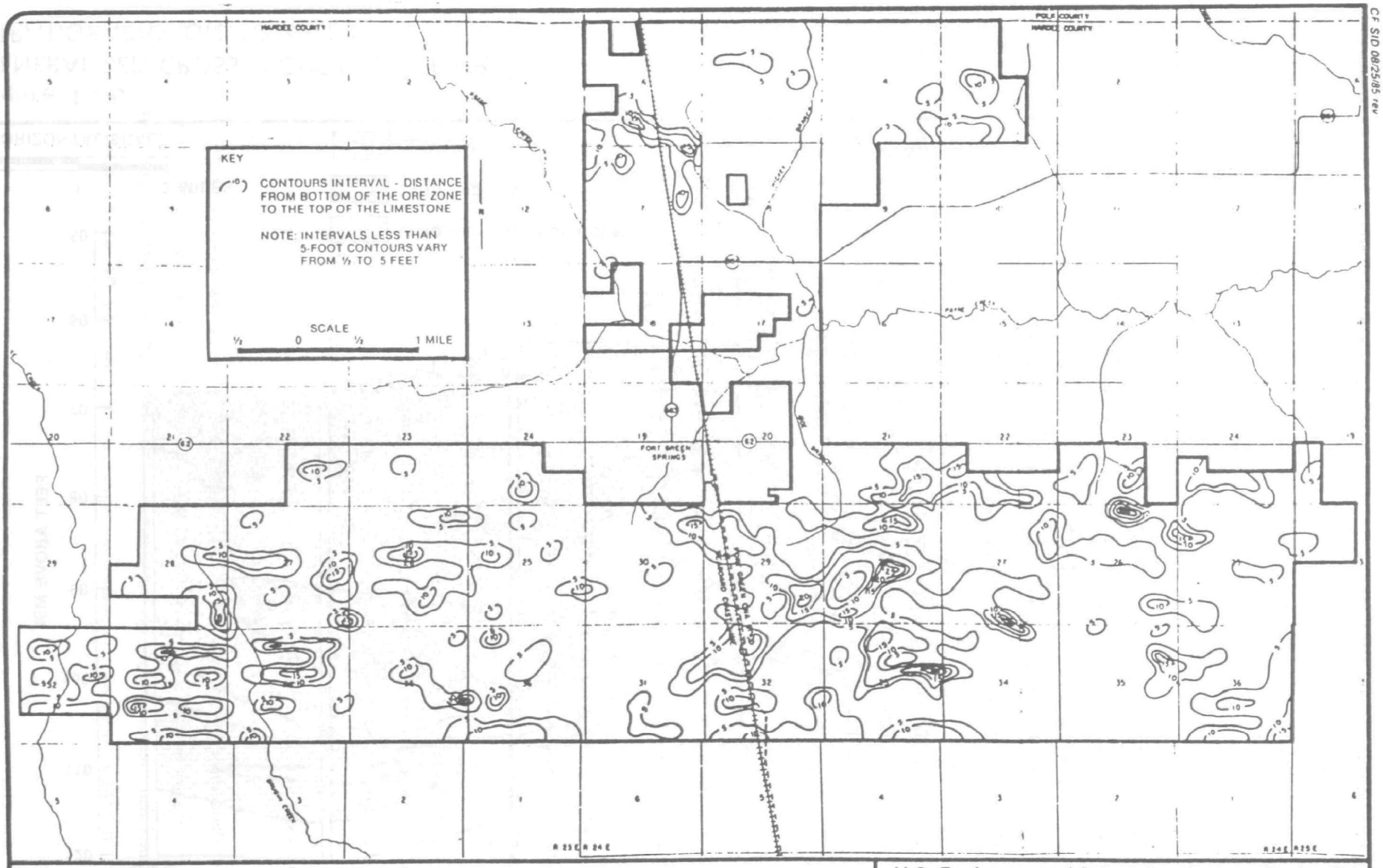

Figure 4.1-5
ISOPACH MAP SHOWING THICKNESS OF MATERIAL BETWEEN ORE ZONE AND HAWTHORN LIMESTONE

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex

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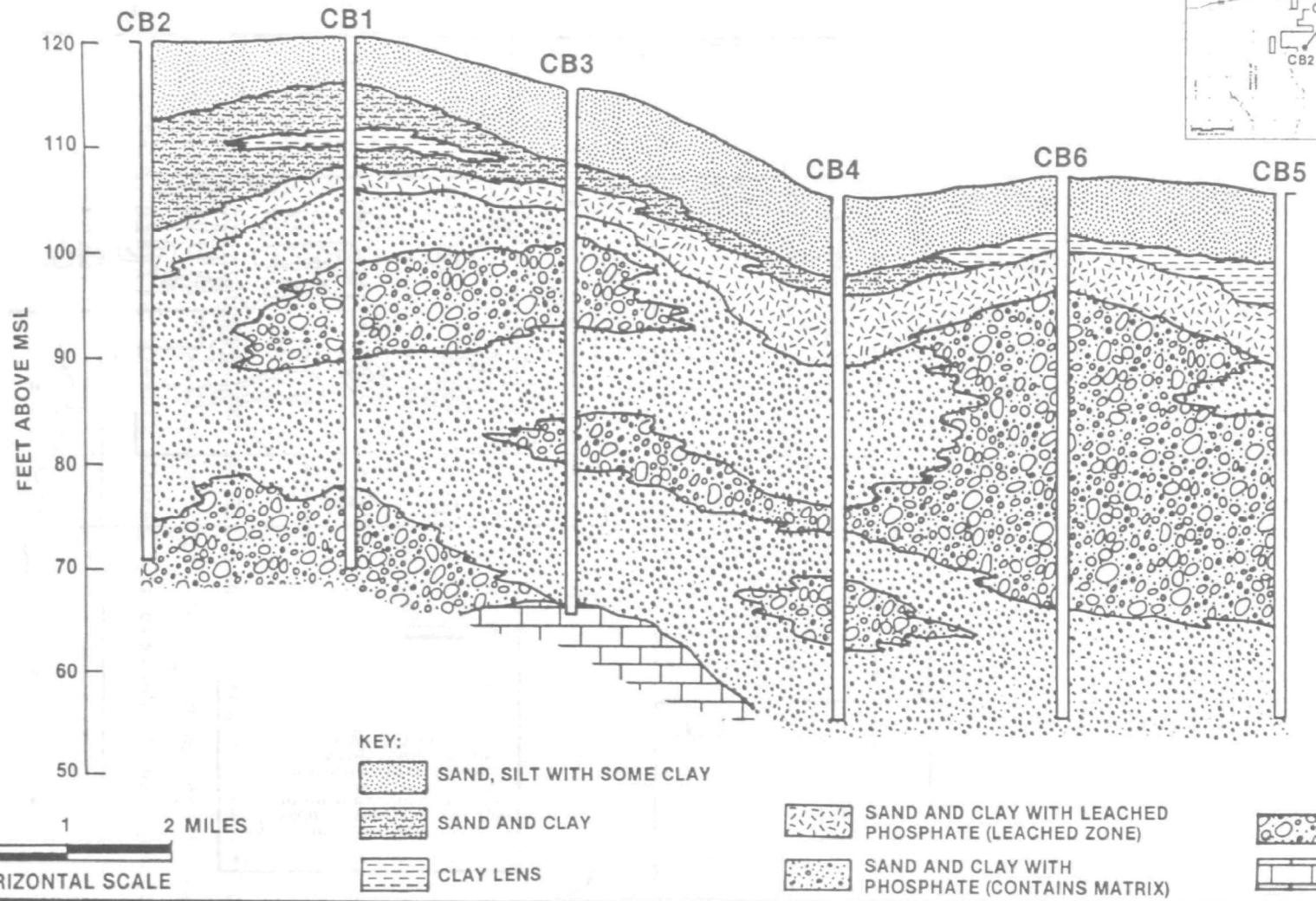

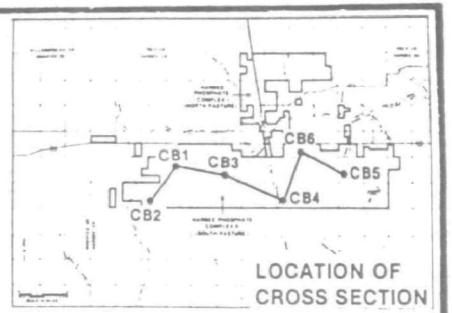

Figure 4.1-6
GENERALIZED CROSS SECTION OF UPPER STRATIGRAPHY ON COMPLEX II

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

downward into the soil profile. This intensive leaching creates nutrient deficient soils that must be fertilized prior to utilization for agricultural purposes. A soils series map of the CF site is provided in Figure 4.1-7. Characteristics of each unit are summarized in Table 4.1.3-1. For more information on soils in general see Brady (1974); for descriptions of soils of this area see Leighty and others (1958), Furman (1975), and Caldwell and others (1958), and SCS Interim Soil Survey for Hardee County (1979).

4.1.3.1 METHODS OF INVESTIGATION

The southern portion of the site west of the rail line (Figure 4.1-7) was surveyed by the United States Department of Agriculture Soil Conservation Service as part of a conservation farm plan developed for the Stuart Brothers, former owners of the land. Most of the remaining site areas were surveyed by qualified soils scientists. However, one small area that was not planned for mining was not surveyed because of inaccessibility. Soil-landscape-vegetation relationships and associations on previously surveyed areas were used as a basis for differentiating soils in previously unmapped areas. This study was supplemented by field reconnaissance. Hand auger samples were used to verify areas of uncertain soils composition. Since the on-site soils investigations were conducted in 1976, the SCS has published an Interim Soil Survey for Hardee County. This 1979 survey was used to update soil series for two of the soils found on the CF site (i.e., Pamlico muck and swamp were updated to Tomoka muck and Delray mucky fine sand depressional, respectively).

4.1.3.2 DESCRIPTION OF SOILS

Predominant soils on the property are the Myakka fine sand and the Myakka fine sand-thin surface. In general, these soils underlie the flat, broad upland areas called flatwoods. Other soils commonly associated with upland areas are the Immokalee, Wabasso, and Wauchula. All of these soils are highly leached, moderately wet, and strongly acid. They have a thin surface horizon underlain by a bleached horizon. At depths from 15 to 40 inches, a layer of accumulated organic matter

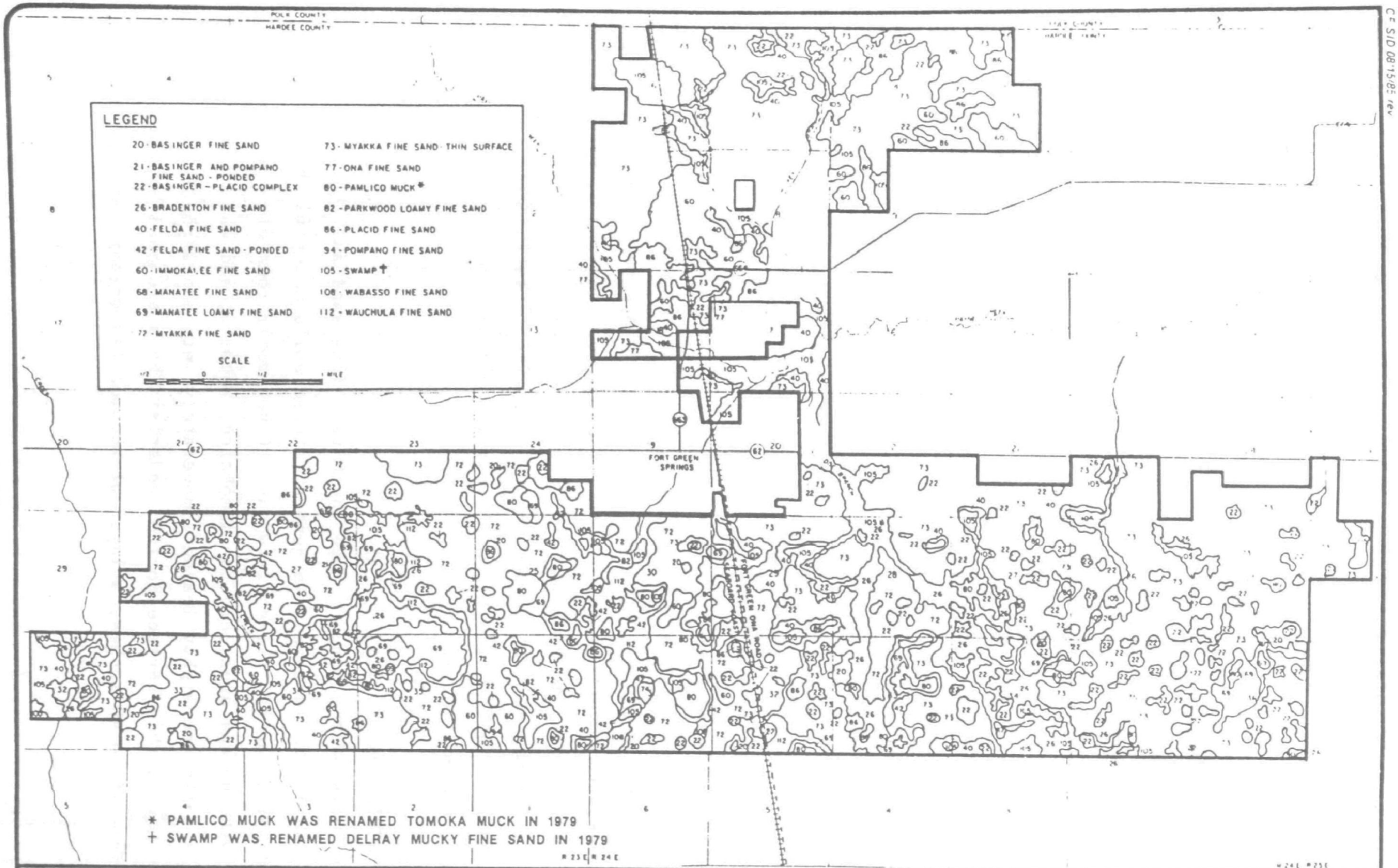

Figure 4.1-7
RECONNAISSANCE SOIL SURVEY MAP OF SITE

SOURCE: DAMES & MOORE, CF DRI, 1976.

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex

Table 4.1.3-1. Characteristics of Site Soils

Soil Type	Number	Landscape Position at the Site	Drainage	Texture (USDA) Surface	Texture (USDA) Subsoil	Dust Potential*	Erosion Potential*	Depth to Bedrock†	Permeability (in./hr.)†**	Wet Season Elevation†† (in feet)	Water Table Duration† (in months)	Presumptive Bearing Value*††	Reservoir Embankment Suitabilities†††
Basinger	20	Grassy marshes	Poor	Fine sand	Fine sand	Low	Low	>60"	>20	+2 to -1	June-Feb	Dry-high Wet-low	Very poor
Bradenton	26	Low lying hummock areas	Poor	Fine sand	Fine sandy loam	Low	Low	>60"	0.6-20	+1 to -1	June-Feb	Dry-high Wet-low	Very poor
Felda	40	Areas near marshes -depressions	Poor	Fine sand	Sandy loam; sandy clay loam	Low	Low	>60"	0.6-20	+2 to -1	June-Feb	Dry-high Wet-low	Moderate
Immokalee	60	Near centers of flat high areas	Poor	Fine sand	Fine sand	Low	Low	>60"	0.6-20	0 to -1	June-Oct	Dry-high Wet-low	Very poor
Manatee	69	Level depressional marshes	Very poor	Loamy fine sand	Fine sandy loam	Moderate	Low	>60"	0.6-20	+1 to -1	June-Mar	Dry-high Wet-low	Very poor
Myakka	72	Level flat high areas	Poor	Sand	Sand	Moderate-Low	Low	>60"	0.6-20	0 to -1	June-Oct	Dry-high Wet-low	Very poor
Ona	77	Level flat areas around marshes	Poor	Fine sand	Fine sand	Moderate-Low	Low	>60"	0.6-20	0 to -1	June-Nov	Dry-high Wet-low	Very poor
Pamlico	80	Marshes	Very poor	Muck	Loamy sand	High	Wind-high Water-low	>60"	0.6-20	+1 to -1	June-Apr	Low	Very poor
Parkwood	82	Flat areas bordering marshes	Poor	Fine sand	Loamy fine sand	Low	Low	>60"	2.0-20	0 to -1	June-Oct	Dry-high Wet-low	Moderate-Very poor
Placid	86	Level depressional marshes	Very poor	Fine sand	Fine sand	Moderate	Low	>60"	6.0-20	0 to -1	June-Feb	Dry-high Wet-low	Very poor
Pompano	94	Flat areas bordering marshes	Poor	Fine sand	Fine sand	Low	Low	>60	>20	0 to -1	June-Nov	Dry-high Wet-low	Very poor
Swamp	105	Depressed swamps and along streams	Very poor	Muck and sand	Fine sand	None	None	>60"	>20	+2 to -1	9-12 mos.	Low-none	Very poor
Wabasso	108	Flat areas bordering marshes	Poor	Fine sand	Fine sand	Low	Low	>60"	0.6-20	0 to -1	June-Feb	Dry-high Wet-low	Very poor
Wauchula	112	Flat areas bordering marshes	Poor	Fine sand	Fine sandy loam	Low	Low	>60"	0.6-20	+1 to -1	June-Oct	Dry-high Wet-low	Very poor

* Personal communication, Lindo Bartelli, Head of Soil Survey Interpretations, USDA, Soil Conservation Service, Washington, D.C.

† Derived from USDA Soil Conservation Service soil series descriptions and soil survey interpretation sheets. Bedrock is defined as the solid rock that underlies the soil and other consolidated material.

** Values denote ranges for the entire soil profile.

†† Elevation is with respect to ground surface.

*** High = greater than 2000 psf; Low = less than 2000 psf.

††† Surficial soils will be modifed by construction procedures to meet engineering design criteria prior to construction.

Source: ESE, 1984.

and mixed iron and aluminum materials is present. Agricultural productivity of the flatwoods soils is limited by wetness. These soils are not suitable for cultivation unless some kind of water control is practiced. Even then, the potential productivity of vegetables or improved pasture is medium and the potential productivity of citrus is low. The potential productivity of pine plantations is moderately high when water control practices are used. These soils cover approximately 62 percent of the CF property.

Soils found primarily in the flat uplands surrounding the marshes and swampy areas are estimated to cover approximately 5 percent of the property and include the Felda, Manatee, Ona, Parkwood, and Pompano soils. Soils in this group are neutral to slightly acid and are somewhat less leached than those found in the flatwoods areas. They lack an organic pan within the profile but are often underlain by calcareous clayey materials. Productivity of the soils found on the flat uplands surrounding the marshes is similar to the potential productivity of the flatwoods soils.

Soils formed in marshes and swampy areas comprise approximately 33 percent of the property. The marshes are grassy depressions which are covered with water during the wet season. During the dry season, the water table in the marsh areas lowers to the soil surface, or is just below it. Marsh soils comprise 20 percent of the property, and are dominated by the Basinger, ponded Felda, Placid, and Pompano series. The swampy areas which are covered with water throughout most of the year, comprise 13 percent of the property. They are hummocky, covered with oak vegetation, and are represented by Bradenton, Tomoka muck (prior to 1979, name was Pamlico Muck), and Delray (prior to 1979, name was swampy soils) mucky fine sand soils. These soils are generally dark colored, often calcareous at the surface, and in low areas have an organic layer varying in thickness from 2 to 30 inches.

Productivity of the soils in the marsh and swamp areas depends on the length of time the soils remain under water and/or the ability to drain the soils. The soils that are flooded by nearby streams are unsuitable for citrus or cultivated crops unless the flood waters can be controlled. These soils do, however, have a high potential for pine plantations. The soils that are flooded by a rising water table are not suitable for pine plantations and sometimes are not suited to growing cultivated crops. The soils in the depressions are difficult to drain because of the lack of suitable outlets for water flow. These soils have a high potential for range because the periodic high water naturally restricts grazing, increasing productivity.

Dust Potential of the Soils

The dust potential of the soils is dependent on a number of factors. These include particle size and organic matter content, soil moisture levels, extent of vegetative cover, soil surface condition (smooth versus rough), and wind velocity and turbulence. Table 4.1.3-1 gives the rating for dust potential of each soil series of the CF property. These ratings show that erosion potential is moderate to low for all soils except Pamlico muck.

Evidence of severe wind erosion such as sand build-up along fence rows and windbreaks and accumulation in ditches was not observed in significant quantities on the site. Low dust potential is charactistic of most of the site soils due to the low organic matter, clay, and silt content. However, dust and wind erosion may result when some soils on the site are dry and exposed for some time. Soils susceptible to erosion under these conditions are those with high levels of organic matter and a deep surface horizon. Pamlico muck, if exposed and dry, is the only soil on the site with high dust potential. Manatee, Myakka, Ona, and Placid soils have moderate to low dust potential when exposed and dry. These last soils all have dark colored surface horizons at least 6 inches thick. It should be emphasized that these soils blow only if dry and exposed.

Erosion Potential of the Soils

In the undisturbed state, soils on the site have a low erosion potential (Table 4.1.3-1) due to the flat topography, the sandy nature of the soils, and the presence of good vegetative cover.

The entire CF site is characterized by low topographic relief. This inhibits rill or gully erosion because of relatively slow water movement from the area.

Soil structure is important in reducing erosion, but not necessarily in all cases. Soils of the property are characterized by high rates of infiltration due to their sandy texture. This increased infiltration reduces run-off considerably. The coarser soil particles typical of the CF site will not become suspended readily and will be transported for much shorter distances than clay or silt particles.

Depth to Bedrock

Borings indicate that the Hawthorn formation (Bedrock) is overlain by an average of 10 to 50 feet of recent undifferentiated clastics. Bedrock is defined as the solid rock that underlies the soil and other consolidated material.

Permeability

Permeability is a measure of the rate at which water will pass through soil under saturated conditions. Typical permeabilities for soils found at the site (Table 4.1.3-1) range from 0.6 to 20 inches per hour for the entire surface profile. The Florida Agricultural Experiment Station has measured the permeability for specific soil layers. These data, expressed as hydraulic conductivity (Table 4.1.3-2) range from 0.03 to 20 inches per hour. The lower permeabilities are the result of a higher fraction of silt and clay sized particles.

Presumptive Bearing Value

For sandy soils such as those found on the site, natural bearing values are high when soils are dry (over 2,000 psf), and become low when soils

Table 4.1.3-2. Hydraulic Conductivity Values for Soils of the Site*

	Depth	Hydraulic Conductivity Inches/Hour
Basinger	0 - 36"	15
	36 - 72"	6
Bradenton	0 - 20"	7
	20 - 72"	0.03
Felda	0 - 36"	7
	36 - 94"	0.03
Immokalee	0 - 42"	15
	42 - 54"	2
	54"+	20
Manatee	0 - 18"	7
	18"+	2
Myakka	0 - 27"	7
	27 - 36"	1
	36 - 50"	4
Ona	0 - 6"	8
	6 - 18"	2
	18 - 72"	5
Parkwood	0 - 8"	2
	8 - 24"	1
	24"+	5
Placid	0 - 72"	20
Pompano	0 - 72"	20
Wabasso	0 - 27"	12
	27 - 36"	0.3
	36"+	0.2
Wauchula	0 - 30"	7
	30 - 36"	0.2
	36 - 48"	4
	48"+	0.05

* These values were measured by the Florida Agricultural Experiment Station for soil types found on the site. These are the laboratory results of field samples analyzed at saturated test conditions. Undisturbed soil was sampled directly in the field in southern Florida on identified soil types and tested in the laboratory. The results represent the rate at which water will flow through soil layers under saturated conditions. Uniform soil layers, or horizons were identified and tested rather than arbitrarily testing at selected depths.

Personal communication, Luther Hammond, Professor of Soil Physics, Department of Soil Science, University of Florida, Gainesville, Florida.

Source: CF APME, 1976.

are saturated (less than 2,000 psf) (Table 4.1.3-1). These soils are suitable for roads, low buildings, and other foundations if adequately drained.

The presumptive bearing value does not consider engineering preparation of the in situ soils or the type of foundations to be constructed. Bearing values for prepared foundations in upland areas can be expected to be greater than 2,000 psf for most footings. The bearing value of the soils in marshy and swampy areas is very low. Soils with high organic content will be removed and replaced with suitable soils prior to construction.

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5.0 RADIATION

5.1 THE AFFECTED ENVIRONMENT

5.1.1 REGIONAL DESCRIPTION

Man has been subjected to radiation from naturally occurring radionuclides throughout his existence on earth. The primary nuclides contributing to this background dose level on a worldwide basis are potassium-40 and nuclides of the uranium-238 and thorium-232 decay chains (EPA, 1972). These nuclides are contained in varying concentrations in the earth's crust and in surface and ground waters. In Florida, the nuclides of the uranium-238 series are the primary source of natural radiation.

The phosphate deposits of Florida contain concentrations of uranium, and its decay products, at levels approximately 30 to 60 times greater than those found in average soil and rock throughout the rest of the United States. Uranium is found both in the phosphate matrix and in the overburden in the region, although concentrations in the matrix are higher and more uniform. The natural radiation levels experienced at the surface due to radioactive materials in the phosphate matrix vary with variations in matrix depth and in overburden composition.

The act of mining and processing phosphate changes the physical form, location, and concentration of naturally occurring radioactive materials. Phosphate mining operations have the potential to increase direct human exposure to naturally occurring radioactivity. The mining, transportation, and processing of the phosphate matrix and overburden can increase exposure by releasing some of these naturally occurring radioactive materials as gases, airborne particulates, or waterborne effluents.

The Areawide EIS (EPA, 1978) presented a detailed discussion of radioactivity in the central Florida phosphate area, and its potential

environmental effects. The conclusion of that study was that the radioactive isotopes of environmental importance in the study area are those in the uranium-238 decay series. This conclusion is based upon their abundance in the matrix and soils, their potential for transport, and their potential for accumulation in human tissue. A detailed discussion of the distribution and effects of these isotopes is presented in the following sections.

5.1.1.1 URANIUM, RADIOISOTOPES AND EXPOSURE

Uranium has two naturally occurring isotopes, uranium-238 and uranium-235. The uranium-238 series has a longer half-life and accounts for 99.28 percent of the naturally occurring uranium. Almost all naturally occurring radiation in the phosphate deposits is associated with uranium and its decay products. Although thorium-232 represents the parent radionuclide of another naturally occurring series, the concentration of thorium in Florida formations is very small compared to uranium.

Specific data on thorium-232 in Florida phosphate-associated media are found in an EPA technical note (EPA, 1975) and in direct correspondence with several phosphate companies after EPA reconnaissance trips in 1974 (Windham, 1974). These data indicate the uranium/thorium ratio (in terms of pCi/g) to be about 90 for marketable rock, 30 for clays and 60 for air particulate samples. Any single ratio may have considerable error since the low values for observed thorium concentrations had high associated errors ($\pm$30 percent). Guimond (1977) shows that thorium-232 radioactivity concentrations in marketable phosphate rock from the study area are two orders of magnitude less than those of natural uranium. Habashi (1966), in using scintillation spectrometry to study radioactivity in phosphate rock, detected no peaks due to thorium or its decay products in phosphate rock samples from Florida, indicating the virtual absence of this particular radionuclide in the samples studied. It is evident that, on an activity basis, thorium contents in the Florida phosphate areas are nearly two orders of magnitude lower

than the world average. Thorium is, therefore, not discussed further in this report.

In the uranium-238 decay series, decay proceeds from U-238, through 13 intermediate daughter radionuclides until the stable nuclide, Pb-206, is reached. This decay series and the associated half-lives are shown in Figure 5.1-1. If the entire series is contained in a sealed environment, a state of equilibrium is reached for the entire series. In undisturbed phosphate deposits, such an equilibrium exists at least for the radionuclides through radium-226. This equilibrium is maintained only if the materials are undisturbed. Mining and processing represent significant disturbances to this equilibrium.

The radionuclides in the uranium decay series which are of greatest importance to human exposure are radium-226, its decay product radon-222, and the radon daughters polonium-218, lead-214, bismuth-214, and polonium-214. These six radionuclides are responsible for the majority of human exposure to radioactivity in phosphate mining and processing.

Radium-226 is of particular interest with respect to human exposure, as it is chemically similar to calcium and tends to be incorporated in the same way as calcium in bone and other biological material. Radium's chemical similarity to calcium is also demonstrated by its tendency to replace calcium in primary phosphatic apatite. Radium-226 has a relatively long half-life (1,620 years) and may enter the body through contaminated drinking water or by breathing suspended particulates contaminated with radium. EPA (1975) limits the total radium concentration (Ra-226 plus Ra-228) in drinking water to less than 5.0 pCi/1.

Radium-226 decays to radon-222, an inert gas. The decay equilibrium from Ra-226 to Rn-222 is largely dependent upon the mobility of gas out of the soil and into the atmosphere. In natural undisturbed conditions, most Rn-222 does not escape the matrix strata.

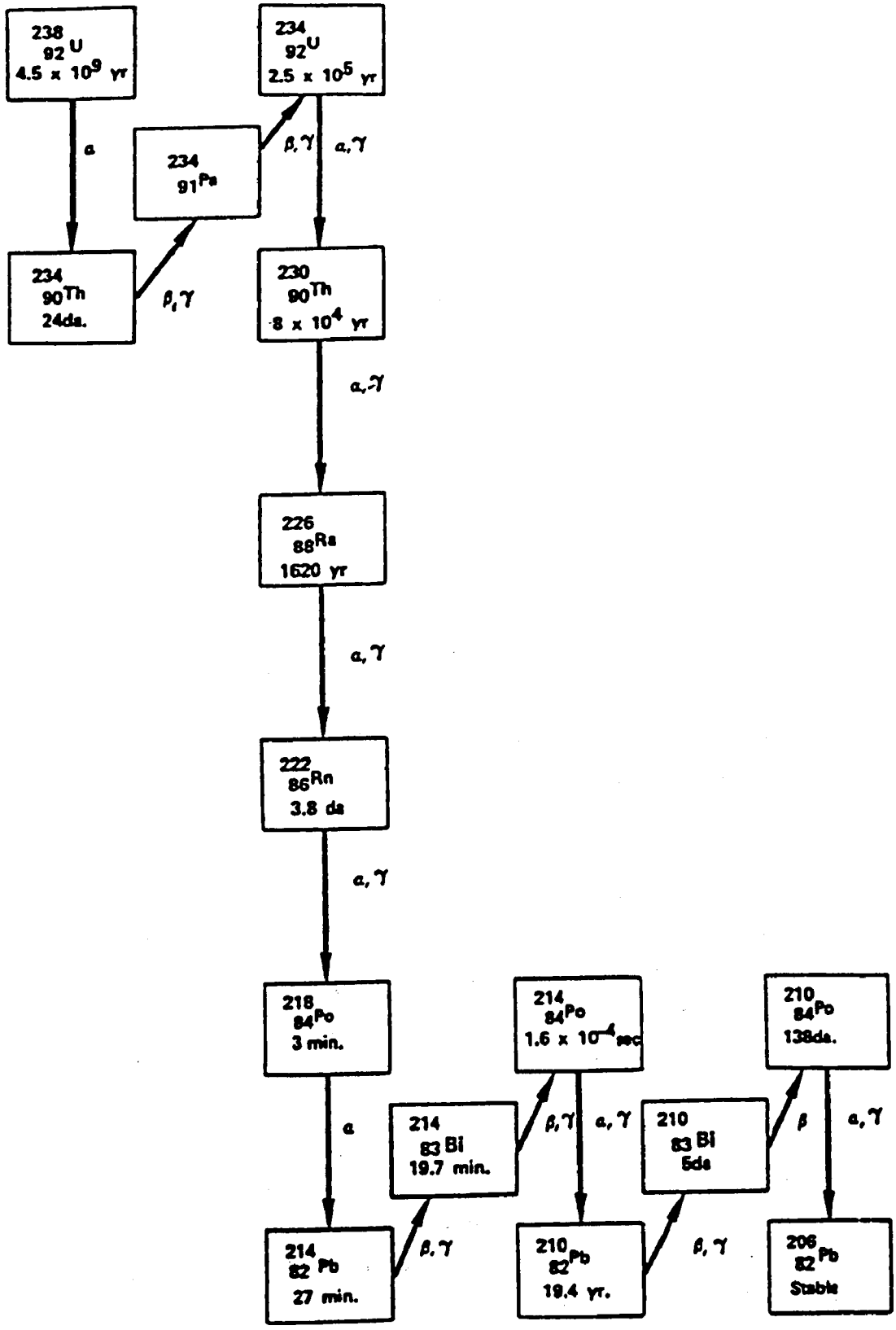

Figure 5.1-1
URANIUM-238 DECAY SERIES

SOURCE: BOLCH, 1979.

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Draft Environmental Impact Statement

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Hardee Phosphate Complex II

Rn-222 and its daughters are of special concern because of the potential mobility of Rn-222 (as a gas) from the environmental media. Once in the atmosphere, radon-222 can be inhaled and thus can increase the exposure to lung tissue. Although not gaseous, the radon daughters enter the body primarily throughout the inhalation of respirable particles formed in the decay of gaseous, airborne radon-222. These radon daughters therefore increase the exposure to lung tissue.

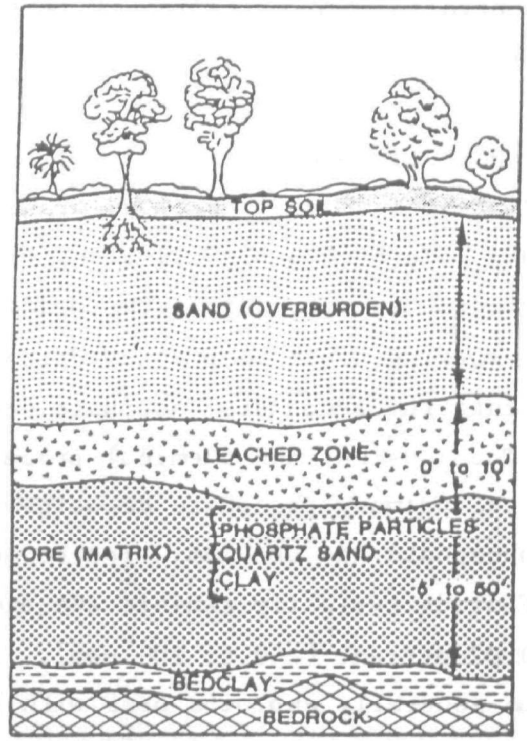
The radionuclides U-238, U-234, Th-230, Ra-226, and Po-210 are all long-lived radionuclides that could become airborne in dusty operations or by other mechanisms. If not controlled, these radionuclides have the potential to be health hazards.

5.1.1.2 RADIOISOTOPES AND PHOSPHATE DEPOSITS

Previous studies (EPA, 1978) have indicated that the uranium present in central Florida phosphate may have been deposited along with the primary deposits of the phosphate mineral apatite during the Middle Miocene epoch. During subsequent reworking of these primary deposits, the phosphate was concentrated into the secondary phosphate deposits now found in central Florida. The physical and chemical processes associated with the reworking of the primary phosphate deposits resulted in the concentration of both phosphate and uranium. The secondary phosphate deposits of central Florida typically exhibit average uranium concentrations of 0.01 to 0.02 percent (100 to 200 ppm). In contrast, commercial mining of uranium generally exploits ores with uranium concentrations 10 to 20 times higher (0.1 to 0.4 percent). Most other minerals in the phosphatic matrix have maximum concentrations of only a few parts per billion (EPA, 1978).

The structure and uranium content of a typical cross section in the central Florida phosphate area is shown in Figure 5.1-2. Representative radium-226 concentrations for various soils, phosphate materials, effluents, and ground waters are summarized in Table 5.1.1-1. Radioactivity levels are typically at minimum levels at the ground surface

AVERAGE URANIUM CONCENTRATIONS AS U_3O_8 IN TYPICAL CENTRAL FLORIDA PHOSPHATE DISTRICT PROFILE



*ppm = Parts Per Million

Figure 5.1-2
AVERAGE URANIUM CONCENTRATIONS AS U_3O_8 IN TYPICAL CENTRAL FLORIDA PHOSPHATE DISTRICT PROFILE

SOURCE: EPA, 1978.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

Table 5.1.1-1. Representative Radium-226 Concentrations in Central Florida Phosphate Area Environment

Item	Radium Concentration
Overburden (excluding leach zone)	10 pCi/g
Leach zone materials	40 pCi/g
Matrix	40 pCi/g
	60 pCi/g
Background soil	1.5 pCi/g
Reclaimed soil	10-30 pCi/g
Silt	1.1 pCi/g
Beach sand	0.9 pCi/g
Wet phosphate rock	29-34 pCi/g
	42 pCi/g
Sand tailings	7.5 pCi/g
	6.2-8 pCi/g
Slime particles	45 pCi/g
	33-52 pCi/g
Slime decant water (dissolved fraction)	1-2 pCi/l
Slime decant water (undissolved fraction)	33.5-52 pCi/g
Mine water	<1.5 pCi/l
Ground water	<1.5 pCi/l
Slime-pond water	<2 pCi/l
Leachate from gypsum pond	60-100 pCi/l
Gypsum	21-33 pCi/l
Phosphate products (undifferentiated)	42 pCi/g
Phosphoric acid plant effluent after double liming	1.8-4.5 pCi/l
Slag from calcination processes	56 pCi/g
Water-table water (mineralized mined areas)	0.55 pCi/l
Upper Floridan water (mineralized mined areas)	1.61 pCi/l
Lower Floridan water (mineralized mined areas)	1.96 pCi/l
Ammonium phosphates	5-6 pCi/g
Superphosphates	21 pCi/g
Phosphoric acid	<1 pCi/l
Animal feed supplements	5-6 pCi/g

Source: U.S. Environmental Protection Agency, 1978.

and increase with depth. Overburden soils are generally mixed layers of sands and clays exhibiting low concentrations of radionuclides.

The leach zone, also known as the aluminum phosphate zone, consists of a discontinuous zone of altered, friable phosphatic sandstone and is considered to be the upper part of the Bone Valley formation. It is the result of water movement through a calcium phosphate zone, converting it to aluminum phosphate. As a result, the leach zone contains radioisotopes at levels comparable to those which are observed within the calcium phosphate matrix zone (the lower Bone Valley formation). Locally, radioisotope levels in the leach zone may be either higher or lower than the underlying matrix. As the aluminum is considered to be an undesirable contaminant in the phosphate rock product, the leach zone is usually not mined, in which case it is removed as overburden material. However, there are some instances in which the leach zone will be mined along with the matrix.

The matrix zone (the calcium phosphate zone) consists of apatite, montmorillonite and other clays, quartz, chert, and calcite, and is considered to be the lower part of the Bone Valley formation. After mining, the matrix is subjected to the beneficiation process to separate the phosphate rock product, the clay and the sand. Most of the uranium and uranium daughter products emerge from the beneficiation process in the phosphate rock product and the discarded clay-sized fraction, with relatively little radioactive material contained in the sand tailings. This distribution results because the radionuclides are contained primarily in the phosphate deposits. About two-thirds of the phosphate is contained in the rock product, and the remainder is entrained in the clay portion (Guimond, 1975).

5.1.1.3 BACKGROUND RADIATION

External gamma radiation levels in Polk County in the vicinity of phosphate beds have been measured and found to be on the order of 60 to 115 million-roentgens/year (mR/yr.) (Williams, 1965; Golden, 1960); these

measurements take into account cosmic radiation as well as gamma sources in the underlying soils. Florida readings agree closely with the approximately 105 mR/yr. gamma level average for the U.S. (EPA, 1972) of which about 45 mR/yr. is attributable to cosmic radiation, and the remainder to terrestrial sources. Both Florida and U.S. average levels yield doses which are well below the 500 millirems/year (mrem/yr.) limits for individuals in the general public, and are more than an order of magnitude below the limits for occupational exposure (NCRP, 1975).

5.1.2 SITE-SPECIFIC DESCRIPTION

To characterize the radiation which exists at the CF site, numerous site-specific studies were performed. These studies included sampling and analysis of external gamma radiation, surface materials, subsurface materials, ground water, and surface water. As part of CF DRI studies and continued monitoring work, the external gamma radiation has been measured on Complexes I and II from July 1976 through June 1982. As part of the EIS monitoring, surface materials were sampled and analyzed from six locations on Complex II in August 1981. Subsurface materials were composited over various depths at 6 bore holes on Complex II in September 1981. Ground water samples have been collected from shallow aquifer, secondary artesian aquifer, and Floridan Aquifer wells on Complexes I and II 11 times between February 1976 and September 1981. Surface water samples were collected quarterly on Complex I from January 1976 through March 1978 and monthly on Complexes I and II from July 1981 through June 1982. Four samples were also collected from mine discharge waters during EIS monitoring. Each analysis is described in further detail in the following sections.

5.1.2.1 EXTERNAL GAMMA RADIATION

External gamma radiation has been measured at the CF site using thermoluminescent dosimeters (TLDs). A total of 16 TLDs are scattered throughout the CF property, including 10 located in the Hardee Phosphate Complex II study area. Dosimeter locations are shown in Figure 5.1-3.

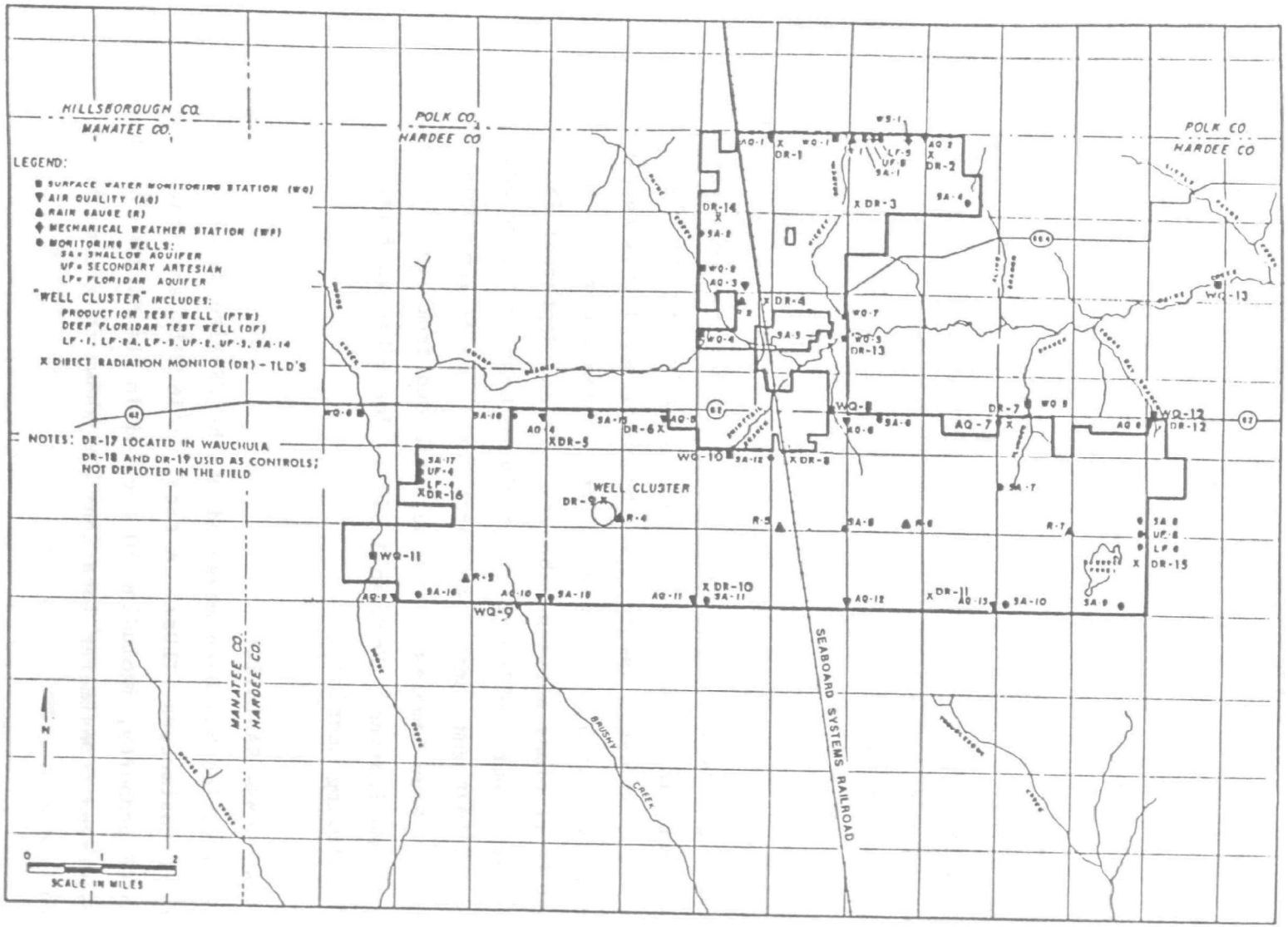


Figure 5.1-3
LOCATION OF ENVIRONMENTAL MONITORING STATIONS

SOURCE: Dames & Moore, CF DRI, 1979.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

CF SID 08/15/85 rev

In addition, one TLD was located in Wauchula and two TLDs were used as controls and were not deployed in the field.

Maximum external gamma radiation dosages encountered on the CF property are summarized in Table 5.1.2-1 for the period from third quarter 1976, through second quarter 1981. For the EIS study period (third quarter 1981, through second quarter 1982), gamma radiation dosages measured at all 17 TLD stations are summarized in Table 5.1.2-2.

Effective January 1, 1986, CF modified its environmental monitoring program after generating a 10-year data base. In this revised program, external gamma radiation measurements have been discontinued.

5.1.2.2 SURFACE MATERIALS

To characterize existing Ra-226 in surface soils and vegetation, one soil sample and two pasture grass samples were collected at six sites distributed in the South Pasture. Sample locations are shown in Figure 5.1-4. These samples were analyzed for Ra-226. In addition, stream sediment samples were collected at surface water quality stations WQ-2, WQ-3, WQ-5, WQ-8, and WQ-10. These samples were analyzed for Ra-226. The results of these analyses are presented in Table 5.1.2-3. All materials collected were observed to be extremely low to low in radium-226 content.

5.1.2.3 SUBSURFACE MATERIALS

To characterize the subsurface background radiation at the site, a series of six cores were drilled at representative locations over the undisturbed South Pasture Mine site (see Figure 5.1-4). These locations were selected in areas which have typical subsurface characteristics (i.e., soil types, matrix types, and overburden thickness).

Three to five composite samples from each core were collected from various depths from the land surface to the matrix. Typically, composite sample fractions were collected from the overburden, leach zone, upper matrix and lower matrix. These samples were analyzed for radium-226. The results of this sampling and analysis program are summarized in Table 5.1.2-4.

Table 5.1.2-1. Maximum External Gamma Radiation Dosage Encountered on CF Property

Quarter	Dosage, Millirems*					
	1976	1977	1978	1979	1980	1981
1	—	21	--	23	19	16
2	--	26	29	21	39	18
3	21	26	(†)	13	(†)	
4	31	29	25	21	33	

* Above data has been adjusted for shipping radiation and indicates yearly radiation dosage rate.
† Unable to adjust for shipping radiation during this quarter.

Source: CF Industries, 1982.

Table 5.1.2-2. External Gamma Radiation Measured by TLDs on CF Property From Third Quarter 1981 Through Second Quarter 1982

Station	External Gamma Radiation (MREM/Unit Period)			
	1981		1982	
	3rd Quarter (6/22/81 to 10/09/81)	4th Quarter (9/21/81 to 1/13/82)	1st Quarter (12/21/81 to 4/6/82)	2nd Quarter (3/22/82 to 7/12/82)
1	2.6	6.0	4.3	4.5
2	5.2	6.8	3.6	4.9
3	4.8	3.9	5.2	5.1
4	3.0	6.3	3.2	3.9
5	3.1	5.0	7.3	1.8
6	2.7	3.8	3.1	3.0
7	2.9	8.1	3.2	1.5
8	2.8	6.1	4.6	3.9
9	2.4	10.6	9.4	4.3
10	3.6	6.5	7.5	4.7
11	5.1	4.9	4.0	2.2
12	3.9	7.3	1.8	2.8
13	3.9	7.0	5.7	5.2
14	4.8	12.3	9.1	10.3
15	4.3	9.3	9.0	5.3
16	6.4	10.5	4.8	2.5
17*	1.9	5.8	10.4	4.7
Maximum Yearly Radiation Dosage Rate	21	39	32	33

*Located in Wauchula.
Above data have been adjusted for shipping radiation.

Source: CF Industries, 1982.

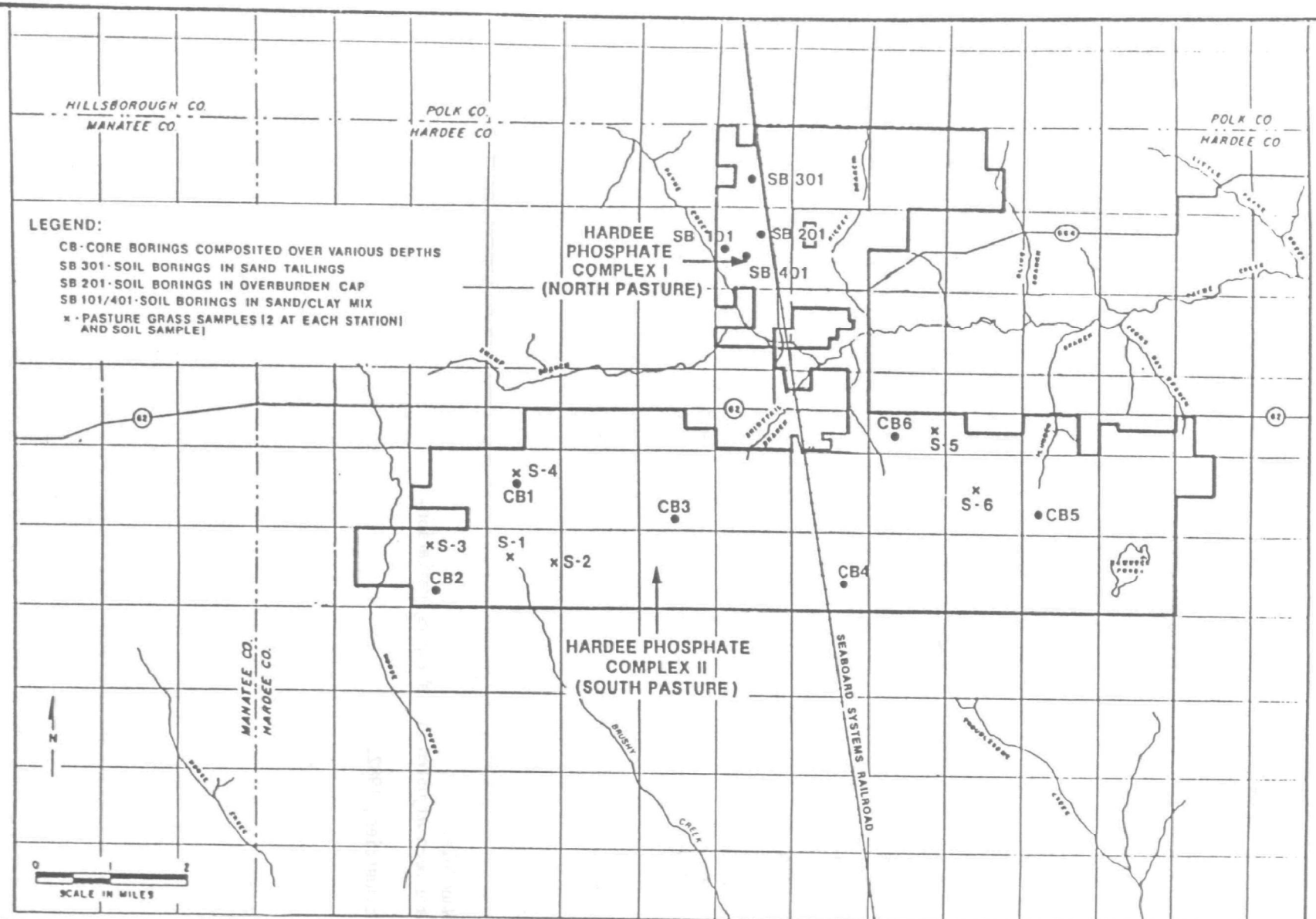


Figure 5.1-4
LOCATIONS OF CORE BORINGS, SOILS SAMPLES, AND PASTURE GRASS SAMPLES COLLECTED ON CF PROPERTY

SOURCE: ESE, 1982.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

Table 5.1.2-3. Radium-226 Analyses of Top Soil, Pasture Grass Samples, and Stream Sediments Collected from the CF Industries Property

Station	Radium-226 Content (Picocuries per gram)			
	Top Soil	Pasture Grass		Stream Sediments
		Sample #1	Sample #2	
S-1	0.6	0.2	0.2	--*
S-2	0.4	0.2	0.04	--
S-3	0.3	0.3	0.1	--
S-4	0.2	0.1	0.04	--
S-5	0.7	0.06	0.2	--
S-6	0.8	0.03	0.09	--
WQ-2	--	--	--	0.1
WQ-3	--	--	--	0.4
WQ-5	--	--	--	2.0
WQ-8	--	--	--	3.0
WQ-10	--	--	--	0.2

(See Figure 5.1-3 for locations of stream sediment stations.)
(See Figure 5.1-4 for locations of top soil and pasture grass stations.)

*-- Indicates analysis not applicable.

Source: ESE, 1982.

Table 5.1.2-4. Radium-226 Analyses of Core Samples Collected From the CF Industries Property

Proposed Site Station	Sample #	(Complex II) Description	Radium-226 Content (Picocuries per gram)
CB1	CB 101	Composite Overburden (0' to 7.5')	1
	CB 102	Leached Zone (12.5' to 14/5')	17
	CB 103	Matrix (18' to 31')	15
CB2	CB 201	Composite Overburden (0' to 6')	2
	CB 202	Composite Overburden (6' to 13.5')	9
	CB 203	Leached Zone (21.5' to 27')	23
	CB 204	Matrix (31' to 49')	23
CB3	CB 301	Composite Overburden (0' to 7.5')	0.4
	CB 302	Leached Zone (9.5' to 12')	23
	CB 303	Upper Matrix (15' to 19')	13
	CB 304	Lower Matrix (19' to 40')	10
CB4	CB 401	Composite Overburden (0' to 7.5')	0.4
	CB 402	Leached Zone (12' to 16')	7
	CB 403	Upper Matrix (16' to 22.5')	37
	CB 404	Lower Matrix (25' to 50')	6
CB5	CB 501	Composite Overburden (0' to 6.5')	2
	CB 502	Composite Overburden (6.5' to 10.5')	38
	CB 503	Leached Zone and Upper Matrix (10.5' to 2.8')	16
	CB 504	Lower Matrix (28' to 50')	6

Table 5.1.2-4. Radium-226 Analyses of Core Samples Collected From the CF Industries Property (Continued, Page 2 of 2)

Proposed Site Station	Sample #	(Complex II) Description	Radium-226 Content (Picocuries per gram)
CB6	CB 601	Composite Overburden (0' to 7.5')	0.8
	CB 602	Leach Zone (7.5' to 16')	43
	CB 603	Upper Matrix (20' to 39')	7
	CB 604	Lower Matrix (39' to 51.5')	19
Reclaimed Areas---Complex I			
SB1	SB 101	Sand/Clay Mix (0' to 1')	18
SB2	SB 201	Overburden Cap (0' to 4.8')	5
SB3	SB 301	Sand Tailings (0' to 4')	19
SB4	SB 401	Sand/Clay Mix (0' to 1')	31

(See Figure 5.1-4 for location of sampling stations.)

Source: ESE, 1982.

In addition, to assist in characterization of the expected radiation levels after reclamation, a series of four cores, varying from 1 to 4.8 feet deep, were collected from reclamation materials or reclaimed areas at the existing North Mine. Reclaimed materials sampled included sand/clay mix, sand tailings, and an overburden cap. Cores were observed to be relatively homogeneous and, therefore, only one composite sample from the entire core depth was collected. These samples were analyzed for radium-226 and the results are presented in Table 5.1.2-4.

At all six core sample locations on Complex II, the upper portions of the overburden (typically 0 to 6 feet in depth) were observed to have low (<2 pCi/g) radium-226 concentrations. Below that depth, higher radium-226 concentrations were observed in the deeper overburden material. Maximum radium-226 concentrations were typically observed in the leach zone and in the upper portions of the matrix. The observed concentrations and depth of radium-226 generally agreed with other profile data collected elsewhere in central Florida's phosphate area.

In the reclaimed areas, the observed radium-226 concentrations corresponded with the origin and type of material sampled. The overburden cap was observed to have the lowest and the sand/clay mix to have the highest concentration.

5.1.2.4 GROUND WATER

To characterize the existing Ra-226 in the shallow aquifer, secondary artesian aquifer, and Floridan Aquifer, samples were collected and analyzed routinely starting in February 1976. Samples were collected from ten shallow aquifer wells during February 1976, and from three secondary artesian wells and five Floridan Aquifer wells in May 1976. Sampling and analysis on seven shallow aquifer wells (SA-1 through SA-4, SA-6, SA-8, and SA-17) and three secondary artesian wells (UF-4, UF-5, UF-6) and five Floridan Aquifer wells (LF-4, LF-5, LF-6, PTW, and DF) was continued semi-annually through 1978 and was performed annually (April) during 1979, 1980, and 1981.

As part of the EIS monitoring program, shallow aquifer well SA-17, secondary artesian aquifer well UF4, and Floridan Aquifer well LF4 were sampled in September 1981 and analyzed for Ra-226 and gross alpha. The results of this extensive ground water sampling and analysis program are summarized in Table 5.1.2-5.

Shallow aquifer Ra-226 concentrations were observed to be low (almost always less than 1 pCi/l) with some spatial and substantial temporal variation. Waters of the secondary artesian aquifer were observed to have the highest Ra-226 of the three aquifers. While some spatial variation was observed, the secondary artesian aquifer was less temporally variable. In general, the Floridan Aquifer was observed to be lower in Ra-226 as compared to the secondary artesian aquifer; however, on the western portion of the property, there appears to be little difference in Ra-226 levels. Specifically, the results of Ra-226 analyses at UF-4 and LF-4 show little difference, which indicates a good hydraulic connection between the secondary artesian and Floridan Aquifer in this area of the site.

5.1.2.5 SURFACE WATER

To characterize the Ra-226 in surface water environment of the CF site, various sampling and analysis programs have been conducted. Grab samples were collected for Ra-226 analysis at surface water quality stations WQ-1 through WQ-7 on a quarterly basis during 1976 and 1977, and semi-annually during 1978 (see Figure 5.1-4 for station locations). The results of these studies are summarized in Table 5.1.2-6.

As part of the EIS monitoring, more extensive monitoring for Ra-226 and gross alpha was conducted. Samples were collected during July through September 1981 at surface water quality stations WQ-1 through WQ-5 and WQ-7 through WQ-12. In addition, stations WQ-13 and WQ-14 were sampled during September 1981. During October 1981 through June 1982, stations WQ-1 through 5, 7, 8, 10, 13, and 14 were sampled. In addition, samples representative of existing mine discharge were collected during August, September, and October 1981; February 1982; and April 1982. All samples were analyzed for Ra-226 and gross alpha. The results of these analyses are summarized in Tables 5.1.2-7 and 5.1.2-8.

Table 5.1.2-5. Summary of Ground Water Ra-226 and Average Gross Alpha Data for the CF Site

Well No.	Radium-226, pCi/l										Gross Alpha (pCi/l)
	2/76	5/76	10/76	4/77	10/77	4/78	10/78	4/79	4/80	9/81*	9/81*
Shallow Aquifer											
SA-1	0.77	—	0.15	0.07	0.08	0.08	0.03	0.04	0.88	—	—
SA-2	0.34	—	0.19	0.17	0.17	0.17	0.22	0.13	0.52	—	—
SA-3	0.44	—	0.04	0.03	0.02	0.05	0.05	0.01	0.30	—	—
SA-4	0.27	—	0.06	0.06	0.02	0.04	0.9	0.01	0.16	—	—
SA-6	0.37	—	0.36	0.46	0.28	0.31	0.41	—	0.31	—	—
SA-8	0.30	—	0.01	0.04	0.02	0.01	0.01	0.07	1.35	—	—
SA-11	0.34	—	—	—	—	—	—	—	—	—	—
SA-14	0.51	—	—	—	—	—	—	—	—	—	—
SA-16	0.34	—	—	—	—	—	—	—	—	—	—
SA-17	0.29	—	0.11	0.04	0.12	0.08	0.15	0.13	0.22	0.7	13.7
Secondary Artesian											
UF-4	—*	7.22	6.37	6.80	5.61	6.08	6.58	4.61	6.51	7.0	27.9
UF-5	—	9.36	7.83	6.15	8.13	7.00	8.74	5.82	8.72	—	—
UF-6	—	2.27	2.26	2.62	1.96	2.04	1.99	1.69	1.23	—	—
Floridan Aquifer											
LF-1	—	—	—	—	—	—	—	—	—	—	—
LF-4	—	5.86	6.49	6.38	6.23	6.19	6.08	3.43	2.89	8.0	8.4
LF-5	—	1.59	2.08	1.82	1.97	2.15	1.67	1.04	1.51	—	—
LF-6	—	1.56	1.68	1.97	1.38	1.65	1.19	0.58	1.06	—	—
PTW	—	0.75	0.54	1.70	1.08	2.20	0.80	0.35	0.86	—	—
DF	—	0.70	1.49	1.34	1.19	0.66	0.94	0.16	0.68	—	—
PW-B	—	—	—	—	—	—	1.13	—	—	—	—
PW-A	—	—	—	—	—	—	—	1.02	—	—	—

*ESE monitoring for EIS.

Sources: CF Data, 1976-1981.
ESE, 1982.

Table 5.1.2-6. Summary of Radium-226 Concentration in Surface Water, January 1976 Through March 1981

	Radium-226, pCi/l										
Station	1/76	7/76	9/76	11/76	1/77	3/77	7/77	9/77	11/77	1/78	3/78
WQ-1	0.27	0.76	0.07	0.41	0.16	0.22	0.08	0.04	0.47	0.19	0.12
WQ-2	0.44	0.31	0.12	0.25	0.18	0.15	0.20	0.14	0.22	0.16	0.17
WQ-3	0.62	0.15	0.19	0.39	0.09	0.11	0.17	0.59	0.20	0.16	0.20
WQ-4	0.41	0.53	0.45	0.30	0.31	0.41	—	0.31	0.37	0.37	0.33
WQ-5	0.23	0.15	0.19	—	—	—	—	0.08	—	0.17	0.16
WQ-6	0.37	0.09	0.05	0.13	0.07	0.04	0.09	0.31	0.10	0.09	0.08
WQ-7	0.29	0.17	0.28	0.30	0.19	0.24	0.33	0.19	0.34	0.17	0.13

Source: CF, 1981.

Table 5.1.2-7. Summary of Radium-226 Concentration in Surface Water From July 1981 Through June 1982

Station	Radium-226 (p/Ci/1)																
	7/81	8/81	9/81	10/81	11/81	12/81	1/82	2/82	3/82	4/82	5/82	6/82	Mean	Min.	Max.	S*	n†
WQ-1	0.6	0.8	0.4	0.2	0.2	0.3	0.3	0.2	0.5	0.4	0.2	0.2	0.4	0.2	0.8	0.2	13
WQ-2	2.0	0.9	0.2	0.4	0.1	0.1	0.2	0.3	0.2	0.2	0.2	0.1	0.4	<0.1	2.0	0.5	14
WQ-3	0.5	0.9	<0.1	0.5	0.2	0.1	0.1	0.4	0.3	0.4	0.2	0.2	0.3	<0.1	0.9	0.2	13
WQ-4	1.0	2.0	<0.1	0.6	0.5	0.8	0.4	1.0	0.9	0.7	0.5	0.2	0.8	<0.1	2.0	0.5	12
WQ-5	0.3	1.0	<0.1	—	0.3	0.1	0.4	0.7	0.3	0.1	0.3	0.1	0.4	<0.1	1.0	0.4	13
WQ-7	0.5	0.6	0.3	0.3	0.6	0.2	0.3	0.4	0.4	0.3	0.2	0.1	0.3	<0.1	0.6	0.2	13
WQ-8	2.0	1.0	<0.1	0.6	0.4	0.4	0.3	1.0	0.3	0.3	0.6	0.1	0.5	<0.1	2.0	0.4	13
WQ-9	0.2	0.2	0.3	—	—	—	—	—	—	—	—	—	0.2	0.2	0.3	0.06	3
WQ-10	0.2	0.3	0.1	0.3	0.1	—	—	—	1.0	0.5	0.7	0.1	0.4	0.1	1.0	0.4	9
WQ-11	1.0	0.1	—	—	—	—	—	—	—	—	—	—	0.6	0.1	1.0	0.7	2
WQ-12	0.0	2.0	0.2	—	—	—	—	—	—	—	—	—	0.9	0.2	2.0	1.0	2
WQ-13	—	—	1.0	0.3	0.4	0.1	0.4	0.4	0.4	0.3	0.2	0.2	0.4	0.1	1.0	0.3	10
WQ-14	—	—	0.4	0.3	0.6	0.2	0.2	0.5	0.4	0.2	<0.1	0.3	0.3	<0.1	0.6	0.2	10
MDW-1	—	3.0	<0.1	2.0	—	—	—	3.0	—	1.0	—	—	2.0	<0.1	3.0	1.0	5
MDW-2	—	—	3.0	0.8	—	—	—	2.0	—	0.6	—	—	2.0	0.6	3.0	1.0	5

— Indicates no sample collected.
* Standard Deviation.
† Number of samples collected.

Source: ESE, 1982.

Table 5.1.2-8. Summary of Gross Alpha Concentration in Surface Water From July 1981 Through June 1982

Station	Gross Alpha (pCi/l) 7/81	8/81	9/81	10/81	11/81	12/81	1/82	2/82	3/82	4/82	5/82	6/82	Mean	Min.	Max.	S*	n†
WQ-1	1.0	3.7	2.0	2.0	3.0	4.0	3.0	<2.0	<1.9	3.9	1.3	3.6	2.3	<1.8	3.9	1.2	13
WQ-2	<1.4	<2.8	<2.0	2.0	<3.0	<3.0	<3.0	<2.0	2.8	<2.5	1.6	<2.5	1.4	<1.4	2.8	0.5	14
WQ-3	<0.4	2.3	<2.0	<3.0	<0.7	<3.0	<3.0	<3.0	<2.1	<2.1	<1.7	2.4	1.3	<0.4	2.4	0.7	13
WQ-4	<2.2	2.5	2.0	4.0	<3.0	<3.0	<3.0	4.0	2.8	2.3	2.1	2.4	2.2	<1.8	3.9	0.9	13
WQ-5	<1.4	9.8	<2.0	—	<1.0	<3.0	<3.0	<3.0	1.3	<2.2	0.9	2.2	2.0	<1.1	9.8	2.5	13
WQ-7	<0.8	<2.9	<0.6	<2.0	<2.0	<3.0	<3.0	<1.0	0.7	<3.0	1.1	1.8	1.2	<0.6	3.6	0.9	13
WQ-8	3.4	4.8	2.0	3.0	<2.0	3.0	<3.0	<2.0	<1.2	<1.6	1.5	<1.5	1.9	<1.2	4.8	1.3	13
WQ-9	<1.3	4.6	2.0	—	—	—	—	—	—	—	—	—	2.2	<1.3	4.6	2.1	3
WQ-10	<2.5	4.4	<2.0	2.0	<2.0	—	—	—	3.0	1.6	2.0	<1.8	1.8	<1.5	4.4	1.2	9
WQ-11	<1.3	2.6	—	—	—	—	—	—	—	—	—	—	1.6	<1.3	2.6	1.4	2
WQ-12	—	4.9	3.0	—	—	—	—	—	—	—	—	—	4.1	3.3	4.9	1.1	2
WQ-13	—	—	<2.0	<0.7	<2.0	<3.0	3.0	1.0	<0.9	2.5	1.4	2.8	1.6	<0.7	3.0	0.9	10
WQ-14	—	—	<0.7	2.0	<3.0	<3.0	<3.0	<2.0	<1.7	1.2	1.2	4.5	1.6	<0.7	4.5	1.1	10
MDW-1	—	10.0	6.0	11.0	—	—	—	12.0	—	5.8	—	—	10.1	6.2	12.4	2.4	5
MDW-2	—	—	5.0	9.0	—	—	—	7.0	—	4.5	—	—	6.2	4.5	9.2	2.0	5

— Indicates no sample collected.
* Standard Deviation.
† Number of samples collected.

Source: ESE, 1982.

The FDER water quality standard for total radium (Ra-226 plus Ra-228) is 5 pCi/l. In evaluating the observed Ra-226 levels with respect to this standard, it is important to consider the presence (or potential presence) of Ra-228. Radium-228 is first decay daughter in the thorium-232 decay series, and is not associated with the previously discussed U-238 decay series. Therefore, in order for Ra-228 to be present in significant quantities, Th-232 must be present in significant quantities.

In general, on an activity basis (pCi/g to pCi/g), the radioactivity of U-238 and Th-232 in many soils and rocks of the world is approximately a 1:1 ratio. However, Th-232 content of Florida phosphate associated media has been reported by EPA (1975) and Windham (1974). These data indicate that uranium/thorium ratio, on an activity basis (pCi/g to pCi/g), is about 90 for marketable rock and 30 for clays. Based upon these data, it is apparent that uranium content of the material of the phosphate deposits may be as much as 100 times greater than the thorium content.

Similarly, the decay daughters of U-238 and Th-232, Ra-226 and Ra-228, respectively, will follow the same trends. On an activity basis, Ra-226 may exceed Ra-228 by as much as a factor of 100. In other terms, if Ra-226 were observed at the 5 pCi/l level in the site area, Ra-228 would be present only at approximately 0.05 pCi/l. This is well below the detection limit of 1 pCi/l $\pm$ 20 percent for Ra-228 using the USGS analytical procedures (R-1142-76).

Based upon this analysis, Ra-226 levels observed in the surface water are compared directly with the total radium standard of 5 pCi/l. All surface water and mine discharge Ra-226 measurements were observed to be less than 5 pCi/l. All surface water and mine discharge concentrations for gross alpha were observed to be less than the FDER water quality standard of 15 pCi/l.

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6.0 GROUND WATER

6.1 THE AFFECTED ENVIRONMENT

6.1.1 REGIONAL DESCRIPTION--QUANTITY

The lithologic units in the Hardee County area are summarized in Table 6.1.1-1. Although these units vary widely in their water-bearing characteristics, they can be grouped into three major hydrogeologic aquifers:

1. Shallow or water table aquifer,
2. The secondary artesian aquifer, and
3. The Floridan Aquifer.

In general, the shallow aquifer system is highly variable, but is typically capable of yielding small quantities of water; therefore the shallow aquifer system is utilized mostly for domestic supplies or other low-volume uses. The secondary artesian aquifer is locally capable of yielding relatively large quantities of water. However, the major water source in the Hardee County area is the Floridan Aquifer. The following discussion of regional ground water hydrology focuses on the Floridan Aquifer.

The Floridan Aquifer is comprised of primarily tertiary limestones and dolomites. Although limestone units vary widely in hydrogeologic properties, typically they are capable of producing large quantities of water. Yields of 5,000 gallons per minute (gpm) are common. However, due to the presence of various lower permeability rocks and clays separating the limestone units, yield and quality can vary significantly with depth and location.

Recharge to the Floridan Aquifer occurs from rainfall, surface water, or shallow aquifer waters in areas with one of three distinct features:

1. Areas where no confining layer is present and where the aquifer is at or near land surface, or

Table 6.1.1-1. Geohydrologic Characteristics of the Lithological Units

System	Series	Stratigraphic Unit	Lithology	Thickness (ft)	Water-Bearing Characteristics	Well Construction	Common Use, Remarks
Quarternary	Recent and Pleistocene	Undifferentiated sands and clays	Sand, gravel, clay shell, and marl	0-170	Surficial deposits, yield water to shallow wells, a few to several tens of gallons	Open end, open hole, well point, screen, slotted casing	Domestic, agricultural
	Pliocene	Caloosahatchee Marl	Marl, sand, gravel, shell, phosphate, and bone	0-50	Yields water to shallow wells	Open hole	Domestic
		Bone Valley Formation	Phosphate, sand, clay, gravel and bone	0-200	Yields small to moderate quantities of water to shallow wells	Open hole	Domestic
Tertiary	Miocene	Hawthorn Formation	Clay, marl, phosphate, silt, shell, and limestone	150-370	Sand, shell, limestone beds are source of water. The waters are under artesian pressure and are less mineralized than older beds. Yields small quantities of water, tens of gallons per minute	Open hole or cased off	High radioactivity on gamma-ray logs Domestic, stock, agricultural, public supply
	Miocene	Tampa Limestone	Limestone, gray, white, and tan, hard and dense, cherty, fossiliferous, phosphatic, silicified in part. Porosity due primarily to solution cavities	125-235	Yields large quantities of artesian waters. Several hundreds of gallons per minute	Open hole or cased off	Domestic, stock, agricultural, public supply

Table 6.1.1-1. Geohydrologic Characteristics of the Lithological Units (Continued, Page 2 of 2)

System	Series	Stratigraphic Unit	Lithology	Thickness (ft)	Water-Bearing Characteristics	Well Construction	Common Use, Remarks
	Oligocene	Suwannee Limestone	Limestone, white-to-tan, soft-to-hard, granular, porous, oalitic, fossiliferous	100-350	Artesian but mineralized; yields moderate amounts of water, more than 800, as much as 2,500 gallons per minute	Open hole	Agricultural, public supply, Industrial
	Eocene	Ocala Limestone, soft, granular, coquina	Limestone, white-to-tan, chalky, soft, granular coquinoid, dense layered with brown crystalline dolomite. Fossiliferous Lepidocyclina camerina	260-400	Generally most productive formation of aquifer	Open hole	Agricultural, public supply, industrial
		Avon Park Limestone	Limestone, cream-to-tan and brown, soft-to-hard, granular, in part crystalline and dolomitic. Very porous. Water high in mineral content. Distinctive fossil Dictyoconus cookei	200-800	Principal source of water where overlying limestone is thin or absent	Open hole	Agricultural, industrial, public supply

Sources: Stringfield, 1966.
Peek, 1958.
Wilson, 1977.

2. Areas where the Hawthorn confining layer is breached by sinkholes, or
3. Areas where there is a significant water level gradient from the shallow aquifer to the level of the Floridan Aquifer.

The Floridan Aquifer discharges water in primarily three ways:

1. Discharge from wells,
2. Springs and seeps,and
3. Upward leakage in areas where the potentiometric surface of the Floridan Aquifer is higher than the shallow aquifer.

The potentiometric surface of the Floridan Aquifer varies seasonally depending upon the rate at which it is being recharged and discharged. Water levels in the Floridan Aquifer usually reach their lowest near the end of April, the end of the dry season. The water levels generally rise from May through September and then usually remain stable through October. This rise corresponds with the onset of summer rains. With the cessation of rainfall in October, the Floridan Aquifer begins a sharp decline which ends in May. The timing and extent of these seasonal fluctuations in water levels vary from year to year due to variations in the rate of recharge (due to rainfall) and in pumping rates from production wells.

The seasonal fluctuations of the potentiometric surface in a USGS well in Hardee County is presented in Figure 6.1-1. The hydrograph from this USGS well shows seasonal fluctuations as high as 42 feet (between September 1974 and May 1975). In general, there is an increase in the amplitude of the drawdown and recovery with time. According to EPA (1978), this increase is attributed to increases in irrigation pumpage since industrial use generally does not show seasonal fluctuations. The spatial variation of wet and dry season water levels is shown for the Hardee County area in Figures 6.1-2 and 6.1-3. Figure 6.1-2 presents the potentiometric water level of the Floridan Aquifer in May, a dry

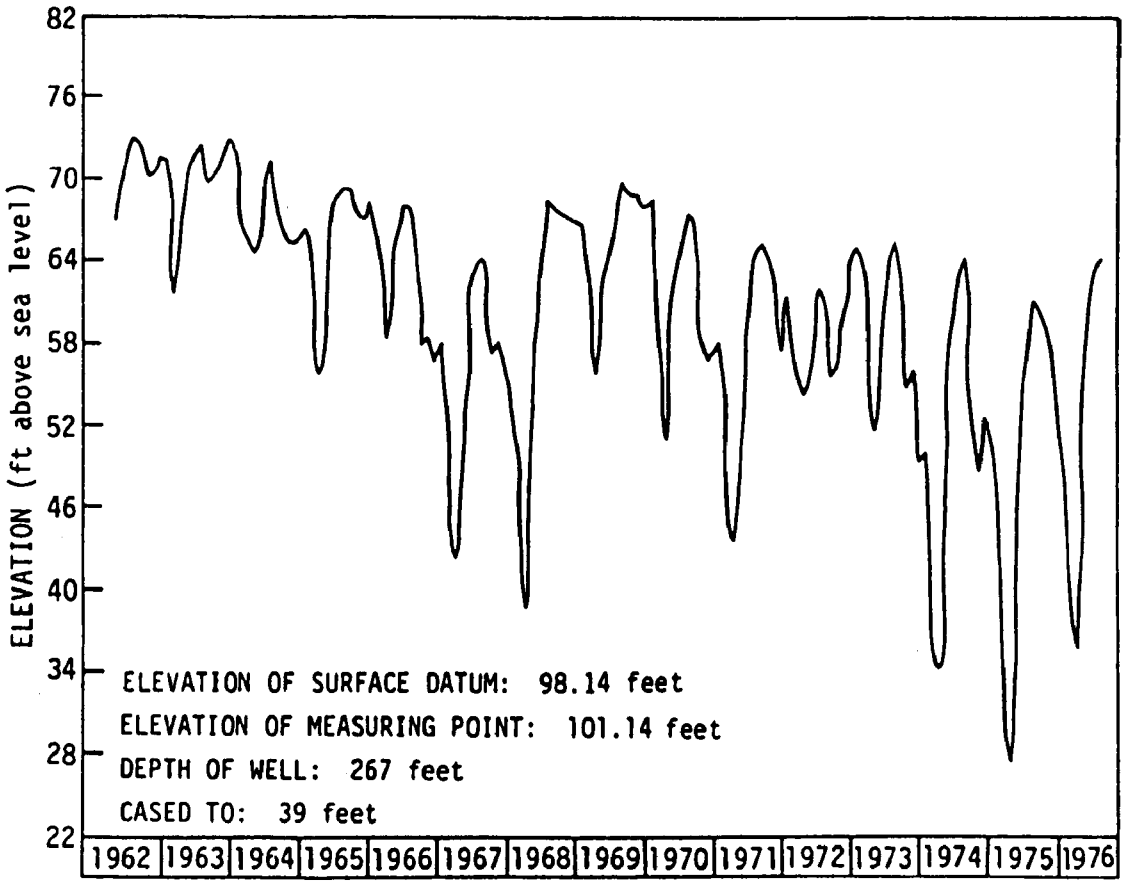

Figure 6.1-1
SEASONAL FLUCTUATIONS OF THE FLORIDAN AQUIFER POTENTIOMETRIC SURFACE IN A USGS WELL

Source: EPA, 1978.

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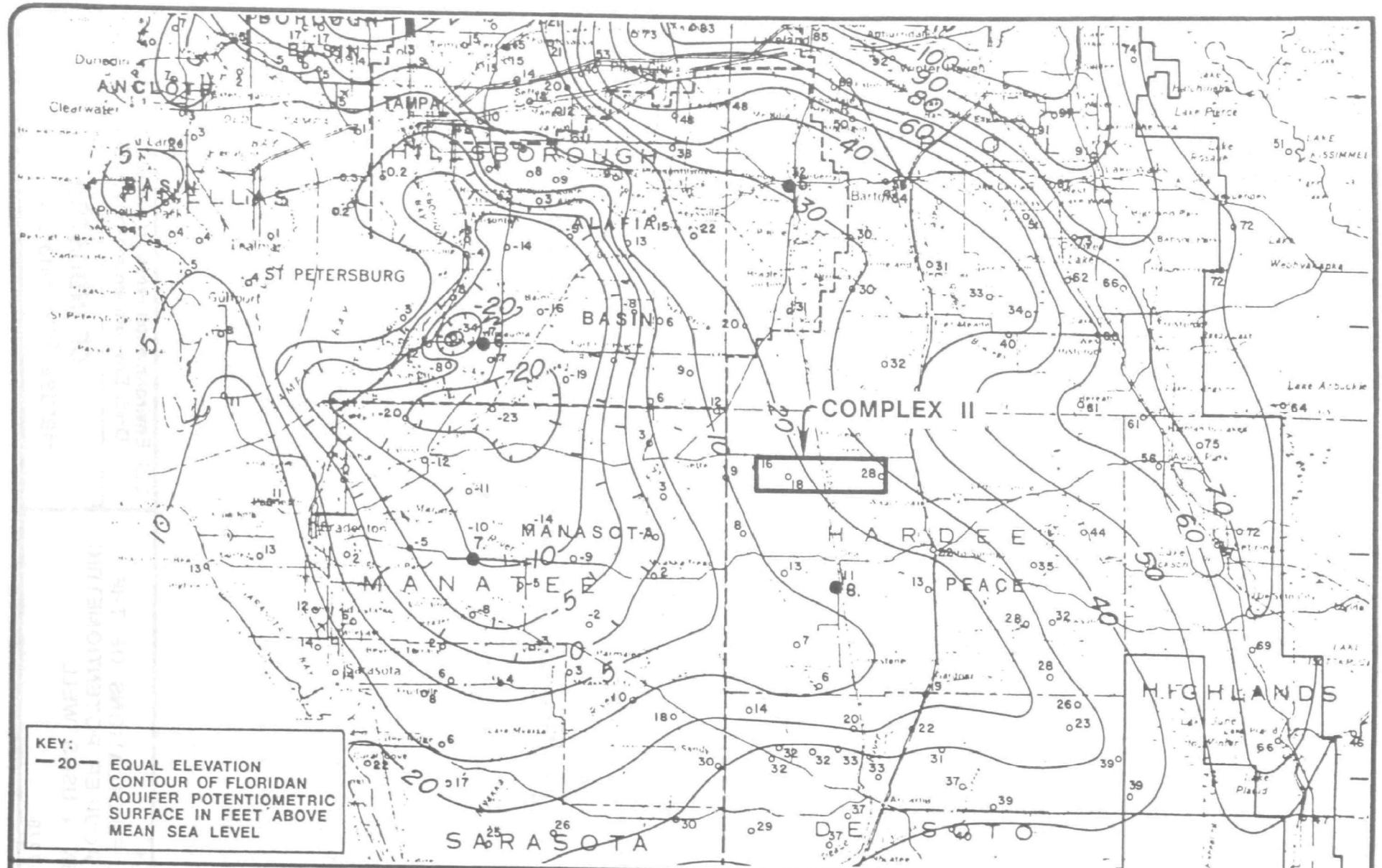

Figure 6.1-2
POTENTIOMETRIC SURFACE OF FLORIDAN AQUIFER, MAY 1981

SOURCE: YOBBI, WOODHAM, AND SCHINER, 1981.

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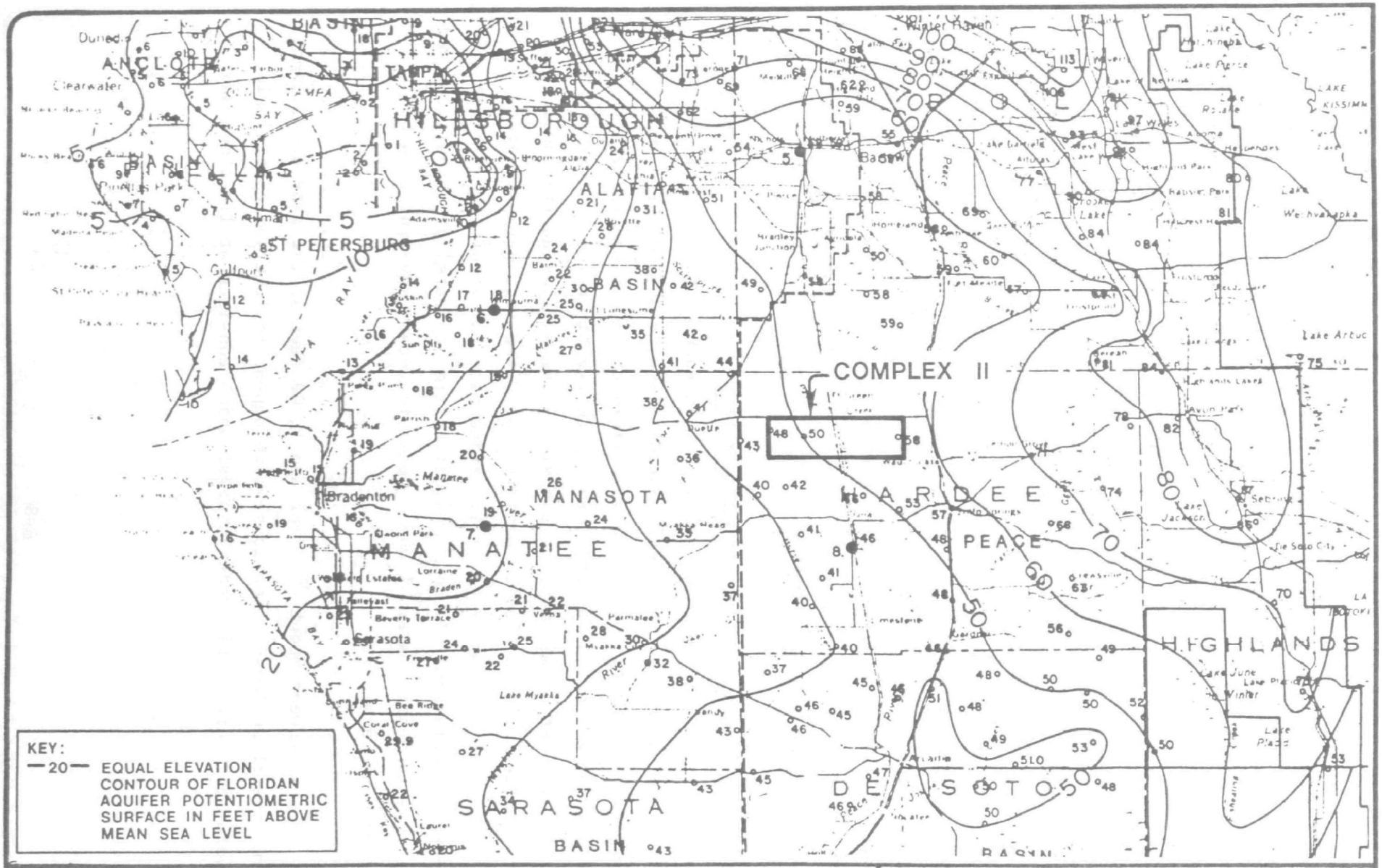

Figure 6.1-3
POTENTIOMETRIC SURFACE OF FLORIDAN AQUIFER, SEPTEMBER 1981

SOURCE: YOBBI, WOODHAM AND SCHINER, 1981

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Hardee Phosphate Complex II

season month; Figure 6.1-3 presents the level in September, a wet season month. In May 1981, the potentiometric surface of the Floridan Aquifer in the Hardee County area varied from 61 feet mean sea level (MSL) in the northeast corner of the county to 6 feet MSL in the southwest portion of the county. This lowering of the potentiometric surface is attributed to deep aquifer pumping for agricultural use and citrus processing in lower Hillsborough County, according to Southwest Florida Water Management District personnel (1982).

In September 1981, after the heavy rains of the summer, the potentiometric surface had risen to 82 feet MSL in the northeast corner of Hardee County and to 37 feet MSL in the southwest corner of the county. This represents an increase between 21 feet and 31 feet in the potentiometric surface in the Floridan Aquifer from May to September. During the dry season, the major trend is generally the movement of the low water level contours inland and an increase in areas of major cones of depression (due to pumpage).

6.1.2 SITE-SPECIFIC DESCRIPTION--QUANTITY

Ground water is present to some degree in each of the geologic formations underlying the CF site in northwestern Hardee County. Some of the formations, however, are capable of yielding significantly larger amounts of water than others. There are two minor aquifers within the upper 375 feet of sediment at the site: the shallow aquifer consisting of undifferentiated clastic material; and, the secondary artesian aquifer which is comprised of limestone material within the Miocene Hawthorn Formation. These two aquifers are separated by a confining bed of less permeable material which tends to retard movement of water between the aquifers.

At depths between about 400 feet and 1,700 feet in the site area, there are several geologic formations which appear to function as a single hydrologic unit. This rock interval which consists of limestone and

dolomite beds of the Tampa, Suwannee, Ocala, Avon Park, and Lake City formations, constitutes the Floridan Aquifer. The Floridan Aquifer is the principal source of large ground water supplies throughout the region. The stratigraphic relationships of aquifers and confining beds at the CF site is summarized in Figure 6.1-4. A detailed explanation of the chart and the logs shown therein is contained in the Consumptive Use Application Supporting Report (CF Industries, Inc., 1975).

Extensive ground water data have been collected on the CF property. These data were collected in 1975 by Dames and Moore for the Application for Development Approval/Development of Regional Impact (ADA/DRI) and Consumptive Use Permit (CUP), and since 1976 to present by CF Industries for monitoring reports submitted to Hardee County. During the DRI and CUP investigations, 28 wells of varying depths were installed in the shallow, secondary artesian and Floridan Aquifers. These include: a Deep Floridan Test Well (DF), a production test well (PTW), three wells in the Floridan Aquifer (LF), five wells in the secondary artesian aquifer (UF), and 18 shallow aquifer (SA) wells. Three wells were later added in the Floridan Aquifer, increasing the total to 31 wells. Since installation in late 1975 and early 1976, 16 wells have been monitored continuously and levels in the remaining wells have been measured monthly. Included in the previous on-site investigations was a total of 28 pump tests: 18 on the shallow aquifer, 2 tests on the secondary artesian, and 8 tests on the Floridan Aquifer. The locations of the on-site wells are presented in Figure 6.1-5.

Because of the large volume of data collected and available for review, investigations for this EIS were limited to drilling 6 corings to a depth of 50 feet during the collection of samples for radiation analyses. A geologic cross-section was prepared from the drilling on the study area and is presented in Section 4: Geotechnical.

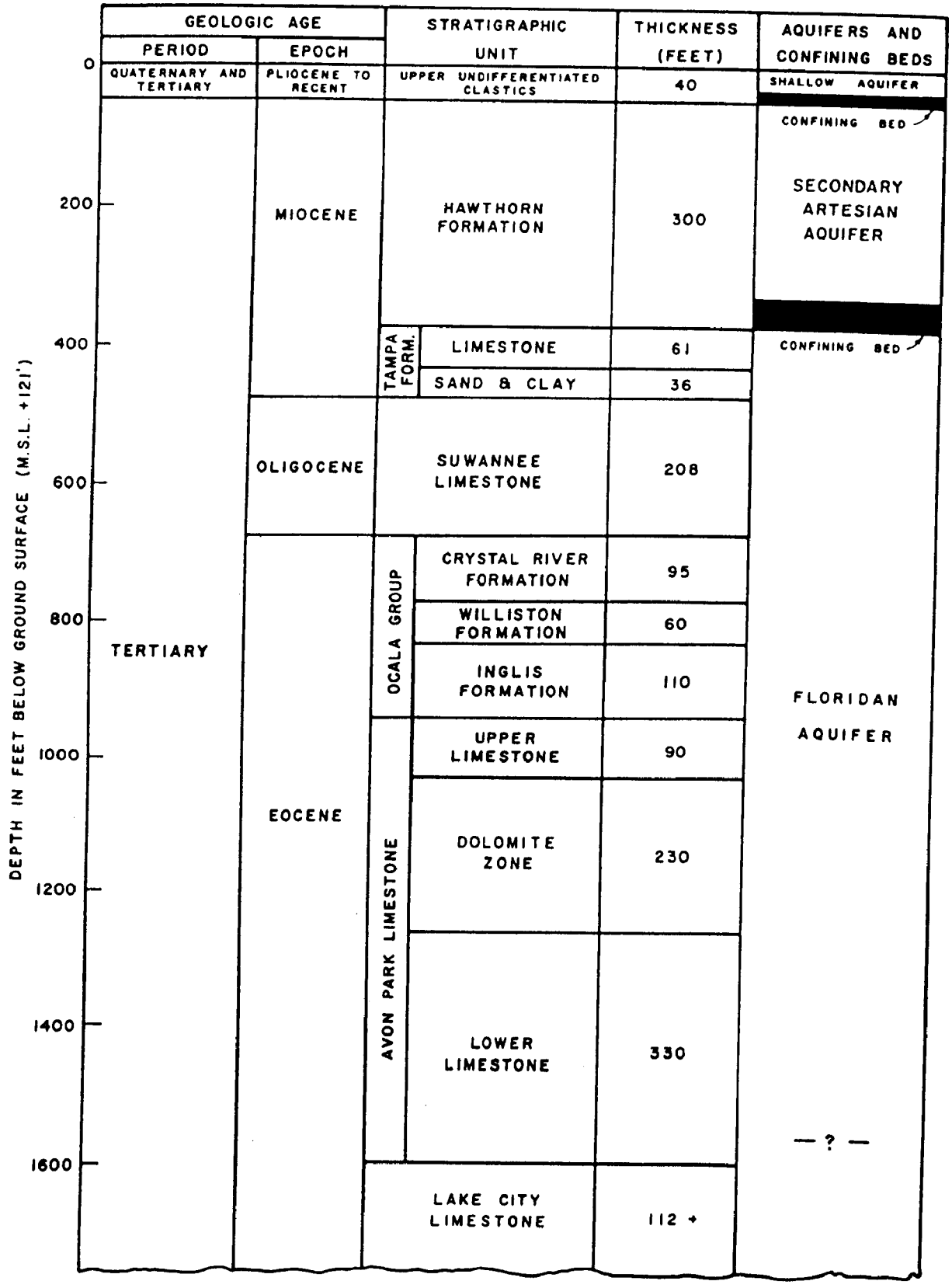

Figure 6.1-4
STRATIGRAPHIC COLUMN, DEEP FLORIDAN TEST WELL

SOURCE: CF MINING CORPORATION, 1976.

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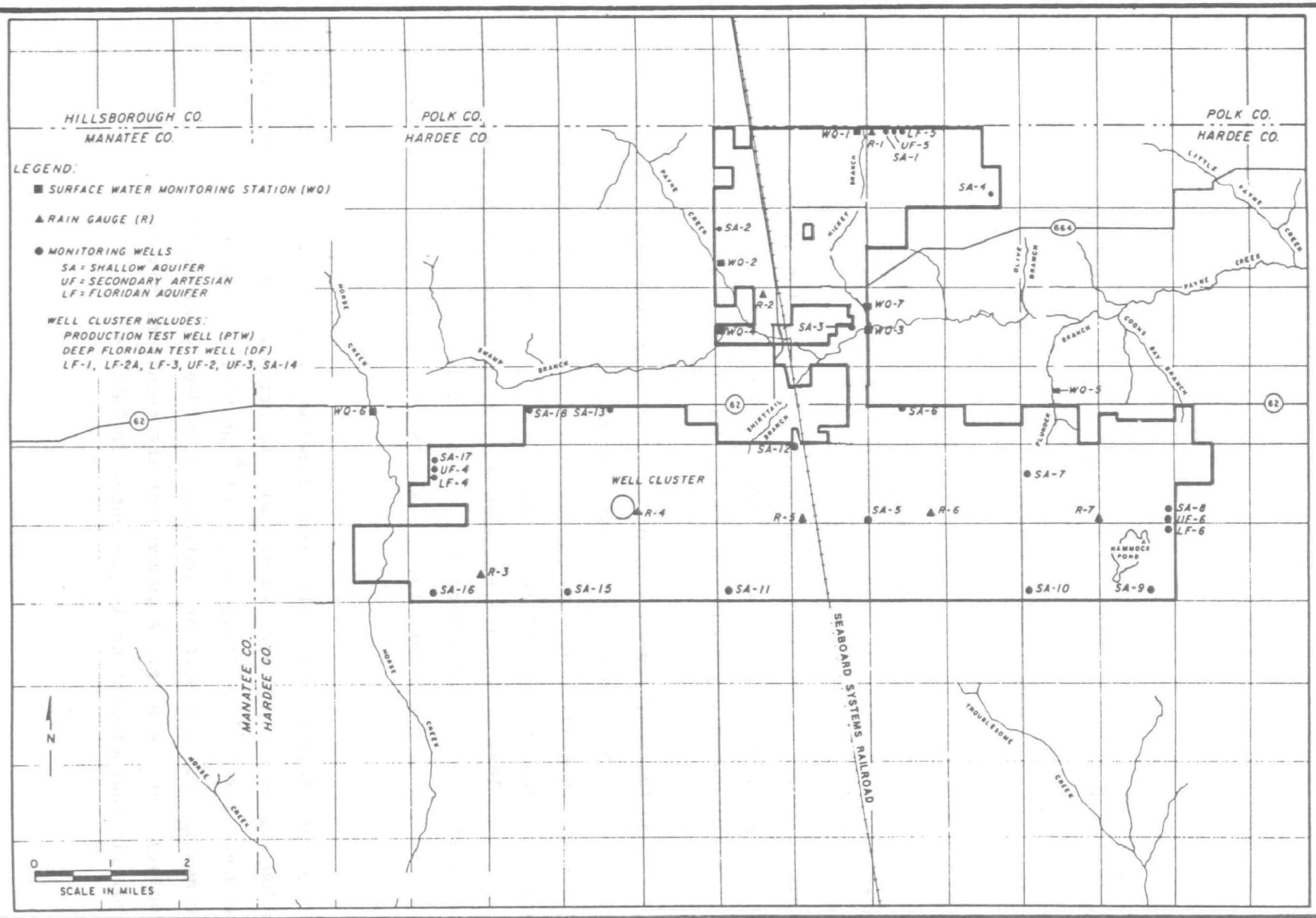

Figure 6.1-5
LOCATION OF HYDROLOGIC DATA COLLECTION STATIONS

SOURCE: CF MINING CORPORATION, 1976

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Hardee Phosphate Complex II

The CF property (referred to as the site) consists of Complex I (the north tract of land) and Complex II (the southern area). Complex I is CF's existing mine, whereas Complex II (referred to as the study area) is the property being studied for this EIS. The descriptions of the site-specific aquifer systems presented in this section are based on data collected by Dames and Moore during the previous studies, by CF during continued monitoring, and by ESE during core sampling and certain investigations conducted on Complex I in its undisturbed state.

6.1.2.1 SHALLOW AQUIFER

The shallow aquifer underlies the site area to depths ranging from 5 to 40 feet. Average thickness is about 30 feet. The material comprising the aquifer is dominantly fine sand and clay with some coarse sand, gravel and shell material. The shallow aquifer is underlain by limestone beds of the Hawthorn Formation in some places and by phosphate matrix in others. According to the Consumptive Use Application Supporting Report (CF Industries, 1975), three wells on Complex II tap the shallow aquifer; all three wells are for domestic supply.

During pump tests of the 18 shallow wells by Dames and Moore, pumping rates ranged from less than 2 gallons per minute to more than 50 gallons per minute. Specific capacities, which are a function of aquifer characteristics and well efficiencies, varied from less than 0.1 to about 3.6 gallons per minute per foot of drawdown. Transmissivities, calculated from drawdown, recovery, and specific capacity data, ranged from less than 200 to about 20,000 gallons per day per foot and averaged about 3,000.

Storage coefficients calculated from drawdown data indicate that the shallow aquifer varies from water-table to artesian conditions over the site area, 3×10^{-1} at SA-11 to 2×10^{-8} at SA-15. This range of conditions is a result of confining beds due to variations in lithology over the site. A summary of the resulting shallow aquifer hydrologic characteristics is presented in Table 6.1.2-1.

Table 6.1.2-1. Shallow Aquifer Hydrologic Characteristics

Well No.	Total Depth (Ft.)	Pumping Rate (gpm)	Specific Capacity (gpm/ft)	Calculated Transmissivity (T) (gpd/ft) (using following methods) Drawdown vs. time	Recovery vs. t/t'	Specific Capacity*	Representative Transmissivity (gpd/ft)	Calculated Storage Coeff. (S) Drawdown
SA-1	51	50	3.5	14,200	7,600	7,000	8,000	—
SA-2	30	40	2.8	4,400	7,700	5,600	6,000	$3x10^{-4}$
SA-31	25	3.3	.6	970	1,200	1,200	1,100	$2x10^{-3}$
SA-4	30	<2	<.1	—	—	—	<200	—
SA-5	40	10	.85	1,000	1,200	1,200	1,100	—
SA-6	56	<2	<.1	—	—	—	<200	—
SA-7	52.5	10	.7	750	820	1,400	900	$6x10^{-3}$
SA-8	35	8.7	.5	2,600	2,300	1,000	2,000	—
SA-9	44	7	0.36	420	440	720	500	$4x10^{-3}$
SA-10	44	5.8	0.23	140	220	460	300	$4x10^{-2}$
SA-11	47	8	0.99	590	920	2,000	1,000	$3x10^{-1}$
SA-12	44	<2	.1	—	—	—	<200	—
SA-13	66	5.8	0.27	1,700	900	540	1,000	—
SA-14	60	14	0.93	1,500	1,500	1,900	1,500	$4x10^{-5}$
SA-15	55	8.5	1.09	2,800	1,700	2,200	2,000	$2x10^{-8}$
SA-16	50	54	4.6	48,000	18,000	9,200	20,000	—
SA-17	51	28	3.6	7,400	5,300	7,200	6,000	$5x10^{-6}$
SA-18	55	15.5	0.99	1,900	1,700	2,000	1,000	$1x10^{-5}$

*U.S. Geological Survey Water-Supply Paper 1536-I, p. 331, 1962.

Source: CF Mining Corporation, 1975.

The physical characteristics of the shallow aquifer were determined during the drilling of six cores at representative locations over the Complex II site. A geologic cross-section prepared from the drilling on the study area is presented in Section 4: Geotechnical. The results show that the thickness and lithology of the shallow aquifer is similar to descriptions reported in previous studies.

From 1976 to present, water level recorders were maintained by CF on 7 shallow aquifer wells, 5 of which are on the study area (i.e., SA-6, SA-8, SA-10, SA-15, and SA-17) and 2 are on the existing mine site (i.e., SA-1 and SA-3).

The hydrograph from SA-17 is presented in Figure 6.1-6 for the monthly water levels from January 1976 through June 1982. The hydrograph indicates that the highest level of 119.5 feet occurred during 1976, 1978, 1979, and 1980, while the lowest level of 114 occurred in 1976 and 1981. These high and low values correspond to a depth of 0.1 and 5.6 feet, respectively, below the ground surface. The effects of the below normal rainfall (3-inch deficit) during the dry season from October 1981 through March 1982 is seen in the general decline and lack of fluctuations in the shallow aquifer water levels during this period.

The hydrographs from the shallow aquifer recorders for the EIS study period are shown in Figure 6.1-7. These hydrographs indicate that from July 1981 through June 1982, levels in the shallow aquifer varied by as much as 8 feet in SA-10 and about 4.5 feet at SA-8 and SA-17. The large increase in levels in most of the wells in early and late August 1981 is the result of heavy rainfall of about 3 inches and 4 inches on August 3-4 and August 20-24, 1981 respectively.

The differences between individual wells with respect to the range of water level fluctuations and response to rainfall probably result from variations in the lithology of the shallow aquifer and on-site rainfall

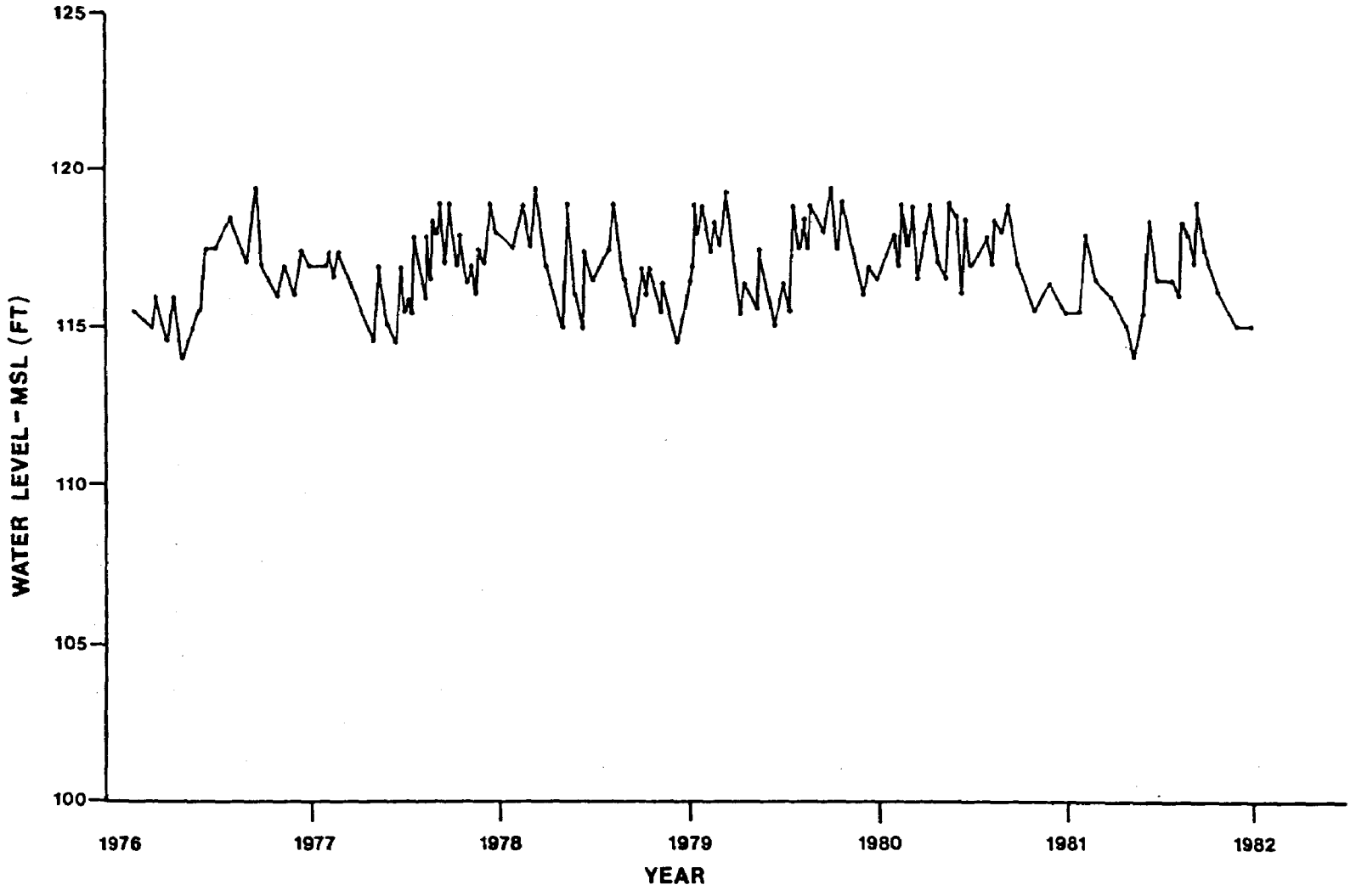

Figure 6.1-6
HYDROGRAPH OF SHALLOW AQUIFER WELL SA-17 ON CF COMPLEX II, JANUARY 1976 THROUGH JUNE 1982

SOURCES: CF MINING CORPORATION, 1976-1982; ESE, 1982.

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Draft Environmental Impact Statement

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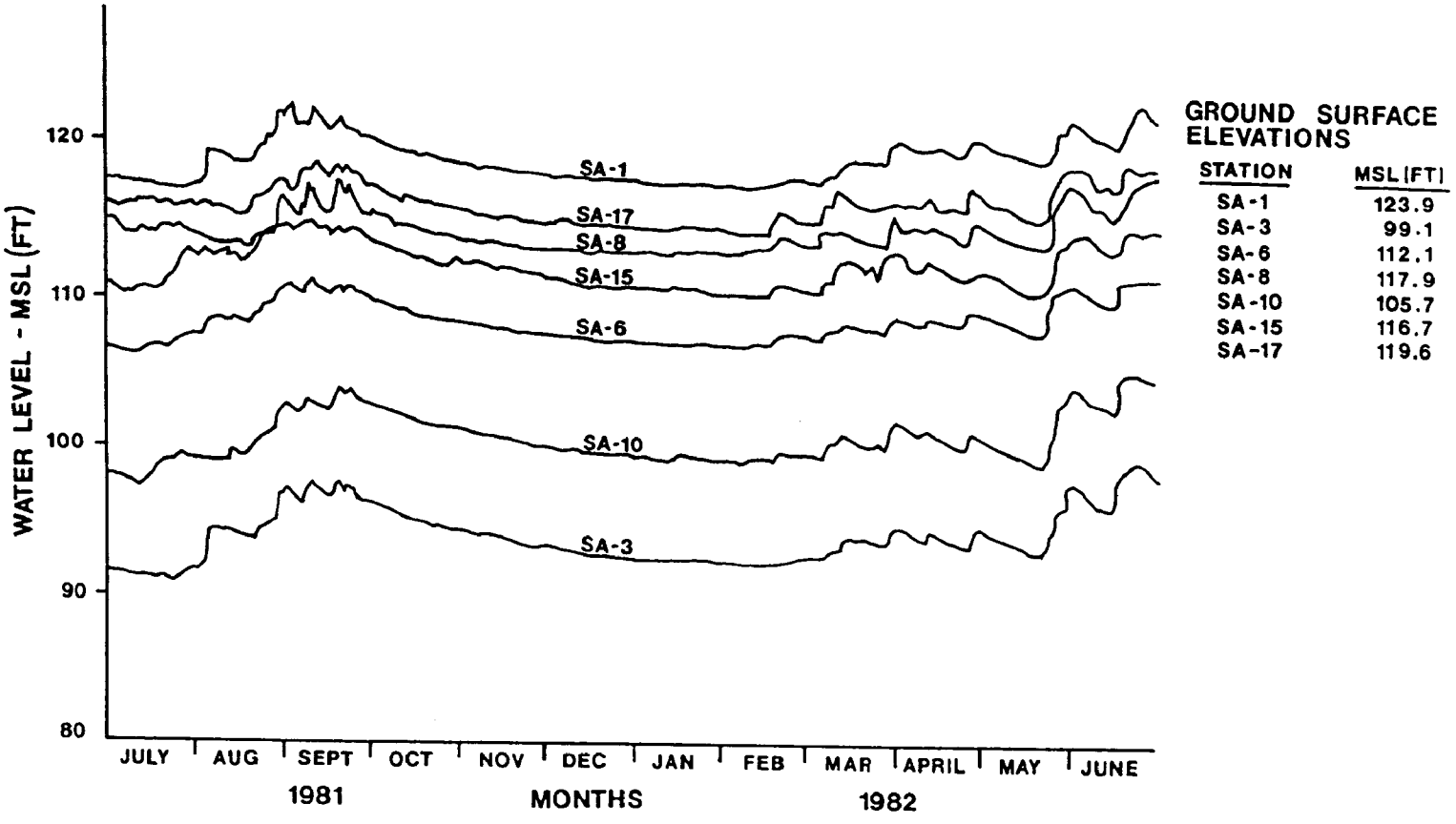

Figure 6.1-7
HYDROGRAPHS OF SHALLOW AQUIFER WELLS ON CF PROPERTY, JULY 1981 THROUGH JUNE 1982

SOURCES: CF MINING CORPORATION, 1982; ESE, 1982.

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

distribution. The high water levels at the continuous recorders on Complex 11 ranged from 0 to 2 feet below ground surface during September 1981. The low water levels occurred in July 1981 and ranged from 4 to 9 feet below ground surface.

Contour maps of the potentiometric surface in the shallow aquifer are shown in Figure 6.1-8 for the wet season (September 1981) and Figure 6.1-9 for the dry season (May 1982). These maps were developed from the water level recordings and monthly water elevation measurements in the surficial aquifer wells, along with land surface topographic maps. The results of these contour maps show the water level gradient generally to be about 10 feet per mile, sloping downward towards the north on the east side of the property and downward towards the south on the west side. The highest potentiometric surface is in the northwest area of the study area, and the lowest is in the north-central section where Doe Branch intersects the property line.

6.1.2.2 SECONDARY ARTESIAN AQUIFER

At the CF Hardee site, the secondary artesian aquifer consists of about 250 feet of alternating limestone and clay within the Hawthorn Formation. Examination of well cuttings and gamma-ray logs from wells drilled on-site indicates that in most places the secondary artesian aquifer is overlain by clay beds at the base of the shallow undifferentiated clastics. At the DF well in the cluster area, the thickness of the overlying clays is about 30 feet. About 50 feet of basal Hawthorn or upper Tampa clays separate the water-bearing zones in the Hawthorn Formation from the underlying Floridan Aquifer.

During the CUP investigations, static water levels in the Hawthorn differed by as much as 25 feet when both UF-2 and UF-3 were at approximately the same depth. The reason for this difference in water levels is not well defined but could be due to differences in well construction, water-bearing zones within the Hawthorn having different water levels, or possible fracturing in the area.

04-30-84

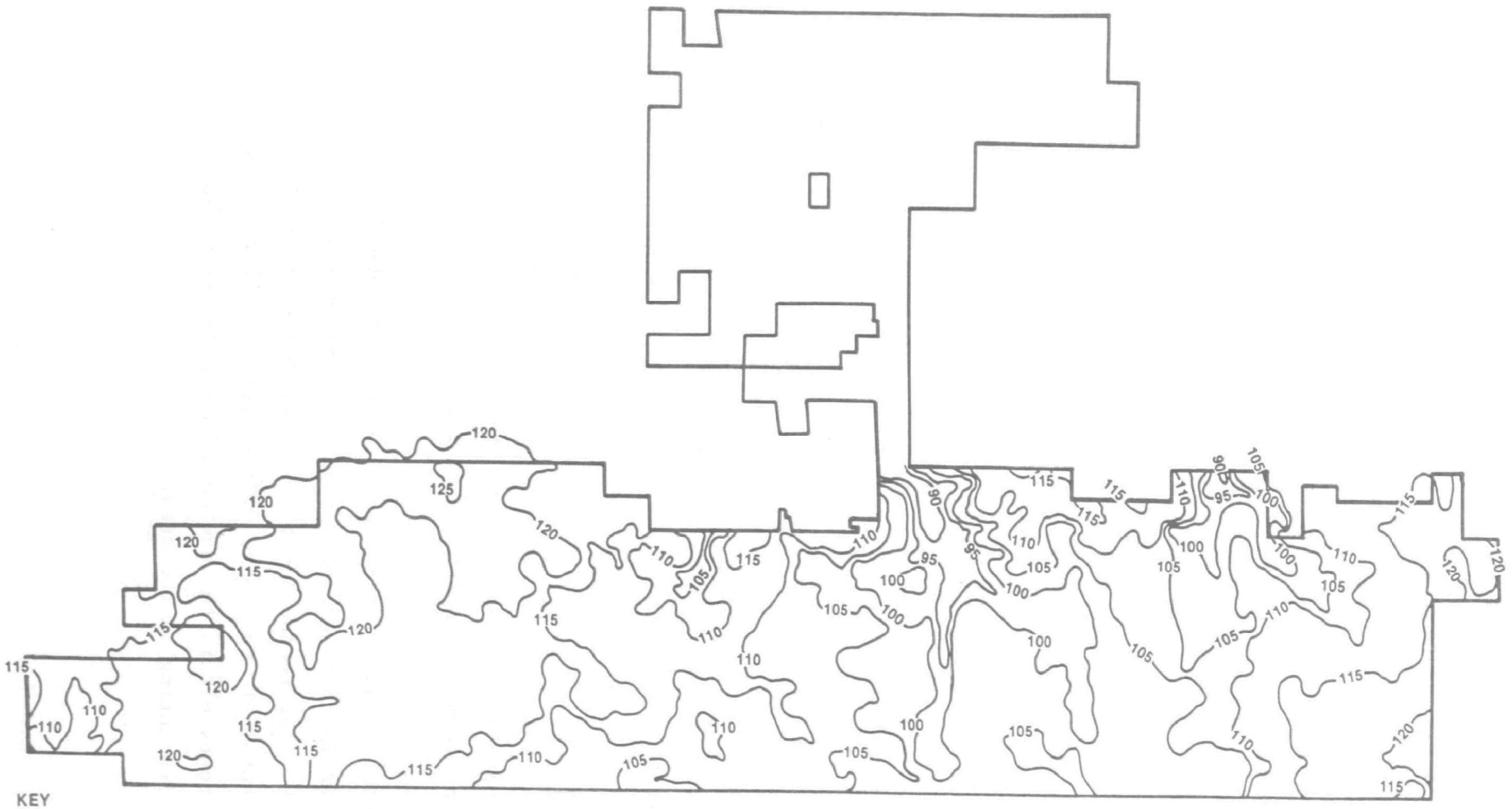

Figure 6.1-8
POTENTIOMETRIC SURFACE OF SHALLOW AQUIFER
IN SEPTEMBER 1981

Source: ESE, 1984.

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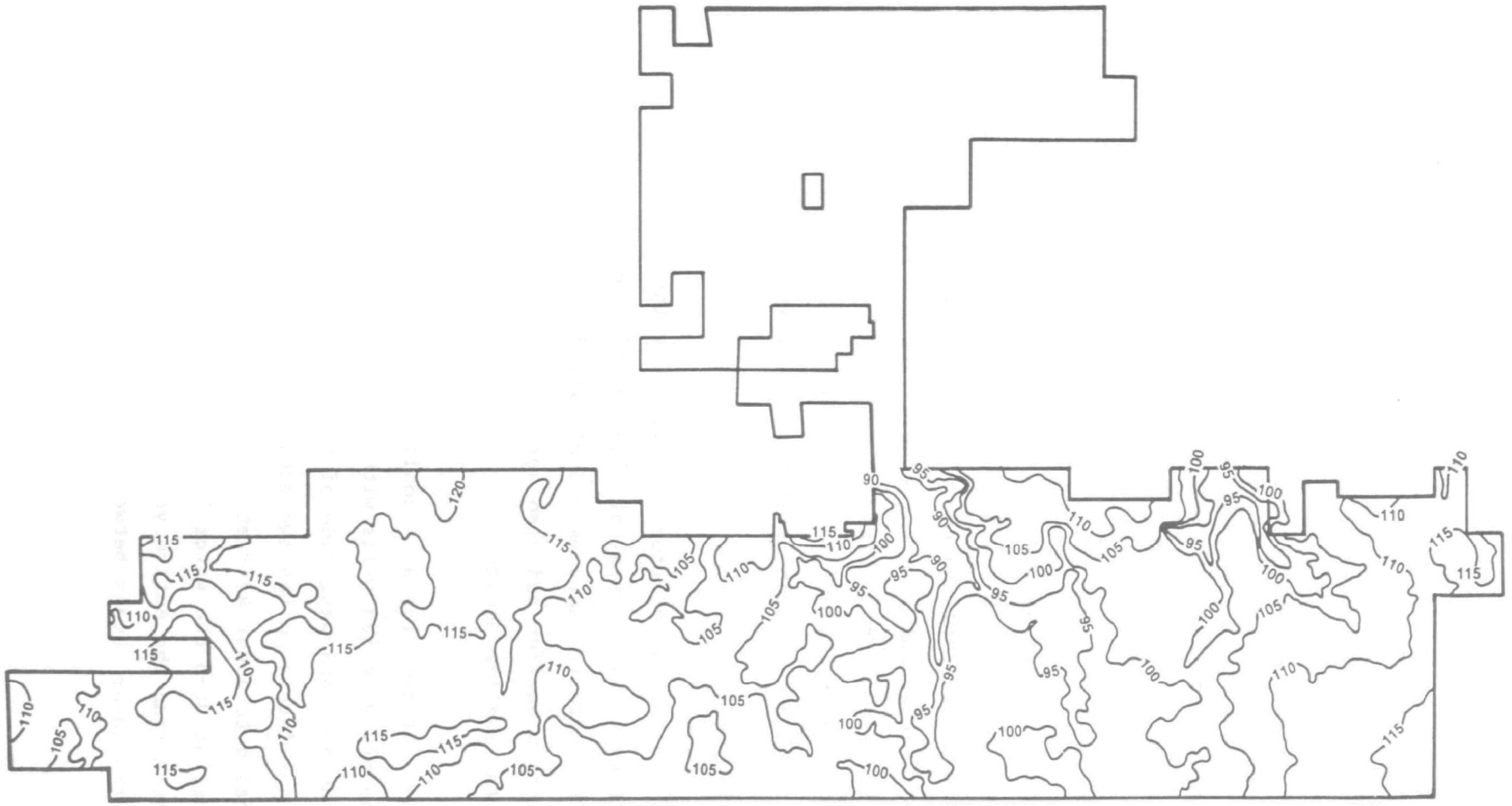

Figure 6.1-9
POTENTIOMETRIC SURFACE OF SHALLOW AQUIFER IN MAY 1982

Source: ESE, 1984.

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

There was a wide range of results from pump tests conducted in Wells UF-3 and UF-2 suggesting that there may be appreciable differences in water-bearing characteristics of individual zones within the secondary artesian aquifer. For example, pumping rates in tests of UF-3 and UF-2 were 3.5 gallons per minute and 80 gallons per minute, respectively. Specific capacity was less than 0.5 gpm/ft at UF-3 and transmissivity ranged from 120 gpd/ft in the UF-3 test to 3,000 gpd/ft in the UF-2 test. After the pump tests were completed, UF-2 was deepened and is now also in the Floridan Aquifer. A representative value for transmissivity of the secondary artesian at the CF site is most likely about 1,000 gpd/ft.

Water level recorders have been maintained since January 1976 by CF on four wells in the secondary artesian, 3 of which are in the study area (i.e., UF-3, UF-4, and UF-6) and one well, UF-5, is on CF's existing mine site. The hydrographs from these wells for the period July 1981 through June 1982 are shown in Figure 6.1-10. These hydrographs indicated that during the year, levels in the secondary artesian varied only 7 feet at UF-3 and as much as 18 feet at Wells UF-4, UF-5, and UF-6.

At the base of the shallow aquifer and overlying the limestone of the Hawthorn Formation is an interval of clay material averaging about 30 feet thick. This material acts as a confining layer for water in the underlying artesian aquifer and also serves to retard downward movement of water from the shallow aquifer.

The effectiveness of the clay as a confining layer is indicated by comparing secondary artesian wells with nearby wells in the shallow aquifer. On the east and west side of the study area, the difference between the water levels in the two aquifers was about 62 feet in early July and decreased to about 47 feet in late September on an annual basis. However, at UF-3 the water level was about 20 feet below the shallow aquifer during the entire year. Although the reason for the difference in the water levels between UF-3 and the other secondary

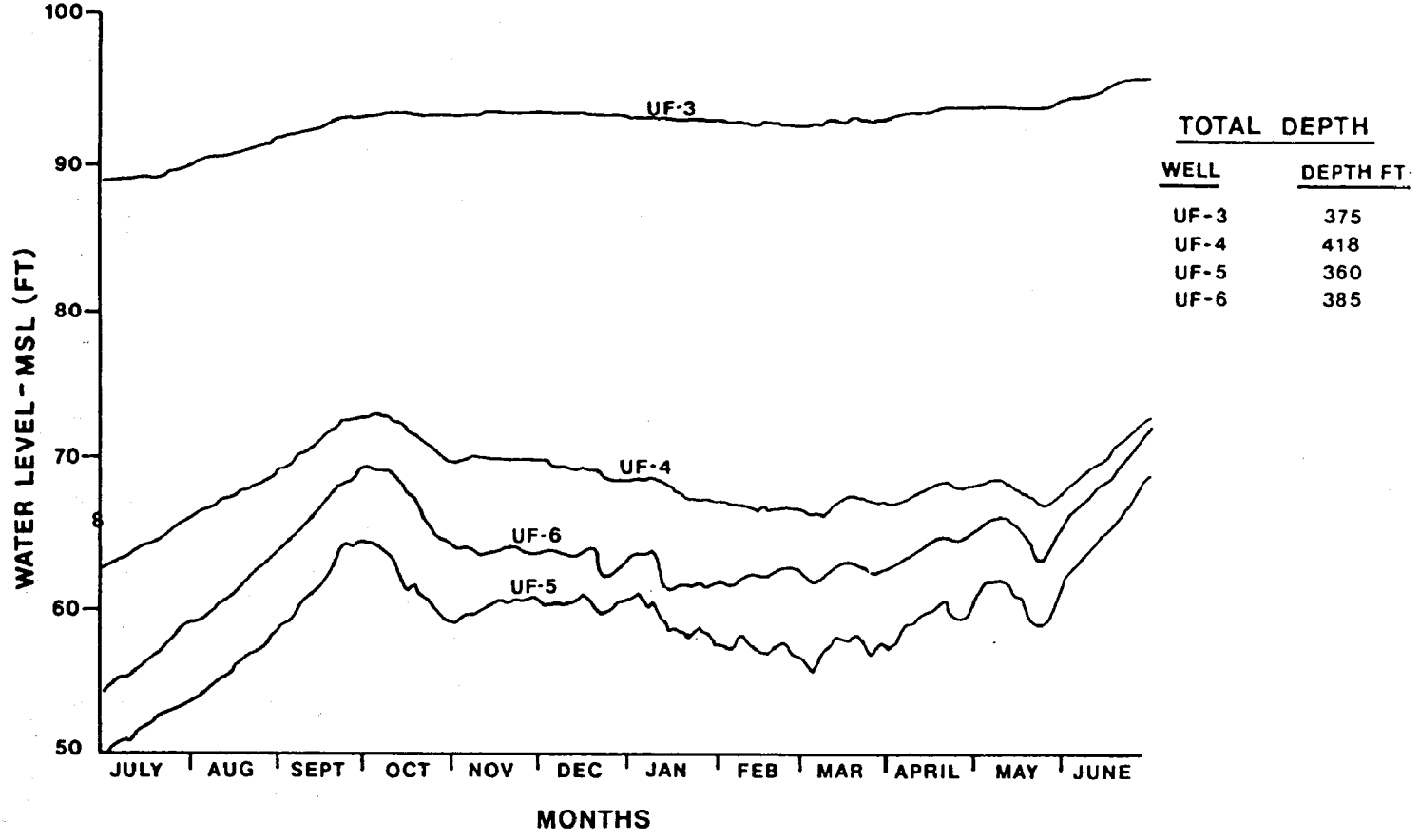

Figure 6.1-10
HYDROGRAPHS OF SECONDARY ARTESIAN AQUIFER WELLS ON CF PROPERTY, JULY 1981 THROUGH JUNE 1982

Source: ESE, 1982.

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

artesian aquifer wells is not well defined, the water levels in UF-3 appear to respond more closely to the shallow aquifer water levels than do the other UF wells.

6.1.2.3 FLORIDAN AQUIFER

The Floridan Aquifer is more than 1,300 feet thick at the CF site in Hardee County. This aquifer consists of limestone and dolomite beds of the Tampa, Suwannee, Ocala, Avon Park, and Lake City Formations and is confined above by the clays at the base of the Hawthorn and the upper part of the Tampa Formations.

Although the entire aquifer seems to behave as an interconnected hydrologic unit, there were minor differences measured in the potentiometric head between the Avon Park and Lake City Limestones during CUP investigations, suggesting the presence of a semi-confining bed within the aquifer.

The results of a series of pump tests and flowmeter surveys conducted in the Floridan Aquifer during the CUP investigations showed that there was a significant difference in water-yielding potential or permeability of the various units.

An aquifer test of the Tampa Formation was conducted to evaluate its water-bearing characteristics and the nature of the overlying confining beds. Static water levels taken prior to testing indicated a similar potentiometric head to that of the underlying Suwannee Limestone but a significant difference from that of the overlying Hawthorn. For this reason, the Tampa Formation was included within the Floridan Aquifer at the site.

The pump test of the Tampa Formation was conducted using the airlift technique. The pumping rate was measured at 100 gpm using a 90° V-notch weir. Specific capacity was 0.96 gpm/ft and transmissivity calculated from recovery data was 3,000 gpd/ft.

Two short-term airlift pump tests were conducted in Well LF-3. The zone from 510 to 678 feet in the Suwannee Limestone was pumped at a rate of about 1,400 gallons per minute for each test. Transmissivity values calculated from the test using the recovery versus t/t' plot were 30,000 and 31,000 gpd/ft. Because the airlifting technique results in more of a constant drawdown than a constant production type of test, drawdown data in the pumped well were not used to calculate aquifer coefficients.

Two short-term airlift tests (one 10-hour test and one 6-hour test) in conjunction with a flowmeter survey were conducted in the DF well. The pumping rate for both tests was about 2,000 gallons per minute. The zone tested was from depths of 519 to 1,073 feet below ground surface and included Suwannee Limestone, Ocala Group, the Upper Avon Park Limestone, and the top 50-feet of the Avon Park dolomite unit. Results of the flowmeter data are shown in Figure 6.1-11.

The transmissivity calculated during a 10-hour test for the entire interval was approximately 190,000 gpd/ft. The flowmeter indicated that about 31 percent of the flow was from the Suwannee, 7 percent from the Ocala, 15 percent from the Upper Avon Park Limestone, and about 47 percent from the top 50-feet of the Avon Park dolomite. Based on these percentages and a total transmissivity of about 190,000 gpd/ft, the following transmissivity values were calculated for the individual formations:

Suwannee Limestone	T =	59,000
Ocala Group	T =	13,000
Upper Avon Park Limestone	T =	29,000
Top 50 feet of Avon Park dolomite	T =	89,000
TOTAL	Total T =	190,000

During the 10-hour airlift test, drawdown and recovery data were collected in Well LF-3 about 850 feet south of the pumping well. Assuming 31 percent of the flow was from the Suwannee, a transmissivity

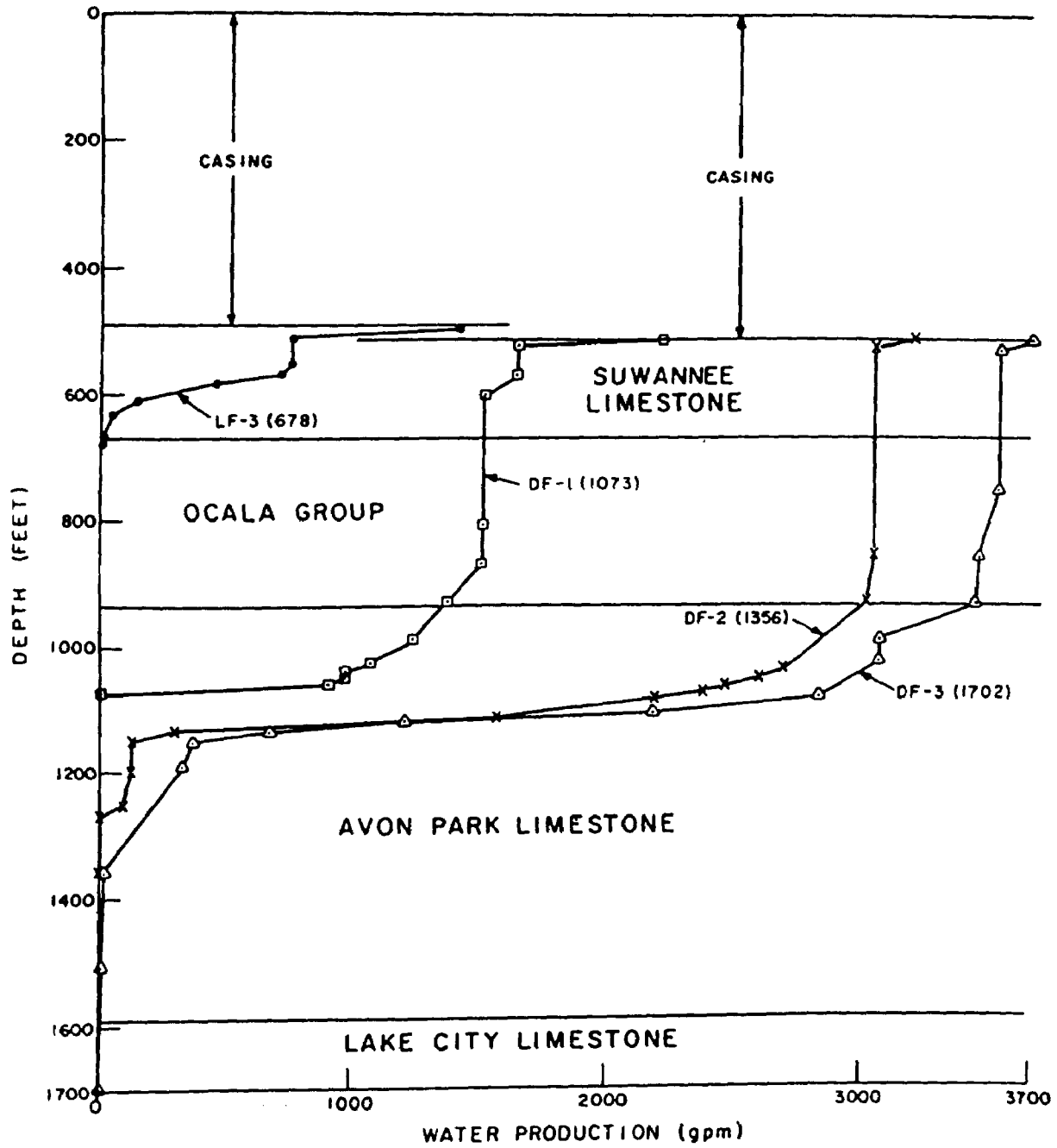

Figure 6.1-11
SUMMARY OF FLOWMETER DATA INDICATING DEPTHS OF PRINCIPAL WATER BEARING ZONES AT THE DF WELL
SOURCE: CF MINING CORPORATION, 1976.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

of 24,000 gpd/ft was calculated from drawdown data and 37,000 gpd/ft from recovery data. Also, a storage coefficient of 0.00005 for the Suwannee was calculated based on the drawdown data.

Total transmissivity for the 6-hour test at the DF well was approximately 170,000 gpd/ft. Using the method previously discussed, transmissivities for individual formations were as follows:

Suwannee Limestone	T =	53,000
Ocala Group	T =	12,000
Upper Avon Park Limestone	T =	25,000
Top 50 feet of Avon Park dolomite	T =	80,000
TOTAL	Total T =	170,000

Additional zones of the Floridan Aquifer were tested using airlift pumping in combination with another flowmeter survey. An average of 3,200 gallons per minute was pumped from depths between 514 and 1,356 feet. Total transmissivity for the zone which included the complete Avon Park dolomite, was calculated from recovery data in the DF well. The calculated value of 2,600,000 gpd/ft is basically a value for the highly transmissive dolomite zone.

A final flowmeter survey was conducted when the DF well reached a total depth of 1,702 feet. The zone tested was between 514 and 1,702 feet and included the Suwannee, Ocala, Avon Park, and part of the Lake City formations. Approximately 3,700 gallons per minute were pumped using the airlift method. A total transmissivity of about 3,800,000 gpd/ft was calculated based on recovery data from the DF well. Since this number appeared high compared to other test results, a second calculation utilizing the specific capacity method (USGS, 1962) was made.

Specific capacity, or discharge divided by drawdown in the pumping well, was equal to approximately 925 gpd/ft. The calculation was based on a pumping rate of 3,700 gpm and a drawdown in the DF well of 4 feet.

Drawdown in the well was determined by using a down-hole pressure sensor which measures the change in formation pressure and thus cancels out drawdown due to friction loss of water moving up-hole. Transmissivity based on a specific capacity of 925 gpd/ft and storage coefficient of 0.00005 was about 2,100,000 gpd/ft which is in line with previous calculated values.

A 1,000 gallon-per-minute airlift test was performed for 11 hours in LF-3. The pumping well was cased to 950 feet and had open hole to a depth of 1,121 feet. Transmissivity calculated from recovery data was for the Avon Park Limestone and approximated 880,000 gpd/ft.

During a 12-hour pumping test of Lake City Limestone conducted in the DF well, approximately 40 gallons per minute were pumped from the zone between 1,500 and 1,702 feet using the airlift method. After 12 hours of pumping, there was a total drawdown of about 58 feet giving a specific capacity of about 17 gpd/ft. Calculations made from recovery data show that transmissivity for the Lake City Limestone is about 1,400 gpd/ft, significantly lower than that for the overlying Avon Park Limestone.

A large scale pump and recovery test of the Avon Park limestone and dolomite was conducted at the CF site in Hardee County beginning December 13, 1975 and continuing for six days of pumping and six days of recovery. Water was pumped from the Production Test Well (PTW) at a constant rate of about 5,700 gallons per minute. Thirty-eight observation wells (including 18 shallow aquifer wells on the CF property) at varying distances and direction from the PTW were used to monitor water levels in the shallow aquifer, the Hawthorn Formation, the Tampa Formation, the Suwannee Limestone, the Avon Park Limestone, and the Lake City Limestone.

An observation well 15,000 feet to the west-northwest of the cluster was the only outlying well which reacted to the pump test. Its corrected

drawdown of 2.3 feet is considered large in comparison to drawdowns of 3.5 and 3.3 feet for two wells which are 414 feet and 990 feet, respectively, from PTW.

Because anisotropic conditions were encountered, dolomite aquifer characteristics of transmissivity and storage coefficient and leakage for confining beds could not be calculated by normal radial flow ground water hydrology analytical methods. In order to obtain an indication of the magnitude of the transmissivity of the "permeable zone" between a well 15,000 feet from the test well cluster, Darcys Law Q=TIW was used and a transmissivity value of 20,000,000 gpd/ft was obtained.

Variability within the "permeable zone" is shown by the specific capacity (SC) of PTW and DF which are located only 153 feet apart. The DF test well had only 4 feet of drawdown for a pumping rate of 3,700 gpm (SC = 925 gpm/ft) whereas PTW had a drawdown of 20 feet for 5,700 gpm (285 gpm/ft). However, during the PTW pumping test, a test well cluster area drawdown of only 3.3 feet occurred (SC = 1,727 gpm/ft).

Outside of the permeable zone, transmissivities are lower and may be on the order of 500,000 gpd/ft or less.

A composite or areawide transmissivity value for the low and high value zones combined may exceed 2 million gpd/ft based upon specific capacities, potentiometric contours, and previous flow meter surveys conducted.

The storage coefficient for the Floridan Aquifer has been estimated to be 0.001 and 0.01 based upon the drawdowns observed. This is considered a high artesian storage value but is believed to be reasonable due to the great aquifer thickness which exceeds 1,300 feet. A reliable leakage value cannot be obtained from the PTW pumping test.

Based upon the large-scale pump test (6 days) data collected on the production test well and the analyses completed, the following conclusions have been reached:

1. The Avon Park dolomite is very much anisotropic such that a "permeable zone" trends west-northwest between the test well cluster and an area about one-half mile north of LF-4.
2. The highly permeable zone probably controls potentiometric water level contours. This is illustrated by water level contours plotted for Hardee County (Wilson, 1975).
3. Identical Suwannee water level responses at the cluster indicate that the "highly permeable" zone penetrated by PTW is greater than 1,200 feet wide.
4. The Floridan Aquifer includes geologic formations from the Lake City Limestone up through the Tampa Formations indicated by pumping water level responses in these formations. The total thickness exceeds 1,300 feet.
5. A confining bed exists between the Floridan Aquifer and secondary artesian aquifer as indicated by Hawthorn water levels monitored during the PTW pumping test.
6. Transmissivities of the Avon Park dolomite may range from less than 500,000 to more than 20,000,000 gpd/ft on an areal basis. The storage coefficient is believed to be in the order of 0.001 to 0.01. A leakage value for confining beds bounding the Floridan Aquifer was not calculated based upon the PTW pumping test.
7. Determination of pumping levels for pumping rates other than 5,700 gpm can be extrapolated directly from plots of the pump test data.

Water level recorders have been maintained since February 1976 by CF on 5 wells in the Floridan Aquifer. One of these wells is in Complex I (LF-5), and the remaining four wells are on Complex II (LF-1, LF-4, LF-6, and DF). The hydrograph from LF-4 is presented in Figure 6.1-12 for the period from February 1976 through June 1982. The hydrograph indicates that the highest level (55.5 feet MSL) occurred in October

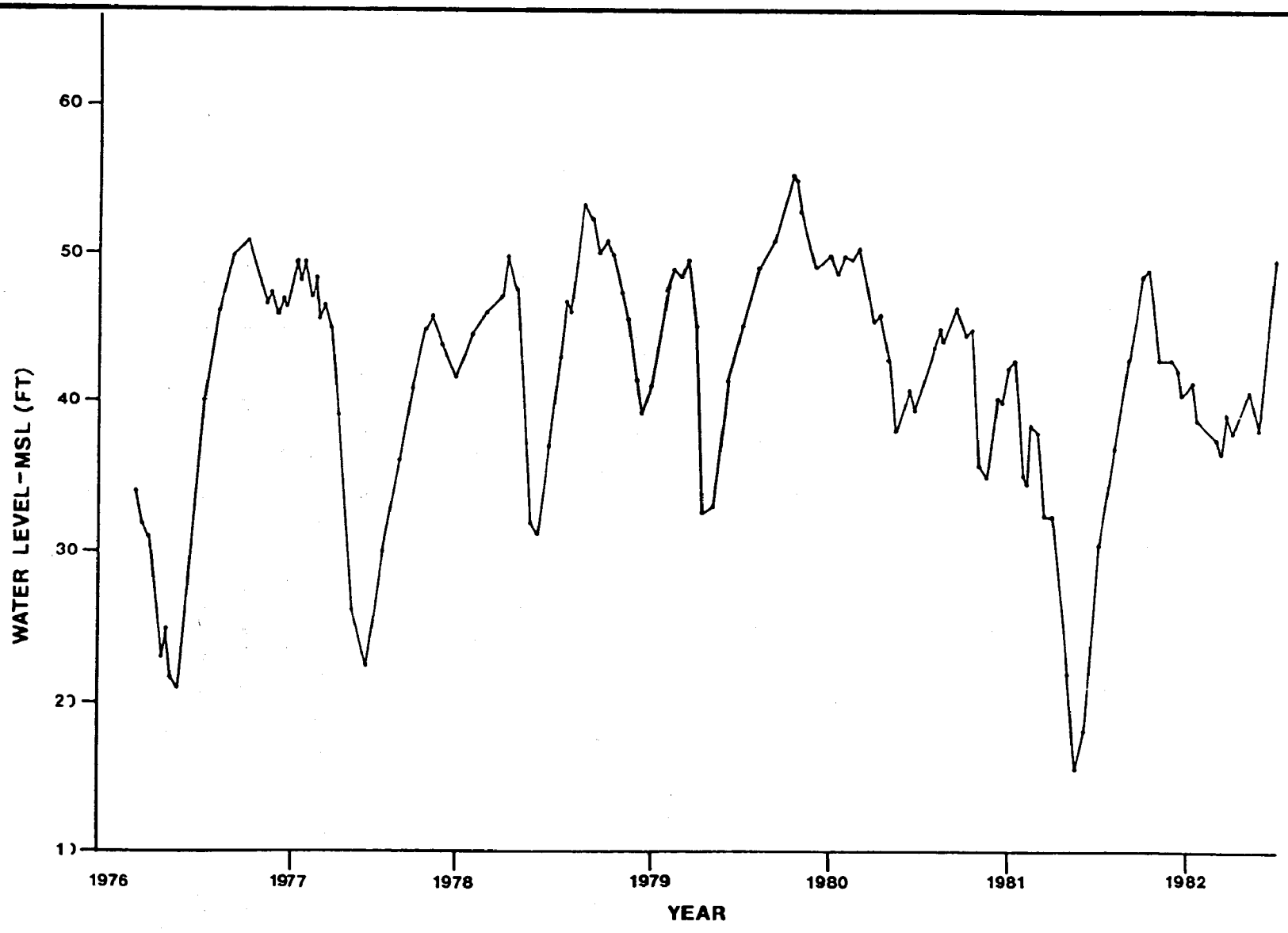

Figure 6.1-12
HYDROGRAPH OF FLORIDAN WELL LF-4 ON CF COMPLEX II, FEBRUARY 1976 THROUGH JUNE 1982

SOURCES: CF MINING CORPORATION, 1976-1982; ESE, 1982.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

1980 and the lowest level (15.5 feet MSL) occurred in May 1981. The general trend of the levels does not indicate a decline in the overall potentiometric surface over the six-year period. The low water level in May 1981 corresponds with a regional drought in which heavy agricultural pumping occurred west of the site according to Southwest Florida Water Management District personnel (1982).

The hydrology from LF-1, LF-4, and LF-6 for the period from July 1981 through June 1982 are shown in Figure 6.1-13. LF-5 was not included on the figure because its water level was nearly identical (within 1 foot) of LF-6. The water level for Well DF was between the water levels recorded at LF-1 and LF-4 for the entire year.

The hydrographs indicated that during the study period, levels in the Floridan Aquifer fluctuated about 21 feet. The highest level was at LF-6 (63 feet MSL) and the lowest was at LF-4 (30 feet MSL). The gradient of the potentiometric surface across the property is about 1 foot/mile pitching downward in the southwestern direction.

Water-bearing zones in the secondary artesian are separated from the underlying Floridan Aquifer by about 50 feet of basal Hawthorn or upper Tampa clays. The effectiveness of the clays as confining material is indicated by significant differences in water levels measured in the two aquifers. The less permeable material in the second confining bed tends to retard downward movement of water from the Hawthorn Formation into the Tampa Formation.

This resistance to downward movement on the west side of Complex II with head differences as great as 55 feet, appears to be greater than the east side where the head difference was a maximum of 8 feet. However, this difference could be due to greater drawdowns on the west side from the long pumping center on the Hillsborough/Manatee County line, as shown in Figure 6.1-2.

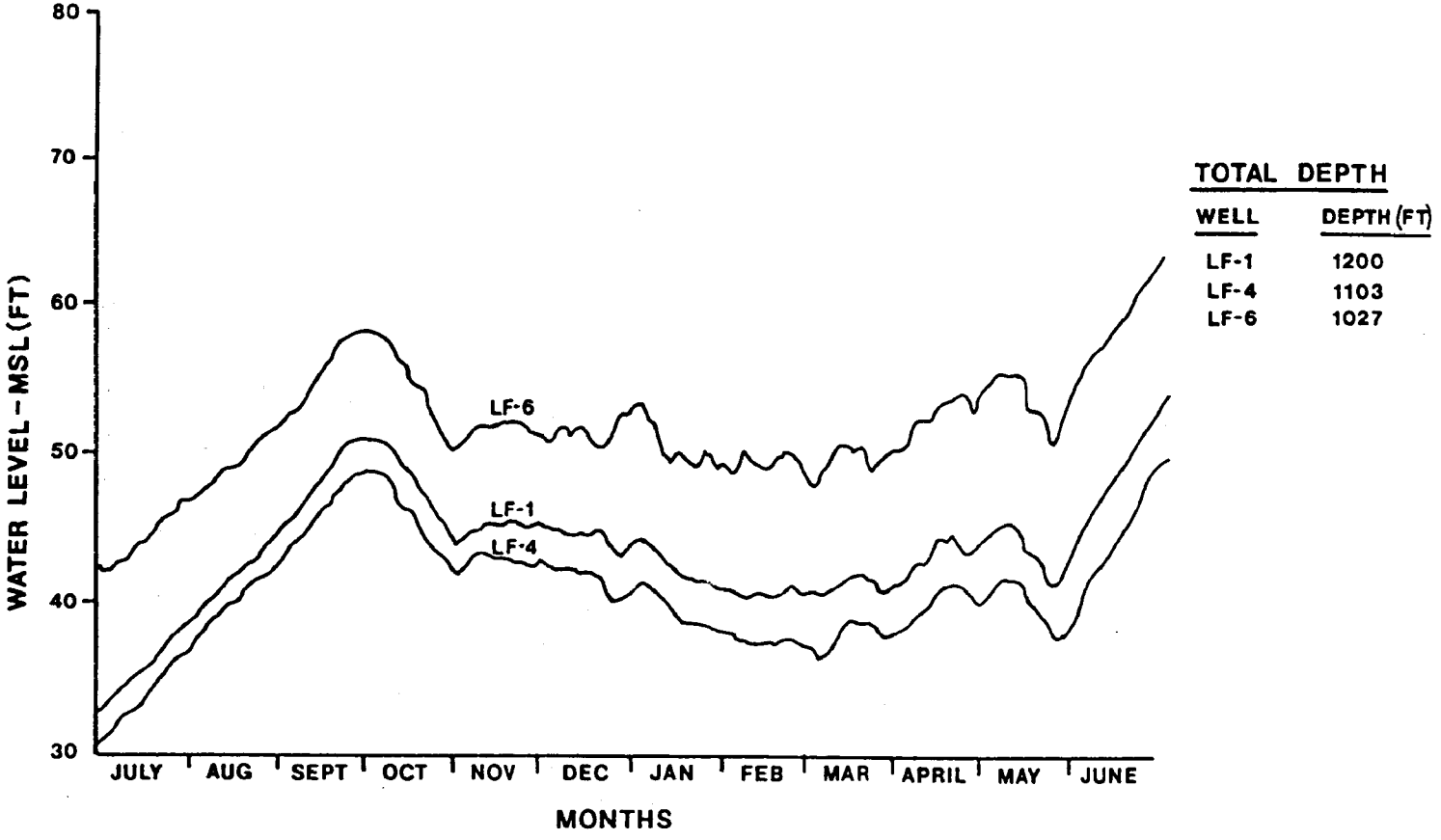

Figure 6.1-13
HYDROGRAPHS OF FLORIDAN WELLS ON CF COMPLEX II, JULY 1981 THROUGH JUNE 1982

SOURCES: CF MINING CORPORATION, 1981-1982; ESE, 1982.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

The resulting head differences measured between the shallow aquifer and Floridan Aquifer was also greater on the western portion of Complex II (as high as 87 feet) than on the eastern area (maximum measured was about 71 feet).

6.1.2.4 RECHARGE AND WATER MOVEMENT

Precipitation is the ultimate source of recharge to the ground water system at the CF project area. The shallow aquifer contains water derived from direct recharge of local precipitation. Water entering the shallow aquifer by infiltration moves laterally in a direction that is controlled for the most part by topography. After the periods of high rainfall, water generally moves through the shallow aquifer into the surface drainage courses to provide base flow to the streams on Complex II for several weeks.

Recharge of the secondary artesian aquifer is supplied by downward movement of water from the shallow aquifer and by lateral movement of water from areas to the north and east where the potentiometric surfaces of both the secondary artesian and Floridan Aquifer are higher (Wilson, 1975). The principal for both vertical and lateral movement is essentially the same in that water moves in the direction of decreasing head. For example, at the CF site, July 1981, the water level in the shallow aquifer (approximately 116 feet MSL) was about 62 feet above the water level in the secondary artesian aquifer (approximately 54 feet MSL). Thus, water from the shallow aquifer had the potential to move through the first confining bed and into the secondary artesian aquifer in response to the vertical hydraulic gradient.

Recharge to the Floridan Aquifer also occurs both laterally and vertically. Lateral inflow is from the north and east where potentiometric levels are higher than at the project area. There is the potential on the site for vertical recharge through the confining beds and the secondary artesian aquifer into the Floridan Aquifer.

The difference in potentiometric head above and below confining beds in combination with the vertical permeablilites of the confining beds control the rate or amount of water moving through the system. During the study period, July 1981 through June 1982, the head difference was observed to be greater on the western portion of the property (therefore it had a greater recharge potential), than on the eastern portion.

Even though a downward gradient exists on the site, the results of the CUP pump tests indicate that no measurable leakance occurs in the site area. This is attributable to the confining beds between the aquifers.

An inventory of water wells was conducted to determine the location, depth, and other pertinent information about water wells in the vicinity of the project site. A summary of water well data is presented in Table 6.1.2-2, Inventory of Wells in the Vicinity of CF Industries' Hardee County Phosphate Project Site (CF Industries, Inc. 1975). Well locations are shown on Figure 6.1-14.

6.1.2.5 SUMMARY

One major and two minor aquifers underlie the CF Hardee phosphate project site in northwestern Hardee County. The major aquifer is the Floridan Artesian Aquifer. The minor aquifers are the shallow aquifer and the secondary artesian aquifer. The aquifers are separated by confining beds.

The Floridan Aquifer consists of more than 1,300 feet of limestone and dolomite within the Tampa, Suwannee, Ocala, Avon Park, and Lake City Formations. The aquifer is confined above by clays of the basal Hawthorn or Upper Tampa Formations. Static water level measurements, pump tests and flowmeter surveys indicate that differences in potentiometric head exist between formations and that there are significant differences in permeabilities within the aquifer. A representative transmissivity for the entire Floridan Aquifer at the CF site is more than 2,000,000 gpd/ft. Transmissivities for the individual formations

Table 6.1.2-2. Inventory of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Site

Well Number*	Location	Depth	Amount/Size of Casing (ft.-inch DIA)	Average Yield (gpm)	Use	Permit No.	Date Drilled	Pump	Ground Surface Elev.	Source of Data†
HA-1	N27°36'5" E82°2'48"	900	400-12		Irrig.		1956		133	1
HA-2	N27°34'7" E82°2'55"	1,062	82-12	2,000	Unused		1957	None	123	1
HA-3	N27°34'11" E82°02'50"	1,062	82-12	2,000	Unused		1957	None	127	2
HA-4	N27°35'30" E82°0'53"	965	124-12	1,760	Irrig.		1962	Turbine	122	1
HA-5	Sec. 10 T33S R23E	900	98-10		Irrig.	74067910				4
HA-6	N27°31'12" E81°59'56"	1,360	900-10	2,000	Irrig.		1959	Turbine	90	1
HA-7	N27°36'20" E81°58'38"	810	88-10		Irrig.			Turbine	125	2
HA-8	N27°35'44" E81°59'4"	960	10-0		Irrig.		1962	Turbine	125	1
HA-9	N27°35'43" E81°59'3" SW 1/4	400	90-4		Domes.		1960		125	1
HA-10	Sec 23 T33S R23E NE 1/4		4		Domes.					3
HA-11	Sec 12 T33S R23E		12"		Irrig.	72117040				4
HA-12	N27°35'45" E81°57'2" NW 1/4	930	200-10"		Irrig.		1956	Turbine	122	1
HA-13	Sec 20 T33S R24E	840	168-12		Irrig.	73013850				4
HA-14	N27°35'47" E81°56'13"	950	120-12	1,100	Irrig.			Turbine	111	1
HA-15	N27°35'48" E81°56'1"	580	100-4	50	Irrig.			Centrif.	110	1
HA-16	Sec 5 T34S R24E	868	445-8		Irrig.	75047850				4

Table 6.1.2-2. Inventory of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Site (Continued, Page 2 of 4)

Well Number*	Location	Depth	Amount/Size of Casing (ft.-inch DIA)	Average Yield (gpm)	Use	Permit No.	Date Drilled	Pump	Ground Surface Elev.	Source of Data†
HA-17	NE 1/4 Sec 9 T33S R24E	932	392-10		Irrig.	72024940				4
HA-18	SE 1/4 Sec 21 T33S R24E		79-4		Domes.					3
HA-19	NW 1/4 Sec 3 T33S R24E		16-2		Irrig.					3
HA-20	Sec 3 T33S R24E	931	150-8		Irrig.	74064530				4
HA-21	SW 1/4 Sec 22 T33S R24E		4		Domes.					3
HA-22	Sec 22 T33S R24E	560	406-8		Irrig.	74114890				4
HA-23	N27°31'9" E81°54'13"	210	120-4	30	Domes.		1971		110	1
HA-24	N27°30'40" E81°54'19"	617	110-8	250	Irrig.			Turbine	109	1
HA-25	Sec 2 T33S R24E	662	163-8		Irrig.	74084850				4
HA-26	Sec 11 T33S R24E		8		Irrig.	72012300				4
HA-27	N27°37'03" E81°53'0"	887	164-12	1,700	Irrig.		1963	None	104	2
HA-28	N27°36'3" E81°52'29"	986	239-12	1,900	Irrig.		1957	Turbine	108	1
HA-29	SW 1/4 Sec 11 T34S R24E	1,130	117-10		Domes.	74074830				4
HA-30	N27°37'38" E81°52'1"									1
HA-31	N27°37'37" E81°51'58"	944	248-10		Irrig.		1957	Turbine	121	2

Table 6.1.2-2. Inventory of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Site (Continued, Page 3 of 4)

Well Number*	Location	Depth	Amount/Size of Casing (ft.-inch DIA)	Average Yield (gpm)	Use	Permit No.	Date Drilled	Pump	Ground Surface Elev.	Source of Data†
HA-32	N27°31'20" E81°52'19"	1,060	200-12	1,800	Irrig.		1957	Turbine	107	2
HA-33	N27°31'8" E81°52'19"	1,060	100-12	1,800	Irrig.		1957	Turbine	107	1
HA-34	N27°30'28" E81°52'28"	1,220	200-12	2,000	Irrig.		1956	Turbine	106	1
HA-35	N27°36'14" E81°50'48"	900			Irrig.				104	1
HA-36	N27°35'38" E81°51'15" NE 1/4	1,139	248-12	1,000	Irrig.		1951	Turbine	125	2
HA-37	Sec 31 T33S R25E	1,040	222-8		Irrig.	71061380				4
HA-38	Sec 6 T34S R25E		12		Irrig.	71078650				4
HA-39	Sec 6 T34S R25E	1,062	454-10		Irrig.	71028380				4
HA-40	N27°32'49" E81°50'47"	1,062	139-10		Irrig.		1971		115	1
HA-41	Sec 18 T34S R25E		6		Irrig.	72012340				4
HA-42	N27°38'28" E81°50'20"	354	90-6	500	Irrig.		1955	Turbine	119	1
HA-43	N27°36'18" E81°50'28"	335	100-8		Irrig.		1946	Turbine	123	1
HA-44	Sec 20 T33S R25E	1,075	155-10		Irrig	74115000				4
HA-45	N27°30'8" E81°50'13"	537	100-8	750	Irrig.		1956	Turbine	98	1
HI-1	Sec 34 T32S R22E	916	250-30			74129330				4
HI-2	Sec 34 T32S R22E	916	295-12			74129345				4
HI-3	Sec 34 T32S R22E	916	290-10		Obser.	74129346				4

Table 6.1.2-2. Inventory of Wells in the Vicinity of CF Industries Hardee County Phosphate Project Site (Continued, Page 4 of 4)

Well Number*	Location	Depth	Amount/Size of Casing (ft.-inch DIA)	Average Yield (gpm)	Use	Permit No.	Date Drilled	Pump	Ground Surface Elev.	Source of Data†
HI-4	Sec 34 T32S R22E	910	272-30			75129430				4
MA-1	N27°34'54" E82°06'17"	1,135	90-12	1,800	Stock		1961	Turbine		2
MA-2	N27°33'06" E82°03'51"	1,178	160-12		Irrig.		1959	Turbine	115	2
PO-1	Sec 28 T32S R23E	1,568	175-20		Indus.	74092360				4
PO-2	Sec 28 T32S R23E	906	195-20		Indus.	74092370				4
PO-3	Sec 28 T32S R23E	836	360-16		Indus.	74092380				4
PO-4	Sec 28 T32S R23E	1,020	294-16		Indus.	74092390				4
PO-5	Sec 28 T32S R23E	740	180-6		Indus.	74121210				4
PO-6	N27°38'49" E81°51'11"									1

*HA = Hardee County
HI = Hillsborough County
MA = Manatee County
PO = Polk County

†1 = USGS Open File Report
2 = Division of Geology IC No. 53
3 = Personal Communication
4 = SWFWMD

Source: ESE, 1986.

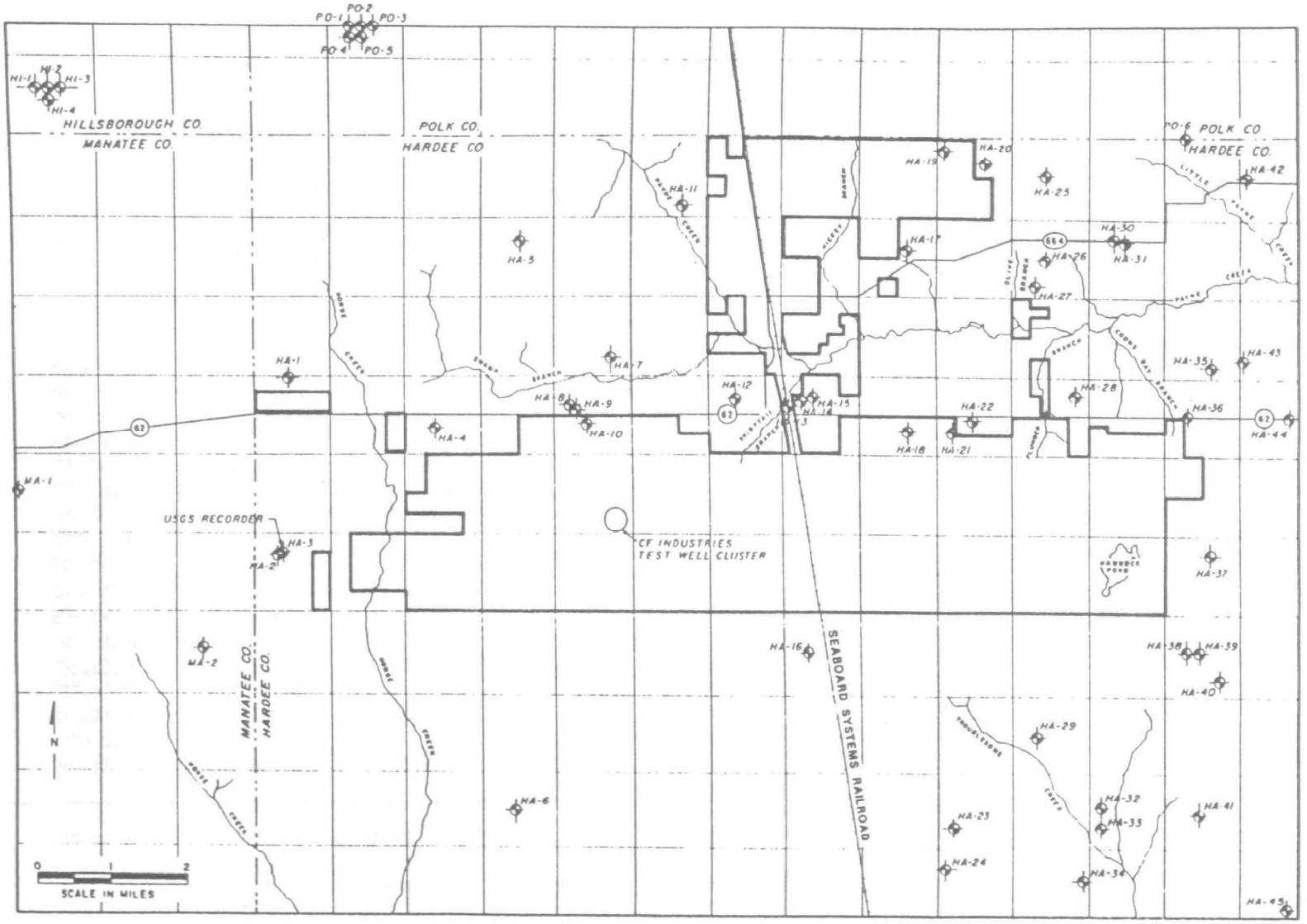

Figure 6.1-14
LOCATION OF WELLS IN THE VICINITY OF CF INDUSTRIES
HARDEE COUNTY PHOSPHATE PROJECT AREA

SOURCE: DAMES & MOORE, 1976

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

are as follows: Tampa--3000 gpd/ft; Suwannee--30,000 to 50,000 gpd/ft; Ocala--12,000 gpd/ft; Upper Avon Park Limestone--25,000 gpd/ft; Avon Park dolomite--approximately 2,000,000 gpd/ft; and part of the Lake City Limestone--1,400 gpd/ft.

The secondary artesian aquifer consists of about 250 feet of alternating limestone and clay within the Hawthorn Formation and is confined above by clay beds at the base of the shallow, undifferentiated clastic material. A representative transmissivity for the secondary artesian aquifer at the site is 100 gpd/ft.

The shallow aquifer underlies most of the CF property varving in thickness from 15 to 40 feet. Lithic compositon is dominantly clay and fine sand with some coarser sand and gravel. Evalution of data collected during 18 shallow aquifer tests indicated that the aquifer exhibited both artesian and water-table characteristics and that a representative transmissivity would be about 3,000 gpd/ft.

Table 6.1.2-3 is a summary of the physical and hydrological properties of aquifers and confining beds at the CF Hardee phosphate project area.

The ground water monitoring of the potentiometric surface in the shallow, secondary artesian aquifer and Floridan Aquifer from July 1981 through June 1982 indicated that the site is in a recharge condition. The head difference between the shallow aquifer and Floridan Aquifer has a downward gradient and, in July 1981, was as high as 87 feet on the western portion of the site and about 71 feet on the eastern portion. The smallest difference between the potentiometric surfaces of the shallow and deep aquifers was in September 1981 when the shallow aquifer was about 65 feet above the Floridan Aquifer.

6.1.3 REGIONAL DESCRIPTION--QUALITY

Variations in ground water quality occur over the site under natural conditions. Agriculture, mining, chemical processing, and the

Table 6.1.2-3. Summary of Aquifer and Confining Bed Characteristics

Aquifers and Confining Beds		Physical Properties: Thickness (feet)	Physical Properties: Depth (feet below ground surface)	Physical Properties: Dominant Lithic Type	Hydrological Properties: Representative Transmissivity (GPD/ft)	Hydrological Properties: Storage coefficient	Hydrological Properties: Static Water Level. (12/75) (Ft above MSL)	Hydrological Properties: Vertical Hydraulic Gradient (ft/ft)	Hydrological Properties: Horizontal Hydraulic Gradient (ft/ft)
Shallow Aquifer (undifferentiated clastic deposits)		40	0-40	Clay with Sand	3000	10^{-8} to 10^{-1}	118		variable
First Confining Bed (basal undifferentiated clastics/ upper Hawthorn)		30	40-70	Clay				.9	
Secondary Artesian Aquifer (Hawthorn Formation)		250	70-320	Limestone with Clay	1000	10^{-5} to 10^{-3}	89		
Second Confining Bed (basal Hawthorn clays)		50	320-370	Clay with Limestone				.9	
Floridan Aquifer	Tampa Formation	60	370-430	Limestone	3000		45		.0002
	Sand/Clay Unit	35	430-465	Sand/Clay					
	Suwannee Limestone	210	465-675	Limestone	30,000-50,000	10^{-3} to 10^{-2}	45		
	Ocala Group	270	675-945	Limestone	12,000		45		
	Avon Park Limestone	90	945-1035	Limestone	25,000				
	Dolomite Unit	230	1035-1265	Dolomite	>2,000,000				
		330	1265-1595	Limestone/ Dolomite			45		
	Lake City Limestone	107+	1595-1702+	Limestone	1,400		45-		

Source: Dames & Moore, 1976.

overpumping of public-supply wells have resulted in local degradation of some areas through contamination. The EPA (1978) document presents an overview of the ground water quality in the region. The following section presents summaries of descriptions from this overview on the shallow (also called the surficial or water table) aquifer, secondary artesian aquifer and the Floridan Aquifer.

6.1.3.1 SHALLOW AQUIFER

The water in the Shallow Aquifer is generally soft and has a low dissolved-solids content (less than 100 milligrams per liter) in the inland areas. The shallow aquifer is contaminated locally from nutrients from fertilized agricultural land, and leakage from sewers, seepage from industrial lagoons, septic systems, and landfills. Contamination of the shallow aquifer is generally evidenced by increased concentrations of dissolved constituents such as chloride, nitrate, fluoride, phosphate, sulfate, and, in some areas, bacteria and viruses (U.S. Army Corps of Engineers, 1977).

In Hardee and DeSoto Counties, the shallow aquifer is believed to increase in thickness from north to south and is capped at a depth between 40 to 65 feet. Wells completed in the shallow aquifer are generally used for domestic purposes, lawn-watering, or stock-watering. In general, this aquifer has high iron concentrations and has a pH value below 7 (i.e., it is slightly acidic).

6.1.3.2 SECONDARY ARTESIAN AQUIFER

Regional water quality data for the secondary artesian aquifer are limited and most of the existing information is combined with the results of sampling in the lower Floridan Aquifer. The secondary artesian aquifer is widely used as a source of water, although yields of individual wells and total withdrawals from this aquifer are generally less than those associated with the Floridan Aquifer (USGS, 1977).

In general, water quality in the secondary artesian aquifer is better than that of the Floridan Aquifer. The median values for dissolved solids, calcium and magnesium, sulfate, and hardness are all substantially less for the secondary artesian aquifer. Median concentrations of chloride and sodium are nearly equal to slightly lower while fluoride concentrations are slightly higher in value (see Table 6.1.3-1).

6.1.3.3 FLORIDAN AQUIFER

The Floridan Aquifer is an underground freshwater reservoir which extends under the entire peninsular portion of the state. Under natural conditions, highly mineralized water underlies the Floridan Aquifer at various depths. As shown in Figure 6.1-15, water obtained on-site from the Floridan Aquifer generally can be used as potable water, e.g., it provides the public water supply for the City of Arcadia. However, in the coastal areas (0-10 miles inland) from Hillsborough County to Charlotte County, the Floridan Aquifer contains essentially no potable water.

In coastal areas where drainage canals and tidal channels, as well as pumping near the coast, have reduced the potentiometric head, saltwater intrusion is an important concern. As a result of these influences, a saltwater wedge has migrated inland. The pumping of the deep aquifer water for irrigation is largely responsible for inland saltwater intrusion in the Floridan Aquifer.

The following discussion of ground water quality of the Floridan Aquifer in Hardee and DeSoto Counties is extracted from EPA (1978):

> Within the Floridan Aquifer, dissolved-solids concentrations generally increase from northern Hardee County toward southern DeSoto County and also increase with depth. Concentrations exceeding 500 milligrams per liter occur in the upper part of the Aquifer in southeastern and southwestern DeSoto County, in the lower Floridan Aquifer, along the Peace River, in the southern part of Hardee County, and in all of DeSoto County. The water temperature

Table 6.1.3.1. Median values and ranges of water quality characteristics for Hardee County

Aquifer	Parameter	Number of Samples	Median Value	Range of Value
Secondary Artesian	Dissolved	12	236	174 - 300
Floridan	Solids	6	479	242 - 623
Secondary Artesian	Calcium + Magnesium	7	47	44 - 58
Floridan	Total	7	68	58 - 31
Secondary Artesian	Sulfate	7	3.6	0 - 100
Floridan		7	200	47 - 300
Secondary Artesian	Hardness	7	160	130 - 200
Floridan		9	280	180 - 380
Secondary Artesian	Sodium	7	9.3	6.5 - 13
Floridan		6	11	8.1 - 14
Secondary Artesian	Flouride	8	1.1	0.5 - 1.7
Floridan		6	0.8	0.1 - 1.1
Secondary Artesian	Temperature	10	23.5	23.0 - 24.5
Floridan		8	27.0	25.5 - 29.5
Secondary Artesian	Chloride	13	12	6.0 - 36
Floridan		10	13	9.0 - 30

Source: USGS, 1977.

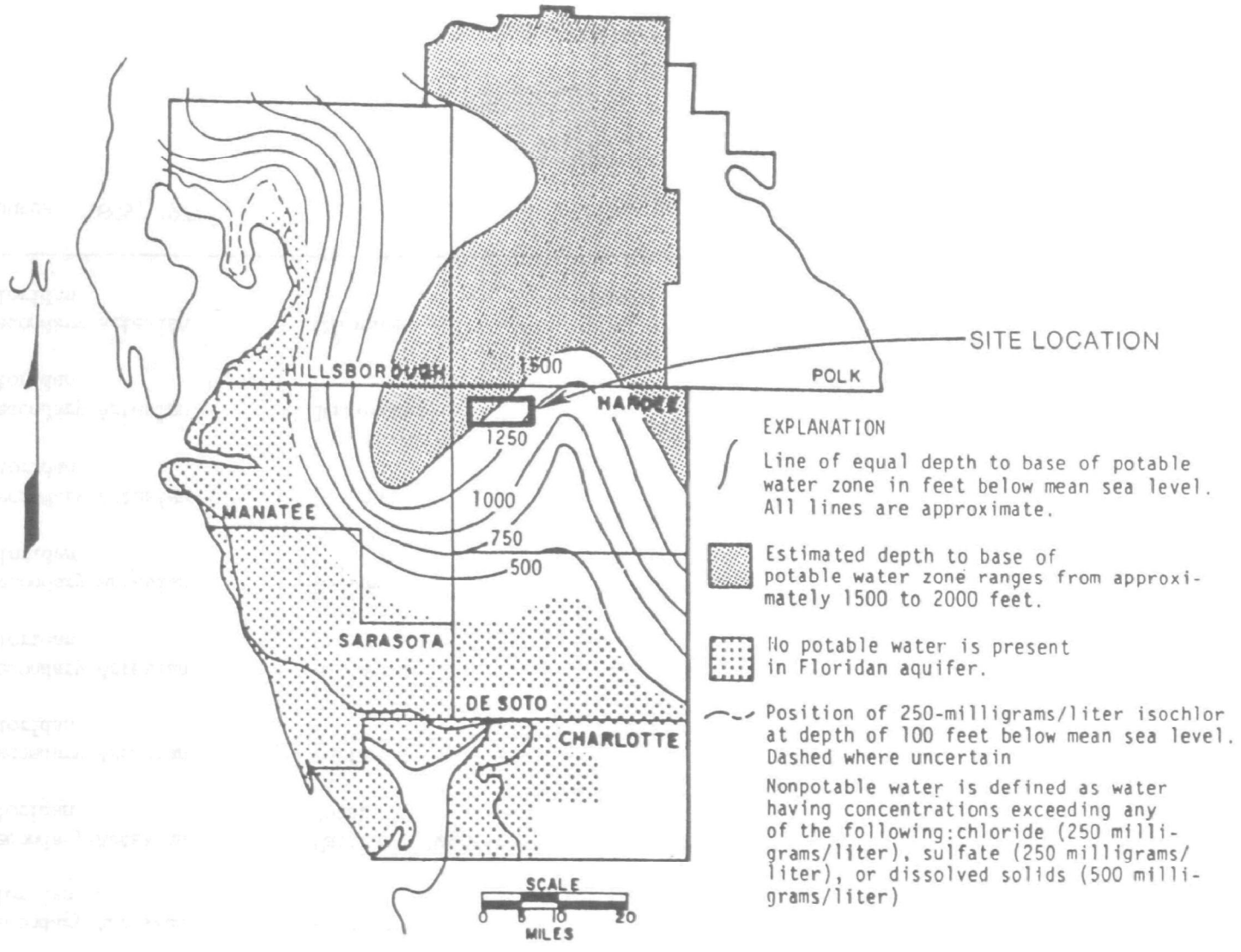

Figure 6.1 - 15
DEPTH TO BASE OF POTABLE WATER ZONE IN FLORIDAN AQUIFER, 1975

Source: EPA, 1978.

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Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

CF SID 08/15/85 rev

generally increases from northern Hardee to southwestern DeSoto County, as well as with depth. The water underlying Hardee and DeSoto Counties is generally hard because of the predominance of calcium- and magnesium-rich limestone and dolomite in the matrix. Generally, water from the upper part of the Floridan Aquifer is moderately hard to hard (61 to 180 milligrams per liter) in northern Hardee County, increasing in hardness toward southern DeSoto County where the water is very hard (exceeding 500 milligrams per liter). Within the lower part of the Floridan Aquifer, the only moderately hard to hard water occurs in the northeast corner of Hardee County, with hardness increasing toward the southwest.

Sulfate concentrations in Hardee and DeSoto Counties generally increase with depth. Most is probably derived from the solution of gypsum and anhydrite (calcium-sulfate minerals) found in the lower Floridan Aquifer. In the upper Floridan, concentrations generally increase from north Hardee to southwest DeSoto. Southwest of Arcadia, concentrations range from 100 to more than 250 milligrams per liter. Only in the northern half of Hardee County does water from the lower Floridan contain less than 100 milligrams per liter of sulfate. A zone exhibiting more than 250 milligrams per liter extends across southernmost Hardee County, northern DeSoto County, and along the Peace River valley, with the water in most of southern DeSoto County containing less sulfate (101-250 milligrams per liter).

Chloride concentrations in the Floridan Aquifer in Hardee and DeSoto Counties generally are less than 50 milligrams per liter although in areas south of Arcadia they range from 50 to 250 milligrams per liter and near the southwest Sarasota-DeSoto County line exceed 250 milligrams per liter. Concentrations of fluoride in the Floridan Aquifer underlying the two counties form a concentric pattern, increasing toward the center. In both the upper and lower Floridan Aquifers, concentrations are 0.8 milligrams per liter or less only along the periphery of Hardee and DeSoto Counties (except along the western boundary where concentrations are higher). In much of the central area along the Hardee-DeSoto County line, Aquifer concentrations in the upper Floridan exceed 1.4 milligrams per liter (and some exceed 2.0 milligrams per liter). In the lower Floridan, concentrations exceeding 1.4 milligram per liter are restricted to western DeSoto County. The principal source of fluoride in Hardee and DeSoto Counties is fluorapatite, a mineral restricted to rocks of the upper Floridan Aquifer and younger deposits. Fluorapatite is the principal source mineral of phosphate in the land-pebble mining district of central Florida.

6.1.4 SITE-SPECIFIC DESCRIPTION--QUALITY

6.1.4.1 DATA COLLECTION

Previous Studies

As part of the previous studies on the CF property, extensive ground water quality data have been collected. During the CF DRI and the CUP investigations by Dames and Moore, water quality data were collected during aquifer pump tests. From early 1976 until June 1982 monthly ground water samples were collected from 18 shallow aquifer wells (SA-1 through SA-18), 4 secondary artesian aquifer wells (UF-3 through UF-6), and 7 Floridan Aquifer wells (UF-2, LF-1, LF-4, LF-5, LF-6, DF, and PTW). Well UF-2 was originally a secondary artesian well that was re-drilled to the present depth of 443 feet. It is in the uppermost area of the Floridan Aquifer. The monthly analyses conducted on these samples include: temperature, pH, ammonia, nitrite, nitrate, orthophosphate, total phosphorus, sulfate, alkalinity (bicarbonate and carbonate), dissolved silica, total dissolved solids (TDS), fluoride, and conductivity.

Semi-annual analyses from early 1976 until June 1982 were also conducted on seven of the shallow aquifer wells (SA-1, 2, 3, 4, 6, 8, and 17), three secondary artesian wells (UF-4, UF-5, and UF-6) and five Floridan Aquifer wells (LF-4, LF-5, LF-6; PTW, and DF). These semi-annual analyses include calcium, magnesium, sodium, potassium, chloride, iron, and strontium. Radium-226 sampling is discussed in Section 5.0--Radiation.

EIS Monitoring

Because of the detailed and continuing field monitoring program, monitoring for the EIS was limited to split sampling with CF from one shallow aquifer well (SA-17), one secondary artesian well (UF-4), and one Floridan Aquifer well (LF-4). ESE and CF analyzed these samples for all parameters in CF's monthly and semi-annual parameter list (see Table 6.1.4-1). In addition, ESE analyzed the samples for metals.

Table 6.1.4-1. Results of Split Sampling Conducted by CF/ESE on Three Wells, October 1981

Parameter	Shallow Aquifer SA-17		Seconary Artesian UF-4		Floridan LF-4	
	CF	ESE	CF	ESE	CF	ESE
Alkalinity (ppm $CaCO_3$)	90.8	82	242.4	202	211.0	181
Fecal Coliform (Col/100 ml)	12	<4	0	<4	0	<4
Fluoride (ppm F)	0.82	0.83	2.26	2.31	2.24	2.26
Ammonia (ppm N)	<0.05	0.01	0.12	0.25	0.12	0.24
Nitrate (ppm N)	<0.01	<0.004	<0.01	<0.004	<0.01	<0.004
Nitrite (ppm N)	0.008	0.010	<0.004	<0.004	<0.001	<0.004
pH (std Units)	8.1	6.20	8.0	7.50	8.1	7.40
T. Phosphorus (ppm P)	1.0	1.33	0.2	0.288	<0.1	0.018
Phosphate diss. (ppm PO_4	0.4	0.543	0.0	<0.010	<0.1	<0.010
Silica diss. (ppm SiO_2)	7.8	7.4	46.6	44.9	43.2	39.9
Susp. Solids (ppm)	20.2	26.0	50.8	87.0	22.6	20.0
Diss. Solids (ppm)	135	155	398	422	379	401
Conductivity (umhos/cm)	180	140	650	460	620	440
Sulfate (ppm)	6.9	<1	10.9	16	10.5	12
Turbidity (NTU)	11.0	14.0	12.0	17.0	7.8	13.0
BOD (ppm)	—	—	—	—	—	—
Temp. (C°)	25.0		25.0		25.0	
Chloride (ppm Cl)	4.09	8	92.24	87	94.06	86
Calcium (ppm Ca)	17	16.0	23	66.3	24	57.2
Mg (ppm Mg)	19	13.8	26	33.2	28	23.0
Na (ppm Na)	3	6.30	50	94.7	50	76.6
K (ppm K)	1	1.20	2	2.70	1	2.10
Fe (ppm Fe)	<1	.41	<1	3.11	1	4.06
Sr (ppm Sr)	<1	.189	<1	0.302	<1	0.387
Arsenic, total (ug/l)	NA	<10	NA	<10	NA	<10
Chromium, total (ug/l)	NA	6.7	NA	12	NA	<3.0
Copper, total (ug/l)	NA	196	NA	11.0	NA	2.4
Lead, total (ug/l)	NA	40.0	NA	<18.0	NA	<18.0
Zinc, total (ug/l)	NA	164.0	NA	102.0	NA	7.2
Beryllium (ug/l)	NA	<1.0	NA	<1.0	NA	<1.0
Cadmium, total (ug/l)	NA	<0.2	NA	<0.2	NA	<0.2
Selenium, total (ug/l)	NA	<23	NA	<23	NA	<23
Silver, total (ug/l)	NA	<0.4	NA	<0.4	NA	<0.4
Mercury, total (ug/l)	NA	0.4	NA	0.5	NA	0.4
Nickel (ug/l)	NA	<5.0	NA	9.2	NA	<5.0
Relative Error Cation/Anion Balance (Percent)	4	12	36	20	29	10

NA = Not analyzed.

Sources: CF, 1982.
ESE, 1982.

The wells were sampled by the same procedure that CF uses during monthly sampling. The method used by CF to extract the samples utilized a thief sampler. This sampler consisted of a bailing device which allows the sample to be extracted from a selected depth. The wells are not pumped before sampling in order to obtain an undisturbed sample from a discrete depth interval. In general, the split sample analyses compare moderately favorably. Major differences exist in the analyses of cations and anions. A cation-anion balance was calculated and is included in Table 6.1.4-1.

6.1.4.2 DATA ASSESSMENT

Shallow Aquifer

The 18 Shallow Aquifer wells were divided into 3 groups for discussion purposes:

1. Complex I,
2. Complex II-East, and
3. Complex II-West.

Details of well depths and location can be found in Table 6.1.4-2. Complex I included Wells SA-1 through SA-4, which range in depth from 25 to 51 feet and have monitor zones between 5 and 51 feet below the surface. Complex II-East included Wells SA-5 through SA-10 and ranged in depth from 35 to 66 feet with monitor zones between 5 and 66 feet. Complex II-West included Wells SA-11 to SA-18 and ranged in depth from 45 to 66 feet with monitor zones between 5 and 66 feet.

The mean concentration of the analyses conducted by CF for the 18 shallow aquifer wells are summarized for July 1981 through June 1982 in Table 6.1.4-3. The monthly analyses used to compile this table are presented in Appendix A to this report.

Average total dissolved solids (TDS) concentrations were somewhat variable with location as a direct function of the substrate (i.e., carbonaceous versus clayey or siliceous) characteristics of the aquifer. Linear regression analysis indicates a highly significant correlation

Table 6.1.4-2. Location and Description of Existing Wells Drilled by CF Mining Corporation

Well No.	Location* North	Location* East	Ground Level Elevation	Total Depth (In Feet)	Casing Depth (In Feet)	Casing Diameter (In Inches)	Monitored Zones (Feet)
SA-1	60698.117	57769.308	123.9	51	51	6	5-51
SA-2	53874.851	45750.726	113.3	30	30	6	5-30
SA-3	47208.819	54996.422	99.1	25	25	6	5-25
SA-4	55822.678	64982.087	120.3	30	30	6	5-30
SA-5	34048.580	56335.408	105.3	66	66	6	5-66
SA-6	41969.327	59133.238	112.1	56	56	6	5-56
SA-7	37931.175	67298.860	106.8	52.5	52	6	5-52.5
SA-8	34770.304	77396.733	117.9	35	35	6	5-35
SA-9	28902.101	75248.616	118.8	44	44	6	5-44
SA-10	28970.300	67370.672	105.7	44	44	6	5-44
SA-11	28855.100	47516.517	105.0	47	47	6	5-44
SA-12	34315.672	51591.215	119.6	45	45	6	5-45
SA-13	41988.346	37768.314	126.1	66	66	6	5-66
SA-14	34280.992	40321.390	120.9	60	60	6	5-60
SA-15	28975.314	35273.553	116.7	55	55	6	5-55
SA-16	29307.336	25996.360	118.8	60	60	6	5-60
SA-17	37452.141	26164.405	119.6	51	51	6	5-51
SA-18	42018.579	32580.104	120.8	55	55	6	5-55
UF-2	34417.226	39874.944	117.4	433	375	5	374-433
UF-3	34285.380	39921.683	117.6	375	91	10	65-375
UF-4	37352.531	26200.749	119.6	418	102	8	102-418
UF-5	60695.754	57670.013	123.6	360	84	8	84-360
UF-6	34691.817	77401.967	117.5	385	84	8	84-385
LF-1	34381.671	40273.115	121.3	1200	948	8	900-1200
LF-2A	34567.697	39875.488	118.5	1175	950	8	510-675,950-1175
LF-3	33289.416	40275.388	120.2	1121	945	8	510-675,950-1121
LF-4	37289.466	26226.180	119.6	1103	479	8	479-1103
LF-5	60694.758	57869.228	124.4	948	412	8	380-948
LF-6	34628.549	77402.964	118.1	1027	471	8	471-1027
PTW	34274.392	40168.483	121.3	1175	950	20	950-1175
DF	34123.773	40156.720	120.8	1702	1500	10	514-675,1500-1702

* Florida coordinate system.

Source: CF Mining Corporation, 1976.

Table 6.1.4-3. Mean Concentrations of Water Quality Data Collected From Shallow Aquifer Wells from July 1981 Through June 1982

Parameter	Complex I				Complex II - East						Complex II - West							
	SA-1	SA-2	SA-3	SA-4	SA-5	SA-6	SA-7	SA-8	SA-9	SA-10	SA-11	SA-12	SA-13	SA-14	SA-15	SA-16	SA-17	SA-18
Temperature (Field) °C	23.7	24.7	23.5	23.3	24.7	24.5	24.5	24.4	24.4	24.5	24.4	22.5	24.25	24.5	24.7	24.2	24.4	24.4
pH (Lab)	6.5	6.0	6.5	6.2	7.2	7.3	5.6	6.3	5.9	7.31	7.8	6.4	6.0	7.1	6.7	7.0	6.4	7.7
Ammonia (NH_3)	0.11	0.06	0.06	0.05	0.08	0.06	0.11	0.07	0.12	0.06	0.06	0.09	0.06	0.05	0.07	0.08	0.07	0.06
Nitrite (NO_2) ppb	2	6.3	5.17	1.42	21.8	1.8	16.9	27.7	15.0	18.8	2.0	1.75	3.6	3.3	42.3	4.2	13.0	5.7
Nitrate (NO_3)	.06	0.04	0.02	0.02	0.13	0.02	0.95	0.03	0.06	0.02	0.12	0.03	0.04	0.30	0.04	0.02	0.04	0.04
Orthophosphate	0.13	0.22	0.28	0.68	0.97	0.08	1.68	0.19	0.43	0.17	0.06	0.83	0.14	1.38	1.18	1.78	0.45	0.09
Total Phosphorus	1.44	0.82	2.16	1.10	2.09	0.47	2.61	4.77	1.00	0.76	0.65	2.36	0.70	2.08	2.98	3.06	1.07	0.36
Sulphate (SO_4)	2.29	15.79	17.05	9.84	5.58	2.09	21.98	32.58	13.41	6.68	2.93	3.90	3.03	1.73	1.38	0.74	6.00	13.34
Bicarbonate alkal. as $CaCO_3$	24.82	11.73	6.71	7.63	156.2	136	8.66	28.36	7.51	100.5	322	17.9	4.50	66	32.21	44.03	28.11	177
Silica (SiO_2)	9.08	6.25	8.31	10.59	17.1	23	14.08	13.10	9.65	18.85	39.28	17.61	7.90	48.8	16.43	17.09	10.25	30.19
TDS (Residue)	77.83	75.08	108.42	70.67	244	168	210	125	109	283	365	75	98	201	109	98	108	260
Fluoride	0.15	0.38	0.35	0.40	0.93	0.27	0.43	0.55	0.27	0.53	0.48	0.51	0.35	0.44	0.76	0.84	0.44	0.42
Conductivity (Lab) umhos/cm	93.08	114.17	155.75	92.83	270	231	204	162	117	345	492	75	88	206	115	122	87	354
Carbonate Alkal. as $CaCO_3$	0.0	0.0	0.0	0.0	0.0	0.64	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.0	0.0	0.0	0.0	1.2
Calcium	12.8	14.6	20.9	17.7	*	36.8	*	22.4	*	*	*	*	*	*	*	*	15.4	*
Magnesium	7.3	11.1	6.5	7.0	*	21.4	*	9.1	*	*	*	*	*	*	*	*	13.2	*
Sodium	19.9	20.1	23.2	18.5	*	18	*	24.4	*	*	*	*	*	*	*	*	15.6	*
Potassium	0.4	0.6	0.85	0.35	*	1.1	*	0.3	*	*	*	*	*	*	*	*	0.9	*
Chloride	13.0	12.8	26.9	12.0	*	14.1	*	14.5	*	*	*	*	*	*	*	*	10.1	*
Iron	0.35	0.2	0.15	0.6	*	0.15	*	17.0	*	*	*	*	*	*	*	*	2.1	*
Strontium	0.1	0.1	0.25	0.3	*	0.35	*	0.1	*	*	*	*	*	*	*	*	0.4	*

* No data collected.

Sources: CF, 1982.
ESE, 1982.

between TDS and alkalinity (r^2 = 0.74, $p<0.01$). The average TDS levels in Complex I was 83 mg/l. TDS concentrations in Complex II-West and Complex II-East show a gradation of increasing TDS concentrations with observed average values of 164 and 190 mg/l, respectively.

Specific conductance, which is a measure of the electrical activity of dissolved constituents (i.e., TDS), was highly variable in the shallow aquifer, ranging from 17 to 570 umhos/cm. Variability in conductivity was consistent with TDS levels and the observed range agrees with values predicted from TDS concentrations. Complex I had the lowest values, with an average value of 114 umhos/cm; conductivities observed in Complex II-East and Complex II-West were approximately the same with average values of 222 and 192 umhos/cm, respectively.

Sulfate levels were highly variable, ranging from 1 to 123.3 mg/l. Average sulfate levels were approximately the same within the Complex I and Complex II-East groups. Average sulfate concentrations ranged from 11.2 to 13.7 mg/l for Complex I and Complex II-East, respectively. Observed levels within the Complex II-West (Horse Creek basin) were substantially lower; sulfate concentrations during the study period averaged 4.1 mg/l. Well SA-18 within the Horse Creek basin exhibited apparently anomalous behavior; sulfate concentrations detected at this location averaged 13.3 mg/l and ranged as high as 123 mg/l.

Fluoride levels ranged from 0.06 to 1.16 mg/l, with little difference observed between the three sampling complexes. No correlation between fluoride and phosphorus was observed. Florida Class G-II ground water quality criteria for fluoride is 1.6 mg/l; no violations of this criteria were observed.

Nutrients

Three inorganic forms of nitrogen (i.e., ammonia, nitrate, and nitrite) were analyzed in the shallow aquifer. Elevated concentrations of nitrogen generally reflect anthropogenic inputs (primarily fertilizer)

from surface water seepage. Ammonia levels ranged from 0.05 to 0.50 mg/l with many of the higher measurements occurring in Complex II-East. Oxidized nitrogen (nitrate-nitrite) is primarily in the form of the more stable nitrate (0-3 mg/l); nitrite ranged from 0 to 0.094 mg/l. In general, average nitrate and nitrite levels were quite low and, with the exception of Wells SA-5, SA-7, SA-11, and SA-14, were less than 0.05 mg/l. The highest average concentration was observed in SA-14 with a reported average value of 0.30 mg/l. Florida Class G-II ground water quality criteria for ground water nitrate is 10.0 mg N/l; no violations of this standard were observed.

As expected, total phosphate concentrations were relatively high, ranging from 0 to 7.7 mg/l with the highest measurement occurring at Well SA-7 in Complex II-East. Average TP concentrations were highest in Complex II-East (1.95 mgP/l). Orthophosphate levels also were high with the highest average concentration detected in Complex II-West (0.74 mgP/l). Average concentration on Complex II-East was 0.59 mgP/l while the lowest average value was in Complex I (0.33 mgP/l). The spatial distribution of orthophosphorus did not conform to any discernible pattern, but showed a great deal of variability even within a particular drainage basin. Average concentrations by station ranged from 0.06 mg/l (SA-11) to 1.78 mg/l (SA-16). Well SA-7 had the two highest individual readings of 7.6 and 3.0 mg/l which occurred in October and November of 1981. No correlations of total and orthophosphorus were observed.

Alkalinity and pH

Alkalinity was generally in the form of bicarbonate, the predominant form of carbonate below a pH value of 8.3. Carbonate alkalinity was measured in Well SA-11 (Complex II-West) during the months of July and August 1981 when pH reached 8.5 and 8.4, respectively. Bicarbonate alkalinity was highly variable, ranging from 0.3 to 342.5 mg/l as $CaCO_3$. The high degree of variability apparently is a reflection of the heterogeneity of the shallow aquifer lithology.

Average alkalinity was highest in Complex II-West with an average concentration of 86.5 mg/l as $CaCO_3$ observed. Average alkalinities by station were relatively low within Complex I and did not exceed 25 mg/l as $CaCO_3$. Highest average alkalinities by station were observed in SA-11 (322 mg/l as $CaCO_3$) and SA-18 (177 mg/l as $CaCO_3$).

Measurements of pH reflect generally acidic conditions; pH ranged from 4.9 to 8.5. Average pH levels for Complex I and Complex II were similar and ranged between pH 6.1 and pH 6.6. No basin-wide differences were apparent; however, some wells reflect basic conditions (SA-11 and SA-18) as a function of high ambient alkalinity concentrations. Acidic ground water is probably the result of seepage of colored acidic surface waters into the shallow aquifer. The amount of alkalinity (acid neutralization) also will determine pH.

Secondary Artesian Aquifer

Secondary artesian wells included UF-3 through UF-6 and ranged in depth from 360 to 418 feet (see Table 6.1.4-2), with monitor zones between 65 and 418 feet. A summary of the data from samples collected at these wells from July 1981 through June 1982 is presented in Table 6.1.4-4.

Dissolved Ions

Average conductivity values are comparable in Stations UF-3 to UF-6 (423 to 629/umhos/cm). Sulfate levels were similar in the wells and ranged from 0.2 to 29.1 mg/l.

Average fluoride levels were twice as high in Wells UF-3, UF-4, and UF-5 (2.03 to 2.31 mg/l) as Well UF-6 (1.14 mg/l). The Florida Class G-II criteria for fluoride in ground water (1.5 mg/l) was exceeded in all of the samples from Wells UF-3, UF-4 and UF-5; observed concentrations in Well UF-6, however, were substantially lower and did not exceed criteria.

Table 6.1.4-4. Mean Concentration of Water Quality Data Collected From Secondary Artesian Aquifer From July 1981 Through June 1982

Parameter†	UF-3	UF-4	UF-5	UF-6
Temperature (Field) C°	24.2	24.5	24.2	24.5
pH (lab - SU)	8.22	8.15	8.15	7.92
Ammonia (NH_3)	0.34	0.20	0.25	0.10
Nitrite (NO_2) ppb	11.3	8.3	18.0	0.9
Nitrate (NO_3)	0.02	0.03	0.07	0.01
Orthophosphate	0.08	0.07	0.08	0.13
T. Phosphorous	0.21	0.63	0.43	0.55
Sulfate (SO_4)	7.52	8.08	12.7	8.6
Bicarb. Alk. $CaCO_3$	298	241	268	246
Silica (SiO_2)	45.5	45.1	48.7	40.4
TDS (residue)	431	445	440	294
Fluoride	2.03	2.24	2.31	1.14
Conductivity (lab) umhos/cm	595	629	543	423
Carbonate Alk. as $CaCO_3$	5.2	1.6	2.3	1.4
Calcium	*	49.6	49.7	45.4
Magnesium	*	31.9	34.0	31.8
Sodium	*	33.6	33.1	30.5
Potassium	*	5.6	6.4	3.2
Chloride	*	88.3	63.5	13.3
Iron	*	0.15	0.4	0.1
Strontium	*	1.2	2.5	0.5

* No data collected.
† All units are mg/l unless otherwise indicated.

Sources: CF, 1982.
ESE, 1982.

Nutrients

Ammonia, nitrate and nitrite concentrations were measured at all stations. Average ammonia levels were relatively constant between stations ranging from 0.10 to 0.34 mg/l, with values generally lower at UF-6. Nitrite was generally less than 10 ug/l; however, two somewhat elevated peaks (69 and 78 ug/l) were observed at two sampling points. Nitrate was also observed to have relatively high peaks (UF-4, UF-5) but generally remained below 0.07 mg/l. No violations of the Florida Class G-II nitrate criteria (10 mg N/l) were observed.

Average total phosphorus levels were somewhat variable between stations and ranged from 0.21 to 0.63 mgP/l. Minimum concentrations were observed in Well UF-3; total phosphorus concentrations in the remaining wells were approximately a factor of 2 to 3 times higher. Average orthophosphate was found at similar levels at all stations and ranged from 0.07 to 0.13 mgP/l. No correlations between total and orthophosphate were observed. In addition, no relationship was observed between orthophosphorus and fluoride concentrations, thus suggesting that some other mineral phase besides fluorapatite controls the aqueous solubility of these two species in the secondary artesian aquifer.

Alkalinity and pH

Alkalinity was found predominantly as bicarbonate, however, depending upon the pH levels at each station, some carbonate alkalinity was measured. The mean pH levels were all alkaline, as would be expected, ranging from 7.9 to 8.2.

Floridan Aquifer

The Floridan Aquifer well group included Wells LF-1 through LF-6, UF-2, PTW, and DF. The other wells range in depth from 948 to 1,702 feet (see Table 6.1.4-2). Wells LF-2, LF-3, and DF have monitor zones at multiple depths, and the remaining wells have monitor zones between 374 and 1,200 feet. A summary of the mean concentration of data from samples collected from each well during monthly sampling from July 1981 through

June 1982 is presented in Table 6.1.4-5. The results of water quality sampling during pump tests conducted in 1975 are presented in Table 6.1.4-6.

Dissolved Ions

Conductivity values in UF-2 were high with an average concentration of 1,765 umhos/cm, and may be the result of subsurface contamination. Average conductivity levels ranged from 301 to 363 umhos/cm in Wells LF-1, LF-5, and LF-6. Observed conductivities in Well LF-4 were somewhat higher, averaging 539 umhos/cm. Well DF was much higher and averaged 1,550 umhos/cm; this value of conductivity probably reflects saltwater intrusion at the deepest level.

TDS levels were also generally much higher in Wells UF-2 and DF; an average concentration of 750 and 1,240 mg/l was observed in Wells UF-2 and DF, respectively, compared with average TDS levels ranging from 202 to 413 mg/l in the remaining Floridan Aquifer wells. The federal secondary drinking water standard for TDS is 500 mg/l for primarily aesthetic reasons; water from these two wells is unsuitable for drinking purposes. No general trend of increasing TDS with depth was observed except for Well DF.

Sulfate levels in Wells UF-2, LF-1, LF-4, LF-5, LF-6, and PTW were variable and ranged from 0 to 60.3 mg/l. No pronounced differences were apparent between these wells; however, Well DF, which was the deepest Floridan Aquifer well, exhibited much higher levels which ranged from 407.6 to 1,561 mg/l at the deepest level. High sulfate levels generally reflect dissolution of sulfate minerals (e.g., gypsum and anhydrite) or may be indicative of saline intrusion. Using chloride as a tracer for saline intrusion (see Table 6.1.4-6) indicates that the accretion of sulfate in the Floridan Aquifer is primarily marine in origin. This is not true for Well DF where sulfate levels greatly exceed predicted levels based upon ambient chloride levels; an average concentration of 830 mg/l was observed

Table 6.1.4-5. Mean Concentration of Water Quality Data Collected From Floridan Aquifer From July 1981 Through June 1982

Parameter†	UF-2	LF-1	LF-4	LF-5	LF-6	DF	PTW
Temperature (Field) C°	25.0	26.0	24.7	25.4	26.2	27.7	26.9
pH (lab - SU)	11.3	8.52	8.22	8.15	8.22	7.43	8.7
Ammonia (NH_3)	0.47	0.15	0.18	0.15	0.11	0.12	0.16
Nitrite (NO_2) ppb	1.0	1.7	1.5	1.1	1.0	9.7	1.78
Nitrate (NO_3)	0.01	0.01	0.01	0.01	0.01	0.03	0.01
Orthophosphate	0.08	0.06	0.16	0.10	0.09	0.08	0.06
T. Phosphorous	0.58	0.46	0.44	0.58	0.41	0.33	0.38
Sulfate (SO_4)	32.89	12.4	10.2	46.3	47.0	830	22.0
Bicarb. Alk. $CaCO_3$	0.0	70.7	211	152	166	70	96
Silica (SiO_2)	5.8	3.8	40.1	17.9	19.8	5.1	7.1
TDS (residue)	750	202	413	274	280	1,242	158
Fluoride	1.05	0.43	2.22	0.62	0.38	1.01	0.43
Conductivity (lab) umhos/cm	1,765	301	539	314	363	1,552	279
Carbonate Alk. as $CaCO_3$	134.8	7.2	1.0	1.8	2.4	0.00	17.3
Calcium	*	*	36.9	44.7	45.5	173.2	18.6
Magnesium	*	*	31.6	28.4	30.0	50.0	23.8
Sodium	*	*	33.8	19.7	34.0	31.3	29.8
Potassium	*	*	5.9	4.0	4.3	10.5	18.9
Chloride	*	*	82.1	11.5	8.5	46.3	19.2
Iron	*	*	0.1	0.2	0.2	0.05	0.1
Strontium	*	*	2.1	5.6	14.8	19.5	7.1

* No data collected.
† All units are mg/l unless otherwise indicated.

Sources: CF, 1982.
ESE, 1982.

Table 6.1.4-6. Summary of Ground Water Quality Data Collected During 1975 Pump Tests

	Combination Samples Collected From Surface Discharge During Pumping from Indicated Zone								In-Hole Samples Collected From Indicated Depth During Pumping (LF-3 open hole 514-678; DF open hole 510-1704)							
Date Sampled	10/7/75	10/7/75	12/11/75*	9/30/75	10/14/75	10/28/75	11/10/75		10/28/75							
Well	SA-14	UF-3	UF-2	DF	DF	DF	LF-3	LF-3	DF	DF	DF	DF	DF	DF	DF	DF
Depth Sampled	(5-60)	(90-375)	(375-433)	(510-852)	(510-1356)	(510-1704)	(550)	(640)	(550)	(1000)	(1122)	(1236)	(1320)	(1410)	(1510)	(1650)
Specific Conductance†	325	580		320	361	350										2400
Alkalinity as HCO_3	208	427		102	151	111										105
Alkalinity as CO_3	125	256		100	91	73										68
Total Dissolved Solids as Residue	287	421		283	239	250	260	279	201	225	231	274	289	448	835	2792
Total Dissolved Solids (Calculated)	290	425		266	232	238										
Total Hardness as $CaCO_3$							206	198	209	207	210	226	226	298	585	
Ammonia (NH_3)	<0.06	<0.06		0.50	<0.06	0.38										
Nitrate (NO_3)	0.43	0.14		2.5	0.9	5.8										0.42
Nitrite (NO_2)**	20	18		2.6	38	<0.1										0.74
Total Phosphate	3.1	0.09		0.05	0.08	0.02										0.03
Sulfate (SO_4)	32	15		53	47	56	88	75	60	60	64	80	85	84	209	1590
Chloride (Cl)	38	50		10	10	8.6	1.0	1.3	8.7	8.2	8.7	9.2	8.9	10	13	18
Fluoride (F)	0.51	1.9		0.45	0.43	0.40										1.3
Calcium (Ca)	33	30		44	34	46										560
Magnesium (Mg)	12	24		25	16	20										100
Iron (Fe)	0.46	1.4		1.3	3.6	0.08										0.19
Sodium (Na)	14	0.46		8.0	17	7.0	7.6	22	7.7	7.8	7.7	8.2	7.9	8.5	10	14
Potassium (K)	12	35		1.7	1.8	1.5										3.4
Silica (SiO_2)	19	11		18	14	17										18
Strontium (Sr)	0.03	0.28		2.0	0.14	2.1										

All parameters given in mg/liter except as noted

* Data not available at time of report
† umhos/cm
** ppb

Source: Dames and Moore, 1976.

compared with a predicted concentration of 6.5 mg/l. The elevated sulfate levels are probably due to the dissolution of sulfate-bearing minerals.

Fluoride levels in Wells LF-1, LF-5, LF-6, and PTW were similar, generally ranging from 0.37 to 0.59 mg/l; however, Well LF-5 had a peak (1.13 mg/l) in November 1981. Wells UF-2 and DF averaged 1.05 and 1.01 mg/l, respectively, with a peak of 1.61 mg/l observed in July 1981 in Well DF. Well LF-4 exhibited fluoride levels greater than all other wells ranging from 1.89 to 2.32 mg/l. Florida Class G-II fluoride water quality standards were exceeded in 14 percent of samples from Well DF and in all of the samples from Well LF-4.

Ionic content (including calcium, magnesium, sodium, potassium, chloride, and strontium) was much higher in Well DF; however, Well LF-4 in October 1981 had higher sodium and chloride levels than all wells except DF.

Nutrients

Inorganic nitrogen levels were relatively constant in all stations, with the exception of a slight nitrate-nitrite peak observed in Well DF. In March 1982, nitrate levels were observed to reach a maximum concentration of 0.19 mg/l in Well DF; otherwise, during the study period, nitrate levels remained below 0.06 mg/l. Observed levels were approximately two orders of magnitude below the established criterion for Class G-II ground waters in Florida (10 mgN/l). Excluding Well UF-2, ammonia levels were also quite low, averaging less than 0.20 mg/l. No violation of the Florida Class G-II nitrate standard (10 mgN/l) was observed.

Total phosphate levels were also similar in all stations; however, a peak was observed in Well LF-5 in March 1982. Levels generally ranged

from 0 to 1.6 mg/l; however, the LF-5 peak reached 2.9 mg/l. Orthophosphate levels ranged from 0 to 0.9 mg/l in all wells; no correlation with total phosphate was observed.

Alkalinity and pH

Alkalinity was generally of the bicarbonate form in all wells except UF-2; however, some carbonate alkalinity was also observed indicating some pH values of 8.3 or greater. Well UF-2 showed basic conditions (pH = 11.1 to 11.9) and, subsequently, alkalinity was predominantly carbonate in form, ranging from 78.1 to 155.6 mg/l as $CaCO_3$. These levels are unusually high and may be indicative of subsurface contamination. Aqueous solutions in contact with calcite and in equilibrium with typical levels of gaseous CO_2 observed in subsurface soils (10^{-2} to 10^{-3} atm) have pH levels of 8.4 or less (Stumm and Morgan, 1981). Data from all other stations generally conform to this model for the Floridan Aquifer. Wells LF-1 and DF had the least alkalinity and were also the deepest wells. Total alkalinity averaged 78 mg/l as $CaCO_3$ in Well LF-1 and 70 mg/l as $CaCO_3$ in DF; elevated levels of alkalinity were observed in both wells in July 1981 (141 and 152 mg/l as $CaCO_3$, respectively). Alkalinity in Wells LF-5, LF-6 and PTW were observed at similar levels which ranged from 62 to 245 mg/l as $CaCO_3$. Well LF-4 had the highest levels of total alkalinity which averaged 212 mg/l as $CaCO_3$.

Excluding Well UF-2, carbonate alkalinity was detected most often in Well PTW where pH values were never below 8.3 (8.3 to 9.5). Well LF-1 also had high pH values which averaged 8.5. Most other wells had pH values between 8.0 and 8.5, except for Well DF which had values ranging from 7.0 to 8.1. Violations of federal secondary water quality pH standards (6.5-8.5) were observed in Wells LF-1 (6/9 samples), PTW (6/9 samples), and UF-2 (11/11 samples).

Water Quality Aquifer Testing

Several airlift pump tests were conducted during late 1975 on Wells DF, LF-3, UF-2, UF-3, and SA-14. Water samples were collected at various depths during the pumping; water quality data are presented in Table 6.1.4-6. A comparison of parameters sampled during both the monthly sampling and the pump test sampling is presented in the following section.

In the pump test sampling of the shallow aquifer well (SA-14), conductivity, bicarbonate alkalinity ($CaCO_3$), TDS (residue), nitrite (NO_2), sulfate (SO_4), and fluoride were all higher than the ranges recorded in the monthly sampling. Ammonia (NH_3), nitrate (NO_3) and total phosphate all fell within the monthly ranges, whereas silica (SiO_2) fell below them.

In the secondary artesian well (UF-3), only nitrate and nitrite was above the ranges of the monthly sampling. Total phosphate and sulfate were at the upper limits of the monthly ranges, but silica fell below the range. All other parameters duplicated were within the ranges of the monthly sampling.

Of the samples taken from the deep Floridan wells, alkalinity, nitrite, total phosphate, and silica all fell within the ranges, although silica was near the higher end of the range on two occasions. Conductivity, total dissolved solids, sulfate, and fluoride all fell below the ranges. Nitrate was above the range on all 3 occasions, and ammonia was above the range on 2 of the 3 days.

The DF well was also sampled at selected depths during October of 1975, but only five parameters were tested. TDS, total hardness, sulfate and chloride concentrations all increased slightly as the depth increased, and then increased significantly at the lowest two depths. Sodium concentration also increased as depth increased, but not as significantly.

The Florida Department of Natural Resources has published average concentrations of TDS, sulfate, chloride and fluoride in the lower Floridan Aquifer (RI 83). Concentrations of chloride and fluoride from the lowermost water sample (1,650 feet) in the DF well agree with the results of the report. The concentration of TDS (2,792 ppm) was about five times higher than maximum concentration (500 mg/l) listed in the text, and sulfate (1,590 ppm) was about 15 times the concentration of 100 mg/l reported in the text.

6.1.4.3 SUMMARY

A total of 18 wells ranging in depth from 25 to 66 feet were used to monitor the surficial aquifer. These wells were sampled monthly for 14 parameters; 7 of the wells were sampled once for an additional 7 parameters. As expected, a close relationship between TDS and conductivity was observed; these parameters in turn were apparently dictated to a large extent by the localized presence or absence of carbonaceous material within the surficial aquifer. Conductivity had a low measurement of 17 umhos/cm and a high reading of 570 uhmos/cm, whereas TDS (residue) ranged between 2 and 501 ppm. In general, the average concentrations of TDS and conductivity on Complex II were about twice those of Complex I. Levels of pH were somewhat low relative to ambient alkalinities and may reflect organic acids leaching from detrital material in surface soil horizons. Within the wells, pH ranged from 4.9 to 8.5. Sulfate levels ranged from 1 to 123 mg/l. The average sulfate levels on Complex II-East and Complex I were about three times greater than those on Complex II-West. No violations of fluoride were observed with all values less than 1.16 mg/l.

Nutrient sampling included ammonia, nitrate, nitrite, total phosphorus, and orthophosphate. In general, average nitrate and nitrite values were low. Ammonia levels ranged from 0.05 to 0.5 mg/l, with the majority of high values occurring on Complex II-East. Average TP and orthophosphate concentrations were relatively high with ranges from 0 to 7.7 mg/l and 0 to 7.6 mg/l, respectively.

A total of 4 wells ranging in depth from 360 to 418 feet were used to monitor the secondary artesian aquifer. These wells were sampled monthly for the same parameters as those in the surficial aquifer. Conductivity had a low measurement of 200 uhmos/cm and a high reading of 660 uhmos/cm, whereas TDS ranged between 58 and 517 ppm. The average values were about two to three times larger than the surficial aquifer averages. Inorganic nitrogenous species generally were low. Orthophosphate and total phosphorus were lower than the surficial aquifer, with ranges from 0.0 to 0.8 ppm and 0.0 to 1.3 ppm, respectively. Alkalinities reflected the calcareous matrix of the secondary artesian aquifer with a bicarbonate alkalinity range between 146.6 and 341.3 ppm. All samples in three of the four wells exceeded the 1.6 mg/1 fluoride ground water criteria.

A total of 7 wells, ranging in depth from 433 to 1,702 feet, were used to monitor the Floridan Aquifer. These wells were sampled monthly for the same parameters as those in the surfical aquifer. pH in the wells ranged between 7.0 and 9.5, except in Well UF-2 (11.1 to 11.9), which is apparently influenced by subsurface contamination. Conductivities were typically moderate, averaging less than 550 umhos/cm with the exception of Wells UF-2 and DF; similarly, average TDS levels (excluding Wells UF-2 and DF) ranged between 202 and 413 mg/1. With respect to other wells in the Floridan Aquifer group, Well DF was unique chemically, and apparently is influenced by dissolution of sulfate-bearing minerals; conductivity, TDS and sulfate levels were all approximately 3 to 10 times in excess of observed values in the other wells. Sulfate levels were less than 100 mg/1 in all wells, except Well DF which had values between 400 and 1,600 mg/1. Nutrients were generally low and no violations of Florida Class G-II criteria of 10 mgN/1 were observed for nitrate. TP and orthophosphate were generally less than 1.6 mg/1 and 0.9 mg/1, respectively.

Alkalinity was generally of the bicarbonate form in all wells except UF-2. The two deepest wells, LF-1 and DF, had the least alkalinity.

Carbonate alkalinity was detected most often in Well PTW. Violations of federal secondary water quality standards for pH were observed in Wells LF-1 (6 of 9 samples), PTW (6 of 9 samples), and UF-2 (11 of 11 samples). Fluoride levels were similar in four of the wells with values less than 0.6 mg/l. The Florida Class G-II fluoride criteria was exceeded, however, in one of the Well DF samples and in all of Well LF-4 samples.

The mean concentrations of the ground water parameters measured in well PTW were compared to the Florida Class III surface water standards to evaluate the effects of deep well make-up on mine discharge water meeting Class III standards. The comparison indicated that all parameters measured were below the standards except pH, which had a mean value of 8.7 (which is a 0.2 units above the criteria). This pH in make-up water will buffer the recirculation water. Since the streamflow water quality is generally acidic and often below the minimum standard of 6.0, mine discharge from the more buffered recirculation waters will generally improve the acidic conditions in the receiving streams.

Effective January 1, 1986, CF modified its groundwater monitoring program after generating a 10-year data base. In this revised program, groundwater levels are being recorded continuously at 10 monitoring wells. In addition, groundwater quality information is being generated from seven monitoring wells.

6.2 REFERENCES: GROUND WATER

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7.0 SURFACE WATER

7.1 AFFECTED ENVIRONMENT

7.1.1 REGIONAL DESCRIPTION--QUANTITY

The CF Industries Hardee Phosphate Complex II is located in the west-central portion of the Peace River Basin as shown in Figure 7.1-1. The site is drained primarily by two tributaries of the Peace River: Payne Creek and Horse Creek.

The Peace River Basin drains portions of Polk, Highlands, Hardee, Manatee, Sarasota, DeSoto, and Charlotte Counties. The total drainage area at the mouth of the Peace River is approximately 2,300 square miles; total main channel length is approximately 105 miles (Florida Board of Conservation, Division of Water Resources and Conservation, 1966). Other major tributaries of the Peace River include Peace, Charlie, Joshua, and Prairie Creeks.

Terrain in the northern portion of the basin is generally above 100 feet MSL and decreases southward toward Charlotte Harbor. The northern Peace River Basin lies in the Polk Uplands which are characterized by marshy flatlands and rolling hills. The Southern Peace River basin lies primarily in the DeSoto Plain which is characterized by many lakes and large areas of poorly drained swampland. The DeSoto Plain is flat, having an incline of about 15 to 25 feet in 40 miles. The depressional areas within the basin are an important factor in recharging the shallow aquifer and in retarding runoff to provide natural flood control and a source of baseflow during dry periods.

The USGS has maintained numerous stream gauging stations on the Peace River and its tributaries. Pertinent data from those stations in the vicinity of the CF site are summarized in Table 7.1.1-1. Station locations are shown in Figure 7.1-1.

Table 7.1.1-1. Summary of Pertinent Data from USGS Stations in the Region

Station Number	Name/Location	Period of Record	Drainage Area ($miles^2$)	Average Flow (cfs)	Maximum Flow (cfs)	Minimum Flow (cfs)
02297155	Horse Creek near Myakka Head	1977-1980	41	NA	904	0.04
02297310	Horse Creek near Arcadia	1950-1980	218	194	11,700	0.0
02295420	Payne Creek near Bowling Green	1963-68, 1980	121	111	2,190	0.84
02294650	Peace River at Bartow	1939-1980	390	252	4,140	1.1
02294898	Peace River at Fort Meade	1974-1980	465	169	1,360	1.9
02295637	Peace River at Zolfo Springs	1933-1980	826	680	26,300	22.0
02296750	Peace River at Arcadia	1931-1980	1,367	1,155	36,200	37.0

NA = Not Available

Source: USGS, 1980.

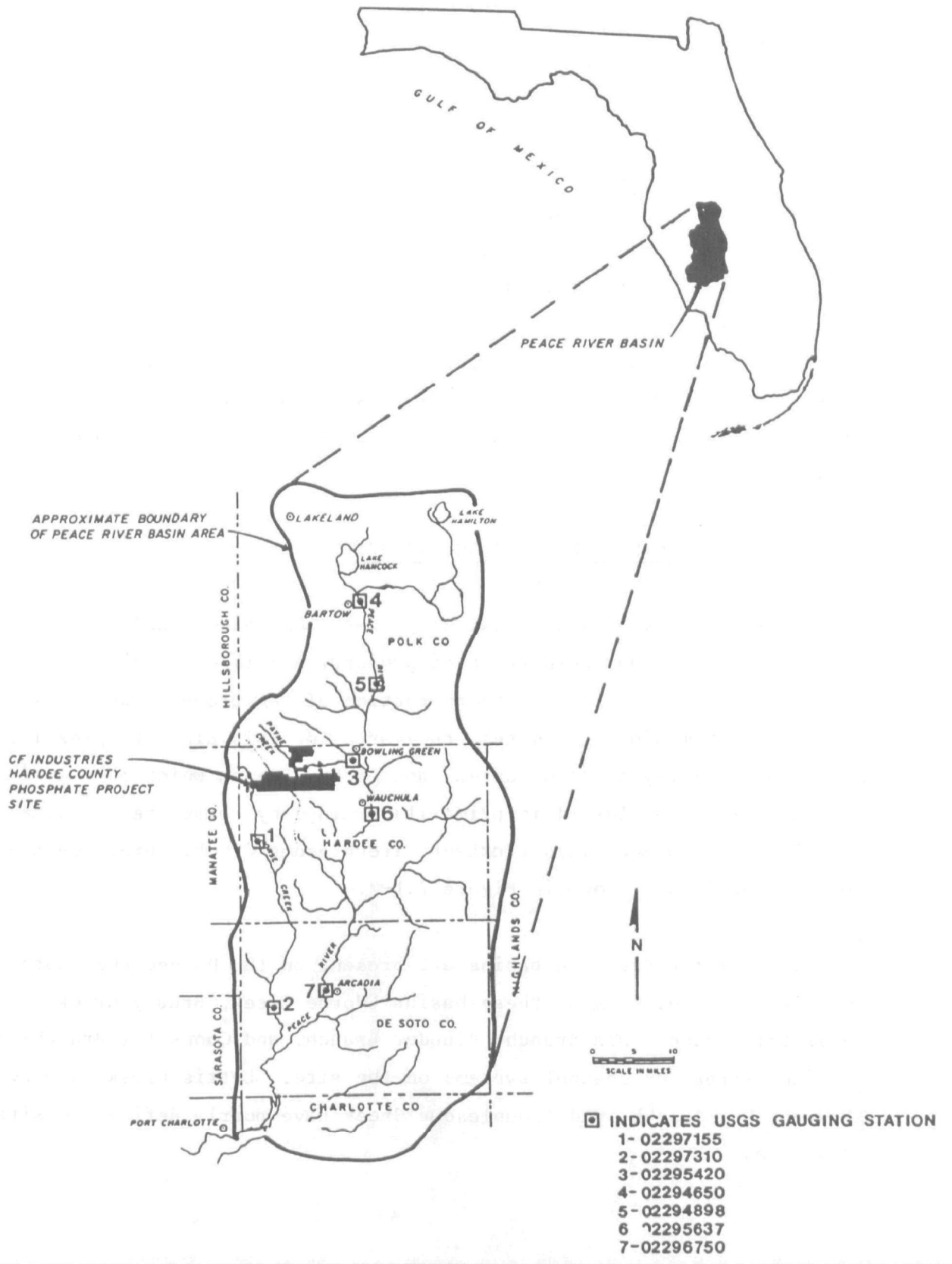


Figure 7.1-1
PEACE RIVER DRAINAGE BASIN

SOURCES: CF MINING CORPORATION, 1976; ESE, 1982.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

Average annual rainfall in Hardee County is 54 inches (Hughes et al., 1971); however, monthly and annual variation can be significant. Approximately 60 percent of the total annual average precipitation occurs during the months of June, July, August, and September. During these months, intense thunderstorms of relatively short duration saturate the surface soils and raise the shallow aquifer. As a result, stream discharges may rapidly increase and local flooding often occurs. During the remainder of the year, rains are generally of the gentle frontal type. During this drier period, the water table normally drops and some streams become dry. On an annual basis, EPA (1979) characterizes the area as having an average rainfall of about 55 inches, an average evapo-transpiration of 39 inches, an average total surface runoff of 15 inches, and an aquifer recharge of between 1/2 and 5 inches.

7.1.2 SITE-SPECIFIC DESCRIPTION--QUANTITY

7.1.2.1 BASIN DESCRIPTIONS

The CF property consists of two complexes, Complexes I and II. Complex I is the northern tract of property and is currently being mined by CF; Complex II is the southern portion of the property which is proposed for mining and is the study area for this EIS. Complex I is drained primarily by Payne Creek, and Hickey Branch which is one of its tributaries. Complex II is primarily drained by Horse Creek, Payne Creek and, to a much lesser extent, Troublesome Creek. Drainage areas on Complex II are shown in Figure 7.1-2.

Portions of ten drainage basins are present on the Hardee Phosphate Complex II site. Six of these basins (Horse Creek, Brushy Creek, Shirttail Branch, Doe Branch, Plunder Branch, and Coons Bay Branch) have defined stream or channel systems on the site. Lettis Creek, Gum Swamp Branch, Hog Branch, and Troublesome Creek have poorly defined on-site drainages.

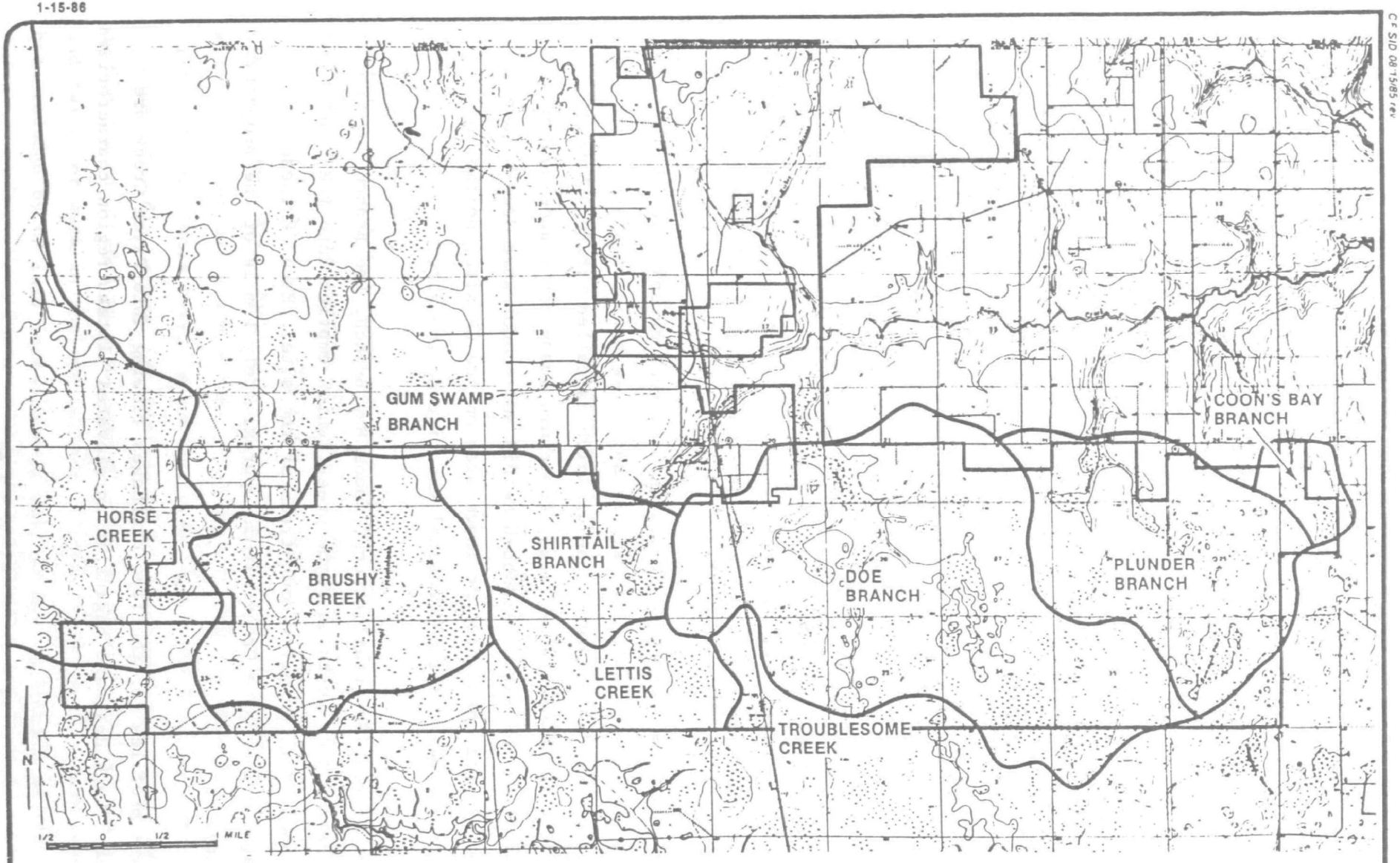


Figure 7.1-2
DRAINAGE BASIN AREAS ON COMPLEX II PROPERTY

SOURCE: ESE, 1985.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

CF SID 001585 rev.

The property is located on a regional drainage divide with the western half of the property draining south and the eastern half draining to the north and then east.

Other than the two minor drainages (Hog Branch and Gum Swamp Branch), Horse Creek is the only drainage system which does not begin with a headwater area on the property. Horse Creek is an intermittently flowing stream within the property which has an average annual flow of over 5 cfs at the property exit. The headwater region of Horse Creek lies about 4 river miles above the property.

In addition to Horse Creek, the other on-site drainages flowing to the south are Brushy Creek, Lettis Creek, and Troublesome Creek. Horse Creek and Troublesome Creek are direct tributaries of the Peace River, joining the Peace River at approximately 40 and 9 river miles downstream of the site, respectively. Brushy Creek is a direct tributary of Horse Creek, which it joins south of Ona, about 11 river miles downstream of the site. Lettis Creek is a minor tributary of Brushy Creek, which it joins about 3 miles south of the property.

The four streams flowing to the south vary considerably and do not exhibit uniform characteristics. Brushy Creek basin consists primarily of two main headwater areas, one of which is called Mitchell Hammock, draining into a relatively large floodplain swamp conveyance system extending off the site. Although Lettis and Troublesome Creeks have a portion of their headwater drainage area on the CF site, neither of these creeks has a defined channel existing on the site.

Plunder Branch, Shirttail Branch, Coons Bay Branch, Doe Branch and Gum Swamp Branch flow north to Payne Creek, which empties into the Peace River about 8 river miles downstream of the site. Each of these drainages joins Payne Creek within approximately 1 mile of the property boundary.

Drainage profiles for the five drainages flowing into Payne Creek are similar. Each drainage begins in an elevated plateau region characterized

by relatively flat elevations and large wetland complexes, generally marshes with intermixed oak hammock. Each of these headwater wetlands has a high natural lip or barrier which retains water in the wetland. The headwater wetlands complexes are generally marshes, most often dominated by maidencane. Vegetation along the well-defined channels and the lower reaches of the systems usually consists of oak hammock, maple/tupelo swamp, pop ash swamp, or bottomland hardwoods forest.

Immediately adjacent to the headwater wetlands, the downstream segment is represented largely by incised stream channels or by narrow distinct floodplains serving as conveyances for transporting waters from the plateau wetland headwaters. While some of the headwater wetlands likely retain water throughout the year, these conveyance systems flow only seasonally to ephemerally and are usually dry for portions of the year.

The lowest portion of each stream, near the northern property boundary, could generally be characterized as an area of reduced velocity and lower stream gradient in which water begins to spread out over a broad floodplain depositing materials carried in the flowing waters. Throughout the year, these lower reaches generally contain isolated pools of water along the primary stream channel.

The tenth drainage basin, namely Hog Branch, drains to the east by overland flow across upland regions. No wetlands nor defined stream channels are associated with the onsite drainage system.

7.1.2.2 DATA COLLECTION

Previous Studies

CF Industries has maintained an extensive monitoring network of stream level recorders and rainfall stations on the property since July 1975, as shown in Figure 7.1-3. Continuous recorders are located at Stations WQ-1, WQ-2, WQ-3, WQ-4, and WQ-7, and current measurements are generally taken every six months to calibrate stage/discharge curves for each station. These level recordings have been reduced by CF into average daily discharges. A staff gauge has been read since July 1979 on Doe Branch at WQ-8 at a minimum of once per week in the dry periods and twice per week in the wet periods. These staff heights have also been reduced by CF into instantaneous discharges. A summary of the

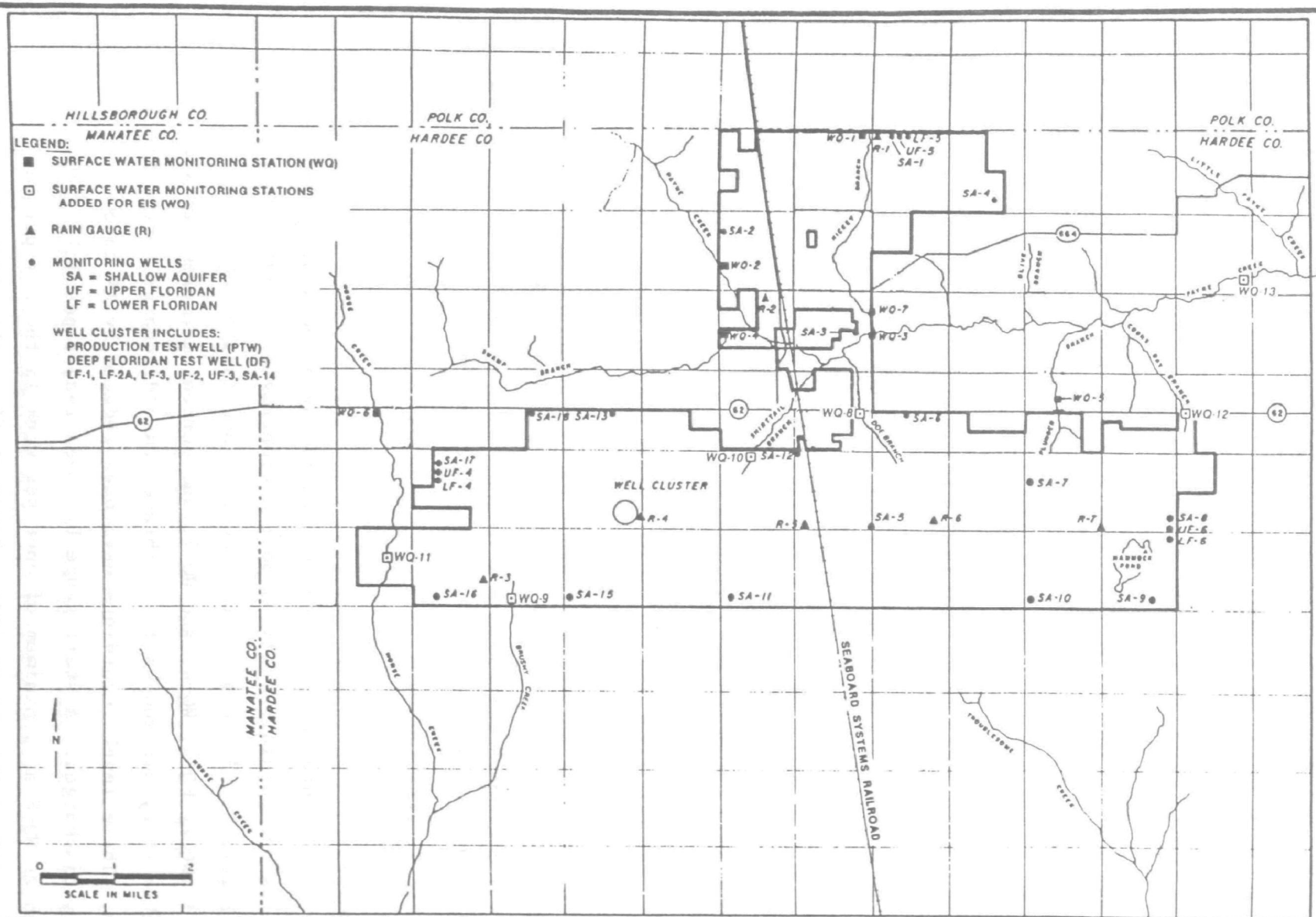


Figure 7.1-3
LOCATION OF HYDROLOGIC DATA COLLECTION STATIONS

SOURCES: CF MINING CORPORATION, 1976; DAMES & MOORE, 1976; ESE, 1985.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

CF SID 08/15/85 rev

annual range of discharges recorded on Hickey Branch, Gum Swamp Branch, Doe Branch, and Payne Creek is presented in Table 7.1.2-1. Continuous rainfall recordings have been collected at eight stations since July 1975 and have been reduced and tabulated by CF Industries. The total rainfall which occurred each year on the CF site is shown in the right column of Table 7.1.2-1.

EIS Monitoring

The monitoring period for the EIS data collection effort was from July 1981 through June 1982 and includes data collected by both CF Industries and ESE. The surface water level recorders, staff gauge readings, and continuous rainfall recordings as described in the preceding section (Previous Studies) were maintained from July 1981 through June 1982 and were reduced by CF Industries. ESE measured stream flows monthly at Stations WQ-5, WQ-8, WQ-9, WQ-10, WQ-11, and WQ-12 from July 1981 through September 1981. After meetings with EPA in late September 1981, the monitoring program was revised and additional flow measurements were taken in September 1981 at Stations WQ-1 through WQ-4, WQ-7, WQ-13, and WQ-14. Stations WQ-9 and WQ-12 were dropped from the program after September 1981. These changes resulted in monthly stream measurements taken from October 1981 through June 1982 at Stations WQ-1 through WQ-5, WQ-7, WQ-8, WQ-10, WQ-11, WQ-13, and WQ-14.

ESE installed a Stevens Type-A level recorder on Horse Creek at Station WQ-11 in July 1981 and maintained this gauge through June 1982. The monthly flows measured at this station were used to develop a stage/discharge curve. This stage/discharge curve was used to reduce the level recordings into average daily flows.

7.1.2.3 DATA ASSESSMENT

In order to estimate long-term average daily discharges for the ungauged streams on the property, a correlation was needed between a long-term gauging station and streams on the property. As stated in the CF DRI (1976), the Payne Creek Basin is hydrologically similar to the upstream

Table 7.1.2-1. Annual Range of Discharges Recorded on Streams Draining CF Property, January 1976 Through 1982

Year		Range of Discharges (cfs)						Total Rainfall for Year*
		Hickey Branch		Gum Swamp	Doe Branch	Payne Creek		
		WQ-1	WQ-7	WQ-4	WQ-8	WQ-2	WQ-3	
1976	Low	0.15	0.25	NF	ND	1.0	4.0	46.88
	High	19.20	29.70	11.30	ND	135+	133	
1977	Low	1.20	1.90	NF	ND	3.9	5.0	42.79
	high	20.70	50+	17.2	ND	63.5	160	
1978	Low	1.20	0.75	NF	ND	8.8	6.0	45.78
	High	55.80	65.00	18.0	ND	129	240	
1979	Low	0.50	1.5	NF	NF	5.0	3.5	49.67
	High	80.00	120+	110	130	230	300	
1980	Low	1.9	1.0	NF	NF	8.0	14.0	44.27
	High	82.4	68.0	73.0	56.0	125	150	
1981	Low	NF	NF	NF	NF	NF	4.9	43.88
	High	50.0	60.0	36.5	39.0	70	163	
1982	Low	2.0	1.2	0.6	NF	4.0	7.0	62.77
	High	40.4	42.8	30.6	1.4	42.0	94.0	

NF = No Flow
ND = No Data
*Station R-2, except 1978 is R-1 and 1976 is NOAA station in Wauchula.

Sources: CF Data, 1976-1982.
NOAA, 1976.
ESE, 1982.

portion of the Little Manatee River Basin. Therefore, the USGS gauging station 02300100 on the Little Manatee River at Fort Lonesome was chosen. This gauge has been operating since September 1963 and has a drainage area of 38.4 square miles (USGS, 1978). The on-site stations for correlation were limited to WQ-4, Gum Swamp Branch, and WQ-8, Doe Branch, since the other gauges are influenced by discharge from existing mining operations. Station WQ-4 has a drainage area of 10.1 square miles (CF Mining Corporation, 1976) and WQ-8 has a drainage area of 8.0 square miles.

The correlation between Station WQ-4 and the USGS station was determined by performing a regression analysis between the average monthly flows at each of these stations from January 1976 through September 1981. The correlation coefficient (r) was determined to be 0.72. The regression analysis between the average monthly flows at WQ-8 and the USGS station was performed for the period of overlapping record, i.e., February 1979 through September 1981. The correlation coefficient (r) for this analysis was 0.76. The results of these regression analyses showed that the average 17-year flow rate was 0.35 cfs per square mile (cfsm) for the CF property.

For each of the other surface water stations on Complex II, total drainage basins were delineated on 2-foot interval topographic maps provided by CF Industries. The results are depicted in Figure 7.1-2. The size of the basins and the percent of each basin in the mine property were planimetered from these maps. The average flows at each station on Complex II were calculated by multiplying the drainage area of each basin by the 17-year flow rate (0.35 cfsm) as determined in the previously described regression analyses. The basin areas and average flows are presented in Table 7.1.2-2.

The results of the on-site rainfall monitoring are presented as monthly totals in Table 7.1.2-3. By comparing the site average rainfall to the NOAA gauge located in Wauchula, the site rainfall during the monitoring

Table 7.1.2-2. Drainage Areas and Average Flows for Each Surface Water Sampling Station

Surface Water Station	Location	Point Source Discharges Upstream of Surface Water Station	Drainage Basin Area (sq. mi.)	Percent of Basin on CF Property	Average Flow (cfs)
PAYNE CREEK BASIN					
	Hickey Branch				
WQ-1	Inflow to property	Agrico Mine	1.9	0	2*
WQ-7	Outflow from property	Agrico and CF Mines	6.7	47	7*
	Gum Swamp Branch				
WQ-4	Inflow to property	None	10.1	2	3.6
	Shirttail Branch				
WQ-10	Outflow from property	None	2.3	97	0.8
	Doe Branch				
WQ-8	Outflow from property	None	8.0	90	2.8
	Plunder Branch				
WQ-5	Outflow to property	None	4.2	88	1.6
	Coons Bay Branch				
WQ-12	Outflow	None	0.5	56	0.2
	Payne Creek				
WQ-2	Inflow to property	Agrico Mine	26.3	2	26*
WQ-3	Outflow from property	Agrico and CF Mines	57.4	29	57*
WQ-13	Upstream of Little Payne Creek	Agrico and CF Mines	68.4	32	68*
WQ-14	Downstream of Little Payne Creek	Agrico and CF Mines	121.0†	18	121*
HORSE CREEK BASIN					
	Brushy Creek				
WQ-9	Outflow from property	None	4.2	98	1.5
	Horse Creek				
WQ-11	Outflow from property	None	17.9	9.5	6.3

* Estimated from relationship in CF DRI, i.e., 1.0 cfs/sq. mi.
† USGS, 1980.

Sources: ESE, 1982.
USGS, 1980.
CF Mining Corporation, 1976.
USGS Quadrangles, 1956, 1972.

Table 7.1.2-3. Monthly Rainfall on CF Property, July 1981 Through June 1982

Year	Month	Rainfall on CF Property								Normal* at Wauchula	Departure from Normal for Site
		RG-1	RG-2	RG-3	RG-4	RG-5	RG-6	RG-7	Site Average		
1981	July	4.57	4.49	5.41	9.64	8.24	7.21	5.01	6.37	9.04	-2.67
	August	12.79	10.88	6.09	10.65	10.31	12.68	8.11	10.22	7.48	+2.74
	September	3.60	5.06	8.16	3.97	3.20	3.83	4.77	4.66	7.88	-3.22
	October	0.05	0.23	0.79	1.27	0.73	0.50	0.28	0.55	3.05	-2.50
	November	0.76	0.97	0.83	0.47	0.85	0.67	0.37	0.70	1.63	-0.93
	December	0.74	1.30	0.91	0.71	0.65	0.87	0.66	0.83	1.70	-0.87
1982	January	1.06	1.22	0.89	0.90	0.85	0.86	1.02	0.97	2.20	-1.23
	February	1.65	2.03	1.87	1.66	1.70	2.27	2.10	1.90	2.79	-0.89
	March	7.23	7.26	6.56	6.23	6.30	6.02	5.49	6.44	3.39	+3.05
	April	3.44	3.95	3.47	3.74	4.47	3.79	3.83	3.81	2.85	+0.96
	May	7.57	10.27	7.38	10.89	11.75	9.23	7.44	9.22	3.99	+5.23
	June	12.43	13.34	10.38	12.29	13.51	13.86	15.21	13.00	8.66	+4.34
ANNUAL TOTAL		55.89	61.00	52.74	62.42	62.56	61.79	54.29	58.67	54.66	+4.01

Note: See Figure 7.1-3 for locations of stations.

*Normal is 30-year average precipitation from 1941 to 1970.

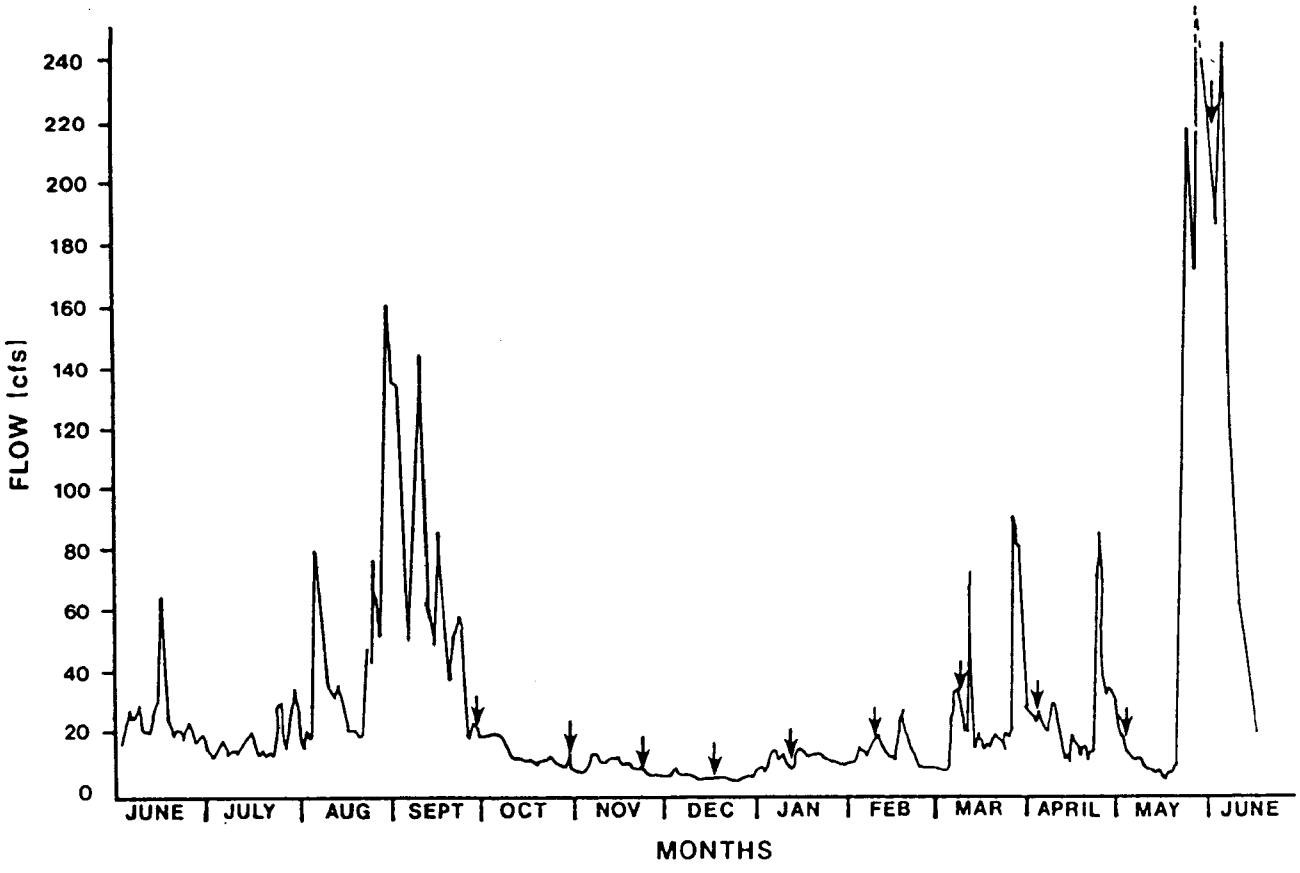
Sources: CF Industries, 1982.
ESE, 1982.
NOAA, 1982.

year is 4 inches above "normal" (the 30-year average precipitation). According to SWFWMD (1981) classification, the monitoring year would be classified as a normal year. Even though the annual rainfall for the site is classified as normal, the monthly precipitation totals varied widely from monthly normals. The months of July, September, October, and January had rainfall deficits of more than 1 inch, the largest being over 3 inches in September. These deficits were balanced primarily by rainfall in excess of normals by +2.74, +3.05, +5.23, and +4.34 inches in August, March, May, and June. The result of the high monthly rainfall in August was a steep increase in the stream flows and peaks occurring in September 1981. Likewise, the surplus rain in May and June caused local flooding on several of the streams. The average daily discharges at Stations WQ-3, WQ-4, WQ-7 and WQ-11 are presented in Figures 7.1-4 through 7.1-7. The results of the monthly flow measurements are presented in Table 7.1.2-4.

The results of the EIS flow measurements and CF monitoring program on the Complex II tract yielded the following information:

1. Stations WQ-9 and WQ-12 were dry or ponded during July and August sampling and were flowing in September as a result of about 3 inches of rainfall during the six days prior to sampling.
2. In general, the monthly measurements at WQ-5, WQ-8, and WQ-10 showed similar flow patterns, i.e., dry or ponded during the monthly sampling for the entire year except during heavy rainfall periods in August, September, and June.
3. The reduction of the level recording at Station WQ-11 showed that Horse Creek was dry or ponded during December and January and during parts of November, February, and May. During the remaining months, the stream had flowing conditions.

The monitoring on the Complex I tract indicated that, in general, all the streams on the existing mine site were flowing during the sampling period.



NOTE: ARROWS INDICATE SAMPLE DATES OF FLOW MEASUREMENTS AND WATER QUALITY SAMPLING

Figure 7.1-4
HYDROGRAPH OF AVERAGE DAILY FLOW AT STATION WQ-3 (PAYNE CREEK) EXITING CF INDUSTRIES PROPERTY, JUNE 1981 THROUGH JUNE 1982
SOURCES: CF, 1982 ESE, 1982

U.S. Environmental Protection Agency, Region IV
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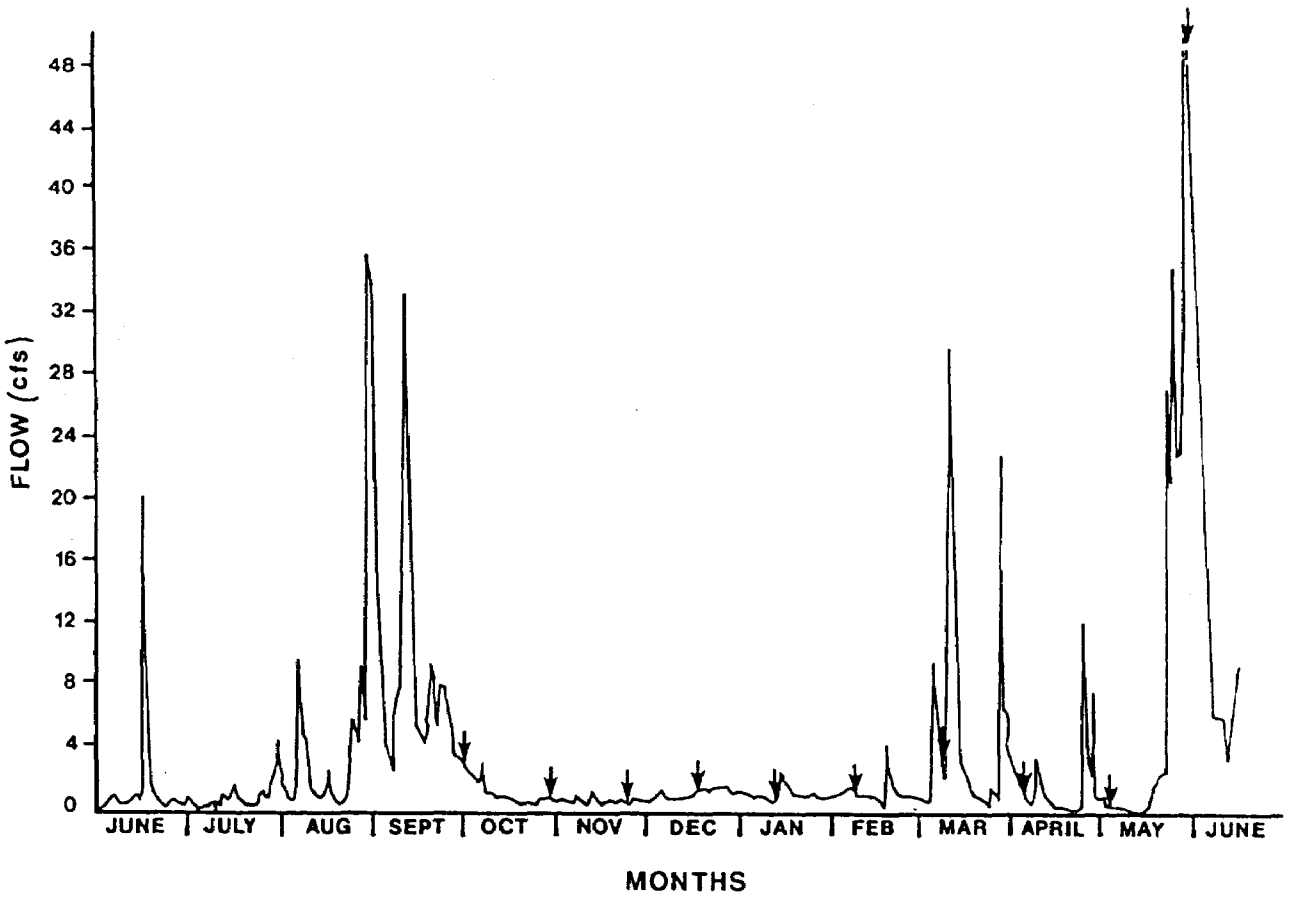
CF INDUSTRIES
Hardee Phosphate Complex II



NOTE: ARROWS INDICATE SAMPLE DATES OF FLOW MEASUREMENTS AND WATER QUALITY SAMPLING

Figure 7.1-5
HYDROGRAPH OF AVERAGE DAILY FLOW AT STATION WQ-4 (GUM SWAMP BRANCH) ENTERING CF PROPERTY FROM JUNE 1981 THROUGH JUNE 1982

SOURCES: CF, 1982 ESE, 1982

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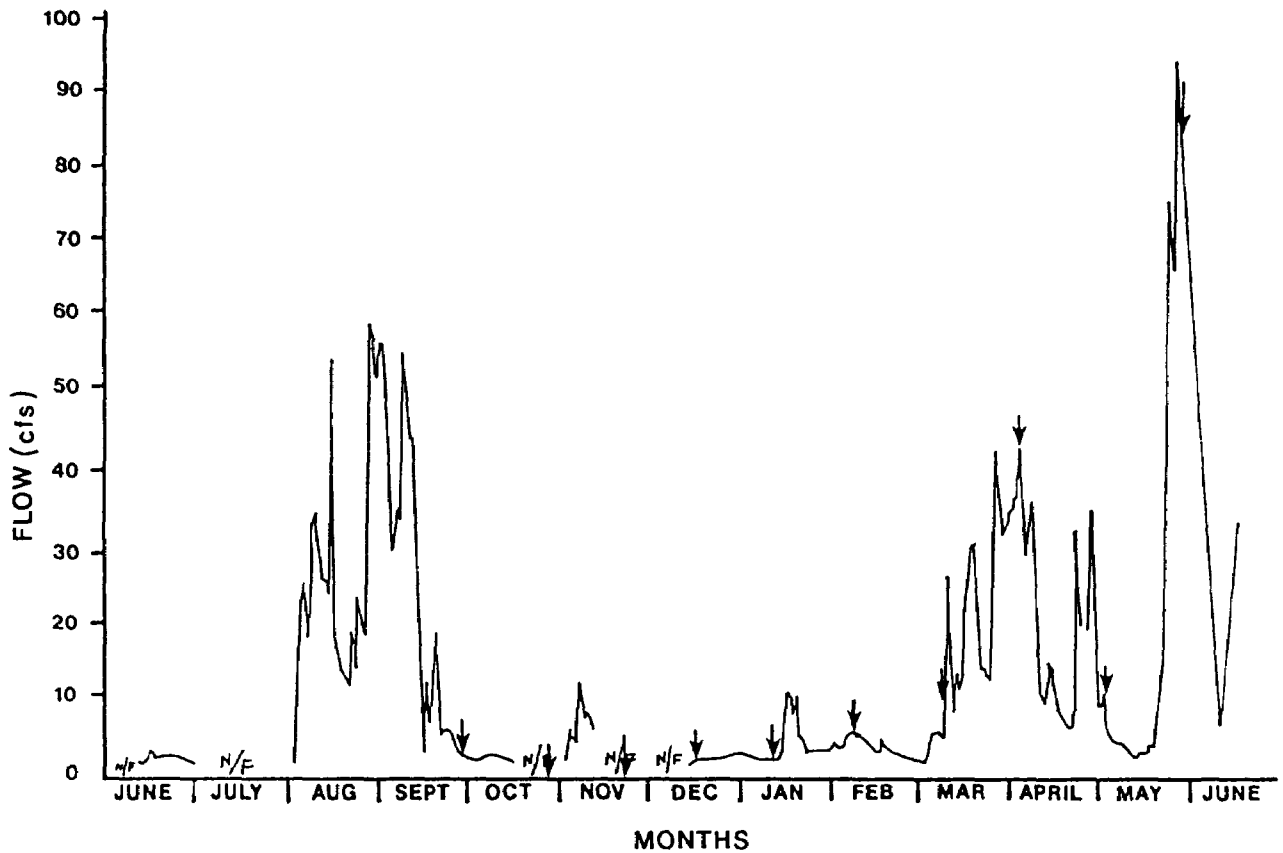
Hardee Phosphate Complex II



NOTE: ARROWS INDICATE SAMPLE DATES OF FLOW MEASUREMENTS AND WATER QUALITY SAMPLING
N/F INDICATES NO FLOW

Figure 7.1-6
HYDROGRAPH OF AVERAGE DAILY FLOW AT STATION WQ-7 (HICKEY BRANCH) EXITING CF PROPERTY, JUNE 1981 THROUGH JUNE 1982
SOURCES: CF, 1982 ESE, 1982

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Hardee Phosphate Complex II

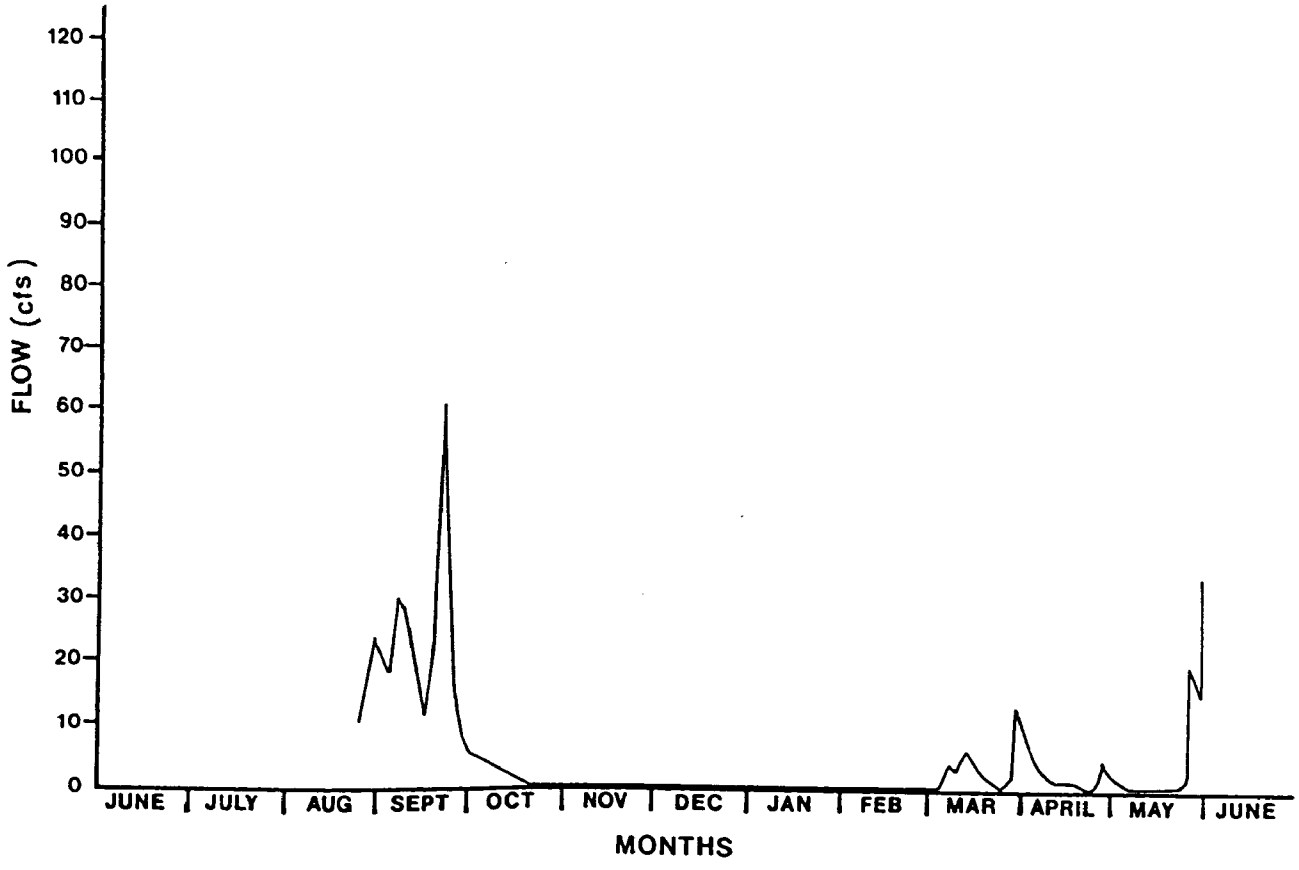

Figure 7.1-7
HYDROGRAPH OF AVERAGE DAILY FLOW AT STATION WQ-11 (HORSE CREEK), AUGUST 1981 THROUGH JUNE 1982

SOURCES: CF, 1982
ESE, 1982

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Hardee Phosphate Complex II

Table 7.1.2-4. Summary of Instantaneous Flows Measured at Surface Water Stations

Station	Instantaneous Flows Measured (cfs)											
	1981						1982					
	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	June
WQ-1	—	—	4.80*	1.16	1.80	5.30	4.98	10.34	8.26	17.42	5.94	18.72
WQ-2	—	—	7.08	7.64	4.34	2.74	5.14	11.76	12.17	8.91	8.45	103.82
WQ-3	—	—	11.03	9.34	5.08	3.42	5.59	12.99	14.27	11.24	9.69	115†
WQ-4	—	—	2.01	P	0.31	0.48	0.34	0.66	1.56	0.98	0.39	50.12
WQ-5	P	P	0.49	P	P	P	P	0.03	0.05	P	P	1.84
WQ-6	—	—	—	—	—	—	—	—	—	—	—	—
WQ-7	—	—	3.0†	0.62	0.46	1.72	1.84	7.93	6.56	33.87	6.79	43†
WQ-8	P	P	3.45	P	P	P	P	P	P	P	P	18.41
WQ-9	P	P	5.75	—	—	—	—	—	—	—	—	—
WQ-10	P	4.34	0.48	P	P	P	D	D	P	P	P	13.54
WQ-11	1.23	14.37	120	P	—	—	D	P	2.78	2.92	P	25.73
WQ-12	D	P	<0.01	—	—	—	—	—	—	—	—	—
WQ-13	—	—	19.83	12.01	7.71	7.29	8.91	19.82	34.19	42.15	20.31	320
WQ-14	—	—	32.66	16.58	10.66	14.61	12.29	28.62	48.04	55.11	29.69	391.1†

* Estimated from S/D curve developed by ESE.
† Estimated from S/D curve from CF for WQ-3, and WQ-7 and from USGS for WQ-14.

P indicates ponded.
D indicates dry.
— indicates no data collected.

Source: ESE, 1982.

7.1.3 REGIONAL DESCRIPTION--QUALITY

The CF property is drained primarily by Horse Creek and tributaries of Payne Creek, which drain to the Peace River. The following section presents a brief discussion of the regional water quality of Horse Creek and the Peace River.

7.1.3.1 HORSE CREEK

The CF properties are located near the headwaters of Horse Creek. Water quality data have been collected in this reach of the creek by CF at Station WQ-6. Downstream, water quality data have been collected for Mississippi Chemical Corporation (MCC) at Station MCC-2 (see Figure 7.1-8). Further downstream near Arcadia, extensive water quality data have been collected by USGS.

A comparative summary of water quality changes along the length of Horse Creek is presented in Table 7.1.3-1. Although collected at different times and during different flow conditions, these data are useful for the assessment of general similarities, differences, and changes within the basin. In general, dissolved material in the water increases from upstream to downstream, as is observed for alkalinity, conductivity, and total phosphate. Although some minor differences are observed, the two upstream stations have similar water quality. These stations differ significantly from the downstream station at Arcadia.

USGS has maintained a water quality station on Horse Creek near Arcadia since 1962. The drainage area at this station is approximately 212 square miles. The water quality observations made at this site are summarized in Table 7.1.3-2. For comparative purposes, this table also reflects applicable Florida Class III water quality standards.

The following observations were made from the water quality summary for Horse Creek near Arcadia. No mean concentrations violate Florida Class III standards. However, violations occur for the extreme values of alkalinity, conductivity, dissolved oxygen (DO), pH, and mercury. Since alkalinity is generally low (38 mg/l as $CaCO_3$), even the low to

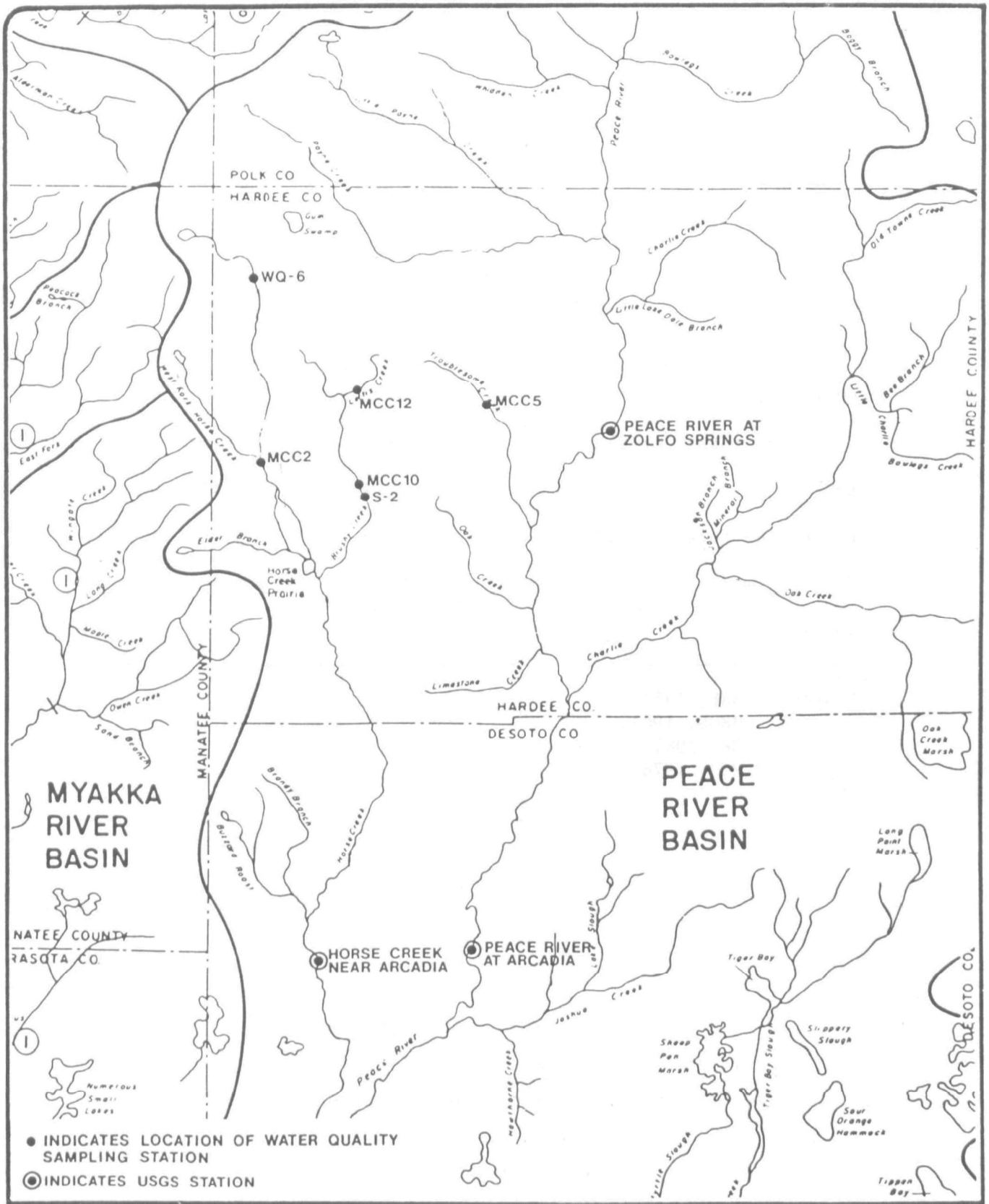

Figure 7.1-8
LOCATIONS OF REGIONAL WATER QUALITY STATIONS
SOURCES: EPA, 1978
ESE, 1982

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Table 7.1.3-1. Comparison Summary of Selected Water Quality Parameters Along Horse Creek

	Mean Concentration		
	At Headwaters	At MCC-2	At Arcadia
Alkalinity (mg/l)	11.6	30.5	38.0
Coliforms, fecal (#/100 ml)	212.0	271.0	--
Conductivity (umhos)	118.0	136.0	251.0
DO (mg/l)	--	8.0	7.7
Nitrogen, total (mg/l)	--	1.10	1.32
pH	6.22	6.16	6.92
Phosphate, total (mg/l)	0.46	0.66	1.37
Sulfate (mg/l)	8.3	8.3	30.2
TOC (mg/l)	--	24.0	19.0

Sources: ESE, 1981.
USGS, 1981.
CF, 1981.
MCC, 1976.

Table 7.1.3-2. Summary of Water Quality Data for Horse Creek Near Arcadia (USGS Station 02297310)

Paraneter	Mean	Maximum Value	Minimum Value	Standard Deviation	Number of Samples	17-3 Class III Standard
Alkalinity (mg/l)	38.0	114.0	11.0	33.0	25	>20.0
BOD (mg/l)	0.9	2.0	0.4	0.4	18	—
Chlorides (mg/l)	15.8	29.0	7.2	4.7	38	—
Color (pt-co units)	125.0	300.0	30.0	77.0	26	—
Conductivity (umhos)	251.0	753.0	64.0	169.0	104	500.0
DO (mg/l)	7.7	—	1.9	6.5	78	>5.0
Fluoride (mg/l)	0.5	1.5	0.1	0.2	36	10.0
Hardness, total (mg/l)	75.0	200.0	0.3	58.0	25	—
pH	6.92	8.5	5.5	0.60	51	6.0 to 8.5
Sulfate (mg/l)	30.2	138.0	4.8	32.3	26	—
TOC (mg/l)	19.0	40.0	4.0	9.3	18	—
Turbidity (JTU)	9.0	30.0	1.0	8.7	13	—
$NH_3 + NH_4^+$ (mgN/l)	0.05	0.12	0.02	0.03	9	—
Organic N (mgN/l)	1.03	2.00	0.67	0.40	10	—
TKN (mgN/l)	1.14	2.02	0.73	0.42	8	—
$NO_3 + NO_2$ (mgN/l)	0.18	0.29	0.07	0.07	8	—
Total N (mgN/l)	1.32	2.09	0.91	0.36	8	—
Ortho PO_4 (mg/l)	1.54	5.8	0.70	1.16	17	—
Total PO_4 (mg/l)	1.37	1.70	0.91	0.41	3	—
Aluminum, total (ug/l)	190.0	250.0	60.0	—	2	—
Arsenic, total (ug/l)	1.0	1.0	1.0	—	2	50.0
Cadmium, total (ug/l)	0.5	1.0	*	—	2	1.2
Copper, dissolved (ug/l)	4.0	10.0	*	5.0	3	30 (total)
Iron, total (mg/l)	0.785	0.990	0.580	—	2	1.0
Lead, total (ug/l)	6.5	7.0	6.0	—	2	30.0
Mercury, total (ug/l)	0.3	0.5	0.1	—	2	0.2
Nickel, total (ug/l)	3.0	5.0	1.0	—	2	100.0
Zinc, dissolved (ug/l)	8.0	10.0	5.0	—	2	30.0

* Values less than detection limits.

Source: USGS, 1980.

moderate color levels (125 PCU) produce acidic conditions. Nitrogen levels are low; however, nitrate-nitrite are moderate to high, indicating fertilizer input from leached ground water or runoff. Total phosphate is high, averaging 1.37 mg/1. Waters are generally well oxygenated, with DO average 7.7 mg/1 and biological oxygen demand (BOD) average 0.9 mg/1. Dissolved ions are moderate. Specific conductivity averaged 251 umhos/cm, indicating a TDS concentration of 140 to 225 mg/1.

7.1.3.2 PEACE RIVER

Payne Creek flows into the Peace River downstream of its confluence with Little Payne Creek. No long-term water quality stations are located on Payne Creek. Over the past 30 years, water quality data in the Peace River have been collected by USGS at Zolfo Springs, south of the Payne Creek inflow. Table 7.1.3-3 summarizes the water quality gathered at this site from August 1951 to May 1981.

The following observations were made from the water quality summary at this USGS station. Waters in the Peace River at Zolfo Springs have low to moderate color levels, high conductivity, and high phosphate levels. Color averages 65 PCUs, with moderate alkalinity (52 mg/1 as $CaCO_3$). pH averaged slightly in the basic range (7.16). Dissolved solids are high at the station. Specific conductance averaged 388 umhos/cm, indicating a Total Dissolved Solids concentration of 210 to 350 mg/1. Nitrogen is low in the river; however, nitrate-nitrite is high (1.13 mg/1), indicating fertilizer input from ground water or runoff. Total phosphate is high, averaging 7.17 mg/1. Dissolved oxygen was observed at moderate levels, averaging 6.9 mg/1, and BOD was generally low, averaging 1.4 mg/1.

Water quality has also been monitored by USGS on the Peace River near Arcadia, at a station located about 33 miles downstream of the Zolfo Springs station. Water quality at this station is similar to that observed at Zolfo Springs. These similarities may be seen in the comparison of the two stations which appears in Table 7.1.3-4.

Table 7.1.3-3. Summary of Water Quality Data for Peace River at Zolfo Springs (USGS Station 02295637)

Parameter	Mean	Maximum Value	Minimum Value	Standard Deviation	Number of Samples	17-3 Class III Standard
Alkalinity (mg/l)	59.0	89.0	*	18.0	53	>20.0
BOD (mg/l)	1.4	3.5	*	0.8	17	—
Chlorides (mg/l)	15.2	21.0	9.4	2.4	54	—
Color (pt-co units)	65.0	180.0	*	53.0	52	—
Conductivity (umhos)	388.0	900.0	—	124.0	143	500.0
DO (mg/l)	6.9	12.9	*	1.8	95	5.0
Fluoride (mg/l)	4.7	213.0	0.2	24.0	78	—
Hardness, total (mg/l)	147.0	260.0	48.0	53.0	51	—
pH	7.16	8.35	4.20	—	111	6.0 to 8.5
Sulfate (mg/l)	88.0	180.0	13.0	42.0	52	—
TOC (mg/l)	17.0	35.0	7.0	9.0	16	—
Turbidity (JTU)	11.2	230.0	1.0	29.3	59	—
$NH_3 + NH_4^+$ (mgN/l)	0.11	0.88	*	0.14	59	—
Organic N (mgN/l)	0.89	2.10	0.38	0.43	58	—
TKN (mgN/l)	0.93	2.15	0.41	0.41	41	—
$NO_3 + NO_2$ (mgN/l)	1.13	2.67	0.45	0.50	41	—
Total N (mgN/l)	2.21	5.49	1.01	0.88	44	—
Ortho PO_4 (mg/l)	10.26	87.0	0.11	10.25	76	—
Total PO_4 (mg/l)	7.17	13.0	0.60	2.78	22	—
Aluminum, total (ug/l)	45.0	90.0	*	—	2	—
Arsenic, total (ug/l)	1.0	—	—	—	1	50.0
Cadmium, total (ug/l)	*	—	—	—	1	1.2
Copper, dissolved (ug/l)	28.0	100.0	*	48.0	4	30.0
Iron, total (mg/l)	0.333	0.400	0.250	0.076	3	1.0
Lead, total (ug/l)	1.0	—	—	—	1	30.0
Mercury, total (ug/l)	0.5	—	—	—	1	0.2
Nickel, total (ug/l)	5.0	—	—	—	1	100.0
Zinc, dissolved (ug/l)	17.0	40.0	*	21.0	3	30.0

* Values less than detection limits.

Source: USGS, 1980.

Table 7.1.3-4. Comparison Summary of Water Quality Data Along Peace River

Parameter	Mean Concentrations	
	Zolfo Springs	Arcadia
Alkalinity (mg/l)	52	44
BOD (mg/l)	1.4	1.4
Chlorides (mg/l)	15.2	15.8
Color (PCU)	65	88
Conductivity (umhos)	388	300
DO (mg/l)	6.9	7.5
Fluoride (mg/l)	4.7	1.6
Hardness, total (mg/l)	147	117
pH	7.16	7.41
Sulfate (mg/l)	88	65
TOC (mg/l)	17	16
Turbidity (JTU)	11.2	5.1
$NH_3 + NH_4^+$ (mgN/l)	0.11	0.08
Organic N (mgN/l)	0.89	0.98
TKN (mgN/l)	0.93	1.13
$NO_3 + NO_2$ (mgN/l)	1.13	0.78
Total N (mgN/l)	2.21	2.00
Ortho PO_4 (mg/l)	10.26	8.13
Total PO_4 (mg/l)	7.17	8.33

Source: USGS, 1980.

7.1.4 SITE-SPECIFIC DESCRIPTION--QUALITY

7.1.4.1 DATA COLLECTION

Previous Studies

CF Industries has collected weekly grab samples at Stations WQ-1 through WQ-7 since July 1975. The analyses performed include:

1. pH
2. Conductivity
3. Alkalinity
4. Fluoride
5. Ammonia
6. Nitrate
7. Nitrite
8. Orthophosphate
9. Total phosphorus
10. Silica
11. Sulfate
12. Total suspended solids
13. Fecal coliforms
14. Turbidity
15. Radium-226, analyzed quarterly by Pembroke Laboratory during 1976 and 1977 and twice during 1978. CF collected samples twice during 1981.

Continuous measurements of temperature, dissolved oxygen, pH, and conductivity are made at Stations WQ-1, WQ-2, WQ-3, and WQ-7.

Water quality data are reported quarterly to Hardee County, FDER and EPA.

EIS Monitoring

ESE initiated water quality sampling efforts on the CF property in July 1981, and conducted a 1-year monitoring program that covered the period July 1981 through June 1982. ESE visited the CF property in June 1981 and observed that, except for Horse Creek, none of the other five

streams on the South Pasture mine site were flowing at the property boundaries. Therefore, the period of July 1981 through June 1982 is representative of a complete wet and dry season annual cycle. Streamflow hydrographs showing water quality sampling dates are presented in Figures 7.1-4 through 7.1-7 for Stations WQ-3, WQ-4, WQ-7, and WQ-11.

ESE performed the following sampling and analyses for the water year July 1981 through June 1982 (see Table 7.1.4-1 for referenced parameter listings and Figure 7.1-3 for station locations).

Station(s)	Monthly Sampling	Seasonal (S) Metals Sampling
WQ 1-4 and 7	CF list--July and August ESE/FDER-M lists--Sept.-June	FDER-S list--Sept., Oct., Feb., April
WQ-5	ESE/FDER-M lists--July-June	FDER-S list--July, Sept., Oct., Feb.
WQ-6	CF List--July-June	None
WQ-8 and 10	ESE/FDER-M lists--July-June	FDER-S list--July, Sept., Oct., Feb.
WQ-9, 11, and 12	ESE list--July-Sept.	None
WQ-13 and 14	ESE/FDER-M lists--Sept.-June	FDER-S list--Sept., Oct., Feb., April

7.1.4.2 DATA ASSESSMENT

Water quality data gathered during the EIS and during previous studies have been summarized by statistical analyses using the raw data values. The raw water quality data for the EIS monitoring are included in Appendix B. The raw data for sampling conducted by CF Industries, Mississippi Chemical Corporation (MCC), and Farmland Industries are extensive and are, therefore, not included in this report.

Table 7.1.4-1. Surface Water Quality Parameters

	CF*	ESE†	FDER**
Alkalinity	X	X	M
Ammonia	X	X	M
Arsenic			S
Bacteriological Quality:			
Fecal Coliform	X	X	
Beryllium			S
BOD		X	M
Cadmium			S
Chlorides			M
Chromium, Total			S
Copper			S
Cyanide			S
Dissolved Oxygen	X	X	M
Fluoride Ion	X	X	M
Iron			S
Lead			S
Mercury			S
Nickel			S
Nutrients:	X	X	M
Nitrate/Nitrite	X	X	
TKN		X	
Total Phosphorus	X	X	
Total Orthophosphate	X	X	
pH	X	X	M
Radioactive Substances:			
Radium-226	X (Varied)	X	M
Gross Alpha		X	M
Selenium			S
Silver			S
Specific Conductance	X	X	M

Table 7.1.4-1. Surface Water Quality Parameters (Continued, Page 2 of 2)

	CF*	ESE†	FDER**
Silica	X	X	
Sulfate	X	X	
Suspended Solids	X	X	
Temperature	X††	X	
Turbidity	X	X	M
Zinc			S
Color		X	

* Water quality parameters sampled by CF Industries on a weekly basis at Stations WQ-1-7 from July 1975 to present.
† Water quality parameters sampled by ESE at Stations WQ-5, 8, 9, 10, 11, and 12 during July, August, and September 1981 as originally proposed in draft POS.
**Water quality parameters requested by FDER to be sampled over one year period with "M" indicating monthly sampling and "S" indicating seasonal metals sampling (3 to 4 times over year).
††Stations WQ 1, 2, 3, 7 continuous.

Source: ESE, 1981.

Horse Creek Basin

Three streams are discussed in Horse Creek Basin, including Horse Creek (WQ-11), Brushy Creek (WQ-9), and Lettis Creek (no sampling on CF property). Water quality data on the CF site for Horse and Brushy Creeks include three months (July through September) during 1981. Historical data near the property on Horse Creek were collected by CF Industries (WQ-6) and by Mississippi Chemical Company (MCC-2). Historical data on Brushy Creek were collected at MCC-10 and Farmland Industries Station S-2 downstream of the site. Data for Lettis Creek were collected during previous studies of MCC's proposed mine at Station MCC-12 located about 3 miles south of Complex II (see Figure 7.1-8 for location of stations).

Horse Creek traverses the western end of Complex II, with 9.5 percent of its basin upstream of Station WQ-11 draining CF property. The water quality sampling station on Horse Creek (WQ-11) was located about one-half mile north of CF's southern boundary in an open area. The channel at this location was generally broad and shallow. The stream bottom was primarily sand with some organic muck in the pooled areas. Brushy Creek drains 4.2 square miles at Station WQ-9, with 98 percent of that drainage on CF property. The sampling station on Brushy Creek was located on the upstream side of the dirt road that runs along CF's south property line. The ditch-like channel was in a open area. The channel was shallow and heavily vegetated. Lettis Creek does not traverse CF property, but has a small portion of its drainage basin on the property (but no defined channel exiting the property). Therefore, no sampling was conducted on this creek.

Land use in the basin consists primarily of rangeland, marsh and flatwoods, and forested swamps bordering the streams.

Water quality data collected for the basin during the EIS monitoring and previous studies are summarized in Tables 7.1.4-2 through 7.1.4-5.

Table 7.1.4-2. Summary of Water Quality Data Collected at WQ-11 and WQ-9 From July 1981 Through September 1981

PARAMETER	STATION WQ-9 (BRUSHY CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-11 (HORSE CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	1.92	0.00	5.75	3.32	3	45.2	1.23	120	65.1	3
COLOR (PCU)	383	250	500	126	3	333	250	500	144	3
METHY.B.A. SUBST. (MG/L)					0					0
OIL & GREASE (MG/L)					0					0
SUSP.SOLIDS (MG/L)	46	5	108	55	3	<5	<5	<5	0	3
TURBIDITY (NTU)	2.00	0.70	3.80	1.61	3	0.93	0.70	1.10	0.21	3
WATER TEMP (C)	27.9	24.8	32.0	3.7	3	26.0	24.6	27.5	2.1	2
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	65.7	50.0	75.0	13.7	3	123	55.0	200	72.9	0
CYANIDE (MG/L)					0					0
CHLORIDE (MG/L)	8	6	9	1	3	18	9	26	8	3
FLUORIDE (MG/L)	0.20	0.16	0.24	0.04	3	0.23	0.17	0.30	0.07	3
SULFATE (MG/L)	2	<1	3	1	3	13	<1	35	19	3
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	9	4	18	8	3	5	4	6	1	3
PH	5.17	5.00	6.50		3	5.37	5.20	5.60		3
NUTRIENTS:										
AMMONIA (MG/L-N)	0.12	0.03	0.25	0.11	3	<0.03	<0.03	0.05	0.02	3
AMMONIA,UNIONIZED (MG/L)	<0.001	<0.001	<0.001	0.000	3	<0.001	<0.001	<0.001	0.000	2
NO3 + NO2 (MG/L-N)	0.018	0.013	0.022	0.004	3	0.007	0.005	0.010	0.003	3
TKN (MG/L-N)	2.91	1.31	3.72	1.39	3	1.60	0.92	1.99	0.59	3
T. ORG. N. (MG/L-N)	2.79	1.27	3.64	1.32	3	1.57	0.91	1.93	0.58	3
T. PHOSPHOROUS (MG/L-P)	0.708	0.505	0.989	0.251	3	0.477	0.190	0.941	0.405	3
DISS. O-PO4 (MG/L-P)	0.522	0.348	0.626	0.152	3	0.408	0.107	0.841	0.384	3
SILICA, DISS(MG/L AS SIO2)	5.5	4.3	7.2	1.5	3	4.4	2.3	5.6	1.9	3
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	2.7	1.3	3.8	1.3	3	2.1	1.1	2.8	0.9	3
BOD (5 DA.-MG/L)	3.7	1.5	5.4	2.0	3	1.9	1.0	2.4	0.8	3
METALS:										
ARSENIC,TOTAL(UG/L)					0					0
BERYLLIUM (UG/L)					0					0
CADMIUM,TOTAL(UG/L)					0					0
CHROMIUM,TOTAL(UG/L)					0					0
COPPER,TOTAL(UG/L)					0					0
IRON,TOTAL(UG/L)					0					0
LEAD,TOTAL(UG/L)					0					0
MERCURY,TOTAL(UG/L)					0					0
NICKEL (UG/L)					0					0
SELENIUM,TOTAL(UG/L)					0					0
SILVER,TOTAL(UG/L)					0					0
ZINC,TOTAL(UG/L)					0					0
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	687	241	1400	624	3	435	60	980	483	3

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-3. Summary of Water Quality Data Collected at Station WQ-6

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNITY(MG/L)	32.30	75.96	3.94	12.89	138	>20 MG/L	22
F COL(MPN/100ML)	348.79	2800.00	15.00	453.29	133	800 MPN/100 ML	14
F(MG/L)	0.41	1.81	0.10	0.18	138	<10 MG/L	0
NH3(MG/L)	0.13	1.30	0.01	0.16	138		0
NITRATE(MG/L)	0.06	1.30	0.01	0.17	138		0
NITRITE(MG/L)	0.02	0.24	0.00	0.04	138		0
PH	6.71	8.00	5.50	0.32	135	6.0-8.5	2
TOTAL P(MG/L)	1.16	5.10	0.30	0.80	138		0
O_PO4(MG/L)	0.86	3.90	0.00	0.55	138		0
SILICA(MG/L)	9.96	20.70	0.40	4.24	135		0
S SOLIDS(MG/L)	54.44	1384.00	0.50	147.87	138		0
COND(UMHOS/CM)	136.78	276.00	4.00	44.65	134	<500 UMHOS/CM	0
SO4(MG/L)	5.31	74.00	0.20	8.74	138		0
TURBID(NTU)	4.07	44.00	0.20	5.65	129		0

Sources: CF, 1976-1982.
ESE, 1982.

Table 7.1.4-4. Summary of Water Quality Data Collected on Brushy Creek Downstream of Complex II

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
FLOW(CFS)	1.86	6.60	0.00	1.97	10		0
H2O TEMP(DEG C	24.16	30.50	15.00	4.65	22		0
COND(UMHOS/CM)	170.32	290.00	76.00	54.93	22	<500 UMHOS/CM	0
PH	5.92	6.80	5.20	0.00	22	6.0-8.5	8
D.OXYGEN(MG/L)	4.67	7.90	0.50	2.41	22	>5.0 MG/L	11
S SOLIDS(MG/L)	63.23	207.00	1.50	75.88	22		0
ORG(MG/L)	5.00	5.00	5.00	0.00	10	<5.0 MG/L	0
TOC(MG/L)	37.20	380.00	0.17	78.07	22		0
F COL(MPN/100ML)	222.32	1040.00	0.00	282.47	22	800 MPN/100 ML	1
O_PO4(MG/L)	0.98	2.66	0.04	0.78	22		0
TOTAL P(MG/L	20.61	188.00	0.04	52.91	22		0
NH3(MG/L)	0.13	0.29	0.05	0.07	10		0
ORG N(MG/L	1.28	3.80	0.26	0.73	22		0
NO3+NO2(MG/L)	2.61	10.10	0.00	3.64	22		0
TKN(MG/L)	0.39	1.70	0.03	0.55	12		0
BOD(MG/L)	19.15	72.00	1.00	20.73	22		0
ACIDITY	18.30	34.00	6.00	9.93	10		0
ALKALNTY(MG/L)	23.53	97.00	0.51	24.56	22	>20 MG/L	13
TURBID(NTU)	133.27	423.00	1.00	174.77	22		0
COLOR(CPU)	169.41	500.00	0.27	179.03	22		0
TS(MG/L)	111.11	278.00	0.94	88.93	22		0
F(MG/L)	6.08	35.00	0.00	10.94	22	<10 MG/L	5
SO4(MG/L)	166.67	1780.00	4.00	411.57	22		0
FE(MG/L)	0.32	1.84	0.00	0.50	22	<1.0 MG/L	2
AL(MG/L)	313.16	3820.00	0.50	852.33	22		0
AS(MG/L)	0.02	0.03	0.00	0.01	10	<0.05 MG/L	0

Sources: MCC, 1976.
ESE, 1980.
ESE, 1982.

Table 7.1.4-5. Summary of Water Quality Data Collected At Station MCC-12

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
FLOW(CFS)	1.13	3.00	0.00	1.13	8		0
H2O TEMP(DEG C	21.38	27.00	11.00	6.46	8		0
COND(UMHOS/CM)	195.00	290.00	140.00	46.90	8	<500 UMHOS/CM	0
PH	6.21	6.80	5.80	0.00	8	6.0-8.5	1
D.OXYGEN(MG/L)	3.55	6.40	1.30	1.69	8	>5.0 MG/L	7
S SOLIDS(MG/L)	7.38	12.00	1.00	4.21	8		0
O&G(MG/L)	5.00	5.00	5.00	0.00	8	<5.0 MG/L	0
TOC(MG/L)	28.38	62.00	0.00	17.58	8		0
F COL(MPN/100ML)	415.00	2800.00	0.00	970.89	8	800 MPN/100 ML	1
O_PO4(MG/L)	0.15	0.26	0.08	0.06	8		0
TOTAL P(MG/L	0.30	0.56	0.00	0.19	8		0
NH3(MG/L)	0.19	0.36	0.10	0.08	8		0
ORG N(MG/L	1.51	2.10	0.90	0.41	8		0
NO3+NO2(MG/L)	0.03	0.10	0.00	0.04	8		0
BOD(MG/L)	2.66	6.00	0.00	1.90	8		0
ACIDITY	15.88	30.00	6.00	7.81	8		0
ALKALNTY(MG/L)	51.63	103.00	4.00	29.56	8	>20 MG/L	1
TURBID(NTU)	2.13	5.00	0.00	1.73	8		0
COLOR(CPU)	275.00	450.00	160.00	85.19	8		0
TS(MG/L)	183.75	260.00	130.00	42.41	8		0
F(MG/L)	0.26	0.34	0.24	0.04	8	<10 MG/L	0
SO4(MG/L)	3.75	12.00	1.00	3.69	8		0
FE(MG/L)	0.35	0.60	0.14	0.17	8	<1.0 MG/L	0
AL(MG/L)	1.19	2.00	0.50	0.53	8		0
AS(MG/L)	0.02	0.03	0.00	0.01	8	<0.05 MG/L	0

Sources: MCC, 1976.
ESE, 1982.

General Parameters

Waters in the basin can generally be considered to be colored waters of low turbidity. Color levels were highest in Brushy Creek (383 PCU), and lowest in Lettis Creek (275 PCU). These levels can be considered typical for Florida streams traversing the swampland areas. Color reflects the effects of contact with swamplands where decaying organic vegetation forms humic and fulvic acids. These materials make up most of the color in Florida waters, and affect pH, productivity, and metal transport. Suspended solids were lowest in Horse Creek during the EIS monitoring (<5 mg/l), but historically, the data appeared variable with a maximum of 1,437 mg/l. Brushy Creek experienced a buildup of suspended matter during ponded conditions. Turbidity was generally less than three NTUs for all the streams, but historically, Horse Creek experienced higher turbidities, reaching a maximum of 52 NTUs. Lack of turbulence and slow moving conditions are probably the reasons for little suspended material in the streams.

Dissolved Ions

Total Dissolved Solids (TDS) were highest in Lettis Creek, and lowest in Brushy Creek. Specific conductance, historically, averages 115 umhos/cm for Lettis Creek, indicating a TDS level of 85 to 140 mg/l. Brushy Creek averages 66 umhos/cm indicating a TDS level of 36 to 59 mg/l.

Alkalinity and pH

Alkalinity is highest in Lettis Creek (51.63 mg/l as $CaCO_3$). EIS monitoring indicated Horse Creek had the lowest alkalinity (5 mg/l as $CaCO_3$), but historically levels were slightly higher (11.6 mg/l as $CaCO_3$). Alkalinity in the streams was often below the minimum standard for Florida Class III waters; historically, Horse Creek was below the standard in 117 of the 145 samplings. Low alkalinity suggests low buffering capacity in the stream and, with acidic input, acidic conditions could be expected. Generally, acidic conditions are found in the streams; Brushy Creek is the most acidic with a mean pH of 5.17, while Lettis Creek is the least acidic with a pH of 6.22. The same order is observed with organic color, and these acids may be determinative of pH in the streams.

Nutrients

Nitrogen was lowest in Lettis Creek and highest in Brushy Creek. Lettis Creek had an organic nitrogen concentration of 1.51 mg/l, whereas concentrations in Brushy Creek averaged 2.79 mg/l. Values of organic nitrogen were higher in Brushy Creek during ponded conditions indicating the buildup of organic matter when flushing is reduced. Inorganic nitrogen (ammonia, nitrate, nitrite) was observed at lower levels in Horse Creek.

Total phosphorus levels were highest in Brushy Creek (0.708 mg/l) and lowest in Lettis Creek (0.30 mg/l). The form of this phosphate was primarily ortho-phosphate which represented as much as 85 percent of the total. These conditions illustrate the low productivity levels in the stream. In a productive system, inorganic phosphate is taken up rapidly and converted to an organic form. These organic forms are generally less accessible to organisms and therefore build up and become the predominant form in the water body.

DO/BOD

Both DO and BOD were low in the streams. DO averaged less than 3 mg/l in all the streams, whereas potential DO saturation values ranged from 7 to 11 mg/l. Low DO values can be expected when BOD is high; however, BOD averaged less than 4 mg/l for all the streams.

The possible mechanisms that can cause the loss or consumption of oxygen are:

1. Oxidation of organic and inorganic substances,
2. Respiration by aquatic organisms (both plant and animal),
3. Oxygen diffusion to the atmosphere,
4. Nitrification of ammonia, and
5. Iron organic matter interactions in colored waters.

Microbiology

Fecal coliform counts were highest in Brushy Creek (687/100 ml), possibly due to ponded conditions, and were lowest (historically) in Horse Creek (212/100 ml). These conditions probably reflect impact from cattle and rangeland runoff.

Payne Creek Basin: Tributaries Draining Complex II

Water quality samples were collected from four tributaries draining Complex II north to Payne Creek. These tributaries include Shirttail Creek (WQ-10), Doe Branch (WQ-8), Plunder Branch (WQ-5), and Coons Bay Branch (WQ-12). Samples were collected monthly at Station WQ-5, Station WQ-8, and Station WQ-10 during the period July 1981 to June 1982, and from July 1981 through September 1981 at Station WQ-12. Historical data collected by CF Industries at WQ-5 were also used to assess water quality.

Water quality data on these streams during the EIS monitoring are summarized in Tables 7.1.4-6 and 7.1.4-7. Historical data at Station WQ-5 are presented in Table 7.1.4-8. These streams are generally slow moving and most samplings were collected from ponded water. All streams were observed to have some movement in September 1981. Flow was also observed at Stations WQ-5, 8, and 10 during the month of June 1982. Land use in the basin is primarily forested swamp, rangeland, flatwoods, and marsh. Drainage basin areas and estimated average flows at each station are presented in Table 7.1.2-2.

The sampling station on Plunder Branch (WQ-5) was a pooled area approximately 30 feet upstream of the culverts at SR 62. This pooled area is about 30-feet across, 2-feet deep and densely wooded. The samples were collected where the pool drained into a small, poorly defined channel which was heavily vegetated. The sampling station on Doe Branch (WQ-8) was on the upstream side of the culverts at SR 62. The stream channel at this location was open, very broad and shallow. The stream bottom was primarily organic muck. The channel was usually ponded and covered with vegetation. Shirttail Branch (WQ-10) was sampled about one-half mile south of SR 62 at CF's property boundary. Samples were collected from a stream channel which was moderately wooded with moderate understory. The stream channel contained much wood debris. Coons Bay Branch (WQ-12) sampling location was on the upstream side of the culvert at SR 62. The channel was poorly defined.

Table 7.1.4-6. Summary of Water Quality Data Collected at WQ-10 and WQ-8, July 1981 Through June 1982

PARAMETER	STATION WQ-8 (DOE BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-10 (SHIRTTAIL BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	1.82	0.00	18.4	5.32	12	2.23	0.00	13.5	4.81	8
COLOR (PCU)	183	75	500	129	12	236	105	400	106	8
METHY.B.A. SURST. (MG/L)	<0.50	<0.50	<0.50	0.00	3	<0.50	<0.50	<0.50	0.00	2
OIL & GREASE (MG/L)	<5	<5	<5	0	3	<5	<5	<5	0	2
SUSP.SOLIDS (MG/L)	17	<5	90	25	12	9	<5	30	10	8
TURBIDITY (NTU)	2.67	0.90	7.90	1.91	12	2.71	0.90	5.20	1.75	8
WATER TEMP (C)	20.1	9.5	30.0	6.4	12	21.3	9.3	29.0	6.2	8
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	283	77.0	670	161	12	194	54.0	604	179	9
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000	3	<0.005	<0.005	<0.005	0.000	2
CHLORIDE (MG/L)	35	9	50	14	12	22	9	40	10	7
FLUORIDE (MG/L)	0.36	0.23	0.40	0.05	12	0.84	0.26	2.55	0.81	8
SULFATE (MG/L)	48	<1	277	73	12	48	<1	749	86	8
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	45	14	76	17	12	17	7	35	10	8
PH	3.98	5.30	7.40	0.61	12	5.70	5.30	7.10	0.72	9
NUTRIENTS:										
AMMONIA (MG/L-N)	0.17	0.02	0.58	0.18	12	0.05	0.02	0.10	0.03	8
AMMONIA,UNIONIZED(MG/L)	0.001	<0.001	0.005	0.001	12	<0.001	<0.001	<0.001	0.00	8
NO3 + NO2 (MG/L-N)	0.281	0.004	1.44	0.443	12	0.008	<0.004	0.014	0.004	8
TKN (MG/L-N)	2.47	1.02	7.96	2.03	12	1.67	0.94	3.63	0.91	8
T. ORG. N. (MG/L-N)	2.30	0.92	7.87	1.98	12	1.62	0.92	3.56	0.90	8
T. PHOSPHOROUS (MG/L-P)	0.541	0.149	1.32	0.315	12	0.772	0.506	1.21	0.216	8
DISS. O-PO4 (MG/L-P)	0.365	0.113	0.802	0.219	12	0.576	0.390	0.898	0.174	8
SILICA, DISS(MG/L AS SIO2)	9.6	4.0	13.8	3.6	12	6.9	4.0	10.2	2.2	8
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	1.6	0.2	2.8	0.8	12	2.3	0.4	3.8	1.3	8
BOD (5 DA.-MG/L)	4.0	1.1	16.8	4.2	12	3.2	1.6	5.4	1.3	8
METALS:										
ARSENIC,TOTAL(UG/L)	<11	<11	14	3.3	5	<11	<11	14	3.5	4
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	5	<1.0	<1.0	<1.0	0.0	4
CADMIUM,TOTAL(UG/L)	0.5	<0.2	1.1	0.3	5	0.3	<0.2	0.5	0.2	4
CHROMIUM,TOTAL(UG/L)	<6.0	<6.0	8.4	2.1	5	4.2	<3.0	6.7	2.1	4
COPPER,TOTAL(UG/L)	2.1	<1.0	5.8	2.1	5	3.6	<2.2	7.7	3.0	4
IRON,TOTAL(UG/L)	734	182	1810	666	5	772	99	1320	586	4
LEAD,TOTAL(UG/L)	3.7	<3.0	6.5	2.2	5	4.6	<4.0	6.5	1.9	4
MERCURY,TOTAL(UG/L)	0.4	<0.2	1.0	0.3	5	0.5	<0.2	1.0	0.4	4
NICKEL (UG/L)	5.2	<5.0	8.5	2.3	5	6.8	<5.0	13.0	5.0	4
SELENIUM,TOTAL(UG/L)	7.6	<0.9	15	6.8	5	9.4	<1.0	15	6.3	4
SILVER,TOTAL(UG/L)	0.8	<0.4	3.0	1.2	5	0.9	<0.4	3.0	1.4	4
ZINC,TOTAL(UG/L)	37.7	3.6	100.0	41.0	5	51.1	<1.0	120.0	53.3	4
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	233	4	880	252	12	149	<4	390	119	8

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-7. Summary of Water Quality Data Collected at WQ-5, July 1981 Through June 1982, and WQ-12, July 1981 Through September 1981

PARAMETER	STATION WQ-5 (PLUNDER BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-12 (COONS BAY BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	0.22	0.00	1.84	0.56	11	0.002	<0.00	0.005	0.004	2
COLOR (PCU)	207	100	500	118	13	313	250	375	88	2
METHY.B.A. SURST. (MG/L)	<0.50	<0.50	<0.50	0.00	2					0
OIL & GREASE (MG/L)	<5	<5	<5	0	2					0
SUSP.SOLIDS (MG/L)	26	<5	111	33	13	111	13	208	138	2
TURBIDITY (NTU)	4.01	1.00	12.0	3.30	13	9.85	1.70	18.0	11.5	2
WATER TEMP (C)	20.8	6.8	29.0	6.6	12	28.3	26.0	30.6	3.3	2
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	249	104	400	81.2	11	450	350	550	141	2
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000	2					0
CHLORIDE (MG/L)	21	9	31	8	13	60	49	70	15	2
FLUORIDE (MG/L)	0.60	0.27	0.76	0.14	13	0.28	0.22	0.35	0.09	2
SULFATE (MG/L)	23	<1	110	39	13	163	125	201	54	2
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	69	13	122	39	13	20	5	34	21	2
PH	6.21	5.70	7.50	0.42	11	5.23	5.00	5.80		2
NUTRIENTS:										
AMMONIA (MG/L-N)	0.04	<0.01	0.07	0.03	13	0.19	0.09	0.28	0.13	2
AMMONIA,UNIONIZED(MG/L)	<0.001	<0.001	0.001	0.00	12	<0.001	<0.001	<0.001	0.000	2
NO3 + NO2 (MG/L-N)	0.016	<0.004	0.061	0.020	13	0.027	0.011	0.043	0.023	2
TKN (MG/L-N)	1.64	1.14	3.07	0.56	13	4.10	1.83	6.38	3.22	2
T. ORG. N. (MG/L-N)	1.60	1.08	3.00	0.55	13	3.91	1.73	6.07	3.08	2
T. PHOSPHOROUS (MG/L-P)	1.29	0.867	1.92	0.345	13	1.15	0.668	1.63	0.681	2
DISS. O-PO4 (MG/L-P)	0.903	0.501	1.48	0.353	13	0.581	0.566	0.597	0.022	2
SILICA, DISS(MG/L AS SIO2)	14.6	6.4	23.5	6.0	13	12.8	12.3	13.3	0.7	2
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	3.4	1.5	6.2	1.7	11	2.7	1.2	4.3	2.2	2
BOD (5 DA,-MG/L)	3.5	<1.0	8.2	2.6	13	3.1	1.8	4.4	1.8	2
METALS:										
ARSENIC,TOTAL(UG/L)	<11	<11	14	3.8	4					0
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	4					0
CADMIUM,TOTAL(UG/L)	0.3	<0.2	0.5	0.2	4					0
CHROMIUM,TOTAL(UG/L)	4.3	<3.0	8.1	2.8	4					0
COPPER,TOTAL(UG/L)	2.9	<2.0	5.1	2.0	4					0
IRON,TOTAL(UG/L)	2290	429	3910	1660	4					0
LEAD,TOTAL(UG/L)	<11.0	<11.0	11.1	2.5	4					0
MERCURY,TOTAL(UG/L)	1.1	0.3	2.4	0.9	4					0
NICKEL (UG/L)	6.3	<5.0	9.6	3.3	4					0
SELENIUM,TOTAL(UG/L)	4.4	<0.9	15	7.2	4					0
SILVER,TOTAL(UG/L)	0.9	<0.4	3.0	1.4	4					0
ZINC,TOTAL(UG/L)	32.9	<2.0	83.0	35.9	4					0
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	236	<4	1020	298	13					0

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-8 Summary of Water Quality Data Collected at WQ-5 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNTY(MG/L)	32.30	75.96	3.94	12.89	138	>20 MG/L	22
F COL(MPN/100ML)	348.79	2800.00	15.00	453.29	133	800 MPN/100 ML	14
F(MG/L)	0.40	1.81	0.10	0.18	138	<10 MG/L	0
NH3(MG/L)	0.13	1.30	0.01	0.16	138		0
NITRATE(MG/L)	0.16	1.30	0.01	0.17	138		0
NITRITE(MG/L)	0.03	0.24	0.00	0.04	138		0
PH	6.71	8.00	5.50	0.32	135	6.0-8.5	2
TOTAL P(MG/L)	1.16	5.10	0.30	0.80	138		0
O_PO4(MG/L)	0.86	3.90	0.00	0.55	138		0
SILICA(MG/L)	9.96	20.70	0.40	4.24	135		0
S SOLIDS(MG/L)	34.44	1384.00	0.50	147.87	138		0
COND(UMHOS/CM)	136.78	278.00	4.00	44.65	134	<500 UMHOS/CM	0
SO4(MG/L)	5.31	74.00	0.20	8.74	138		0
TURBID(NTU)	4.07	44.00	0.20	5.65	129		0

Sources: CF, 1976-1982.
ESE, 1982.

General Parameters

As in the Horse Creek Basin, organic color is an important part of the water chemistry of the streams draining Complex II. Coons Bay branch had the highest organic color levels, averaging 313 PCU, whereas Doe Branch had the lowest, averaging 183 PCU. Color appeared to be higher during flow conditions, indicating the effect of flushing in swamps. In contrast, suspended matter was higher during ponded conditions.

Suspended solids were highest in Coons Bay Branch (111 mg/l) and lowest in Shirttail Branch (9 mg/l). Turbidity was highest in Doe Branch (14.3 NTU) and lowest in Shirttail Branch (3.06 NTU). Methylene Blue active substances and oil and grease were not detected in any of the streams sampled indicating little impact from man.

Dissolved Ions

Specific conductance measurements were highest in Coons Bay Branch (450 umhos/cm) and lowest, historically, in Plunder Branch (139 umhos/cm). These levels correspond to Total Dissolved Solids levels of 247 to 405 mg/l in Coons Bay Branch and 76 to 125 mg/l in Plunder Branch. Dissolved ions appeared to have negative correlation with flow (i.e., dissolved ions were low when flow was high) probably due to less influence by ground water inflow.

Alkalinity and pH

The balance of acidity and alkalinity determines the pH of waters. In the four streams considered, high organic acid inflow would infer acidic conditions. This is substantiated by pH measurements; historically, Plunder Branch had the highest pH (6.66), and the measurements in Coons Bay Branch were the lowest (5.23). Alkalinity would be expected to neutralize some of the acid. However, when alkalinity is low, its buffering may not be substantial.

Plunder Branch had the highest alkalinity (69 mg/l as $CaCO_3$) and highest pH. Shirttail Branch had the lowest alkalinity (17 mg/l as $CaCO_3$) and the second lowest pH (5.90).

Nutrients

Nitrogen levels were higher during ponded conditions, possibly reflecting the buildup of organic matter when little flushing is occurring. Plunder Branch exhibited the lowest total Kjeldahl nitrogen (1.64 mg/l) and Coons Bay Branch the highest (4.10 mg/l).

Nitrate-nitrite was highest in Doe Branch (0.28 mg/l) and may indicate fertilizer input. Total phosphorus was highest in Plunder Branch (1.29 mg/l) and lowest in Doe Branch (0.541 mg/l). Total phosphorus was primarily ortho-phosphate (50 to 70 percent), however, the proportion of ortho-phosphate decreased during ponded conditions, indicating the buildup of organic matter with little flushing.

DO/BOD

As in the Horse Creek Basin, both DO and BOD were low, possibly indicating the effect of oxygen removal in swamps and little DO replacement. All dissolved oxygen averages were below 4 mg/l while expected saturation values might range from 7 to 11 mg/l. BOD averaged 4 mg/l and less for all the streams. Lower DO and higher BOD were observed during ponded conditions at some samplings.

Metals

Water quality standards violations were observed at all stations for zinc, mercury, and iron (Coons Bay Branch was not sampled for metals). In addition, violations of the cadmium and silver standard were observed in Doe Branch and Plunder Branch. Metals solubility is affected by pH and acidic conditions may be a factor in metals levels. In addition, the complexing of metals with humic and fulvic acids (chelation) will affect dissolution and transport of metals.

Microbiology

Coliform levels were highest (historically) in Plunder Branch (349/100 ml) and lowest in Shirttail Branch (149/100 ml). Coliform counts probably reflect runoff from rangeland and cattle grazing areas.

Payne Creek Basin: Tributaries Draining Complex I

Ten water quality samples were collected during the period September 1981 to June 1982 from five stations on tributaries draining Complex I. Tributaries include Hickey Branch (WQ-1 and 7), Gum Swamp Branch (WQ-4), and Payne Creek on the property (WQ-2 and 3). These data, along with historical data obtained from CF are summarized in Tables 7.1.4-9 through 7.1.4-16. The existing Agrico mine located north of CF property discharges water to Payne Creek and Hickey Branch upstream of the CF sampling stations (see Figure 7.1-9). All stations were flowing during monthly sampling except WQ-4 during October 1981.

The water sampled at Station WQ-1 is predominantly Agrico's mine discharge. Samples were collected on the downstream side of four 18-inch culverts which drained into a shallow, sand botton channel. The area was open and moderately vegetated. The water sampled at Station WQ-7 is a combination of CF's discharge from their existing mine, Agrico's discharge, and about 5 square miles of natural drainage. Sampling stations at WQ-2, WQ-3, and WQ-7 were similar, i.e., they were well-defined sand bottom channels through moderately wooded areas. It is important to note that CF's Discharge Point 001 is essentially Agrico's discharge with no discharge water added from CF's operations. All discharges from CF's operations are from CF's Discharge Point 002.

The samples collected at WQ-2 and WQ-3 are representative of Agrico's discharge and about 50 square miles of natural drainage. Gum Swamp Branch has a drainage basin of about 10 square miles and no point source discharges. The stream channel at the sampling location was well-defined with a sandy bottom. The station was in a thickly wooded area with moderate understory. Average daily flows at WQ-3, WQ-4, and WQ-7, along with water quality sampling dates indicated are presented in Figures 7.1-4 through 7.1-6 in the surface water quantity discussion.

Land use in the basin is primarily flatwoods, rangeland, forested wetlands, marsh, and disturbed areas (mined land).

Table 7.1.4-9. Summary of Water Quality Data Collected at WQ-1 and WQ-7, September 1981 Through June 1982

PARAMETER	STATION WQ-1 (HICKEY BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-7 (HICKEY BRANCH) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	7.87	1.16	18.7	6.01	10	10.6	0.46	43.0	15.1	10
COLOR (PCU)	29	10	50	15	10	58	25	100	23	10
METHY.B.A. SUBST. (MG/L)	<0.50	<0.50	<0.50	0.00	3	<0.50	<0.50	<0.50	0.00	3
OIL & GREASE (MG/L)	<5	<5	<5	0	3	<5	<5	<5	0	3
SUSP.SOLIDS (MG/L)	8	<5	14	5	10	7	<5	18	5	10
TURBIDITY (NTU)	3.79	1.80	6.90	1.48	10	1.67	0.80	3.00	0.68	10
WATER TEMP (C)	22.2	15.5	28.3	4.6	10	20.2	9.1	28.0	6.2	10
DISSOLVED IONS:										
SP.CONDUCT.-FIELD (UMHOS/CM)	290	150	381	77.5	10	325	270	376	30.3	10
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000002	4	<0.005	<0.005	<0.005	0.000002	4
CHLORIDE (MG/L)	14	13	16	1	10	15	13	18	2	10
FLUORIDE (MG/L)	1.71	1.40	1.97	0.18	10	1.76	1.37	2.20	0.22	10
SULFATE (MG/L)	45	37	54	7	10	38	29	50	8	10
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	102	88	113	8	10	97	76	106	11	10
PH	7.15	6.40	8.70	0.67	10	6.94	6.30	7.80	0.40	10
NUTRIENTS:										
AMMONIA (MG/L-N)	0.03	<0.008	0.13	0.05	10	0.04	<0.01	0.09	0.03	10
AMMONIA,UNIONIZED (MG/L)	<0.001	<0.001	0.001	0.0003	10	<0.001	<0.001	0.001	0.00	10
NO3 + NO2 (MG/L-N)	0.018	<0.004	0.041	0.016	10	0.234	0.073	0.509	0.152	10
TKN (MG/L-N)	1.12	0.89	1.44	0.15	10	1.14	0.71	1.94	0.35	10
T. ORG. N. (MG/L-N)	1.09	0.76	1.44	0.39	10	1.10	0.70	1.90	0.34	10
T. PHOSPHOROUS (MG/L-P)	0.340	0.114	0.507	0.118	10	0.510	0.376	0.729	0.112	10
DISS. O-PO4 (MG/L-P)	0.160	0.050	0.315	0.098	10	0.417	0.321	0.646	0.098	10
SILICA, DISS(MG/L AS SIO2)	0.8	<0.1	2.3	0.7	10	1.6	<0.2	3.3	1.1	10
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	7.4	6.2	9.5	0.9	10	7.1	4.9	9.9	1.7	10
BOD (5 DA.-MG/L)	3.5	1.6	5.3	1.0	10	2.7	1.3	4.2	0.9	10
METALS:										
ARSENIC,TOTAL(UG/L)	<15	<15	<15	2.4	4	<15	<15	<15	2.6	4
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	4	<1.0	<1.0	<1.0	0.0	4
CADMIUM,TOTAL(UG/L)	0.6	<0.2	1.5	0.7	4	0.3	<0.2	0.8	0.3	4
CHROMIUM,TOTAL(UG/L)	11	<6.0	30	13	4	6.3	<6.0	12	4.0	4
COPPER,TOTAL(UG/L)	5.9	<2.0	10.7	4.0	4	3.8	<2.0	9.2	3.8	4
IRON,TOTAL(UG/L)	206	176	240	33	4	157	<30	281	132	4
LEAD,TOTAL(UG/L)	6.1	<2.0	15.9	7.0	4	5.2	<2.0	11.3	4.7	4
MERCURY,TOTAL(UG/L)	0.2	<0.2	0.3	0.08	4	0.2	<0.1	0.4	0.1	4
NICKEL (UG/L)	<8.0	<8.0	9.2	2.7	4	<6.0	<6.0	8.5	2.4	4
SELENIUM,TOTAL(UG/L)	3.5	<0.9	13	6.0	4	3.5	<0.9	13	6.0	4
SILVER,TOTAL(UG/L)	<0.4	<0.4	<0.4	0.0001	4	<0.4	<0.4	<0.4	0.0001	4
ZINC,TOTAL(UG/L)	51.5	<2.0	145.0	64.8	4	49.3	<2.0	92.0	44.6	4
COLIFORM:										
COLIFORM,FEC.(#/100ML)	33	8	108	35	10	648	52	1900	700	10

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-10. Summary of Water Quality Data Collected at WQ-1 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNTY(MG/L)	91.77	123.80	7.81	15.21	275	>20 MG/L	1
F COL(MPN/100ML)	53.45	2500.00	0.00	179.41	267	800 MPN/100 ML	2
F(MG/L)	1.53	2.62	0.55	0.30	275	<10 MG/L	0
NH3(MG/L)	0.09	2.50	0.01	0.19	275		0
NITRATE(MG/L)	0.56	2.20	0.00	0.20	274		0
NITRITE(MG/L)	0.01	0.10	0.00	0.01	275		0
PH	8.09	9.50	6.60	0.60	272	6.0-8.5	61
TOTAL P(MG/L)	0.89	5.00	0.10	0.60	275		0
O_PO4(MG/L)	0.41	1.50	0.00	0.34	275		0
SILICA(MG/L)	1.48	8.40	0.00	1.17	274		0
S SOLIDS(MG/L)	12.60	338.00	1.00	21.10	275		0
COND(UMHOS/CM)	321.73	480.00	24.00	46.71	271	<500 UMHOS/CM	0
SO4(MG/L)	67.56	288.00	6.40	20.90	275		0
TURBID(NTU)	6.62	44.00	0.40	4.60	252		0

Sources: CF, 1976-1982.
ESE, 1982.

Table 7.1.4-11. Summary of Water Quality Data Collected at WQ-7 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNITY(MG/L)	70.6[illegible]	127.10	6.24	20.33	276	>20 MG/L	3
F COL(MPN/100ML)	2[illegible]5.64	4900.00	7.00	394.01	271	800 MPN/100 ML	10
F(MG/L)	1.3[illegible]	2.44	0.47	0.35	276	<10 MG/L	0
NH3(MG/L)	0.67	29.00	0.01	2.68	275		0
NITRATE(MG/L)	0.3[illegible]	12.03	0.00	1.15	275		0
NITRITE(MG/L)	0.17	4.75	0.00	0.60	276		0
PH	7.53	8.70	5.90	0.38	273	6.0-8.5	2
TOTAL P(MG/L)	0.[illegible]1	3.10	0.20	0.42	276		0
O_PO4(MG/L)	0.57	1.80	0.00	0.31	276		0
SILICA(MG/L)	2.41	11.80	0.10	1.42	275		0
S SOLIDS(MG/L)	4.63	108.00	0.20	7.73	276		0
COND(UMHOS/CM)	2[illegible]9.71	430.00	4.00	56.84	272	<500 UMHOS/CM	0
SO4(MG/L)	5[illegible].77	162.00	3.50	18.39	275		0
TURBID(NTU)	2.92	80.00	0.20	6.07	253		0

Sources: CF, 1976-1982.
ESE, 1982.

Table 7.1.4-12. Summary of Water Quality Data Collected at WQ-4, September 1981 Through June 1982

STATION WQ-4
(GUM SWAMP BRANCH)

PARAMETER	MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:					
STREAM FLOW (CFS)	5.68	0.00	50.1	15.6	10
COLOR (PCU)	141	25	470	141	10
METHY.B.A. SUBST. (MG/L)	<0.50	<0.50	<0.50	0.00	3
OIL & GREASE (MG/L)	<5	<5	<5	0	3
SUSP.SOLIDS (MG/L)	<5	<5	10	3	10
TURBIDITY (NTU)	1.08	0.60	3.80	0.98	10
WATER TEMP (C)	18.2	5.5	26.4	6.7	10
DISSOLVED IONS:					
SP.CONDUCT.,FIELD (UMHOS/CM)	179	73.0	268	62.0	10
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000002	4
CHLORIDE (MG/L)	27	9	35	8	10
FLUORIDE (MG/L)	0.38	0.21	0.49	0.07	10
SULFATE (MG/L)	20	<1	30	11	10
ALKALINITY AND PH:					
ALKALINITY (MG/L AS CACO3)	31	17	44	8	10
PH	6.05	5.30	7.30	0.57	10
NUTRIENTS:					
AMMONIA (MG/L-N)	0.03	<0.01	0.05	0.01	10
AMMONIA,UNIONIZED(MG/L)	<0.001	<0.001	<0.001	0.00	10
NO3 + NO2 (MG/L-N)	0.923	0.045	1.55	0.496	10
TKN (MG/L-N)	0.91	0.51	1.49	0.36	10
T. ORG. N. (MG/L-N)	0.89	0.49	1.44	0.35	10
T. PHOSPHOROUS (MG/L-P)	0.611	0.265	0.936	0.261	10
DISS. O-PO4 (MG/L-P)	0.548	0.238	0.858	0.234	10
SILICA, DISS(MG/L AS SIO2)	6.6	3.7	10.2	1.7	10
OXYGEN AND OXYGEN DEMAND:					
DISS. OXYGEN (MG/L)	6.2	2.8	9.1	1.9	10
BOD (5 DA.-MG/L)	1.1	<1.0	2.1	0.7	10
METALS:					
ARSENIC,TOTAL(UG/L)	<15	<15	<15	2.6	4
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	4
CADMIUM,TOTAL(UG/L)	0.6	<0.2	1.7	0.7	4
CHROMIUM,TOTAL(UG/L)	<6.0	<6.0	7.4	1.9	4
COPPER,TOTAL(UG/L)	2.3	<1.0	6.2	2.6	4
IRON,TOTAL(UG/L)	560	227	1170	417	4
LEAD,TOTAL(UG/L)	3.2	<2.0	6.5	2.4	4
MERCURY,TOTAL(UG/L)	0.7	<0.1	2.2	1.0	4
NICKEL (UG/L)	<6.0	<6.0	8.5	2.4	4
SELENIUM,TOTAL(UG/L)	3.5	<0.9	13	6.0	4
SILVER,TOTAL(UG/L)	<0.4	<0.4	<0.4	0.0001	4
ZINC,TOTAL(UG/L)	37.5	5.0	68.0	35.3	4
MICROBIOLOGY:					
COLIFORM,FEC.(#/100ML)	230	12	640	206	10

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-13. Summary of Water Quality Data Collected at WQ-4 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNTY(MG/L)	41.17	75.10	1.45	13.59	270	>20 MG/L	26
F COL(MPN/100ML)	17.97	1210.00	0.00	129.53	263	800 MPN/100 ML	2
F(MG/L)	1.34	2.35	0.25	0.43	270	<10 MG/L	0
NH3(MG/L)	0.07	0.94	0.01	0.08	270		0
NITRATE(MG/L)	0.55	6.10	0.01	0.75	269		0
NITRITE(MG/L)	0.03	0.45	0.00	0.05	270		0
PH	7.24	8.30	6.30	0.41	267	6.0-8.5	0
TOTAL P(MG/L)	1.07	7.80	0.30	0.84	270		0
O_PO4(MG/L)	0.42	6.20	0.00	0.76	270		0
SILICA(MG/L)	5.64	379.00	0.60	22.91	269		0
S SOLIDS(MG/L)	6.98	663.40	0.00	40.45	270		0
COND(UMHOS/CM)	277.76	405.00	65.00	77.25	267	<500 UMHOS/CM	0
SO4(MG/L)	69.36	130.20	1.00	30.32	270		0
TURBID(NTU)	3.33	30.00	0.00	3.59	247		0

Sources: CF, 1976-1982.
ESE, 1982.

Table 7.1.4-14. Summary of Water Quality Data Collected at WQ-2 and WQ-3, September 1981 Through June 1982

PARAMETER	STATION WQ-2 (PAYNE CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-3 (PAYNE CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	101	2.74	845	263	10	19.8	3.42	115	33.6	10
COLOR (PCU)	67	15	450	128	11	87	15	400	118	10
METHY.B.A. SURST. (MG/L)	<0.50	<0.50	<0.50	0.00	4	<0.50	<0.50	<0.50	0.00	3
OIL & GREASE (MG/L)	<5	<5	<5	0	4	<5	<5	<5	0	3
SUSP.SOLIDS (MG/L)	<5	<5	6	2	11	<5	<5	9	2	10
TURBIDITY (NTU)	0.87	0.25	2.50	0.67	11	1.43	0.50	5.20	1.42	10
WATER TEMP (C)	20.3	7.9	25.8	6.0	11	20.3	10.0	27.0	5.8	10
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	300	130	481	105	11	297	160	453	90.7	10
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000001	5	<0.005	<0.005	<0.005	0.000002	4
CHLORIDE (MG/L)	14	12	16	2	11	17	13	20	2	10
FLUORIDE (MG/L)	1.54	0.70	2.05	0.41	11	1.38	0.69	1.83	0.35	10
SULFATE (MG/L)	77	20	116	27	11	74	4	128	33	10
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	71	27	98	18	11	64	33	96	16	10
PH	6.70	5.80	8.00	0.60	11	6.89	6.50	7.80	0.42	10
NUTRIENTS:										
AMMONIA (MG/L-N)	0.02	<0.01	0.03	0.008	11	0.02	<0.01	0.12	0.03	10
AMMONIA,UNIONIZED(MG/L)	<0.001	<0.001	<0.001	0.000	11	<0.001	<0.001	<0.001	0.000	10
NO3 + NO2 (MG/L-N)	0.099	0.005	0.204	0.068	11	0.238	0.051	0.557	0.143	10
TKN (MG/L-N)	0.60	0.24	1.42	0.31	11	0.81	0.35	1.94	0.49	10
T. ORG. N. (MG/L-N)	0.59	0.24	1.40	0.31	11	0.79	0.34	1.82	0.46	10
T. PHOSPHOROUS (MG/L-P)	0.725	0.346	1.12	0.207	11	0.774	0.386	1.60	0.324	10
DISS. O-PO4 (MG/L-P)	0.644	0.318	0.972	0.178	11	0.624	0.366	0.792	0.140	10
SILICA, DISS(MG/L AS SIO2)	2.8	0.8	4.4	1.3	11	3.5	2.0	5.9	1.3	10
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	7.9	3.9	10.7	1.8	11	7.3	2.4	10.5	2.3	10
BOD (5 DAY,-MG/L)	1.9	<1.0	4.8	1.5	11	1.5	<1.0	2.4	0.8	10
METALS:										
ARSENIC,TOTAL(UG/L)	<15	<15	<15	2.2	5	<15	<15	<15	2.6	4
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	5	<1.0	<1.0	<1.0	0.0	4
CADMIUM,TOTAL(UG/L)	0.4	<0.2	1.1	0.4	5	0.6	<0.2	1.9	0.9	4
CHROMIUM,TOTAL(UG/L)	<6.0	<6.0	7.6	1.9	5	7.7	<6.0	17	6.3	4
COPPER,TOTAL(UG/L)	5.1	<2.0	15.0	5.8	5	2.2	<1.0	3.8	1.5	4
IRON,TOTAL(UG/L)	113	<30	281	101	5	203	22	606	271	4
LEAD,TOTAL(UG/L)	5.0	<2.0	6.5	2.3	5	3.6	<2.0	6.5	2.6	4
MERCURY,TOTAL(UG/L)	<0.2	<0.2	0.3	0.08	5	0.2	<0.1	0.5	0.2	4
NICKEL (UG/L)	8.8	<8.0	18.0	5.6	5	<8.0	<8.0	8.5	2.3	4
SELENIUM,TOTAL(UG/L)	5.3	<0.9	13	6.6	5	3.5	<0.9	13	6.0	4
SILVER,TOTAL(UG/L)	<0.4	<0.4	<0.4	0.0001	5	<0.4	<0.4	<0.4	0.0001	4
ZINC,TOTAL(UG/L)	40.5	<2.0	125.0	53.9	5	39.4	<2.0	102.0	48.3	4
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	163	48	440	147	10	138	20	420	123	10

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

Table 7.1.4-15. Summary of Water Quality Data Collected at WQ-2 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNTY(MG/L)	44.19	156.77	6.90	14.49	269	>20 MG/L	13
F COL(MPN/100ML)	170.29	7400.00	0.00	515.65	262	800 MPN/100 ML	6
F(MG/L)	1.48	2.71	0.56	0.39	269	<10 MG/L	0
NH3(MG/L)	0.09	0.67	0.01	0.10	269		0
NITRATE(MG/L)	0.67	7.30	0.01	0.86	268		0
NITRITE(MG/L)	0.06	0.93	0.00	0.10	269		0
PH	7.32	8.30	6.00	0.37	266	6.0-8.5	0
TOTAL P(MG/L)	1.12	6.80	0.30	0.85	269		0
O_PO4(MG/L)	0.80	6.20	0.00	0.72	269		0
SILICA(MG/L)	3.94	9.53	0.40	1.68	268		0
S SOLIDS(MG/L)	5.69	166.70	0.00	11.11	269		0
COND(UMHOS/CM)	299.17	430.00	97.00	70.96	266	<500 UMHOS/CM	0
SO4(MG/L)	78.92	140.70	1.20	29.07	268		0
TURBID(NTU)	5.12	32.00	0.00	5.70	246		0

Sources: CF, 1976-1982.
ESE, 1982.

Table 7.1.4-16. Summary of Water Quality Data Collected at WQ-3 by CF Industries

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
ALKALNTY(MG/L)	44.9[illegible]	156.77	6.90	14.49	269	>20 MG/L	13
F COL(MPN/100ML)	170.2[illegible]	7400.00	0.00	515.65	262	800 MPN/100 ML	6
F(MG/L)	1.4[illegible]	2.71	0.56	0.39	269	<10 MG/L	0
NH3(MG/L)	0.0[illegible]	0.67	0.01	0.10	269		0
NITRATE(MG/L)	0.67	7.30	0.01	0.86	268		0
NITRITE(MG/L)	0.06	0.93	0.00	0.10	269		0
PH	7.32	8.30	6.00	0.37	266	6.0-8.5	0
TOTAL P(MG/L)	1.12	6.80	0.30	0.85	269		0
O_PO4(MG/L)	0.8[illegible]	6.20	0.00	0.72	269		0
SILICA(MG/L)	3.[illegible]	9.53	0.40	1.68	268		0
S SOLIDS(MG/L)	5.6[illegible]	166.70	0.00	11.11	269		0
COND(UMHOS/CM)	[illegible]9.17	430.00	97.00	70.96	266	<500 UMHOS/CM	0
SO4(MG/L)	7[illegible].92	140.70	1.20	29.07	268		0
TURBID(NTU)	5.12	32.00	0.00	5.70	246		0

Sources: CF, 1976-1982.
ESE, 1982.

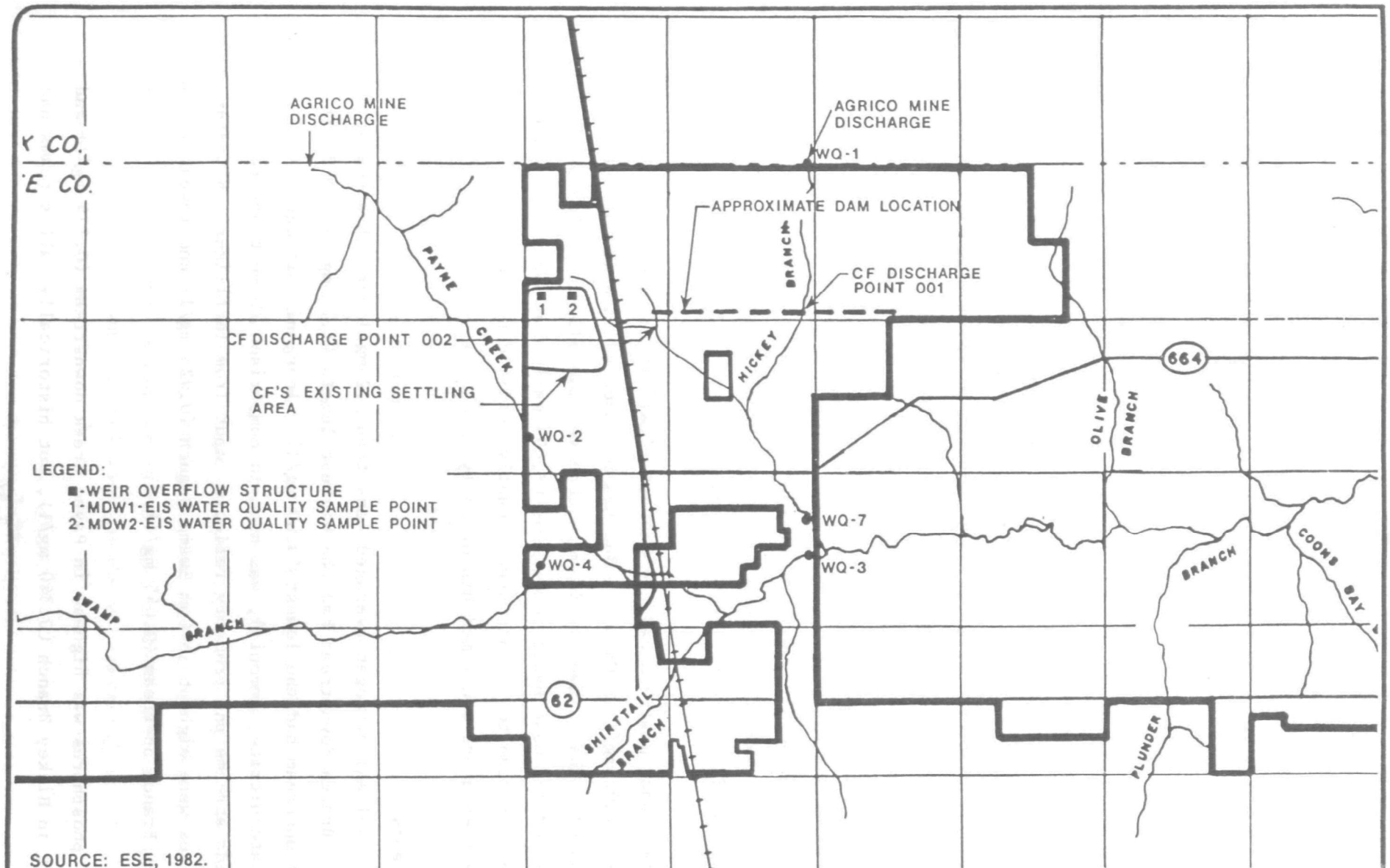

Figure 7.1-9
LOCATION OF POINT SOURCE DISCHARGES ON COMPLEX I

SOURCE: ESE, 1982

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

General Parameters

Color levels in Payne Creek Basin are generally much lower than those in Horse Creek Basin. Gum Swamp Branch had the highest color levels (141 PCU) and Hickey Branch upstream had the lowest (29 PCU). Suspended solids in all streams averaged less than 15 mg/l, both historically and in EIS monitoring. Turbidity was generally less than 5 NTU at all stations.

Dissolved Ions

Specific conductance was highest in Hickey Branch (290 to 325 umhos/cm) and lowest in Gum Swamp Branch (158 to 179 umhos/cm). These values correspond to total dissolved solids levels of 159 to 361 mg/l for Hickey Branch and 87 to 161 mg/l in Gum Swamp Branch. Specific conductance was somewhat negatively correlated with flow.

Alkalinity and pH

Acidity in these streams is determined by natural organic acid input and alkalinity, however, Agrico's mine discharges may have higher alkalinity and may produce more buffering in the streams.

Hickey Branch upstream had the highest alkalinity of the stations sampled (102 mg/l as $CaCO_3$). Gum Swamp Branch had the lowest (31 mg/l as $CaCO_3$). These same trends were observed for pH; Hickey Branch reflected the most basic conditions (7.69) while Gum Swamp Branch was the only stream to exhibit predominantly acidic conditions (6.42). These trends are confirmed historically.

Nutrients

Total Kjeldahl nitrogen averaged less than 1.2 mg/l for all streams; Hickey Branch downstream had the highest levels (1.14 mg/l) and Payne Creek upstream had the lowest (0.60 mg/l). Inorganic nitrogen, (nitrate-nitrite, ammonia), was high in comparison to most natural Florida streams and probably reflects input from fertilizer. Nitrate-nitrites were highest in Gum Swamp Branch (0.923 mg/l) and lowest in Hickey Branch upstream (0.045 mg/l).

Total phosphorus was highest in Payne Creek downstream (0.774 mg/l) and lowest in Hickey Branch (0.340 mg/l), but historically, all streams had

much higher levels averaging more than 0.8 mg/l in the past six years. Total phosphorus concentrations were variable, historically (i.e., Hickey Branch upstream ranged from 0.10 to 5.0 mg/l) which may reflect mine discharge. Ortho-phosphate was the predominant form of phosphorus ranging from 50 to 90 percent.

Dissolved Oxygen/BOD

Dissolved oxygen was much higher in comparison to levels in other basins, possibly indicating less contact with wetlands. DO was highest at the Payne Creek upstream station (7.9 mg/l) and lowest in Gum Swamp Branch (6.2 mg/l). BOD was less than 4 mg/l at all stations, but was lowest in Gum Swamp Branch (1.1 mg/l).

Metals

Violations of water quality standards were observed for cadmium, mercury, and zinc for all stations. In addition, violation of the iron standard was observed in Gum Swamp Branch, reflecting greater solubility in acidic waters and complexing with organic acids.

Microbiology

Fecal coliform counts were highest in Hickey Branch downstream (648/100ml) and lowest in Hickey Branch upstream (33/100ml). The high coliform levels probably reflect runoff from rangeland and cattle grazing areas.

Comparison of Upstream and Downstream Stations--Stations WQ-1 (upstream) and WQ-7 (downstream) can be used to detect changes in water quality in Hickey Branch. Waters downstream appear to have more organic color but less suspended matter. As might be expected from this, pH and alkalinity are both lower downstream as a result of the color from wetlands. Nitrogen levels are comparable at both stations; however, nitrate-nitrite levels are higher downstream indicating some fertilization in the drainage basin. Total phosphorus is also higher downstream (WQ-1 = 0.340 mg/l; WQ-7 = 0.510 mg/l). No significant differences are apparent in dissolved oxygen concentrations; however, BOD was slightly higher upstream (3.5 mg/l). Coliform levels were much higher downstream.

Two stations on Payne Creek (WQ-2, WQ-3) were also sampled at entrance and exit points of CF property. Agrico discharge enters Payne Creek upstream of WQ-2 and Gum Swamp, Shirttail and Doe Branches enter the stream between WQ-2 and WQ-3. Color levels are higher downstream (as expected) as a result of confluence with streams of higher color levels (Shirttail, Gum Swamp, and Doe Branches). Acidity and alkalinity are both lower downstream, probably as a result of higher color levels. Nitrogen levels are also higher downstream, however, nitrate-nitrite is much higher indicating the possibility of fertilizer input from Gum Swamp or Doe Branch. Total phosphorus levels are very similar (0.725 through 0.774 mg/l) and are made up primarily of ortho-phosphorus (80 to 90 percent). Dissolved oxygen, BOD, metals and coliform levels did not change significantly downstream.

Payne Creek Downstream of Site

Two stations (WQ-13, WQ-14) east of Complex I, above and below the Little Payne Creek confluence, were sampled between September 1981 and June 1982. The stream cross-sections at these stations are generally well-defined with steep banks. The stream bottoms were primarily sand. The areas were moderately wooded with some understory. These data are summarized in Table 7.1.4-17. These stations represent the accumulation of all CF runoff, and can be used to assess the influence of Little Payne Creek on water quality.

General Parameters

Color levels were similar between upstream and downstream stations (93 and 85 PCU) and represent no significant change from stations further upstream (87 PCU at Station WQ-3). Suspended matter was low at both stations, however, November 1981 samplings showed higher values (>100 NTU), a phenomenom which was also observed upstream. Methylene Blue active substances and oil and grease were low at both stations.

Dissolved Ions

Specific conductance was higher at the downstream station (320 umhos/cm), and lower upstream (266 umhos/cm). These levels

Table 7.1.4-17. Summary of Water Quality Data Collected at WQ-13 and WQ-14, September 1981 Through June 1982

PARAMETER	STATION WQ-13 (PAYNE CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	STATION WQ-14 (PAYNE CREEK) MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)	47.2	0.00	320	96.7	10	63.9	10.7	391	116	10
COLOR (PCU)	93	20	400	114	10	85	20	400	115	10
METHY.B.A. SUBST. (MG/L)	<0.50	<0.50	<0.50	0.00	3	<0.50	<0.50	<0.50	0.00	3
OIL & GREASE (MG/L)	<5	<5	<5	0	3	<5	<5	<5	0	3
SUSP.SOLIDS (MG/L)	<5	<5	18	5	10	<5	<5	12	3	10
TURBIDITY (NTU)	1.44	0.50	3.30	0.90	10	0.99	0.50	2.50	0.67	10
WATER TEMP (C)	18.6	7.1	25.5	6.4	10	18.4	7.1	25.8	6.3	10
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	266	128	396	91.1	10	320	151	388	64.7	10
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000002	4	<0.005	<0.005	<0.005	0.000002	4
CHLORIDE (MG/L)	19	12	27	4	10	18	12	23	3	10
FLUORIDE (MG/L)	1.47	0.59	2.55	0.54	10	1.30	0.67	1.84	0.30	10
SULFATE (MG/L)	63	18	80	21	10	50	22	75	16	10
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	59	10	85	26	10	66	29	82	15	10
PH	6.17	5.40	7.80	0.77	10	6.78	6.00	7.80	0.48	10
NUTRIENTS:										
AMMONIA (MG/L-N)	0.10	<0.01	0.78	0.24	10	0.06	<0.01	0.31	0.10	10
AMMONIA,UNIONIZED(MG/L)	<0.001	<0.001	<0.001	0.00	10	<0.001	<0.001	<0.001	0.00	10
NO3 + NO2 (MG/L-N)	0.568	0.007	0.992	0.291	10	1.56	0.311	2.69	0.759	10
TKN (MG/L-N)	0.91	0.42	1.70	0.39	10	0.92	0.46	1.46	0.34	10
T. ORG. N. (MG/L-N)	0.81	0.05	1.69	0.47	10	0.86	0.45	1.42	0.33	10
T. PHOSPHOROUS (MG/L-P)	0.657	0.490	1.02	0.147	10	0.705	0.474	1.05	0.176	10
DISS. O-PO4 (MG/L-P)	0.607	0.403	0.992	0.168	10	0.628	0.424	0.889	0.142	10
SILICA, DISS(MG/L AS SIO2)	3.6	1.9	6.6	1.7	10	3.1	1.9	4.6	1.0	10
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	7.7	3.8	10.4	2.3	10	7.7	4.7	9.8	1.6	10
BOD (5 DA.-MG/L)	1.4	<1.0	3.6	0.9	10	1.3	<1.0	3.6	1.0	10
METALS:										
ARSENIC,TOTAL(UG/L)	<15	<15	<15	2.6	4	<15	<15	<15	2.6	4
BERYLLIUM (UG/L)	<1.0	<1.0	<1.0	0.0	4	<1.0	<1.0	<1.0	0.0	4
CADMIUM,TOTAL(UG/L)	1.0	<0.2	2.9	1.3	4	0.3	0.3	0.5	0.10	4
CHROMIUM,TOTAL(UG/L)	<6.0	<6.0	6.9	1.8	4	6.3	<6.0	9.8	3.1	4
COPPER,TOTAL(UG/L)	2.4	<1.0	6.7	2.9	4	2.9	<1.0	8.7	3.9	4
IRON,TOTAL(UG/L)	181	<30	568	260	4	122	<30	308	131	4
LEAD,TOTAL(UG/L)	2.8	<2.0	6.5	2.5	4	2.8	<2.0	6.5	2.5	4
MERCURY,TOTAL(UG/L)	0.4	<0.2	1.0	0.4	4	0.2	<0.2	0.4	0.2	4
NICKEL (UG/L)	<8.0	<8.0	8.5	2.2	4	<6.0	<6.0	8.5	2.4	4
SELENIUM,TOTAL(UG/L)	3.5	<0.9	13	6.0	4	3.5	<0.9	13	6.0	4
SILVER,TOTAL(UG/L)	<0.4	<0.4	<0.4	0.0001	4	<0.4	<0.4	<0.4	0.0001	4
ZINC,TOTAL(UG/L)	28.4	<1.0	74.0	35.1	4	38.8	3.0	81.0	38.2	4
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	177	<4	665	200	10	311	<4	660	260	10

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

represent a Total Dissolved Solids range of 176 to 280 mg/l downstream and 146 to 239 mg/l upstream. No significant difference in dissolved ion concentration from upstream was detected.

Alkalinity and pH

Alkalinity was highest downstream (66 mg/l), however levels were not significantly different (59 mg/l at WQ-13) and did not differ greatly from stations further upstream (64 mg/l at WQ-3). Measurements of pH revealed near neutral conditions at Stations WQ-3, WQ-13, and WQ-14.

Nutrients

Total Kjeldahl nitrogen levels were similar at both stations and further upstream (0.81 to 0.92 mg/l), however nitrate-nitrite showed a gradual increase in concentation with progression downstream. Payne Creek exiting CF property averaged 0.222 mg/l nitrate-nitrite while just above the Little Payne Creek confluence measurements averaged 0.568 mg/l reflecting higher levels with greater drainage basin area. Confluence with Little Payne Creek greatly increased nitrate-nitrite levels; measurements averaged 1.56 mg/l at Station WQ-14. Total phosphorus concentrations were slightly higher downstream of Little Payne Creek (0.705 mg/l), but lower than values found at Station WQ-3 (0.774 mg/l). Ortho-phosphate was the primary constituent of the total phosphorus, ranging from 80 to 90 percent.

Dissolved Oxygen/BOD

Dissolved oxygen and BOD levels were similar at both stations and upstream (DO = 7.3 to 7.7 mg/l; BOD = 1.3 to 1.5 mg/l).

Metals

Metals values were similar to those near CF property; cadmium, however, decreased downstream of confluence with Little Payne Creek. Mercury and zinc violated water quality standards at both stations and cadmium violated standards only upstream of Little Payne Creek.

Microbiology

Fecal coliform levels appeared to increase after confluence with Little Payne Creek. Average values increased from 177 to 311 MPN/100ml.

Troublesome Creek

The headwater wetlands for Troublesome Creek are contained in the south central portion of the CF property. The drainage basin on the property comprises approximately 0.9 square miles of the upper headwaters for the Troublesome Creek system. The property contains no defined channel or conveyance system. The systems on the property are characterized by seasonably wet marshes and a small maple hardwood swamp.

Although no samples were collected in Troublesome Creek on the CF site, data have been collected downstream of the site at MCC-5 and SW-11 during previous studies of the Mississippi Chemical Company and Farmland proposed mine sites. The locations of these stations are shown in Figure 7.1-8 and the data are summarized in Table 7.1.4-18.

Water quality in Troublesome Creek is similar to that of streams draining Complex II. Color levels are almost as high as the most colored stream draining Complex II (294 PCU) and this is reflected in the slightly acidic conditions (pH = 6.11). The stream may be more acidic if not for the buffering capacity in the stream; alkalinity was high in comparison to other streams draining Complex II (64 mg/l). Specific conductance averaged 229 umhos/cm indicating a Total Dissolved Solids level of 126 to 206 mg/l. Nitrogen levels were lower than the other streams, however nitrate-nitrite was much higher (1.09 mg/l). Some nitrogen data appear to conflict (TKN and Org N), however, this is probably the result of different samples collected and one high organic nitrogen measurement (36 mg/l). Total phosphorus was moderate in comparison to other streams draining Complex II and was made up primarily of ortho-phosphate (68 percent). Dissolved oxygen was higher than in the other streams (6.7 mg/l) and BOD was observed at a comparable level (3.40 mg/l).

Violations of Water Quality Criteria

Violations of water quality criteria have been assessed for EIS monitoring and historical data, and are summarized in Tables 7.1.4-19 and 7.1.4-20.

Table 7.1.4-18. Summary of Water Quality Data Collected at Stations SW-11 and MCC-5

PARAMETER	MEAN	MAXIMUM VALUE	MINIMUM VALUE	STANDARD DEVIATION	NUMBER OF SAMPLES	17-3 CLASS III STANDARD	NUMBER OF VIOLATIONS
FLOW(CFS)	7.15	59.04	0.00	13.41	19		0
H20 TEMP(DEG C	22.67	29.00	10.00	5.76	19		0
COND(UMHOS/CM)-	229.32	380.00	99.00	87.44	19	<500 UMHOS/CM	0
PH	6.11	7.50	5.20	0.00	18	6.0-8.5	3
D.OXYGEN(MG/L)	6.79	10.00	3.50	2.05	18	>5.0 MG/L	5
S SOLIDS(MG/L)	8.37	46.00	3.00	9.37	19		0
O&G(MG/L)	5.00	5.00	5.00	0.00	18	<5.0 MG/L	0
TOC(MG/L)	22.83	43.00	3.50	12.13	19		0
F COL(MPN/100ML)	410.79	3400.00	0.00	758.03	19	800 MPN/100 ML	2
O_PO4(MG/L)	0.52	0.89	0.05	0.22	19		0
TOTAL P(MG/L	0.76	2.20	0.20	0.41	19		0
NH3(MG/L)	0.11	0.35	0.04	0.08	19		0
ORG N(MG/L	3.06	36.00	0.20	8.03	19		0
NO3+NO2(MG/L)	1.09	3.89	0.01	1.20	19		0
TKN(MG/L)	1.16	1.80	0.56	0.41	10		0
SIO2(MG/L)	4.23	8.40	1.10	2.40	12		0
BOD(MG/L)	3.40	6.10	0.00	2.10	7		0
ACIDITY	11.71	18.00	7.00	4.23	7		0
ALKALNITY(MG/L)	64.00	110.00	18.00	36.55	7	>20 MG/L	1
TURBID(NTU)	5.14	12.00	2.00	4.38	7		0
COLOR(CPU)	294.14	760.00	89.00	231.51	7		0
TS(MG/L)	201.43	250.00	160.00	30.24	7		0
F(MG/L)	0.33	0.54	0.16	0.13	7	<10 MG/L	0
SO4(MG/L)	8.57	21.00	2.00	6.37	7		0
FE(MG/L)	0.93	1.70	0.20	0.49	7	<1.0 MG/L	3
AL(MG/L)	1.09	2.00	0.10	0.71	7		0
AS(MG/L)	0.0	0.03	0.00	0.01	7	<0.05 MG/L	0

Sources: MCC, 1976.
ESE, 1980.
ESE, 1982.

Table 7.1.4-19. Summary of Violations of Class III Standards Observed During EIS Monitoring

	WQ1	WQ2	WQ3	WQ4	WQ5	WQ7	WQ8	WQ9	WQ10	WQ11	WQ12	WQ13	WQ14
Methyl BA subst V10	*0	0	0	0	0	0	0	—	0	—	—	0	0
	†3	4	3	3	2	3	3	—	2	—	—	3	3
Oil and Grease	0	0	0	0	0	0	0	—	0	—	—	0	0
	3	4	3	3	2	3	3	—	2	—	—	3	3
Cyanide	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	11	10	10	1 4	10	13	3	10	3	2	10	10
Fluoride	0	0	0	0	0	0	0	0	0	0	0	0	0
	10	11	10	10	1 3	10	12	3	8	3	2	10	10
Alkalinity	0	0	0	1	2	0	1	3	5	3	1	1	0
	10	11	10	10	1 3	10	12	3	7	3	2	10	10
pH	1	1	0	2	1	0	3	—	4	—	—	2	0
	9	11	8	9	7	7	9	—	6	—	—	10	9
Ammonia	0	0	0	0	0	0	0	—	0	—	—	0	0
	10	11	10	10	8	10	9	—	6	—	—	10	10
DO	0	1	1	3	9	1	12	3	8	3	2	2	1
	10	11	10	10	1 1	10	12	3	8	3	2	10	10
Arsenic	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Beryllium	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Cadmium	1	1	1	1	0	0	1	—	0	—	—	1	0
	4	5	4	4	4	4	5	—	4	—	—	4	4

Table 7.1.4-19. Summary of Violations of Class III Standards Observed During EIS Monitoring (Continued, Page 2 of 2)

	WQ1	WQ2	WQ3	WQ4	WQ5	WQ7	WQ8	WQ9	WQ10	WQ11	WQ12	WQ13	WQ14
Chromium	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Copper	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Iron	0	0	0	1	3	0	1	—	2	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Lead	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Mercury	3	2	2	2	4	1	4	—	3	—	—	2	2
	4	5	4	4	4	4	5	—	4	—	—	4	4
Nickel	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Selenium	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Silver	0	0	0	0	0	0	0	—	0	—	—	0	0
	4	5	4	4	4	4	5	—	4	—	—	4	4
Zinc	2	2	2	2	2	2	2	—	2	—	—	2	2
	4	5	4	4	4	4	5	—	4	—	—	4	4
Coliform	0	0	0	0	0	0	0	0	0	0	—	0	0
	10	10	10	10	13	10	12	3	8	3	—	10	10

* Top value indicates number of violations.
† Bottom value indicates number of observations.

Source: ESE, 1982.

Table 7.1.4-20. Summary of Violation of Class III Standards Measured in Streams Draining CF Property

	CF6	MCC10 S-2	MCC12	MCC5 SW11	WQ1	WQ2	WQ3	WQ4	WQ5	WQ7
Oil and Grease	*—	0	0	0	—	—	—	—	—	—
	†—	10	8	18	—	—	—	—	—	—
Fluoride	0	5	0	0	2	0	0	0	0	0
	145	22	8	7	275	269	270	244	138	276
Alkalinity	117	13	1	1	1	13	26	117	22	3
	145	22	8	7	275	269	270	244	138	276
pH	59	8	1	3	61	0	0	3	2	2
	142	22	8	18	272	266	267	241	135	273
Dissolved Oxygen	—	11	7	5	—	—	—	—	—	—
	—	22	8	18	—	—	—	—	—	—
Arsenic	—	0	0	0	—	—	—	—	—	—
	—	10	8	7	—	—	—	—	—	—
Iron	—	2	0	3	—	—	—	—	—	—
	—	22	8	7	—	—	—	—	—	—
Fecal Coliform	7	1	1	2	2	6	2	13	14	10
	138	22	8	19	267	262	263	237	133	271

* Top value indicates number of violations.
† Bottom value indicates number of observations.

Sources: MCC, 1975.
CF, 1982.
ESE, 1980, 1982.

Streams in Horse Creek Basin primarily violated alkalinity and dissolved oxygen criteria. Horse Creek violated the <20 mg/l as $CaCO_3$ alkalinity criteria in all three EIS monitoring samples, indicating the poor buffering capacity of the stream. The dissolved oxygen criteria of 5.0 mg/l was also violated in all samples.

In the streams draining Complex II to Payne Creek, a number of criteria were violated. Alkalinity, pH, DO, iron, mercury and zinc criteria were violated in all streams and the cadmium standard was violated in one of five samples in Doe Branch. Alkalinity was violated most often in Shirttail Branch (71 percent of samples) and in only one or two samples for the other streams. A similar trend was observed in pH violations; Shirttail Branch had a pH of <6.0 in 67 percent of the samples while the others were in violation in 30 percent or fewer of the samplings.

Dissolved oxygen criteria were violated in all samples except in Plunder Branch where 80 percent of the samples violated standards. Iron and zinc standards were violated in 40 to 75 percent of the samples while the mercury standard was violated in 75 to 100 percent of the samples taken. EIS monitoring revealed no violations of fecal coliform levels, however, Plunder Branch has historically violated the standard in 10 percent of the samples.

Tributaries draining Complex I to Payne Creek violated several standards including alkalinity, pH, DO, cadmium, mercury, zinc, iron, and fecal coliforms. The alkalinity standard was violated during EIS monitoring by Gum Swamp Branch (only 10 percent of samples) but historically Hickey Branch (1 percent), Payne Creek (5 to 10 percent) and Gum Swamp Branch (50 percent of samples) all showed some violations. Violations of the upper pH standard (>8.5) were observed in Hickey Branch in 1 to 22 percent of the samplings, while violations of the lower pH standard (6.0) were observed in Gum Swamp Branch (1 to 22 percent). Payne Creek violated the lower pH standard only once both historically and during EIS monitoring. DO violations were observed least frequently in Hickey Branch (0 to 1 percent) and most frequently in Gum Swamp Branch (30 percent). Violations of cadmium, mercury and zinc standards were

observed at all stations (20 to 75 percent) and iron violated standards in Gum Swamp Branch in 1 out of 4 samplings. Fecal coliform violations were not detected during EIS monitoring, but historically violations have been detected in all streams in 1 to 5 percent of the samplings.

Violations of water quality standards for pH, DO, alkalinity, iron and fecal coliforms were observed in Troublesome Creek downstream of the CF property. Alkalinity standards were violated in 1 out of 7 samples while the lower pH standard was violated in 3 out of 18. Dissolved oxygen levels were below 5 mg/l in 5 out of 18 samples. Iron violated standards in 3 out of 7 samples and fecal coliforms were at violating levels in 2 out of 19 samples.

Stations on Payne Creek near Little Payne Creek violated alkalinity, pH, DO, cadmium, mercury and zinc standards. Alkalinity (10 percent) and pH (20 percent) violated standards only at the upstream station indicating moderating effects of Little Payne Creek. Dissolved oxygen standards were violated at both stations in 10 to 20 percent of the samples. Mercury and zinc violated standards in 2 out of 4 samples at both stations and cadmium was in violation on 1 out of 4 samples at the upstream station.

Sampling of Sediments and Mine Discharge Samples

In order to characterize the quality of discharge water from the proposed mine site, ESE collected water quality samples from the water recirculation system at the two overflow weirs (MDW-1 and MDW-2) in CF's existing clay settling pond once each season (see Figure 7.1-9). The results of this sampling have been summarized in Table 7.1.4-21. These data will be used for the impact assessment discussions, since they are site-specific (Complex I). However, the concentrations measured are probably worse than those expected from Complex II because the samples collected represent mostly recycled water with little ground water make-up water (approximately 0.08 percent of total recirculation flow at Complex I). On the other hand, the proposed water balance for Complex II, which specifies a total CF discharge of 3.8 cfs, assumes a ground water pumping rate of 7.5 cfs (approximately 5.3 percent of the total recirculation flow). Therefore, water quality concentrations on Complex II should be diluted from those measured in Complex I.

Table 7.1.4-21. Summary of Water Quality Data Collected From CF's Mine Recirculation System at Stations MDW-1 and MDW-2

PARAMETER	Station MDW-1 MEAN	MINIMUM	MAXIMUM	STD.DEV.	#	Station MDW-2 MEAN	MINIMUM	MAXIMUM	STD.DEV.	#
GENERAL PARAMETERS:										
STREAM FLOW (CFS)					0					0
COLOR (PCU)	30	10	100	39	5	32	10	100	39	5
METHY.B.A. SUBST. (MG/L)	<0.50	<0.50	<0.50	0.00	3	<0.50	<0.50	<0.50	0.00	3
OIL & GREASE (MG/L)	<5	<5	<5	0	3	<5	<5	<5	0	3
SUSP.SOLIDS (MG/L)	19	<5	30	10	5	16	<5	31	10	5
TURBIDITY (NTU)	11.7	0.60	26.0	9.26	5	10.2	0.50	26.0	9.61	5
WATER TEMP (C)	25.8	22.4	31.2	3.9	4	26.1	22.0	31.2	4.1	4
DISSOLVED IONS:										
SP.CONDUCT.,FIELD (UMHOS/CM)	396	230	537	155	3	394	214	548	169	3
CYANIDE (MG/L)	<0.005	<0.005	<0.005	0.000	3	<0.005	<0.005	<0.005	0.000	3
CHLORIDE (MG/L)	15	13	17	2	5	15	13	17	2	5
FLUORIDE (MG/L)	2.56	1.97	2.92	0.39	5	2.55	1.98	2.98	0.38	5
SULFATE (MG/L)	147	71	285	81	5	207	72	601	222	5
ALKALINITY AND PH:										
ALKALINITY (MG/L AS CACO3)	68	52	86	12	5	70	50	87	14	5
PH	7.89	7.50	8.50		3	7.72	7.30	8.60		3
NUTRIENTS:										
AMMONIA (MG/L-N)	5.72	0.11	9.62	2.92	5	6.08	0.16	11.3	3.44	5
AMMONIA,UNIONIZED(MG/L)	0.681	0.142	1.35	0.619	4	0.723	0.103	1.34	0.687	3
NO3 + NO2 (MG/L-N)	0.175	0.042	0.342	0.123	5	0.146	<0.004	0.300	0.130	5
TKN (MG/L-N)	10.1	5.32	15.5	4.14	5	9.72	5.10	14.8	3.94	5
T. ORG. N. (MG/L-N)	4.36	3.05	5.89	1.17	5	3.06	2.02	3.54	0.61	5
T. PHOSPHORUS (MG/L-P)	0.743	0.325	1.58	0.491	5	0.592	0.336	0.942	0.224	5
DISS. O-PO4 (MG/L-P)	0.229	0.030	0.556	0.215	5	0.288	0.032	0.819	0.312	5
SILICA, DISS(MG/L AS SIO2)	3.2	2.1	4.1	0.8	5	3.4	2.1	4.4	0.9	5
OXYGEN AND OXYGEN DEMAND:										
DISS. OXYGEN (MG/L)	10.1	7.5	13.6	2.6	4	10.9	6.7	15.0	4.0	4
BOD (5 DA.-MG/L)	8.6	3.9	15.6	4.7	5	11.0	3.4	33.0	12.5	5
METALS:										
ARSENIC,TOTAL(UG/L)	<21	<21	<21	1.5	3	<21	<21	<21	1.5	3
BERYLLIUM (UG/L)	14	<1.0	42	24	3	<1.0	<1.0	<1.0	0.0	3
CADMIUM,TOTAL(UG/L)	0.3	<0.2	0.5	0.2	3	0.3	<0.2	0.6	0.3	3
CHROMIUM,TOTAL(UG/L)	<9.0	<9.0	<9.0	1.6	3	<6.0	<6.0	<6.0	1.3	3
COPPER,TOTAL(UG/L)	2.8	<2.0	5.8	2.6	3	<2.0	<2.0	2.3	0.7	3
IRON,TOTAL(UG/L)	247	<30	502	244	3	153	<30	364	186	3
LEAD,TOTAL(UG/L)	3.2	<2.0	6.5	2.9	3	3.2	<2.0	6.5	2.9	3
MERCURY,TOTAL(UG/L)	0.2	<0.2	0.3	0.1	3	<0.2	<0.2	0.2	0.08	3
NICKEL (UG/L)	<8.0	<8.0	8.5	2.5	3	<8.0	<8.0	8.5	2.5	3
SELENIUM,TOTAL(UG/L)	4.5	<0.9	13	6.9	3	4.5	<0.9	13	6.9	3
SILVER,TOTAL(UG/L)	<0.4	<0.4	<0.4	0.000	3	<0.4	<0.4	<0.4	0.00	3
ZINC,TOTAL(UG/L)	25.9	<2.0	68.0	36.7	3	20.9	<2.0	52.0	27.3	3
MICROBIOLOGY:										
COLIFORM,FEC.(#/100ML)	149	4	545	225	5	51	40	80	17	5

MIN = MINIMUM; MAX = MAXIMUM; S.D. = STANDARD DEVIATION; # = NUMBER OF OBSERVATIONS
MEAN VALUE WAS CALCULATED USING HALF THE VALUE OF THE DETECTION LIMIT FOR OBSERVATIONS THAT WERE LESS THAN THE DETECTION LIMIT.

SOURCE: ESE, 1982

ESE also collected sediment samples at Stations WQ-2, 3, 5, 8, and 10 in October 1981 and the results of these samplings are presented in Table 7.1.4-22.

Chemical content of waters is generally a reflection of sediment content, due either to dissolution or deposition. This can be seen in many of the sediment samples taken from water quality stations during October 1981.

Stations in Shirttail Branch, Doe Branch, and Plunder Branch all had sediment samples taken and analyzed. Acidity in the sediment appeared to be directly correlated with alkalinity in the water column and may reflect the buffering capacity of the sediment. Nitrogen levels are also consistent between water and sediment; October 1981 showed high TKN values for Station WQ-10 in both sediment and water. In contrast, phosphorus water concentations did not correlate with sediment concentrations. Metals which exceeded water quality standards (cadmium, mercury, iron, zinc) were higher in sediments from these stations than other sediments sampled.

Other sediments sampled during October 1981 were from two Payne Creek stations (WQ-2 and WQ-3). These stations both had moderate levels of alkalinity and neutral pH in the water column. This was also observed in the sediment pH which is near neutral. Nitrogen levels were low in both water and sediment. Phosphorus concentrations were not correlated between sediment and water. Metals appeared to be low in sediments, however, cadmium, mercury, and zinc violated water quality standards.

7.1.4.3 SUMMARY

Water quality of streams at the mine site can generally be separated into two large groups--those draining Complex II, and those draining Complex I. Streams draining Complex II are impacted from swampland more than those draining Complex I. Color levels are higher and pH and alkalinity are lower indicating primarily acidic conditions. Dissolved

Table 7.1.4-22. Summary of Chemical Analyses Performed on Stream Sediment Samples

ENVIRONMENTAL SCIENCE & ENGINEERING 08/03/82 FIELD GROUP CF-6 STATUS IS PRELIMINARY

PROJECT NUMBER R1714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

PARAMETERS	STORET #	SAMPLE NUMBERS WQ-2 129400	WQ-3 129401	WQ-5 129402	WQ-8 129403	WQ-10 129404	WQ-50 129405
DATE		10/29/81	10/29/81	10/29/81	10/29/81	10/29/81	10/29/81
TIME		1500	1700	1100	1115	1215	1100
NH3,MUD (MG/KG-DRY)	611	<12	<12	<12	<12	<12	<12
AS,SEDIMENT(MG/KG)	1003	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
BERYLLIUM,SED(MG/KG)	1013	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
CD,SED(DRY-MG/KG)	1028	<0.05	0.08	0.2	0.2	0.4	0.1
CR,SED(MG/KG-DRY)	1029	0.6	1	3	9	2	3
CU, SED (DRY-MG/KG)	1043	0.2	0.2	3	0.9	0.7	3
CYANIDE,SED(MG/KG)	721	<490	<495	<495	<500	<490	<500
FLUORIDE,MUD(MG/KG)	949	48	23	23	324	8	28
FE,SED(MG/KG-DRY)	1170	84	75	229	789	252	265
PB,SED(MG/KG-DRY)	1052	0.7	0.5	7	3	2	13
HG,SED(MG/KG-DRY)	71921	<0.02	<0.02	<0.03	<0.02	<0.03	<0.02
NI,SED(MG/KG-DRY)	1[illegible]	0.7	1	2	6	0.5	0.9
T. ORG. N,SED (MG/KG)	625	61.0	29.9	183	112	227	271
PHOSPHORUS,SED(DRY,MG/KG-P)	668	69.3	228	209	1370	24.5	240
PH,MUD	7-310	7.4	7.2	7.1	6.9	5.5	6.9
RADIUM 226(PC/G)	9[illegible]7	0.1	0.4	2	3	0.2	2
SE,SED(MG/KG-DRY)	1148	<0.7	<0.7	<0.7	<0.7	<0.7	<0.7
AG,SED(MG/KG-DRY)	1078	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
SO4,SED(MG/KG)	81612	<50	<50	<50	<50	<50	<50
ZN,SED(MG/KG-DRY)	1093	2	1	14	4	2	9

Source: ESE, 1982.

oxygen is lower in Complex II streams, probably as a result of contact with swampland. Nutrient levels are about the same in the streams draining both Complexes. However, nitrate-nitrite levels are high in Complex I, probably as a result of fertilizer input. Zinc and mercury violated water quality standards in both basins; iron violated standards most often in Complex II streams; cadmium violated standards more often in Complex I.

All on-site streams, except for Horse Creek, Brushy Creek, Troublesome Creek and Lettis Creek drain into Payne Creek. Water quality in Payne Creek after inputs from all streams is generally similar to that of streams in Complex I. Alkalinity, pH, nutrient, and DO levels are all comparable to Payne Creek levels before entering CF property. Little Payne Creek has a moderating effect on alkalinity, pH, and cadmium levels, but increases nitrate-nitrite levels.

Effective January 1, 1986, CF modified its surface water monitoring program after generating a 10-year data base. In this revised program, continuous surface water streamflow data and water quality information are being generated at Stations WQ-3 and WQ-7. Station WQ-3 is located on Payne Creek, and Station WQ-7 is located on Hickey Branch (see Figure 7.1-3).

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8.0 AQUATIC ECOLOGY

8.1 THE AFFECTED ENVIRONMENT

8.1.1 REGIONAL DESCRIPTION

Two central Florida aquatic community types were identified in the Phosphate Industry Areawide Environmental Impact Statement (U.S. Environmental Protection Agency, 1978). Standing water, or lentic, aquatic communities is one type which includes natural or manmade lakes and impoundments, ponds, pits and seasonal or permanent wetlands. Except for some interconnections between low lying wetlands, the lentic communities represent essentially discrete ecosystems. Many of the smaller lentic systems are intermittent, generally becoming dry during early spring. They provide support for transitional communities during only part of the year. Most of the natural large lentic water bodies have permanent water. They are shallow with wide littoral zones which support comparatively large populations of aquatic flora and fauna.

A second aquatic community type is the lotic, or flowing-water, community, which includes rivers, streams and their tributaries. Most of these systems have water that is stained red-brown due to humic acids being washed downstream from adjacent lentic systems. The streams are relatively slow-moving and moderately to densely covered with emergent aquatic vegetation. They usually have well developed shoreline terrestrial communities. Flows vary greatly between wet and dry seasons. During the dry season, stream flow is confined to main channels while most of the smaller tributaries cease flowing and either form a series of pools, or become completely dry. During the wet season, streams become contiguous with lentic systems within the floodplain. A diversity of flora and fauna utilize lotic habitats.

CF Industries' proposed Hardee Phosphate Complex II is located in a portion of central Florida which is devoid of major lakes. The primary lentic systems within this area are composed of either seasonal or permanent wetlands. Lotic systems within CF Hardee Phosphate Complex II are comprised of 2nd and 3rd order streams that are seasonally

influenced. Horse Creek is a 2nd order stream, and all others are 3rd order. In this phosphate mining region, drainage patterns have been altered in many places by channelization for flood prevention or for agricultural (citrus, cattle) purposes.

8.1.2 SITE-SPECIFIC DESCRIPTION

CF Industries' Hardee Phosphate Complex II comprises agricultural lands (cattle), flatwoods, hardwood hammocks, riparian forests, marshes, and sloughs. As discussed in Section 7.0, portions of ten drainage systems within the Peace River drainage basin are present on this site:

1. Horse Creek
2. Brushy Creek
3. Shirttail Branch
4. Doe Branch
5. Plunder Branch
6. Coon's Bay Branch
7. Lettis Creek
8. Troublesome Creek
9. Gum Swamp Branch
10. Hog Branch

Only Lettis Creek and Troublesome Creek have poorly defined on-site drainages, as they represent only the upper extremities of their respective watersheds. All other systems have defined on-site streams or channels. At least one aquatic ecology sampling station was established in the vicinity of the property boundary and channel exit point for each of the six major drainage systems (Figure 8.1-1). Additional sampling stations were established for Horse Creek and Brushy Creek to provide further documentation of these stream habitats. The property is located on a regional drainage divide with the western half of the property draining south and the eastern half draining to the north and then east. Specific descriptions of sampling stations are provided in the following paragraphs.

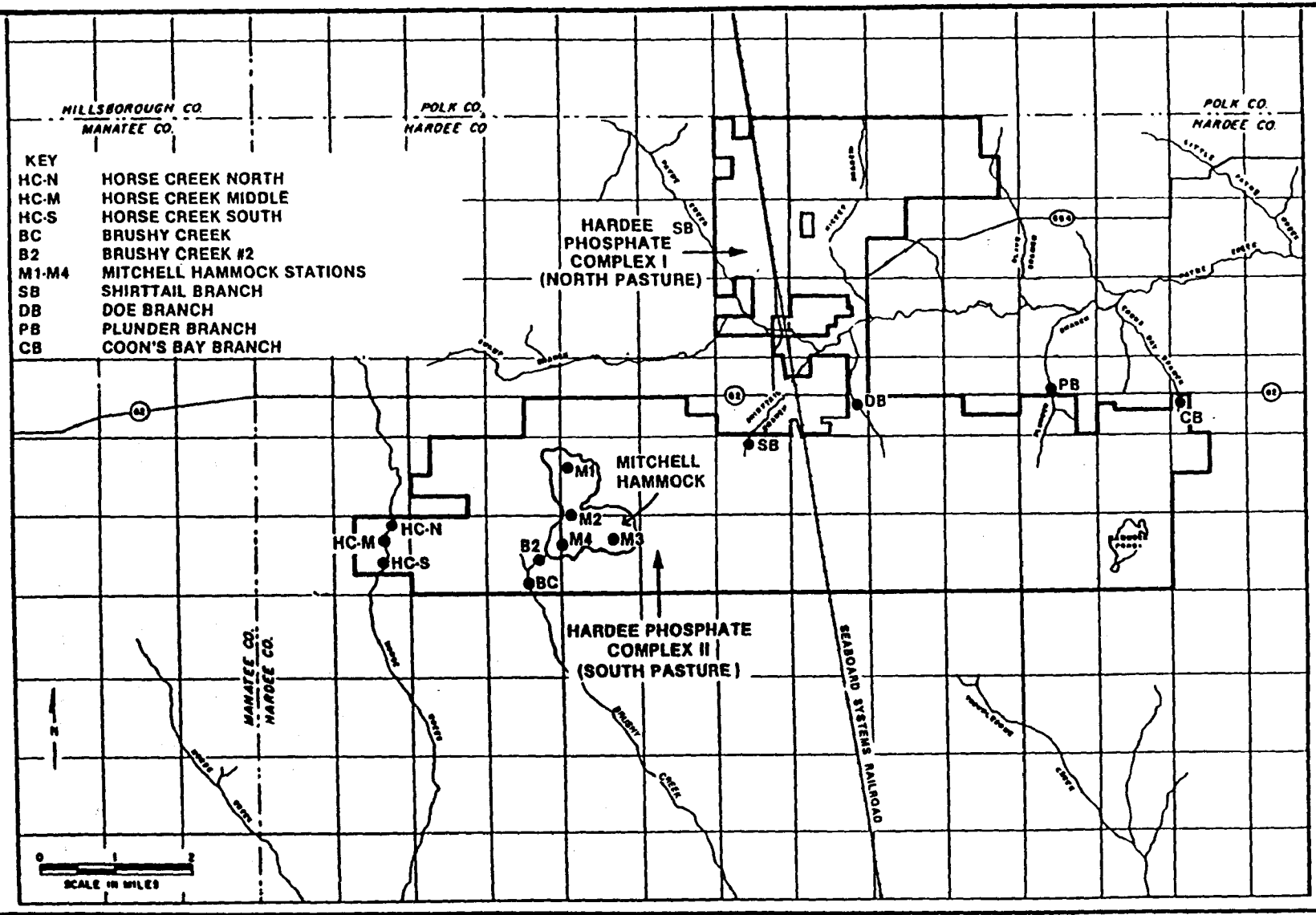

Figure 8.1-1
AQUATIC ECOLOGY SAMPLING STATION LOCATIONS

SOURCE: ESE, 1982.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
Hardee Phosphate Complex II

CF SID 08/15/85 rev.

8.1.2.1 HORSE CREEK

Of the eight systems, Horse Creek is the only system which does not begin as a headwater area on the property. Horse Creek flows intermittently in a southerly direction within the property, and has an average annual flow of over 5 cfs at the point where it leaves the property. The headwater region of Horse Creek lies about 4 river miles north of the property. Initially, only one sampling station (HC-S) was located within a laurel oak hammock near the southern property boundary. The channel at this location was approximately 15 meters wide and 1 meter deep during the dry season. Stream reaches above and below the sampling location were less channelized.

Two additional stations were included in October 1981. One station, Horse Creek-Middle, HM, was centrally located along the stream course on-site and within a marsh dominated by a mixed assemblage of maiden-cane, pickerelweed, galingale, and buttonbush. Water depths at Station HC-M were generally less than 0.5 meter and the channel was relatively diffuse. The northernmost Horse Creek station (HC-N) was near the northwestern property boundary and within an oak hammock/pine flatwoods area. At this station, the channel was well defined; however, it was narrower (5 to 10 meters) and shallower (0.25 meters to 0.5 meters) than at Station HC-S.

8.1.2.2 BRUSHY CREEK

The major portion of Brushy Creek's headwaters are within the site's boundaries. Although they are separate systems on-site, Brushy Creek becomes a tributary to Horse Creek approximately 20 kilometers south of the property. The Brushy Creek drainage system includes two lobes of hardwood swamp/herbaceous marsh which are separated by a dirt road. Mitchell Hammock is the largest of the two lobes and is located east of Brushy Creek's main channel. Initially, one sampling station (BC) was established in a pickerelweed/arrowhead marsh along the main channel. This area was chosen primarily because of the persistence of an aquatic habitat within the "pool" area of the marsh. As with all of the drainage systems during the initial sampling trips, the drought of the

preceding year had diminished aquatic habitats, complicating selection of aquatic ecology sampling stations.

One additional sampling station (BC-2) was located in an herbaceous marsh on the perimeter of a tupelo swamp which received flow from Mitchell Hammock. This station was sampled only in October 1981.

Four stations were added to represent Mitchell Hammock: M1 was located along a transect within a maple/tupelo swamp, M2 and M3 were within separate maidencane marshes, and M4 was located in a maidencane/pickerelweed/arrowhead marsh. The marsh containing M4 eventually channelized and connected to the main body of Brushy Creek through BC-2. These Mitchell Hammock stations were sampled only in February 1982.

8.1.2.3 SHIRTTAIL BRANCH

Shirttail Branch was the only drainage system in the western section of the property that had a northerly flow, becoming a tributary to Payne Creek. The aquatic ecology station (SB) was located in a pooled (0.5 to 1.0 meter deep and 8 meters wide) area along the northern boundary. This area was connected to a laurel oak hammock by a well defined channel. No additional sampling stations were added for this drainage system throughout the program.

8.1.2.4 DOE BRANCH

Doe Branch represents the largest and most complex drainage system on the CF Hardee Phosphate Complex II site. The headwaters of Doe Branch are located near the southern property boundary and, when flowing, become a tributary of Payne Creek approximately 1 mile north of Highway 62 (which is a part of the northern property boundary). The east and west pastures are separated by both a railroad and Fort Green-Ona Road. Portions of Doe Branch's western sub-basin were isolated by this east-west boundary. Only one aquatic ecology sampling station (DB) was established for Doe Branch in a pool which drains a pop ash/hardwood

swamp forest, south of Highway 62. Station DB was between 25 and 30 meters wide and ranged from 0.75 meters to 1.5 meters in depth. The hardwood swamp channel was included for qualitative sampling during the last three sampling trips.

8.1.2.5 PLUNDER BRANCH

Plunder Branch is a complex drainage system consisting of numerous marshes and swamps which are interconnected by sand-bottomed channels. Plunder Branch is also a tributary of Payne Creek, approximately 1 mile north of Highway 62. The aquatic ecology sampling station, PB, was located in a small pooled area north of Highway 62 and was surrounded by a mixed hardwood swamp. Most of the Plunder Branch drainage system is south of Highway 62 and within the CF Hardee Phosphate Complex II site.

8.1.2.6 COON'S BAY BRANCH

Coon's Bay Branch is a 3rd order intermittent stream course which, when flowing, connects to Payne Creek. The headwaters for Coon's Bay Branch are located within the extreme northeastern corner of CF Hardee Phosphate Complex II. Areas off-site but adjacent to the hardwood swamp have been altered for agricultural (citrus) interests. One aquatic ecology sampling station (CB) was located in the main "channel" of Coon's Bay Branch along the northern property boundary and Highway 62. The water level at this location seldom exceeded 0.2 meters in depth and 4 to 5 meters in width.

8.1.3 METHODOLOGY

Due to the complexity of each drainage system, the aquatic sampling program had to be designed to ensure collection of system-representative populations. The shallow nature of all six systems and their sampling stations restricted the types of sampling methodology available for use. However, collection methods remained consistent for all sampling efforts.

Additional sampling stations were added for both Horse Creek and Brushy Creek during the final two sampling episodes. In addition, four transects with aquatic sampling stations were included in Mitchell Hammock for one sampling event in February 1982.

8.1.3.1 PHYTOPLANKTON

Representative phytoplankton samples were collected from just below the surface at all stations. Samples were preserved with Acid-Lugol's solution. An aliquot of 800 milliliters was concentrated by sedimentation to a final count volume of 5 milliliters. Population estimates were derived from counts in a Palmer-Maloney Chamber. At least 200 cells were counted from each sample utilizing a magnification of 400X. Counts were converted to cells per milliliter.

Algal dominance was defined by the algae with the greatest abundance at a particular station. Codominant algae were those algae which comprised 10 percent or more of the population density.

8.1.3.2 PERIPHYTON

Submerged twigs, rocks and aquatic macrophytes were sampled by scraping off sections of the attached periphyton community. Diatoms were acid cleaned and mounted on slides for microscopic examination at 1000X magnification. Other algal groups were examined qualitatively under the compound microscope to obtain presence/absence data for each stream station sampled.

8.1.3.3 BENTHIC MACROINVERTEBRATES

Infaunal benthic macroinvertebrates were sampled quantitatively with a 10.8-centimeter (internal diameter) stainless steel coring device which penetrated sediments to a depth of 15 centimeters. Each sample was washed through a 0.5 millimeter mesh sieve and preserved with a 10 percent formalin solution containing rose bengal stain (Mason and Yevich, 1967). During the initial sampling effort in July 1981, three core samples per station were collected. Beginning in August 1981, a

total of nine cores per sampling station were collected and sieved in the field. Six cores per station were processed for quantitative population estimates. The remaining cores were stored for future use on an as needed basis to refine the quantitative data.

Epifaunal macroinvertebrates were sampled qualitatively with Hester-Dendy multiple plate artificial substrate samplers, a 0.5-millimeter mesh dip net, and 30-centimeter square 0.5-millimeter mesh drift nets. Hester-Dendy samplers were suspended for 4 weeks from stationary structures so that they hung just above the sediment/water interface. Colonization was allowed to occur for approximately one month. Attached organisms were removed and preserved as described for the infauna.

Following a field visit by an EPA project team in October 1981, the quantitative sample collection was replaced by a more intensive qualitative survey of all stream stations. This change was requested by EPA to allow greater collection coverage and, therefore, more population information on the diverse habitats present around each sampling station.

8.1.3.4 FISH

Dip netting was used to collect small fish at most sampling locations. Where possible, a beach seine was used to sample larger fish in wide channels and pools. Representative individuals of each taxon were preserved and retained as reference specimens. All remaining fish were returned to the water unharmed.

8.1.4 COMMUNITY ANALYSIS

8.1.4.1 PHYTOPLANKTON

Algal populations found on the CF Hardee Phosphate Complex II site generally fit into two categories: (1) phytoplankton (free-floating), and (2) periphyton (attached). Both populations are integrated in shallow water. Algal populations are important primary producers in lakes, ponds, and rivers. In areas of extensive marsh with intermittent flooding, rooted vascular plants are the major primary producers and the

importance of phytoplankton is diminished. However, the stems of vascular plants and other substrates may be a source of attachment for periphyton.

Descriptions of populations found on the CF Hardee Phosphate Complex II site are based on the results of five sampling periods: July, August, September, and October 1981; and February 1982. Presence/absence matrices of taxa identified at each sampling station and during each trip are found in Tables 8.4.1-1 through 8.4.1-5.

July 1981

Phytoplankton populations in Horse Creek were dominated by the blue-green alga, Anabaena sp., which comprised 56.6 percent of the cells counted (Table 8.1.4-6). Green algae made up most of the remaining cells, with Chlamydomonas sp. accounting for 13.8 percent of the total. Chlamydomonas sp. was dominant in Brushy Creek (35.6 percent of the total), along with other green algae and the diatoms, Melosira sp. and Nitzschia sp.

The Shirttail Branch phytoplankton community was dominated by Chlamydomonas sp. (28.2 percent of the cells) and other unidentified green algae (11.7 percent) in July 1981. Other numerically important algae found in Shirttail Branch included the euglenophyte, Trachelomonas volvocina (19.4 percent), and the cryptophyte, Chroomonas sp. (13.6 percent).

The diatom, Navicula confervacea, comprised 31.7 percent of the total cells counted from Doe Branch samples, followed by the blue-green alga, Oscillatoria sp. (22.2 percent). Chlamydomonas sp. and other species of diatoms were also abundant in this stream.

Euglenophytes were dominant in Plunder Branch during the July 1981 sampling effort (Table 8.1.4-6); Euglena gracilis (27.3 percent) and Trachelomonas volvocina (16.7 percent) were the most abundant species in

this group. The cryptophyte, Chroomonas nordstedtii (18.3 percent), and Chlamydomonas sp. were also relatively important in Plunder Branch. Of the six sampling stations, Coon's Bay Branch was the only creek that was completely dry during the July 1981 trip. Phytoplankton populations in the remaining creeks had densities which ranged from 10,110 cells/ml in Plunder Branch to 607 cells/ml in Shirttail Branch (Table 8.1.4-7). A total of 66 taxa were enumerated for all stations, ranging from 26 taxa at Horse Creek to 36 taxa at Brushy Creek. Although population densities were low, the algal taxa were fairly evenly distributed, as evidenced by species diversity, evenness, and richness (Table 8.1.4-7).

August 1981

The density of blue-green algae in Horse Creek declined in August 1981, when compared with July 1981. Green algae, particularly Chlamydomonas sp., were dominant, accounting for 56 percent of the total cells identified (Table 8.1.4-8). Chroomonas sp. and Nitzschia palea each accounted for more than 10 percent of the total phytoplankton community in Horse Creek during August 1981.

Chlamydomonas sp. (41.4 percent of the total) continued to be the dominant alga in Brushy Creek, and various euglenophytes comprised most of the remaining cells. A shift in dominance was observed in Shirttail Branch populations in August 1981, when the blue-green alga, Oscillatoria geminata, was the most abundant species (29.9 percent), followed by Chlamydomonas sp. (13.9 percent), and Nitzschia sp. (13.7 percent).

Diatoms continued to be the most abundant algae in Doe Branch, (76 percent of the total) with species of Nitzschia and Navicula accounting for the majority of the cells (Table 8.1.4-8). Blue-green algae declined in relative importance to 11 percent of the total.

The two dominants in Plunder Branch during July 1981, Chlamydomonas sp. and Chroomonas nordstedtii, were also dominant during August 1981. The

euglenophytes, Lepocinclis fusiformis and Trachelomonas pulcherrima, and the pyrrophyte, Glenodinium sp., each represented over 10 percent of the total cells collected in Plunder Branch during August. Total phytoplankton abundance (Table 8.1.4-7) followed the trend observed in July 1981, with highest densities found in Plunder Branch (7,132 cells/ml), and lowest densities found in Shirttail Branch (324 cells/ml).

September 1981

Green algae continued to be the dominant group in Horse Creek during September 1981 with Hyalotheca sp. and unidentified flagellated green algae accounting for most of the cells (Table 8.1.4-9). Several species of diatoms comprised an additional 23 percent of the phytoplankton community. Blue-green algae, particularly Oscillatoria geminata, were dominant in Brushy Creek (57 percent of the total), and chrysophytes represented 20 percent of the cells counted.

The species composition in Shirttail Branch during September 1981 was different from the species composition during each of the two preceding months. Navicula confervacea accounted for 64.7 percent of the total cells identified in September 1981, and all the diatoms taken together comprised 79 percent of the algal population (Table 8.1.4-9). Green algae made up most of the remaining cells, with 19 percent of the total. Doe Branch algal populations were codominated by several groups, including chrysophytes (32 percent), green algae (25 percent), diatoms (22 percent), and euglenophytes (10 percent).

Diatoms were dominant in Plunder Branch during September 1981, unlike during the previous sampling efforts, accounting for 89 percent of the total cells identified. Navicula confervacea was the most abundant species in Plunder Branch, as it was in Shirttail Branch, with 18.4 percent of the total cells.

The phytoplankton community in Coon's Bay Branch was dominated by unidentified flagellated green algae (83.9 percent) in September 1981. Cryptophytes and diatoms made up the remainder of the Coon's Bay Branch population. Total densities ranged from 148 cells/ml in Coon's Bay Branch to 1,600 cells/ml in Plunder Branch (Table 8.1.4-7).

October 1981

The three stations sampled in Horse Creek during October 1981 had similar algal communities. Green algae, cryptophytes, and diatoms all made up substantial fractions of the total cells counted (Table 8.1.4-10). Numerically dominant species in Horse Creek included the green alga, Chlamydomonas sp.; the cryptophyte, Chroomonas sp.; and the diatom, Nitzschia sp. Blue-green algae continued to be important in Brushy Creek during October 1981 (23 percent), but several species of diatoms together comprised 69 percent of the total cells identified.

The blue-green alga, Oscillatoria geminata, was dominant in Shirttail Branch with 55 percent of the population (Table 8.1.4-10). Unidentified flagellated chrysophytes and Chroomonas sp. accounted for most of the remaining cells found in Shirttail Branch during October 1981.

Chroomonas sp. was also abundant in Doe Branch, accounting for 42.1 percent of the total cells. Oscillatoria sp. and an unidentified flagellated chrysophyte each represented more than 11 percent of the algal population in Doe Branch.

Chroomonas sp. was also abundant in Plunder Branch during October 1981 (30.1 percent), but euglenophytes, particularly Lepocinclis sp. and Trachelomonas volvocina, were dominant, with 59 percent of the total cells. Total densities ranged from a mean of 505 cells/ml for the three stations in Horse Creek to 7,376 cells/ml in Brushy Creek (Table 8.1.4-7).

February 1982

There was considerable variation in the algal communities observed at the different Horse Creek stations during February 1982 (Table 8.1.4-11). The cryptophyte, Chroomonas nordstedtii, was dominant at the southernmost station (HC-S), with 63 percent of the total cells. Several species of diatoms combined accounted for a total of 65 percent of the cells at the central station (HC-M), and algal dominance was evenly divided among green algae, euglenophytes, chrysophytes, and cryptophytes at the northernmost Horse Creek station (HC-N).

Blue-green algae were not found at all in Brushy Creek during February 1982, unlike previous months. Trachelomonas volvocina was the dominant species (40.7 percent) during the winter sampling episode, followed by several species of diatoms and green algae.

T. volvocina was also the single most abundant species in Shirttail Branch during February 1982 with 30.5 percent of the total cells. Other numerically important algae found at that time included green algae, cryptophytes, and diatoms.

Several species of diatoms, including Eunotia sp. (23.4 percent) and Achnanthes hungarica (16.4 percent), taken together accounted for 73 percent of the total cells collected in Doe Branch in February 1982 (Table 8.1.4-11). Species of green algae, cryptophytes, and diatoms were all numerous in Plunder Branch collections, with Chroomonas nordstedtii representing the dominant species (37.2 percent of total cells). Diatoms comprised 74 percent of the total cells found in Coon's Bay Branch during February 1982, with Nitzschia sp. accounting for 50.3 percent of all cells (Table 8.1.4-11).

Four transects in Mitchell Hammock were sampled for phytoplankton during February 1982. Transects 1 and 4 were dominated by diatoms characteristic of nonsubmerged to shallow water areas (Lowe, 1974). Transect 2 was dominated by one species, Synura uvella, which is

flagellated and therefore more mobile than diatoms. The cryptophytes, chlorophytes, and euglenophytes numerically dominant at Transect 3 are characteristic of an area receiving organic loading. Total phytoplankton densities during February 1982 ranged from 941 cells/ml in Doe Branch to 30,768 cells/ml in Mitchell Hammock Transect 2 (Table 8.1.4-7).

Analysis of algal populations found on the CF Hardee Phosphate Complex II site reveals two basic species groupings. Several diatom genera which were dominant or codominant at many of the stations are characteristic of shallow systems and were of a benthic or epiphytic origin. In these shallow areas, phytoplankton supply a small portion of the total primary production, due to the presence of vascular plants. However, the algae are important as food for grazing macroinvertebrates. The second species group includes cryptophytes, chlorophytes, and euglenophytes which are characteristic of areas with permanent water receiving organic loading, such as stock ponds.

8.1.4.2 PERIPHYTON

Periphyton samples were collected at the CF Hardee Phosphate Complex II site during five sampling periods: July, August, September, and October 1981; and February 1982. As discussed previously in the phytoplankton section, phytoplankton and periphyton populations interact in shallow water, and sharp distinctions between the communities become impossible. Periphyton growth is often extensive on stems of vascular plants, submerged tree trunks and limbs, and other surfaces available in shallow water. Periphytic organisms are grazed upon by many aquatic invertebrates as well as some fish.

An examination of the presence/absence matrices for periphyton taxa identified from each of the five collecting efforts (Tables 8.1.4-12 through 8.1.4-16) reveals lists of algae closely resembling the phytoplankton list of taxa (Table 8.1.4-1). The similarity in populations of algae collected from different habitats (attached versus free-floating) underscores the significant interaction between the phytoplankton and

periphyton in the predominantly shallow waters of the CF Hardee Phosphate Complex II site. Most of the periphyton were species typical of shallow water bogs or marsh systems. Many of these, particularly the diatoms, have resting stages that are resistant to desiccation. The resting stages remain viable in the soil surface during the dry season, ready to initiate rapid asexual reproduction when the area is reflooded.

8.1.4.3 BENTHIC INFAUNA

Benthic infauna are aquatic invertebrates which live in the substrate and are generally large enough to be seen with the unaided eye. They feed on a variety of organic materials including detritus, algae, and other invertebrates, and are important food items for larger invertebrates, fish, and some water fowl. Benthic invertebrate communities have been analyzed for their capacity to reflect environmental quality, especially degradation in water quality due to organic pollution. Since benthic invertebrates have relatively long life cycles, are limited in mobility, and occupy diverse aquatic habitats, they are indicators of present and past water quality, substrate type, and flow regime.

Characterizations of benthic infaunal populations found on the CF Hardee Phosphate Complex II site are based on the results of five sampling periods: July, August, September, and October 1981; and February 1982. Not all stations were sampled during all field efforts. A list of the taxa identified and presence/absence matrices by trip are presented in Tables 8.1.4-17 to 8.1.4-21.

July 1981

Oligochaete worms accounted for 90 percent of the benthic infauna collected in Horse Creek during July 1981 (Table 8.1.4-22). Most of the individuals were the tubificid, Limnodrilus hoffmeisteri, and immature tubificids which probably also represented L. hoffmeisteri.

Populations in Brushy Creek were also dominated by tubificids (85 percent of the individuals) which were mostly immature. Beetles of the family Heteroceridae made up the remaining 15 percent of the individuals found in Brushy Creek (Table 8.1.4-22).

Core samples from Shirttail Branch were relatively evenly populated by tubificids and chironomid larvae. Insects were dominant in Doe Branch, where two chironomid species and dragonfly larvae combined to account for 80 percent of the organisms. Immature tubificids and one species of naidid oligochaete were the only infauna collected from Plunder Branch (Table 8.1.4-22). Highest total densities were found in Brushy Creek during July 1981 (3,175 individuals/m^2) and lowest densities were found in Doe Branch and Plunder Branch (182/m^2).

August 1981

Oligochaete worms continued to numerically dominate the infauna of Horse Creek during August 1981, comprising 97 percent of all organisms identified. The tubificid, Aulodrilus pigueti, was the most abundant species collected (Table 8.1.4-23).

Oligochaetes also continued their dominance in Brushy Creek (84 percent of the total), with immature tubificids forming the largest group. Cores from Shirttail Branch were again populated by oligochaetes and insect larvae (41 percent and 59 percent of total individuals, respectively) with larvae of midges (Chironomus spp.) comprising the most abundant group. The only two species of infauna collected in Doe Branch during August 1981 were the amphipod, Hyalella azteca (50 percent of the total) and the chironomid, Polypedilum illinoense (50 percent of the total). Plunder Branch samples were again strongly dominated by oligochaetes, including immature individuals, as well as tubificids and naidids. These worms accounted for 93 percent of the organisms collected in Plunder Branch. Total densities were highest in Horse Creek during August 1981, at 6,114 individuals/m^2, and lowest in Doe Branch, at 73 individuals/m^2 (Table 8.1.4-23).

September 1981

Oligochaetes were still the dominant infaunal group in Horse Creek during September 1981, but many more species of tubificids and naidids were found. Immature oligochaetes remained the most abundant group collected. A total of 20 percent of the collections was composed of insect larvae, almost all belonging to the Chironomidae (Table 8.1.4-24).

Brushy Creek collections also continued to be dominated by oligochaetes, particularly tubificids. Limnodrilus hoffmeisteri and immature tubificids (probably also L. hoffmeisteri) were the most abundant oligochaetes found in Brushy Creek. Several insect species, predominantly chironomids, made up the remainder of the samples (Table 8.1.4-24).

The infauna of Shirttail Branch became more diverse in September 1981, although oligochaetes were still dominant, representing 65 percent of the total organisms collected. Various insect species accounted for 23 percent of the organisms, and molluscs, particularly gastropods of the family Ancylidae, made up the remaining 13 percent of the total (Table 8.1.4-24).

Naidid oligochaetes were the dominant group in Doe Branch during September 1981, when all oligochaete groups comprised 92 percent of the organisms collected. Tubificid oligochaetes, especially immature and adult Limnodrilus hoffmeisteri, represented 99 percent of the infaunal population at Plunder Branch during September 1981 (Table 8.1.4-24).

Several tubificid and naidid oligochaete species were identified from Coon's Bay Branch core samples; all oligochaetes added up to 62 percent of the total organisms counted. The remaining 38 percent of the organisms were various insects, including Collembola (springtails) and several chironomid species. Highest total densities were found in Horse Creek, with 11,753 individuals/m^2, and lowest densities were found in Brushy Creek, with 2,628 individuals/m^2 (Table 8.1.4-24).

October 1981

Three stations in Horse Creek were the only sites investigated for benthic infauna during October 1981. As mentioned previously, the emphasis on benthic communities shifted from quantitative cores to qualitative population samples at the request of EPA field team members. Oligochaetes and insects were the dominant groups at all the stations, but there were differences in species composition within these groups. Limnodrilus hoffmeisteri and Aulodrilus pigueti were the dominant tubificids at the southern Horse Creek station (HC-S), and larval chironomids were the dominant insects. L. hoffmeisteri and A. pigueti were also dominant at the central Horse Creek station (HC-M), but the most abundant insect was Caenis sp., a mayfly larva. Populations at the northern Horse Creek station (HC-N) included the same oligochaetes that were found at the other stations in Horse Creek. Two chironomid species were the most abundant insects found at this station. Total densities at all three stations were similar, ranging from 3,139 to 3,741 individuals/m^2 (Table 8.1.4-25).

February 1982

Once again, the three stations in Horse Creek were the only stations sampled. In general, the populations were similar at all stations, with oligochaetes accounting for 61 percent to 82 percent of the total organisms identified. The central station was inhabited by a greater variety of insect species than the other two stations, probably because it was in a marshy area with a greater variety of habitat types. Chironomid larvae comprised all of the insects collected at the northern and southern stations in Horse Creek. Total densities ranged from 1,186 individuals/m^2 at the southern station to 310 individuals/m^2 at the northern station (Table 8.1.4-26).

The Shannon-Weaver diversity index calculated for benthic infauna ranged from a low of 0.72 in Plunder Branch to a high of 3.97 in Coon's Bay over the first three collection episodes (Table 8.1.4-27). Diversity generally increased from July 1981 to September 1981, which resulted

primarily from increases in species richness rather than species evenness. Doe Branch and Plunder Branch stations were generally the least diverse due to low species richness. The low species richness at these two stations probably resulted from bottoms composed principally of organic fine sediments.

In Horse Creek during October 1981 and February 1982 the highest diversity was displayed by the central station, which resulted from a higher species richness. The higher species richness resulted from the greater complexity of the habitat due to the aquatic macrophytes present.

The benthic infauna in the streams on the CF Hardee Phosphate Complex II site were numerically dominated by a relatively limited variety of organisms. Tubificid oligochaetes, especially Limnodrilus hoffmeisteri, were ubiquitous during all sampling periods. Several species of insects usually comprised the remainder of the samples, with larval chironomids found most often.

8.1.4.4 EPIFAUNA

Epifaunal organisms are aquatic invertebrates living on substrates such as vegetation, rocks, logs, etc. Some of the species recovered in infaunal core samples are also found in epifaunal samples, but the assemblages found in the two habitats are usually distinct. Epifauna feed on organic materials such as detritus, algae, and other invertebrates. They are fed upon by other invertebrates, fish, and some water fowl.

The presence/absence data (Tables 8.1.4-28 through 8.1.4-32), although qualitative, nevertheless reveal differences between sampling stations. These data will be discussed separately for each trip.

July 1981

Epifaunal populations sampled in Horse Creek during July 1981 included species of leech, gastropod, water mite, shrimp, and insects belonging to several families (Table 8.1.4-28). Only a few species were found in Brushy Creek; these included oligochaete worms, shrimp, and two species of mosquito larvae. The Shirttail Branch epifaunal community also included oligochaetes and a crustacean, but supported a more diverse insect fauna than was found in Brushy Creek. Various mayflies, water scorpions, water beetles, mosquito larvae, and chironomids were collected in Shirttail Branch during July 1981. Few epifaunal species were collected in Doe Branch; those found included one species of naidid oligochaete, a gastropod, an amphipod, and five species of insects. More epifaunal species were found in Plunder Branch than at any other station sampled during July 1981 (Table 8.1.4-28). Various species of oligochaetes, molluscs, and insects contributed to the diverse epifaunal community found in Plunder Branch.

August 1981

A large number of epifaunal species was collected in Horse Creek during August 1981 (Table 8.1.4-29). Many aquatic groups were represented including turbellarians, oligochaetes, leeches, several molluscs, water mites, various crustaceans, and numerous insect families and species. Considerably fewer epifaunal species were found in Brushy Creek than in Horse Creek, but most of the groups listed for Horse Creek were represented by at least one species in Brushy Creek. More species of insects were collected than any other group. Shirttail Branch was inhabited by relatively large numbers of oligochaete and mollusc species, along with a moderate number of insect species. Many of the insects found in Doe Branch during August 1981 were not dipterans, which were the dominant insect group at most stations. Various mayflies, dragonflies, beetles, and other insect groups were represented in Doe Branch, as well as several dipterans. Several species of the ubiquitous oligochaetes were found, as well as some crustaceans (Table 8.1.4-29). Epifaunal populations in Plunder Branch were similar to those in Doe

Branch, except that more species of molluscs and dipterans were found in Doe Branch during August 1981.

September 1981

Large numbers of epifaunal species were collected from the six stations sampled during September 1981 (Table 8.1.4-30). The majority of the species collected at all stations were insects. Various species of oligochaete worms were found at each station; Coon's Bay Branch and Horse Creek had the fewest species, and Plunder Branch had the most species of oligochaetes. Leeches were found in Brushy Creek, Doe Branch, Plunder Branch, and Shirttail Branch. Various molluscs were collected at all stations except Coon's Bay Branch; Doe Branch supported the most species. At least one species of crustacean was found at every station sampled during September 1981. Eight types of crustaceans were collected from Shirttail Branch; these included cladocerans, ostracods, copepods, isopods, shrimp, and crayfish (Table 8.1.4-30). A lesser number of crustacean types was found at the other stations. A large number of insect species was found at each station sampled. Insect orders represented in the collections included Collembola (springtails), Ephemeroptera (mayflies), Odonata (dragonflies and damselflies), Hemiptera (bugs), Lepidoptera (moths and butterflies), Coleoptera (beetles), Trichoptera (caddisflies), and Diptera (flies and mosquitoes).

October 1981

Each of the eight stations sampled in October 1981 was inhabited by a variety of epifaunal species (Table 8.1.4-31). Oligochaete worms and insects were the dominant groups, in terms of number of species, at all stations. Plunder Branch and Doe Branch were inhabited by the largest variety of tubificid and naidid oligochaetes; the central Horse Creek station produced only immature worms. No molluscs were collected from Brushy Creek 2 or Horse Creek Middle, while Doe Branch samples contained several species of bivalves and gastropods. Crustaceans were collected at every station sampled during October 1981. Crayfish were found at

every station, amphipods were found at five of the eight stations, and other crustacean groups were represented at four or fewer stations. Large numbers of insect species were collected at most of the stations sampled during October 1981 (Table 8.1.4-31). Insect orders represented included Collembola, Ephemeroptera, Odonata, Hemiptera, Coleoptera, Trichoptera, Lepidoptera, and Diptera. Each station had its own, different insect community, composed of a unique combination of species belonging to these orders. The community at each station was established in response to a large number of abiotic and biotic factors which combined to create a unique environment at each location sampled.

February 1982

A presence/absence matrix of the invertebrate epifaunal taxa collected from the eight stations sampled during February 1982 is presented in Table 8.1.4-32. As was the case during preceding sampling efforts, naidid and tubificid oligochaetes and insects were the most abundant groups represented. The greatest number of oligochaete species was found in Plunder Branch, while Horse Creek North and Shirttail Branch samples did not contain any oligochaetes. Leeches were found in Brushy Creek, Doe Branch, and Horse Creek North. Bivalve and gastropod molluscs were found in Brushy Creek, Doe Branch, Horse Creek Middle, Plunder Branch, and Shirttail Branch. At least one species of crustacean was found at every station except Horse Creek North. Cladocera, copepods, isopods, amphipods, and crayfish were the crustacean groups represented in the February 1982 collections. There were more insect species collected at each station than species of any other group. Orders of insects represented in the samples included Collembola, Ephemeroptera, Odonata, Hemiptera, Lepidoptera, Coleoptera, Trichoptera, and Diptera. There was a different species mix at each station, established in response to the different environmental factors present.

Hester-Dendy multiplate samplers were submerged in July 1981 and retrieved approximately 4 weeks later in August 1981, and were colonized by a wide variety of organisms (Table 8.1.4-33). Hester-Dendy samplers deployed at Brushy Creek were numerically dominated by nematodes (44 percent). Oligochates, principally naidids, and insects comprised the majority of the remaining taxa. Samplers placed in Doe Branch were numerically dominated by insect taxa (64 percent). The dominant insects were the chironomids, Polypedilum illinoense (17.3 percent) and Nembocera sp. (32.7 percent). Naidid oligochaetes comprised an additional 18 percent of the fauna which colonized the substrates. Horse Creek samplers were dominated by naidid oligochaetes (71 percent), particularly Haemonais waldvogeli (46.1 percent). Insects, principally chironomids, comprised an additional 23 percent of the organisms. In Plunder Branch the naidid oligochaete Bratislavia unidentata accounted for 58.4 percent of the organisms found on Hester-Dendy samplers; insects, principally chironomids, accounted for an additional 25 percent of the organisms. Seven mollusc taxa were identified from Plunder Branch samplers. Shirttail Branch samplers were dominated by Chironomus spp. and Dero vaga which accounted for 30.8 percent and 20.5 percent of all organisms, respectively.

Hester-Dendy samplers were deployed in August 1981 and retrieved in September 1981 (Table 8.1.4-34). Ninety-seven percent of the fauna which colonized the samplers in Brushy Creek were oligochaetes. These were principally naidid species, with Dero trifida accounting for 74.1 percent of all organisms. Doe Branch samplers were codominated by oligochaetes (45 percent) and insects (42 percent). Immature tubificids were the most common oligochaete (31 percent), and Chironomus sp. (12 percent) and Nembocera sp. (12.4 percent) were the most common insects. Hester-Dendy samplers in Horse Creek were colonized predominantly by insect taxa (73 percent), with Chironomus spp. accounting for 47 percent. Naidid oligochaetes accounted for an additional 27 percent of the organisms. Plunder Branch samplers were dominated by B. unidentata (66 percent) as in the previous sample

period. Oligochaetes as a group comprised 79 percent of the organisms on Plunder Branch Hester-Dendy samplers, and insects comprised 15 percent. Thirty-three taxa colonized Hester-Dendy samplers in Shirttail Branch. No one taxa heavily dominated the collection; the gastropods Laevapex sp. and Helisoma sp. were most common, equalling 19.4 percent and 17.7 percent of all organisms.

The final Hester-Dendy sampling period was from September 1981 to October 1981 (Table 8.1.4-35). The samplers placed in Doe Branch were colonized predominantly by insect taxa (83 percent), with the dominant organism the ceratopogonid Palpomyia sp. (40.4 percent). Naidid oligochaetes accounted for the remaining 17 percent of the organisms. Samplers in Doe Branch were more evenly colonized with naidid oligochaetes (23 percent), molluscs (13 percent), arachnids (8 percent), crustaceans (4 percent), and insects (50 percent), and no one species numerically dominated the collection. Ninety-three percent of the organisms which colonized Hester-Dendy samplers deployed in Horse Creek were insects. Chironomus spp. were the most prevalent, accounting for 57.3 percent of all organisms. Naidid oligochaetes equalled 6 percent of the organisms. Plunder Branch samples were comprised of 70 percent insects and 22 percent naidid oligochaetes. Laevapex sp. (21.4 percent) was again the most common animal on Hester-Dendy samplers in Shirttail Branch.

Shannon-Weaver diversity calculated for Hester-Dendy collections ranged from 1.54 to 4.45 over all sites and collections (Table 8.1.4-36). Diversity was generally highest for samplers deployed from September 1981 to October 1981 which resulted primarily from an increase in species richness. The lowest value (1.54) recorded for Brushy Creek in August 1981 to September 1981 resulted from both low species richness and low evenness components.

In February 1982, core and dipnet samples were collected in Mitchell Hammock to provide baseline data on benthos of a "nonflowing" system.

Sampling by both core and dipnet resulted in the collection of 92 benthic macroinvertebrate taxa (Table 8.1.4-37). Dipnet samples collected 82 of the total taxa, while core samples collected 46 of the total taxa. Forty-five taxa were collected only in dipnets. The number of taxa per station ranged from 24 to 60. Within Mitchell Hammock as a whole, Coleoptera, Diptera and Oligochaete were the dominant taxa collected, representing 28.6 percent, 24.2 percent, and 17.6 percent, respectively, of the total taxa collected.

Epifaunal invertebrates collected from the CF Hardee Phosphate Complex II site were predominantly oligochaete worms, molluscs, crustaceans, and insects. The majority of the animals collected were insects; tubificid and naidid oligochaetes formed the second most abundant group found at most stations during most sampling trips. Many more epifaunal species were collected from each station than infaunal species. This diversity difference is to be expected, and is usually due to the wide variety of habitat types available to epifauna.

8.1.4.5 FISH

Fish are an important component of freshwater ecosystems and an integral part of food webs. They are consumers of phytoplankton and benthos and serve as food for higher trophic levels, including birds and man. Cyprinodontidae (killifishes and topminnows) and Centrarchidae (sunfishes and basses) are the most important freshwater fish families in Florida. A comparatively large number of exotic species are established in the state's waters, and there is significant penetration of marine fishes into Florida's freshwater habitat.

At least 21 species of fish and 2 species of amphibians were collected on the CF Hardee Phosphate Complex II site between August 1981 and February 1982 (Table 8.1.4-37). Direct, quantitative comparisons between stations and sampling trips cannot be made, due to the relatively limited, qualitative sampling efforts. In addition, all stations were not sampled during each sampling trip due to water level conditions.

Most of the fish collected belonged to one of four families. Representatives of the Centrarchidae included several species of sunfish (Elassoma evergladei, Everglades pygmy sunfish; Lepomis macrochirus, bluegill; L. marginatus, dollar sunfish; and L. punctatus, spotted sunfish), warmouth (Chaenobryttus gulosus), and largemouth bass (Micropterus salmoides). Catfish species collected included the native brown and yellow bullheads (Ictalurus nebulosus and I. natalis), and the tadpole madtom (Notorus gyrinus), as well as the exotic walking catfish (Clarias batrachis). Members of the Poeciliidae, or livebearer family, found on the property included the sailfin molly (Poecilia latipinna), mosquitofish (Gambusia affinis), and least killifish (Heterandria formosa). The fourth family represented by several species was the killifish family, Cyprinodontidae. The flagfish (Jordanella floridae), bluefin killifish (Lucania goodei), and a killifish (Fundulus sp.), are members of the Cyprinodontidae family which were collected on the site.

The fish species collected on the site can be roughly divided into two habitat-associated assemblages. The areas characterized by soft bottoms, sluggish flow, dense aquatic vegetation, and periodic low dissolved oxygen are inhabited primarily by groups such as the livebearers. These types of fish are generally small and find refuge in aquatic vegetation. They are tolerant of low dissolved oxygen levels and, because they are livebearers, their reproductive success is not dependent upon substrate type.

The second habitat type is characterized by more open, flowing water; sandy bottoms; and fewer periods of low dissolved oxygen. These areas favor the survival of the larger predatory species such as centrarchids. The greater flow in these water bodies leads to a more scoured, sandy bottom, which is conducive to nest building by egg-laying species.

8.1.5 SUMMARY

The aquatic communities on the CF Industries Hardee Phosphate Complex II site were examined between July 1981 and February 1982. The communities studied included phytoplankton, periphyton, benthic infauna, epifauna, and fish. Sampling stations were located in Horse Creek, Brushy Creek, Shirttail Branch, Doe Branch, Plunder Branch, Coon's Bay Branch, and Mitchell Hammock.

In areas of extensive marsh with intermittent flooding, rooted vascular plants are the major primary producers and the importance of phytoplankton is diminished. However, periphyton and epifauna may attach to the plant stems and the substrate. Several genera of diatoms were usually the dominant or codominant algae in these shallow areas. Areas with permanent water receiving organic loading were characterized by cryptophytes, chlorophytes, and euglenophytes.

Benthic infaunal populations were numerically dominated by a relatively limited variety of organisms. Tubificid oligochaetes, especially Limnodrilus hoffmeisteri, were ubiquitous during all sampling periods. Larval chironomids (midges) usually comprised the remainder of the samples. Epifaunal populations contained more species than infaunal populations, due to the wider diversity of habitats utilized by epifaunal organisms. Major groups represented included naidid oligochaetes, molluscs, crustaceans, and insects. Several orders of insects were normally represented in the epifauna of each station. Dipterans were usually the most numerous insects collected.

Most of the fish species collected belonged to the sunfish, catfish, livebearer, and killifish families. Areas characterized by soft bottoms, sluggish flow, dense aquatic vegetation, and periodic low dissolved oxygen were inhabited primarily by the smaller livebearers and killifish. Areas with more open, flowing water; sandy bottoms; and fewer periods of low dissolved oxygen were inhabited by larger, predatory forms such as sunfish.

Table 8.1.4-1 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, July, 1981 (Page 1 of 2)

	BC	DB	HC	PB	SB
CYANOPHYTA					
ANACYSTIS SP.		X	X		
LYNGBIA SP.		X			
OSCILLATORIA SP.	X	X	X	X	
OSCILLATORIA GEMINATA		X			
ANABAENA SP.	X		X		
CHLOROPHYTA					
CHLAMYDOMONAS SP.	X	X	X	X	X
CARTERIA SP.			X		
EUDORINA SP.	X				X
PTEROMONAS SPP.	X			X	
CLOSTERIUM SP.	X		X		
COSMARIUM SP.		X	X		
ACTINASTRUM SP.	X				
SCENEDESMUS SP.	X		X	X	
SCENEDESMUS ACUTIFORMIS	X				
CRUCIGENIA SP.			X		
ANKISTRODESMUS SP.	X	X	X	X	
TETRAEDRON SP.					X
SCHRODERIA SETIGERA		X			
KIRCHNERIELLA SPP					X
ELAKATOTHRIX SP.		X			
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	X				
UNIDENTIFIED FLAGELLATED GREEN ALGAE	X	X	X	X	X
EUGLENOPHYTA					
PHACUS SP.	X	X	X	X	X
PHACUS ACUMINATA	X			X	
EUGLENA SP.			X	X	X
EUGLENA ACUS			X	X	
EUGLENA GRACILIS	X		X	X	X
LEPOCINCLIS SP.	X	X			X
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR				X	
LEPOCINCLIS FUSIFORMIS				X	
TRACHELOMONAS SP.				X	X
TRACHELOMONAS VOLVOCINA	X	X	X	X	X
TRACHELOMONAS HISPIDA				X	X
TRACHELOMONAS SUBERBA				X	
CHRYSOPHYTA					
DINOBRYON SP.	X				
OCHROMONAS SP.				X	
UROGLENOPSIS SPP.					X
MALLOMONAS SP.	X				

Table 8.1.4-1 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, July, 1981 (Continued, Page 2 of 2)

	BC	DB	HC	PB	SB
SYNURA SP.	X		X	X	
CHRYSAMOEBA SP.		X	X		
UNID. FLAG. CHRYSOPHYTE					X
CRYPTOPHYTA CRYPTOPHYCEAE					
CHROOMONAS SP.		X			X
CHROOMONAS SALINA				X	
CHROOMONAS NORDSTEDTII	X		X	X	
CRYPTOMONAS SP.	X	X	X		X
BACILLARIOPHYCEAE					
CYCLOTELLA SP.	X	X		X	X
MELOSIRA SP.	X		X	X	
FRAGILARIA SP.		X			
FRAGILARIA CROTONENSIS	X				
SYNEDRA SP.	X	X	X		X
ACHNANTHES SP.		X		X	X
COCCONEIS, SP.				X	
NAVICULA SP.	X	X		X	X
NAVICULA CONFERVACEA	X	X			X
PINNULARIA SP.	X	X			X
CYMBELLA SP.				X	X
GOMPHONEMA SP.	X	X			X
GOMPHONEMA PARVULA		X			
RHOPALODIA GIBBA				X	
EUNOTIA SP.	X	X	X	X	X
NITZSCHIA SP.	X	X	X	X	X
NITZSCHIA PALEA		X		X	
PYRROPHYTA					
GYMNODINIUM SP.	X				
GLENODINIUM SP.	X		X	X	X
PERIDINIUM SP.	X				
PERIDINIUM INCONSPICUUM	X		X		

Key to Stations: HN = Horse Creek North
HM = Horse Creek Middle
HS = Horse Creek South
BC = Brushy Creek
SB = Shirttail Branch
DB = Doe Branch
PB = Plunder Branch
CB = Coon's Bay Branch
M1-M4 = Mitchell Hammock Transect 1 through 4

Source: ESE, 1983

Table 8.1.4-2 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex Site II, August, 1981 (Page 1 of 2)

	BC	DB	HC	PB	SB
CYANOPHYTA					
LYNGBIA SP.		X		X	
OSCILLATORIA GEMINATA					X
ANABAENA SP.	X	X	X	X	X
CHLOROPHYTA					
CHLAMYDOMONAS SP.	X	X	X	X	X
CARTERIA SP.			X		
CHLOROGONIUM SP.	X				
EUDORINA SP.		X	X	X	
PTEROMONAS SPP.	X		X	X	X
MOUGEOTIA SP.		X	X		
CLOSTERIUM SP.		X	X		X
DESMIDIUM SPP.			X		
PEDIASTRUM SP.		X			
SCENEDESMUS SP.	X	X	X		
CRUCIGENIA SP.			X		X
ANKISTRODESMUS SP.	X	X	X	X	
SELENASTRUM SP.	X				
CLOSTERIOPSIS SP.					X
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED				X	
UNIDENTIFIED FLAGELLATED GREEN ALGAE		X	X	X	X
EUGLENOPHYTA					
PHACUS SP.	X	X	X	X	X
PHACUS ACUMINATA	X	X	X		
PHACUS LONGICAUDA	X				
PHACUS TORTUS	X				
EUGLENA SP.			X	X	X
EUGLENA ACUS				X	
EUGLENA GRACILIS	X	X		X	
LEPOCINCLIS SP.				X	
LEPOCINCLIS FUSIFORMIS	X	X		X	
TRACHELOMONAS SP.	X	X	X	X	X
TRACHELOMONAS VOLVOCINA	X			X	X
TRACHELOMONAS HISPIDA				X	
TRACHELOMONAS ARMATA	X				
TRACHELOMONAS PULCHERRIMA	X			X	X
CHRYSOPHYTA					
DINOBRYON SP.	X				
MALLOMONAS SP.	X	X	X	X	
SYNURA SP.		X	X	X	
CRYPTOPHYTA CRYPTOPHYCEAE					

Table 8.1.4-2 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex Site II, August, 1981 (Continued, Page 2 of 2)

	BC	DB	HC	PB	SB
CHROOMONAS SP.	X	X	X		X
CHROOMONAS NORDSTEDTII	X			X	
CRYPTOMONAS SP.	X	X	X	X	
BACILLARIOPHYCEAE					
CYCLOTELLA SP.		X	X		
MELOSIRA SP.		X			X
MELOSIRA VARIANS			X		
SYNEDRA SP.		X			
ACHNANTHES SP.		X	X	X	X
ACHNANTHES EXIGUA		X			
FRUSTULIA SP.		X	X		X
NAVICULA SP.	X	X	X	X	X
NAVICULA PUPULA		X			
NAVICULA CONFERVACEA		X			X
PINNULARIA SP.	X	X			X
PINNULARIA BRAUNII		X			
CARPATOGRAMMA SPP.		X			
CYMBELLA SP.		X			X
GOMPHONEMA SP.		X			X
GOMPHONEMA ANGUSTATUM		X			
RHOPALODIA GIBBA		X			
EUNOTIA SP.		X			X
NITZSCHIA SP.		X	X	X	X
NITZSCHIA PALEA	X		X		
PYRROPHYTA					
GLENODINIUM SP.	X		X	X	

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Source: ESE, 1983

Table 8.1.4-3 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, September, 1981 (Page 1 of 2)

	BC	CB	DB	HC	PB	SB
CYANOPHYTA						
OSCILLATORIA SP.	X		X		X	
OSCILLATORIA GEMINATA	X		X		X	
ANABAENA SP.				X		
CHLOROPHYTA						
CHLAMYDOMONAS SP.	X		X	X	X	X
CHLOROGONIUM SP.			X			
PTEROMONAS SPP.	X		X	X		X
MOUGEOTIA SP.	X					
CLOSTERIUM SP.	X			X		X
COSMARIUM SP.				X		
HYALOTAECA SP.				X		
EUASTRUM SPP.				X		
SCENEDESMUS SP.				X	X	
SCENEDESMUS BIJUGA				X		
SCENEDESMUS DENTICULATUS				X		
OOCYSTIS SP.			X	X		
ANKISTRODESMUS SP.	X		X		X	
ANKISTRODESMUS FALCATUS				X		X
SELENASTRUM SP.					X	
TETRAEDRON MINIMUM				X		
SCHRODERIA SETIGERA			X			
CLOSTERIOPSIS SP.				X		
CHLOROCOCCUM SPP.	X		X	X	X	X
UNIDENTIFIED FLAGELLATED GREEN ALGAE		X		X		X
EUGLENOPHYTA						
PHACUS SP.	X	X	X	X	X	X
EUGLENA SP.	X		X	X		
LEPOCINCLIS SP.	X					
TRACHELOMONAS SP.	X		X	X	X	
CHRYSOPHYTA						
DINOBRYON SP.			X			
MALLOMONAS SP.	X		X	X		
SYNURA SP.	X		X			
CHRYSAMOEBA SP.		X				
UNID. FLAG. CHRYSOPHYTE	X		X		X	
CRYPTOPHYTA CRYPTOPHYCEAE						
CHROOMONAS SP.	X		X	X	X	X
CRYPTOMONAS SP.	X	X	X	X		
BACILLARIOPHYCEAE						

Table 8.1.4-3 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, September, 1981 (Continued, Page 2 of 2)

	BC	CB	DB	HC	PB	SB
CYCLOTELLA SP.		X		X	X	X
MELOSIRA SP.		X		X	X	X
MELOSIRA VARIANS					X	
FRAGILARIA SP.				X		
SYNEDRA SP.	X	X	X	X	X	
ACHNANTHES SP.	X	X	X	X	X	X
COCCONEIS PLACENTULA					X	
DIPLONEIS SP.					X	
FRUSTULIA SP.			X	X	X	X
NAVICULA SP.		X	X		X	X
NAVICULA CONFERVACEA					X	X
PINNULARIA SP.		X	X	X	X	
NEIDIUM SP.					X	
CYMBELLA SP.			X			
GOMPHONEMA SP.			X		X	X
EPITHEMIA SP.					X	
RHOPALODIA GIBBA					X	
EUNOTIA SP.	X	X	X	X	X	X
HANTZSCHIA SP.					X	
NITZSCHIA SP.	X	X	X	X	X	X
PYRROPHYTA						
GLENODINIUM SP.			X			

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Source: ESE, 1983.

Table 8.1.4-4 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, October, 1981 (Page 1 of 2)

	BC	DB	HS	HM	HN	PB	SB
CYANOPHYTA							
ANACYSTIS SP.	X						
HYDROCOLEUM SP.	X						
OSCILLATORIA SP.	X	X		X			
OSCILLATORIA GEMINATA		X					X
UNIDENTIFIED FILAMENTOUS BLUE-GREEN				X			
CHLOROPHYTA							
CHLAMYDOMONAS SP.	X	X	X	X	X	X	
CARTERIA SP.				X			
CHLOROGONIUM SP.					X		
PANDORINA SP.					X		
PTEROMONAS SPP.				X	X		
SPIROGYRA SP.			X				
MOUGEOTIA SP.	X	X	X	X			
CLOSTERIUM SP.	X		X	X	X		
STAURASTRUM SP.		X					
COSMARIUM SP.				X			
HYALOTAECA SP.			X				
SCENEDESMUS SP.	X	X	X	X	X		
COELASTRUM SP.					X		
ANKISTRODESMUS SP.	X		X	X	X	X	X
TETRAEDRON MINIMUM				X	X		
QUADRIGULA SP.			X				
CLOSTERIOPSIS SP.			X	X	X		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	X			X	X		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	X			X	X	X	
EUGLENOPHYTA							
PHACUS SP.	X	X	X	X	X	X	X
PHACUS ACUMINATA						X	
EUGLENA SP.	X	X	X	X	X	X	X
EUGLENA ACUS						X	X
LEPOCINCLIS SP.						X	
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR		X				X	X
TRACHELOMONAS SP.	X		X	X	X	X	X
TRACHELOMONAS VOLVICINA		X	X			X	X
TRACHELOMONAS HISPIDA						X	
TRACHELOMONAS CYLINDRICA						X	
CHRYSOPHYTA							
DINOBRYON SP.			X				
MALLOMONAS SP.				X	X		
SYNURA SP.		X	X	X	X		
UNID. FLAG. CHRYSOPHYTE		X	X		X		

Table 8.1.4-4 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, October, 1981 (Continued, Page 2 of 2)

	BC	DB	HS	HM	HN	PB	SB
CRYPTOPHYTA CRYPTOPHYCEAE							
CHROOMONAS SP.	X	X	X	X	X	X	X
CRYPTOMONAS SP.		X	X	X	X	X	X
CRYPTOMONAS MARSONII		X				X	
CRYPTOMONAS OVATA		X				X	
BACILLARIOPHYCEAE							
CYCLOTELLA SP.		X		X	X	X	X
MELOSIRA SP.			X	X			
MELOSIRA ISLANDICA	X						
FRAGILARIA SP.		X					
SYNEDRA SP.	X	X	X	X	X		
SYNEDRA ULNA				X	X		
ACHNANTHES SP.	X	X	X	X	X		
COCCONEIS SP.						X	
FRUSTULIA RHOMBOIDES VAR CAPITATA			X				
FRUSTULIA SP.	X				X		
NAVICULA SP.		X	X	X	X		
NAVICULA CONFERVACEA	X	X	X	X	X		
PINNULARIA SP.	X		X	X	X	X	
AMPHORA SP.					X		
CYMBELLA SP.			X	X	X		
GOMPHONEMA SP.		X					X
EUNOTIA SP.	X	X	X	X	X		
NITZSCHIA SP.	X	X	X	X	X	X	
PYRROPHYTA							
GYMNODINIUM SP.				X		X	
GLENODINIUM SP.	X	X		X			X
GLENODINIUM QUADRIDENS							X
UNIDENTIFIED EPIPHYTE	X						

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CB = Coon's Bay Branch
M1-M4 = Mitchell Hammock Transect 1 through 4

Source: ESE, 1983

Table 8.1.4-5 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, February, 1982 (Page 1 of 3)

	BC	CB	DB	HS	HM	HN	M1	M2	M3	M4	PB	SB
CYANOPHYTA												
ANACYSTIS INCERTA							x					
COCCOCHLORIS SP.							x					
LYNGBIA SP.							x			x		
OSCILLATORIA SP.		x	x				x					
ANABAENA SP.			x				x					
SCYTONEMA SPP							x					
UNIDENTIFIED FILAMENTOUS BLUE-GREEN												x
CHLOROPHYTA												
CHLAMYDOMONAS SP.	x	x	x	x	x	x	x	x	x	x	x	x
CHLOROGONIUM SP.	x											
EUDORINA SP.	x	x	x	x	x			x			x	x
PANDORINA SP.	x							x				
PTEROMONAS SPP.	x			x	x	x		x	x			x
MOUGEOTIA SP.							x		x			
CLOSTERIUM SP.	x					x	x			x		
STAURASTRUM SP.	x											
COSMARIUM SP.						x						
OEDOGONIUM SPP.										x		x
ACTINASTRUM HANTZSCHII						x						
SCENEDESMUS SP.	x			x	x	x			x			
CRUCIGENIA SP.					x	x						
CRUCIGENIA CRUCIFERA				x								
COELASTRUM SP.				x								
COELASTRUM SPHAERICUM				x								
MICRACTINIUM SP.				x		x						
OOCYSTIS SP.	x											
ANKISTRODESMUS SP.			x	x			x	x				
ANKISTRODESMUS FALCATUS	x				x	x			x			
ANKISTRODESMUS CONTORTUS	x				x	x			x			
TETRAEDRON MINIMUM				x	x	x						
SCHRODERIA SETIGERA				x								
CLOSTERIOPSIS LONGISSIMA					x							
KIRCHNERIELLA SPP	x					x						
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	x	x			x							x
UNIDENTIFIED FLAGELLATED GREEN ALGAE					x							
EUGLENOPHYTA												
PHACUS SP.	x		x	x	x	x	x		x	x	x	x
PHACUS ACUMINATA	x			x				x		x		x
PHACUS TORTUS	x											x
PHACUS CF. CRITICULARIS												x
EUGLENA SP.	x	x	x	x		x			x	x	x	x
EUGLENA ACUS	x			x	x	x	x				x	x

Table 8.1.4-5 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, February, 1982 (Continued, Page 2 of 3)

	HC	CB	DB	HS	HM	HN	M1	M2	M3	M4	PB	SB
LEPOCINCLIS SP.									x	x		
LEPOCINCLIS FUSIFORMIS	x					x						x
TRACHELOMONAS SP.							x	x				
TRACHELOMONAS VOLVOCINA	x	x	x	x	x	x			x	x	x	x
TRACHELOMONAS HISPIDA	x				x	x						
TRACHELOMONAS CYLINDRICA	x									x		x
TRACHELOMONAS ARMATA	x											
CHRYSOPHYTA												
OPHIOCYTIUM SP.	x				x		x					
DINOBRYON SP.										x		
EBRIA SP.				x								
MALLOMONAS SP.	x		x	x	x	x			x	x	x	
SYNURA UVELLA			x	x				x		x		x
SYNURA UVELLA (SINGLE CELLS)	x			x	x	x		x	x	x	x	x
CRYPTOPHYTA CRYPTOPHYCEAE												
CHROOMONAS SP.	x	x	x		x		x	x	x	x		x
CHROOMONAS NORDSTEDTII	x	x	x	x	x	x			x		x	x
CRYPTOMONAS SP.	x	x	x	x	x	x	x	x	x	x	x	x
CRYPTOMONAS EROSA								x				
BACILLARIOPHYCEAE												
CYCLOTELLA SP.	x			x	x	x					x	x
MELOSIRA SP.	x		x	x	x		x	x	x			
MELOSIRA GRANULATA	x				x							
MELOSIRA ISLANDICA		x										
MELOSIRA ITALICA					x						x	x
SYNEDRA SP.	x	x		x	x	x	x	x	x	x	x	x
SYNEDRA ULNA	x		x				x	x				
ACHNANTHES SP.	x	x			x					x	x	x
ACHNANTHES EXIGUA			x									
ACHNANTHES HUNGARICA		x	x				x					
FRUSTULIA RHOMBOIDES	x								x	x		
NAVICULA SP.		x	x		x				x	x	x	
NAVICULA PUPULA						x						
NAVICULA CONFERVACEA		x	x	x			x				x	x
PINNULARIA SP.	x	x	x	x			x	x	x	x		
PINNULARIA ACROSPHAERIA			x	x								
STAURONEIS SP.			x									
CYMBELLA SP.			x				x				x	
GOMPHONEMA SP.	x		x				x					
GOMPHONEMA GRACILE			x				x					
EPITHEMIA SP.											x	
LUNOTIA SP.	x	x	x	x			x	x		x		x

Table 8.1.4-5 Presence/Absence Matrix of Phytoplankton Taxa Identified From CF Complex II Site, February, 1982 (Continued, Page 3 of 3)

	BC	CB	DB	HS	HM	HN	M1	M2	M3	M4	PB	SB
EUNOTIA PECTINALIS (INCL. VARIETIES)			x					x				
EUNOTIA CURVATA	x	x		x						x		x
EUNOTIA FLEXUOSA/CURVATA							x					
NITZSCHIA SP..	x	x	x	x	x	x	x	x	x	x	x	x
NITZSCHIA PARVULA		x										
PYRROPHYTA												
GLENODINIUM SP.	x				x	x			x			x
PERIDINIUM SP.				x			x					
UNIDENTIFIED PHYTOFLAGELLATES	x		x	x			x	x	x	x	x	
UNIDENTIFIED COCCOID COLONIES	x			x	x					x		
UNIDENTIFIED COCCOIDS				x						x		

Key to Stations: HN = Horse Creek North
HM = Horse Creek Middle
HS = Horse Creek South
BC = Brushy Creek
SB = Shirttail Branch
DB = Doe Branch
PB = Plunder Branch
CB = Coon's Bay Branch
M1-M4 = Mitchell Hammock Transect 1 through 4

Source: ESE, 1983

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981

	BC		DB	
	#/ML	PCT	#/ML	PCT
CHRYSOPHYTA				
DINOBRYON SP.	3.53	0.18		
OCHROMONAS SP.				
URO GLENOPSIS SPP.				
MALLOMONAS SP.	28.26	1.48		
SYNURA SP.	24.72	1.29		
CHRYSAMOEBA SP.				
UNID. FLAG. CHRYSOPHYTE			7.06	0.34
	57	3	7	0
CRYPTOPHYTA CRYPTOPHYCEAE				
CHROOMONAS SP.			21.19	1.02
CHROOMONAS SALINA				
CHROOMONAS NORDSTEDTII	42.38	2.21		
CRYPTOMONAS SP.	7.06	0.37	24.72	1.19
	49	3	46	2
BACILLARIOPHYCEAE				
CYCLOTELLA SP.	14.13	0.74	11.59	0.51
MELOSIRA SP.	123.17	6.27		
FRAGILARIA SP.			14.13	0.68
FRAGILARIA CROTONENSIS	17.66	0.92		
SYNEDRA SP.	39.85	2.03	180.15	8.70
ACHNANTHES SP.			67.11	3.24
COCCONEIS SP.				
NAVICULA SP.	10.59	0.55	109.53	5.29
NAVICULA CONFERVACEA	10.59	0.55	657.04	31.74
PINNULARIA SP.	24.72	1.29	7.06	0.34
CYMBELLA SP.				
GOMPHONEMA SP.	7.06	0.37	7.06	0.34
GOMPHONEMA PARVULA			24.72	1.19
RHOPALODIA GIBBA				
EUNOTIA SP.	10.59	0.55	38.89	1.88
NITZSCHIA SP.	105.97	5.54	52.98	2.56
NITZSCHIA PALEA			17.66	0.85
	76	19	1,187	57
PYRROPHYTA				
GYMNODINIUM SP.	272.01	14.21		
GLENODINIUM SP.	17.66	0.92		
PERIDINIUM SP.	3.53	0.18		
PERIDINIUM INCONSPICUUM	3.53	0.18		
	297	15		
	1,914	100	2,171	100

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981 (page 2 of 8)

	BC		DB	
	#/ML	PCT	#/ML	PCT
CYANOPHYTA				
ANACYSTIS SP.			3.53	0.17
LYNGBYA SP.			74.18	3.58
OSCILLATORIA SP.	28.25	1.46	459.22	22.19
OSCILLATORIA GEMINATA			14.13	0.68
ANABAENA SP.	24.72	1.29		
	53	3	551	27
CHLOROPHYTA				
CHLAMYDOMONAS SP.	681.77	35.61	204.88	9.90
CARTERIA SP.				
CHLORELLA SP.	7.06	0.37		
PTEROMONAS SPP.	3.53	0.18		
CLOSTERIUM SP.	3.53	0.19		
COSMARIUM SP.			3.53	0.17
ACTINASTRUM SP.	3.53	0.18		
SCENEDESMUS SP.	7.06	0.37		
SCENEDESMUS ACUTIFORMIS	45.92	2.40		
CROCIGENIA SP.				
ANKISTRODESMUS SP.	3.53	0.19	21.19	1.02
TETRAEDRON SP.				
SCHROEDERIA SETIGERA			3.53	0.17
KIRCHNERIELLA SPP				
ELAKATOTHRIX SP.			7.06	0.34
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	105.97	5.54		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	134.23	7.01	17.66	0.85
	94	52	258	12
EUGLENOPHYTA				
PHACUS SP.	31.79	1.66	10.59	0.51
PHACUS ACUMINATA	7.06	0.37		
EUGLENA SP.				
EUGLENA ACUS				
EUGLENA GRACILIS	3.53	0.18		
LEPOCINCLIS SP.	10.59	0.55	3.53	0.17
LEPOCINCLIS FUSIFORMIS VAR. MAJOR				
LEPOCINCLIS FUSIFORMIS				
TRACHELOMONAS SP.				
TRACHELOMONAS VOLVOCINA	49.45	2.58	7.06	0.34
TRACHELOMONAS HISPIDA				
TRACHELOMONAS SUPERBA				
	102	5	21	1

Table 8.1.4-6 Density (#/ml) and Percent Compositon (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981 (page 3 of 8)

	HS	
	#/ML	PCT
CYANOPHYTA		
ANACYSTIS SP.	3.53	.19
LYNGBIA SP.		
OSCILLATORIA SP.	52.98	1.52
OSCILLATORIA GEMINATA		
ANABAENA SP.	1971.13	56.69
	2028	58
CHLOROPHYTA		
CHLAMYDOMONAS SP.	480.42	13.79
CAPTERIA SP.	10.59	0.30
EUDORINA SP.		
PTEROMONAS SPP.		
CLOSTERIUM SP.	3.53	0.10
COSMARIUM SP.	3.53	0.10
ACTINASTRUM SP.		
SCENEDESMUS SP.	21.19	0.61
SCENEDESMUS ACUTIFORMIS		
CRUCIGENIA SP.	10.59	0.30
ANKISTRODESMUS SP.	49.45	1.42
TETRAEDRON SP.		
SCHROEDERIA SETIGERA		
KIRCHNERIELLA SPP		
ELAKATOTHRIX SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	141.36	4.06
	728	21
EUGLENOPHYTA		
PHACUS SP.	3.53	0.10
PHACUS ACUMINATA		
EUGLENA SP.	24.72	0.71
EUGLENA ACUS	3.53	0.10
EUGLENA GRACILIS	7.06	0.20
LEPOCINCLIS SP.		
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR		
LEPOCINCLIS FUSIFORMIS		
TRACHELOMONAS SP.		
TRACHELOMONAS VOLVOCINA	99.93	2.84
TRACHELOMONAS HISPIDA		
TRACHELOMONAS SUPERBA		
	139	4

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981
(page 4 of 8)

	SB	
	#/ML	PCT
CHRYSOPHYTA		
DINOBRYON SP.		
OCHROMONAS SP.		
URO GLENOPSIS SPP.	30.72	4.55
MALLOMONAS SP.		
SYNURA SP.		
CHRYSAMOEBA SP.		
UNID. FLAG. CHRYSOPHYTE	5.48	0.97
	36	6
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	82.42	13.59
CHROOMONAS SALINA		
CHROOMONAS NORDSTEDTII		
CRYPTOMONAS SP.	12.05	2.13
	95	16
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	3.53	0.58
MELOSIRA SP.		
FRAGILARIA SP.		
FRAGILARIA CROTONENSIS		
SYNEDRA SP.	5.30	0.87
ACHNANTHES SP.	2.64	0.48
COCCONEIS SP.		
NAVICULA SP.	7.65	1.26
NAVICULA CONFERVACEA	8.83	1.46
PINNULARIA SP.	1.17	0.19
CYMBELLA SP.	1.17	0.19
GOMPHONEMA SP.	1.76	0.29
GOMPHONEMA PARVULA		
RHOPALODIA GIBBA		
EUNOTIA SP.	2.94	0.48
NITZSCHIA SP.	22.96	3.79
NITZSCHIA PALEA		
	68	11
PYRROPHYTA		
GYMNODINIUM SP.		
GLENODINIUM SP.	7.65	1.26
PERIDINIUM SP.		
PERIDINIUM INCONSPICUUM		
	8	1
	47	10

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981 (page 5 of 8)

	SB	
	#/ML	PCT
CYANOPHYTA		
ANACYSTIS SP.		
LYNGBIA SP.		
OSCILLATORIA SP.		
OSCILLATORIA GEMINATA		
ANABAENA SP.		
CHLOROPHYTA		
CHLAMYDOMONAS SP.	170.73	28.15
CARTERIA SP.		
EUDORINA SP.	1.17	0.19
PTEROMONAS SPP.		
CLOSTERIUM SP.		
COSMARIUM SP.		
ACTINASTRUM SP.		
SCENEDESMUS SP.		
SCENEDESMUS ACUTIFORMIS		
CRUCIGENIA SP.		
ANKISTRODESMUS SP.		
TETRAEDRON SP.	7.06	1.16
SCHROEDERIA SETIGERA		
KIRCHNERIELLA SPP	1.17	0.19
ELAKATOTHRIX SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	70.65	11.65
	251	41
EUGLENOPHYTA		
PHACUS SP.	7.65	1.26
PHACUS ACUMINATA		
EUGLENA SP.	1.17	0.19
EUGLENA ACUS		
EUGLENA GRACILIS	5.30	0.87
LEPOCINCLIS SP.	2.35	0.39
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR		
LEPOCINCLIS FUSIFORMIS		
TRACHELOMONAS SP.	21.19	3.49
TRACHELOMONAS VOLVOCINA	117.74	19.41
TRACHELOMONAS HISPIDA	3.53	0.58
TRACHELOMONAS SUPERBA		
	159	26

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981 (page 6 of 8)

	PB	
	#/ML	PCT
CHRYSOPHYTA		
DINOBRYON SP.		
MICROMONAS SP.	21.19	0.21
URO GLENOPSIS SPP.		
MALLOMONAS SP.		
SYNURA SP.	286.13	2.83
CHRYSAMOEBA SP.		
UNID. FLAG. CHRYSOPHYTE		
	307	3
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.		
CHROOMONAS SALINA	42.39	0.42
CHROOMONAS NORDSTEDTII	1854.56	18.34
CRYPTOMONAS SP.		
	1,897	19
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	10.59	0.10
MELOSIRA SP.	328.52	3.25
FRAGILARIA SP.		
FRAGILARIA CROTONENSIS		
SYNEDRA SP.		
ACHNANTHES SP.	105.97	1.05
COCCONEIS SP.	10.59	0.10
NAVICULA SP.	63.58	0.63
NAVICULA CONFERVACEA		
PINNULARIA SP.		
CYMBELLA SP.	10.59	0.10
GOMPHONEMA SP.		
GOMPHONEMA PARVULA		
RHOPALODIA GIBBA	10.59	0.10
EUNOTIA SP.	116.57	1.15
NITZSCHIA SP.	116.57	1.15
NITZSCHIA PALEA	31.79	0.31
	805	8
PYRROPHYTA		
GYMNODINIUM SP.		
GLENODINIUM SP.	42.39	0.42
PERIDINIUM SP.		
PERIDINIUM INCONSPICUUM		
	42	
	10,110	100

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981 (page 7 of 8)

	PB	
	#/ML	PCT
CYANOPHYTA		
ANACYSTIS SP.		
LYNGBIA SP.		
OSCILLATORIA SP.	551.07	5.45
OSCILLATORIA GEMINATA		
ANABAENA SP.		
	551	5
CHLOROPHYTA		
CHLAMYDOMONAS SP.	1102.14	10.90
CARTERIA SP.		
EUDORINA SP.		
PTEROMONAS SPP.	63.58	0.63
CLOSTERIUM SP.		
COSMARIUM SP.		
ACTINASTRUM SP.		
SCENEDESMUS SP.	21.19	0.21
SCENEDESMUS ACUTIFORMIS		
CRUCIGENIA SP.		
ANKISTRODESMUS SP.	21.19	0.21
TETRAEDRON SP.		
SCHROEDERIA SETIGERA		
KIRCHNERIELLA SPP		
ELAKATOTHRIX SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	233.14	2.31
	1,441	14
EUGLENOPHYTA		
PHACUS SP.	127.16	1.26
PHACUS ACUMINATA	52.98	0.52
EUGLENA SP.	21.19	0.21
EUGLENA ACUS	116.57	1.15
EUGLENA GRACILIS	2755.35	27.25
LEPOCINCLIS SP.		
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR	116.57	1.15
LEPOCINCLIS FUSIFORMIS	42.59	0.42
TRACHELOMONAS SP.	21.19	0.21
TRACHELOMONAS VOLVOCINA	1685.00	16.67
TRACHELOMONAS HISPIDA	95.37	0.94
TRACHELOMONAS SUPERBA	31.79	0.31
	5,066	50

Table 8.1.4-6. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Hardee Phosphate Complex II Site, July 1981
(page 8 of 8)

	HS	
	#/ML	PCT
CHRYSOPHYTA		
DITOMYCHA SP.		
MONOMONAS SP.		
UROGLENOPSIS SP.		
MALLOMONAS SP.		
SYNURA SP.	35.32	1.01
CHRYSAMOEBA SP.	3.53	0.10
UNID. FLAG. CHRYSOPHYTE		
	39	1
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.		
CHROOMONAS SALINA		
CHROOMONAS ACROSTEGII	261.49	7.51
CRYPTOMONAS SP.	60.05	1.72
	321	9
BACILLARIOPHYCEAE		
CYCLOTELLA SP.		
MELOSIRA SP.	7.06	.20
FRAGILARIA SP.		
FRAGILARIA CROTONENSIS		
SYNEDRA SP.	35.32	1.01
ACHNANTHES SP.		
COCCONEIS SP.		
NAVICULA SP.		
NAVICULA CONFERVACEA		
PINNULARIA SP.		
CYMBELLA SP.		
GOMPHONEMA SP.		
GOMPHONEMA PARVULA		
RHOPALODIA GIBBA		
EUNOTIA SP.	3.53	.10
NITZSCHIA SP.	52.98	1.52
NITZSCHIA PALEA		
	99	3
PYRROPHYTA		
GYMNODINIUM SP.		
GLENODINIUM SP.	63.58	1.83
PERIDINIUM SP.		
PERIDINIUM INCONSPICUUM	67.11	1.93
	131	4
	3483	100

Key to Stations:
BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-7. Phytoplankton Abundance, Number of Taxa, Species Diversity, Richness and Evenness Indices for CF Hardee Complex II Sampling Stations

Date	BC	DB	HC	PB	SB	CB	HM	HN	M1	M2	M3	M4
July 1981												
Number of Taxa (66)*	36	28	26	32	27							
Total Number/ml	1,914	2,070	3,483	10,110	607							
Species Diversity	3.56	3.23	2.45	3.33	3.30							
Species Richness	4.63	3.54	3.07	3.36	4.06							
Evenness	0.69	0.67	0.52	0.67	0.69							
August 1981												
Number of Taxa (60)*	26	37	28	26	24							
Total Number/ml	1,512	1,945	548	7,132	324							
Species Diversity	3.09	3.77	3.30	2.95	3.38							
Species Richness	3.41	4.75	4.28	2.82	3.98							
Evenness	0.66	0.72	0.69	0.63	0.74							
September 1981												
Number of Taxa (55)*	21	28	31	29	17	12						
Total Number/ml	735	249	480	1,600	209	148						
Species Diversity	2.71	3.59	3.65	3.80	2.12	1.09						
Species Richness	3.03	4.90	4.86	3.80	3.00	2.20						
Evenness	0.62	0.75	0.74	0.78	0.52	0.30						
October 1981												
Number of Taxa (64)*	24	26	28	22	16		35	32				
Total Number/ml	7,376	943	478	13,455	4,510		393	645				
Species Diversity	2.68	3.12	3.48	2.83	2.05		3.86	3.60				
Species Richness	2.58	3.65	4.38	2.21	1.78		5.52	4.79				
Evenness	0.58	0.66	0.72	0.64	0.51		0.76	0.72				

Table 8.1.4-7. Phytoplankton Abundance, Number of Taxa, Species Diversity, Richness and Evenness Indices for CF Hardee Complex II Sampling Stations (Continued, Page 2 of 2)

Date	BC	DB	HC	PB	SB	CB	HM	HN	M1	M2	M3	M4
February 1982												
Number of Taxa (89)*	44	29	35	20	29	20	31	27	30	20	23	27
Total Number/ml	23,791	941	4,223	10,308	2,575	6,747	17,486	1,298	7,424	30,768	1,501	6,851
Species Diversity	3.44	3.72	3.38	2.64	3.48	2.60	3.64	3.97	4.08	1.96	2.92	4.03
Species Richness	4.27	4.09	4.07	2.06	3.57	2.16	3.07	3.63	3.25	1.84	3.01	2.94
Evenness	0.63	0.77	0.46	0.61	0.72	0.60	0.73	0.84	0.83	0.45	0.65	0.85

* Total number of taxa per trip.

Source: ESE, 1983.

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981

	BC		DB	
	#/ML	PCT	#/ML	PCT
CYANOPHYTA				
LYNGBYA SP.			174.85	8.99
OSCILLATORIA GEMINATA				
ANABAENA SP.	24.72	1.64	31.79	1.63
	25	2	207	11
CHLOROPHYTA				
CHLAMYDOMONAS SP.	625.25	41.[illegible]	68.88	3.54
CARTERIA SP.				
CHLOROCOCCIUM SP.	3.53	0.23		
EUDORINA SP.			5.30	0.27
EUTREPTIA SPP.	17.66	1.17		
MOUGEOTIA SP.			5.30	0.27
CLOSTERIUM SP.			5.30	0.27
GLOEOCYSTIS SP.				
PEDIASTRUM SP.			5.30	0.27
SCENEDESMUS SP.	3.53	0.23	5.30	0.27
CRUCIGENIA SP.				
ANKISTRODESMUS SP.	7.06	0.47	5.30	0.27
SELENASTRUM SP.	3.53	0.23		
CLOSTERIOPSIS SP.				
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED				
UNIDENTIFIED FLAGELLATED GREEN ALGAE			31.79	1.63
	661	44	132	7
EUGLENOPHYTA				
PHACUS SP.	95.37	6.31	10.59	0.54
PHACUS ACUMINATA	10.59	0.70	15.89	0.82
PHACUS LONGICAUDA	38.85	2.57		
PHACUS TORTUS	10.59	0.70		
EUGLENA SP.				
EUGLENA ACUS				
EUGLENA GRACILIS	116.57	7.71	5.30	0.27
LEPOCINCLIS SP.				
LEPOCINCLIS FUSIFORMIS	148.36	9.81	5.30	0.27
TRACHELOMONAS SP.	10.59	0.70	21.19	1.09
TRACHELOMONAS VOLVOCINA	169.56	11.22		
TRACHELOMONAS HISPIDA				
TRACHELOMONAS ARMATA	14.12	0.93		
TRACHELOMONAS PULCHERRIMA	14.13	0.93		
	629	42	58	3
CHRYSOPHYTA				

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 2 of 8)

	BC		DB	
	#/ML	PCT	#/ML	PCT
DINOBRYON SP.	3.53	.23		
PALLOMONAS SP.	17.66	1.17	5.30	0.27
SYNURA SP.			5.30	0.27
	21	1	11	1
CRYPTOPHYTA CRYPTOPHYCEAE				
CHROOMONAS SP.	3.53	0.23	37.09	1.91
CHROOMONAS NORDSTEDTII	10.59	.70		
CRYPTOMONAS SP.	17.66	1.17	15.89	0.82
	32	2	53	3
BACILLARIOPHYCEAE				
CYCLOTELLA SP.			31.79	1.63
MELOSIRA SP.			21.19	1.09
MELOSIRA VARIANS				
SYNEDRA SP.			26.49	1.36
ACHNANTHES SP.			95.37	4.90
ACHNANTHES EXIGUA			21.19	1.09
FRUSTULIA SP.			10.59	0.54
NAVICULA SP.	3.53	0.23	111.27	5.72
NAVICULA PUPULA			5.30	0.27
NAVICULA CONFERVACEA			291.43	14.99
PINNULARIA SP.	3.53	0.23	10.59	0.54
PINNULARIA BRAUNII			37.09	1.91
CAMPYLODISCUS SPP.			5.30	0.27
CYMBELLA SP.			26.49	1.36
GOMPHONEMA SP.			10.59	0.54
GOMPHONEMA ANGUSTATUM			84.78	4.36
RHOPALODIA GIBBA			5.30	0.27
SURIRELLA SP.			111.27	5.72
NITZSCHIA SP.			577.56	29.70
NITZSCHIA PALEA	24.72	1.64		
	32	2	1,484	76
PYRROPHYTA				
GLENODINIUM SP.	113.33	7.48		
	113	7	0	0
	1,512	100	1,945	100

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 3 of 8)

	HS	
	#/ML	PCT
CYANOPHYTA		
LYNGBIA SP.		
OSCILLATORIA GEMINATA		
ANABAENA SP.	4.71	.8
	6	1
CHLOROPHYTA		
CHLAMYDOMONAS SP.	191.75	34.81
CARTERIA SP.	1.17	0.21
CHLOROGONIUM SP.		
EUDORINA SP.	1.76	0.32
PTEROMONAS SPP.	1.76	0.32
MOUGEOTIA SP.	4.70	0.86
CLOSTERIUM SP.	1.76	0.32
DESMIDIUM SPP.	44.15	8.06
PEDIASTRUM SP.		
SCENEDESMUS SP.	24.72	4.51
CRUCIGENIA SP.	1.17	0.21
ANKISTRODESMUS SP.	1.17	0.21
SELENASTRUM SP.		
CLOSTERIOPSIS SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	35.32	6.45
	308	56
EUGLENOPHYTA		
PHACUS SP.	8.82	1.61
PHACUS ACUMINATA	1.17	0.21
PHACUS LONGICAUDA		
PHACUS TORTUS		
EUGLENA SP.	15.89	2.9
EUGLENA ACUS		
EUGLENA GRACILIS		
LEPOCINCLIS SP.		
LEPOCINCLIS FUSIFORMIS		
TRACHELOMONAS SP.	10.01	1.83
TRACHELOMONAS VOLVOCINA		
TRACHELOMONAS HISPIDA		
TRACHELOMONAS ARMATA		
TRACHELOMONAS PULCHERRIMA		
	36	7
CHRYSOPHYTA		

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 4 of 8)

	HC	
	#/ML	PCT
DINOBRYON SP.		
MALLOMONAS SP.	2.94	0.54
SYNURA SP.	4.12	0.75
	7	1
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	68.68	12.57
CHROOMONAS ACROLSTERTII		
CRYPTOMONAS SP.	15.30	2.75
	84	15
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	1.76	0.32
MELOSIRA SP.		
MELOSIRA VARIANS	2.35	0.43
SYNEDRA SP.		
ACHNANTHES SP.	1.76	0.32
ACHNANTHES EXIGUA		
FRUSTULIA SP.	1.17	0.21
NAVICULA SP.	4.12	0.75
NAVICULA FUPULA		
NAVICULA CONFERVACEA		
PINNULARIA SP.		
PINNULARIA BRAUNII		
CERATOGRAMMA SPP.		
CYMBELLA SP.		
GOMPHONEMA SP.		
GOMPHONEMA ANGUSTATUM		
RHOPALODIA GIBBA		
EUNOTIA SP.		
NITZSCHIA SP.	31.79	5.80
NITZSCHIA PALEA	62.40	11.39
	105	19
PYRROPHYTA		
GLENODINIUM SP.	2.35	0.43
	2	0
	548	100

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 5 of 8)

	PB	
	#/ML	PCT
CYANOPHYTA		
LYNGBIA SP.	296.72	4.16
OSCILLATORIA GEMINATA		
ANABAENA SP.	63.58	0.89
	360	5
CHLOROPHYTA		
CHLAMYDOMONAS SP.	1384.73	19.42
CARTERIA SP.		
CHLOROGONIUM SP.		
EUDORINA SP.	14.13	0.20
PTEROMONAS SPP.	52.98	0.74
MOUGEOTIA SP.		
CLOSTERIUM SP.		
DESMIDIUM SPP.		
PEDIASTRUM SP.		
SCENEDESMUS SP.		
CRUCIGENIA SP.		
ANKISTRODESMUS SP.	3.53	0.05
SELENASTRUM SP.		
CLOSTERIOPSIS SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	169.56	2.38
UNIDENTIFIED FLAGELLATED GREEN ALGAE	10.59	0.15
	1,636	23
EUGLENOPHYTA		
PHACUS SP.	21.19	0.30
PHACUS ACUMINATA		
PHACUS LONGICAUDA		
PHACUS TORTUS		
EUGLENA SP.	24.72	0.35
EUGLENA ACUS	14.12	0.20
EUGLENA GRACILIS	42.39	0.59
LEPOCINCLIS SP.	81.24	1.14
LEPOCINCLIS FUSIFORMIS	787.74	11.05
TRACHELOMONAS SP.	52.98	0.74
TRACHELOMONAS VOLVOCINA	540.47	7.58
TRACHELOMONAS HISPIDA	222.54	3.12
TRACHELOMONAS ARMATA		
TRACHELOMONAS PULCHERRIMA	812.47	11.39
	2,600	36
CHRYSOPHYTA		

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 6 of 8)

	PB	
	#/ML	PCT
DINOBRYON SP.		
MALLOMONAS SP.	226.08	3.17
SYNURA SP.	42.38	0.59
	268	4
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.		
CHROOMONAS NORDSTEDTII	1349.41	18.92
CRYPTOMONAS SP.	60.05	0.84
	1,409	20
BACILLARIOPHYCEAE		
CYCLOTELLA SP.		
MELOSIRA SP.		
MELOSIRA VARIANS		
SYNEDRA SP.		
ACHNANTHES SP.	3.53	0.05
ACHNANTHES EXIGUA		
FRUSTULIA SP.		
NAVICULA SP.	10.59	0.15
NAVICULA PUPULA		
NAVICULA CONFERVACEA		
PINNULARIA SP.		
PINNULARIA BRAUNII		
CAMPYLODISCUS SPP.		
CYMBELLA SP.		
GOMPHONEMA SP.		
GOMPHONEMA ANGUSTATUM		
RHOPALODIA GIBBA		
EUNOTIA SP.		
NITZSCHIA SP.	10.59	0.15
NITZSCHIA PALEA		
	25	0
PYRROPHYTA		
GLENODINIUM SP.	833.67	11.69
	834	12
	7,132	100

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981 (Continued, Page 7 of 8)

	SB	
	#/ML	PCT
CYANOPHYTA		
LYNGBIA SP.		
OSCILLATORIA GEMINATA	96.97	29.94
ANABAENA SP.	4.41	1.37
	1 1	31
CHLOROPHYTA		
CHLAMYDOMONAS SP.	44.86	13.85
CARTERIA SP.		
CHLOROGONIUM SP.		
EUDORINA SP.		
PTEROMONAS SPP.	1.76	0.54
MOUGEOTIA SP.		
CLOSTERIUM SP.	2.12	0.65
DESMIDIUM SPP.		
PEDIASTRUM SP.		
SCENEDESMUS SP.		
CRUCIGENIA SP.	0.88	0.27
ANKISTRODESMUS SP.		
SELENASTRUM SP.		
CLOSTERIOPSIS SP.	0.70	0.22
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	28.18	8.67
	78	24
EUGLENOPHYTA		
PHACUS SP.	10.99	3.38
PHACUS ACUMINATA		
PHACUS LONGICAUDA		
PHACUS TORTUS		
EUGLENA SP.	4.76	1.35
EUGLENA ACUS		
EUGLENA GRACILIS		
LEPOCINCLIS SP.		
LEPOCINCLIS FUSIFORMIS		
TRACHELOMONAS SP.	5.65	1.74
TRACHELOMONAS VOLVOCINA	1.41	0.44
TRACHELOMONAS HISPIDA		
TRACHELOMONAS ARMATA		
TRACHELOMONAS PULCHERRIMA	4.06	1.25
	26	8
CHRYSOPHYTA		

Table 8.1.4-8. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, August 1981. (Continued, Page 8 of 8)

	SB	
	#/ML	PCT
DINOBRYON SP.		
MALLOMONAS SP.		
SYNURA SP.		
	----------	------
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	14.93	4.56
CHROOMONAS NORDSTEDTII		
CRYPTOMONAS SP.		
	----------	------
	5	5
BACILLARIOPHYCEAE		
CYCLOTELLA SP.		
MELOSIRA SP.	22.96	7.0
MELOSIRA VARIANS		
SYNEDRA SP.		
ACHNANTHES SP.	14.48	4.47
ACHNANTHES EXIGUA		
FRUSTULIA SP.	1.76	0.54
NAVICULA SP.	7.94	2.45
NAVICULA PUPULA		
NAVICULA CONFERVACEA	2.65	0.82
PINNULARIA SP.	1.41	0.44
PINNULARIA BRAUNII		
CARPATOGRAMMA SPP.		
CYMBELLA SP.	1.41	0.44
GOMPHONEMA SP.	0.88	0.27
GOMPHONEMA ANGUSTATUM		
RHOPALODIA GIBBA		
EUNOTIA SP.	5.29	1.63
NITZSCHIA SP.	44.33	13.69
NITZSCHIA PALEA		
	----------	------
	103	32
PYRROPHYTA		
GLENODINIUM SP.		
	----------	------
	3	1
	----------	------
	324	100

Key to Stations: BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981

	BC		CB		DB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
CRYPTOPHYTA CRYPTOPHYCEAE						
CHROOMONAS SP.	27.67	3.77			13.42	5.41
CRYPTOMONAS SP.	4.71	0.64	9.18	6.19	6.35	2.56
	32	4	9	6	20	8
BACILLARIOPHYCEAE						
CYCLOTELLA SP.			0.70	0.47		
MELOSIRA SP.			1.41	0.95		
MELOSIRA VARIANS						
FRAGILARIA SP.						
SYNEDRA SP.	1.76	0.24	0.70	0.47	5.65	2.28
ACHNANTHES SP.	1.76	0.24	3.53	2.38	8.47	3.41
COCCONEIS PLACENTULA						
DIPLONEIS SP.						
FRUSTULIA SP.					0.70	0.28
NAVICULA SP.			2.12	1.43	12.72	5.12
NAVICULA CONFERVACEA						
PINNULARIA SP.			0.70	0.47	0.70	0.28
NEIDIUM SP.						
CYMBELLA SP.					1.41	0.57
GOMPHONEMA SP.					0.70	0.28
EPITHEMIA SP.						
RHOPALODIA GIBBA						
EUNOTIA SP.	1.76	0.24	0.70	0.47	4.94	1.99
HANTZSCHIA SP.						
NITZSCHIA SP.	17.66	2.40	3.53	2.38	18.37	7.40
	23	3	13	9	54	22
PYRROPHYTA						
GLENODINIUM SP.					0.70	0.28
	0	0	0	0	1	0
	735	100	148	100	249	100

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981. (Continued, Page 2 of 8)

	BC		CB		DB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
CYANOPHYTA						
OSCILLATORIA SP.	56.52	7.69			2.82	1.14
OSCILLATORIA GEMINATA	359.13	48.88			4.94	1.99
ANABAENA SP.						
	416	57	0	0	8	3
CHLOROPHYTA						
CHLAMYDOMONAS SP.	25.90	3.53			43.09	17.36
CHLOROCOCCIUM SP.					0.70	0.28
PTEROMONAS SPP.	1.76	0.24			0.70	0.28
MOUGEOTIA SP.	2.35	0.32				
CLOSTERIUM SP.	8.24	1.12				
COSMARIUM SP.						
HYALOTHECA SP.						
EUASTRUM SPP.						
SCENEDESMUS SP.						
SCENEDESMUS BIJUGA						
SCENEDESMUS DENTICULATUS						
OOCYSTIS SP.					1.41	0.57
ANKISTRODESMUS SP.	3.53	0.48			2.12	0.85
ANKISTRODESMUS FALCATUS						
SELENASTRUM SP.						
TETRAEDRON MINIMUM						
SCHRODERIA SETIGERA					0.70	0.28
CLOSTERIOPSIS SP.						
CHLOROCOCCUM SPP.	18.84	2.56			14.12	5.69
UNIDENTIFIED FLAGELLATED GREEN ALGAE			124.34	83.90		
	61	8	124	84	63	25
EUGLENOPHYTA						
PHACUS SP.	3.53	0.48	0.70	0.47	4.94	1.99
EUGLENA SP.	6.47	0.88			2.83	1.14
LEPOCINCLIS SP.	1.17	0.16				
TRACHELOMONAS SP.	41.80	5.69			16.25	6.55
	53	7	1	0	24	10
CHRYSOPHYTA						
DINOBRYON SP.					1.41	0.57
MALLOMONAS SP.	3.53	0.48			2.12	0.85
SYNURA SP.	62.99	8.57			3.53	1.42
CHRYSAMOEBA SP.			0.70	0.47		
UNID. FLAG. CHRYSOPHYTE	83.69	11.38			72.76	29.32
	150	20	1	0	80	32

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981. (Continued, Page 3 of 8)

	HS	
	#/ML	PCT
CYANOPHYTA		
OSCILLATORIA SP.		
OSCILLATORIA GEMINATA		
ANABAENA SP.	18.83	3.92
	19	4
CHLOROPHYTA		
CHLAMYDOMONAS SP.	41.21	8.58
CHLOROGONIUM SP.		
PTEROMONAS SPP.	5.88	1.22
MOUGEOTIA SP.		
CLOSTERIUM SP.	4.71	0.98
COSMARIUM SP.	1.17	0.24
HYALOTHECA SP.	120.10	24.99
EUASTRUM SPP.	1.17	0.24
SCENEDESMUS SP.	2.35	0.49
SCENEDESMUS BIJUGA	7.06	1.47
SCENEDESMUS DENTICULATUS	4.70	0.98
OOCYSTIS SP.	1.17	0.24
ANKISTRODESMUS SP.		
ANKISTRODESMUS FALCATUS	15.30	3.18
SELENASTRUM SP.		
TETRAEDRON MINIMUM	3.53	0.73
SCHRODERIA SETIGERA		
CLOSTERIOPSIS SP.	1.17	0.24
CHLOROCOCCUM SPP.	7.06	1.47
UNIDENTIFIED FLAGELLATED GREEN ALGAE	84.77	17.64
	301	63
EUGLENOPHYTA		
PHACUS SP.	1.17	0.24
EUGLENA SP.	1.17	0.24
LEPOCINCLIS SP.		
TRACHELOMONAS SP.	7.06	1.47
	9	2
CHRYSOPHYTA		
DINOBRYON SP.		
MALLOMONAS SP.	1.17	0.24
SYNURA SP.		
CHRYSAMOEBA SP.		
UNID. FLAG. CHRYSOPHYTE		
	1	0

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981. (Continued, Page 4 of 8)

	HS	
	#/ML	PCT
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	31.79	6.62
CRYPTOMONAS SP.	8.24	1.71
	40	8
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	1.17	0.24
MELOSIRA SP.	16.48	3.43
MELOSIRA VARIANS		
FRAGILARIA SP.	4.71	0.98
SYNEDRA SP.	1.17	0.24
ACHNANTHES SP.	21.19	4.41
COCCONEIS PLACENTULA		
DIPLONEIS SP.		
FRUSTULIA SP.	5.88	1.22
NAVICULA SP.		
NAVICULA CONFERVACEA		
PINNULARIA SP.	2.35	0.49
NEIDIUM SP.		
CYMBELLA SP.		
GOMPHONEMA SP.		
EPITHEMIA SP.		
RHOPALODIA GIBBA		
EUNOTIA SP.	3.53	0.73
HANTZSCHIA SP.		
NITZSCHIA SP.	52.98	11.03
	109	23
PYRROPHYTA		
GLENODINIUM SP.		
	0	0
	480	100

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981. (Continued, Page 5 of 8)

	PB	
	#/ML	PCT
CYANOPHYTA		
OSCILLATORIA SP.	26.49	1.66
OSCILLATORIA GEMINATA	5.30	0.33
ANABAENA SP.		
	32	2
CHLOROPHYTA		
CHLAMYDOMONAS SP.	29.14	1.82
CHLOROGONIUM SP.		
PTEROMONAS SPP.		
MOUGEOTIA SP.		
CLOSTERIUM SP.		
COSMARIUM SP.		
HYALOTHECA SP.		
EUASTRUM SPP.		
SCENEDESMUS SP.	2.65	0.17
SCENEDESMUS BIJUGA		
SCENEDESMUS DENTICULATUS		
OOCYSTIS SP.		
ANKISTRODESMUS SP.	2.65	0.17
ANKISTRODESMUS FALCATUS		
SELENASTRUM SP.	2.65	0.17
TETRAEDRON MINIMUM		
SCHRODERIA SETIGERA		
CLOSTERIOPSIS SP.		
CHLOROCOCCUM SPP.	26.49	1.66
UNIDENTIFIED FLAGELLATED GREEN ALGAE		
	64	4
EUGLENOPHYTA		
PHACUS SP.	2.65	0.17
EUGLENA SP.		
LEPOCINCLIS SP.		
TRACHELOMONAS SP.	13.24	0.83
	16	1
CHRYSOPHYTA		
DINOBRYON SP.		
MALLOMONAS SP.		
SYNURA SP.		
CHRYSAMOEBA SP.		
UNID. FLAG. CHRYSOPHYTE	39.74	2.48
	40	2

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981 (Continued, Page 6 of 8)

	PB	
	#/ML	PCT
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	18.54	1.16
CRYPTOMONAS SP.		
	19	1
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	18.54	1.16
MELOSIRA SP.	286.13	17.89
MELOSIRA VARIANS	82.13	5.13
FRAGILARIA SP.		
SYNEDRA SP.	214.60	13.42
ACHNANTHES SP.	47.69	2.98
COCCONEIS PLACENTULA	29.14	1.82
EPITHEMIA SP.	5.30	0.33
FRUSTULIA SP.	15.89	0.99
NAVICULA SP.	153.66	9.61
NAVICULA CONFERVACEA	294.08	18.38
PINNULARIA SP.	2.65	0.17
NEIDIUM SP.	7.95	0.50
CYMBELLA SP.		
GOMPHONEMA SP.	37.09	2.32
EPITHEMIA SP.	66.23	4.14
RHOPALODIA GIBBA	52.98	3.31
EUNOTIA SP.	68.88	4.31
HANTZSCHIA SP.	5.30	0.33
NITZSCHIA SP.	42.38	2.65
	1,431	89
PYRROPHYTA		
GLENODINIUM SP.		
	0	0
	1,600	100

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981. (Continued, Page 7 of 8)

	SB	
	#/ML	PCT
CYANOPHYTA		
OSCILLATORIA SP.		
OSCILLATORIA GEMINATA		
ANABAENA SP.		
	0	0
CHLOROPHYTA		
CHLAMYDOMONAS SP.	2.12	1.01
CHLOROGONIUM SP.		
EUTETRAMONAS SP.	0.70	0.33
MOUGEOTIA SP.		
CLOSTERIUM SP.	2.65	1.27
COSMARIUM SP.		
HYALOTHECA SP.		
EUASTRUM SPP.		
SCENEDESMUS SP.		
SCENEDESMUS BIJUGA		
SCENEDESMUS DENTICULATUS		
OOCYSTIS SP.		
ANKISTRODESMUS SP.		
ANKISTRODESMUS FALCATUS	0.88	0.42
SELENASTRUM SP.		
TETRAEDRON MINIMUM		
SCHRODERIA SETIGERA		
CLOSTERIOPSIS SP.		
CHLOROCOCCUM SPP.	16.43	7.86
UNIDENTIFIED FLAGELLATED GREEN ALGAE	16.78	8.03
	40	19
EUGLENOPHYTA		
PHACUS SP.	1.41	0.67
EUGLENA SP.		
LEPOCINCLIS SP.		
TRACHELOMONAS SP.		
	1	1
CHRYSOPHYTA		
DINOBRYON SP.		
SYNURA SP.		
CHRYSAMOEBA SP.		
UNID. FLAG. CHRYSOPHYTE		
	0	0

Table 8.1.4-9. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, September 1981 (Continued, Page 8 of 8)

	SB	
	#/ML	PCT
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	1.76	0.84
CRYPTOMONAS SP.		
	2	1
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	0.88	0.42
MELOSIRA SP.	7.77	3.72
MELOSIRA VARIANS		
FRAGILARIA SP.		
SYNEDRA SP.		
ACHNANTHES SP.	6.71	3.21
COCCONEIS PLACENTULA		
DIPLONEIS SP.		
FRUSTULIA SP.	0.88	0.42
NAVICULA SP.	4.06	1.94
NAVICULA CONFERVACEA	135.12	64.65
PINNULARIA SP.		
NEIDIUM SP.		
CYMBELLA SP.		
GOMPHONEMA SP.	2.65	1.27
EPITHEMIA SP.		
RHOPALODIA GIBBA		
EUNOTIA SP.	2.65	1.27
HANTZSCHIA SP.		
NITZSCHIA SP.	5.65	2.70
	166	80
PYRROPHYTA		
GLENODINIUM SP.		
	3	0
	219	100

Source: ESE, 1984.

Key to Stations:

BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981.

	BC		DB	
	#/ML	PCT	#/ML	PCT
CYANOPHYTA				
ANACYSTIS SP.	52.98	1.72		
MYXOSARCINA SP.	63.59	2.06		
OSCILLATORIA SP.	1547.23	50.98	110.21	11.69
OSCILLATORIA GEMINATA			6.36	0.67
UNIDENTIFIED FILAMENTOUS BLUE-GREEN				
	1,664	23	117	12
CHLOROPHYTA				
CHLAMYDOMONAS SP.	10.59	0.14	9.54	1.01
CARTERIA SP.				
CHLOROCOCCUM SP.				
PANDORINA SP.				
PLANOSINA SP.				
SPIROGYRA SP.				
MOUGEOTIA SP.	21.19	0.29	4.24	0.45
CLOSTERIUM SP.	74.18	1.01		
STAURASTRUM SP.			2.12	0.22
COSMARIUM SP.				
HYALOTHECA SP.				
SCENEDESMUS SP.	10.59	0.14	2.12	0.22
COELASTRUM SP.				
ANKISTRODESMUS SP.	10.59	0.14		
TETRAEDRON MINIMUM				
QUADRIGULA SP.				
CLOSTERIOPSIS SP.				
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	10.59	0.14		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	21.19	0.29		
	159	2	18	2
EUGLENOPHYTA				
PHACUS SP.	10.59	0.14	5.30	0.56
PHACUS ACUMINATA				
EUGLENA SP.	10.59	0.14	16.95	1.80
EUGLENA ACUS				
LEPOCINCLIS SP.				
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR			23.84	2.53
TRACHELOMONAS SP.	10.59	0.14		
TRACHELOMONAS VOLVOCINA			24.90	2.64
TRACHELOMONAS HISPIDA				
TRACHELOMONAS CYLINDRICA				
	32	1	71	8

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 2 of 8)

	BC		DB	
	#/ML	PCT	#/ML	PCT
CHRYSOPHYTA				
DINOBRYON SP.				
PELAGOM. SP.				
SYNURA SP.			15.89	1.69
UNID. FLAG. CHRYSOPHYTE			104.91	11.13
		1	121	13
CRYPTOPHYTA, CRYPTOPHYCEAE				
CHROO. GRAC SP.	63.50	0.96	396.87	42.09
CRYPT. ORAS SP.			89.02	9.44
CRYPTOMONAS MARSSONII			15.89	1.69
CRYPTOMONAS OVATA			10.59	1.12
	64	1	512	54
BACILLARIOPHYCEAE				
CYCLOTELLA SP.			2.12	0.22
MELOSIRA SP.				
MELOSIRA ISLANDICA	2310.25	31.32		
FRAGILARIA SP.			2.12	0.22
SYNEDRA SP.	21.19	0.29	2.12	0.22
SYNEDRA ULNA				
ACHNANTHES SP.	10.59	0.14	21.19	2.25
COCCONEIS SP.				
FRUSTULIA RHOMPOIDES VAR CAPITATA				
FRUSTULIA SP.	10.59	0.14		
NAVICULA SP.			16.43	1.74
NAVICULA CONFERVACEA	858.39	11.64	9.01	0.96
PINNULARIA SP.	158.96	2.16		
AMPHORA SP.				
CYMBELLA SP.				
GOMPHONEMA SP.			13.24	1.40
EUNOTIA SP.	52.98	0.72	6.36	0.67
NITZSCHIA SP.	1685.00	22.84	15.89	1.69
	5,108	69	88	9
PYRROPHYTA				
CYSTODINIUM SP.				
GLENODINIUM SP.	31.78	0.43	15.89	1.69
GLENODINIUM QUADRIDENS				
	32	0	16	2
UNIDENTIFIED PHYTE	317.92	4.31		
	318	4	3	0
	7,376	100	943	100

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 3 of 8)

	HS		HM		HN	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
CYANOPHYTA						
ANACYSTIS SP.						
HYDROCOLEUS SP.						
OSCILLATORIA SP.			1.17	0.30		
OSCILLATORIA TENUIS						
UNIDENTIFIED FILAMENTOUS BLUE-GREEN			5.00	1.27		
			6	2		
CHLOROPHYTA						
CHLAMYDOMONAS SP.	44.74	9.36	41.21	10.48	101.26	15.71
CARTERIA SP.			1.17	0.30		
CHLOROGONIUM SP.					2.35	0.36
PANDORINA SP.					1.17	0.18
STAURONEIS SP.			5.00	1.27	12.36	1.92
SPIROGYRA SP.	2.35	0.49				
MOUGEOTIA SP.	29.43	6.16	0.88	0.22		
CLOSTERIUM SP.	21.19	4.43	2.94	0.75	8.24	1.28
STAURASTRUM SP.						
COSMARIUM SP.			1.17	0.30		
HYALOTHECA SP.	44.74	9.36				
SCENEDESMUS SP.	5.88	1.23	23.25	5.91	41.80	6.49
COELASTRUM SP.					1.76	0.27
ANKISTRODESMUS SP.	4.70	0.98	17.36	4.42	13.54	2.10
TETRAEDRON MINIMUM			7.06	1.80	8.24	1.28
QUADRIGULA SP.	1.17	0.24				
CLOSTERIOPSIS SP.	1.17	0.24	1.76	0.45	16.48	2.56
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED			1.17	0.30	2.94	0.46
UNIDENTIFIED FLAGELLATED GREEN ALGAE			0.88	0.22	3.53	0.55
	155	32	104	26	214	33
EUGLENOPHYTA						
PHACUS SP.	4.70	0.98	7.06	1.80	9.41	1.46
PHACUS ACUMINATA						
EUGLENA SP.	2.35	0.49	3.53	0.90	1.17	0.18
EUGLENA ACUS						
LEPOCINCLIS SP.						
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR						
TRACHELOMONAS SP.	1.17	0.24	32.96	8.38	36.27	5.64
TRACHELOMONAS VOLVOCINA	16.48	3.46				
TRACHELOMONAS HISPIDA						
TRACHELOMONAS CYLINDRICA						
	25	5	44	11	46	9

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 4 of 8)

	HS		HM		HN	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
CHRYSOPHYTA						
DICTYOCHA SP.	1.17	0.24				
ALLOPORA SP.			1.76	0.45	0.59	0.09
SYNURA SP.	2.35	0.49	0.88	0.22	4.70	0.73
UNID. FLAG. CHRYSOPHYTE	1.17	0.24			3.53	0.55
	5	1	3	1	12	2
CRYPTOPHYTA CRYPTOPHYCEAE						
CHROOMONAS SP.	36.50	7.64	105.68	26.88	188.40	29.24
CRYPTOMONAS SP.	5.85	1.23	15.01	3.82	22.37	3.47
CRYPTOMONAS ERFURDII						
CRYPTOMONAS OVATA						
	42	9	121	31	211	33
BACILLARIOPHYCEAE						
CYCLOTELLA SP.			1.17	0.30	1.17	0.18
MELOSIRA SP.	34.14	7.15	7.65	1.95		
MELOSIRA ISLANDICA						
FRAGILARIA SP.						
SYNEDRA SP.	14.13	2.96	2.06	0.52	11.18	1.73
SYNEDRA ULNA			5.59	1.42	10.59	1.64
ACHNANTHES SP.	1.17	0.24	4.41	1.12	8.83	1.37
COCCONEIS SP.						
FRUSTULIA RHOMBOIDES VAR CAPITATA	1.17	0.24				
FRUSTULIA SP.					2.35	0.36
NAVICULA SP.	9.41	1.97	7.06	1.80	6.47	1.00
NAVICULA CONFERVACEA	20.01	4.19	19.42	4.94	3.53	0.55
PINNULARIA SP.	4.70	0.98	4.12	1.05	2.35	0.36
AMPHORA SP.					1.17	0.18
CYMBELLA SP.	1.17	0.24	2.94	0.75	2.94	0.46
GOMPHONEMA SP.						
EUNOTIA SP.	3.53	0.74	16.48	4.19	27.08	4.20
NITZSCHIA SP.	161.31	33.76	41.21	10.48	81.83	12.70
	251	52	112	29	159	25
PYRROPHYTA						
GYMNODINIUM SP.			0.88	0.22		
GLENODINIUM SP.			2.94	0.75		
GLENODINIUM QUADRIDENS						
		1	4	1	1	0
UNIDENTIFIED EUPHYTE						
	1	1	2	0	0	0
	478	100	392	100	645	100

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 5 of 8)

	PB	
	#/ML	PCT
CYANOPHYTA		
ANACYSTIS SP.		
MYXOSARCINA SP.		
OSCILLATORIA SP.		
OSCILLATORIA LIMOSA		
UNIDENTIFIED FILAMENTOUS BLUE-GREEN		
	0	0
CHLOROPHYTA		
CHLAMYDOMONAS SP.	91.84	0.68
CARTERIA SP.		
CHLOROCOCCUM SP.		
PANDORINA SP.		
PLEUROMAS SP.		
SPIROGYRA SP.		
MOUGEOTIA SP.		
CLOSTERIUM SP.		
STAURASTRUM SP.		
COSMARIUM SP.		
HYALOTHECA SP.		
SCENEDESMUS SP.		
COELASTRUM SP.		
ANKISTRODESMUS SP.	10.59	0.08
TETRAEDRON MINIMUM		
QUADRIGULA SP.		
CLOSTERIOPSIS SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE	35.32	0.26
	138	1
EUGLENOPHYTA		
PHACUS SP.	113.04	0.84
PHACUS ACUMINATA	144.83	1.08
EUGLENA SP.	180.15	1.34
EUGLENA ACUS	21.19	0.16
LEPOCINCLIS SP.	1992.33	14.81
LEPOCINCLIS FUSIFORMIS VAR. MAJOR	1271.70	9.45
TRACHELOMONAS SP.	233.14	1.73
TRACHELOMONAS VOLVOCINA	3677.33	27.33
TRACHELOMONAS HISPIDA	113.04	0.84
TRACHELOMONAS CYLINDRICA	158.96	1.18
	7,906	59

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) or Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 6 of 8)

	PB	
	#/ML	PCT
CHRYSOPHYTA		
DINOBRYON SP.		
KALLOTHRIX SP.		
SYNURA SP.		
UNID. FLAG. CHRYSOPHYTE		
	0	0
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	4146.24	30.69
CRYPTOMONAS SP.	201.35	1.50
CRYPTOMONAS PARSONII	731.22	5.43
CRYPTOMONAS OVATA	243.74	1.81
	5,225	39
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	10.59	0.08
MELOSIRA SP.		
MELOSIRA ISLANDICA		
FRAGILARIA SP.		
SYNEDRA SP.		
SYNEDRA ULNA		
ACHNANTHES SP.		
COCCONEIS SP.	10.59	0.08
FRUSTULIA RHOMBOIDES VAR CAPITATA		
FRUSTULIA SP.		
NAVICULA SP.		
NAVICULA CONFERVACEA		
PINNULARIA SP.	21.19	0.16
AMPHORA SP.		
CYMBELLA SP.		
GOMPHONEMA SP.		
EUNOTIA SP.		
NITZSCHIA SP.	10.59	0.08
	53	0
CYANOPHYTA		
SYNECHOCOCCUS SP.	134.23	1.00
GLOEOCAPSA SP.		
GLOEOTRICHIA ECHINULATA		
	134	1
	13,455	100

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981. (Continued, Page 7 of 8)

	SB	
	#/ML	PCT
CYANOPHYTA		
ANACYSTIS SP.		
HYDROCOLEUS SP.		
OSCILLATORIA SP.		
OSCILLATORIA CHLORINA	2458.43	54.51
UNIDENTIFIED FILAMENTOUS BLUE-GREEN		
	2,458	55
CHLOROPHYTA		
CHLAMYDOMONAS SP.		
CARTERIA SP.		
CHLOROCOCCIUM SP.		
FANDORINA SP.		
GLOEOMONAS SP.		
SPIROGYRA SP.		
MOUGEOTIA SP.		
CLOSTERIUM SP.		
STAURASTRUM SP.		
COSMARIUM SP.		
HYALOTHECA SP.		
SCENEDESMUS SP.		
COELASTRUM SP.		
ANKISTRODESMUS SP.	35.32	0.78
TETRAEDRON MINIMUM		
QUADRIGULA SP.		
CLOSTERIOPSIS SP.		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED		
UNIDENTIFIED FLAGELLATED GREEN ALGAE		
	35	1
EUGLENOPHYTA		
PHACUS SP.	55.93	1.24
PHACUS ACUMINATA		
EUGLENA SP.	11.77	0.26
EUGLENA ACUS	11.77	0.26
LEPOCINCLIS SP.		
LEPOCLINCLIS FUSIFORMIS VAR. MAJOR	20.40	0.46
TRACHELOMONAS SP.	32.38	0.73
TRACHELOMONAS VOLVOCINA	197.23	4.37
TRACHELOMONAS HISPIDA		
TRACHELOMONAS CYLINDRICA		
	317	7

Table 8.1.4-10. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, October 1981 (Continued, Page 8 of 8)

	SB	
	#/ML	PCT
CHRYSOPHYTA		
DINOBRYON SP.		
KALLOMONAS SP.		
SYNURA SP.	92.48	1.93
UNID. FLAG. CHRYSOPHYTE	712.38	15.81
	795	18
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	812.47	18.02
CRYPTOMONAS SP.	17.66	.39
CRYPTOMONAS MARSSONII		
CRYPTOMONAS OVATA		
	831	19
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	8.83	0.20
MELOSIRA SP.		
MELOSIRA ISLANDICA		
FRAGILARIA SP.		
SYNEDRA SP.		
SYNEDRA ULNA		
ACHNANTHES SP.		
COCCONEIS SP.		
FRUSTULIA RHOMBOIDES VAR CAPITATA		
FRUSTULIA SP.		
NAVICULA SP.		
NAVICULA CONFERVACEA		
PINNULARIA SP.		
AMPHORA SP.		
CYMBELLA SP.		
GOMPHONEMA SP.	8.83	0.20
EUNOTIA SP.		
NITZSCHIA SP.		
	16	0
PYRRHOPHYTA		
PERIDINIUM SP.		
GLENODINIUM SP.	35.32	0.78
GLENODINIUM QUADRIDENS	8.83	0.20
	44	1
	4,510	100

Key to Stations:

BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982

	BC		CB		DB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
CYANOPHYTA						
ANACYSTIS INCERTA						
COCCOCHLOPIS SP.						
LYNGBIA SP.						
OSCILLATORIA SP.			17.66	0.26	16.48	1.75
ANABAENA SP.					3.53	0.38
SCYTONEMA SPP						
UNIDENTIFIED FILAMENTOUS BLUE-GREEN						
	0	0	18	0	20	2
CHLOROPHYTA						
CHLAMYDOMONAS SP.	1836.90	7.72	997.93	14.79	58.87	6.26
CHLOROGONIUM SP.	17.66	0.07				
EUDORINA SP.	88.31	0.37	35.32	0.52	1.17	0.12
PANDORINA SP.	17.66	0.07				
PTEROMONAS SPP.	388.57	1.63				
MOUGEOTIA SP.						
CLOSTERIUM SP.	88.31	0.37				
STAURASTRUM SP.	17.66	0.07				
COSMARIUM SP.						
OEDOGONIUM SPP.						
ACTINASTRUM HANTZSCHII						
SCENEDESMUS SP.	105.97	0.45				
CRUCIGENIA SP.						
CRUCIGENIA CRUCIFERA						
COELASTRUM SP.						
COELASTRUM SPHAERICUM						
MICRACTINIUM SP.						
OOCYSTIS SP.	52.98	0.22				
ANKISTRODESMUS SP.					3.53	0.38
ANKISTRODESMUS FALCATUS	1130.40	4.75				
ANKISTRODESMUS CONTORTUS	282.60	1.19				
TETRAEDRON MINIMUM						
SCHRODERIA SETIGERA						
CLOSTERIOPSIS LONGISSIMA						
KIRCHNERIELLA SPP	70.64	0.30				
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	70.65	0.30	17.66	0.26		
UNIDENTIFIED FLAGELLATED GREEN ALGAE						
	4,168	18	1,051	16	64	7
EUGLENOPHYTA						
PHACUS SP.	123.63	0.52			17.66	1.88
PHACUS ACUMINATA	52.98	0.22				
PHACUS TORTUS	17.66	0.07				

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982 (Continued, Page 2 of 12)

	BC		CB		DB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT
PHACUS CF. ORBICULARIS						
EUGLENA SP.	264.93	1.11	105.97	1.57	10.59	1.13
EUGLENA ACUS	123.63	0.52				
LEPOCINCLIS SP.						
LEPOCINCLIS FUSIFORMIS	158.96	0.67				
TRACHELOMONAS SP.						
TRACHELOMONAS VOLVOCINA	9679.05	40.68	317.92	4.71	71.82	7.63
TRACHELOMONAS HISPIDA	17.66	0.07				
TRACHELOMONAS CYLINDRICA	105.97	0.45				
TRACHELOMONAS ARMATA	17.66	0.07				
	10,562	44	424	6	100	11
CHRYSOPHYTA						
OPHIOCYTIUM SP.	52.98	0.22				
DINOBRYON SP.						
ERRIA SP.						
MALLOMONAS SP.	759.48	3.19			1.17	0.12
SYNURA UVELLA					3.53	0.38
SYNURA UVELLA (SINGLE CELLS)	1042.08	4.38				
	1,855	8	0	0	5	0
CRYPTOPHYTA CRYPTOPHYCEAE						
CHROOMONAS SP.	229.61	0.97	114.80	1.70	37.67	4.00
CHROOMONAS NORDSTEDTII	1024.42	4.31	105.97	1.57	21.19	2.25
CRYPTOMONAS SP.	158.96	0.67	17.66	0.26	9.41	1.00
CRYPTOMONAS EROSA						
	1,413	6	238	4	68	7
BACILLARIOPHYCEAE						
CYCLOTELLA SP.	35.32	0.15				
MELOSIRA SP.	2419.76	10.17			2.35	0.25
MELOSIRA GRANULATA	105.97	0.45				
MELOSIRA ISLANDICA			635.84	9.42		
MELOSIRA ITALICA						
SYNEDRA SP.	688.83	2.90	388.57	5.76		
SYNEDRA ULNA	17.66	0.07			40.03	4.26
ACHNANTHES SP.	52.98	0.22	220.78	3.27		
ACHNANTHES EXIGUA					4.71	0.50
ACHNANTHES HUNGARICA			35.32	0.52	154.25	16.40
FRUSTULIA RHOMBOIDES	52.98	0.22				
NAVICULA SP.			17.66	0.26	9.42	1.00
NAVICULA PUPULA						
NAVICULA CONFERVACEA			105.97	1.57	88.31	9.39

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982 (Continued, Page 3 of 12)

PINNULARIA SP.	141.30	0.59	114.80	1.70	4.70	0.50
PINNULARIA ACROSPHAERIA					43.56	4.63
STAURONEIS SP.					3.53	0.38
CYMBELLA SP.					1.17	0.12
GOMPHONEMA SP.	52.98	0.22			8.24	0.88
GOMPHONEMA GRACILE					28.26	3.00
EPITHEMIA SP.						
EUNOTIA SP.	105.97	0.45	17.66	0.26	220.19	23.41
EUNOTIA PECTINALIS (INCL. VARIETIES)					15.30	1.63
EUNOTIA CURVATA	300.26	1.26	79.48	1.18		
EUNOTIA FLEXUOSA/CURVATA						
NITZSCHIA SP.	1607.28	6.76	3391.20	50.26	58.87	6.26
NITZSCHIA PARVULA			8.83	0.13		
	5,581	23	5,016	74	683	73
PYRROPHYTA						
GLENODINIUM SP.	123.63	0.52				
PERIDINIUM SP.						
	124	1	0	0	0	0
UNIDENTIFIED PHYTOFLAGELLATES	35.32	0.15			1.17	0.12
UNIDENTIFIED COCCOID COLONIES	52.98	0.22				
UNIDENTIFIED COCCOIDS						
	88	0	0	0	1	0
	23,791	100	6,747	100	941	100

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 4 of 12)

	HC		HM		HN		M1	
	#/ML	PCT	#/ML	PCT	#/ML	PCT	#/ML	PCT
CYANOPHYTA								
APHANOCAPSA INCERTA							323.81	4.36
COCCOCHLORIS SP.							326.75	4.40
LYNGBYA SP.							105.97	1.43
OSCILLATORIA SP.							117.75	1.59
ANABAENA SP.							158.96	2.14
SCYTONEMA SP.							288.48	3.89
UNIDENTIFIED FILAMENTOUS BLUE-GREEN								
	0	0	0	0	0	0	1,322	18
CHLOROPHYTA								
CHLAMYDOMONAS SP.	280.83	6.65	1095.07	6.26	105.97	8.16	250.22	3.37
CHLOROCOCCUM SP.								
EUGLENA SP.	10.59	0.25	35.32	0.20				
EUGLENA SP.								
PTEROMONAS SP.	10.59	0.25	70.65	0.40	21.19	1.63		
MOUGEOTIA SP.							23.55	0.32
CLOSTERIUM SP.					10.59	0.82	38.27	0.52
STAURASTRUM SP.								
COSMARIUM SP.					5.30	0.41		
GEIDOMONAS SP.								
ACTINASTRUM HANTZSCHII					5.30	0.41		
SCENEDESMUS SP.	15.89	0.38	105.97	0.61	37.09	2.86		
CRUCIGENIA SP.			35.32	0.20	10.60	0.82		
CRUCIGENIA CRUCIFERA	10.59	0.25						
COELASTRUM SP.	10.59	0.25						
COELASTRUM SPHAERICUM	15.89	0.38						
MICRACTINIUM SP.	10.59	0.25			5.30	0.41		
COLYSTIS SP.								
ANKISTRODESMUS SP.	10.59	0.25					26.49	0.36
ANKISTRODESMUS FALCATUS			671.17	3.84	42.39	3.26		
ANKISTRODESMUS CONTORTUS			105.97	0.61	21.19	1.63		
TETRAEDRON MINIMUM	5.30	0.13	35.32	0.20	5.30	0.41		
SCHROEDERIA SETIGERA	42.39	1.00						
CLOSTERIOPSIS LONGISSIMA			35.32	0.20				
KIRCHNERIELLA SPP					10.60	0.82		
UNIDENTIFIED COCCOID-GREENS-NON-FLAGELLATED			105.97	0.61				
UNIDENTIFIED FLAGELLATED GREEN ALGAE			176.62	1.01				
	424	10	2,473	14	281	22	339	5
EUGLENOPHYTA								
EUGLENA SP.	121.87	2.89	105.97	0.61	10.59	0.82	141.30	1.90
EUGLENA ACUMINATA	21.19	0.50						
EUGLENA TORTUS								

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982 (Continued, Page 5 of 12)

	HC		HM		HN		M1	
	#/ML	PCT	#/ML	PCT	#/ML	PCT	#/ML	PCT
PHACUS CF. ORBICULARIS								
EUGLENA SP.	21.19	0.50			31.79	2.45		
EUGLENA AGUS	21.19	0.50	35.32	0.20	68.88	5.30	61.82	0.83
LEPOCINCLIS SP.								
LEPOCINCLIS FUSIFORMIS					31.79	2.45		
TRACHELOMONAS SP.							111.86	1.51
TRACHELOMONAS VOLVOCINA	291.43	6.90	777.15	4.44	95.37	7.35		
TRACHELOMONAS HISPIDA			35.32	0.20	21.19	1.63		
TRACHELOMONAS CYLINDRICA								
TRACHELOMONAS ARMATA								
	477	11	954	5	260	20	315	4
CHRYSOPHYTA								
CHROMULINE SP.			35.32	0.20			26.49	0.36
DINOBRYON SP.								
ERMIA SP.	21.19	0.50						
MALLOMONAS SP.	10.59	0.25	211.95	1.21	84.77	6.53		
SYNURA UVELLA	5.30	0.13						
SYNURA UVELLA (SINGLE CELLS)	280.83	6.65	777.15	4.44	153.66	11.83		
	318	8	1,024	6	238	18	26	0
CRYPTOPHYTA CRYPTOPHYCEAE								
CHROOMONAS SP.			141.30	0.81			456.28	6.15
CHROOMONAS ACUTISTRIATA	2665.27	63.11	1236.37	7.07	254.34	19.59		
CRYPTOMONAS SP.	31.79	0.75	141.30	0.81	26.49	2.04	38.27	0.52
CRYPTOMONAS EROSA								
	2,697	64	1,519	9	281	22	495	7
BACILLARIOPHYCEAE								
CYCLOTELLA SP.	31.79	0.75	2508.07	14.34	137.76	10.61		
MELOSIRA SP.	26.49	0.63	3850.42	22.02			70.65	0.95
MELOSIRA GRANULATA			2614.05	14.95				
MELOSIRA ISLANDICA								
MELOSIRA ITALICA			1377.67	7.88				
SYNEDRA SP.	47.68	1.13	105.97	0.61	42.39	3.26	70.65	0.95
SYNEDRA ULNA							632.90	8.53
ACHNANTHES SP.			35.32	0.20				
ACHNANTHES EXIGUA								
ACHNANTHES HUNGARICA							1630.83	21.97
FRUSTULIA RHOMBOIDES								
NAVICULA SP.			70.65	0.40				
NAVICULA FUPULA					5.30	0.41		
NAVICULA CONFERVACEA	5.30	0.13					244.33	3.29

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982 (Continued, Page 6 of 12)

PINNULARIA SP.	10.59	0.25					150.13	2.02
PINNULARIA ACROSPHAERIA	10.59	0.25						
SYNEDRA SP.								
SYNEDRA SP.							38.27	0.52
SYNEDRA SP.							64.76	0.87
SYNEDRA GRACILE							26.49	0.36
EPITHEMIA SP.								
EUNOTIA SP.	10.59	0.25					556.37	7.49
EUNOTIA RECTINALIS (INCL. VARIETIES)								
EUNOTIA CURVATA	31.79	0.75						
EUNOTIA FLEXUOSA/CURVATA							347.36	4.68
NITZSCHIA SP.	42.38	1.00	812.47	4.65	31.79	2.45	730.05	9.83
NITZSCHIA PARVULA								
	217	5	11,375	65	217	17	4,563	61
PYRROPHYTA								
GLENODINIUM SP.			35.32	0.20	21.19	1.63		
PERIDINIUM SP.	15.89	0.38					52.98	0.71
	16	0	35	0	21	2	53	1
UNIDENTIFIED PHYTOFLAGELLATES	58.28	1.38					312.03	4.20
UNIDENTIFIED COCCOID COLONIES	5.30	0.13	105.97	0.61				
UNIDENTIFIED COCCOIDS	10.59	0.25						
	74	2	106	1	0	0	312	4
	4,223	100	17,486	100	1,298	100	7,424	100

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 7 of 12)

	M2		M3		M4		PB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT	#/ML	PCT
CYANOPHYTA								
APHANOCYSTIS INCERTA								
COCCOCHLORIS SP.								
LYNGBYA SP.					63.58	0.93		
OSCILLATORIA SP.								
ANABAENA SP.								
SCYTONEMA SPP								
UNIDENTIFIED FILAMENTOUS BLUE-GREEN								
	0	0	0	0	64	1	0	0
CHLOROPHYTA								
CHLAMYDOMONAS SP.	706.50	2.30	335.58	22.35	682.95	9.97	2168.95	21.04
CHLOROCOCCUM SP.								
EUDORINA SP.	70.65	0.23					35.32	0.34
PANDORINA SP.	247.27	0.80						
PTEROMONAS SPP.	176.62	0.57	24.72	1.65				
MOUGEOTIA SP.			7.06	0.47				
CLOSTERIUM SP.					374.44	5.47		
STAURASTRUM SP.								
COSMARIUM SP.								
OEDOGONIUM SPP.					42.39	0.62		
ACTINASTRUM HANTZSCHII								
SCENEDESMUS SP.			3.53	0.24				
CRUCIGENIA SP.								
CRUCIGENIA CRUCIFERA								
COELASTRUM SP.								
COELASTRUM SPHAERICUM								
MICRACTINIUM SP.								
COCYSTIS SP.								
ANKISTRODESMUS SP.	35.32	0.11						
ANKISTRODESMUS FALCATUS			7.06	0.47				
ANKISTRODESMUS CONTORTUS			10.59	0.71				
TETRAEDRON MINIMUM								
SCHRODERIA SETIGERA								
CLOSTERIOPSIS LONGISSIMA								
KIRCHNERIELLA SPP								
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED								
UNIDENTIFIED FLAGELLATED GREEN ALGAE								
	1,236	4	389	26	1,100	16	2,204	21
EUGLENOPHYTA								
PHACUS SP.			10.59	0.71	164.85	2.41	35.32	0.34
PHACUS ACUMINATA	105.97	0.34			32.97	0.48		
PHACUS TORTUS								

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982 (Continued, Page 8 of 12)

	M2		M3		M4		PB	
	#/ML	PCT	#/ML	PCT	#/ML	PCT	#/ML	PCT
PHACUS CF. ORBICULARIS								
EUGLENA SP.			7.06	0.47	32.97	0.48	102.44	0.99
EUGLENA ACUS							35.32	0.34
LEPOCINCLIS SP.			24.72	1.65	63.58	0.93		
LEPOCINCLIS FUSIFORMIS								
TRACHELOMONAS SP.	1589.62	5.17						
TRACHELOMONAS VOLVOCINA			169.56	11.29	850.15	12.41	642.91	6.24
TRACHELOMONAS HISPIDA								
TRACHELOMONAS CYLINDRICA					247.27	3.61		
TRACHELOMONAS ARMATA								
	1,696	6	212	14	1,392	20	816	8
CHRYSOPHYTA								
OPHIOCYTIUM SP.								
DINOBRYON SP.					21.19	0.31		
ERMIA SP.								
MALLOMONAS SP.			28.26	1.88	21.19	0.31	35.32	0.34
SYNURA UVELLA	141.30	0.46			63.58	0.93		
SYNURA UVELLA (SINGLE CELLS)	20629.80	67.05	24.72	1.65	282.60	4.13	81.24	0.79
	20,771	68	53	4	389	6	117	1
CRYPTOPHYTA CRYPTOPHYCEAE								
CHROOMONAS SP.	70.65	0.23	70.65	4.71	167.20	2.44		
CHROOMONAS NORDSTEDTII			568.73	37.88			3836.29	37.22
CRYPTOMONAS SP.	529.87	1.72	56.52	3.76	251.98	3.68	45.92	0.45
CRYPTOMONAS EROSA	1518.97	4.94						
	2,119	7	696	46	419	6	3,882	38
BACILLARIOPHYCEAE								
CYCLOTELLA SP.							70.65	0.69
MELOSIRA SP.	211.95	0.69	7.06	0.47				
MELOSIRA GRANULATA								
MELOSIRA ISLANDICA								
MELOSIRA ITALICA							2119.50	20.56
SYNEDRA SP.	141.30	0.46	7.06	0.47	843.09	12.31	381.51	3.70
SYNEDRA ULNA	353.25	1.15						
ACHNANTHES SP.					211.95	3.09	296.73	2.88
ACHNANTHES EXIGUA								
ACHNANTHES HUNGARICA								
FRUSTULIA RHOMBOIDES			3.53	0.24	202.53	2.96		
NAVICULA SP.			10.59	0.71	84.78	1.24	10.59	0.10
NAVICULA RUFULA								
NAVICULA CONFERVACEA							31.79	0.31

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 9 of 12)

PINNULARIA SP.	176.62	0.57	3.53	0.24	190.75	2.78		
PINNULARIA ACROSPHAERIA								
STAUROGLEIS SP.								
CYMBELLA SP.							35.32	0.34
GOMPHONEMA SP.								
COMPHONEMA GRACILE								
EPITHEMIA SP.							35.32	0.34
EUNOTIA SP.	353.25	1.15			367.38	5.36		
EUNOTIA PECTINALIS (INCL. VARIETIES)	105.97	0.34						
EUNOTIA CURVATA					169.56	2.48		
EUNOTIA FLEXUOSA/CURVATA								
NITZSCHIA SP.	3426.52	11.14	88.31	5.88	1125.69	16.43	173.09	1.68
NITZSCHIA PARVULA								
	4,769	15	120	8	3,196	47	3,154	31
PYRROPHYTA								
GLENODINIUM SP.			3.53	0.24				
PERIDINIUM SP.								
	0	0	4	0	0	0	0	0
UNIDENTIFIED PHYTOFLAGELLATES	176.62	0.57	28.26	1.88	141.30	2.06	134.23	1.30
UNIDENTIFIED COCCOID COLONIES					127.17	1.86		
UNIDENTIFIED COCCOIDS					23.55	0.34		
	177	1	28	2	292	4	134	1
	30,768	100	1,501	100	6,851	100	10,308	100

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 10 of 12)

	SB	
	#/ML	PCT
CYANOPHYTA		
APHANOCYSTIS INCERTA		
COCCOCHLORIS SP.		
LYNGBYA SP.		
OSCILLATORIA SP.		
ANABAENA SP.		
SCYTONEMA SPP		
UNIDENTIFIED FILAMENTOUS BLUE-GREEN	15.89	0.62
	16	1
CHLOROPHYTA		
CHLAMYDOMONAS SP.	349.71	13.58
CHLOROGONIUM SP.		
EUDORINA SP.	15.89	0.62
PANDORINA SP.		
PTEROMONAS SPP.	5.30	0.21
MOUGEOTIA SP.		
CLOSTERIUM SP.		
STAURASTRUM SP.		
COSMARIUM SP.		
OEDOGONIUM SPP.	52.98	2.06
ACTINASTRUM HANTZSCHII		
SCENEDESMUS SP.		
CRUCIGENIA SP.		
CRUCIGENIA CRUCIFERA		
COELASTRUM SP.		
COLLASTRUM SPHAERICUM		
MICRACTINIUM SP.		
COCYSTIS SP.		
ANKISTRODESMUS SP.		
ANKISTRODESMUS FALCATUS		
ANKISTRODESMUS CONTORTUS		
TETRAEDRON MINIMUM		
SCHRODERIA SETIGERA		
CLOSTERIOPSIS LONGISSIMA		
KIRCHNERIELLA SPP		
UNIDENTIFIED COCCOIDGREENS-NON-FLAGELLATED	5.30	0.21
UNIDENTIFIED FLAGELLATED GREEN ALGAE		
	429	17
EUGLENOPHYTA		
PHACUS SP.	52.98	2.06
PHACUS ACUMINATA	5.30	0.21
PHACUS TORTUS	5.30	0.21

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 11 of 12)

	SB	
	#/ML	PCT
FUSCUS CF. ORBICULARIS	5.30	0.21
EUGLENA SP.	47.68	1.85
EUGLENA ACUS	26.49	1.03
LEPOCINCLIS SP.		
LEPOCINCLIS FUSIFORMIS	15.89	0.62
TRACHELOMONAS SP.		
TRACHELOMONAS VOLVOCINA	784.21	30.45
TRACHELOMONAS HISPIDA		
TRACHELOMONAS CYLINDRICA	5.30	0.21
TRACHELOMONAS ARMATA		
	948	37
CHRYSOPHYTA		
CHROMULINA SP.		
CHRYSOCOCCUS SP.		
ERMIA SP.		
MALLOMONAS SP.		
SYNURA UVELLA	21.19	0.82
SYNURA UVELLA (SINGLE CELLS)	68.88	2.67
	90	3
CRYPTOPHYTA CRYPTOPHYCEAE		
CHROOMONAS SP.	370.91	14.40
CHROOMONAS NORDSTEDTII	174.85	6.79
CRYPTOMONAS SP.	153.66	5.97
CRYPTOMONAS EROSA		
	699	27
BACILLARIOPHYCEAE		
CYCLOTELLA SP.	10.60	0.41
MELOSIRA SP.		
MELOSIRA GRANULATA		
MELOSIRA ISLANDICA		
MELOSIRA ITALICA	74.18	2.88
SYNEDRA SP.	105.97	4.11
SYNEDRA ULNA		
ACHNANTHES SP.	37.09	1.44
ACHNANTHES EXIGUA		
ACHNANTHES HUNGARICA		
FRUSTULIA PHOMBOIDES		
NAVICULA SP.		
NAVICULA FUPULA		
NAVICULA CONFERVACEA	68.88	2.67

Table 8.1.4-11. Density (#/ml) and Percent Composition (PCT) of Phytoplankton Taxa Identified from CF Complex II Site, February 1982. (Continued, Page 12 of 12)

PINNULARIA SP.		
PINNULARIA ACROSPHAERIA		
STAURONEIS SP.		
CYMBELLA SP.		
COMPHONEMA SP.		
COMPHONEMA GRACILE		
EPITHEMIA SP.		
EUNOTIA SP.	5.30	0.21
EUNOTIA PECTINALIS (INCL. VARIETIES)		
EUNOTIA CURVATA	10.60	.0.41
EUNOTIA FLEXUOSA/CURVATA		
NITZSCHIA SP.	74.18	2.88
NITZSCHIA PARVULA		
	387	15
PYRROPHYTA		
GLENODINIUM SP.	5.30	0.21
PERIDINIUM SP.		
	5	0
UNIDENTIFIED PHYTOFLAGELLATES		
UNIDENTIFIED COCCOID COLONIES		
UNIDENTIFIED COCCOIDS		
	0	0
	2,575	100
	8,225	500

Key to Stations:
- BC = Brushy Creek
- DB = Doe Branch
- HC = Horse Creek*
- PB = Plunder Branch
- CB = Coons Bay
- SB = Shirttail Branch
- HM = Horse Creek Mid Station
- HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-12. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, July 1981

Taxon	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek
Cyanophyta					
Anabaena spp.	X		X	X	X
Anacystis spp.			X		
Lyngbya spp.	X		X	X	
Oscillatoria spp.	X		X	X	
Chlorophyta					
Ankistrodesmus spp.	X		X	X	
Chlamydomonas spp.				X	
Closterium spp.					X
Cosmarium spp.			X		
Crucigenia spp.	X				
Euastrum spp.				X	
Eudorina spp.				X	
Mougeotia spp.	X			X	
Pandorina spp.					
Scenedesmus spp.	X		X	X	
Unidentified coccoid greens				X	X
Unidentified filamentous greens	X			X	X
Euglenophyta					
Phacus spp.	X			X	X
P. acuminata					X
Trachelomonas volvocina	X		X	X	X
Bacillariophyceae					
Achnanthes spp.	X	X	X	X	X
A. exigua	X	X	X		
A. hungarica			X		X
Carpatogramma crucicula			X		
Cocconeis spp.	X	X			
C. placentula					
Cyclotella spp.	X	X	X		
Cymbella spp.		X	X	X	
Diploneis spp.		X	X		
Epithemia spp.	X				
Eunotia spp.	X	X	X	X	X
E. indica		X			
E. pectinalis	X			X	
Frustulia rhomboides		X	X		
Gomphonema spp.	X	X	X	X	X
Melosira spp.	X	X	X	X	X
M. varians				X	X

Table 8.1.4-12. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, July 1981 (Continued, Page 2 of 2)

Taxon	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek
Bacillariophyceae (Continued)					
Navicula spp.	X	X	X	X	X
N. confervacea	X	X	X	X	X
N. pupula		X		X	
Nitzschia spp.	X	X	X	X	X
N. acicularis	X				
N. palea		X			
N. parvula					
Pinnularia spp.	X	X	X	X	X
P. abaugensis	X				
Rhopalodia gibba	X	X		X	
Synedra spp.	X		X	X	
S. ulna	X			X	
Chrysophyta					
Dinobryon spp.					X
Pyrrophyta					
Peridinium spp.	X				
P. inconspicuum				X	

Source: ESE, 1983

Table 8.1.4-13. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, August 1981

Taxon	Station				
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek
Cyanophyta					
Anabaena spp.		X			
A. variabilis	X	X			
Lyngbya spp.	X		X	X	X
Oscillatoria spp.	X		X		
O. geminata	X				
Chlorophyta					
Ankistrodesmus spp.	X		X		
Chlamydomonas spp.	X	X			X
Closterium spp.		X		X	
Mougeotia spp.	X				
Scenedesmus spp.	X			X	X
Schroederia setigerum			X		
Spirogyra spp.	X	X			
Staurastrum spp.					X
Unidentified coccoids			X		
Unidentified filaments		X			
Unidentified flagellates			X		X
Euglenophyta					
Phacus spp.		X		X	X
Trachelomonas spp.	X				
T. hispida	X				
T. volvocina	X				X
Bacillariophyceae					
Achnanthes spp.	X	X	X	X	X
A. exigua	X	X			
Cocconeis spp.	X				
C. placentula	X				
Cymbella spp.					X
Eunotia spp.	X	X	X		X
Frustulia spp.				X	
Gomphonema spp.	X	X			
G. angustatum					X
Gyrosigma spp.	X				
Melosira spp.	X	X		X	X
M. varians	X	X		X	
Navicula spp.	X	X	X	X	X
N. confervacea	X	X	X		X
N. pupula	X	X			X

Table 8.1.4-13. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, August 1981 (Continued, Page 2 of 2)

Taxon	Station				
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek
Bacillariophyceae (Continued)					
Nitzschia spp.	X	X	X	X	X
N. palea	X	X	X	X	X
Pinnularia spp.	X	X	X	X	X
Rhopalodia gibba	X	X			
Synedra spp.	X			X	
S. ulna	X				
Chrysophyta					
Centritractus spp.		X			
Mallomonas spp.					X
Ophiocytium spp.					X
Pyrrophyta					
Chroomonas spp.	X				X
Cryptomonas spp.	X		X		

Source: ESE, 1983.

Table 8.1.4-14. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, September 1981

Taxon	Station					
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek	Coon's Bay Branch
Cyanophyta						
Anabaena spp.	X	X				
Anacystis spp.						
Oscillatoria spp.	X		X			
Chlorophyta						
Chlamydomonas spp.			X			
Chlorococcum spp.						X
Kirchneriella spp.			X			
Mougeotia spp.					X	
Oedogonium spp.		X			X	
Pteromonas spp.			X			
Spirogyra spp.				X		
Ulothrix spp.					X	
Euglenophyta						
Phacus spp.		X				
Trachelomonas spp.	X	X	X			
Bacillariophyceae						
Achnanthes spp.	X	X	X			
Cocconeis spp.	X					
C. placentula			X			
Cyclotella spp.			X			
Cymbella spp.	X	X	X		X	
Diploneis spp.	X		X			
Epithemia spp.	X					
Eunotia spp.	X	X	X	X	X	X
E. curvata						X
Frustulia rhomboides	X	X	X	X		
Gomphonema spp.	X	X	X			
Melosira spp.		X		X	X	X
M. islandica					X	
M. italica	X	X				
Navicula spp.	X	X	X			X
N. confervacea	X	X	X	X	X	
Nitzschia spp.	X	X	X	X	X	X
Pinnularia spp.	X	X	X	X	X	X
Rhopalodia gibba	X					
Stauroneis spp.	X					
Synedra spp.	X	X	X			X

Table 8.1.4-14. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, September 1981 (Continued, Page 2 of 2)

Taxon	Station					
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek	Brushy Creek	Coon's Bay Branch
Chrysophyta						
Mallomonas spp.	X	X	X			
Unidentified flagellates	X					
Pyrrophyta						
Chroomonas spp.						X
Cryptomonas spp.			X			

Source: ESE, 1983.

Table 8.1.4-15. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, October 1981

Taxon	Station						
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek South	Horse Creek Middle	Horse Creek North	Brushy Creek
Cyanophyta							
Anabaena spp.	X			X	X		X
Lyngbya spp.	X						
Oscillatoria spp.			X	X	X		X
Unidentified filaments				X			
Chlorophyta							
Ankistrodesmus spp.			X	X	X		
A. falcatus						X	X
Chlamydomonas spp.		X		X			
Closteriopsis spp.				X		X	
Closterium spp.	X			X	X		X
Cosmarium spp.				X	X		
Desmidium spp.				X			
Euastrum spp.				X	X	X	
Hyalotheca spp.				X			
Micrasterias spp.					X		
M. pinnatifida				X			
Mougeotia spp.				X	X		X
Oocystis spp.				X			
Oedogonium spp.		X			X		
Pediastrum spp.						X	
Pleurotaenium spp.				X			
Pteromonas spp.				X			
Quadrigula spp.					X		
Scenedesmus spp.				X			
Spirogyra spp.				X			X
Staurastrum spp.						X	
Ulothrix spp.				X	X		X
Unidentified coccoids							X
Unidentified filaments	X		X	X			X
Euglenophyta							
Euglena spp.							X
Phacus acuminata		X					
Trachelomonas spp.	X		X	X		X	X
Bacillariophyceae							
Achnanthes spp.	X	X	X	X	X	X	X
A. exigua		X	X				
A. hungarica		X	X	X			
Cocconeis spp.	X	X				X	

Table 8.1.4-15. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, October 1981 (Continued, Page 2 of 3)

Taxon	Station						
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek South	Horse Creek Middle	Horse Creek North	Brushy Creek
Bacillariophyceae (Continued)							
Cyclotella meneghiniana		X	X				
Cymbella spp.	X	X	X		X		X
C. minuta						X	
Diploneis spp.			X				
Epithemia spp.	X						
Eunotia spp.	X		X		X	X	X
E. curvata				X			
E. diodon	X	X					
E. major var. major		X					
E. pectinalis var. minor	X				X	X	X
E. pectinalis var. pectinalis						X	
E. cf. sudetica		X			X	X	X
Frustulia rhomboides		X		X	X	X	
Gomphonema spp.	X	X	X	X			X
G. parvulum					X		
G. sphaerophorum			X		X	X	
G. subclavatum	X	X	X	X			
Hantzschia spp.	X						
Melosira spp.	X						
M. granulata				X			
M. islandica				X		X	X
M. italica		X					
Navicula spp.				X		X	
N. confervacea	X	X	X	X	X	X	X
N. pupula		X					
Nitzschia spp.	X	X	X	X		X	
N. filiformis					X	X	
N. palea				X	X	X	X
Pinnularia spp.	X	X	X	X	X		X
P. abaugensis			X				
Rhopalodia gibba	X	X					
Stauroneis spp.							X
Surirella spp.	X						
Synedra spp.	X		X			X	X
S. ulna				X	X	X	
Chrysophyta							
Mallomonas spp.	X			X			
Ophiocytium spp.				X			X

Table 8.1.4-15. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, October 1981 (Continued, Page 3 of 3)

Taxon	Station						
	Plunder Branch	Shirttail Branch	Doe Branch	Horse Creek South	Horse Creek Middle	Horse Creek North	Brushy Creek
Pyrrophyta							
Glenodinium spp.							X
Cryptophyta							
Chroomonas spp.	X			X		X	
Cryptomonas spp.	X					X	X

Source: ESE, 1983.

Table 8.1.4-16. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, February 1982

Taxon	Station											
	PB	SB	DB	HS	HM	HN	BC	CB	M1	M2	M3	M4
Cyanophyta												
Anabaena spp.	X											
Lyngbya spp.		X										
Oscillatoria spp.	X		X			X						
O. geminata	X											
Chlorophyta												
Ankistrodesmus spp.			X	X	X	X	X	X				
Asterococcus spp.												
Chlamydomonas spp.	X			X	X		X					
Chlorogonium spp.												
Closterium spp.							X					
Coelastrum spp.				X			X					
Cosmarium spp.							X					
Euastrum spp.						X						
Eudorina spp.		X		X			X			X		
Gloeocystis spp.					X							
Kirchneriella spp.						X						
Micratinium spp.				X								
Mougeotia spp.	X						X			X		
Oedogonium spp.	X			X			X					
Pandorina spp.		X			X							
Pediastrum duplex var. reticulatum					X							
Pteromonas spp.				X		X	X			X		
Scenedesmus spp.	X			X		X	X					
S. arcuatus					X							
Selenastrum spp.				X								
Staurastrum spp.												
Ulothrix spp.							X					
Unidentified coccoids			X	X		X	X	X				
Unidentified colonies							X					
Unidentified filaments				X			X					
Euglenophyta												
Euglena spp.								X			X	
Lepocinclis spp.											X	
Phacus spp.	X		X	X			X					
Trachelomonas spp.		X	X	X			X					X
Bacillariophyceae												
Achnanthes spp.	X	X		X		X	X	X		X	X	X
A. exigua	X	X	X			X			X	X		X
A. hungarica			X									

Table 8.1.4-16. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, February 1982 (Continued, Page 2 of 3)

Taxon	Station											
	PB	SB	DB	HS	HM	HN	BC	CB	M1	M2	M3	M4
Bacillariophyceae (Continued)												
A. cf. peragalli						X						
Cyclotella meneghiniana			X		X	X					X	
C. striata	X	X	X				X	X				
Cocconeis placentula	X											
Cymbella spp.	X		X	X		X				X		
C. lanceolata								X				
C. minuta		X				X				X		X
Diploneis spp.								X	X			
D. smithii	X	X										
Epithemia spp.	X											
E. argus var. alpestris	X											
Eunotia spp.	X			X					X		X	
E. arcus var. bidens										X		
E. curvata			X	X	X		X	X			X	X
E. diodon								X				
E. flexuosa	X	X							X	X	X	
E. formica						X						
E. incisa		X			X						X	
E. indica												X
E. pectinalis varieties	X			X	X			X		X	X	
E. pectinalis var. minor			X		X	X			X			X
E. sudetica/incisa			X	X	X	X	X			X		
E. tautoniensis										X		
E. triodon var. triodon												X
Frustulia rhomboides	X	X		X	X	X	X	X	X	X	X	X
Gomphonema spp.				X		X						X
G. gracile		X		X	X			X			X	
G. parvulum		X	X		X							
G. sphaerophorum		X				X					X	
G. subclavatum									X			
Hantzschia spp.								X				
H. amphioxys								X	X			
Melosira spp.								X		X	X	X
M. granulata			X		X	X	X					
M. islandica				X				X				
M. italica	X	X										
Navicula spp.						X		X				
N. confervacea	X	X	X	X	X	X	X	X	X	X		
N. pupula			X	X		X						

Table 8.1.4-16. Presence/Absence Matrix of Periphyton Taxa Identified From CF Complex II Site, February 1982 (Continued, Page 3 of 3)

Taxon	Station											
	PB	SB	DB	HS	HM	HN	BC	CB	M1	M2	M3	M4
Bacillariophyceae (Continued)												
N. salinarum			X									
Neidium spp.		X										
N. iridis						X						
Nitzschia spp.	X	X		X	X	X	X		X		X	X
N. acicularis						X						
N. clausii				X	X	X						
N. obtusa								X				
N. palea	X	X		X			X	X	X	X	X	X
N. parvula								X				
N. tryblionella			X									
Pinnularia spp.		X	X	X	X	X	X	X		X		
P. acrosphaeria			X						X	X		
P. biceps var. biceps												X
P. braunii										X		X
Rhopalodia spp.	X											
R. gibba var. ventricosa	X		X		X	X						
Stauroneis spp.			X			X		X				
Surirella spp.								X				
Synedra spp.				X			X			X	X	
S. ulna	X		X			X			X			
Chrysophyta												
Mallomonas spp.			X		X		X			X	X	
Ophiocytium spp.	X	X			X	X	X					
Synura spp.									X			
Pyrrophyta												
Peridinium spp.				X			X					
Cryptophyta												
Cryptomonas spp.	X	X	X	X	X		X			X	X	
Chroomonas spp.		X										
Unidentified flagellates					X	X		X		X		X
Unidentified filaments					X	X					X	

Key to Stations: PB = Plunder Branch
SB = Shirttail Branch
DB = Doe Branch
HS = Horse Creek South
HM = Horse Creek Middle
HN = Horse Creek North
BC = Brushy Creek
CB = Coon's Bay Branch
M1 - M4 = Mitchell Hammock Transect 1 through 4

Source: ESE, 1983.

Table 8.1.4-17. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, July 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
ANNELIDA													
LUMBRICULIDAE	X				X								
TUBIFICIDAE (W/O CAPILLIFORM	X				X							X	X
TUBIFICIDAE (W CAPILLIFORM SE	X				X								
LIMNODRILUS HOFFMEISTERI					X								
AULODRILUS PIGUETTI													X
PSAMMORYCTIDES CONVOLUTUS	X												
DERO SP.	X												
DERO NIVEA												X	
DERO TRIFIDA				X									
PRISTINA LONGISOMA	X				X								
PROBODELLA SPP.	X												
INSECTA													
SYNTHURIDAE						X							
LIBELLULIDAE				X									
HETEROCERIDAE	X												
TANYPUS CAPINATUS				X									
CHIRONOMUS PLUMOSUS													X
POLYPEDILUM ILLINOENSE				X									
SPELDICHIPCNOMUS HOLOPPASINUS						X							X

Key to Stations: BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-18. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, August 1981.

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CNIDARIA													
HYDROZOA					x								
TURBELLARIA													
TURBELLARIA					x								
NEMATODA													
NEMATODA	x												
ANNELIDA													
LUMBRICULIDAE	x				x								
TUBIFICIDAE (W/O CAPILLIFORM	x				x							x	x
TUBIFICIDAE (W CAPILLIFORM SE	x				x								
LIMNODRILUS HOFFMEISTERI	x				x							x	
AULODRILUS PIGUETTI					x								
NAIDIDAE	x				x							x	x
DERO SP.	x				x								x
DERO DIGITATA					x							x	
DERO NIVEA	x											x	
DERO OBTUSA					x								
DERO VAGA													x
STYLARIA SP.					x								
PRISTINA LONGISETA LONGISETA					x								
PRISTINA LONGISOMA	x												x
PRISTINA OSBORNI					x								
BRATISLAVIA UNIDENTATA	x				x								
HAEMONAIS WALDVOGELI					x							x	
HIRUDINEA	x												
CRUSTACEA													
ASELLUS SP.												x	
HYALELLA AZTECA				x									
CRANGONYX SP.	x												
INSECTA													
HEMIPTERA	x												
CYRALIDAE												x	
COLEOPTERA	x												x
DYTISCIDAE	x												
ENOCHRUS SPP. ADULT	x												
CHAOBORUS SP.					x								x
MONOPELOPIA BOLIEKA												x	
LAPSIA SP.	x												
CHIRONOMUS SPP.													x
DICROTENDIPES SP.												x	

Table 8.1.4-18. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, August 1981. (Continued, Page 2 of 2)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SP
POLYPEDILUM SP.												x	
POLYPEDILUM ILLINOENSE	x			x									x
SOELOTHIRCNOMUS HOLOPRASINUS	x												
TANYTARSUS SP.						x							
ECTOPROCTA												x	

Key to Stations:
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DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-19. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, September 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA				x	x								
ANNELIDA													
LUMBRICULIDAE	x		x		x								
TUBIFICIDAE (W/O CAPILLIFORM	x		x		x							x	x
TUBIFICIDAE (W CAPILLIFORM SE	x		x	x	x							x	x
LIMNODRILUS HOFFMEISTERI	x		x		x							x	x
AULODRILUS PIGUETTI			x		x							x	x
NAIDIDAE	x		x	x	x							x	x
SLAVINA APPENDICULATA					x								
DERO SP.	x		x	x	x								x
DERO DIGITATA				x								x	x
DERO NIVEA	x				x								x
DERO TRIFIDA	x			x									x
DERO PECTINATA			x										
DERO FLABELLIGER	x												x
DERO SP.A (CF.TRIFIDA-DIGITATA)													x
STYLARIA FOSSULARIS			x										
PRISTINA SP.			x		x								
PRISTINA LONGISETA LEIDYI					x								
PRISTINA FORELI					x								
PRISTINA LONGISOMA				x	x								
PRISTINA SYNCLITES			x										
PRISTINA BREVISETA													x
PRISTINA AEQUISETA					x								
BRATISLAVIA UNIDENTATA	x				x								x
HAEMONAIS WALDVOGELI					x							x	x
HIRUDINEA					x								
MOLLUSCA													
ANCYLIDAE				y	x								y
SPHAERIUM SP.	x												x
CRUSTACEA													
OSTRACODA	x												
CRANGONYX SP.												x	
INSECTA													
COLLEMBOLA			x										
LEPISMATIDAE													x
CORNAGRIONIDAE			x										
BUENOA SPP.				x									
PYRALIDAE				x									
COLEOPTERA PUPA			x										x

Table 8.1.4-19. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, September 1981 (Continued, Page 2 of 2)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CYSTICUS SPP. LARVAE	x												
CULEX SP.	x												
CHAOBORUS SP.				x								x	x
PROBEZZIA SP.					x								
TANYPUS CAPINATUS													x
APLABESMYIA PARAJANTA					x								
MONOPELOPIA BOLIEKA			x										
LABRUNDINIA SP.			x										
LABRUNDINIA FLORIDANA			x		x								
LARSIA SP.			x		x								
CLINOTANYPUS PINGUIS					x								x
CHIRONOMINI UNIDENTIFIED FIRST INSTAR			x										
CHIRONOMUS SP.	x		x	x									x
CHIRONOMUS SITSMATERUS	x		x	x	x								
CHIRONOMUS SPP.					x								
CRYPTOCHIRONOMUS FULVUS					x								
PARACHIRONOMUS CARINATUS			x										
PSEUDOSMUS PECKAE				x									
POLYPEDILUM HALTERALIS					x								
POLYPEDILUM ILLINOENSE	x		x		x								x
TRIBELOS SP. D					x								
GOELDICHIRONOMUS HOLOPRASINUS	x		x										x
KIEFFERULUS DUX	x		x		x								x
XENOCHIRONOMUS XENOLABIS					x								
TANYTARSUS SP.				x									
TANYTARSUS SPP.					x								
HEMEROPA SP.				x									

Key to Stations:
- BC = Brushy Creek
- DB = Doe Branch
- HC = Horse Creek*
- PB = Plunder Branch
- CB = Coons Bay
- SB = Shirttail Branch
- HM = Horse Creek Mid Station
- HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-20. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, October 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA					x								
ANNELIDA													
TUBIFICIDAE (W/O CAPILLIFORM					x	x	x						
TUBIFICIDAE (W CAPILLIFORM SE					x	x	x						
LIMNODRILUS HOFFMEISTERI					x	x	x						
EULODRILUS PIGUETTI					x	x	x						
NAIDIDAE					x								
SLAVINA APPENDICULATA					x								
DERO SP.						x							
DERO DIGITATA						x							
DERO VAGA						x							
PRATISLAVIA UNIDENTATA						x							
HARNISCHIA VALDVOGELI					x								
MOLLUSCA													
ANCYLIDAE					x								
ARACHNIDA													
ACARINA						x							
INSECTA													
COLLEMBOLA SP F					x	x							
BOURTIELLA SP						x							
CALLIBAETIS SPP.						x							
CAENIS SP.						x	x						
CORETHUS SP							x						
AEHYLLA SPP.						x	x						
ENALLAGMA SP.						x							
HEMIPTERA						x							
CLIVACIA AREOLARIS					x								
TRICHOPTERA							x						
HYDROCANTHUS SPP.						x							
BERDSUS SPP. LARVAE						x							
PROCLADIUS SP.						x							
MONOPELOPIA PALIEKA						x							
LAPPUNDINIA JOHANNSENI						x							
CLINOTANYPUS PINGUIS							x						
CHIRONOMUS SP.					x		x						
CHIRONOMUS STIGMATERUS					x								
PARACHIRONOMUS CARINATUS					x								
POLYPEDILUM HALTERALIS						x	x						
POLYPEDILUM ILLINOENSE					x	x	x						
TANYTARSUS SP.					x	x	x						

Key to Stations:

BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-21. Presence/Absence Matrix of Benthic Infaunal Taxa Identified From CF Complex II Site, February 1982.

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
NEMATODA							x						
ANNELIDA													
LUMBRICULIDAE					x	x	x						
TUBIFICIDAE (W/O CAPILLIFORM					x	x	x						
TUBIFICIDAE (W CAPILLIFORM SE					x	x	x						
DERO DIGITATA					x								
PRISTINA LONGISOMA						x							
HAEMONAIS WALDVOGELI							x						
HIRUDINEA							x						
ARACHNIDA													
ACARINA						y							
CRUSTACEA													
BRANCHIOPODA						x							
HYALELLA AZTECA					x								
CRANGONYX SP.					x	x							
INSECTA													
COLLEMBOLA						x							
HEMIPTERA						x							
GALLEPUCALLA SP						x							
DIPTERA SP. NR. PSYCLEDIDAE						x							
SCIARA SP						x							
CERATOPOGON SP.						x							
LARSIA SP.						x							
CHIRONOMUS SPP.						x							
POLYPEDILUM ILLINOENSE					x	x	x						
TANYTARSUS SPP.					x		x						
CHRYSOPS SP.						x							

Key to Stations:
- BC = Brushy Creek
- DB = Doe Branch
- HC = Horse Creek*
- PB = Plunder Branch
- CB = Coons Bay
- SB = Shirttail Branch
- HM = Horse Creek Mid Station
- HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-22. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981

TRIP = 1 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	2007.50	63.22	63.22
HETEROCERIDAE	474.50	14.94	78.16
LUMBRICULIDAE	292.00	9.20	87.36
PSAMMORYCTIDES CONVOLUTUS	146.00	4.60	91.96
TUBIFICIDAE (W CAPILLIFORM SE	109.50	3.45	95.41
DERO SP.	73.00	2.30	97.71
PRISTINA LONGISOMA	36.50	1.15	98.86
ERPODELLA SPP.	36.50	1.15	100.01
	3,175	100.01	

Table 8.1.4-22. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981 (Continued, Page 2 of 5)

TRIP = 1 GROUP = OB

SPECIES NAME	#/M**2	PCT	CUM_PCT
POLYPEDILUM ILLINOENSE	73.00	40.00	40.00
DERO TRIFIDA	36.50	20.00	60.00
LIMNELLULIDAE	36.50	20.00	80.00
TANYPUS CAPINATUS	36.50	20.00	100.00
	182	100.00	

Table 8.1.4-22. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981. (Continued, Page 3 of 5)

TPIP = 1 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	401.50	52.38	52.38
LIMNODRILUS HOFFMEISTERI	146.00	19.05	71.43
LUMBRICULIDAE	73.00	9.52	80.95
TUBIFICIDAE (W CAPILLIFORM SE	36.50	4.76	85.71
PRISTINA LONGISOMA	36.50	4.76	90.47
SMYNTHURIDAE	36.50	4.76	95.23
GOELDICHIRONOMUS HOLOPRASINUS	36.50	4.76	99.99
	766	99.99	

Table 8.1.4-22. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981 (Continued, Page 4 of 5)

TRIP = 1 GROUP = PB

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	146.00	80.00	80.00
DERO NIVEA	36.50	20.00	100.00
	182	100.00	

Table 8.1.4-22. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, July 1981. (Continued, Page 5 of 5)

TRIP = 1 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM PCT
AULODRILUS PIGUETTI	73.00	28.57	28.57
CHIRONOMUS PLUMOSUS	73.00	28.57	57.14
GOELDICHIRONOMUS HOLOPRASINUS	73.00	28.57	85.71
TUBIFICIDAE (W/O CAPILLIFORM	36.50	14.29	100.00
	255	100.00	

Key to Stations:
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DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-23. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981

TRIP = 2 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	2098.75	54.50	54.50
TUBIFICIDAE (W CAPILLIFORM SE	383.25	9.95	64.45
LUMBRICULIDAE	346.75	9.00	73.45
NEMATODA	219.00	5.69	79.14
COLEOPTERA	200.75	5.21	84.35
NAIDIDAE	127.75	3.32	87.67
DERO SP.	73.00	1.90	89.57
PRISTINA LONGISOMA	73.00	1.90	91.47
PRATISLAVIA UNIDENTATA	73.00	1.90	93.37
POLYPEDILUM ILLINOENSE	54.75	1.42	94.79
ENDOCHURUS SPP. ADULT	36.50	0.95	95.74
LARSIA SP.	36.50	0.95	96.69
LIMNODRILUS HOFFMEISTERI	18.25	0.47	97.16
DERO NIVEA	18.25	0.47	97.63
HIRUDINEA	18.25	0.47	98.10
CRANGONYX SP.	18.25	0.47	98.57
HEMIPTERA	18.25	0.47	99.04
CYTISCIDAE	18.25	0.47	99.51
GOELDICHIRONOMUS HOLOPRASINUS	18.25	0.47	99.98
	3,851	99.98	

Table 8.1.4-23. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981 (Continued, Page 2 of 5)

TRIP = 2 GROUP = D8

SPECIES NAME	#/M**2	PCT	CUM PCT
HYALELLA AZTECA	36.50	50.00	50.00
POLYPEDILUM ILLINOENSE	36.50	50.00	100.00
	73	100.00	

Table 8.1.4-23. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981. (Continued, Page 3 of 5)

TRIP = 2 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
AULODRILUS PIGUETTI	2445.50	40.00	40.00
TUBIFICIDAE (W/O CAPILLIFORM	1825.00	29.85	69.85
HAEMONAIS WALDVOGELI	547.50	8.96	78.81
NAIDIDAE	383.25	6.27	85.08
DERO DIGITATA	346.75	5.67	90.75
DERO OBTUSA	127.75	2.09	92.84
LIMNODRILUS HOFFMEISTERI	91.25	1.49	94.33
TURBELLARIA	54.75	0.90	95.23
DERO SP.	54.75	0.90	96.13
CHAETOPUS SP.	54.75	0.90	97.03
TANYTARSUS SP.	54.75	0.90	97.93
ANTHOZOA	18.25	0.30	98.23
LUMBRICULIDAE	18.25	0.30	98.53
TUBIFICIDAE (W CAPILLIFORM SE	18.25	0.30	98.83
STYLARIA SP.	18.25	0.30	99.13
PRISTINA LONGISETA LONGISETA	18.25	0.30	99.43
PRISTINA OSBORNI	18.25	0.30	99.73
BRATISLAVIA UNIDENTATA	18.25	0.30	100.03
	6,114	100.03	

Table 8.1.4-23. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981. (Continued, Page 4 of 5)

TRIP = 2 GROUP = PB

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	693.50	44.71	44.71
LIMNODRILUS HOFFMEISTERI	219.00	14.12	58.83
DERO NIVEA	182.50	11.76	70.59
MACROMAIS MALDVOGELI	164.25	10.59	81.18
DERO DIGITATA	109.50	7.06	88.24
NAIDIDAE	73.00	4.71	92.95
ASELLUS SP.	18.25	1.18	94.13
PYRALIDAE	18.25	1.18	95.31
MONOPELOPIA POLIEKA	18.25	1.18	96.49
DICROTENDIPES SP.	18.25	1.18	97.67
POLYPEDILUM SP.	18.25	1.18	98.85
ECTOPROCTA	18.25	1.18	100.03
	1,551	100.03	

Table 8.1.4-23. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, August 1981. (Continued, Page 5 of 5)

TRIP = 2 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM PCT
CHIRONOMUS SPP.	273.75	46.87	46.87
TUBIFICIDAE W/O CAPILLIFORM	73.00	12.50	59.37
NAIDIDAE	73.00	12.50	71.87
DERO VAGA	54.75	9.37	81.24
COLEOPTERA	36.50	6.25	87.49
DERO SP.	18.25	3.12	90.61
PRISTINA LONGISOMA	18.25	3.12	93.73
CHAOBORUS SP.	18.25	3.12	96.85
POLYPEDILUM ILLINOENSE	18.25	3.12	99.97
	584	99.97	

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SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981

TRIP = 3 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	894.25	34.03	34.03
LIMNODRILUS HOFFMEISTERI	547.50	20.83	54.86
NAIDIDAE	273.75	10.42	65.28
CHIRONOMUS SP.	200.75	7.64	72.92
LUMBRICULIDAE	127.75	4.86	77.78
TUPIFICIDAE (W CAPILLIFORM SE	109.50	4.17	81.95
SCELOICHIRONOMUS HOLOPRASINUS	109.50	4.17	86.12
DERO SP.	73.00	2.78	88.90
PRATISLAVIA UNIDENTATA	54.75	2.08	90.98
OSTRACODA	54.75	2.08	93.05
CHIRONOMUS STIGMATERUS	36.50	1.39	94.45
DERO NIVEA	18.25	0.69	95.14
DERO TRIFIDA	18.25	0.69	95.83
DERO FLABELLIGER	18.25	0.69	96.52
SPHAERIUM SP.	18.25	0.69	97.21
DYSTICUS SPP. LARVAE	18.25	0.69	97.90
CULEX SP.	18.25	0.69	98.59
POLYPEDILUM ILLINOENSE	18.25	0.69	99.28
KIEFFERULUS DUX	18.25	0.69	99.97
	2,628	99.97	

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981 (Continued, Page 2 of 6)

TRIP = -3 GROUP = CB

SPECIES NAME	#/M**2	PCT	CUM_PCT
LUMBRICULIDAE	584.00	14.81	14.81
STYLARIA FOSSULARIS	438.00	11.11	25.92
TUBIFICIDAE (W CAPILLIFORM SE	401.50	10.19	36.11
CHIRONOMUS SP.	383.25	9.72	45.83
POLYPEDILUM ILLINOENSE	383.25	9.72	55.55
GOELDICHIRONOMUS HOLOPRASINUS	273.75	6.94	62.49
TUBIFICIDAE (W/O CAPILLIFORM	219.00	5.56	68.05
NAIDIDAE	200.75	5.09	73.14
DERO PECTINATA	164.25	4.17	77.31
LIMNODRILUS HOFFMEISTERI	146.00	3.70	81.01
PRISTINA SP.	109.50	2.78	83.79
COLLEMBOLA	109.50	2.78	86.57
PARACHIRONOMUS CARINATUS	109.50	2.78	89.35
AULODRILUS PIGUETTI	73.00	1.85	91.20
CHIRONOMUS SITMATERUS	73.00	1.85	93.05
DERO SP.	54.75	1.39	94.44
PRISTINA SYNCLITES	36.50	0.93	95.37
MONOPELOPIA BOLIEKA	36.50	0.93	96.30
CHIRONOMINI UNIDENTIFIED FIRST INSTAR	36.50	0.93	97.23
COENAGRIONIDAE	18.25	0.46	97.69
COLEOPTERA PUPA	18.25	0.46	98.15
LABRUNDINIA SP.	18.25	0.46	98.61
LABRUNDINIA FLORIDANA	18.25	0.46	99.07
LARSIA SP.	18.25	0.46	99.53
KIEFFERULUS DUX	18.25	0.46	99.99
	3,942	99.99	

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981 (Continued, Page 3 of 6)

TRIP = 3 GROUP = DB

SPECIES NAME	#/M**2	PCT	CUM_PCT
NAIDIDAE	1806.75	64.71	64.71
DERO TRIFIDA	383.25	13.73	78.44
DERO SP.	237.25	8.50	86.94
DERO DIGITATA	73.00	2.61	89.55
ANCYLIDAE	54.75	1.96	91.51
TUBIFICIDAE (W CAPILLIFORM SE	36.50	1.31	92.82
CHIRONOMUS SITOMATERUS	36.50	1.31	94.13
TURBELLARIA	18.25	0.65	94.78
PRISTINA LONGISOMA	18.25	0.65	95.43
QUEDA SPP.	18.25	0.65	96.09
PYSALIDAE	18.25	0.65	96.73
CHAETOPUS SP.	18.25	0.65	97.38
CHIRONOMUS SP.	18.25	0.65	98.03
PEDICHOMUS BECKAE	18.25	0.65	98.68
TANYTARSUS SP.	18.25	0.65	99.33
HEMEROCERA SP.	18.25	0.65	99.98
	2,792	99.98	

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981 (Continued, Page 4 of 6)

TRIP = 3 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM PCT
TUBIFICIDAE (W CAPILLIFORM SE	2920.00	24.84	24.84
TUBIFICIDAE (W/O CAPILLIFORM	2299.50	19.57	44.41
AULODRILUS PIGUETTI	1076.75	9.16	53.57
NAIDIDAE	748.25	6.37	59.94
CRYPTOCHIRONOMUS FULVUS	675.25	5.75	65.69
CHIRONOMUS SPP.	602.25	5.12	70.81
BRATISLAVIA UNIDENTATA	492.75	4.19	75.00
XENOCHIRONOMUS XENOLABIS	492.75	4.19	79.19
TURBELLARIA	365.00	3.11	82.30
DERO NIVEA	310.25	2.64	84.94
ANCYLIDAE	310.25	2.64	87.58
LUMBRICULIDAE	164.25	1.40	88.98
TANYTARSUS SPP.	164.25	1.40	90.38
LIMNODRILUS HOFFMEISTERI	146.00	1.24	91.62
SLAVINA APPENDICULATA	146.00	1.24	92.85
DERO SP.	127.75	1.09	93.95
PRISTINA LONGISOMA	127.75	1.09	95.04
PROBEZZIA SP.	73.00	0.62	95.65
LAGRUNDINIA FLORIDANA	73.00	0.62	96.28
CHIRONOMUS SITOMATERUS	73.00	0.62	96.90
PRISTINA SP.	54.75	0.47	97.37
POLYPEDILUM ILLINOENSE	54.75	0.47	97.84
PRISTINA ACQUISETA	36.50	0.31	98.15
HIRUDINEA	36.50	0.31	98.45
LARSIA SP.	36.50	0.31	98.77
PRISTINA LONGISETA LEIDYI	18.25	0.16	98.93
PRISTINA FOREL I	18.25	0.16	99.09
HAEMONAIS WALDVOGELI	18.25	0.16	99.25
ABLABESMYIA PARAJANTA	18.25	0.16	99.41
CLINOTANYPUS PINGUIS	18.25	0.16	99.57
POLYPEDILUM HALTERALIS	18.25	0.16	99.73
EINFELDIA SP B	18.25	0.16	99.89
KIEFFERULUS DUX	18.25	0.16	100.05
	11,753	100.05	

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981 (Continued, Page 5 of 6)

TRIP = 3 GROUP = PB

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	3376.25	72.55	72.55
LIMNODRILUS HOFFMEISTERI	821.25	17.65	90.20
HAEMONAIS WALDVOGELI	182.50	3.92	94.12
DERO DIGITATA	91.25	1.96	96.08
AULODRILUS PIGUETTI	54.75	1.18	97.26
NAIDIDAE	54.75	1.18	98.44
TUBIFICIDAE (W CAPILLIFORM SE	36.50	0.78	99.22
CRAVCOMYX SP.	18.25	0.39	99.61
CHAOBORUS SP.	18.25	0.39	100.00
	4,654	100.00	

Table 8.1.4-24. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified from CF Complex II Site, September 1981 (Continued, Page 6 of 6)

TRIP = 3 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM_PCT
NAIDIDAE	529.25	18.71	18.71
CHIRONOMUS SP.	401.50	14.19	32.90
HAEMONAIS WALDVOGELI	310.25	10.97	43.87
ANCYLIDAE	310.25	10.97	54.84
TUBIFICIDAE (W/O CAPILLIFORM	273.75	9.68	64.52
LIMNODRILUS HOFFMEISTERI	237.25	8.39	72.91
AULODRILUS PIGUETTI	91.25	3.23	76.14
DERO DIGITATA	91.25	3.23	79.37
DERO SP.	73.00	2.58	81.95
TUBIFICIDAE (W CAPILLIFORM SE	54.75	1.94	83.89
SPHAERIUM SP.	54.75	1.94	85.83
POLYPEDILUM ILLINOENSE	54.75	1.94	87.77
DERO NIVEA	36.50	1.29	89.06
DERO FLABELLIGER	36.50	1.29	90.35
DERO SP.A (CF.TRIFIDA-DIGITATA)	36.50	1.29	91.64
CLINOTANYPUS PINGUIS	36.50	1.29	92.93
GOELDICHIRONOMUS HOLOPRASINUS	36.50	1.29	94.22
KIEFFERULUS DUX	36.50	1.29	95.51
DERO TRIFIDA	18.25	0.65	96.15
PRISTINA BREVISETA	18.25	0.65	96.81
BRATISLAVIA UNIDENTATA	18.25	0.65	97.46
LEPISMATIDAE	18.25	0.65	98.11
COLEOPTERA PUPA	18.25	0.65	98.75
CHAOBORUS SP.	18.25	0.65	99.41
TANYPUS CAPINATUS	18.25	0.65	100.06
	2,829	100.06	

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CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-25. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, October 1981

TRIP = A GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	1022.00	32.56	32.56
LIMNODRILUS HOFFMEISTERI	803.00	25.58	58.14
AULODRILUS PIGUETTI	675.25	21.51	79.65
CHIRONOMUS SP.	328.50	10.47	90.12
TANYTARSUS SP.	109.50	3.49	93.61
PARACHIRONOMUS CARINATUS	36.50	1.16	94.77
TURBELLARIA	18.25	0.58	95.35
TUBIFICIDAE (W CAPILLIFORM SE	18.25	0.58	95.93
NAIDIDAE	18.25	0.58	96.51
SLAVINA APPENDICULATA	18.25	0.58	97.09
HAEMONAIS WALDVOGELI	18.25	0.58	97.67
ANCYLIDAE	18.25	0.58	98.25
CLIMACIA AREOLARIS	18.25	0.58	98.83
CHIRONOMUS SITOPATERUS	18.25	0.58	99.41
POLYPEDILUM ILLINOENSE	18.25	0.58	99.99
COLLEMBOLA SP B	0.00		99.99
	3,139	99.99	

Table 8.1.4-25. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, October 1981. (Continued, Page 2 of 3)

TRIP = 4 GROUP = HM

SPECIES NAME	#/M**2	PCT	CUM_PCT
AULODRILUS PIGUETTI	1149.75	30.73	30.73
TUBIFICIDAE (W/O CAPILLIFORM	602.25	16.10	46.83
LIMNODRILUS HOFFMEISTERI	584.00	15.61	62.44
CAENIS SP.	511.00	13.66	76.10
TANYTARSUS SP.	146.00	3.90	80.00
POLYPEDILUM HALTERALIS	109.50	2.93	82.93
COLLEMBOLA SP 2	91.25	2.44	85.37
POLYPEDILUM ILLINOENSE	91.25	2.44	87.81
PRATISLAVIA UNICENTATA	54.75	1.46	89.27
CALLIBAETIS SPP.	54.75	1.46	90.73
HYDROCANTHUS SPP.	54.75	1.46	92.19
DERO SP.	36.50	0.98	93.17
APHYLLA SPP.	36.50	0.98	94.15
MONOPELOPIA POLIEKA	36.50	0.98	95.13
TUBIFICIDAE (W CAPILLIFORM SE	18.25	0.49	95.62
DERO DIGITATA	18.25	0.49	96.11
DERO VAGA	18.25	0.49	96.60
ACARINA	18.25	0.49	97.09
BOURTIELLA SP	18.25	0.49	97.58
ENALLAGMA SP.	18.25	0.49	98.07
HEMIPTERA	18.25	0.49	98.56
BEROSUS SPP. LARVAE	18.25	0.49	99.05
PROCLADIUS SP.	18.25	0.49	99.54
LABRUNDINIA JOHANNSENI	18.25	0.49	100.03
	3,741	100.03	

Table 8.1.4-25. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, October 1981 (Continued, Page 3 of 3)

TRIP = 4 GROUP = HN

SPECIES NAME	#/M**2	PCT	CUM_PCT
AULODRILUS PIGUETTI	748.25	23.84	23.84
POLYPEDILUM HALTERALIS	693.50	22.09	45.93
TUBIFICIDAE (W/O CAPILLIFORM	474.50	15.12	61.05
TANYTARSUS SP.	474.50	15.12	76.17
CAENIS SP.	219.00	6.98	83.15
LIMNODRILUS HOFFMEISTERI	200.75	6.40	89.55
POLYPEDILUM ILLINOENSE	164.25	5.23	94.78
DOMPHUS SP	36.50	1.16	95.94
APHYLLA SPP.	36.50	1.16	97.10
CHIRONOMUS SP.	36.50	1.16	98.25
TUBIFICIDAE (W CAPILLIFORM SE	18.25	0.58	98.84
TRICHOPTERA	18.25	0.58	99.42
CLINOTANYPUS PINGUIS	18.25	0.58	100.00
	3,139	100.00	

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HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-26. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, February 1982

TRIP = 5 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	565.75	47.69	47.69
LUMBRICULIDAE	310.25	26.15	73.84
TANYTARSUS SPP.	91.25	7.69	81.53
TUBIFICIDAE (W CAPILLIFORM SE	73.00	6.15	87.68
POLYPEDILUM ILLINOENSE	73.00	6.15	93.83
HYALELLA AZTECA	36.50	3.08	96.91
NERO DIGITATA	18.25	1.54	98.45
CRANGONYX SP.	18.25	1.54	99.99
	1,186	99.99	

Table 8.1.4-26. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, February 1982. (Continued, Page 2 of 3)

TRIP = 5 GROUP = HM

SPECIES NAME	#/M**2	PCT	CUM_PCT
LUMBRICULIDAE	273.75	26.32	26.32
TUBIFICIDAE (W CAPILLIFORM SE	219.00	21.05	47.37
TUBIFICIDAE (W/O CAPILLIFORM	127.75	12.28	59.65
CRAGONYX SP.	73.00	7.02	66.67
POLYPEDILUM ILLINOENSE	73.00	7.02	73.69
SCIARA SP	54.75	5.26	78.95
HEMIPTERA	36.50	3.51	82.46
LARSIA SP.	36.50	3.51	85.97
CHRYSOPS SP.	36.50	3.51	89.48
PRISTINA LONGISOMA	18.25	1.75	91.23
ACARINA	18.25	1.75	92.98
COLLEMBOLA	18.25	1.75	94.73
GALLERUCALLA SP	18.25	1.75	96.48
DIPTERA SP. NR. PSYCHODIDAE	18.25	1.75	98.23
CHIRONOMUS SPP.	18.25	1.75	99.98
BRANCHIOPODA	0.00		99.98
CERATOPOGON SP.	0.00		99.98
	1,040	99.98	

Table 8.1.4-26. Density (#/m^2) and Percent Composition (PCT) of Benthic Infauna Identified in Horse Creek, February 1982. (Continued, Page 3 of 3)

TRIP = 5 GROUP = HN

SPECIES NAME	#/M**2	PCT	CUM_PCT
TUBIFICIDAE (W/O CAPILLIFORM	127.75	41.18	41.18
LUMBRICULIDAE	54.75	17.65	58.83
TANYTARSUS SPP.	36.50	11.76	70.59
NEMATODA	18.25	5.88	76.47
TUBIFICIDAE (W CAPILLIFORM SE	18.25	5.88	82.35
HAEMOPIS WALDVOGELI	18.25	5.88	88.23
HIRUDINEA	18.25	5.88	94.11
POLYPEDILUM ILLINOENSE	18.25	5.88	99.99
	319	99.99	

Key to Stations:
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SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-27. Shannon-Weaver Diversity (H'), Margalef's Species Richness (J), and Pielou's Evenness (E) Indices for Benthic Infauna Identified from CF Complex II Site, July 1981 to February 1982

TRIP = 1

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	1.7837	0.8681	0.5966
DB	1.0220	0.5762	0.9613
HC	2.1043	0.8934	0.7496
PB	0.7219	0.1921	0.7219
SB	1.9503	0.5412	0.9752

TRIP = 2

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	2.5382	2.1803	0.5975
DB	1.0000	0.2331	1.0000
HC	2.4723	1.2499	0.5929
PB	2.5542	1.4973	0.7125
SB	2.4581	1.2560	0.7754

TRIP = 3

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	3.0789	2.2851	0.7248
CB	3.9677	2.0996	0.8544
DB	1.5408	1.8905	0.4852
HC	3.6750	3.4145	0.7285
PB	1.3403	0.9473	0.4228
SB	3.7793	3.5199	0.8138

TRIP = 4

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
HC	2.4804	1.7388	0.6349
HM	3.1992	2.7957	0.6956
HN	2.8967	1.4904	0.7828

TRIP = 5

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
HC	2.1754	0.9889	0.7118
HM	3.2366	2.0153	0.8264
HN	2.5352	1.2203	0.8451

Table 8.1.4-27. Shannon-Weaver Diversity (H'), Margalef's Species Richness (J), and Pielou's Evenness (E) Indices for Benthic Infauna Identified from CF Complex II Site, July 1981 to February 1982 (page 2 of 2)

Key to Stations:
BC = Brushy Creek
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HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-28. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, July 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA													
TURBELLARIA												x	
ANNELIDA													
LUMBRICULIDAE	x												
TUBIFICIDAE (W/O CAPILLIFORM	x												
TUBIFEX HARMANI	x												x
DERO SP.													x
DERO DIGITATA												x	x
DERO NIVEA				x								x	
DERO PECTINATA			•									x	
DERO OBTUSA												x	
PRISTINA LONGISETA LEIDYI	x											x	x
PRISTINA LONGISOMA													x
HAEMONAIS WALDVOGELI					x								
ENCHYTRAEIDAE													
ERPOBDELLA SPP.												x	
MOLLUSCA													
POMACEA PALUDOSA												x	
AMNICOLA												x	
LAEVAPEX SPP.												x	
HELISOMA SCALARIS												x	
HELISOMA DURYI				y									
PHYSA SP.												y	
LYMNAEA SP					y								
PYSSANODONTA CUBENSIS												y	
ARACHNIDA													
ACARINA					x								
CRUSTACEA													x
BRANCHIOPODA													
ASELLUS SP A												x	
HYALELLA AZTECA				y									
PALAEMONETES PALUDOSUS					y								
STREPTOCEPHALUS SPP.	x												
INSECTA													
BAETIS SPEITHI													y
CALLIBAETIS FLORIDANA													y
CAENIS DIMINUTA												x	
ERYTHEMIS SIMPLICICOLLIS				x								y	
PACHYDIPLAX LONGIPENNIS				y								x	
COENAGRIONIDAE												x	

Table 8.1.4-28. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, July 1981. (Continued, Page 2 of 2)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4/PB	SB
NEMALLENIA SPP.				x							x	
GERRIS SP.				x								x
BELOSTOMA SPP.				x	x						x	
RANATRA SPP.				x								x
PELOCORIS SP.					x							x
PYRALIDAE												
DINEUTUS SPP.					x							x
DYTISCIDAE												
COPTOTOMUS SP.					x							x
COPTOTOMUS SPP. LARVAE												
LACCOPHILUS SPP.					x							
HYDROCANTHUS SPP.					x							
SUPHISELLUS SPP.					x							
SPHAERIDINIDAE					x							x
TROPISTERNUS SPP. LARVAE												
AEDES SPP.	x											x
ANOPHELES SPP.												
PSOROPHORA SPP.	x										x	
CERATOPOGONIDAE											x	
PALPOMYIA LINEATA				x							x	
CERATOPOGON SP.											x	
CONCHAPELOPIA SP.											x	
MONOPELOPIA BOLIEKA											x	
CHIRONOMUS SP.												x
CHIRONOMUS PLUMOSUS											x	
DICROTENDIPES SPP.											x	
DICROTENDIPES NEOMODESTUS											x	
PARACHIRONOMUS SP.											x	
PARACHIRONOMUS CARINATUS				x								
POLYPEDILUM CONVICTUM					y							y
POLYPEDILUM ILLINOENSE					x						x	
SOELDICHIRONOMUS HOLOPPASINUS												x
KIEFFERULUS DUY												x
TANYTARSUS SP.											y	
TANYTARSUS SPP.												

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*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-29. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, August 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CNIDARIA													
HYDROZOA				X									X
TURBELLARIA													
TURBELLARIA					X							X	X
RHYNCHOCOEL													
RHYNCHOCOEL					X								
NEMATODA													
NEMATODA	X												
ANNELIDA													
LUMBRICULIDAE	X				X								
TUBIFICIDAE W/O CAPILLIFORM	X				X								X
TUBIFICIDAE W CAPILLIFORM SE												X	
EULOSCOLEX BIGUETTI												X	
NAIDIDAE	X			X	X							X	X
SLAVINA APPENDICULATA					X								
DERO SP.	X			X	X								X
DERO DIGITATA	X			X	X								
DERO NIVEA					X								X
DERO PECTINATA				X	X								X
DERO VAGA				X	X								X
STYLARIA FOSSULARIS					X								
PRISTINA LONGISETA LONGISETA					X								
PRISTINE LONGISOMA	X												X
PRATISLAVIA UNIDENTATA					X								
HARMOTHOE VALDIVIELI					X							X	X
HIRUDINEA	X				X								
MOLLUSCA													
GASTROPODA												X	
ANCYLIDAE				X	X							X	
LAEVAPEX SPP.					X							X	X
PLANORBIDAE				X	X							X	X
GYRAULUS SP.													X
HELISOMA SPP.												X	
PHYSA SP.												X	X
SPHAERIIDAE	X											X	X
ARACHNIDA													
ARACHNIDA	X				X								X
ACARINA					X							X	

Table 8.1.4-29. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, August 1981. (Continued, Page 2 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CRUSTACEA													
OSTRACODA	x				x							x	x
HYALELLA AZTECA				x	x								
CRANGONYX SP.	x			x	x							x	x
PALAEMONETES PALUDOSUS	x			x	x							x	
PROCAMBARUS SPP.					x								x
INSECTA													
COLLEMBOLA	x				x							x	
EPHEMEROPTERA				x									
BAETIS SP.					x								
CALLIBAETIS SPP.					x								
CAENIS DIMINUTA					x							x	
ODONATA	x			x									
GOMPHIDAE					x								
ROYERIA SP.					x								
LIBELLULIDAE				x	x							x	
EPYTHEMIS SP.				x	x							x	
PACHYDIPLAX LONGIPENNES				x	x							x	x
PERITHEMIS SPP.												x	
LIBELLULA SPP.					x								
COENAGRIONIDAE				x	x							x	
ENALLAGMA SP.					x							x	
ISCHNURA SP.					x								
ARGIA SPP.				x									
HEMIPTERA	x				x							x	
BELOSTOMATIDAE													x
BELOSTOMA SPP.				x									
PELOCORIS SP.				x	x							x	
CORIXIDAE					x								
NOTONECTIDAE					x								
BUENOA SPP.					x								
NEOPLEA STRIOLA					x								
HYDROPTILIDAE					x								
COLEOPTERA					x								
COLEOPTERA SP. A LARVAE				x	x								x
DINEUTUS SPP. LARVAE					x								
DYTISCIDAE					x								
COPTOTOMUS SPP. LARVAE					x								
COPTOTOMUS SPP. ADULT					x								
LACCOPHILUS SPP. LARVAE	x				x								
LACCOPHILUS SPP. PUPAE				x									
LACCOPHILUS SPP. ADULT					x								
DYSTICUS SPP. LARVAE	x				x								
CRELATUS SPP. ADULT	x				x								

Table 8.1.4-29. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, August 1981. (Continued, Page 3 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CELINA SPP. ADULT	x				x								
RIDESSUS GROUP PUPAE					x								
CYBISTER SP. (LARVAE)					x								x
PACHYDRUS SPP. LARVAE					x								
HYDROVATUS SPP. LARVAE					x								
HYDROVATUS SPP. ADULT					x								
MATUS SPP. LARVAE					x								
ACILIUS SPP. LARVAE					x								
NOTERIDAE					x								
HYDROCANTHUS SPP.	x			x	x								
HYDROCANTHUS SPP. LARVAE					x								
HYDROCANTHUS SPP. ADULT					x								
SUPHIS INFLATUS	x				x								
PELTODYTES SPP. LARVAE												x	
PELTODYTES SPP. ADULT					x							x	
HYDROPHILIDAE					x								
TROPISTERNUS SPP. LARVAE					x								x
ENOCHRUS SPP. ADULT	x												
BEROSUS SPP. LARVAE					x								
BEROSUS SPP. ADULT					x								
SCRITES SP. LARVAE					x								x
PELONOMUS SPP.	x												
STENELMIS SP.					x								
CURCULIONIDAE	x				x								
TERRESTRIAL DIPTERA				x	x								
AEDES SPP.	x			x	x								
ANOPHELES SPP.	x				x								x
MANSONIA SP.				x	x								
PSOROPHORA SPP.	x			x									x
PSOROPHORA SP. A	x												
PSOROPHORA SP. B	x												
CHAOBORUS SP.					x								x
PALPOMYIA SP.					x								
PROBEZZIA SP.					x								
TANYPODINAE PUPA				x	x								
TANYPUS CARINATUS				x								x	
APLABESMYIA CINCTIPES						x							
APLABESMYIA PARAJANTA						x							
APLABESMYIA PELLENIS						x							x
APLABESMYIA PHILOSPHAGNOS						x							x
MONOPELOPIA PALIENA				x	x							x	x
LABRUNDINIA JOHANNSENI						x							
LARSIA SP.	x			x	x							x	
LARSIA SPP.					x							x	
RUTTIPELOPIA CURRANI												x	

Table 8.1.4-29. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, August 1981 (Continued, Page 4 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
ORTHOCLADIINAE SP. PUPA												X	
CHIRONOMINI SP. PUPA					X								
CHIRONOMINI UNIDENTIFIED FIRST INSTAR					X								X
CHIRONOMUS SP.	X			X								X	
CHIRONOMUS CARUS				X	X							X	X
CHIRONOMUS SITGMATERUS					X							X	X
CHIRONOMUS SPP.					X							X	X
DICROTENDIPES SP.					X							X	
DICROTENDIPES NEOMODESTUS												X	X
ENDOCHIRONOMUS NIGRICANS												X	
GLYPTOTENDIPES SP.												X	
PARACHIRONOMUS CARINATUS					X							X	X
POLYPEDILUM ILLINOENSE	X			X	X							X	X
POLYPEDILUM SPP				X	X								
PSEUDOCHIRONOMUS NR. RICHARDSONI					X							X	
SIMFELDIA SP A	X				X								
SIMFELDIA SP B													X
SOELDICHIRONOMUS HOLOPRASINUS					X							X	X
KIEFFERULUS DUX					X							X	X
TANYTARSUS SP.				X									
TANYTARSUS SPP.	X				X							X	X
CALOPSECTRA (=TANYTARSUS) SP.13 (ROBACK)												X	
HEMERODROMIA SP.				X	X							X	
TABANUS SP.	X												
AMPHIPIA													
RANA SPP. (TADPOLE)					X								

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Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-30. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, September 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA													
TURBELLARIA												x	
ANNELIDA													
LUMBRICULIDAE	x		x										
TUBIFICIDAE (W/O CAPILLIFORM	x		x										
TUBIFICIDAE (W CAPILLIFORM SE			x									x	
NAIDIDAE	x		x	x	x							x	x
SLAVINA APPENDICULATA				x	x								
DERO SP.	x			x								x	x
DERO DIGITATA	x											x	
DERO NIVEA	x			x								x	x
DERO TRIFIDA	x											x	
DERO PECTINATA				x	x								x
DERO VAGA				x									
PRISTINA ACUMINATA												x	
BRATISLAVIA UNIDENTATA	x				x							x	x
HAEMONAIS WALDVOGELI				x	x							x	x
ALLONAIS PARAGUAYENSIS												x	
HIRUDINEA	x			x								x	x
MOLLUSCA													
ANCYLIDAE				x	x							x	
LAEVAPEX SPP.				x	x							x	x
PLANORBIDAE												x	
HELISOMA SPP.				x	x								x
HELISOMA SCALARIS	x			x	x								
PHYSA SP.				x								x	x
SPHAERIIDAE				x									
SPHAERIUM SP.	x												
ARACHNIDA													
ARACHNIDA	x		x	x								x	
ACARINA				x								x	
CRUSTACEA													
BRANCHIOPODA	x			x	x							x	x
OSTRACODA	x		x	x								x	x
COPEPODA	x			x	x							x	x
ASELLUS SP.				x									x
HYALELLA AZTECA				x	x								
CRANGONYX SP.	x												
PALAEMONIDAE													x
PALAEMONETES SP.					x								
PALAEMONETES PALUDOSUS				x	x							x	x

Table 8.1.4-30. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, September 1981 (Continued, Page 2 of 5)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
ASTACIDAE	x												x
PROCAMBARUS SPP.					x							x	x
INSECTA													
COLLEMBOLA													x
EPHEMEROPTERA				x									
CHOROTERPES HUBBELLI					x								
CALLIBAETIS SPP.	x			x	x								x
CAENIS SP.					x							x	x
APHYLLA SPP.					x								
LIBELLULIDAE			x	x	x							x	x
ERYTHEMIS SP.			x	x								x	
PACHYDIPLAX LONGIPENNES				x	x							x	x
PERITHEMIS SPP.				x								x	
LIBELLULA SPP.				x									
MIATHYRIA SP				x	x							x	
COENAGRIONIDAE													x
ENALLAGMA SP.			x	x									y
ISCHNURA SP.	y			y								x	
HEMIPTERA					y								
HEMIPTERA PUPA												x	
BELOSTOMA SPP.	x		x		y							x	
PELOCORIS SP.				x								x	
CORIXIDAE	y				y								
NOTONECTIDAE					y								
BUENOA SPP.				x	x								
MESOVELIA SP.													x
HYDROMETRA SP												x	
NEOPLEA STRIOLA												x	
POLYCENTROPUS SP.					y								
CHEUMATOPSYCHE SP.				x									y
OXYETHIRA SP.					y								
LEPIDOPTERA			x										
COLEOPTERA					x							x	
COLEOPTERA SP. A LARVAE					x								x
DINEUTUS SPP.					y								y
DINEUTUS SPP. LARVAE				y								x	
DINEUTUS SPP. ADULT					y								
CORTOTOMUS SP.				x	y							y	y
CORTOTOMUS SPP. LARVAE				y									
CORTOTOMUS SPP. ADULT	x				y								x
LACCOPHILUS SPP.					y								
LACCOPHILUS SPP. ADULT					y								
DYTICUS SPP. LARVAE	x		x	x									x
DYTICUS SPP. ADULT	x			x									

Table 8.1.4-30. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, September 1981. (Continued, Page 3 of 5)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
COPELATUS SPP.				X									
COPELATUS SPP. ADULT												X	
BIDESSUS GROUP ADULT	X											X	
CYBISTER SP. (LARVAE)	X			X									
PACHYDRUS SPP.	X												
PACHYDRUS SPP. LARVAE	X				X								
HYDROVATUS SPP. ADULT	X												
NATUS SPP. LARVAE					X								
NATUS SPP. ADULT	X												
HYDROPOROUS SP. LARVAE	X												
HYDROPOROUS SP. ADULT	X												
NOTERIDAE JUVENILE	X												
HYDROCANTHUS SPP.	X			X	X							X	
HYDROCANTHUS SPP. LARVAE				X									X
HYDROCANTHUS SPP. ADULT				X	X								
SUPHISELLUS SPP.	X												
SUPHISELLUS SP. ADULT				X	X							X	
SUPHIS INFLATUS	X			X	X								X
HALIPLUS SPP.ADULT	X				X								
PELTODYTES SPP.												X	
PELTODYTES SPP. LARVAE	X			X									X
TROPISTERNUS SPP.					X								
TROPISTERNUS SPP. LARVAE	X				X								
TROPISTERNUS SPP. ADULT	X											X	
BEROSUS SPP.					X								
BEROSUS SPP. ADULT					X								
SCIRTES SPP.				X									
SCIRTES SP. LARVAE	X												X
DRYOPS SP. LARVAE													X
STENELMIS SP.					X								
GALLERUCALLA SP													X
CURCULIONIDAE				X									
CULICIDAE SP. PUPA	X												
AEDES SPP.				X								X	
ANOPHELES SPP.	X												
CULEX SP.	X												
CHAOBORUS SP.	X			X	X							X	X
CHAOBORUS SP PUPA					X								
BEZZIA SP.					X								
CHIRONOMIDAE ADULTS				X	X							X	X
TANYPODINAE SP.					X								
TANYPODINAE PUPA					X								X
APLAREMYIA SP.					X								
APLAREMYIA PARAJANTA					X								
APLAREMYIA ORNATA				X									X

Table 8.1.4-30. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, September 1981 (Continued, Page 4 of 5)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
ABLABESMYIA MALLOCHI					x								x
ABLABESMYIA PHILOSPHAGNOS				x								x	
MONOPELOPIA SP.					x								x
LABRUNDINIA JOHANNSENI				x	x								x
LABRUNDINIA FLORIDANA					y								x
LABRUNDINIA SP PUPA	x				x							x	x
LARSIA SP.				x	x								
LARSIA SPP					y							x	x
LARSIA SP PUPA													x
PENTANEURA SP.													x
CHIRONOMINI												x	
CHIRORONINI SPP ADULTS					x								x
CHIRONOMINI UNIDENTIFIED PUPA	x				x								
CHIRONOMINI UNIDENTIFIED FIRST INSTAR					x								
CHIRONOMUS SP.	x		x	x	x							x	x
CHIRONOMUS CARUS	x		x		x								
CHIRONOMUS SITGMATERUS	x				x							x	
CHIRONOMUS SPP.					y							x	
CHIRONOMUS CRASSICAUDATUS					x							x	
CHIRONOMUS CRASSICAUDATUS PUPA				x								x	
CRYPTOCHIRONOMUS SP.			x		y								
CRYPTOCHIRONOMUS FULVUS					y								
CRYPTOCHIRONOMUS DIGITATUS				x									
DICROTENDIPES SP.												x	
DICROTENDIPES NEOMODESTUS												x	
DICROTENDIPES NERVOSUS					y								
DICROTENDIPES MODESTUS					v								
GLYPTOTENDIPES SP.	y											v	
PARACHIRONOMUS SP.			x										
PARACHIRONOMUS CARINATUS				x	x							x	x
PARACHIRONOMUS HIRTALATUS					y								
PARACHIRONOMUS CARINATUS ADULT					x								
POLYPEDILUM SP.				v	x								
POLYPEDILUM ILLINOENSE	x			x	x							x	y
POLYPEDILUM SPP			x	x	y								x
TRIBELOS SP.					x								
TRIBELOS SP.												v	
TRIBELOS SP.					v							v	v
TRIBELOS SP PUPA													y
GOELDICHIRONOMUS HOLOPRASINUS	x		x	x	y							x	x
KIEFFERULUS DUX				x	y							x	x
KIEFFERULUS DUX ADULT					y								
LAUTERBORNIELLA VARIPENNIS												x	
TANYTARSINI SP. PUPA				v									
TANYTARSUS SP.				x	v							x	x

Table 8.1.4-30. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, September 1981. (Continued, Page 5 of 5)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TANYTARSUS SPP.												x	x
TANYTARSUS SP. A				x	x							x	x
TANYTARSUS SPP. ADULT												x	
NEMOCERA SP.				x									x
THAUMALEIDAE SP													x

Key to Stations:
BC = Brushy Creek
DB = Doe Branch
HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-31. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, October 1981

	BC	B2	GB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA													
TURBELLARIA				x									x
ANNELIDA													
LUMBRICULIDAE						x						x	
TUBIFICIDAE (W/O CAPILLIFORM				x								x	
TUBIFICIDAE (W CAPILLIFORM SE												x	
LIMNODRILUS HOFFMEISTERI				x									
AULODRILUS PIGUETTI				x			x					x	x
NAIDIDAE	x			x	x							x	x
SLAVINA APPENDICULATA	x				x								
DERO SP.	x	x		x	x							x	x
DERO DIGITATA	x			x								x	x
DERO NIVEA				x	x							x	x
DERO TRIFIDA	x	x		x								x	
DERO PECTINATA				x	x								
DERO VAGA	x			x			x						
HAEMONAIS WALDVOGELI		x		x								x	x
ALLONAIS PARAGUAYENSIS				x									
HIRUDINIDAE							x						
MOLLUSCA													
ANCYLIDAE	x				x								
LAEVAPEX SPP.				x			x					x	x
HELISOMA SPP.				x	x								x
HELISOMA SCALARIS				x			x						
PHYSA SP.				x									
LYMNAEA SP				x									
BIVALVIA												x	x
SPHAERIIDAE				x									
ARACHNIDA													
ARACHNIDA				x								x	x
ACARINA					x								
HYDRACARINA SP				x									x
CRUSTACEA													
BRANCHIOPODA					x								
COPEPODA					x								
CYCLOPIDAE					x								
HYALELLA AZTECA				x	x	x	x						x
CRANGONYX SP.	x												
EUCARIDA DECAPODA												x	
PALAEMONETES PALUDOSUS				x	x	x	x						
PROCAMBARUS SPP.	x	x		x	x	x	x					x	x

Table 8.1.4-31. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, October 1981 (Continued, Page 2 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
INSECTA													
COLLEMBOLA SP C	x			x	x		x					x	x
CALLIBAETIS SPP.	x			x	x	x	x					x	x
CALLIBAETIS FLORIDANA	x												
CAENIS SP.					x	x							x
ODONATA							x						
GOMPHUS SP						x							
LIBELLULIDAE	x			x	x								
SYMPETRUM SP.				x									
ERYTHEMIS SP.					x		x						
PACHYDIPLAX LONGIPENNES	x	x		x	x		x					x	x
PERITHEMIS SPP.							x						
MIATHYRIA SP				x									
PLATHEMIS SP				x	x								
COENAGRIONIDAE	x												
ENALLAGMA SP.				x									x
ISCHNURA SP.						x							
BELOSTOMA SPP.	x	x				x							
RANATRA SPP.													x
PELOCORIS SP.					x								
RUENOA SPP.		x											
MESOVELIA SP.				x									x
ORTHOTRICHIA SP.					x								
OXYETHIRA SP.					x								
PARAPONYX SP						x							
PYRALIDAE SP A							x						
PYRALIDAE SP B	x			x	x	x	x						x
DINEUTUS SPP. ADULT													x
COPTOTOMUS SP.					x								
COPTOTOMUS SPP. LARVAE					x								
COPTOTOMUS SPP. ADULT				x			x						
LACCOPHILUS SPP.	x												
BIDESSUS (GROUP)				x	x								
CYBISTER SP. (LARVAE)					x								
PACHYDRUS SPP.	x												
NATUS SP.	x												
HYDROPORUS SP. LARVAE					x							x	
AGABUS SP LARVAE					x								
HYDROCANTHUS SP.	x	x		x	x								
SUPHISELLUS SPP.	x												
PELTODYTES SPP.					x	x							
PELTODYTES SPP. LARVAE	x				x								
TROPISTERNUS SPP.	x												
TROPISTERNUS SPP. LARVAE	x												
TROPISTERNUS SPP. ADULT	x			x	x								

Table 8.1.4-31. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, October 1981. (Continued, Page 3 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
ENOCHRUS SPP.					x								
ENOCHRUS SPP. LARVAE	x			x									
ENOCHRUS SPP. ADULT				x									
BEROSUS SPP.					x								
BEROSUS SPP. ADULT												x	
HYDROCHUS SP ADULT				x									
HYDROCHARA SP.ADULT				x									
DRYOPS SP. LARVAE				x									
STENELMIS SP.					x								
DONACIA SP	x				x								
PRIONOCERA SP	x						x						x
DICRANOMYIA SP.		x											
TIPULA SP. LARVAE	x												x
CULICIDAE SP. PUPA	x											x	
AEDES SPP.	x				x								
AEDES SP A				x								x	
AEDES SP B				x									
ANOPHELES SPP.				x								x	
MANSONIA SP				x									
CHAOBORUS SP.	x			x								x	x
PALPOMYIA SP.	x				x	x	x					x	
CHIRONOMIDAE ADULTS					x								
TANYPODINAE SP.					x								
TANYPUS CARINATUS												x	
ABLABESMYIA PARAJANTA				x	x	x	x						
ABLABESMYIA ORNATA					x	x	x						
MONOPELOPIA BOLIEKA	x			x	x								
LABRUNDINIA JOHANNSENI					x		x						
LABRUNDINIA FLORIDANA	x				x								
LABRUNDINIA SP PUPA					x								
LAPSTA SP.	x	x			x								
CLINOTANYPUS PINGUIS													x
CORYNONEURA SP.												x	
CHIRONOMUS SP.		x		x								x	x
CHIRONOMUS CARUS				x									x
CHIRONOMUS SPP.	x			x	x								x
GLYPTOTENDIPES SP.												x	
PARACHIRONOMUS CARINATUS				x	x		x						
PEDIONOMUS BECKAE													x
POLYPEDILUM SP.		x			x								x
POLYPEDILUM HALTERALIS						x							
POLYPEDILUM ILLINOENSE	x	x		x	x	x	x					x	
POLYPEDILUM ILLINOENSE PUPA				x									
STENOCHIRONOMUS SP.							x						
TRIBELOS SP. B					x								x

Table 8.1.4-31. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, October 1981. (Continued, Page 4 of 4)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
PHAENOPSECTRA OBEDIENS													X
GOELDICHIPONOMUS HOLOPRASINUS	X	X		X	X							X	X
GOELDICHIRONOMUS HOLOPRASINUS PUPA												X	
KIEFFERULUS DUX	X	X		X	X								X
CLADOPELMA SP. LARVAE							Y						
TANYTARSUS SP.					X	X						X	
TANYTARSUS SPP.					X								X
NEMBOCERA SP.	X			X									
TABANUS SP.						X							
TABANUS SP B				X									
THAUMALEIDAE SP													X
PSYCHODA SP					X								
AMPHIBIA													
RANA SPP. (TADPOLE)				X									

Key to Stations:
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HC = Horse Creek*
PB = Plunder Branch
CB = Coons Bay
SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-32. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, February 1981

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
TURBELLARIA													
TURBELLARIA				X									
NEMATODA													
NEMATODA													X
ANNELIDA													
LUMBRICULIDAE	X		X		X	X	X					X	X
TUBIFICIDAE (W/O CAPILLIFORM	X		X	X								X	
TUBIFICIDAE (W CAPILLIFORM SE	X											X	
LIMNODRILUS HOFFMEISTERI												X	
NAIDIDAE			X	X	X							X	
DERO SP.	X											X	
DERO DIGITATA						X						X	
DERO NIVEA												X	
DERO TRIFIDA												X	
DERO SP.A (CF.TRIFIDA-DIGITATA)	X											X	
DERO VAGA												X	
PRISTINA LONGISOMA						X							
HAEMONAIS WALDVOGELI				X									
ALLONAIS PARAGUAYENSIS												X	
HIRUDINEA	X			X			X						
MOLLUSCA													
GASTROPODA						X							
POMACEA PALUDOSA				X								X	
AMNICOLA						X							
LAEVAPEX SPP.												X	
HELISOMA SPP.	X			X		X							
PHYSA SP.				X		X						X	
SPHAERIUM SP.	X			X								X	X
CRUSTACEA													
BRANCHIOPODA				X		X							
COPEPODA						X							
ASELLUS SP.			X										
HYALELLA AZTECA				X	X								
CRANGONYX SP.	X					X							
PALAEMONETES PALUDOSUS				X	X							X	
ASTACIDAE	X												
PROCAMBARUS SPP.	X			X	X							X	X
INSECTA													
COLLEMBOLA			X	X		X							X
EPHEMEROPTERA												X	

Table 8.1.4-32. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, February 1981 (Continued, Page 2 of 3)

	BC	B2	CB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
CALLIBAETIS FLORIDANA												x	
LIBELLULIDAE	x												
ERYTHEMIS SP.				x									
PACHYDIPLAX LONGIPENNES	x			x		x						x	
MIATHYRIA SP				x									
PLATHEMIS SP							x						
COENAGRIONIDAE	x			x								x	
ENALLAGMA SP.												v	
ARGIA SPP.				x									
HEMIPTERA				x		x							
BELOSTOMA SPP.	x			x								x	x
RANATRA SPP.				x								x	
PELOCORIS SP.				x									
NOTONECTA UNDULATA												x	
BUENOA SPP.						x							
LEPIDOPTERA			x	x								x	
DINEUTUS SPP. ADULT							x						
COPTOTOMUS SPP. LARVAE												x	
COPTOTHUS INTERROGATUS			x	x	y		y					v	x
DYTISCUS SPP.						x							
COPELATUS CAELATIPENNIS												x	
BIDESSUS GROUP LARVAE												x	
HYDROVATUS SPP. ADULT			x		y								
THERMONECTUS BASILLARIS			x	x								v	x
HYDROCANTHUS ORLONGUS	v					x							
SUPHISELLUS SPP.						x							
SUPHIS INFLATUS	x												
PELTODYTES SPP. ADULT												x	
TROPISTERNUS SPP.			x										
TROPISTERNUS SPP. LARVAE	y											v	y
TROPISTERNUS BLATCHLEYI				y								y	
TROPISTERNUS LATERALIS	x		x	x								v	y
ENOCHRUS BLATCHLEYI						x						x	
ENOCHRUS OCHRACEUS	v					x							
TROPISTERNUS BLATCHLEYI	y												
HYDROCHUS SP ADULT						v							
PELONOMUS SP. LARVAE			y										y
STENELMIS SP. LARVAE			x										
CURCULIONIDAE	v												
TIPULIDAE			x			x							
PRIONOCERA SP												v	
DICRANOMYIA SP.			y				v						
ULONOPPHA SP.													y
AEDES SP P			y										
CULEX SP.			x			x						x	

Table 8.1.4-32. Presence/Absence Matrix of Benthic Epifaunal Taxa Identified From CF Complex II Site, February 1981. (Continued, Page 3 of 3)

	BC	B2	CB	DB	DB	HC	HM	HN	M1	M2	M3	M4	PB	SB
PSOROPHORA SPP.			x											
TANYPUS CARINATUS													x	
LARSIA SP.	x		x			x								
CLINOTANYPUS PINGUIS				x										
SMITTIA GR.SP.			x		x									
CHIRONOMUS SPP.	x			x									x	x
POLYPEDILUM ILLINOENSE	x		x	x	x	x	x						x	x
EINFELDIA SP A														x
GOELDICHIRONOMUS HOLOPRASINUS	x		x											x
KIEFFERULUS DUX	x			x	x		x						x	x
TANYTARSUS SPP.	x		x		x		x							
NEMBOCERA SP.				x										

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- CB = Coons Bay
- SB = Shirttail Branch
- HM = Horse Creek Mid Station
- HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Stations with no taxa present were not sampled.

Source: ESE, 1984.

Table 8.1.4-33. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981.

TRIP = 2 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM PCT
NEMATODA	69.55	44.08	44.08
NAIDIDAE	21.40	13.56	57.64
SPHAERIIDAE	10.70	6.78	64.42
DERO DIGITATA	8.02	5.08	69.50
AEDES SPP.	8.02	5.08	74.58
TUBIFICIDAE (W/O CAPILLIFORM	5.35	3.39	77.97
DERO SP.	5.35	3.39	81.36
COLLEMBOLA	5.35	3.39	84.75
HEMIPTERA	5.35	3.39	88.14
LUMBRICULIDAE	2.67	1.69	89.83
ARACHNIDA	2.67	1.69	91.52
OSTRACODA	2.67	1.69	93.21
ODONATA	2.67	1.69	94.90
PSORORHORA SPP.	2.67	1.69	96.59
LARSIA SP.	2.67	1.69	98.29
POLYPEDILUM ILLINOENSE	2.67	1.69	99.97
	158	99.97	

Table 8.1.4-33. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981 (Continued, Page 2 of 5)

TPIP = 2 GROUP = DB

SPECIES NAME	#/M**2	PCT	CUM PCT
NEMOCERA SP.	187.25	32.72	32.72
POLYPEDILUM SPP	98.97	17.29	50.01
HYDROZOA	64.20	11.22	61.23
DERO VAGA	56.17	9.81	71.04
NAIDIDAE	40.12	7.01	78.05
HYALELLA AZTECA	26.75	4.67	82.72
MONOPELOPIA BOLIEKA	10.70	1.87	84.59
ODONATA	8.02	1.40	85.99
COENAGRIONIDAE	8.02	1.40	87.39
MANSONIA SP	8.02	1.40	88.79
LAPSIA SP.	8.02	1.40	90.19
DERO PECTINATA	5.35	0.93	91.12
ANCYLIDAE	5.35	0.93	92.05
LIBELLULIDAE	5.35	0.93	92.98
PELOCORIS SP.	5.35	0.93	93.91
DERO DIGITATA	2.67	0.47	94.38
PLANORBIDAE	2.67	0.47	94.85
EPHEMEROPTERA	2.67	0.47	95.32
ERYTHEMIS SP.	2.67	0.47	95.79
PACHYDIPLAX LONGIPENNES	2.67	0.47	96.26
ARGIA SPP.	2.67	0.47	96.73
COLEOPTERA SP. A LARVAE	2.67	0.47	97.20
TERRESTRIAL DIPTERA	2.67	0.47	97.67
AEDES SPP.	2.67	0.47	98.14
PSOROPHORA SPP.	2.67	0.47	98.61
CHIRONOMUS SP.	2.67	0.47	99.08
CHIRONOMUS CARUS	2.67	0.47	99.55
TANYTARSUS SP.	2.67	0.47	100.02
	572	100.02	

Table 8.1.4-33. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981. (Continued, Page 3 of 5)

TRIP = 2 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
HAEMONAIS WALDVOGELI	302.27	46.13	46.13
NAIDIDAE	90.95	13.88	60.01
LUMBRICULIDAE	42.90	6.53	66.54
COLLEMBOLA	37.45	5.72	72.26
GOELDICHIRONOMUS HOLOPRASINUS	21.40	3.27	75.53
CHIRONOMUS SPP.	16.05	2.45	77.98
POLYPEDILUM ILLINOENSE	16.05	2.45	80.43
DERO DIGITATA	13.37	2.04	82.47
TANYTARSUS SPP.	13.37	2.04	84.51
PLANORBIDAE	10.70	1.63	86.14
HELEBRULUS DUX	10.70	1.63	87.77
BRATISLAVIA UNIDENTATA	8.02	1.22	88.99
CRANGONYX SP.	8.02	1.22	90.21
RHYNCHOCOEL	5.35	0.82	91.03
DERO SP.	5.35	0.82	91.85
ANCYLIDAE	5.35	0.82	92.67
LAEVAPEX SPP.	5.35	0.82	93.49
LARSIA SP.	5.35	0.82	94.31
EINFELDIA SP A	5.35	0.82	95.13
TUBIFICIDAE W/O CAPILLIFORM	2.67	0.41	95.54
HIRUDINEA	2.67	0.41	95.95
OSTRACODA	2.67	0.41	96.36
LIBELLULIDAE	2.67	0.41	96.77
DINEUTUS SPP. LARVAE	2.67	0.41	97.18
DYTISCIDAE	2.67	0.41	97.59
LACCOPHILUS SPP. LARVAE	2.67	0.41	98.00
DYSTICUS SPP. LARVAE	2.67	0.41	98.41
PALPOMYIA SP.	2.67	0.41	98.82
CHIRONOMINI UNIDENTIFIED FIRST INSTAR	2.67	0.41	99.23
DICROTENDIPES SP.	2.67	0.41	99.64
PARACHIRONOMUS CARINATUS	2.67	0.41	100.05
	655	100.05	

Table 8.1.4-33. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981 (Continued, Page 4 of 5)

TRIP = 2 GROUP = PB

SPECIES NAME	#/M**2	PCT	CUM PCT
HAEMONAIS WALDVOGELI	813.20	58.35	58.35
TANYTARSUS SPP.	104.32	7.49	65.84
ANCYLIDAE	85.60	6.14	71.98
OSTRACODA	64.20	4.61	76.59
CHIRONOMUS SPP.	56.17	4.03	80.62
NAIDIDAE	34.77	2.49	83.11
GLYPTOTENDIPES SP.	29.42	2.11	85.22
DICROTENDIPES NEOMODESTUS	26.75	1.92	87.14
CHIRONOMUS CARUS	24.07	1.73	88.87
DICROTENDIPES SP.	24.07	1.73	90.60
LIMNELLULIDAE	18.72	1.34	91.94
LAEVAPEX SPP.	16.05	1.15	93.09
CRICOTOPUS (ORTHOCLADIINAE) SP.	16.05	1.15	94.24
TUBIFICIDAE (W CAPILLIFORM SE	10.70	0.77	95.01
PERITHEMIS SPP.	10.70	0.77	95.78
POLYPEDILUM ILLINOENSE	10.70	0.77	96.55
HELISOMA SPP.	8.02	0.58	97.13
LARSIA SP.	8.02	0.58	97.71
AMNICOLA	5.35	0.38	98.09
PLANORBIDAE	5.35	0.38	98.47
KIEFFERULUS DUX	5.35	0.38	98.85
PHYSA SP.	2.67	0.19	99.04
SPHAERIIDAE	2.67	0.19	99.23
ACARINA	2.67	0.19	99.42
TANYPUS CARINATUS	2.67	0.19	99.61
CUTTIPELOPIA CURRANI	2.67	0.19	99.80
ORTHOCLADIINAE SP. PUPA	2.67	0.19	99.99
	1,394	99.99	

Table 8.1.4-33. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, July to August 1981. (Continued, Page 5 of 5)

TRIP = 2 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM_PCT
CHIRONOMUS SPP.	64.20	30.77	30.77
DERO VAGA	42.80	20.51	51.28
OSTRACODA	26.75	12.82	64.10
DERO SP.	21.40	10.26	74.36
NAIDIDAE	10.70	5.13	79.49
DERO PECTINATA	10.70	5.13	84.62
GOELDICHIRONOMUS HOLOPRASINUS	10.70	5.13	89.75
ARACHNIDA	5.35	2.56	92.31
ABLABESMYIA PHILOSPHAGNOS	5.35	2.56	94.87
CHIRONOMUS CARUS	5.35	2.56	97.43
DICROTENDIPES NEOMODESTUS	5.35	2.56	99.99
	209	99.99	

Key to Stations:
BC = Brushy Creek
DB = Doe Branch
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SB = Shirttail Branch
HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-34. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981.

TRIP = 1 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM_PCT
DERO TRIFIDA	291.57	74.16	74.16
DERO DIGITATA	32.10	8.16	82.32
PRATISLAVIA UNIDENTATA	24.07	6.12	88.44
NAIDIDAE	16.05	4.08	92.52
DERO SP.	8.02	2.04	94.56
ISCHNURA SP.	5.35	1.36	95.92
LUMBRICULIDAE	2.67	0.68	96.60
TUPIFICIDAE (W/O CAPILLIFORM	2.67	0.68	97.28
DERO NIVEA	2.67	0.68	97.96
HELISOMA SCALARIS	2.67	0.68	98.64
CRANGONYX SP.	2.67	0.68	99.32
HYDROPOROUS SP. LARVAE	2.67	0.68	100.00
	393	100.00	

Table 8.1.4-34. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981 (Continued, Page 2 of 5)

TRIP = 3 GROUP = DB

SPECIES NAME	#/M**2	PCT	CUM PCT
NAIDIDAE	124.83	30.98	30.98
NEMOCERA SP.	49.93	12.39	43.37
CHIRONOMUS SP.	48.15	11.95	55.32
HAEMONAIS WALDVOGELI	33.88	8.41	63.73
ANCYLIDAE	30.32	7.52	71.25
POLYPEDILUM ILLINOENSE	12.48	3.10	74.35
DERO VAGA	10.70	2.66	77.01
PACHYDIPLAX LONGIPENNES	10.70	2.66	79.67
HYALELLA AZTECA	7.13	1.77	81.44
CHAOBORUS SP.	7.13	1.77	83.21
PARACHIRONOMUS CARINATUS	5.35	1.33	84.54
TANYTARSUS SP.	5.35	1.33	85.87
SLAVINA APPENDICULATA	3.57	0.89	86.75
DERO SP.	3.57	0.89	87.65
DERO NIVEA	3.57	0.89	88.54
PHYSA SP.	3.57	0.89	89.43
CALLIBAETIS SPP.	3.57	0.89	90.32
PELOCORIS SP.	3.57	0.89	91.21
SCIRTES SPP.	3.57	0.89	92.10
TANYTARSUS SP. A	3.57	0.89	92.99
DERO PECTINATA	1.78	0.44	93.43
HELISOMA SCALARIS	1.78	0.44	93.87
SPHAERIIDAE	1.78	0.44	94.31
ACARINA	1.78	0.44	94.75
ASELLUS SP.	1.78	0.44	95.19
PALAEMONETES PALUDOSUS	1.78	0.44	95.63
PERITHEMIS SPP.	1.78	0.44	96.07
ISCHNURA SP.	1.78	0.44	96.51
CHEUMATOPSYCHE SP.	1.78	0.44	96.95
CORTOTOMUS SP.	1.78	0.44	97.39
PELTODYTES SPP. LARVAE	1.78	0.44	97.83
AEDES SPP.	1.78	0.44	98.27
MONOPELOPIA SP.	1.78	0.44	98.71
POLYPEDILUM SP.	1.78	0.44	99.15
GOELDICHIRONOMUS HOLOPRASINUS	1.78	0.44	99.59
KIEFFERULUS DUX	1.78	0.44	100.03
	403	100.03	

Table 8.1.4-34. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981 (Continued, Page 3 of 5)

TRIP = 3 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM_PCT
CHIRONOMUS SPP.	290.68	47.11	47.11
NAIDIDAE	78.47	12.72	59.83
SLAVINA APPENDICULATA	71.33	11.56	71.39
POLYPEDILUM SPP	26.75	4.34	75.73
EINFELDIA SP B	21.40	3.47	79.20
TANYTARSUS SP.	21.40	3.47	82.67
CAENIS SP.	14.27	2.31	84.98
GOELDICHIRONOMUS HOLOPRASINUS	12.48	2.02	87.00
BRATISLAVIA UNIDENTATA	10.70	1.73	88.73
CRYPTOCHIRONOMUS SP.	7.13	1.16	89.89
KIEFFERULUS DUX	7.13	1.16	91.05
LARSIA SP.	5.35	0.87	91.92
POLYPEDILUM SP.	5.35	0.87	92.79
DERO PECTINATA	3.57	0.58	93.37
DINEUTUS SPP.	3.57	0.58	93.95
CORYNONEURA SP.	3.57	0.58	94.53
TANYPODINAE SP.	3.57	0.58	95.11
DICROTENDIPES MODESTUS	3.57	0.58	95.69
PARACHIRONOMUS CARINATUS	3.57	0.58	96.27
POLYPEDILUM ILLINOENSE	3.57	0.58	96.85
HAEMONAIS WALDVOGELI	1.78	0.29	97.14
CALLIBAETIS SPP.	1.78	0.29	97.43
COLEOPTERA	1.78	0.29	97.72
BEROSUS SPP.	1.78	0.29	98.01
STENELMIS SP.	1.78	0.29	98.30
ABLABESMYIA PHILOSPHAGNOS	1.78	0.29	98.59
LABRUNDINIA FLORIDANA	1.78	0.29	98.88
CHIRONOMINI UNIDENTIFIED FIRST INSTAR	1.78	0.29	99.17
CHIRONOMUS CARUS	1.78	0.29	99.46
DICROTENDIPES NERVOSUS	1.78	0.29	99.75
TRIBELOS SP.	1.78	0.29	100.04
	617	100.04	

Table 8.1.4-34. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981. (Continued, Page 4 of 5)

TRIP = 3 GROUP = P8

SPECIES NAME	#/M**2	PCT	CUM_PCT
MAEMONAIS WALDVOGELI	285.33	66.12	66.12
NAIDIDAE	19.62	4.55	70.67
LAEVAPEX SPP.	19.62	4.55	75.22
DERO NIVEA	14.27	3.31	78.53
CHIRONOMUS SP.	14.27	3.31	81.84
ERYTHEMIS SP.	10.70	2.48	84.32
DERO TRIFIDA	8.92	2.07	86.39
TUBIFICIDAE (W CAPILLIFORM SE	7.13	1.65	88.04
ACARINA	5.35	1.24	89.28
PERITHEMIS SPP.	5.35	1.24	90.52
NEOPLEA STRIOLA	5.35	1.24	91.76
GLYPTOTENDIPES SP.	5.35	1.24	93.00
EINFELDIA SP.	5.35	1.24	94.24
DERO DIGITATA	3.57	0.83	95.07
DICROTENDIPES SP.	3.57	0.83	95.90
DERO SP.	1.78	0.41	96.31
PRISTINA ACUMINATA	1.78	0.41	96.72
CAENIS SP.	1.78	0.41	97.13
LIBELLULIDAE	1.78	0.41	97.54
BELOSTOMA SPP.	1.78	0.41	97.95
PELTODYTES SPP.	1.78	0.41	98.36
MONOPELOPIA SP.	1.78	0.41	98.77
KIEFFERULUS DUX	1.78	0.41	99.18
LAUTERBORNIELLA VARIPENNIS	1.78	0.41	99.59
TANYTARSUS SP.	1.78	0.41	100.00
	432	100.00	

Table 8.1.4-34. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, August to September 1981 (Continued, Page 5 of 5)

TRIP = 3 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM_PCT
LAEVAPEX SPP.	135.53	19.44	19.44
HELISOMA SPP.	123.05	17.65	37.09
TANYTARSUS SP.	69.55	9.98	47.07
NAIDIDAE	60.63	8.70	55.77
HAEMONAIS WALDVOGELI	44.58	6.39	62.16
KIEFFERULUS DUX	39.23	5.63	67.79
DERO PECTINATA	26.75	3.84	71.63
POLYPEDILUM SPP	23.18	3.32	74.95
PHYSA SP.	17.83	2.56	77.51
CHIRONOMUS SP.	17.83	2.56	80.07
EINFELDIA SP B	17.83	2.56	82.63
DERO NIVEA	14.27	2.05	84.68
PACHYDIPLAX LONGIPENNES	14.27	2.05	86.73
TANYTARSUS SP. A	14.27	2.05	88.78
CAENIS SP.	12.48	1.79	90.57
COLLEMBOLA	10.70	1.53	92.10
BRATISLAVIA UNIDENTATA	7.13	1.02	93.12
ABLABESMYIA ORNATA	7.13	1.02	94.14
DINEUTUS SPP.	5.35	0.77	94.91
LABRUNDINIA JOHANNSENI	5.35	0.77	95.68
CHIRONOMINI UNIDENTIFIED PUPA	5.35	0.77	96.45
TANYPODINAE PUPA	3.57	0.51	96.96
GOELDICHIRONOMUS HOLOPRASINUS	3.57	0.51	97.47
DERO SP.	1.78	0.26	97.73
HIRUDINEA	1.78	0.26	97.99
ASTACIDAE	1.78	0.26	98.25
CORIOTOMUS SP.	1.78	0.26	98.51
CALLEPUCALLA SP	1.78	0.26	98.77
LAPSIA SP PUPA	1.78	0.26	99.03
PENTANEURA SP.	1.78	0.26	99.29
CHIRONOMINI	1.78	0.26	99.55
NEMOCERA SP.	1.78	0.26	99.81
THAUMALEIDAE SP	1.78	0.26	100.07
	697	100.07	

Key to Stations:
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HM = Horse Creek Mid Station
HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-35. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981.

TRIP = 4 GROUP = BC

SPECIES NAME	#/M**2	PCT	CUM_PCT
PALPOMYIA SP.	108.78	40.40	40.40
CHAOBORUS SP.	26.75	9.93	50.33
DERO VAGA	24.97	9.27	59.60
COLLEMBOLA SP B	16.05	5.96	65.56
POLYPEDILUM ILLINOENSE	16.05	5.96	71.52
NAIDIDAE	14.27	5.30	76.82
MONOPELOPIA BOLIEKA	14.27	5.30	82.12
AEDES SPP.	7.13	2.65	84.77
LARSIA SP.	7.13	2.65	87.42
DERO SP.	5.35	1.99	89.41
COENAGRIONIDAE	3.57	1.33	90.74
PYRALIDAE SP B	3.57	1.33	92.07
TROPISTERNUS SPP. ADULT	3.57	1.33	93.40
GOELDICHIRONOMUS HOLOPRASINUS	3.57	1.33	94.73
ANCYLIDAE	1.78	0.66	95.39
CALLIBAETIS SPP.	1.78	0.66	96.05
LIBELLULIDAE	1.78	0.66	96.71
PELTODYTES SPP. LARVAE	1.78	0.66	97.37
TROPISTERNUS SPP. LARVAE	1.78	0.66	98.03
ENOCHRUS SPP. LARVAE	1.78	0.66	98.69
TIPULA SP. LARVAE	1.78	0.66	99.35
HEMPOCERA SP.	1.78	0.66	100.01
	269	100.01	

Table 8.1.4-35. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981 (Continued, Page 2 of 5)

TRIP = 4 GROUP = DB

SPECIES NAME	#/M**2	PCT	CUM_PCT
NEMOCERA SP.	69.55	12.69	12.69
POLYPEDILUM ILLINOENSE	66.87	12.20	24.89
LAEVAPEX SPP.	56.17	10.25	35.14
ARACHNIDA	40.12	7.32	42.46
DERO PECTINATA	34.77	6.34	48.80
DERO NIVEA	29.42	5.37	54.17
MONOPELOPIA BOLIEKA	29.42	5.37	59.54
NAIDIDAE	24.07	4.39	63.93
DERO SP.	21.40	3.90	67.83
KIEFFERULUS DUX	18.72	3.41	71.24
PALAEMONETES PALUDOSUS	13.37	2.44	73.68
CALLIBAETIS SPP.	13.37	2.44	76.12
AEDES SP A	13.37	2.44	78.56
HYALELLA AZTECA	10.70	1.95	80.51
DERO VAGA	8.02	1.46	81.97
HELISOMA SPP.	8.02	1.46	83.43
PACHYDIPLAX LONGIPENNIS	8.02	1.46	84.89
MESOVELIA SP.	8.02	1.46	86.35
TURBELLARIA	5.35	0.98	87.33
PHYSA SP.	5.35	0.98	88.31
ENALLAGMA SP.	5.35	0.98	89.29
ORYCPS SP. LARVAE	5.35	0.98	90.27
DERO DIGITATA	2.67	0.49	90.75
DERO TRIFIDA	2.67	0.49	91.25
HAEMONAIS WALDVOGELI	2.67	0.49	91.74
ALLONAIS PARAGUAYENSIS	2.67	0.49	92.23
LYMNAEA SP	2.67	0.49	92.72
HYDRACARINA SP	2.67	0.49	93.21
COLLEMBOLA SP B	2.67	0.49	93.70
LIBELLULIDAE	2.67	0.49	94.19
TROPISTERNUS SPP. ADULT	2.67	0.49	94.68
ENOCHRUS SPP. ADULT	2.67	0.49	95.17
HYDROCHUS SP ADULT	2.67	0.49	95.66
HYDROCHARA SP.ADULT	2.67	0.49	96.15
AEDES SP B	2.67	0.49	96.64
ANOPHELES SPP.	2.67	0.49	97.13
MANSONIA SP	2.67	0.49	97.62
CHAOBORUS SP.	2.67	0.49	98.11
ABLABESMYIA PAPAJANTA	2.67	0.49	98.60
CHIRONOMUS SPP.	2.67	0.49	99.09
POLYPEDILUM ILLINOENSE PUPA	2.67	0.49	99.58
GOELDICHIRONOMUS HOLOPRASINUS	2.67	0.49	100.07
	548	100.07	

Table 8.1.4-35. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981 (Continued, Page 3 of 5)

TRIP = 4 GROUP = HC

SPECIES NAME	#/M**2	PCT	CUM PCT
CHIRONOMUS SPP.	238.97	57.27	57.27
CAENIS SP.	39.23	9.40	66.67
GOELDICHIRONOMUS HOLOPRASINUS	23.18	5.56	72.23
NAIDIDAE	14.27	3.42	75.65
CALLIBAETIS SPP.	14.27	3.42	79.07
PACHYDIPLAX LONGIPENNES	12.48	2.99	82.06
ABLABESMYIA ORNATA	8.92	2.14	84.20
NIEFFERULUS DUX	7.13	1.71	85.91
TANYTARSUS SP.	7.13	1.71	87.62
SLAVINA APPENDICULATA	5.35	1.28	88.90
DERO PECTINATA	5.35	1.28	90.18
COLLEMBOLA SP B	5.35	1.28	91.45
CRICOTOPUS SP. B	5.35	1.28	92.74
ENDOCHIRUS SPP.	3.57	0.86	93.60
LAMPSILIS SP.	3.57	0.86	94.45
POLYPEDILUM ILLINOENSE	3.57	0.86	95.32
DERO SP.	1.78	0.43	95.75
ANCYLIDAE	1.78	0.43	96.18
HYALELLA AZTECA	1.78	0.43	96.61
LIRELLULIDAE	1.78	0.43	97.04
ORTHOTRICHIA SP.	1.78	0.43	97.47
STENELMIS SP.	1.78	0.43	97.90
AEDES SPP.	1.78	0.43	98.33
TANYPODINAE SP.	1.78	0.43	98.75
ABLABESMYIA PARAJANTA	1.78	0.43	99.19
LADRUNDINIA FLORIDANA	1.78	0.43	99.62
POLYPEDILUM SP.	1.78	0.43	100.05
	417	100.05	

Table 8.1.4-35. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981 (Continued, Page 4 of 5)

TRIP = 4 GROUP = PB

SPECIES NAME	#/M**2	PCT	CUM PCT
GOELDICHIRONOMUS HOLOPRASINUS	65.98	28.91	28.91
CHIRONOMUS SP.	37.45	16.41	45.32
DERO NIVEA	19.62	8.60	53.92
CHAOBORUS SP.	19.62	8.60	62.52
NAIDIDAE	12.48	5.47	67.99
LAEVAPEX SPP.	10.70	4.69	72.68
DERO TRIFIDA	7.13	3.12	75.80
TANYTARSUS SP.	7.13	3.12	78.92
DERO SP.	5.35	2.34	81.26
ARACHNIDA	5.35	2.34	83.60
COLLEMBOLA SP B	5.35	2.34	85.94
AEDES SP A	5.35	2.34	88.28
HARMONAIS VALDVOGELI	3.57	1.56	89.84
CALLIBAETIS SPP.	3.57	1.56	91.40
DERO DIGITATA	1.78	0.78	92.18
EUCARIDA DECAPODA	1.78	0.78	92.95
HYDROPORUS SP. LARVAE	1.78	0.78	93.74
BEROSUS SPP. ADULT	1.78	0.78	94.52
CULICIDAE SP. PUPA	1.78	0.78	95.30
ANOPHELES SPP.	1.78	0.78	96.08
PALPOMYIA SP.	1.78	0.78	96.85
COPYNEURA SP.	1.78	0.78	97.64
GLYPTOTENDIPES SP.	1.78	0.78	98.42
POLYPEDILUM ILLINOENSE	1.78	0.78	99.20
GOELDICHIRONOMUS HOLOPRASINUS PUPA	1.78	0.78	99.98
	228	99.98	

Table 8.1.4-35. Density (#/m^2) and Percent Composition (PCT) of Fauna Colonizing Hester-Dendy Samplers, September to October 1981. (Continued, Page 5 of 5)

TRIP = 4 GROUP = SB

SPECIES NAME	#/M**2	PCT	CUM_PCT
LARVAREN SPP.	37.45	21.43	21.43
NIEFFERILUS DUX	28.53	16.33	37.76
CHAOBORUS SP.	16.05	9.19	46.95
NAEMONAIS VALOVOGELI	8.92	5.11	52.06
HYDRACARINA SP	7.13	4.08	56.14
CHIRONOMUS SPP.	7.13	4.08	60.22
DERO SP.	5.35	3.06	63.28
COLLEMBOLA SP B	5.35	3.06	66.34
CAENIS SP.	5.35	3.06	69.40
PACHYDIPLAX LONGIPENNIS	5.35	3.06	72.46
MESOVELIA SP.	5.35	3.06	75.52
PISCICOLA SP B	5.35	3.06	78.58
GOELDICHIRONOMUS HOLOPRASINUS	5.35	3.06	81.64
NAIDIDAE	3.57	2.04	83.68
MELISOMA SPP.	3.57	2.04	85.72
CHIRONOMUS CAPUS	3.57	2.04	87.76
TURBELLARIA	1.78	1.02	88.78
DERO DIGITATA	1.78	1.02	89.80
DERO NIVEA	1.78	1.02	90.82
ARACHNIDA	1.78	1.02	91.84
HYALELLA AZTECA	1.78	1.02	92.86
ENALLAGMA SP.	1.78	1.02	93.88
PARATPA SPP.	1.78	1.02	94.90
PRIONOCEPA SP	1.78	1.02	95.92
TIPULA SP. LARVAE	1.78	1.02	96.94
PHAENOPSECTRA OBEDIENS	1.78	1.02	97.96
TANYTARSUS SPP.	1.78	1.02	98.98
THAUMALEIDAE SP	1.78	1.02	100.00
	175	100.00	

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HN = Horse Creek North Station

*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Source: ESE, 1984.

Table 8.1.4-36. Shannon-Weaver Diversity (H'), Margalef's Species Richness (J), and Pielou's Evenness (E) Indices Calculated for Hester-Dendy Multiplate Samplers

TRIP = 2

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	2.9721	2.9640	0.7439
DB	3.2970	4.2521	0.6859
HC	3.1339	4.6251	0.6325
PB	2.6394	3.5914	0.5488
SB	2.9118	1.9728	0.8417

TRIP = 3

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	1.5423	1.9411	0.4302
DB	3.6932	5.0336	0.7124
HC	2.9586	4.6699	0.5972
PB	2.3051	3.9557	0.4964
SB	3.9123	4.9978	0.7755

TRIP = 4

GROUP	DIVERSITY (H')	RICHNESS (J)	EVENNESS (E)
BC	3.2143	3.7525	0.7297
DB	4.4796	6.5003	0.8307
HC	2.6543	4.3089	0.5647
PB	3.5998	4.4197	0.7753
SB	4.0497	5.2306	0.8424

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HM = Horse Creek Mid Station
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*When three stations were sampled in Horse Creek, HC was the southern station at the property exit line.

Note: Trip 2 = July-August, 1981
Trip 3 = August-September, 1981
Trip 4 = September-October, 1981

Source: ESE, 1984.

Table 8.1.4-37.* Species Presence/Absence Matrix by Transect and Habitat, Mitchell Hammock, February 1982

Taxa	Infauna						Epifauna						Epixylous					
Transect:	1	2	3	4	S	M	1	2	3	4	S	M	1	2	3	4	S	M
Nematoda sp.				X		X												
Annelida																		
Oligochaeta																		
Lumbriculidae sp.		X				X	X	X		X	X							
Naididae																		
Naididae sp.	X	X	X	X	X	X	X	X	X	X	X							
Allonais paraguayensis									X									
Dero digitata		X			X	X	X	X	X	X	X							
Dero nivea						X	X	X	X	X								
Dero pectinata						X												
Dero trifida									X									
Dero vega							X		X	X								
Dero sp. A1										X	X							
Dero spp.						X	X	X	X	X	X							
Haemonais waldvogeli	X					X	X											
Nais communis						X												
Pristina longiseta									X									
Slavina appendiculata							X											
Tubificidae																		
Tubificidae sp. A	X	X		X	X	X		X	X									
Tubificidae sp. B	X					X			X									
Hirudinea sp.		X					X		X		X							
Crustacea																		
Branchiopoda sp.	X			X	X													
Copepoda sp.	X		X					X										
Amphipoda																		
Crangonyx sp.		X						X	X	X	X							
Decapoda																		
Procambrus sp.		X					X	X	X	X	X							
Insecta																		
Collumbola sp.	X			X		X	X	X										
Ephemeroptera																		
Baetidae																		
Caenis sp.									X									
Callibaetis sp.				X					X									

Table 8.1.4-37. Species Presence/Absence Matrix by Transect and Habitat, Mitchell Hammock, February 1982 (Continued, Page 2 of 5)

Taxa	Infauna						Epifauna						Epixylous					
Transect:	1	2	3	4	S	M	1	2	3	4	S	M	1	2	3	4	S	M
Odonata																		
Anisoptera																		
Ashnidae																		
Anax sp.									X									
Libellulidae																		
Erythemis sp.								X	X		X							
Miathyria sp.									X									
Libellula sp.	X						X		X									
Pachydiplax longipennis					X		X		X		X							
Tramea sp.		X																
Zygoptera																		
Coenagriidae																		
Enallagma sp.					X			X	X		X							
Nehalennia sp. A							X											
Nehalennia sp. B							X			X								
Hemiptera																		
Mesoveliidae																		
Mesovelia sp.							X											
Gerridae																		
Gerris sp.							X											
Naucoridae																		
Pelocoris sp.									X									
Nepidae																		
Ranatra sp.				X			X		X									
Megaloptera																		
Corydalidae																		
Chavliodes sp.							X									X		
Lepidoptera																		
Pyralidae sp.					X				X									
Coeloptera																		
Haliplidae																		
Peltodytes oppositus									X									

Table 8.1.4-37. Species Presence/Absence Matrix by Transect and Habitat, Mitchell Hammock, February 1982 (Continued, Page 3 of 5)

Taxa	Infauna						Epifauna						Epixylous					
Transect:	1	2	3	4	S	M	1	2	3	4	S	M	1	2	3	4	S	M
Dytiscidae																		
Bidessus gr sp.	X				X													
Celina grossula	X				X			X										
Copelatus caelatipennis								X										
Coptotomus interrogatus	X					X		X	X									
Hydroporus sp.				X				X	X									
Hydrovatus compressus								X										
Laccophilus proximus								X	X			X						
Pachydrus princeps									X			X						
Thermonectus bassilaris								X			X	X						
Noteridae																		
Hydrocanthus oblongus				X				X	X	X		X						
Hydrocanthus regis									X			X						
Suphis inflatus					X			X	X	X		X						
Suphisellus gibbulus (?)						X		X	X	X		X						
Gyrinidae																		
Dineutus carolinus										X								
Hydrophilidae																		
Berosus striatus								X	X									
Cymbiodyta blanchardi (?)	X							X										
Enochrus blatchleyi								X	X			X						
Enochrus cinctus									X									
Enochrus ochraceus									X									
Hydrochus callosus									X									
Tropisternus blatchleyi									X			X						
Tropisternus lateralis						X		X	X	X		X						
Tropisternus striolatus					X				X			X						
Dryopidae																		
Peloconus sp.								X										
Helodidae																		
Scrites sp.										X		X						
Curculionidae																		
Hylobius sp.									X									
Diptera																		
Tipulidae																		
Helius pos. flavipes					X													
Tipula sp.								X										

Table 8.1.4-37. Species Presence/Absence Matrix by Transect and Habitat, Mitchell' Hammock, February 1982 (Continued, Page 4 of 5)

Taxa	Infauna						Epifauna						Epixylous					
Transect:	1	2	3	4	S	M	1	2	3	4	S	M	1	2	3	4	S	M
Culicidae																		
Chaoborinae																		
Chaoborus sp.	X			X														
Culicinae																		
Culex sp.							X											
Chironomidae																		
Tanypodinae																		
Ablabesmyia peleenis	X			X		X	X		X									
Ablabesmyia sp.				X					X									
Larsia sp.					X	X	X		X		X							
Psectrotanypus sp.									X									
Tanypus carinatus	X																	
Chironominae																		
Chironomini																		
Chironomus carus									X									
Chironomus sp.	X	X		X		X				X								
Endochironomus nigracans									X									
Goeldichironomus holoprasinus	X							X	X									
Kiefferulus dux				X	X	X	X	X	X	X	X					X		
Parachironomus carinatus									X									
Parachironomus hirtalatus									X									
Polypedilum illinoense	X			X	X	X	X	X	X	X	X					X		
Tanytarsini																		
Calopsectra sp. 13 (Roback)							X		X									
Tanytarsus nr. xanthus									X									
Tabanidae																		
Chrysops sp.		X						X										
Tabanus sp.							X									X		
Ephydridae																		
Hydrelia sp.					X			X										
Gastropoda																		
Physidae																		
Physa sp.							X	X	X									

Table 8.1.4-37. Species Presence/Absence Matrix by Transect and Habitat, Mitchell Hammock, February 1982 (Continued, Page 5 of 5)

Taxa	Infauna						Epifauna						Epixylous					
Transect:	1	2	3	4	S	M	1	2	3	4	S	M	1	2	3	4	S	M
Ancylidae																		
Laevapex sp.					X		X	X	X	X	X							
Limnaeidae																		
Limnaea sp.							X											

Source: ESE, 1982.

Table 8.1.4-38. Presence/Absence Matrix of Fish and Amphibians Identified From CF Complex II Site, August 1981 to February 1982

Taxon	Station								
	HN	HM	HS	BC	B2	SB	DB	PB	CB
Teleostei									
Notemigonus crysoleucas			X						
Notropis sp.			X						
Erimyzon oblongus			X						
Ictalurus natalis			X						
Ictalurus nebulosus			X						
Notorus gyrinus	X								
Notorus sp.							X		
Clarius batrachus							X		
Fundulus sp.		X	X						
Jordanella floridae	X	X	X				X		
Lucania goodei			X						
Gambusia affinis	X	X	X	X	X	X	X	X	
Heterandria formosa	X	X	X	X	X	X	X	X	
Poecilia latipinna	X		X	X			X		
Labidesthes sicculus			X						
Elassoma evergladei	X		X						
Lepomis macrochirus			X						
Lepomis marginatus			X						
Lepomis punctatus							X		
Lepomis sp.			X				X		
Chaenobryttus gulosus			X				X		
Micropterus salmoides			X				X		
Etheostoma sp.						X			
Unidentified fish			X					X	X
Unidentified fish larva			X			X	X	X	X
Unidentified fish egg								X	
Amphibia									
Rana spp. (tadpole)			X	X			X		
Salamondridae			X						

Key to Stations:
HN = Horse Creek North
HM = Horse Creek Middle
HS = Horse Creek South
BC = Brushy Creek
B2 = Brushy Creek 2
SB = Shirttail Branch
DB = Doe Branch
PB = Plunder Branch
CB = Coon's Bay Branch

Source: ESE, 1983.

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Mason, W.T., Jr. and Yevich, P.P. 1967. The Use of Phloxine B and Rose Bengal Stains to Facilitate Sorting Benthic Samples. Trans. Am. Microsc. Soc., 86:221-223.

U.S. Environmental Protection Agency. 1978. Final Areawide Environmental Impact Statement. Central Florida Phosphate Industry. EPA 904/9-78-026a, Vol. 3.

9.0 TERRESTRIAL ECOLOGY

9.1 THE AFFECTED ENVIRONMENT

9.1.1 REGIONAL DESCRIPTION

The CF Hardee Phosphate Complex II site, located in the northwestern quarter of Hardee County, occurs within the coastal lowland ecoregion of the Beech-Sweetgum-Magnolia-Pine-Oak Province of Peninsular Florida (Bailey, 1976). The vegetative pattern in the region can be characterized as temperate/sub-tropical plant associations. Their distribution, community structure, and species composition are influenced by intrinsic biological interactions and various topographic, edaphic, hydrologic, geologic, and climatic factors.

A general description of the land use and cover types occurring in the site region is presented in the Central Florida Phosphate Industry Areawide Impact Assessment (U.S. Environmental Protection Agency, 1977). The study encompassed a seven-county area of western Peninsular Florida, including Hardee County. Five major plant community types were described for the region:

1. Agricultural Land--including cropland, pasture, orchards, citrus groves, nurseries, parklands for recreation, and old fields;
2. Rangeland--including herbaceous rangeland, shrub and brush rangeland, and mixed rangeland;
3. Forest Uplands--consisting of oak hammocks, pine flatwoods, scrubby flatwoods or oak scrub, sandhill, and sand pine scrub;
4. Wetlands--including wooded wetlands (mixed hardwood swamp, cypress swamp, bayhead, shrub swamp) and nonwooded wetlands (wet prairie, deep freshwater marsh, salt marsh, artificially created marsh); and
5. Water--including lakes, ponds, borrow pits, stock ponds, canals, and streams.

All of the five major plant community types outlined in the Central Florida Phosphate Industry Areawide Impact Assessment occur on and in

the immediate vicinity of the site. Citrus grove is the dominant agricultural land use north of the site; however, only 2.6 acres of citrus grove occur on the site proper. The rest of the land adjacent to the site is predominantly palmetto rangeland and pine flatwoods. Topographic relief to these relatively flat uplands is provided by natural creeks. Major wetlands and hardwood hammocks occur along creek drainages both on and off the site. The only vegetation associations which do not occur onsite and are rare or nonexistent within the immediate vicinity of the site are sandhill, sand pine scrub, cypress swamp, and salt marsh.

9.1.2 SITE-SPECIFIC DESCRIPTION

9.1.2.1 VEGETATION AND WILDLIFE

The CF Industries Hardee Phosphate Complex II mine site property is located south of State Road (SR) 62 near Fort Green Springs in the northwestern quarter of Hardee County and occupies an area approximately 10 miles by 2.5 miles. The 14,994.0-acre site extends from Horse Creek on the west to Coon's Bay Branch on the east.

Vegetation within the CF Hardee Phosphate Complex II site generally is typical of regional plant community types. The property consists of wetland and upland associations, most of which have been altered by logging, fire, draining, and other agricultural practices. Currently, the proposed mine site is predominantly managed for cattle (fire maintenance, grass seeding and combining, and cattle rotation). Wetland/floodplain complexes exist along eight major on-site drainages (i.e., Horse Creek, Brushy Creek, Shirttail Branch, Doe Branch, Plunder Branch, Coon's Bay Branch, Lettis Creek, and Troublesome Creek), and one minor on-site drainage (Gum Swamp Branch). A tenth minor drainage area on the CF mine site, Hog Branch, drains to the east by overland sheet flow through pine flatwoods and palmetto rangeland.

Vegetation within the site has been separated into nine major groupings based upon the Florida Land Use and Cover Classification System (FLUCCS), 1976. Table 9.1.2-1 provides the FLUCCS Level III legend, acreages, and percentages for the CF mine site vegetation map. The vegetation map (see Figure 9.1-1) is divided into both eastern and western portions by the Seaboard Coast Line Railroad. A plant species

Table 9.1.2-1. Legend, Acreages, and Percentages for CF Industries Hardee Phosphate Complex II Proposed Mine Site Vegetation Map

FLUCCS* LEVEL III	Description	Acreage	Percent of Total Acreage
211	Row Crops	13.1	0.09
212	Field Crops	44.1	0.29
213	Improved Pasture	1,310.3	8.74
231	Orange Grove	2.6	0.02
321	Palmetto Prairies	6,957.2	46.40
411	Pine Flatwoods	732.7	4.89
422	Other Hardwoods	2,354.0	15.70
621	Freshwater Swamp	1,240.4	8.27
641	Freshwater Marsh	2,339.6	15.60
	TOTAL	14,994.0	100.00

* Florida Land Use and Cover Classification System (FLUCCS).

Source: FLUCCS, 1976.
ESE, 1983.

X X X X

Morus rubra L. Red mulberry
Nyssa sylvatica var. biflora (Walt.) Sarg. Blackgum
Persea borbonia (L.) Spreng. Red bay*

PAGE NOT

AVAILABLE

DIGITALLY

inventory of the site by plant community type is presented in Table 9.1.2-2. Taxonomic identification of plant species follows that of Wunderlin (1982). Plant species identified during the botanical investigations by Dames and Moore (CF DRI, 1976) which were not observed during the latest surveys (i.e., 1981 to 1982) were taxonomically updated and included in the plant species inventory table.

The wildlife composition of an area is ultimately determined by the natural resources available within it. These resources make up a life support system for a given species requirement. Basic requirements for survival of a wildlife species include an adequate supply of food, water, shelter from predators and varying climatic conditions and resources to successfully breed and rear offspring.

The CF Hardee Phosphate Complex II site is located within a region that is characterized by a climate of widely ranging temperatures and high rainfall, nearly level topography resulting in large or numerous areas of water drainage and retention (wetlands), and complex soil structure and plant community composition. These combined factors produce suitable habitat for a diverse composition of wildlife species represented by amphibians, reptiles, birds, and mammals.

A particular animal's habitat is usually considered in terms of the plant community in which it is found. Many animals have life requirements that are not satisfied by a single plant community. An animal's mobility enables it to move to numerous communities until its needs are met. Some animals spend much time on the edge of two adjacent and different communities (ecotones) where they benefit from resources found in both. To describe the habitat utilized by each animal occurring on the CF mine site property would be a very complex presentation. Instead, a discussion of the major plant communities is provided, including the important faunal species found in each. Tables 9.1.2-3 through 9.1.2-5 list the fauna known or expected to occur on the CF mine site property and the major plant communities utilized by each.

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
TREES (Overstory and Understory)								
Acer rubrum var. trilobum K. Koch.	Red maple				X	X	X	
Carpinus caroliniana Walt.	Ironwood			X	X			
Carya aquatica (Michx.f.) Nutt.	Water hickory*				X			
Carya glabra (Mill.) Sweet	Pignut hickory			X				
Celtis laevigata Willd.	Hackberry			X	X			
Citrus aurantium L.	Sour orange			X				
Citrus paradisi (L.) Medic.	Grapefruit			X				
Citrus reticulata Blanco.	Tangerine			X				
Citrus sinensis (L.) Osbeck.	Sweet orange			X				
Cornus foemina Mill.	Stiff cornell			X	X			
Diospyros virginiana L.	Persimmon		X	X				
Fraxinus caroliniana Mill.	Pop ash				X	X		
Fraxinus pennsylvanica Marsh.	Red ash*					X		
Gleditsia aquatica Marsh.	Water locust*				X			
Gordonia lasianthus (L.) Ellis	Loblolly bay				X			
Ilex cassine L.	Dahoon holly			X	X			
Ilex decidua Walt.	Possum haw*				X			
Juniperus silicicola (Small) Bailey	Southern red cedar			X				
Liquidambar styraciflua L.	Sweetgum			X	X			
Magnolia grandiflora L.	Southern magnolia			X				
Magnolia virginiana L.	Sweet bay				X			
Morus rubra L.	Red mulberry			X				
Nyssa sylvatica var. biflora (Walt.) Sarg.	Blackgum				X	X		
Persea borbonia (L.) Spreng.	Red bay*				X			

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 2 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
TREES (Overstory and Understory) (Continued)								
Persea palustris (Raf.) Sarg.	Swamp red bay			X	X			
Pinus elliottii Engelm.	Slash pine		X	X				
Pinus palustris Mill.	Longleaf pine		X					
Prunus caroliniana Ait.	Carolina laurel-cherry			X				
Quercus chapmanii Sarg.	Chapman's oak*		X					
Quercus geminata Small	Sand live oak		X	X				
Quercus laurifolia Michx.	Laurel oak			X	X			
Quercus myrtifolia Willd.	Myrtle oak		X					
Quercus nigra L.	Water oak			X	X			
Quercus virginiana Mill.	Live oak			X				
Sabal palmetto (Walt.) Lodd. ex Schultes	Cabbage palm			X				
Ulmus americana L.	American elm			X	X	X		
SHRUBS AND SMALL TREES								
Asimina reticulata Chapm.	Pawpaw		X					
Baccharis halimifolia L.	Salt bush	X	X	X				
Bumelia reclinata Vent.	Buckthorn			X				
Callicarpa americana L.	American beautybush		X	X				
Cassia ligustrina L.	Senna		X					
Cephalanthus occidentalis L.	Buttonbush				X	X	X	
Chionanthus virginicus L.	Fringe tree				X			
Crataegus viridis L.	Hawthorn			X				
Decodon verticillatus (L.) Ell.	Water willow				X	X	X	
Euonymus americanus L.	Strawberry bush			X				

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 3 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
SHRUBS AND SMALL TREES (Continued)								
Ilex glabra (L.) A. Gray	Gallberry		X	X				
Itea virginica L.	Virginia willow				X			
Lantana camara L.	Shrub verbena	X						
Licania michauxii Prance	Gopher apple		X					
Lyonia fruticosa (Michx.) Torr.	Staggerbush		X					
Lyonia lucida (Lam.) D. Don	Fetterbush		X	X	X			
Myrica cerifera L.	Wax-myrtle		X	X	X	X	X	
Psidium guajava L.	Guava	X		X				
Quercus minima (Sarg.) Small	Dwarf live oak		X					
Quercus pumila Walt.	Running oak		X					
Rhapidophyllum hystrix (Pursh) Wendl. and Drude	Needle palm				X			
Rhododendron viscosum var. *serrulatum* (Small) Ahles.	Florida azalea			X				
Rhus copallina L.	Winged sumac		X	X				
Rosa palustris Marsh.	Swamp rose			X	X			
Sabal minor (Jacq.) Pers.	Blue-stem palmetto			X	X			
Sageretia minutiflora (Michx.) Mohr	Buckthorn			X				
Salix caroliniana Michx.	Carolina willow				X	X	X	
Sambucus canadensis L.	Florida elderberry			X	X	X	X	
Serenoa repens (Bartr.) Small	Saw palmetto		X	X				
Solanum diphyllum L.	Nightshade			X				
Triumfetta semitriloba Jacq.	Barbush*	X						
Vaccinium arboreum Marsh.	Sparkleberry			X				
Vaccinium corymbosum L.	Swamp blueberry				X			

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 4 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
SHRUBS AND SMALL TREES (Continued)								
Vaccinium darrowii Camp	Shiny blueberry		X					
Vaccinium myrsinites Lam.	Shiny blueberry		X	X				
Viburnum nudum L.	Possum-haw viburnum				X			
Viburnum obovatum Walt.	Black haw			X				
Ximenia americana L.	Tallowwood			X				
Zanthoxylum clava-herculis L.	Hercules club			X				
Zanthoxylum fagara (L.) Sarg.	Wild lime			X				
HERBS								
Acalypha gracilens A. Gray	Three-star mercury	X						
Acanthospermum hispidum DC.	Acanthospermum*	X						
Ageratina jucunda (Greene) Clewell and Wooten	Thoroughwort	X	X					
Amaranthus viridis L.	Pigweed	X						
Ambrosia artemisiifolia L.	Ragweed	X						
Amorpha herbacea Walt.	Lead plant			X				
Andropogon glomeratus var. glaucopsis (Ell.) Hitchc.	Glaucous bushy bluestem		X				X	
Andropogon ternarius var. cabanisii (Hackel) Fern. and Grise.	Chalky bluestem*		X					
Andropogon virginicus L.	Broomsedge	X	X	X				
Arisaema triphyllum (L.) Schott	Jack-in-the-pulpit				X			
Aristida purpurascens Poir.	Wire grass		X					
Aristida spiciformis Ell.	Wire grass		X					
Aristida stricta Michx.	Wire grass		X					
Aristida tenuispica Hitchc.	Three awn grass*		X					
Asclepias feayi Chapm.	Milkweed		X					

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 5 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Asclepias pedicellata Walt.	Milkweed		X					
Asclepias perennis Walt.	Milkweed				X			
Aster carolinianus Walt.	Bushy aster				X		X	
Aster reticulatus Pursh	Aster		X					
Aster subulatus Michx.	Annual saltmarsh aster						X	
Aster tortifolius Michx.	Aster		X				X	
Axonopus affinis Chase	Carpet grass	X	X	X			X	
Axonopus furcatus (Fluegge) Hitchc.	Carpet grass	X	X	X			X	
Azolla caroliniana Willd.	Mosquito fern				X			X
Bacopa caroliniana (Walt.) Robins.	Water hyssop				X		X	X
Bacopa monnieri (L.) Pennell	Water hyssop	X			X		X	
Bidens alba var. radiata (Sch.-Bip.) Ballard ex Melchert	Spanish needles	X						
Bidens bipinnata L.	Spanish needles				X			
Bidens mitis (Michx.) Sherff	Beggar-tick						X	
Bigelowia nudata subsp. australis L.C. Anders	Bigelowia						X	
Blechnum serrulatum L.C. Rich.	Toothed mid-sorus fern				X			
Boehmeria cylindrica (L.) SW.	False nettle				X		X	
Boltonia diffusa Ell.	Boltonia					X	X	
Buchnera americana L.	Blueheart	X	X					

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 6 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Bulbostylis ciliatifolia (Ell.) Fern.	Bulbostylis		X					
Canna flaccida Salisb.	Indian shot	X						
Capsicum frutescens L.	Tabasco pepper*	X						
Carex alata Torr. and Gray	Carex*						X	
Carex glaucescens Ell.	Carex				X			
Carex lupulina Muhl. ex Schkuhr	Carex				X			
Carphephorus corymbosus (Nutt.) Torr. and Gray	Deer tongue		X					
Carphephorus odoratissimus (J.F. Gmel) Herbert.	Vanilla plant		X					
Carphephorus paniculatus (J.F. Gmel.) Herbert.	Vanilla plant		X					
Cassia chamaecrista L.	Partridge pea	X	X	X				
Cassia nictitans var. aspera (Muhl. ex Ell.) Torr. and Gray.	Senna	X	X	X				
Cassia obtusifolia L.	Sicklepod			X				
Cenchrus echinatus L.	Sand bur	X						
Cenchrus incertus M.A. Curtis	Sandspur	X						
Centella asiatica (L.) Urban	Coinwort			X	X		X	
Ceratophyllum demersum L.	Coontail						X	X
Chamaesyce hirta (L.) Millsp.	Hairy Spurge	X						
Chamaesyce hypericifolia (L.) Millsp.	Spurge	X						
Chamaesyce hyssopifolia (L.) Small	Spurge	X						

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 7 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Chamaesyce maculata (L.) Small	Spurge	X						
Chapmannia floridana Torr. and Gray	Alicia		X					
Chaptalia tomentosa Vent.	Chaptalia		X					
Chasmanthium laxum (L.) Yates.	Spike Chasmanthium			X				
Chenopodium ambrosioides L.	Mexican tea	X		X				
Cicuta mexicana Coult. and Rose	Water hemlock				X			
Cirsium horridulum Michx.	Purple thistle	X	X					
Cladium jamaicense Crantz	Saw grass					X	X	
Cnidoscolus stimulosus (Michx.) Engelm. and Gray	Tread-softly		X			X		
Commelina diffusa Burm.f.	Dayflower	X		X				
Commelina elegans HBK	Dayflower			X				
Commelina erecta L.	Dayflower			X				
Conoclinium coelestinum (L.) DC	Mist flower	X		X			X	
Conyza canadensis var. pusilla (Nutt.) Crong.	Horseweed	X	X	X				
Coreopsis leavenworthii Torr. and Gray	Tick weed	X	X					
Crinum americanum L.	String lily				X			
Crotalaria mucronata Desv.	Rattlebox	X	X	X				
Crotalaria rotundifolia (Walt.) Gmel.	Rattlebox	X	X					
Croton glandulosus L.	Croton		X					
Crotonopsis linearis Michx.	Crotonopsis		X					

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 8 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Cuphea carthagenensis (Jacq.) Macbr.	Waxweed			X				
Cuthbertia ornata Small	Roseling		X					
Cynodon dactylon (L.) Pers.	Bermuda grass	X						
Cyperus articulatus L.	Galingale						X	
Cyperus brevifolius (Rottb.) Hassk.	Galingale		X					
Cyperus globulosus Aubl.	Galingale	X	X				X	
Cyperus haspan L.	Galingale						X	
Cyperus polystachyos var. texensis (Torr.) Fern.	Galingale	X					X	
Cyperus retrorsus Chapm.	Galingale	X	X	X				
Dalea pinnata (Walt. ex J.F. Gmel.) Barneby	Prairie clover		X					
Desmodium incanum DC.	Beggar lice	X	X	X				
Desmodium marilandicum (L.) DC.	Beggar lice*	X						
Desmodium triflorum (L.) DC.	Beggar lice	X						
Dichanthelium commutatum (Schult.) Gould	Dichanthelium grass			X				
Dichanthelium sabulorum (Lam.) Gould and Clark	Dichanthelium grass		X	X				
Dichondra caroliniensis Michx.	False pennywort			X				
Dichromena colorata (L.) Hitchc.	White-top sedge	X					X	
Digitaria ciliaris (Retz.) Koel.	Crabgrass	X						
Diodia teres Walt.	Buttonweed	X					X	

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 9 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Diodia virginiana L.	Buttonweed				X	X	X	
Drymaria cordata (L.) Willd. ex Roem. and Schult.	Chickweed	X		X				
Dryopteris ludoviciana (Kunze) Small	Fern			X				
Dyschoriste humistrata (Michx.) Kuntze	Twin flower			X				
Eclipta alba (L.) Hassk.	Eclipta					X	X	
Eichhornia crassipes (Mart.) Solms.	Water hyacinth					X		X
Eleocharis baldwinii (Torr.) Chapm.	Clubrush				X	X	X	X
Eleocharis equisetoides (Ell.) Torr.	Clubrush						X	
Elephantopus carolinianus Raeusch.	Elephant's foot			X				
Elephantopus elatus Bertol.	Elephant's foot		X	X				
Eleusine indica (L.) Gaertn.	Goose grass	X						
Elytraria caroliniensis (J.F. Gmel) Pers.	Elytraria			X				
Eragrostis elliottii S. Wats.	Love grass		X					
Eragrostis refracta (Muhl.) Scribn.	Love grass*		X					
Eragrostis spectabilis (Pursh) Steud.	Love grass	X	X					
Erechtites hieracifolia (L.) Raf.	Fireweed			X				
Erianthus giganteus (Walt.) Muhl.	Sugarcane plume grass	X					X	

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 10 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Erigeron quercifolius Lam.	Fleabane	X	X					
Erigeron strigosus Muhl.	Daisy fleabane	X	X					
Erigeron vernus (L.) Torr. and Gray	Fleabane	X	X					
Eriocaulon decangulare L.	Hatpins				X	X	X	
Eryngium aromaticum Baldw. ex Ell.	Fragrant eryngium*		X					
Eulophia alta (L.) Fawcett and Rendle	Wild coco		X					
Eupatorium capillifolium (Lam.) Small	Dog fennel	X	X	X			X	
Eupatorium compositifolium Walt.	Thoroughwort	X						
Eupatorium mohrii Greene	Thoroughwort		X					
Euphorbia polyphylla Engelm.	Euphorbia		X					
Eustachys petraea (Sw.) Desv.	Finger grass	X	X					
Euthamia minor (Michx.) Greene	Bushy goldenrod	X	X					
Fimbristylis schoenoides Vahl.	Fringe rush		X					
Froelichia floridana (Nutt.) Moq.	Cottonweed	X						
Fuirenia brevisita (Cov.) Cov.	Umbrella grass	X					X	
Galium hispidulum Michx.	Bedstraw		X					
Galium tinctorium L.	Bedstraw	X					X	
Gaura angustifolia Michx.	Southern gaura	X						
Geranium carolinianum L.	Cranesbill	X						

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 11 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Gomphrena serrata L.	Gomphrena	X						
Gnaphalium obtusifolium L.	Cudweed		X					
Gratiola ramosa Walt.	Hedge hyssop						X	
Gratiola hispida (Benth.) Pollard	Hedge hyssop		X					
Gymnopogon chapmanianus Hitchc.	Florida beardgrass	X						
Habenaria odontopetala Reichb. f.	Orchid				X			
Habenaria repens Nutt.	Water spider orchid					X		
Hedyotis procumbens (J.F. Gmel.) Fosberg	Innocence	X	X					
Helianthemum corymbosum Michx.	Rock rose		X					
Helianthus annuus L.	Common sunflower	X						
Heterotheca subaxilaris (Lam.) Britt. and Rusby	Golden aster	X	X	X				
Hieracium gronovii L.	Hieracium		X					
Hordeum vulgare L.	Rye grass	X						
Hydrocotyle umbellata L.	Marsh pennywort	X	X	X	X	X	X	
Hydrolea corymbosa Macbr.ex Ell.	Sky flower					X	X	
Hygrophila lacustris (Schlecht.) Nees.	Hygrophila				X		X	
Hymenocallis crassifolia Herb.	Spider lily*				X		X	
Hypericum cistifolium Lam.	St. John's wort		X					
Hypericum fasciculatum Lam.	St. John's wort						X	
Hypericum hypericoides (L.) Crantz.	St. Andrew's-Cros			X			X	

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 12 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Hypericum mutilum L.	Dwarf St. John's wort	X					X	
Hypericum myrtifolium Lam.	St. John's wort						X	
Hypericum tetrapetalum Lam.	St. Andrew's cross		X					
Hypoxis juncea J.E. Smitch	Star grass		X	X				
Hypoxis leptocarpa Engelm.	Star grass			X				
Hyptis alata (Raf.) Shinners	Musky mint	X	X		X	X	X	
Hyptis verticillata Jacq.	Bittermint	X		X				
Iresine diffusa Humb. and Bonpl. ex Willd.	Iresine	X		X				
Iris hexagona var. savannarum (Small) Foster	Blueflag				X	X	X	
Juncus effusus var. solutus (Fern. and Wieg.) Hamet-Ahti	Softrush					X	X	
Juncus marginatus Rostk.	Rush	X	X				X	
Juncus repens Michx.	Creeping rush						X	X
Juncus scirpoides Lam.	Rush	X	X				X	
Justicia ovata (Walt.) Landau	Water willow					X	X	
Lachnanthes caroliniana (Lam.) Dandy	Redroot				X	X	X	
Lachnocaulon anceps (Walt.) Morong.	Bog buttons	X	X					
Lechea deckertii Small	Pinweed		X					
Leersia hexandra Sw.	Rice cut grass	X					X	
Lemna obscura (Austin) Daubs.	Duckweed				X	X	X	X

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 13 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Lemna valdiviana Phil.	Duckweed				X	X	X	X
Leonotis nepetaefolia (L.) R.Br.	Lion's paw	X						
Lepidium virginicum L.	Pepper grass	X						
Lespedeza striata (Thunb.) Hook and Arn.	Korean clover	X						
Liatris gracilis Pursh	Blazing star		X					
Liatris tenuifolia Nutt.	Blazing star		X					
Lilium catesbaei Walt.	Pine lily		X					
Limnobium spongia (Bosc) Steud.	Frogs-bit				X	X	X	X
Linaria canadensis (L.) Dum.	Toad flax	X						
Lindernia anagallidea (Michx.) Pennell	False pimpernel			X			X	
Lindernia grandiflora Nutt.	False pimpernel	X				X	X	
Lippia nodiflora (L.) Michx.	Carpetweed	X	X	X			X	
Lobelia feayana A. Gray	Lobelia		X					
Lobelia homophylla F.W. Wimm.	Lobelia		X					
Ludwigia arcuata Walt.	Evening primrose					X	X	
Ludwigia maritima Harper	Evening primrose		X					
Ludwigia octovalvis (Jacq.) Raven	Evening primrose	X			X	X	X	
Ludwigia peruviana (L.) Hara	Evening primrose	X			X	X		
Ludwigia pilosa Walt.	Evening primrose					X	X	
Ludwigia repens J.R. Forst.	Evening primrose					X	X	X
Ludwigia suffruticosa Walt.	Evening primrose		X					
Lycopus rubellus Moench	Water hoarhound				X	X		

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 14 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Lygodesmia aphylla (Nutt.) DC	Rose rush		X					
Lythrum alatum var. lanceolatum (Ell.) Torr. and Gray ex Rothr.	Lythrum	X					X	
Macroptilium lathyroides (L.) Urban	Macroptilium	X						
Malaxis spicata Sw.	Adder's mouth				X			
Micranthemum glomeratum (Chapm.) Shinners	Micranthemum						X	X
Mitchella repens L.	Partridge berry			X				
Murdannia nudiflora (L.) Brenan	Murdannia	X		X				
Nephrolepis exaltata (L.) Schott	Boston fern			X	X			
Nuphar luteum subsp. macrophyllum (Small) Beal	Spadderdock*						X	
Nymphaea odorata Ait.	Fragrant white water lily						X	X
Nymphoides aquatica (J.F. Gmel.) Kuntze	Floating hearts				X	X	X	X
Oplismenus setarius (Lam.) Roem. and Schult.	Woodgrass			X				
Orontium aquaticum L.	Golden club				X			
Osmunda cinnamomea L.	Cinnamon fern				X			
Osmunda regalis var. spectabilis (Willd.) A. Gray	Royal fern				X			
Oxalis florida subsp. prostrata (Haworth) Lourt.	Sourgrass	X		X				
Panicum anceps Michx.	Panic grass				X	X	X	

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 15 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Panicum hemitomon Schult.	Maidencane					X	X	
Panicum maximum Jacq.	Guinea-grass	X						
Panicum rigidulum Nees.	Redtop panicum				X	X	X	
Parietaria floridana Nutt.	Pellitory	X		X				
Paspalum conjugatum Berg.	Sour paspalum			X				
Paspalum notatum Fluegge.	Bahia grass	X						
Paspalum repens Berg.	River paspalum					X		
Paspalum setaceum Michx.	Thin paspalum	X						
Paspalum urvillei Steud.	Vasey grass	X					X	
Peltandra virginica (L.) Schott and Endl.	Arrow arum				X	X		
Phoebanthus grandiflora (Torr. and Gray) Blake	Phoebanthus		X					
Phytolacca americana L.	Pokeweed	X		X				
Pilobelphis rigida (Bartr. ex Benth.) Raf.	Savory pennyroyal		X					
Piriqueta caroliniana (Walt.) Urban	Piriqueta		X					
Pistia stratiotes L.	Water lettuce				X			
Pityopsis graminifolia (Michx.) Nutt.	Golden aster		X					
Platanthera ciliaris (L.) Lindl.	Yellow fringed orchid		X					
Pluchea camphorata (L.) DC	Camphorweed				X	X	X	
Pluchea foetida (L.) Small	Camphorweed					X	X	
Pluchea longifolia Nash.	Swamp Camphorweed			X	X			
Pluchea odorata (L.) Cass.	Camphorweed				X	X	X	
Pluchea rosea Godfrey	Marsh fleabane						X	

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 16 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Poinsettia cyathophora (Murr.) Kl. and Gke.	Poinsettia	X						
Poinsettia heterophylla (L.) Kl. and Gke.	Poinsettia	X						
Polygala grandiflora Walt.	Milkwort	X	X	X				
Polygala lutea L.	Milkwort		X					
Polygala rugellii Shuttlew.	Milkwort	X	X				X	
Polygala setacea Michx.	Milkwort		X					
Polygonella sp.	Polygonella*		X					
Polygonum densiflorum Meisn.	Smartweed					X	X	
Polygonum hydropiperoides Michx.	Smartweed				X	X	X	X
Polygonum punctatum Ell.	Smartweed						X	
Polypodium dispersum A.M. Evans	Comb fern				X			
Polypremum procumbens L.	Polypremum	X						
Pontederia cordata L.	Pickerelweed		X		X	X	X	X
Portulaca pilosa L.	Rose purslane	X						
Proserpinaca palustris L.	Mermaid weed						X	X
Proserpinaca pectinata Lam.	Mermaid weed						X	X
Psychotria nervosa Sw.	Wild coffee			X				
Psychotria sulzneri Small	Wild coffee			X				
Pteridium aquilinum (L.) Kuhn	Bracken fern		X					
Pteris tripartita (Sw.) Presl	Giant bracken fern*				X			
Pterocaulon virgatum (L.) DC.	Blackroot	X	X					
Ptilimnium capillaceum (Michx.) Raf.	Mock bishop's weed	X		X		X		

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 17 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Rhexia mariana L.	Meadow beauty		X				X	
Rhexia nuttallii James	Meadow beauty		X				X	
Rhexia petiolata Walt.	Meadow beauty		X					
Rhyncheletrum repens (Willd.) C.E. Hubb.	Natal grass	X						
Rhynchospora fascicularis (Michx.) Vahl.	Beakrush		X					
Rhynchospora inundata (Oakes) Fern.	Beakrush				X	X	X	
Rhynchospora miliacea (Lam.) A. Gray	Beakrush				X		X	
Richardia brasiliensis (Moq.) Gomez.	Richardia	X						
Ruellia caroliniensis (J.F. Gmel.) Steud.	Ruellia			X				
Rumex hastatulus Baldw.	Common dock	X						
Sabatia grandiflora (A. Gray) Small	Marsh pink		X					
Sacciolepis indica (L.) Chase	Sacciolepis						X	
Sacciolepis striata (L.) Nash	Sacciolepis						X	
Sagittaria graminea Michx.	Arrowhead						X	
Sagittaria isoetiformis J.G. Smith	Arrowhead						X	X
Sagittaria lancifolia L.	Wapato					X	X	
Salvia lyrata L.	Sage	X	X	X				

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 18 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Samolus valerandi L.	False pimpernel				X		X	
Sanicula canadensis L.	Sanicula			X				
Saururus cernuus L.	Lizard's tail				X	X		
Schizachyrium scoparium (Michx.) Nash.	Little bluestem		X					
Scirpus robustus Pursh	Bulrush						X	
Scleria pauciflora Muhl.	Nutrush		X					
Scleria reticularis Michx.	Nutrush		X	X				
Scoparia dulcis L.	Sweet broom	X	X	X				
Scutellaria integrifolia L.	Scull's cap			X				
Secale cereale L.	Rye	X						
Setaria geniculata (Lam.) Beauv.	Foxtail	X	X					
Setaria magna Griseb.	Giant foxtail					X		
Sida acuta Burm. f.	Sida	X		X				
Sisyrinchium atlanticum Bickn.	Blue-eyed grass	X					X	
Solanum americanum Mill.	Common nightshade	X						
Solanum capsicoides All.	Soda apple	X		X				
Solidago fistulosa Ait.	Goldenrod	X	X					
Solidago gigantea Ait.	Goldenrod	X		X				
Sorghastrum secundum (Ell.) Nash	Indian grass		X					
Sorghum bicolor (L.) Moench.	Broom corn	X						
Spartina bakeri Merr.	Cordgrass						X	
Spirodela polyrhiza (L.) Schleiden	Big duckweed				X	X		X

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 19 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Sporobolus indicus (L.) R. Br.	Dropseed	X						
Sporobolus junceus (Michx.) Kunth	Dropseed	X						
Stillingia sylvatica L.	Queen Anne's delight		X					
Syngonanthus flavidulus (Michx.) Ruhe	Syngonanthus		X					
Thalia geniculata L.	Common flag					X	X	
Thelypteris dentata (Forsk.) E. St. John	Fern			X	X			
Thelypteris interrupta (Willd.) Iwatsuki	Fern				X			
Thelypteris kunthii (Desv.) Morton	Fern			X	X			
Thelypteris palustris Schott.	Marsh fern*				X			
Thelypteris resinifera Proctor.	Fern*				X			
Thelypteris torresiana (Gaud.) Alston.	Marianna fern				X			
Triadenum virginicum (L.) Raf.	St. John's wort				X		X	
Trifolium repens L.	White clover	X						
Typha domingensis Pers.	Cattail	X					X	
Typha latifolia L.	Cattail	X					X	
Urena lobata L.	Ceasar's weed	X		X				
Utricularia foliosa L.	Bladderwort*				X			
Utricularia inflata Walt.	Bladderwort				X		X	X
Verbesina virginica L.	Verbesina	X		X				

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 20 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
HERBS (Continued)								
Viola affinis LeConte	Violet		X	X				
Viola lanceolata L.	Bog white violet		X				X	
Viola primulifolia L.	Bog white violet			X			X	
Viola septemloba LeConte	Violet		X	X				
Wolffiella gladiata (Hegelm) Hegelm.	Mud-midget				X	X		X
Woodwardia areolata (L.) Moore	Net veined chain fern			X	X			
Woodwardia virginica (L.) Smith	Net veined chain fern		X		X	X	X	
Xanthosoma sagittifolium (L.) Schott	Elephant ear				X			
Xyris caroliniana Walt.	Yellow-eyed grass		X				X	
Xyris elliottii Chapm.	Yellow-eyed grass*		X					
Xyris platylepis Chapm.	White yellow-eyed grass		X				X	
Yucca filamentosa L.	Yucca		X					
Zamia pumila L.	Coontie*		X					
EPIPHYTES (Herbs and Ferns)								
Encyclia tampensis (Lindl.) Small	Florida butterfly orchid			X	X			
Phlebodium aureum (L.) Small	Serpent fern			X				
Phoradendron serotinum Raf. M.C. Johnst.	Mistletoe			X	X			
Polypodium plumula Humb. and Bonpl. ex Willd.	Plume fern			X	X			

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 21 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
EPIPHYTES (Herbs and Ferns) (Continued)								
Polypodium polypodioides var. michauxianum Weatherby	Resurrection fern			X				
Tillandsia bartramii Ell.	Airplant			X	X	X		
Tillandsia fasciculata Sw.	Cardinal wildpine			X	X			
Tillandsia recurvata (L.) L.	Ball moss		X	X	X	X		
Tillandsia setacea Sw.	Airplant			X	X	X		
Tillandsia usneoides (L.) L.	Spanish moss	X	X	X	X	X		
Tillandsia utriculata L.	Giant wildpine			X	X			
Vittaria lineata (L.) J. Smith	Shoestring fern			X				
VINES								
Abrus precatorius L.	Rosary pea	X		X				
Ampelopsis arborea (L.) Koehne	Peppervine			X				
Apios americana Medic.	Potato bean			X				
Berchemia scandens (Hill) K. Koch	Rattan vine			X	X			
Campsis radicans (L.) Seem.	Trumpet creeper			X				
Cassytha filiformis L.	Love vine		X					
Centrosema floridanum (Britt.) Lakela	Butterfly pea	X	X					
Clematis crispa L.	Leather flower			X				
Dioscorea bulbifera L.	Air yam			X				
Galactia elliottii Nutt.	Milk pea		X	X				
Galactia volubilis (L.) Britt.	Milk pea		X	X				

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 22 of 23)

Scientific Name	Common Name	Habitat Types: Improved Pasture/ Ruderal† (213)	Palmetto Rangeland/ Pine Flatwoods (321/411)	Oak Hammocks (422)	Hardwood Swamps (621) Tree	Hardwood Swamps (621) Shrub	Marsh (641)	Aquatic (Borrow Pits, Stock Ponds, Permanent Pools)
VINES (Continued)								
Gelsemium sempervirens (L.) J. St. Hil.	Carolina jessamine			X	X			
Ipomoea indica (Burm.f.) Merr.	Morning glory	X		X				
Melothria pendula L.	Creeping cucumber			X				
Mikania scandens (L.f.) Willd.	Hempvine			X	X			
Momordica charantia L.	Balsam apple	X		X				
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper			X				
Passiflora lutea L.	Passion flower	X		X				
Rubus betulifolius Small	Blackberry			X	X			
Rubus cuneifolius Pursh	Sand blackberry		X	X				
Rubus trivialis Michx.	Blackberry		X	X				
Smilax auriculata Walt.	Catbriar		X	X				
Smilax bona-nox L.	Greenbriar		X	X				
Smilax laurifolia L.	Bamboo briar				X	X		
Smilax pumila Walt.	Greenbriar			X				
Smilax walteri Pursh	Catbriar				X			
Solanum seaforthianum Andr.	Brazilian nightshade			X				
Toxicodendron radicans (L.) Kuntze	Poison ivy			X	X	X		
Vicia acutifolia Ell.	Pea	X	X	X				
Vitis aestivalis Michx.	Summer grape*				X			
Vitis munsoniana Simpson	Muscadine grape			X	X			
Vitis shuttleworthii House	Calusa grape		X	X				

Table 9.1.2-2. Species Composition of Plant Communities on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 23 of 23)

† Ruderal includes fence rows, railroad edges, cultivated fields, transmission line corridors, roadsides, and ditches.

* Plant species delineated by an asterisk which have been recorded as present on the CF Hardee Phoshphate Complex II proposed mine sites (CF DRI, 1976) were not observed during the 1981-1982 field investigations. Taxonomy of the 1976 listed plant taxa have been updated to reflect current scientific nomenclature (Wunderlin, 1982).

Sources: Dames and Moore, 1976.
ESE, 1982.
Wunderlin, 1982.

Table 9.1.2-3. Amphibians and Reptiles Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Scientific Name	Common Name	Habitat Types				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Improved Pasture/ Cropland
Amphiuma means	Two-toad amphiuma				X	
Siren intermidia	Lesser siren				X	
Siren lacertina	Greater siren				X	
Pseudobranchus striatus	Dwarf siren				X	
Notophthalamus viridescens	Peninsula newt	X	X	X		
Eurycea quadridigitata	Dwarf Salamander			X		
Scaphiopus holbrooki	Eastern spadefoot toad	X	X			
Eleutherodactylus planirostris planirostris	Greenhouse frog			X		
Rana grylio	Pig frog			X	X	
Rana catesbeiana	Bull frog				X	
Rana utricularia	Southern leopard frog	X	X	X	X	
Gastrophryne carolinensis	Eastern narrow-mouth toad	X	X	X	X	
Bufo quercicus	Oak toad	X	X			X
Bufo terrestris terrestris	Southern toad	X	X	X		
Acris gryllus dorsalis	Florida cricket frog		X	X	X	
Hyla cinerea cinerea	Green treefrog	X	X	X	X	
Hyla femoralis	Pine woods treefrog		X			
Hyla gratiosa	Barking treefrog	X	X	X		
Hyla squirella	Squirrel treefrog	X	X		X	
Pseudacris nigrita	Chorus frog		X	X	X	
Limnaoedus ocularis	Little grass frog	X	X		X	
Alligator mississippiensis	American alligator			X	X	
Chelydra serpentina serpentina	Snapping turtle			X	X	
Kinosternon bauri bauri	Striped mud turtle			X		
Kinosternon subrubrum steindachneri	Florida mud turtle			X		
Terrapene carolina bauri	Florida box turtle	X	X	X		
Chrysemys floridana peninsularis	Peninsula cooter			X		
Chrysemys nelsoni	Red-bellied turtle			X	X	
Deirochelys reticularia	Chicken turtle				X	
Gopherus polyphemus	Gopher tortoise	X	X			
Trionyx ferox	Florida soft-shelled turtle			X		
Anolis carolinensis	Green anole	X	X	X	X	X

Table 9.1.2-3. Amphibians and Reptiles Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 2 of 2)

Scientific Name	Common Name	Habitat Types				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Improved Pasture/ Cropland
Sceloporus undulatus	Fence lizard	X				
Leiolopisma laterale	Ground skink	X	X	X		
Eumeces inexpectatus	Southeastern five-lined skink	X		X		
Cnemidophorus sexlineatus	Six-lined racerunner	X				
Ophisaurus ventralis	Eastern glass lizard		X			
Nerodia sipedon	Banded water snake			X		
Nerodia cycolpion floridana	Green water snake				X	
Nerodia fasciata pictiventris	Florida water snake				X	
Nerodia txispilota	Brown water snake				X	
Seminatrix pygaea	Black swamp snake			X		
Thamnophis sirtalis sirtalis	Garter snake			X	X	
Thamnophis sauritus sakeni	Ribbon snake				X	
Virginia stritula	Rough earth snake		X	X		
Storeria occipitomaculata	Red-bellied snake	X	X			
Storeria dekayi	Brown snake		X			
Heterodon platyrhinos	Eastern hognose snake	X				
Heterodon simus	Southern hognose snake	X				
Diadophis punctatus	Ringneck snake	X	X	X	X	
Farancia abacura	Mud snake			X		
Coluber constrictor	Black racer	X	X	X		X
Masticophis flagellum	Eastern coachwhip	X	X			
Opheodrys aestivus	Rough green snake	X		X		
Elaphe obsoleta	Rat snake	X				X
Elaphe guttata	Corn snake	X	X	X		
Pituophis melanoleucus	Pine snake	X	X			
Drymarchon corais couperi	Eastern indigo snake	X	X	X		
Lampropeltis getulus getulus	Eastern kingsnake		X	X		
Lampropeltis elapsoides	Scarlet kingsnake		X	X		
Regina alleni	Striped swamp snake			X		
Micrurus fulvius fulvius	Eastern coral snake	X	X			
Agkistrodon piscivorus conanti	Florida cottonmouth			X	X	
Sistrurus miliarius barbouri	Dusky pigmy rattlesnake	X	X	X		
Crotalus adamanteus	Eastern diamondback rattlesnake	X	X	X		

Source: ESE, 1982.

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Podilymbus podiceps	Pied-Billed Grebe				X	
Phalacrocorax auritus	Double-Crested Cormorant			X	X	
Anhinga anhinga	Anhinga			X	X	
Ardea herodias	Great Blue Heron			X	X	X
Butorides striatus	Green Heron			X	X	X
Florida caerulea	Little Blue Heron			X	X	X
Bubulcus ibis	Cattle Egret			X	X	X
Casmerodius albus	Great Egret			X	X	X
Egretta thula	Snowy Egret			X	X	X
Hydranassa tricolor	Louisiana Heron			X	X	X
Nycticorax nycticorax	Black-Crowned Night Heron			X	X	
Nyctanassa violacea	Yellow-Crowned Night Heron			X	X	
Ixobrychus exilis	Least Bittern				X	
Botaurus lentiginosus	American Bittern				X	
Mycteria americana	Wood Stork			X	X	X
Plegadis falcinellus	Glossy Ibis				X	
Eudocimus albus	White Ibis			X	X	X
Ajaia ajaja	Roseate spoonbill				X	
Anas platyrhynchos	Mallard				X	
Anas fulvigula	Mottled Duck				X	
Anas strepera	Gadwal				X	
Anas acuta	Pintail				X	
Anas crecca	Green-Winged Teal				X	
Anas discors	Blue-Winged Teal				X	
Anas americana	American Wigeon				X	
Anas clypeata	Northern Shoveler				X	
Aix sponsa	Wood Duck			X	X	
Aythya collaris	Ring-necked Duck				X	
Aythya affinis	Lesser Scaup				X	
Oxyura jamaicensis	Ruddy Duck				X	
Lophodytes cucullatus	Hooded Merganser				X	

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 2 of 6)

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Cathartes aura	Turkey Vulture	X	X	X	X	X
Coragyps atratus	Black Vulture	X	X	X	X	X
Elanoides forficatus	Swallow-Tailed Kite		X	X		
Accipiter striatus	Sharp-Shinned Hawk	X	X			
Accipiter cooperii	Cooper's Hawk			X		
Buteo jamaicensis	Red-Tailed Hawk	X	X			
Buteo lineatus	Red-Shouldered Hawk	X	X	X	X	X
Buteo brachyurus	Short-Tailed Hawk	X	X	X		
Circus cyaneus	Marsh Hawk		X		X	X
Falco sparverius	American Kestrel	X	X			X
Falco columbarius	Merlin	X	X	X	X	X
Colinus virginianus	Bobwhite	X	X			X
Meleagris gallopavo	Turkey	X		X		
Grus canadensis pratensis	Florida Sandhill Crane				X	X
Rallus elegans	King Rail				X	
Porzana carolina	Sora				X	
Gallinula chloropus	Common Gallinule				X	
Fulica americana	American Coot				X	
Charadrius vociferus	Killdeer					X
Philohela minor	American Woodcock			X		
Capella gallinago	Common Snipe				X	
Actitis macularia	Spotted Sandpiper				X	
Tringa solitaria	Solitary Sandpiper				X	
Tringa melanoleucus	Greater Yellowlegs				X	

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 3 of 6)

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Tringa flavipes	Lesser Yellowlegs				X	X
Columba livia	Rock Dove					X
Zenaida macroura	Mourning Dove	X	X			X
Columbina passerina	Ground Dove	X	X			X
Coccyzus americanus	Yellow-Billed Cuckoo	X		X		
Coccyzus erythropthalmus	Black-Billed Cuckoo	X		X		
Otus asio	Screech Owl			X		
Bubo virginianus	Great Horned Owl	X		X		
Athene cunicularia floridana	Florida Burrowing Owl		X			X
Strix varia	Barred Owl	X		X		
Asio flammeus	Short-Eared Owl				X	X
Caprimulgus carolinensis	Chuck-Will's-Widow	X	X			
Caprimulgus vociferus	Whip-Poor-Will	X		X		
Chordeiles minor	Common Nighthawk	X	X			X
Chaetura pelagica	Chimney Swift		X		X	X
Archilochus colubris	Ruby-Throated Hummingbird	X				
Megaceryle alcyon	Belted Kingfisher				X	
Colaptes auratus	Common Flicker	X	X	X		
Dryocopus pileatus	Pileated Woodpecker	X	X	X		
Melanerpes carolinus	Red-Bellied Woodpecker	X	X	X		
Melanerpes erythrocephalus	Red-Headed Woodpecker	X	X			
Sphyrapicus varius	Yellow-Bellied Sapsucker	X	X	X		
Picoides villosus audubonii	Hairy Woodpecker		X	X		
Picoides pubescens	Downy Woodpecker	X	X	X		
Tyrannus tyrannus	Eastern Kingbird		X			
Myiarchus crinitus	Great Crested Flycatcher	X	X	X		
Sayornis phoebe	Eastern Phoebe	X	X	X		
Iridoprocne bicolor	Tree Swallow		X	X	X	X

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 4 of 6)

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Progne subis	Purple Martin					X
Cyanocitta cristata	Blue Jay	X	X	X		X
Corvus brachyrhynchos	Common Crow	X	X	X	X	X
Corvus ossifragus	Fish Crow			X	X	X
Parus carolinensis	Carolina Chickadee	X		X		
Parus bicolor	Tufted Titmouse	X		X		
Sitta pusilla	Brown-Headed Nuthatch		X	X		
Troglodytes aedon	House Wren		X	X		
Thryothorus ludovicianus	Carolina Wren	X	X	X	X	
Cistothorus platensis	Short-Billed Marsh Wren				X	
Mimus polyglottos	Mockingbird	X	X	X	X	X
Dumetella carolinensis	Gray Catbird	X	X	X		X
Toxostoma rufum	Brown Thrasher	X		X		
Turdus migratorius	American Robin	X	X	X		X
Catharus guttata	Hermit Thrush	X		X		
Catharus fuscescens	Veery			X		
Sialia sialis	Eastern Bluebird		X			X
Polioptila caerulea	Blue-Gray Gnatcatcher	X	X	X		
Regulus calendula	Ruby-Crowned Kinglet	x		X		
Anthus spinoletta	Water Pipit				X	
Bombycilla cedrorum	Cedar Waxwing	X				
Lanius ludovicianus	Loggerhead Shrike	X	X	X		X
Sturnus vulgaris	Starling					X
Vireo griseus	White-Eyed Vireo	X		X		
Vireo flavifrons	Yellow-Throated Vireo			X		
Vireo solitarius	Solitary Vireo	X		X		

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 5 of 6)

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Vireo olivaceus	Red-Eyed Vireo			X		
Mniotilta varia	Black-and-White Warbler	X		X		
Protonotaria citrea	Prothonotary Warbler			X		
Parula americana	Northern Parula	X		X		
Dendroica coronata	Yellow-Rumped Warbler	X	X	X	X	
Dendroica virens	Black-Throated Green Warbler			X		
Dendroica dominica	Yellow-Throated Warbler	x		X		
Dendroica pinus	Pine Warbler		X			
Dendroica discolor discolor	Prairie Warbler	X	X			
Dendroica palmarum	Palm Warbler	X	X	X	X	
Seiurus aurocapillus	Ovenbird	x		X		
Seiurus noveboracensis	Northern Waterthrush			X		
Geothlypis trichas	Common Yellowthroat	X	X	X	X	
Setophaga ruticilla ruticilla	American Redstart			X		
Passer domesticus	House Sparrow					X
Sturnella magna	Eastern Meadowlark		X		X	X
Agelaius phoeniceus	Red-Winged Blackbird	X	X	X	X	X
Quiscalus major	Boat-Tailed Grackle		X		X	X
Quiscalus quiscula	Common Grackle	X	X		X	
Piranga rubra	Summer Tanager			X		
Cardinalis cardinalis	Cardinal	X	X	X		
Passerina cyanea	Indigo Bunting			X		
Carduelis tristis	American Goldfinch			X		
Pipilo erythrophthalmus	Rufous-Sided Towhee	X	X	X		

Table 9.1.2-4. Bird Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 6 of 6)

Scientific Name	Common Name	Habitat Type				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Pasture/ Cropland
Passerculus sandwichensis	Savannah Sparrow		X		X	
Poocetes gramineus	Vesper Sparrow					X
Aimophila aestivalis	Bachman's Sparrow		X			
Melospiza georgiana	Swamp Sparrow		X	X	X	
Melospiza melodia	Song Sparrow				X	

Source: ESE, 1982.

Table 9.1.2-5. Terrestrial Mammal Species Known or Expected to Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Scientific Name	Common Name	Habitat Types				
		Hardwood Hammock	Rangeland/ Pine Flatwood	Freshwater Swamp	Freshwater Marsh	Improved Pasture/ Cropland
Didelphis virginiana	Virginia Opossum	X	X	X	X	X
Blarina brevicauda	Short-Tailed Shrew	X	X	X	X	X
Cryptotis parva	Least Shrew		X			X
Scalopus aquaticus	Eastern Mole	X		X		
Pipistrellus subflavus	Eastern Pipistrelle	X	X	X		X
Eptesicus fuscus	Big Brown Bat	X	X	X		X
Lasiurus seminolus	Seminole Bat	X	X	X		X
Lasiurus intermedius	Northern Yellow Bat	X	X	X		X
Nycticeius humeralis	Evening Bat	X	X	X		X
Plecotus rafinesquii	Rafinesque's Big-Eared Bat	X	X	X		X
Tadarida brasiliensis	Brazilian Free-Tailed Bat	X	X	X		X
Dasypus novemcinctus	Nine-Banded Armadillo	X	X	X		X
Sylvilagus palustris	Marsh Rabbit			X	X	
Sylvilagus floridanus	Eastern Cottontail	X	X			X
Sciurus carolinensis	Eastern Gray Squirrel	X		X		
Sciurus niger	Fox Squirrel		X			
Glaucomys volans	Southern Flying Squirrel	X		X		
Geomys pinetis	Southeastern Pocket Gopher	X				X
Oryzomys palustris	Marsh Rice Rat				X	
Reithrodontomys humulis	Eastern Harvest Mouse				X	X
Peromyscus gossypinus	Cotton Mouse	X	X	X	X	X
Ochrotomys nuttalli	Golden Mouse	X		X		
Sigmodon hispidus	Hispid Cotton Rat	X	X			X
Neotoma floridana	Eastern Wood Rat			X		
Neofiber alleni	Round-Tailed Muskrat				X	
Vulpes vulpes	Red Fox		X			X
Urocyon cinereoargenteusnus	Gray Fox	X	X	X	X	X
Ursus americanus florida	Florida Black Bear	X	X	X	X	X
Procyon lotor	Raccoon	X	X	X		
Mustela frenata peninsulae	Florida Long-Tailed Weasel			X		
Spilogale putorius	Eastern Spotted Skunk	X	X	X	X	X
Mephitis mephitis	Striped Skunk	X	X	X	X	X
Lutra canadensis	River Otter			X	X	
Lynx rufus	Bobcat	X	X	X	X	
Sus scrofa	Wild Hog	X	X	X	X	X
Odocoileus virginianus	White-Tailed Deer	X	X	X	X	X

Source: ESE, 1982.

Field surveys were conducted in August to September 1981 and February to May 1982 for vegetation, and in August to September 1981 and February 1982 for wildlife. Information also was taken from the CF DRI (1976) field investigations.

Row Crops--211

A small open field (13.1 acres) situated along the northern property boundary has been planted with truck crops. Crops within this field are rotated and can, during the appropriate season, consist of corn, tomato, watermelon, cucumber, green pepper, or strawberry. Depending upon the amount of maintenance, the cultivated field could provide some cover for small animals. Newly sown and mature crops also could provide a food resource for urban-adapted small mammals (e.g., squirrels, rabbits) and passerine birds (e.g., Common and Boat-tailed Grackle, Common Crow).

Field Crops--212

A single tract of land (44.1 acres) on a western portion of the site has been fenced off and cultivated in millet, sunflower, and sorghum. The management objective for the cultivated field was to establish a grain crop for local game birds such as doves and quail. Ground Dove, Mourning Dove, Red-winged Blackbirds and Boat-tailed Grackles were observed feeding in the field. Although cultivated land such as the grain field on the property is similar to improved pasture (i.e., both are maintained in an early successional state), the vegetation usually is higher and gives more wildlife cover.

Improved Pasture--213

Approximately 1,310.3 acres (or 8.74 percent) of the site is composed of improved pasture. Improved pastures consist of native pine flatwoods that have been cleared of all vegetative strata and seeded with grasses (bahia grass, rye) and legumes (white clover, Korean clover, prairie clover) for cattle. Pastures are maintained through fertilization, cattle rotation and seeding/combining operations. Pasture land has a low degree of physical structure, a single level of herbaceous vegetation, and does not support a high diversity of wildlife. The pasture habitat provides little cover for large animals such as white-tailed

deer, gray fox, wildhog, and bobcat. However, these mammals may use pasture edges close to the cover of forested areas. Armadillos and raccoons are often found digging and scavenging in improved pastures. Small mammals trapped in pastures include the house mouse, cotton mouse and cotton rat which become prey for such raptors as Red-shouldered and Red-tailed Hawks, American Kestrel, and Marsh Hawk. Other birds using pasture lands include Loggerhead Shrike, Eastern Meadowlark, Boat-tailed Grackle, Red-winged Blackbird, Carolina Wren, White-eyed Vireo, Yellow-throated Warbler and Common Yellowthroat. Cattle Egrets feed in pastures, and when pastures are flooded, other colonial waterbirds may be seen where food sources are concentrated. These include herons, egrets, White Ibises, Woodstorks and Sandhill Cranes. Black and Turkey Vultures are carrion eaters and scavenge over pastures as well as every other terrestrial community on the site.

Orange Grove--231

Only one citrus grove of approximately 2.6 acres is present on the site proper. The citrus grove, which is of a sweet orange variety, is well maintained and exhibits a low structural diversity. Although wildlife usage is limited, a few frequent visitors to citrus grove habitat include gray and fox squirrel, Northern Cardinal, Blue Jay, and Mocking-bird.

Palmetto Prairies or Palmetto Rangeland--321

Palmetto rangeland is the dominant plant community on the CF mine site, encompassing 46.4 percent of the total area (6,957.2 acres). Palmetto rangeland was pine flatwoods before the land was logged and cattle were introduced. Palmetto rangeland is characterized by a conspicuous dense shrub layer of saw palmetto. Although rangeland has no true understory or overstory tree stratum, a few remnant pines are scattered throughout the association. Scattered woody shrub associates include sand live oak, gallberry, and wax-myrtle. A yearly fire management program opens shrub layers and promotes a proliferation of indigenous herb species (wiregrasses, broomsedges, and composites).

The saw palmetto shrub layer provides good cover for numerous upland dwellers. Palmetto berries and seeds produced by the herbaceous vegetation supply food for herbivores and granivores. Common mammals of rangeland include the cotton rat, cotton mouse, armadillo, raccoon, opossum, and eastern cottontail. Larger mammals include wild hog, white-tailed deer and predators such as bobcat and gray fox. Several bird species common to rangeland are Mourning Dove, Ground Dove, Bobwhite Quail, Common Nighthawk, Western Kingbird, Great-crested Flycatcher, Carolina Wren, Rufous-sided Towhee, Mockingbird, American Robin, and both Palm and Pine Warblers.

Predator species include the Red-shouldered Hawk, American Kestrel, and Loggerhead Shrike. Amphibians and reptiles commonly encountered include oak toad, green anole, six-lined racerunner, black racer, and gopher tortoise. Gopher tortoise are usually found in dryer, well-drained sites.

Pine Flatwoods--411

Large tracts of pine flatwoods are distributed along the northern areas of the property (732.7 acres or 4.89 percent). Pine flatwoods are open to dense woods dominated by an overstory of pines. Longleaf pine occurs on the drier sites; slash pine is frequently found along wetter areas. Shrub layers are dominated by thick saw palmetto and other associated woody taxa (e.g., gallberry, wax-myrtle, sand live oak). In the absence of fire, woody plants form an understory layer. Pine flatwoods on the property are remnant associations that most probably were left as a seed source to the surrounding, logged flatwoods (i.e., rangeland).

Rangeland, therefore, is a modified form of pine flatwood with the canopy species of longleaf pine and slash pine removed. Ground cover and shrub vegetation composition is much the same in both communities. Therefore, wildlife resources discussed for the palmetto rangeland are generally similar for pine flatwoods. However, pine flatwoods differ

by the presence of a pine canopy and a woody understory. There is more vegetative cover for wildlife within the flatwoods, and the addition of vegetative strata (i.e., canopy, understory) allows for greater niche and species diversity. The occurrence of woodpeckers, for instance, is much more indicative of a forested flatwoods.

Woodpeckers present in the flatwoods are represented by the Red-bellied, Pileated, Red-headed, Hairy and Downy Woodpeckers, Common Flicker and Yellow-bellied Sapsucker. The endangered Red-cockaded Woodpecker inhabits pine flatwoods, but has specific requirements for nesting and roosting. The pine flatwoods on-site were searched for Red-cockaded Woodpecker evidence, and none was found.

Other Hardwoods or Oak Hammocks--422

Less than 16 percent (2,354.0 acres) of the site supports hardwood hammock. Hardwood forests on the property have a dominant tree crown of oaks. Oak hammocks usually encircle wetland associations or fringe drainage channels on the property. Hammocks occur on well-drained upland sites to poorly drained lowland areas with thin organic soil layers. Overstory vegetation is usually indicative of hydric and edaphic conditions. Xeric, live oak-dominated forests with well-developed saw palmetto layers are found along dry highlands and usually occur on the same elevations/soils as palmetto rangeland. Mesic laurel oak/cabbage palm associations usually occur along slightly lower elevations adjacent to wetlands and are flooded for short periods of time during high rainfall events. Hydric, laurel oak-dominated areas (bottomland hardwoods) occur within drainage lowlands and are seasonally inundated. Other arboreal associates of the bottomland hardwoods community are elm, pop ash, tupelo, hackberry, sweetgum, and maple. Although FLUCCS recognizes all oak-dominated communities as uplands, bottomland hardwoods are considered to be a freshwater swamp type in other vegetation classification schemes (COE, 1977).

In climax or near climax hammocks, the canopy cover (primarily oak species) intercepts light and limits development of vegetation in the

shrub and herbaceous layers. Hammocks with sparse understory development provide little cover or food for ground and shrub dwelling fauna. The same effect is felt in hammocks that have been overgrazed by cattle. In these hammocks most wildlife utilize edge areas where light penetration is greater.

Mast production from oak species is high and is an important resource for white-tailed deer, wild hog, eastern gray squirrel, southern flying squirrel, Wild Turkey and Bobwhite Quail. The tree component is especially important to birdlife including Common Flicker, Red-bellied Woodpecker, Pileated Woodpecker, Yellow-billed Cuckoo, Barred Owl and numerous passerine (perching) species. Passerines observed in the hammock communities include Blue Jay, Carolina Chickadee, Tufted Titmouse, Carolina Wren, Mockingbird, Catbird, White-eyed Vireo, Yellow-throated Warbler, Parula Warbler, Common Yellowthroat and Rufous-sided Towhee.

Heavy accumulations of leaf litter, tree stumps and downed trunks provide excellent cover for small mammals including cotton mouse and golden mouse. This habitat is also used by herpetofauna including oak toad, southern leopard frog, ground skink, black racer, corn snake, yellow rat snake, and Florida box turtle.

Freshwater Swamp--621

The swamp community represents approximately 8.27 percent (1,240.4 acres) of the CF property area. Freshwater swamps are forested wetlands which are dominated by water tolerant hardwoods. Arboreal overstory and understory components of freshwater swamps include either single dominant or mixed assemblages of red maple, water tupelo, pop ash, sweet bay, swamp red bay, loblolly bay, dahoon holly, and elm. Hardwood swamps usually have deep organic layers and hold stagnant water for long periods of time. Included in this category are shrub swamps. Shrub swamps are young seral stages leading to the formation of hardwood swamps. Buttonbush, red maple, and willow form monotypic stands, usually in association with freshwater marshes and tree swamps. The

mature swamp is similar in structure to the hardwood hammock, and there is much overlap in faunal species composition. Passerine birds observed in mature swamps (in addition to those of the hammock communities) were Yellow-breasted Chat, Prothonotary Warbler, Northern Cardinal, Blue-gray Gnatcatcher and Summer Tanager. The hydrologic aspect of the swamp provides an additional dimension not found in the hammock. Swamps provide a moderated climate in terms of temperature and moisture. During the dry season the swamp acts as a sink, attracting numerous wildlife species as other water sources become unavailable. Swamps provide year-round habitat for many amphibians and reptiles including eastern narrowmouth toad; barking, green and squirrel treefrogs; Florida chorus frog; Florida cricket frog; southern leopard frog; American alligator; Florida mud turtle; Florida red-bellied turtle; water snakes of the genus Nerodia; eastern indigo snake; and Florida cottonmouth. Wild hog, raccoon, armadillo, gray squirrel, and white-tailed deer were frequently observed within the swamps on-site. An Eastern wood rat den was discovered in a maple/tupelo swamp within Mitchell Hammock.

Shrub swamps lack canopy development and associated canopy-dwelling wildlife. Shrub swamps on the CF mine site were judged suitable for colonial wading bird roosting and nesting, but no rookeries were found.

Freshwater Marshes--641

Total area of freshwater marsh on the site equals nearly 2,339.6 acres (15.6 percent). Freshwater marshes are usually circular (highland depressions) to oblong (drainage lowlands), herb-dominated wetlands. Maidencane, sawgrass, pickerelweed, common flag, and wapato are some of the deep water marsh associates. Herbs such as cordgrass, soft rush, broomsedge and iris may form transitional, outer fringes to the deep water areas. Marshes protected from fire during the dry seasons may have scattered shrub (buttonbush, willow) and tree species (tupelo, red maple) throughout.

The marshes vary in depth, plant composition, and amount of open water. The larger marshes normally have more developed zonation and support a diversity of wildlife. Most mammals of the marsh system, such as raccoon, armadillo, rodents, marsh and eastern cottontail rabbits, wild hog, fox and bobcat, utilize the shallow edge zones feeding on crayfish, insects, vegetation or other animals. Some marshes support the round-tailed muskrat which uses deeper pool areas where it builds nests and feeding platforms. Marshes also support several species of frogs and snakes and, occasionally, turtles and alligators. The freshwater marsh is a very productive system and is an important food resource for wading birds. Waders commonly seen using marshes are Great Blue Heron, Little Blue Heron, Green Heron, Snowy Egret, Great Egret and White Ibis. Up to 800 White Ibises were seen in one feeding congregation. Other birds using the marsh system include Sandhill Crane, Greater and Lesser Yellowlegs, American and Least Bittern, Spotted Sandpiper and Long-billed Dowitcher. Tree swallows were often observed feeding on insects over the marsh, and shrubby marsh edges provide habitat for Common and Boat-tailed Grackles, Red-winged Blackbirds and several other passerine species.

Ruderal Land

Ruderal lands on the property comprise an extremely small percentage of disturbed upland, wetland, and permanent water bodies, including borrow pits (stock ponds), unimproved roads, maintained drainage ditches, railroad perimeters, fence rows, and transmission line corridors. Since the ruderal land component of the CF mine site was considered a minor part of the land use on-site, the areas of disturbance were not delineated on the vegetation map by a separate land use category. Ruderal lands, therefore, are incorporated into the major cover classification in which they are situated.

Disturbed upland sites exhibit low structural diversity and high species diversity. Opportunistic, herb taxa usually dominate ruderal lands and are able to survive in a variety of soil types. Typical upland ruderal plants include dropseed, Caesar's weed, beggar-tick, broomsedge, and

dog fennel. The borrow pits/stock ponds on the property support permanent water and may be dominated by floating aquatics such as floating hearts, frogs-bit, and duckweed. These altered habitats support wildlife associated with early successional communities such as pasture and cropland (previously described). Fauna inhabiting ruderal land may be complemented by species of adjacent communities. This concept is illustrated when a transmission corridor intersects a wooded swamp or other dissimilar community. Borrow pits on the site have been excavated for elevating roadbeds. The resultant flooded depressions are used for watering cattle and provide habitat for the American alligator, Florida snapping turtle, peninsula cooter, Florida red-bellied turtle and Florida softshell turtle. These aquatic resources may provide concentrations of food for wading birds and other wildlife.

9.1.2.2 WETLAND/DRAINAGE UNIT DESCRIPTIONS

Portions of ten drainage basins are present on the Hardee Phosphate Complex II site. Six of these basins (Horse Creek, Brushy Creek, Shirttail Branch, Doe Branch, Plunder Branch, and Coon's Bay Branch) have defined stream or channel systems on the site. Lettis Creek and Troublesome Creek have poorly defined drainages on-site, representing the upper end of their respective watersheds. Small portions of the Gum Swamp Branch and Hog Branch drainages are also present on-site.

Each drainage basin on-site was qualitatively surveyed to validate and supplement the existing data base and accurately characterize conditions and functions of each area. Information from these surveys also was used to identify structural breakpoints in the drainage systems and divide the basins into the wetland/drainage study units (Figure 9.1-2).

The results of these survey efforts were used to develop the following descriptions of the delineated wetland/drainage units.

PAGE NOT

AVAILABLE

DIGITALLY

Horse Creek

Horse Creek, an intermittent streamcourse, originates approximately 3.6 river miles upstream from the site, and joins the Peace River, approximately 40 river miles downstream. On-site, the drainage basin supports the main channel with associated laurel oak floodplain, secondary channels with connections to swamps, and isolated, perched maidencane marshes located within higher pine-palmetto rangeland. The main channel on-site was divided into four drainage units (H1-H4).

Drainage Unit H1 consists mostly of laurel oak floodplain interspersed with numerous, small wetland depressions (<1 acres, collectively) which have no recognizable channel connection to Horse Creek. Depressions within the floodplain were dominated by maple, tupelo, and/or pop ash. One small, maple swamp (1.0 acres) is contiguous to the main channel in H1. Two hardwood swamps (16.3 acres) within H1 connect to the Horse Creek channel via secondary channels off of the property. A large central marsh (18.3 acres), dominated by a mixed assemblage of maidencane, pickerelweed, galingale, and buttonbush, is contiguous to the Horse Creek channel within Drainage Unit H2. Drainage Units H3 and H4 are distinct from one another due to an upland oak hammock; however, they are connected downstream at the H3-H4/H2 interface by contiguous wetland vegetation. Drainage Unit H3 supports a continuation of the main channel and a branched secondary channel. Drainage Unit H4 contains a manmade ditch and 6.7 acres of maple/willow swamp.

Drainage units (H5-H8) mainly support isolated marshes of maidencane and pickerelweed situated within upland, pine-palmetto rangeland. One other minor drainage area of Horse Creek (H9), situated at the extreme northwest corner of the property, supports approximately 17.3 acres of isolated marshes.

Brushy Creek

The Brushy Creek system consists primarily of the three Mitchell Hammock units (B4, B5, and B6) and a Y-shaped, second major headwater wetland (B2) which have channels converging into a large hardwood swamp complex (B1) to form the upper end of Brushy Creek.

Brushy Creek below this convergence consists of a poorly defined channel through a hardwoods-dominated floodplain, grading from red maple and pop ash at the upper end through a red maple/tupelo swamp. A very young pop ash-willow swamp covers the floodplain south of a dirt road which crosses the channel.

The wetland area (173.2 acres) of Unit B2 consists of a highly diverse system containing all ten of the associations found in Mitchell Hammock (i.e., oak, maple/tupelo, willow, buttonbush, pop ash, maidencane, maidencane/soft rush, broomsedge/soft rush, sawgrass and pickerelweed/flag). Stands of mature laurel oak floodplain forest and pop ash swamps occur in the north end, grading into red maple swamp and sawgrass/maidencane marshes at the south end. With the exception of the floodplain forest area, the woody vegetation is relatively young in this unit with few trees with Diameter Breast Height (DBH) values in excess of 6-inches. Although no bird nests were noted, the pop ash/buttonbush swamp in the north has most of the characteristics required for a suitable rookery area during high water periods.

Units B4 and B5 in Mitchell Hammock are dominated by maidencane marshes ringed with oak hammock. A maple/tupelo swamp also occurs on the north side of Unit B5. Unit B6 contains a large, mature maple/tupelo swamp on the north. This swamp is an exceptionally well developed mature system with large trees and diverse herbaceous and shrub strata.

Other units of the Brushy Creek system (B3, B7, B8, B9) consist of largely isolated maidencane marshes or red maple shrub swamps with combined wetland acreages of 248.5 acres.

Shirttail Branch

Shirttail Branch is the only drainage in the west pasture that has a northerly flow. The most downstream unit, S1, consists of a defined channel through a narrow laurel oak hammock. In Unit S2, the channel area flows into a broad floodplain bottomland hardwoods community dominated by laurel oak, elm, pop ash, and tupelo. Units S3 and S4 consist of maple shrub swamps. Upstream of Unit S4 are several maidencane and sawgrass marshes and maple swamps in plateau depressional areas (Units S5 and S6). Shirttail Branch has a total of 343.7 acres of forested and non-forested wetlands.

Doe Branch

Doe Branch represents the largest and most complex drainage system on-site. The Doe Branch drainage basin was divided into 14 drainage units. Western drainage units, D12 and D11, drain into D3. The most southwestern drainage unit, D14, is isolated from the rest of the Doe Branch system by the Seaboard Coast Line Railroad tracks and palmetto rangeland but may still drain via pipe or by overland flow during peak rainfall periods into D12. Two maple swamps (25.5 acres) within D12 function as a subsidiary headwater to Doe Branch. An incised channel connects the two swamps to a 24.1- acre maple/bay swamp within D11. A channel from the D11 swamp cuts through hardwood forest and connects to the D3 drainage unit. Central and eastern drainage units also converge within the D3 drainage unit. Drainage Units D9, D10, and D13 form the central drainage region. The central branch begins within maidencane marsh willow swamp/maple swamp headwaters (D10) which connect via channel to wetland units within D9 (13.3 acres of maple swamp).

Drainage Unit D13 supports scattered bay and maple swamps which drain into D9. At the interface of D9 and D3, the incised channel widens into

a bottomland hardwoods. The eastern Doe Branch drainage stem consists of five drainage units (D4-D8) which also converge within D3. Drainage Unit D6 contains headwaters/wetland units for the Doe Branch system. A 108.5-acre maple swamp drains directly into D4 from the D6 drainage unit.

The D4 wetlands (217.7 acres) consist mostly of interspersed maidencane/pickerelweed marshes and maple swamp. Drainage Units D5, D7, and D8 connect either directly by channel or marginally by overland flow to D4. D4 then is directly connected to D3 via an incised channel. Drainage Unit D3 consists primarily of incised channels situated within oak hammock. Channels emanating from the three drainage branches join within D3 and empty into the D1 drainage unit. The major wetland unit within D1 is a pop ash swamp (80.5 acres). This wetland unit continues off the property (D1), eventually channelizes, and connects to Payne Creek.

Plunder Branch

Plunder Branch is a complex drainage system consisting of numerous marshes and swamps which are interconnected by sand-bottom channels. Offsite, to the north (1.3 river miles), the creek ultimately joins with Payne Creek, while on-site the creek splits into a western fork (1.6 river miles) and an eastern fork (2.3 river miles). The Plunder Branch basin was divided into two offsite (P1a, P1b) and six on-site drainage units (P1, P2, P3, P4, P5, P6). The western fork (P3, P2) and the eastern fork (P6, P5, P4) converge at P1 with P3 and P6 containing the headwaters for the Plunder Branch System. The combined drainage wetland area of the two forks and the P1 drainage unit is 552.6 acres; 32 percent in the western fork, 64 percent in the eastern fork and 4 percent in the P1 drainage unit.

Within Unit P3, laurel oak hammocks encircle two maple/tupelo headwater swamps. In the surrounding basin, numerous maidencane marshes within upland rangeland contribute runoff to the main channel either directly,

through secondary channels, or indirectly through ephemeral ditches. The main channel passes through rangeland, flatwoods and oak hammock into the drainage unit of P2 which contains scattered marshes. The P2 drainage unit mainly supports a maple/tupelo swamp (27.7 acres) and is supplemented with 48.7 acres of isolated wetlands in the rest of the drainage unit.

Entering the P1 drainage unit from P2, the western fork joins with the eastern fork channel within the P1 drainage unit.

Headwaters of the eastern fork begin in a large maidencane/arrowhead marsh (Hammock Pond) within Drainage Unit P6. Hammock Pond (95.3 acres) within Unit P6, had recently burned and was dry during the survey. Isolated marshes (50.6 acres) are again the prevalent wetlands of the P6 drainage unit rangeland.

A few upper elevational marshes (11.5 acres) connect to the P5 channel before the channel reaches P4. P4 contains three pop ash swamps (26.8 acres) that are directly associated with the creek.

Finally, the channel exits into P1 and joins the western fork channel. A 9.9-acre mixed hardwood swamp occurs along the western edge of both channels within the P1 unit. The mixed hardwood swamp exhibits a high species diversity within the overstory (pop ash, sweet bay, elm, swamp red bay, red maple, tupelo). Mature overstory trees (12 to 18 inches DBH) reached heights of 45 feet or more. The freshwater swamp possessed deep organic layers (>1m) and was wet throughout.

Coon's Bay Branch

Coon's Bay Branch is a third-order intermittent streamcourse, which drains south to north, ultimately connecting to Payne Creek. Coon's Bay Branch has headwaters within the extreme northeastern corner of the CF Hardee Phosphate Complex II mine site. Within the south pasture, Coon's Bay Branch was divided into four major drainage units (C4, C3, C2, and C1).

The 20.8-acre hardwood swamp in Unit C3 is the main wetland headwaters for the Coon's Bay Branch system. This forested wetland is dominated by mature maples (10 to 13 inches DBH) which exhibit an 80- to 100-percent canopy coverage. Other overstory associates include tupelo, sweet bay, and laurel oak, in order of magnitude. Understory and shrub species consist of wax-myrtle, buttonbush, dahoon holly, stiff cornell, southern elderberry, water willow, and swamp blueberry, situated upon raised hummocks (50 to 57.5 cm). The ground stratum contains a 0- (heavy maple litter) to 100-percent herb cover (lizard's tail, royal fern, false nettle, arum, and maple seedlings). Unit C3 also supports a less mature (4 to 8 inches DBH) and drier segment of the C3 headwater unit. A channel traverses the central portion of the swamp and a manmade ditch skirts the eastern swamp/citrus grove perimeter. The ditch and central channel both join a natural channel, situated within a mesic oak hammock (C2). Mature tupelo, as well as tree and shrub seedlings (stiff cornell, buttonbush) were frequent within the C2 conveyance. The deeply incised channel within C2 meanders through the forest and exits into another maple/tupelo swamp. This hardwood swamp exhibits similar species composition to Unit C3, except for an open canopy, a dense shrub layer, and a contiguous marsh edge. From the swamp exit, a 183m-long channel crosses a wet field (Unit C1). Within Unit C1, the channel skirts a palmetto/bayhead edge and then cuts through a dense palmetto layer. Another channel branches east from the main channel and dead ends into a bayhead, while the main channel exits at CR 62.

The C4 drainage unit within site boundaries supports two small, isolated marshes (2.4 acres) in palmetto rangeland. Offsite, the C4 drainage unit contains the main stream channel with associated hardwood swamp.

Lettis Creek

Lettis Creek is a poorly defined drainage measuring less than one river mile on-site and with an estimated wetlands area of 260.2 acres on-site.

Lettis Creek begins in a 78.6-acre marsh/swamp unit (L4) containing sawgrass grading through buttonbush and willow into a young red maple

shrub swamp. The major community in L3 is a bottomland hardwood community dominated by laurel oak and red maple. Small pop ash shrub swamps also occur along the primary drainage, as a small channel leaves the hardwood community, and enters pop ash and red maple shrub swamp complexes in Units L1 and L2.

Troublesome Creek

The Troublesome Creek system on-site is represented by four small units encompassing a total of 164.6 acres of wetlands. There is no well defined channel on-site. Unit T5 consists of several small maidencane-dominated marshes connected by the Seaboard Coast Line Railroad tracks along the Fort Green-Ona Road. These have a very poorly defined drainage into a maidencane/buttonbush marsh in Unit T4 which extends offsite to the south. Wetlands in Units T1 and T2 consist of red maple shrub swamp and maidencane marsh which also extends offsite. Drainage Unit T1 consists of two separate drainage areas on the property. One area is located with the other drainage units of Troublesome Creek (T1, T2, T4, and T5), while the other is at the extreme southeast corner of the property. A drainage unit initially designated "T3" has subsequently been incorporated into Drainage Unit D10 and is not described here. The southeast drainage area of T1 supports approximately 16.3 acres (i.e., collectively) of isolated marshes. Approximately 4.6 acres of wetlands (marsh/swamp), however, compose the northern tip of Reaphook Swamp, a large wetland complex located off the site.

Gum Swamp Branch

Three small separate drainage areas (G1, G2, and G3), located along the northwestern edge of the property, drain northerly into Gum Swamp Branch. Approximately 23.5 acres of maidencane marshes are isolated within these drainage areas. No well-defined channel extends from the drainage areas offsite.

Hog Branch

Two small areas situated along the extreme eastern property boundary drain by overland flow to the east. These two drainage areas do not support wetlands on-site.

9.1.2.3 WETLANDS CLASSIFICATION

A proposed system for categorization of wetlands within the central Florida region was included in the Final Areawide Environmental Impact Statement for the Central Florida Phosphate Industry [United States Environmental Protection Agency (EPA), 1978]. This categorization was intended to establish guidelines for the protection, mining, and restoration of wetlands within the phosphate region. The following categories were defined:

1. Category I--Protected:

   "...wetlands within and contiguous to rivers and streams having an average annual flow exceeding 5 cubic feet per second (cfs) as well as other specific wetlands determined to serve essential environmental functions, including water quality (these are wetlands that provide an essential synergistic support to the ecosystem and that would have an unacceptable adverse impact if they were altered, modified, or destroyed). This generally includes cypress swamps, swamp forests, wet prairies, and certain fresh water marshes."

2. Category II--Mine and Restore:

   "...wetlands that should be restored as wetlands to perform useful wetland functions. This also includes certain isolated noncategory wetlands that serve a primary function or several minor functions that may be maintained through proper restoration."

3. Category III--Mine with No Restoration to Wetlands:

   "...wetlands that would not have to be restored as wetlands. These are isolated and normally intermittent in

nature, have less significant hydrological functions than Category II, and minimal life-support value."

A refinement of the EPA (1978) guidelines for wetlands categorization was first applied in the ESTECH Mine EIS (1979):

Category I - Protected

A. Mainstem Stream Wetlands: These are wetlands of first and second order rivers and streams upstream to the point where mean annual flow is 5 cfs. Protection shall extend to the lateral wetland boundary which shall be the 25-year flood elevation unless such calculated floodplain is less than one-half the total floodplain as determined by dominant vegetation. In cases where the 25-year floodplain is less than one-half the total vegetated floodplain, a minimum of one-half of the vegetated floodplain shall be protected from mining and significant disturbance by mining operations.

B. Headwater Wetlands: These are wetlands as defined by dominant vegetation that are found as the continuum of first and second order rivers and streams upstream of the point where mean annual flow is 5 cfs. A minimum of 25 percent by area of headwater wetlands shall be protected from mining and significant disturbance by mining. It is the intent to maintain stream wetland continuity by protection of headwater areas.

C. Tributary Wetlands: Tributaries are the lateral streams, creeks and other contiguous water conveyances (whether permanent, intermittant, or seasonal) that contribute flow to first and second order rivers and streams. As the importance of tributary wetlands to regional hydrology, water quality, and fish and wildlife habitat may vary considerably due to contiguity, vegetative structural diversity and hydroperiod, exact determination as Category I Tributary Wetlands will be made on a site-by-site basis. In all cases, however, a minimum

of 25 percent by area of tributary wetlands shall be protected from mining and significant disturbance by mining.

D. Special Concern Wetlands: Although not identified above, certain wetlands not part of stream floodplains may deserve special consideration for inclusion in Category I. These include unique or unusual wetland vegetation communities that would be difficult if not impossible to re-create, wetland communities rare to the site or area, wetlands supporting populations of endangered or rare animals or plants, wetlands of sufficient size to be significant wildlife habitat (e.g., 50 acres with considerable edge), or serve other essential environmental functions including water quality.

Category II - Mine and Restore

A. Mainstem Stream Wetlands: These are all non-protected wetlands contiguous with the first and second order rivers and streams upstream to the point of 5 cfs mean annual flow. This category reaches to the upland edge of the floodplain boundary as determined by dominant vegetation from the designated limit of Category I wetlands.

B. Headwater Wetlands: These are all non-protected wetlands that are found as the continuum of first and second order rivers and streams upstream of the point of 5 cfs mean annual flow. This category reaches to the upland edge of headwater wetlands as determined by dominant vegetation from the designated limits of Category I headwater wetlands.

C. Tributary Wetlands: These are all non-protected wetlands that are contiguous with the lateral streams, creeks and other natural water conveyances (whether permanent, intermittant, or seasonal) that directly contribute flow to the first and second order rivers and streams of the region.

D. Isolated Wetlands: These are all non-protected wetlands in excess of 5 acres in size that are not contiguous to mainstem streams, headwaters or tributaries but do have important

functions in water quantity and quality control and fish and wildlife production. Isolated wetlands need not be replaced in their original location but must be replaced in acreage equal to total acreage destroyed within each sub-drainage basin. Edge/area relationship should be considered in isolated wetland replacement.

Category III - Mine With No Restoration to Wetlands

Category III wetlands are wetlands less than 5 acres in size as defined by dominant vegetation, are isolated, have insignificant hydrological function and do not substantially contribute to maintenance of fish and wildlife production in the region.

The above guidelines further defined wetland category types, but did not reflect differences in functional value.

As a part of the Environmental Impact Statement (EIS) process and assessment of potential impacts resulting from the proposed mine, the functional role and supporting value of on-site wetlands needed to be evaluated. This evaluation would identify the environmental functions of the various wetland areas and determine whether these areas provide essential, useful, minor, or insignificant functions in support to the ecosystem.

Wetlands contained within each of the 59 drainage units on the proposed mine site were delineated. Each wetland unit was evaluated and noted for wetland value using the U.S. Army Corps of Engineers (COE) wetland evaluation procedure of Reppert et al. (1979).

Reppert et al. (1979) stated that their procedure was to be "based upon available scientific knowledge about wetlands and [that their system for wetland evaluation] constitutes an interim tool capable of filling an immediate technology gap". As a first approach, the COE system is all encompassing for wetlands from salt marshes to ephemeral freshwater

ponds. Slight regional modifications to the evaluation system were necessary to provide for available scientific knowledge about central Florida wetlands. The resultant conclusions, based upon this evaluation technique for the CF property, provide a best estimate for the wetland systems functional tendencies. Limitations with this approach are inherent to a system based only upon three levels of valuation (i.e., high, moderate, low).

After final wetland/drainage unit values and rankings were completed, the Areawide Phosphate EIS wetland categorizations values and the ESTECH wetland categorization guidelines were considered before application of a final designation. As a result of the use of the COE evaluation procedure, few of the wetlands with mature old-age swamp or bottomland hardwood vegetation rated above average in value. The majority of these areas (i.e., B6, S2, D1, D3, D9, P2, C3) rated as average in overall value. The parameters developed in the COE method and used in this study contain no specific reference to factors such as maturity of vegetation, diversity of habitat or species, niche diversity (related to strata and species composition), or related factors. Such values may be incorporated into an evaluation of habitat, but as such are evaluated subjectively and are averaged with other factors so that their relative weighting becomes low. Such values are generally not specific to wetlands and perhaps should not be considered in an evaluation of strictly wetland or floodplain areas. However, these are ecological attributes of communities which usually require longer periods of time for development. As such, they may be rare or even unique within a region. Such factors thus should be reviewed in a determination of categorization and have been considered in the Category I wetland classifications. Ability to restore, under existing technology, also was a critical factor in developing wetland categorizations.

A wetlands delineation map is provided (Figure 9.1-3), together with Tables 9.1.2-6 and 9.1.2-7 listing wetland acreages, wetland categories, sub-basin/drainage units, and creek basins.

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Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Horse Creek	H1	Hardwood Swamp	17.3	IA
	H2	Hardwood Swamp	1.0	IA
		Hardwood Swamp	7.2	IIA
		Hardwood Swamp	1.6	III
		Marsh	18.3	IA
		Marsh	2.1	III
	H3	Marsh	2.7	IA
	H4	Hardwood Swamp	6.7	IA
		Marsh	4.6	IA
	H5	Marsh	9.3	IID
		Marsh	7.6	III
	H6	Marsh	24.5	IID
	H7	Hardwood Swamp	20.1	IA
		Marsh	4.2	IIA
		Marsh	1.8	III
	H8	Marsh	18.9	IID
		Marsh	6.4	III
	H9	Marsh	15.3	IID
		Marsh	2.0	III
TOTAL			171.6	
Brushy Creek	B1	Hardwood Swamp	39.0	IIC
		Marsh	0.9	IIC
		Marsh	3.5	III
	B2	Hardwood Swamp	76.0	IC
		Hardwood Swamp	9.1	IIC
		Marsh	73.6	IIC
		Marsh	6.0	IID
		Marsh	8.5	III
	B3	Hardwood Swamp	3.1	IID
		Marsh	12.2	IIC
		Marsh	28.5	IID
		Marsh	13.7	III
	B4	Hardwood Swamp	3.6	ID
		Marsh	114.7	ID
		Marsh	21.2	III
	B5	Hardwood Swamp	61.7	ID
		Marsh	138.7	ID
		Marsh	17.7	IIC
		Marsh	9.6	IID
		Marsh	15.4	III

Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 2 of 6)

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Brushy Creek (Continued)	B6	Hardwood Swamp	17.2	ID
		Hardwood Swamp	34.3	IIC
		Hardwood Swamp	1.0	III
		Marsh	34.3	ID
		Marsh	23.1	IIC
		Marsh	25.9	IID
		Marsh	2.5	III
	B7	Hardwood Swamp	5.6	IIC
		Marsh	23.3	IIC
		Marsh	30.5	IID
		Marsh	3.0	III
	B8	Marsh	27.1	IID
		Marsh	1.7	III
	B9	Hardwood Swamp	19.2	IID
		Marsh	54.2	IID
		Marsh	26.4	III
TOTAL			986.0	
Shirttail Branch	S1	—	—	—
	S2	Hardwood Swamp	18.4	IIC
		Marsh	2.7	III
	S3	Hardwood Swamp	23.1	IIC
		Hardwood Swamp	1.5	III
		Marsh	30.8	IIC
		Marsh	12.5	III
	S4	Hardwood Swamp	13.3	IIC
		Marsh	1.3	IIC
		Marsh	10.4	III
	S5	Hardwood Swamp	58.1	IIC
		Marsh	27.3	IIC
		Marsh	16.9	IIC
		Marsh	8.0	III
	S6	Hardwood Swamp	31.1	IIC
		Marsh	63.6	IIC
		Marsh	9.0	IID
		Marsh	15.7	III
TOTAL			343.7	

Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 3 of 6)

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Doe Branch	D1	Hardwood Swamp	80.5	IC
		Hardwood Swamp	4.3	III
	D2	---	---	---
	D3	Hardwood Swamp	3.0	III
		Marsh	1.5	IIC
		Marsh	5.0	IID
		Marsh	5.1	III
	D4	Hardwood Swamp	44.0	IIC
		Marsh	149.9	IIC
		Marsh	5.9	IID
		Marsh	17.9	III
	D5	Hardwood Swamp	22.8	IIC
		Marsh	27.8	IIC
		Marsh	6.8	IID
		Marsh	10.7	III
	D6	Hardwood Swamp	85.8	IC
		Hardwood Swamp	22.7	IIC
		Hardwood Swamp	1.4	IID
		Marsh	6.0	IIC
		Marsh	73.5	IID
		Marsh	32.2	III
	D7	Hardwood Swamp	14.8	IIC
		Marsh	4.7	III
	D8	Hardwood Swamp	1.5	IIC
		Marsh	13.8	IIC
		Marsh	8.5	IID
		Marsh	4.9	III
	D9	Hardwood Swamp	13.3	IIC
		Hardwood Swamp	3.4	III
		Marsh	5.3	III
	D10	Hardwood Swamp	29.2	IIC
		Marsh	70.1	IIC
		Marsh	32.1	IID
		Marsh	30.3	III
	D11	Hardwood Swamp	24.1	IC
		Hardwood Swamp	9.0	IIC
		Marsh	1.6	IIC
		Marsh	1.5	III
	D12	Hardwood Swamp	25.5	IIC
		Marsh	1.0	IIC
		Marsh	5.5	III

Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 4 of 6)

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Doe Branch (Continued)	D13	Hardwood Swamp	23.7	IIC
		Marsh	5.6	IIC
		Marsh	7.1	IID
		Marsh	5.3	III
	D14	Hardwood Swamp	3.4	IIC
		Marsh	61.1	IIC
		Marsh	20.9	III
TOTAL			1,034.0	
Plunder Branch	P1	Hardwood Swamp	9.9	IC
		Hardwood Swamp	8.4	IIC
		Marsh	2.7	III
	P2	Hardwood Swamp	27.7	IC
		Marsh	38.1	IID
		Marsh	10.6	III
	P3	Hardwood Swamp	48.9	IIC
		Marsh	10.3	IIC
		Marsh	13.8	IID
		Marsh	29.1	III
	P4	Hardwood Swamp	26.8	IIC
		Marsh	5.1	IID
		Marsh	2.2	III
	P5	Hardwood Swamp	29.1	IIC
		Hardwood Swamp	2.0	III
		Marsh	11.5	IIC
		Marsh	74.8	IID
		Marsh	55.7	III
	P6	Marsh	95.3	IIC
		Marsh	30.2	IID
		Marsh	20.4	III
TOTAL			552.6	
Coon's Bay Branch	C1	Hardwood Swamp	4.2	IIC
		Marsh	0.3	III
	C2	Hardwood Swamp	5.2	IIC
		Marsh	7.4	IIC
		Marsh	2.7	III
	C3	Hardwood Swamp	20.8	IC
		Marsh	0.8	III
	C4	Marsh	2.4	III
TOTAL			43.8	

Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 5 of 6)

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Lettis Creek	L1	Hardwood Swamp	10.5	IIC
		Marsh	4.5	III
	L2	Hardwood Swamp	60.3	IIC
		Marsh	10.3	IIC
		Marsh	5.6	IID
		Marsh	34.2	III
	L3	Hardwood Swamp	23.7	IIC
		Marsh	3.4	IIC
		Marsh	6.5	IID
		Marsh	8.5	III
	L4	Hardwood Swamp	71.6	IIC
		Marsh	7.0	IIC
		Marsh	5.5	IID
		Marsh	8.6	III
TOTAL			260.2	
Troublesome Creek	T1	Hardwood Swamp	3.9	IIC
		Hardwood Swamp	5.9	IID
		Marsh	0.7	IIC
		Marsh	10.8	IID
		Marsh	16.3	III
	T2	Marsh	28.7	IIB
		Marsh	4.0	IID
	T3†	--	--	--
	T4	Marsh	47.8	IID
		Marsh	12.2	III
	T5	Marsh	30.0	IID
		Marsh	4.3	III
TOTAL			164.6	
Gum Swamp Branch	G1	Marsh	5.2	IID
		Marsh	4.2	III
	G2	Marsh	4.1	III
	G3	Marsh	10.0	IID
TOTAL			23.5	

Table 9.1.2-6. EPA Category I, II, and III, Wetland Acreages of the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued, Page 6 of 6)

Creek Basin	Sub-Basin/ Drainage Unit	Wetland Type	Acreage	Category*
Hog Branch	--	---	---	---

* Category I--Protected
A--Mainstem Stream Wetlands
B--Headwater Wetlands
C--Tributary Wetlands
D--Special Concern Wetlands
Category II--Mine and Restore
A--Mainstem Stream Wetlands
B--Headwater Wetlands
C--Tributary Wetlands
D--Isolated (Over 5 acres) Wetlands
Category III--Mine With No Restoration to Wetlands
Isolated (Under 5 acres) Wetlands

† A drainage unit initially designated as "T3" has subsequently been incorporated into drainage unit D10.

Source: ESE, 1983.

Table 9.1.2-7. Summary of EPA Category Acreages by Creek/Drainage for CF Industries Hardee Phosphate Complex II Proposed Mine Site

Creek Basin	Creek Basin Acreage	Category Wetland (acres) Percent Creek Basin I	II	III	Total Category, I,II,III Acreage	Total Percent Of Creek Basin
Horse Creek	795	70.7 8.9	79.4 10.0	21.5 2.7	171.6	21.6
Brushy Creek	3,429	446.2 13.0	442.9 12.9	96.9 2.8	986.0	28.8
Shirttail Branch	1,562	0.0 0.0	292.9 18.8	50.8 3.3	343.7	22.0
Doe Branch	4,679	190.4 4.1	688.6 14.7	155.0 3.3	1,034.0	22.1
Plunder Branch	2,374	37.6 1.6	392.3 16.5	122.7 5.2	552.6	23.3
Coon's Bay Branch	259	20.8 8.0	16.8 6.5	6.2 2.4	43.8	16.9
Lettis Creek	1,203	0.0 0.0	204.4 17.0	55.8 4.6	260.2	21.6
Troublesome Creek	552	0.0 0.0	131.8 23.9	32.8 5.9	164.6	29.8
Gum Swamp Branch	118	0.0 0.0	15.2 12.9	8.3 7.0	23.5	19.9
Hog Branch	23	0.0 0.0	0.0 0.0	0.0 0.0	0.0	0.0
TOTAL	14,994	765.7 5.1	2,264.3 15.1	550.0 3.7	3,580.0	23.9

Source: ESE, 1983.

Category I Wetlands

Horse Creek

Horse Creek is an intermittent stream flowing through the western end of the property. The stream has a reach of 3.0 miles above the property and drains approximately 17.9 square miles. The average annual discharge at the exit of the CF property is estimated to be approximately 10.7 cubic feet per second (cfs). Though intermittent in nature, the stream basin does collect and retain pools of water along its primary channel. The principal water retention area is located within the central marsh system (H2). This drainage unit/wetland complex and adjacent upstream (H3) and downstream units (H1) provide relatively high food chain production values, high habitat value, hydrologic support, and water purification function. Therefore, because of the composite value of these systems and because of the large drainage basin and average annual flow (exceeds 5 cfs) to which these interconnected wetlands provide synergistic support, the Horse Creek stream channel and contiguous wetlands located within H1, H2, and H3 are classified as Category I A--Mainstem Stream Wetlands.

Mature hardwood swamps located in Units H4 and H7 did not receive high value ratings due to minimal hydrologic connection and low net primary productivity. However, the two mixed hardwoods swamps were considered mature, relatively pristine associations and are included as Category IA --Mainstem Stream Wetlands. Total acreage of Category IA--Mainstem Stream Wetlands within the Horse Creek drainage equals 70.7 acres.

Brushy Creek

Brushy Creek has its headwaters located within the western portion of the CF property. This drainage headwater area composed of approximately 4.2 square miles, is contained almost entirely within the CF property boundaries. The estimated average annual discharge from this basin at the property boundary is approximately 2.5 cfs. The drainage basin is characterized by two distinct arms; one reach containing primarily Mitchell Hammock (B4, B5, and B6), and another reach comprising a major,

Y-shaped headwater wetland (B2). These units converge and drain through a poorly defined channel and associated hardwood floodplain (B1). In comparatively evaluating the Brushy Creek system, it appears that its highest functional values are related to its ability to store and hold water for potential flood protection, the size of its marsh-dominated wetland complex, and its associated net primary production values. The Mitchell Hammock unit (B4, B5, and B6) serves as a wetland headwater area to the Brushy Creek system. However, investigations conducted for this report indicate that most of its food-chain production values (nutrient transport) are not provided to the main downstream complex (B1) to a significant extent. This occurs since the poorly defined channel/overflow connector through B4 tends to retain and internalize a significant portion of its primary production values by retaining them within the system. This effect is even further pronounced in the upper reach of the Mitchell Hammock complex (B6) since its hydrologic connection is felt to be even less well defined and contributes to the downstream units even less frequently.

The other major headwater wetland complex (B2) contributing to the downstream Brushy Creek system has similar high storage values and is characterized by a more functional connection and more frequent and pronounced hydrologic transport values. In evaluating the Brushy Creek system and developing a wetland categorization, it is felt that these headwater wetland complexes have, as their most significant functional values, floodwater storage, size, and the net primary production values of the larger marsh complexes.

The largest concentration of contiguous marsh/swamp wetland is located within Units B4 and B5. Therefore, these units are classified as Category ID--Special Concern Wetlands. To date, the restoration of hardwood swamps and their biological functions and values has not been adequately demonstrated. Therefore, because of the relative value of these systems and their geographic extent, it was decided that a viable mature hardwood swamp component be preserved as a seed source area. The

wetlands determined to be most representative of the mature vegetative communities within the headwater wetland complexes and which would provide the most viable contribution as a seed source are the central hardwood swamp in B2 and the eastern mature hardwoods in B6. The marshes immediately contiguous to the maple/tupelo swamp in B6 and also connected by channels to Drainage Unit B5 are included, together with the B2 and B6 swamps, as Category I wetlands. Unit B2 is classified as a Category IC--Tributary Wetland, while Unit B6 is included together with contiguous Units B5 and B4 as Category ID--Special Concern Wetlands. Total Category I wetland acreage to be protected from mining within the Brushy Creek drainage is 446.2 acres.

Doe Branch

Doe Branch is an intermittent stream with its headwaters located largely within the CF property. Doe Branch has a drainage area of approximately 7.8 square miles and contributes a calculated flow of 4.6 cfs at the property boundary. Doe Branch is the largest and most complex drainage system contained within the property boundaries.

In evaluating its functional values, the system rated as moderate to high for food chain production, wildlife habitat, floodwater storage, vegetation density and total area of wetlands. Doe Branch is characterized by three discrete headwater reaches.

Above the principal D1 channel floodplain, one headwater wetland/drainage area consists of D11, D12, and D14, another consists of D9, D10, and D13. The third consists of D4, D5, and D6. The D11, D12, and D14 reach rated high for vegetation density and inundation, and moderate to low for all other values. The D9, D10, and D13 reach rated high for net primary production and moderate to low for all other values. The D4, D5, and D6 branch rated high for net primary production, secondary production, floodwater storage, inundation, and total area of wetlands. This reach received a higher composite rating than the other reaches in the system. However, it is similar to the Mitchell Hammock area in that

much of its net production values are internalized by a poor hydrologic connector to the downstream segments. The weaker hydrologic connectors for D5 and D6 make this effect even more pronounced for these wetland units.

In developing a categorization of the wetlands within this drainage basin and to ensure consistency with the areawide EIS guidelines, the overall high value should be assessed along with the restorability of functional components. Although the wetlands within Units D4 and D5 rated very high overall, the majority of wetland type within the units is marsh. It is believed that the functional values of these marsh-dominated drainage units can be restored. Therefore, the D4 and D5 units are classified as Category IIC--Tributary Wetlands. However, within the Doe Branch drainage, two mature hardwood swamps in Units D6 and D11 will be preserved as a future seed source for on-site swamp restoration activities. Because of the relatively large drainage basin, its calculated 4.6 cfs discharge, and its high food-chain production values, the mature hardwood swamp floodplain of D1 will be protected to serve as a natural buffer for Payne Creek from the upstream mining and restoration activities.

Therefore, consistent with the areawide EIS, the wetland/floodplain unit within D1 (80.5 acres) and the mature hardwood areas within D6 and D11 (collectively 109.9 acres) are classified as Category IC--Tributary Wetlands.

Plunder Branch

Plunder Branch is an intermittent stream with headwaters located on the eastern portion of the property. The drainage basin of 4.5 square miles contributes an average annual flow of 2.7 cfs at the exit from the property.

In evaluating the composite functional values for Plunder Branch, its overall comparative rating established the system as having a moderate

value. The wetlands within the Plunder Branch system received their highest comparative values for net primary production and vegetation density with other contributing functional values being ranked moderate to low.

Plunder Branch is divided into two distinct reaches above the stream channel floodplain located in P1. One reach (P2 and P3) contains approximately one-third of the upstream drainage basin. The wetland/floodplain units located within this reach are characterized by a young maple hardwood swamp (P2) and an oak dominated hardwood (P3) system. The second reach (P4, P5, and P6) contains approximately two-thirds of the upstream drainage basin. However, P5 exhibits a weak, possibly ephemeral hydrologic link, and Unit P6 is, for all practical purposes, isolated. The wetland floodplain units within this reach are characterized by an oak/ash hardwood swamp (P4), an oak dominated floodplain (P5) and an open maidencane marsh (P6).

In analyzing the functional values for the Plunder Branch system, only one unit (P1) exhibits characteristically higher value. The wetland unit within P1 was ranked high for food chain production, habitat value, hydrologic support, flood retardation, and vegetation density. Various factors should be noted in evaluating this system, including the uniqueness of swamp type (species composition, diversity and maturity), the presence of an endangered plant (needle palm) that is indicative of permanent soil saturation conditions, and the presence of pockets of water, though intermittent, within the stream bed.

In developing the wetland categorizations consistent with the areawide EIS, the hardwood swamp within P1 is classified as a Category IC--Tributary Wetland. The hardwood swamp within P2 is considered to be a mature, diverse community and a viable future seed source. Therefore, P2 is also classified as a Category IC--Tributary Wetland. Together, the P1 and P2 Category I wetlands amount to 37.6 acres.

Coon's Bay Branch

Coon's Bay Branch has its headwaters located on the eastern border of the CF property. The drainage basin and average annual discharge calculated at the exit from the CF property is 0.5 square miles and 0.3 cfs, respectively. The Coon's Bay drainage system contained on the CF property is characterized by the upper extremities of one reach. The wetland units within this system are immature and mature maple hardwood swamp systems ephemerally to intermittently linked to the downstream systems.

In evaluating the composite functional values for the Coon's Bay system, it is characterized as a comparatively low value system. The higher functional values for the system were flood retardation and vegetation density (C3 only), with most other values ranking low. The maple/tupelo swamp within Unit C3 is considered a mature hardwood wetland that could be preserved for its flood retardation value and possible future use as a seed source. Therefore, the C3 (20.8 acres) unit is classified as a Category IC--Tributary Wetland.

Category II Wetlands

Approximately 2,264.3 acres of wetlands within each drainage basin (i.e., if isolated greater than 5 acres in size or connected or contiguous to a main drainage channel) are classified as Category II wetlands.

Category III Wetlands

A Category III wetland designation is appropriate for the remaining 550 acres of isolated, non-contiguous wetlands of less than 5 acres in size.

9.1.2.4 THREATENED OR ENDANGERED SPECIES

Vegetation

Populations of endangered native plant species have diminished in both size and distribution in Florida by man's disturbances or complete

alterations to their specific habitat requirements. Several governmental agencies and private institutions have produced endangered plant species lists in order to protect these Florida plants, or otherwise educate the populace of the existing condition and importance of these taxa (USFWS, 1984; FCREPA, 1979; FDA, 1978; SI, 1978; CITES, 1973; IUCN, 1972; USFS, 1970).

Plant species which have been listed by these agencies and special concern groups and which have been observed or may occur on-site are listed in Table 9.1.2-8. Officially, protected plant species which are included as endangered or threatened by the USFWS (1984) were not observed in the vicinity of the CF Industries Hardee Phosphate Complex II proposed mine site. The only four plants listed as federally protected [Harper's Beauty (Harperocallis flava), Florida Torreya (Torreya taxifolia), Chapman's Rhododendron (Rhododendron chapmanii), and Key Tree-Cactus (Cereus robinii)] are either restricted to the panhandle or the Florida Keys.

However, three important plant species which have a high likelihood of occurrence or are present on-site, are discussed below, including their designated status. Range and habitat information, unless otherwise cited, is from FCREPA (1979).

Spoon-Flower [Peltandra sagittifolia (Michx.) Morong.]
Spoon-flower is a rare perennial herb which is known to occur from North Carolina to Florida (FCREPA, 1979). In Florida, it occurs throughout the peninsula from Highlands, Hardee, and Manatee counties north to Jefferson County, with a disjunct population in the panhandle. Spoon-flower inhabits wet soil areas such as bogs, ditches, valley bottoms, cypress swamps, bay forests, and lake and stream margins. There is a high probability that spoon-flower occurs within the mature bay and mixed swamps on-site, since the aroid is frequent within its habitat and range.

Table 9.1.2-8. Threatened or Endangered Plant Species Which May Occur on the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Scientific Name	Common Name	Designated Status*							Probability of Occurrence†
		USFWS[1]	CITES[2]	SI[3]	USFS[4]	FDA[5]	FCREPA[6]	IUCN[7]	
Asclepias curtissii Gray	Curtiss Milkweed					T	T		VL
Bonamia grandiflora (Gray) Hall. f.	Florida Bonamia			T			T		VL
Drosera intermedia Hayne in Schrad.	Water Sundew						R		L
Hartwrightia floridana Gray ex Wats.	Florida Hartwrightia			T			R		M
Peltandra sagittifolia (Michx.) Morong.	Spoon-Flower						R		H
Rhapidophyllum hystrix (Pursh) Wendl. & Drude	Needle Palm			T		T	T	V	P
Zamia pumila L.**	Florida Coontie		II	E		T	T	V	H

* E = Endangered
R = Rare
T = Threatened
V = Vulnerable
II = Included in Appendix II of (CITES)

† VL = Very Low; occurrence of this plant species has been recorded within Hardee County, however, suitable habitat does not exist on-site.
L = Low; suitable habitat may exist on-site, however, the rarity of the species restricts the probability of occurrence.
M = Moderate; plant species may occur on-site, since range and suitable habitat exist.
H = High; there is a good possibility of the species occurring on-site, since the plant is relatively frequent within its habitat type and range.
P = Present; the plant indicated is located within property boundaries of the CF Industries' Hardee Phosphate Complex II proposed mine site.

** Currently, Zamia pumila L. is considered the accepted scientific name for Florida Coontie (Wunderlin, 1982). Synonyms (Zamia umbrosa Small, Z. floridana A.DC and Z. integrifolia At.) have been listed as the protected species in the designated status reports.

Sources:
1 U.S. Fish and Wildlife Service, 1984.
2 Convention on International Trade in Endangered Species of Wild Fauna and Flora, 1973.
3 Smithsonian Institution (Ayensu, E.S., and DeFilipps, R.A., 1978).
4 U.S. Forest Service, 1970.
5 Florida Department of Agriculture and Consumer Services, 1978.
6 Florida Committee on Rare and Endangered Plants and Animals, 1979.
7 International Union of Conversation of Nature and Natural Resources, 1972.

Although Peltandra sp. is common within the tree swamps on-site, the two species Peltandra virginica and Peltandra sagittifolia cannot be easily distinguished without the benefit of flowering and fruiting specimens, which were not present during the times of investigation.

Florida Coontie (Zamia pumila L.)

Zamia pumila L. is considered the accepted scientific name for Florida coontie (Wunderlin, 1982). In the past, Florida coontie was considered as two to three separate species and given specific degrees of protected status by various scientific reports. To avoid confusion, the designated status of synonyms of Florida coontie (i.e., Zamia floridana A.DC., Z. integrifolia Ait., and Z. umbrosa Small) will be collectively grouped under the specific epithet of Zamia pumila L. Therefore, Florida coontie has been listed as a threatened (FDA, 1978; FCREPA, 1979), a vulnerable (IUCN, 1972; CITES, 1973) and an endangered (SI, 1978) species.

The Florida coontie is a stout plant which has its stem buried beneath the soil. The exposed deciduous leaves are glossy green and the plant bears cones. Coontie inhabits sandhills, pine flatwoods, shell mounds, hammocks, and xeric oak woods. Although the coontie's range and available habitat occur almost statewide, its numbers have decreaseed greatly over the years. Coontie was used for flour by the Indians in the past, and currently this cycad is being exploited in the nursery trade as an ornamental. In the CF Industries DRI (1976), the Florida coontie was listed as present within the flatwoods on-site. However, specific map locations were not provided, and Florida coontie was not observed during the 1982 field investigations. It is doubtful that the cycad has disappeared since 1976. However, since the occurrence of Florida coontie was not verified during field reconnaissance, it is rated with a "high probability of occurrence" on the site.

Needle Palm [Rhapidophyllum hystrix (Pursh) Wendl. & Drude]

Needle palm has dark green, evergreen leaves and a stout stem which bears sharp-pointed spines at the bases of the petioles. Needle palm

grows in forested habitats which are wet throughout the year, such as hammocks hammocks along spring-fed creeks, swamp and floodplain seepage areas, backwater swamps, and wooded riverbank ravines.

Needle palm occurs intermittently from Highlands and Hardee counties northward to Alachua County and then westward to Walton County in Florida. During the drainage walkover surveys, needle palm was discovered within a mixed hardwood swamp just south of northern site boundaries, where Plunder Branch exits the property (Unit P1). Needle palm has been designated as both a threatened (SI, 1978; FDA, 1978; FCREPA, 1979) and a vulnerable species (IUCN, 1972). Interspersed throughout the tree swamp were 45 healthy specimens of the palm. Herbarium records (USF Herbarium, 1982), pertinent literature (FCREPA, 1979; Shuey and Wunderlin, 1977), and personal communications with needle palm experts (Shuey, 1982; Wunderlin, 1982) agree that needle palm has never been discovered within a mixed hardwood swamp type such as the habitat situated on the property. Only one other known location of needle palm exists in Hardee County, some 8 miles due south along the Peace River drainage. The two Hardee County populations, together with a population center in Highlands County, constitute the southernmost limit of the palm in the United States.

Wildlife

It has been determined that a number of wildlife species populations have declined dramatically in recent years. As a result, the U.S. Fish and Wildlife Service and the Florida Game and Fresh Water Fish Commission have afforded legal protection to species considered endangered, threatened, rare or of special concern.

The CF Industries Hardee Phosphate Complex II site is known to provide habitat for a number of these protected species and may provide suitable habitat for others that have not yet been observed on the site. The species that are known (or expected to occur) in the vicinity of the CF site are discussed below and are included in Table 9.1.2-9.

Table 9.1.2-9. Status of Endangered (E), Threatened (T), and Species of Special Concern (S) Wildlife Species Whose Ranges Include the CF Industries Hardee Phosphate Complex II Proposed Mine Site

Common Name	Scientific Name	Designated Status* Federal	State	Comments
REPTILES				
Gopher tortoise	Gopherus polyphemus	-	S	Occupies dry sandy soils; Habitat--flatwoods, rangeland—present.
American alligator	Alligator mississippiensis	T	S	Habitat—marsh, stream, swamp—present.
Eastern indigo snake	Drymarchon corais couperi	T	T	Varied habitat—present.
BIRDS				
Woodstork	Mycteria americana	E	E	Wetlands, no known nesting—present.
Red-cockaded woodpecker	Picoides borealis	E	T	Restricted primarily to mature pine flatwoods; None sighted.
Southern bald eagle	Haliaeetus l. leucocephalus	E	T	None sighted, occurrence possible as transient.
Southeastern American kestrel	Falco sparverius paulus	-	T	Site is within breeding range, believed present.
Florida sandhill crane	Grus canadensis pratensis	-	T	Nests in shallow emergent freshwater marsh vegetation. Sighted on property.

Table 9.1.2-9. Status of Endangered (E), Threatened (T), and Species of Special Concern (S) Wildlife Species Whose Ranges Include the CF Industries Hardee Phosphate Complex II Proposed Mine Site (Continued. Page 2 of 2)

Common Name	Scientific Name	Designated Status* Federal	State	Comments
BIRDS (Continued)				
Little blue heron	Florida caerulea	-	S	Wetlands, mainly marshes—present.
Snowy egret	Egretta thula	-	S	Wetlands, mainly marshes—present.
Louisiana heron	Hydranassa tricolor	-	S	Wetlands, mainly marshes—present.
Florida burrowing owl	Athene cunicularia floridana	-	S	Improved pasture, none sighted.
Roseate spoonbill	Ajaia ajaja	-	S	None sighted, primarily coastal but uses freshwater marshes infrequently.
MAMMALS				
Florida panther	Felis concolor coryi	E	E	Varied habitat, no recent confirmed sightings.
Florida black bear	Ursus americanus floridanus	-	T	Preferred habitat is thick swamps.

* Federal listings of endangered and threatened wildlife species were derived from the U.S. Fish and Wildlife Service [Endangered and Threatened Species of the Southeastern United States, Region 4, Atlanta (Notebook), most recent update August 3, 1984] State listed protected animals were taken from Florida Game and Fresh Water Fish Commission (Official Lists of Endangered and Potentially Endangered Fauna and Flora in Florida, 1 October 1984). Rules Relating to Endangered or Threatened Species. In: Florida Administrative Code, Chapter 39-27.01-.05. Tallahassee, Florida.

Source: ESE, 1984.

Reptiles

American Alligator (Alligator mississippiensis)--The American alligator, currently federally listed as threatened, inhabits swamps, streams, sloughs, lakes, and marshes. At one time, heavy poaching for hides and destruction of wetland habitat threatened the continuation of this species. Since its classification as a protected species, the alligator has made a remarkable recovery. This large reptile is now fairly common throughout Florida. It has reached sufficient numbers to be considered a pest in some areas of the state.

At least two alligators were frequently observed in the intermittent drainage which flows from Mitchell Hammock into Brushy Creek (CF DRI, 1976). During the 1982 field investigations, alligators or signs of alligators were observed throughout the CF Industries Hardee Phosphate Complex II site. Almost every stock pond or borrow pit which contained permanent water supported at least one alligator. A perched, isolated freshwater marsh near the northern boundary of the site, within the Shirttail Branch drainage, supported two alligators. Within the Doe Branch drainage, eight alligator young were discovered within a marsh edge to a maple swamp. A large (approximately 8 feet long) alligator has been observed within the central marsh located in Mitchell Hammock. Within the Horse Creek channel, two large, deep circular pools, cleared of the surrounding marsh vegetation, appeared to represent alligator holes. However, alligators were not observed in Horse Creek during the field studies.

Alligators are expected to occupy areas of suitable habitat provided by Brushy Creek, Lettis Creek, and Plunder Branch. Some of the larger marsh systems on the CF site may also be of value to the American alligator.

Gopher Tortoise (Gopherus polyphemus)--The gopher tortoise is a terrestrial tortoise of well-drained communities where it excavates underground tunnels. Gopher tortoise burrows provide shelter for other

animals including: gopher frogs, indigo snakes, diamondback rattlesnakes, burrowing owls, small mammals and numerous insects. Decline of the tortoise, listed as a species of special concern, has been attributed to their over-harvesting for food and to loss of habitat. The gopher tortoise has been observed on the CF site and is considered common, based on numerous burrows present in pine flatwoods and other upland communities.

Eastern Indigo Snake (Drymarchon corais couperi)--The eastern indigo snake is designated threatened by both federal and state agencies. This large, docile reptile has been the target of many snake collectors, and its importance in the pet trade has been a major factor in its decline. The indigo inhabits both upland and lowland communities including hydric, mesic and xeric hammocks, swamps, marshes, and flatwoods. During the summer months, indigo snakes of upland areas may seek shelter in gopher tortoise burrows.

At least three indigo snakes have been observed in the large southern tract of the CF property (CF DRI, 1976). Considering these sightings and the large area of suitable habitat on the CF site, the indigo snake's occurrence is judged as common.

Birds

Woodstork (Mycteria americana)--The Woodstork is a colonial wading bird considered endangered by the Florida Game and Freshwater Fish Commission and the U.S. Fish and Wildlife Service. The Woodstork is North America's only native stork and inhabits freshwater and brackish wetlands. Nesting occurs in mangrove and cypress swamps. Freshwater marshes, flooded pastures and ditches are primary feeding areas. The decline of Woodstork populations is attributed to man's manipulation of wetland water levels which alter or eliminate vital feeding areas. Woodstorks have been observed in the vicinity of the CF site, and they are expected to feed in suitable wetlands within the site boundaries.

Southern Bald Eagle (Haliaeetus l. leucocephalus)--The Southern Bald Eagle inhabits rivers, lakes, and estuaries of the southeastern United States. Nesting occurs in pine and cypress trees in proximity to water, with fish being the primary food. No lakes or rivers occur on the CF site, and the small borrow pits are not suitable for the eagle's needs. Bald eagles are not expected on the CF site except as transients. The closest suitable eagle habitat to the site is found in the Peace River system to the east and the Manatee River system to the west.

Red-cockaded Woodpecker (Picoides borealis)--Florida populations of the Red-cockaded Woodpecker are presently considered endangered by the U.S. Fish and Wildlife Service and threatened by the Florida Game and Freshwater Fish Commission. This woodpecker is found in southern pine flatwoods. Habitat requirements for nesting and daily roosting include live, mature, or overmature pine trees (longleaf pine is most commonly used). Because of past logging on the CF site, few mature stands of pine exist. Remaining stands of mature longleaf pine were surveyed and judged suitable for red-cockaded use. Individual trees were examined and revealed neither nest nor roost cavities, and no Red-cockaded Woodpeckers were found. This protected woodpecker is believed to be absent from the CF site.

Southeastern American Kestrel (Falco sparverius paulus)--The Southeastern American Kestrel, a subspecies of the American Kestrel is a small falcon considered threatened by the State of Florida. This bird inhabits open areas including pastures, rangeland, and other ruderal areas on the CF site. The kestrel feeds on insects and small mammals and nests in cavities in trees or artificial structures. Population decline of this species is attributed to loss of nesting sites.

Florida Sandhill Crane (Grus canadensis pratensis)--The Sandhill Crane is listed as threatened by the State of Florida and is non-migratory, unlike the northern subspecies. Cranes inhabit shallow marshes, lake edges, and flooded open pastures. Nests are constructed in shallow

water that is approximately one foot in depth. A naturally low reproductive rate combined with loss of wetland habitat has caused the decline of this species. Suitable crane habitat exists on the CF property, and Sandhill Cranes have been observed on-site.

Wading Birds--Four wading bird species are designated Species of Special Concern by the State of Florida and have been observed on the CF site. These are the Little Blue Heron, Louisiana Heron, Snowy Egret and Roseate Spoonbill. The herons and the egret utilize freshwater marshes, shrub swamps, flooded pastures, and drainage ditches. Roseate Spoonbills are primarily coastal waders; however, they do feed in freshwater marshes infrequently. Cause for concern for these wading birds is due to loss of wetland habitat. The CF site is observed to be an important feeding and staging area for waders, but positive nest records have not been substantiated.

Burrowing Owl (Athene cunicularia floridana)--The major population of Burrowing Owls is located in south-central Florida where it inhabits dry open areas of prairie, sandhill, and pasture communities. Extensive land development is believed to play a part in the decline of this owl's population. Displaced Burrowing Owls have moved onto golf courses, grasslands at airports and industrial sites and landfill areas. Suitable Burrowing Owl habitat occurs on the CF site in pastures and open rangeland, but no owls have been observed.

Mammals

Florida Panther (Felis concolor coryi)--The Florida panther is a large, light brown-colored cat which is designated "endangered" by federal and state agencies. Requirements of this secretive predator's habitat include vast areas of relatively undisturbed wilderness areas. Such areas are provided by the Fakahatchee Strand, Big Cypress Preserve and Everglades National Park in southern Florida. No recent substantiated sightings have been made in the vicinity of the CF site. Due to the

altered condition and openness of the site, suitable habitat is not provided, and no Florida panthers are expected to occur.

Florida Black Bear (Ursus americanus floridanus)--The Florida black bear is considered threatened by the Florida Game and Fresh Water Fish Commission. This large mammal inhabits swamplands with dense undergrowth, and feeds on fruits, berries, insects, honey, and occasionally wild hogs and cattle. A number of recent records of bear populations occur throughout Florida, including portions of Hardee County. Bear populations appear to be stable in national forests in northern Florida, but elsewhere in the state populations are vulnerable. Habitat loss and persecution by man have attributed to the decline of bear populations. No recent bear sightings have occurred on the CF property, but considering their wandering nature, bears may be expected to occur in suitable habitat onsite.

9.1.2.5 RECREATIONALLY AND COMMERCIALLY IMPORTANT WILDLIFE

The varied habitat found on the CF site supports several important game and fur-bearing animals. These include upland game birds, waterfowl, large mammals, and small game and fur-bearing mammals.

Upland Game Birds

Bobwhite Quail, Mourning Doves, and Wild Turkey are important game bird species on the CF site. Quail and Mourning Doves are reported to be abundant, while turkeys are considered common. Quail and doves utilize similar habitat provided by open areas--rangeland, pastures, flatwoods, and ruderal areas. In these open areas they feed on seeds and vegetation provided by dense growth of herbs and shrubs. Several turkeys were observed on the site in both ruderal and hardwood hammock communities.

Waterfowl

The numerous wetlands on the CF site are a valuable resource for waterfowl. The Mottled Duck is believed to be the only breeding duck in the region. Numerous other duck species utilize marshland and wintering areas. The most common migrants and winter residents include Blue-winged Teal, Green-winged Teal, American Widgeon, Ring-necked Duck and Lesser Scaup. The Wood Duck is a year-round resident, but is believed to breed further north in Florida.

Large Mammals

Recent wildlife surveys indicated healthy populations of large mammals on the CF site. White-tailed deer were observed often in flatwoods and hammock edges and were judged abundant. Wild hogs were common to abundant on-site. Several hogs and their characteristic "rooting" signs were observed in hardwood hammocks, rangeland, swamps, and marsh edges.

Small Game and Fur-Bearing Mammals

The CF site supports a number of small game and fur-bearing mammals. Some of the more common species include opossum, raccoon, marsh rabbit, eastern cottontail, and gray squirrel. Other more secretive species include red fox, gray fox, and bobcat. The round-tailed muskrat, although not sighted, is considered abundant in the numerous marshes. Many muskrat feeding platforms, dens and scat were sighted during field surveys. Other species not sighted, but possibly occurring on-site, are the long-tailed weasel and river otter.

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10.0 SOCIOECONOMICS

10.1 THE AFFECTED ENVIRONMENT

This section, which discusses regional and local socioeconomic environments, represents a baseline description of existing and future conditions without implementation of the proposed project. Most information for this section was obtained from recent national, state, and local sources.

In general, the socioeconomic region is defined as Hardee, DeSoto, Highlands, Hillsborough, Manatee, and Polk Counties. The local area consists of Hardee County, within which the proposed project is located. Where appropriate, regional and local boundaries are expanded or contracted to reflect data availability or impact considerations. In addition, site descriptions are provided. Socioeconomic elements described in the baseline description include population, income and employment; land use; transportation; community services and facilities; public finance; cultural resources; and visual resources.

10.1.1 POPULATION, INCOME AND EMPLOYMENT

10.1.1.1 POPULATION

In 1983, Hardee County had a population of 19,782 residents or approximately 1.5 percent of the regional population of 1,293,877 (see Table 10.1.1-1) [University of Florida, Bureau of Economic and Business Research (BEBR), 1984]. Hardee County ranks 49th (of 67 counties) in population size in Florida and is slightly larger than DeSoto County, located immediately south of Hardee County (BEBR, 1984).

The county is characterized by rural development, with 65 percent of the 1983 population residing in unincorporated areas. This figure is similar to 1970 population distributions which showed 63.2 percent residing in unincorporated areas. Three incorporated municipalities are located in Hardee County. Wauchula, the county seat, had a 1983 population of 2,971 inhabitants (BEBR, 1984). The remaining municipalities, Bowling Green and Zolfo Springs, had 2,305 and 1,592 persons, respectively, residing within municipal boundaries (BEBR, 1984).

Table 10.1.1-1. Population and Growth Rates for Hardee County, the Central Florida Region, and Florida

County	Population Counts 1970	1980	Population Estimate 1983	Growth Rate 1970-1983
Hardee	14,889	19,379	19,782	33.0%
DeSoto	13,060	19,039	20,594	57.7%
Highlands	29,507	47,526	53,661	82.0%
Hillsborough	490,265	646,960	693,152	41.4%
Manatee	97,115	148,442	161,464	66.3%
Polk	228,515	321,652	345,224	50.1%
TOTAL REGION	873,351	1,202,998	1,293,877	48.1%
FLORIDA	6,791,418	9,739,992	10,591,701	56.0%

Sources: U.S. Bureau of the Census, 1981.
BEBR, 1984.
ESE, 1984.

The current (1983) population density in Hardee County is 31.0 persons per square mile, which ranks 46th in comparison to other Florida counties. The regional and statewide population densities are 218.4 and 196.0 persons, respectively.

Between 1970 and 1983 population growth in Hardee County was less than that recorded for the region and Florida (see Table 10.1.1-1). During this period, Hardee County's population increased by 33.0 percent, for an average annual growth rate of 2.5 percent. Municipal population growth in the county averaged 31.8 percent, varying from a 70.0 percent increase in Bowling Green to a 1.2 percent decrease in Wauchula.

Population change from 1970 to 1980 was a result of both natural increase and net migration. The U.S. Bureau of the Census attributed 37.2 percent of the county's total population increase of 4,490 to natural increase--the number of births being greater than the number of deaths. Net migration, the result of in-migration and out-migration, was responsible for the remainder of the increase--2,818 persons or 62.8 percent.

10.1.1.2 INCOME

Per capita income in Hardee County, other counties in the region, and the state is identified in Table 10.1.1-2. Per capita incomes in 1982 for Florida and Hardee County were $10,907 and $7,792, respectively. Local personal incomes averaged 28.5 percent less than statewide personal incomes. Hardee County ranks 21st of 67 Florida counties in personal income. Florida per capita income increased by $5,337 between 1975 and 1982. During the same period, Hardee County per capita income increased $3,560 (BEBR, 1984).

Table 10.1.1-2. Per Capita Income on a Place-of-Residence Basis, 1975-1982

Area	1975	1976	1977	1978	1979	1980	1981	1982	1975-1982 Change
Florida	5,530	5,918	6,520	7,330	8,202	9,142	10,165	10,907	97.2%
Counties in the Region									
DeSoto	3,915	4,185	4,687	5,607	6,311	6,791	6,814	7,779	98.7%
Highlands	4,283	4,650	5,286	6,126	6,874	7,544	8,129	8,764	104.6%
Hillsborough	5,195	5,466	5,982	6,750	7,487	8,470	9,398	10,026	93.0%
Manatee	5,102	5,555	6,315	7,210	8,189	9,112	10,052	11,011	115.8%
Polk	4,998	5,254	5,788	6,591	7,341	8,235	8,878	9,226	84.6%
Hardee	4,232	4,430	5,059	5,831	6,687	7,309	7,309	7,792	84.1%
RATIO TO FLORIDA PER CAPITA INCOME									
Counties in the Region									
DeSoto	0.71	0.71	0.72	0.76	0.77	0.74	0.67	0.71	
Highlands	0.77	0.79	0.81	0.84	0.84	0.82	0.80	0.80	
Hillsborough	0.94	0.92	0.92	0.92	0.91	0.93	0.92	0.92	
Manatee	0.92	0.94	0.97	0.98	0.99	0.99	0.99	1.0	
Polk	0.90	0.89	0.89	0.90	0.89	0.90	0.87	0.84	
Hardee	0.76	0.75	0.78	0.79	0.81	0.80	0.72	0.71	

Sources: BEBR, 1983.
BEBR, 1984.
ESE, 1984.

Per capita income in Hardee County, when compared to statewide statistics, is characteristic of other counties in the region. Per capita income in all six counties is less than the state average with the exception of Manatee County in 1982. The 1982 figures range from $7,779 in DeSoto County to $11,011 in Manatee County. Also similar to Hardee County trends is the tendency of three of the six regional counties to increase per capita income slower than statewide averages. Only Manatee and Highlands Counties increased the percentage of statewide income averages.

The agricultural sector is the largest source of earned income in Hardee County, followed by the government sector and retail trades. Total labor and proprietors' income in the farm sector for Hardee County during 1982 was $31,399,000. Non-farm income totalled $50,181,000. Government-related personal income totalled $13,717,000 (BEBR, 1984). The breakdown of 1982 private non-farm income indicates that retail trades contributed $9,015,000. Service industries provided $7,429,000 and manufacturing contributed $5,278,000.

10.1.1.3 EMPLOYMENT

The total 1983 labor force in the six-county region was 624,289 (Florida Department of Labor and Employment Security, 1985). As expected, Hillsborough County had the largest labor force (362,870 persons) and DeSoto the smallest (7,665 persons). The total number of regional labor force unemployed (1983 annual average) was 62,570 or 10.0 percent. County level unemployment rates ranged from a high of 15.6 percent for Polk County, to 7.6 percent for Manatee County. Hardee County's unemployment rate for 1983 was 12.3 percent (Florida Department of Labor and Employment Security, 1985).

Estimated 1982 monthly non-farm employment in Hardee County averaged 3,330 positions. Table 10.1.1-3 identifies the industries within which these positions were classified and compares these figures to region-wide totals. In terms of number of employed, services, wholesale

Table 10.1.1-3. Estimated Average Monthly Employment in Hardee County and the Region by Industrial Sector, 1982

Industrial Sector	Hardee County		Region	
	Number Employed	Percent of Total	Number Employed	Percent of Total
Agriculture, Forestry, and Fishing	2,223	40.0	33,643	6.7
Mining	*	--	*	--
Construction	93	1.7	33,329	6.6
Manufacturing	331	6.0	68,738	13.8
Transportation and Communication	149	2.7	31,953	6.4
Wholesale and Retail Trade	879	15.8	131,314	26.1
Finance, Insurance and Real Estate	213	3.8	31,051	6.2
Services	1,158	21.0	139,186	27.7
Government	349	6.3	27,530	5.5
Other	0	0	*	--
All Industries	5,553	100.0	502,708	100.0

* Low number not identified due to disclosure.

Sources: BEBR, 1983.
ESE, 1984.

and retail trades, and government are the largest non-farm employers in Hardee County. Over 71.6 percent of Hardee County's non-farm employed are located in these industrial classifications. For the region, these three classifications account for only 63.5 percent of total non-farm employment. The major classifications on a region-wide basis are wholesale and retail trade, and services.

Estimated 1980 average monthly agricultural employment of proprietors and wage and salary workers are developed by the U.S. Department of Commerce. The agency estimates 1,173 farm proprietors were located in Hardee County in 1980. In addition, approximately 911 average monthly wage and salary positions result from agricultural activity in the county. These wage and salary related positions account for 16.2 percent of all wage and salary employees in Hardee County.

10.1.1.4 PROJECTIONS

Using 1980 census information, BEBR annually projects future population growth for each county in the state. These projections, defined by BEBR in Florida Statistical Abstract, are based on three assumptions regarding annual net migration in Florida:

1. High projections are similar to the large migration levels of the first half of the 1970s when more people were migrating to Florida than ever before.
2. Medium assumptions imply annual net migration levels similar to the average growth in the 1970s.
3. Low migration levels are similar to small migration levels experienced during 1975 to 1977.

County projections are based on the ratio of each county's share of the total state increase in population from 1970 to 1980.

Table 10.1.1-4 identifies BEBR projections for the state, region, and Hardee County. Utilizing the medium growth projections identified by BEBR, it is estimated that Hardee County will grow in population from

Table 10.1.1-4. Population Projections for the State, Region, and Hardee County (Rounded to Hundreds)

	1982 Population Estimates	Population Projections 1985	1990	2000	2020
STATE	10,375.3				
Low		10,694.3	11,539.7	12,918.1	14,974.3
Medium		11,155.6	12,478.7	14,820.7	18,810.2
High		11,386.2	12,948.2	15,940.5	21,821.2
REGION					
DeSoto	20.2				
Low		20.2	21.0	21.4	18.6
Medium		21.5	23.9	28.2	35.8
High		22.8	26.8	35.0	53.0
Highlands	52.0				
Low		53.8	58.2	61.8	53.7
Medium		57.2	66.2	81.4	103.3
High		60.6	74.1	100.9	152.8
Hillsborough	677.7				
Low		688.6	722.5	769.1	790.2
Medium		717.3	785.4	915.6	1,162.1
High		745.9	848.2	1,062.1	1,533.9
Manatee	159.0				
Low		165.8	181.2	199.2	204.6
Medium		172.7	197.0	237.1	300.9
High		179.6	212.8	275.0	397.2
Polk	338.9				
Low		347.9	371.9	399.6	410.6
Medium		362.4	404.2	475.7	603.8
High		376.9	436.6	551.9	797.0
Hardee	20.0				
Low		19.6	19.4	18.7	16.2
Medium		20.8	22.0	24.6	31.2
High		22.1	24.6	30.5	46.2
REGION TOTAL	1,267.8				
Low		1,295.9	1,374.2	1,469.8	1,493.9
Medium		1,351.9	1,498.7	1,762.6	2,237.1
High		1,407.9	1,623.1	2,055.4	2,980.1
LOCAL					
Hardee	(See projections for Hardee County under regional description above.)				

Sources: BEBR, 1983.
ESE, 1984.

20,000 in 1982 to 24,600 in 2000. This represents a 23.0 percent increase. The growth rate is anticipated to remain similar between the years 2000 and 2020, when a 26.8 percent growth rate is expected. Growth for the region and the state from 1982 to 2000 is expected to occur at 39.0 and 42.8 percent levels, respectively--somewhat higher than population growth projections for Hardee County. With respect to other counties in the region, Hardee County's growth is also characterized as small, with 1982 to 2000 growth rates ranging from Hardee County's low of 23.0 percent to Highlands County's high of 56.5 percent.

Employment levels in Hardee County are expected to increase in the future as phosphate mining activities move south from Polk and eastern Hillsborough Counties. Agricultural activity will also remain an important factor in the local economy. Per capita income should continue to accelerate toward statewide averages as phosphate-related employment is characterized by higher than average county wages.

10.1.2 LAND USE

In general, land use throughout the six-county region varies from intense urban development (along the coastal areas of Hillsborough and Manatee Counties and the Interstate 4 corridor which traverses Hillsborough and Polk Counties), to sparsely populated range and agricultural land, forested uplands and wetlands throughout the remainder of the region. Hardee County land use is characteristic of the sparsely populated portions of the region.

10.1.2.1 LAND USE IN HARDEE COUNTY

Hardee County is predominantly rural, a characteristic of many of the interior counties of central and south Florida. Agriculture is the main economic activity in the county and land use statistics verify the importance of agriculture (see Table 10.1.2-1). According to an areawide Environmental Impact Statement prepared by the U.S.

Table 10.1.2-1. 1975 Generalized Land Use in Hardee County

Land Use Category	Area (Acres)	Percent of County
Urban or Built-Up		
Residential	3,507	0.87
Commercial and Services	293	0.07
Industrial	166	0.04
Transportation, Communications, and Utilities	566	0.14
Other Urban or Built-Up Areas	68	0.02
Agricultural Land		
Cropland and Pasture	102,971	25.54
Orchards, Groves, Vineyards, Nurseries, and Ornamental Horticultural Areas	69,120	17.14
Rangeland	144,723	35.89
Forest Land	11,299	2.80
Water	948	0.24
Wetland	69,412	17.22
Barren Land		
Strip Mines, Quarries, and Gravel Pits	--	--
Other Barren Land	128	0.03
COUNTY TOTAL	403,201	100.00

Sources: Texas Instruments, Inc., 1978.
ESE, 1982.

Environmental Protection Agency in 1978, only 1.1 percent of the county is classified as urban or built-up land.

Agriculture occupies 42.6 percent of the land area. This use includes cropland, pasture, orchards, groves, nurseries, etc. Major crops grown include cucumbers, beans, tomatoes, and watermelons. Grove land includes various types of citrus which occupy areas along Polk and Highland County borders and areas west of Wauchula and Bowling Green.

Rangeland and wetlands are additional major land use categories occupying significant portions of Hardee County. Rangeland occupies 35.9 percent of the county while wetlands occupy 17.2 percent. Both land uses are dispersed throughout the county.

Developed land use in Hardee County consists of approximately 4,600 acres of residential, commercial, industrial, and transportation development. Residential land use comprises 76.2 percent of the total developed land use and is located in what historically has been the growth corridor--an area encompassing U.S. 17 from Bowling Green to Zolfo Springs. Commercial and industrial development is also concentrated in the growth corridor but is primarily centered in the City of Wauchula. Other communities exist in Hardee County outside the growth corridor. With limited public facilities and services, they assist the growth corridor cities in supporting outlying agricultural areas. These small communities include Limestone, Ona, Fort Green Springs, Buchanan, Gardner, Sweetwater, and Lemon Grove.

Future land use patterns are expected to remain similar to present conditions. Anticipated growth during the 1980s is expected to generate the demand for less than 2,000 additional acres of urban or built-up land (Addley and Associates, 1980). For the most part, development is expected to occur within the existing growth corridor. Mined land will increase temporarily as phosphate mining operations shift south from their present centers in Polk and eastern Hillsborough Counties. In

general, this land use change will alter the extent of rangeland and pasture. In time, reclamation efforts will return this land to similar uses. Urban development, as well as mining activities, are regulated by Hardee County through zoning and mining ordinances and a Comprehensive Plan. Where appropriate, similar municipal authority is also exercised.

10.1.2.2 ON-SITE LAND USE

The proposed mine site consists of approximately 14,994 acres in northwest Hardee County. More specifically, the site is situated south of State Road (SR) 62 and adjacent to the community of Fort Green Springs. The site occupies an area approximately 10.0 miles by 2.5 miles, is bisected by a Seaboard Systems Railroad (SSR) corridor, and is situated generally northwest of Wauchula.

Figure 9.1-1, identifies the existing land uses on-site, utilizing the Florida Land Use Cover and Classification System. The site consists primarily of rangeland, wetlands, and forested upland (see Table 10.1.2-2). Several tributaries and creeks exist on the proposed site; however, only Horse Creek flows through the proposed site. Intensive agricultural activities occur on 1,312.9 acres on-site (8.8 percent), all but 59.8 acres are utilized as improved pasture. The remaining intensive agricultural areas are seasonally cultivated in millet (44.1 acres) to establish a grain crop for local game birds such as doves and quail, or in row crops (13.1 acres), or citrus grove (2.6 acres). At other times of the year, these lands are used for grazing cattle. Cattle also utilize the rangeland and forested upland areas.

The majority of the site has been disturbed by logging, fire, draining, and other agricultural practices.

Cultural features which presently exist on-site are identified in Figure 10.1-1. Seven archaeological resource sites were identified by a

Table 10.1.2-2. Present On-Site Land Use

Land Use Type	FLUCCS* Designation	Acreage	Percent of Total Acreage
Agriculture	212 and 213	1,312.9	8.8
Rangeland	321	7,014.4	46.8
Forested Upland	411 and 422	3,068.7	20.5
Wetlands	621 and 641	3,580.0	23.9
TOTAL	---	14,994.0	100.0

*Florida Land Use and Cover Classification System

Source: ESE, 1984.

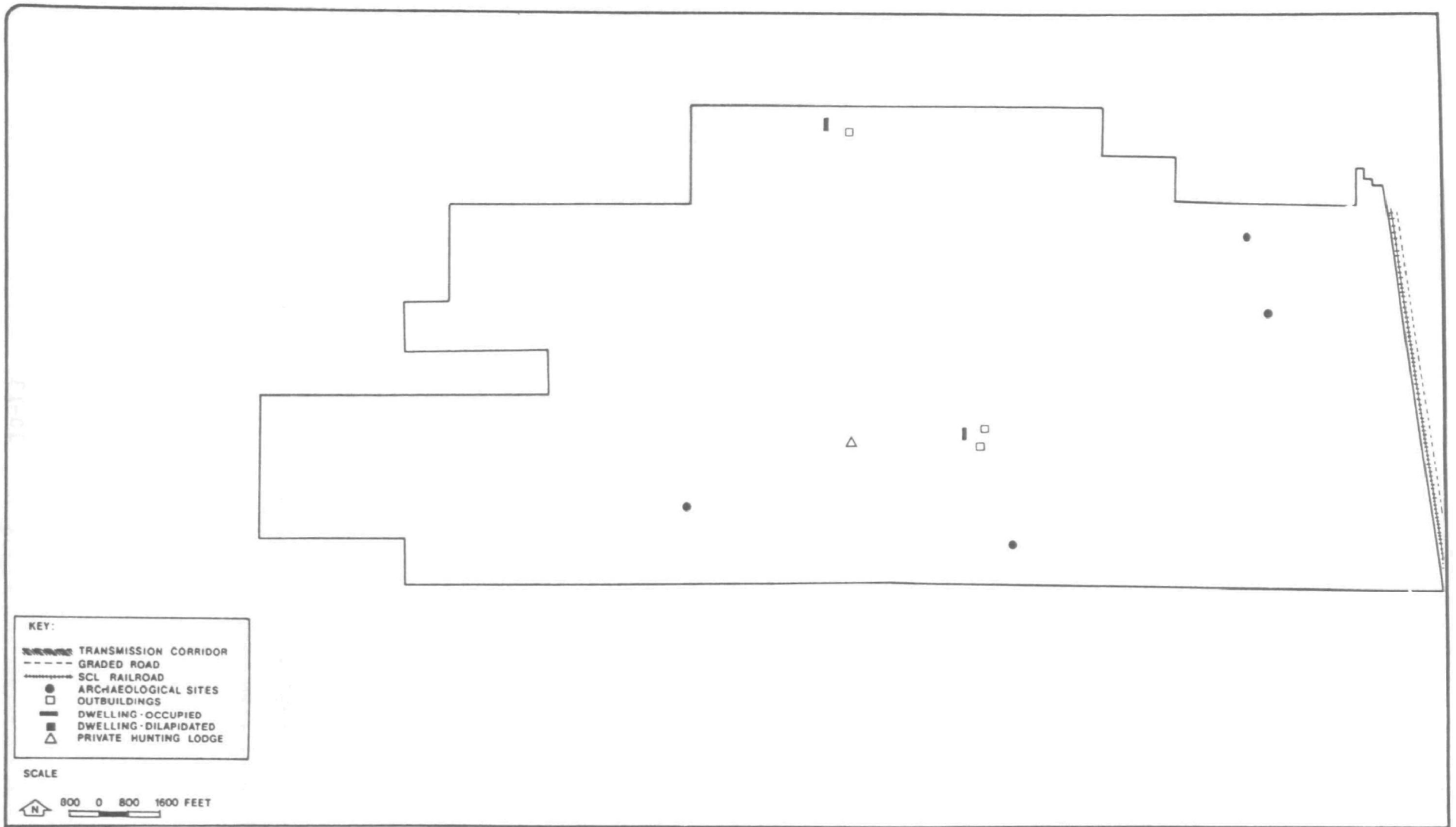
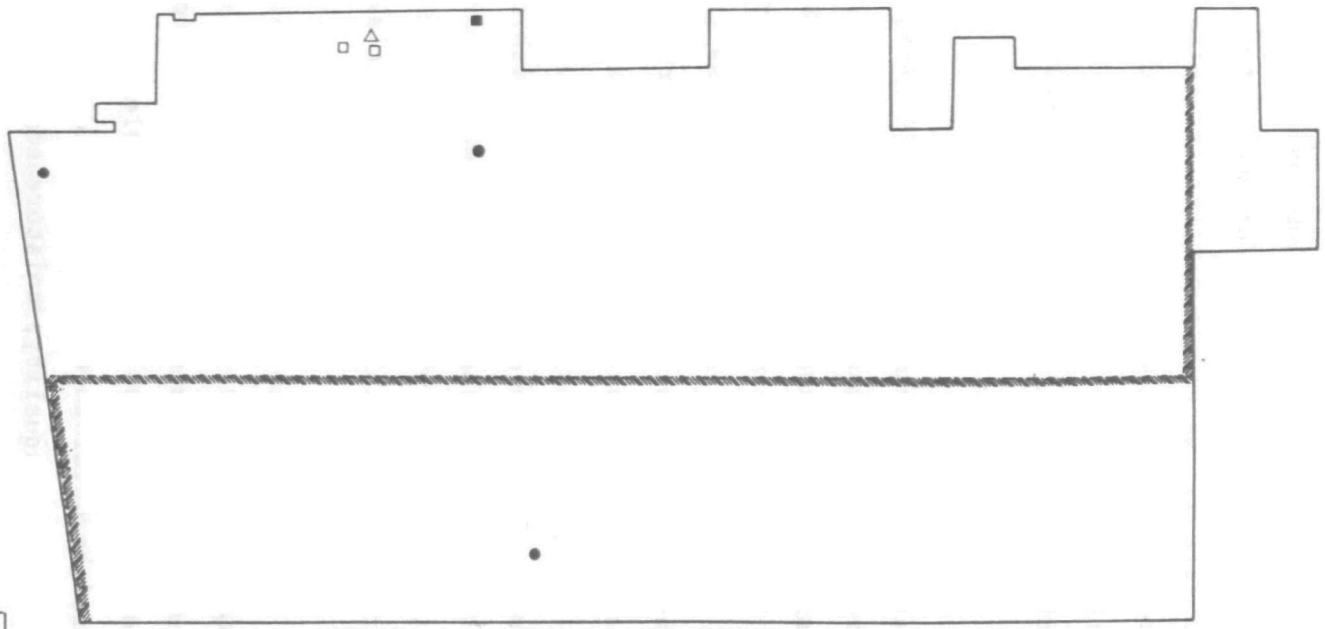


Figure 10.1-1
ON-SITE CULTURAL FEATURES-WESTERN PORTION
(PAGE 1 OF 2)

SOURCE: ESE, 1982

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
South Pasture Mine Site



KEY:

- TRANSMISSION CORRIDOR
- GRADED ROAD
- SCL RAILROAD
- ARCHAEOLOGICAL SITES
- OUTBUILDINGS
- DWELLING - OCCUPIED
- DWELLING - DILAPIDATED
- PRIVATE HUNTING LODGE

SCALE

N 800 0 800 1600 FEET

Figure 10.1-1
ON-SITE CULTURAL FEATURES-EASTERN PORTION
(PAGE 2 OF 2)

SOURCE: ESE, 1982

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
South Pasture Mine Site

cultural resource survey conducted on the property in 1976. Details of each site are provided in Section 10.1.6.

One occupied mobile home is located on the western portion of the site. In addition to the mobile home, one house is situated on the property; and is used as the Central Florida Hunt Club clubhouse. Other on-site structures include five outbuildings utilized for agricultural activities (barns, sheds, etc.). An electric power transmission corridor traverses the eastern portion of the site in an east-west direction and turns south, adjacent to the SSR railroad corridor and Fort Green-Ona Road which bisects the property in a northwest-southeast direction.

Adjacent land uses are in large part similar to on-site uses, with rangeland and agricultural land predominating. Citrus groves are located in several areas adjacent to the site along SR 62. Developed land is also present in Fort Green Springs which consists of residences, church, restaurant, and a combination convenience store/gas station. The developed area in and around Wauchula is situated approximately two miles southeast of the southeast corner of the proposed site.

Zoning throughout the proposed site is designated M-1, which permits phosphate mining activities. Most adjacent areas are zoned A-1 for agricultural activities. Small areas within the community of Fort Green Springs are zoned commercial, industrial, and farm residential to denote existing developed land uses.

10.1.2.3 PRIME AND UNIQUE FARMLAND

Prime farmland is land which is best utilized for production of food, feed, forage, fiber, and oil seed crops and is available for these uses because it is not occupied by development such as buildings or highways. Prime farmland possesses the soil quality, moisture content, and growing season necessary to produce economically sustained high-yield crops when this land is treated and managed according to modern farming practices.

Unique farmland is land other than prime farmland which is utilized for the production of specific high-value food and fiber crops.

The U.S. Soil Conservation Service (SCS) recently completed a soil survey of Hardee County which delineated the extent of soil series in the county, including the proposed mine site. In addition, the SCS has identified prime and unique soils in Hardee County. Nineteen soils are considered unique by the Hardee County SCS office. The SCS does not consider any soil in the county as prime farmland soil (SCS, 1980).

The proposed site consists of approximately 75 percent unique soils. These soils are distributed throughout the site but are not utilized for crop production at this time. The entire project site is under lease to a local rancher/farmer with specific plans to develop a farming operation in the well-drained unimproved areas of the site. Adjacent areas and many other areas throughout Hardee County contain a similar proportion of unique farmland.

10.1.3 TRANSPORTATION

The existing transportation network in the six-county region consists of state highways, local roads, railroads, airports, and seaports. Hardee County transportation facilities consist of state highways, local roads, an SSR railroad line, and Wauchula Municipal Airport (see Figure 10.1-2).

10.1.3.1 HIGHWAY TRANSPORTATION

State highways in the region include the primary arterial highways as well as the interstate highway system. U.S. 17 is the major north-south corridor in Hardee County and directly connects each of the three municipalities in the county, as well as several smaller outlying communities. U.S. 17 is primarily a two-lane, undivided highway. The highest annual average daily traffic (AADT) volumes in the county occur on this roadway in Wauchula where portions of the road are four-laned and traffic volumes reach 11,279 vehicles per day. Table 10.1.3-1 identifies existing traffic volumes for U.S. 17, as well as SR 62 and SR 64.

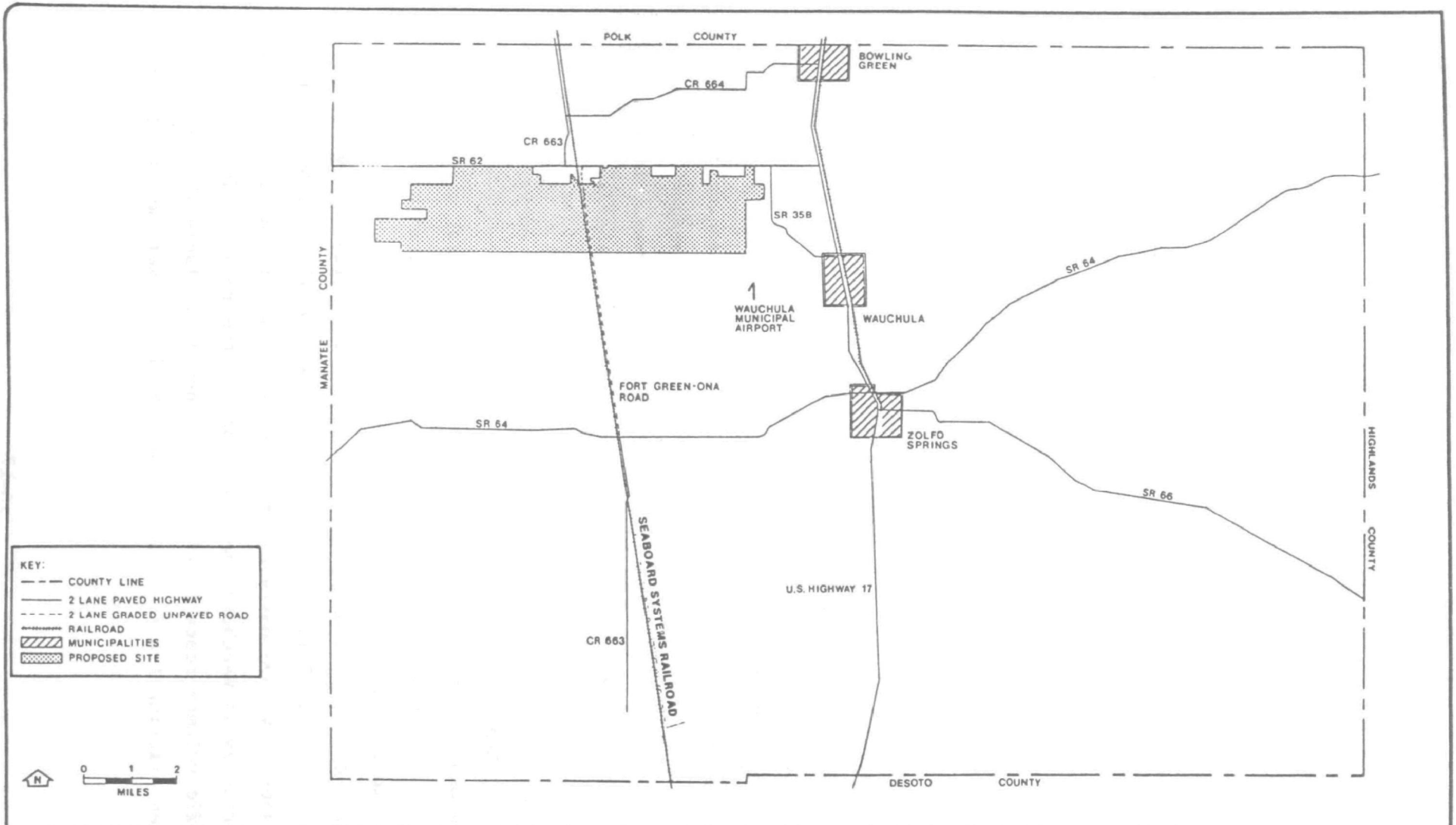


Figure 10.1-2
TRANSPORTATION FACILITIES IN HARDEE COUNTY

Source: FDOT, 1975.

U.S. Environmental Protection Agency, Region IV
Draft Environmental Impact Statement

CF INDUSTRIES
South Pasture Mine Site

Table 10.1.3-1. Annual Average Daily Traffic Counts for Points on Major Highways in Hardee County, 1983 and 1984

Road	Station Location	AADT 1983	AADT 1984
U.S. 17	Bowling Green Southern City Limit	7,046	8,080
U.S. 17	Wauchula Northern City Limit	8,022	9,943
U.S. 17	Wauchula Southern City Limit	10,852	11,279
U.S. 17	Zolfo Springs Southern City Limit	5,343	5,116
U.S. 17	One Mile North of DeSoto County Line	4,153	4,163
SR 64	West of SR 665	1,503	1,277
SR 64	West of Ona	1,610	1,517
SR 64	East of Ona	1,902	1,914
SR 64	West of U.S. 17	2,919	2,723
SR 62	West of SR 37	1,698	1,986
SR 62	East of SR 37	1,371	1,450
SR 62	East of CR 663	1,663	1,485
SR 62	West of U.S. 17	1,700	1,652

Sources: Florida Department of Transportation, 1984.
ESE, 1984.

SR 62 is an east-west, two-lane, undivided, rural minor arterial highway connecting U.S. 301 with U.S. 17 between Bowling Green and Wauchula. The highway travels through Fort Green Springs and portions of the road serve as the northern boundary of the proposed mine site.

SR 64 and SR 66 are also east-west, two-lane, undivided, rural minor arterial highways. SR 64 traverses central Manatee and Hardee Counties and connects Bradenton to Zolfo Springs. The highway continues to Avon Park in Highlands County. SR 66 extends from Zolfo Springs to U.S. 27 and U.S. 98, south of Sebring in Highlands County.

Roads in proximity to the proposed mine site include the previously described SR 62, as well as CR 663, CR 664, CR 35B, and Fort Green-Ona Road (a graded, unpaved road maintained by the county). As previously stated, portions of SR 62 serve as the northern boundary of the proposed mine site. CR 663 and CR 664 connect Bowling Green with Fort Green and Fort Green Springs. The road terminates at SR 62; however, 0.3 miles east of this intersection, the Fort Green-Ona Road continues in a north-south orientation, bisecting the proposed mine site and connecting SR 62 with SR 64. CR 663 continues south of SR 64. CR 35B is situated near the east boundary of the proposed mine site and provides local access to areas west of Wauchula and south of SR 62.

Highway transportation is limited, for the most part, to private vehicles. Public transportation in Hardee County is available only in Wauchula, which is serviced by Trailways Bus System.

10.1.3.2 RAIL TRANSPORTATION

The railroad network in the six-county region is extensively developed, a partial result of the demands placed on the system by the phosphate industry in west-central Florida. Seaboard Systems Railroad Company (SSR) owns and operates approximately 480 miles of rail lines in the region, including two active lines: one paralleling U.S. 17 in Hardee County and one bisecting the proposed mine site (see Figure 10.1-2).

Major switch yards are located in Mulberry, Lakeland, and Tampa. These switch yards connect the major municipalities and phosphate mines in the region with the ports in Tampa and Port Manatee.

10.1.3.3 WATER TRANSPORTATION

Port facilities in the region consist of ports on Tampa Bay. All but Port Manatee are located in Hillsborough County. Tonnage handled by ports in Tampa totalled 43,597,171 in 1983, while Port Manatee handled 5,744,331 tons in fiscal 1982-1983. Approximately 3,868 and 1,050 vessels entered ports in Tampa and Port Manatee, respectively, in 1983 (Tampa Port Authority, 1984; and Port Manatee Tonnage Report, 1983).

10.1.3.4 AIR TRANSPORTATION

Several commercial and numerous general aviation facilities are located in the region, primarily along the highly populated coastal areas of Manatee and Hillsborough Counties. The only public facility in Hardee County is Wauchula Municipal Airport, located 5 miles west of Wauchula on Vandolah Road. The facility consists of 3,450- and 2,200-foot turf runways, hangars, and tie-downs (FAA, 1984).

10.1.4 COMMUNITY SERVICES AND FACILITIES

The extent of community services and facilities descriptions is limited to Hardee County except for housing. A regional description of housing is provided due to the extent of commuting patterns in the region.

10.1.4.1 HOUSING

Table 10.1.4-1 presents structural, occupancy, and financial characteristics of the housing stock in Hardee County and other counties in the region during 1980. The majority of dwelling units within all regional counties are owner-occupied units. Within each county there were approximately two to three times more owner-occupied units than renter-occupied units. This ratio is greatest (3:1) in Highlands and Hardee Counties (U.S. Bureau of the Census, 1980).

Table 10.1.4-1. Housing Characteristics For Year-Round Housing Stock in the Region

	Counties in the Region					
	Hardee	DeSoto	Highlands	Hillsborough	Manatee	Polk
Owner-Occupied						
Total Units	4,716	4,716	4,689	159,104	46,054	80,568
Lacking Plumbing For Exclusive Use†	49	49	56	572	146	445
Median Value ($)	25,900	25,900	27,700	37,400	45,200	36,000
Vacancy Rate (%)	3.1	3.1	1.2	2.2	2.7	1.9
Renter-Occupied						
Total Units	1,537	1,537	1,567	78,839	15,944	33,826
Lacking Plumbing For Exclusive Use†	64	64	96	1,144	245	893
Median Contract Value ($)	129	129	123	188	211	160
Vacancy Rate (%)	10.2	10.2	10.1	8.8	17.9	11.4
Total Housing Units*						
Total Units	6,964	6,964	7,297	260,391	82,680	126,579
Median Rooms	5.1	5.1	4.8	5.0	4.5	5.0
Percent Lacking Plumbing†	2.1	2.1	2.8	0.9	0.8	1.3
Persons Per Housing Unit	2.78	2.78	2.61	2.48	1.80	2.54
Percent Change 1970 to 1980	47.1	47.1	82.1	56.4	95.1	66.0

* Includes year-round housing units only.
† Includes hot and cold piped water, a flush toilet, and a bathtub or shower.

Sources: U.S. Bureau of the Census, 1980.
ESE, 1982.

Housing growth since 1970 in the counties within the region can be examined by referring to the volume of building permit activity. Table 10.1.4-2 presents the number of dwelling units authorized in single unit and multi-unit structures for the years 1973 to 1982. Not all units authorized by building permits may have been constructed, but the data indicates relative housing growth. In most cases the figures reflect the building boom of 1973 and early 1974 and the subsequent slump in 1975, as well as the apparent decrease in building activity in 1980-1982.

A review of real property tags sold to owners of mobile homes is used to establish trends in year-round mobile home activity. These tags are required for mobile home owners who own the land on which the mobile home is located. Mobile home real property tags are reported on a fiscal year basis from July 1 to June 30. Records from fiscal years 1976 through 1980 indicate less mobile home activity in Hardee County than in the other counties of the region, with the greatest activity in Polk County.

10.1.4.2 SCHOOLS

Hardee County is served by one school district (Table 10.1.4-3). Each of the three municipalities in the county contains elementary schools which supervise grades K through 5. Students at the grade 6 level and all junior and senior high school students are transported to educational facilities in Wauchula. As of January 1984, two of four elementary schools within the county operate above capacity. Prior to the opening of a new senior high school in 1981, this was also the case at the grade 7 through 12 level. The new senior high school has relieved the over-enrollment problems at the junior and senior high level.

10.1.4.3 FIRE PROTECTION

Fire protection is provided in Hardee County by the Wauchula Fire Department, several volunteer fire departments, and the Division of

Table 10.1.4-2. Building Permit Activity, Number of New Housing Units Authorized

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1973 to 1982 (Total)
Hardee											
Single Family	46	225	153	105	111	90	90	114	132	94	1,164
Multi-Family	2	6	8	0	73	26	20	21	22	6	184
DeSoto											
Single Family	84	199	100	77	97	114	173	160	64	58	1,126
Multi-Family	2	32	5	9	40	12	6	17	24	4	151
Highlands											
Single Family	779	565	450	615	680	759	857	732	676	450	6,563
Multi-Family	271	160	54	127	343	287	337	512	329	245	2,665
Hillsborough											
Single Family	4,696	3,362	2,409	3,643	5,115	5,952	6,635	5,136	4,213	4,359	45,520
Multi-Family	10,359	2,447	856	533	1,083	2,752	1,715	3,679	4,089	3,280	30,793
Manatee											
Single Family	1,452	831	554	853	1,245	1,596	1,920	1,135	841	845	11,272
Multi-Family	4,154	1,799	203	606	1,424	2,419	3,022	3,001	2,284	988	19,000
Polk											
Single Family	2,537	1,604	1,733	2,233	2,825	2,679	2,552	2,565	1,552	1,201	21,481
Multi-Family	4,328	609	222	376	694	1,015	1,336	1,660	1,201	1,100	12,541

Sources: BEBR, 1974-1983.
ESE, 1984.

Table 10.1.4-3. Hardee County School District--Selected Characteristics

Schools	Grades Supervised	Estimated Capacity	1/84 Enrollment	Excess Enrollment	Excess Capacity
High Schools					
Hardee Senior High	9-12	850	675	—	175
Middle Schools					
Hardee Junior High	7-9	1,400	1,116	—	284
Elementary Schools					
Bowling Green Elementary	K-5	550	526	—	24
North Wauchula Elementary	K-3	800	765	—	35
Wauchula Elementary	4-6	750	821	71	—
Zolfo Springs Elementary	K-5	600	615	15	—

Source: Hardee County School Board, 1984.

Forestry. The Wauchula Fire Department station is located in Wauchula and is equipped with three pumpers, one tanker, one rescue vehicle, and several support vehicles. The department maintains 11 full-time paid employees and has approximately 15 volunteer personnel (City of Wauchula Fire Department, 1985). Several volunteer stations are located in Hardee County with a major station in Zolfo Springs which is equipped with two pumpers and one tank truck and has approximately 10 volunteer personnel, the other in Bowling Green is equipped with two pumpers, 1 brush truck, and a support vehicle. (City of Wauchula Fire Department, 1985). The Division of Forestry maintains brush firefighting equipment for non-structural fires in Hardee County as well as other counties in the region.

10.1.4.4 POLICE PROTECTION

The Hardee County Sheriff's Department serves all unincorporated areas in the county and has a staff of 49 persons, including 14 patrolmen, 6 investigators, and an auxiliary posse of 14 persons and 10 part-time deputies. During the daytime shift, 2 patrolmen are on duty, 3 are on duty in the evening, and 2 patrolman works the midnight patrol. The additional patrolmen are on duty during weekends.

The county owns 15 marked patrol cars and a single 4-wheel drive vehicle. The latter is used primarily by the agricultural investigator, whose major function is to work with local ranchers on cattle-rustling problems. For the administrative staff, 4 unmarked cars are leased. Detention facilities consist of a jail designed for a maximum of 32 persons; however, facilities are being expanded. Historically, the average inmate population has been about 50 persons (Hardee County Sheriff's Department, 1985).

10.1.4.5 HEALTH SERVICES

The only hospital facility in Hardee County is Hardee Memorial Hospital. Located in Wauchula, this facility was opened in June 1970 and has 50 licensed beds and over 100 full-time employees. Emergency and

postoperative recovery are among the medical services provided (Hardee Memorial Hospital, 1986).

Hardee County is below the federal standard of 4.0 hospital beds per 1,000 persons--a standard which has also been adopted by the regional authority (South Central Florida Health Systems Council, 1982). However, the relatively low utilization (50.0 percent) of existing hospital beds in this county suggests that at present there is no real demand for additional facilities (Hardee Memorial Hospital, 1986).

Hardee County also has a lack of nursing home facilities. Federal and regional regulatory agencies have recommended 27 nursing home beds per 1,000 persons aged 65 and over. Hardee County presently has one nursing home employing approximately 20 persons.

The South Florida Health Systems Council periodically surveys the active physicians in its region and, based on a ratio of one physician per 2,000 persons, determines the sufficiency of medical practitioners in this region. For 1984, the University of Florida Bureau of Economic and Business Research records indicate that there are 10 active physicians in Hardee County, which creates a physician-to-person ratio similar to the standard set by the South Central Florida Health Systems Council.

10.1.4.6 RECREATION

Recreational facilities in Hardee County include approximately 10 local recreational parks located in or adjacent to the county's municipalities, one State Fish and Wildlife Management Area, portions of a state park, and a portion of a state canoe trail. Located on the Peace River, Pioneer Park in Zolfo Springs is a Florida Fish and Wildlife Management Area. Facilities at the park include camping, picnicking, canoeing, fishing, nature trails, and an outdoor zoo. Approximately 280 acres of the Highlands Hammock State Park are located in eastern Hardee County, with the remainder of the park's 3,800 acres lying in adjacent Highlands County. This park's principal attraction is its

extensive system of nature trails, including the popular "Catwalk Trail," a boarded walkway through a cypress swamp. Other facilities include campsites, picnic tables, fishing areas, and museum exhibits. The Peace River Canoe Trail traverses the entire width of Hardee County from north to south. Also located in Hardee County is the Payne's Creek Historical Site, a 341-acre state special-feature site.

10.1.4.7 PUBLIC UTILITIES

In Hardee County, the incorporated municipalities of Bowling Green, Wauchula, and Zolfo Springs provide potable water to their residents and households situated just outside their corporate boundaries. Bowling Green derives its water from 4 wells capable of producing 2,000,000 gallons per day (GPD). Currently, average consumption is 370,000 GPD which is less than 20 percent of capacity. This water system also includes emergency capacity of 225,000 gallons (Bowling Green Superintendent of Water and Sewer, 1982).

Wauchula also has a well field of 4 deep wells which at maximum capacity would provide 3 MGD; however, present demand is 1 MGD. A 100,000-gallon reservoir is located on the east side of the municipality at the water treatment plant. Additional water storage is provided by 2 water towers capable of holding 200,000 and 100,000 gallons, respectively (Wauchula Superintendent of Water and Sewer, 1982).

Zolfo Springs utilizes 2 deep wells to provide its service area with a 4,500,000 GPD capacity. Currently this system operates at approximately 67 percent of capacity. A reservoir which contains 210,000 gallons supplies emergency capacity for this system (Zolfo Springs Superintendent of Water and Sewer, 1982).

Due to capacity and extent of distribution networks, there are no plans by any of these municipalities to expand their potable water service areas. Households residing outside of service areas depend upon individual wells for water supply.

Wastewater treatment is not available in most of Hardee County. The municipalities of Bowling Green and Wauchula provide wastewater treatment for households situated in their own wastewater service areas; Bowling Green's wastewater treatment plant has a licensed capacity of 200,000 GPD.

Wauchula currently treats an average 500,000 gallons per day (GPD) of wastewater, which is 50 percent of its capacity. Secondary level treatment is provided by a plant located east of downtown Wauchula. Households located in the southern half of Hardee County are not serviced by a wastewater network. The more remote, sparsely populated areas rely upon individual private treatment systems.

Hardee County has one Class I landfill, located approximately 3 miles to the northeast of the City of Wauchula. This landfill occupies 97.5 acres and has a life expectancy of 20 years. All refuse collected in Hardee County and its three municipalities is disposed of in this landfill. Residents are charged for disposal on their annual tax bills. Before the opening of the new landfill in January 1984, Hardee County had three landfills which were located outside of the city limits of the three municipalities and are now closed (Hardee County Engineering Department, 1984).

Electric power is provided throughout the county by Florida Power Corporation (FPC), the City of Wauchula, and the Peace River Electric Cooperative. Headquartered in Wauchula, the Peace River Electric Cooperative does not have its own generating facility. It does, however, own and maintain a distribution network, which provides electricity primarily to rural customers in 10 Florida counties including Hardee County. The City of Wauchula provides electricity for the area in and around Wauchula. WPC maintains 6 electric generators to share peak-hour demands on occasion and purchases power from FPC. It provides electricity to residential and commercial users.

There are no natural gas distributors or pipelines in Hardee County, but liquid petroleum is available from distributors serving the area. Telephone service is provided by United Telephone Company throughout the county.

10.1.5 PUBLIC FINANCE

Revenue sources and expenditures for counties in the region and municipalities within Hardee County are summarized in Tables 10.1.5-1 and 10.1.5-2. In general, property taxes, intergovernmental transfers, and charges for services are the major revenue sources for county governments. Together these sources contribute from 63.9 to 84.7 percent of total county revenues. In 1982-1983, rural counties (Hardee, DeSoto, and Highlands) relied on taxes, transfers, and service charges for an average of 81.9 percent of county revenues, while the urban counties (Hillsborough, Polk, and Manatee) relied on these sources for 71.0 percent of total revenues. Municipal revenues are generated primarily from internal revenue, charges for services, and other financing sources (see Table 10.1.5-2).

Hardee County's assessed property values have decreased in the past few years as have property tax revenues (Florida Department of Banking and Finance, 1981, 1983). The county-wide millage rate fluctuated during the past seven years and is lower than the mid-1970's (see Table 10.1.5-3).

Major expenditures for counties in the region are variable, depending upon the urban or rural nature of the particular county. The three urban counties (Hillsborough, Polk, and Manatee) expend large portions of revenue for human services and public safety. The rural counties (Hardee, DeSoto, and Highlands) expend revenues for transportation, public safety, and general governmental services. Hardee County expended over $1,500,000 for each of these expenditure categories, representing 81.2 percent of all expenditures in fiscal year 1982-1983.

Table 10.1.5-1. Revenues and Expeditures of County Governments in Region—Fiscal Year 1982-1983

	Hardee	DeSoto	Highlands	Hillsborough	Manatee	Polk
Revenues						
-Property Taxes	2,064,722	2,517,048	6,845,316	91,157,497	27,304,629	28,251,854
-Licenses & Permits	99,917	75,293	277,731	3,353,791	968,664	1,398,626
-Intergovernmental Revenue	2,499,766	2,203,148	3,735,811	63,735,591	12,929,177	45,840,843
-Charges for Services	1,523,947	280,110	1,424,086	44,489,170	68,682,099	18,757,431
-Fines and Forfeitures	170,709	150,950	288,015	1,836,814	934,250	1,661,813
-Miscellaneous	166,277	176,142	1,778,906	33,549,567	16,070,398	10,273,964
-Other Financing Sources	731,000	501,265	685,043	19,363,623	35,551,925	39,170,272
TOTAL	7,256,338	5,903,956	15,034,908	257,486,053	162,441,142	145,354,803
Expenditures						
-General Governmental Services	1,477,100	1,594,757	4,229,212	48,500,168	14,903,462	19,477,268
-Public Safety	2,572,031	1,590,740	4,253,005	55,134,732	16,847,205	21,273,719
-Physical Environment	607,409	68,076	553,713	26,379,965	21,011,538	4,019,288
-Transportation	1,940,040	1,563,271	4,128,410	27,568,628	12,791,321	9,321,820
-Economic Environment	18,427	8,862	46,775	8,878,848	878,456	3,812,944
-Human Services	459,346	259,855	933,855	30,370,439	45,366,688	20,951,280
-Culture/Recreation	123,260	36,984	32,847	13,351,905	4,183,913	623,818
-Debt Service	3,854	233,684	428,699	6,194,645	9,499,610	2,240,483
-Other Financing uses	176,000	501,265	52,187	36,195,333	39,129,763	25,870,110
TOTAL	7,377,467	5,857,494	14,658,703	252,574,663	164,611,956	107,590,730
Revenues Less Expenditures	(121,129)*	46,462	376,205	4,911,390	(2,170,814)	37,764,073

* Parentheses indicate expenditures exceeded revenues.

Source: Florida Department of Banking and Finance, 1981.

Table 10.1.5-2. Revenues and Expeditures of Municipal Governments in Hardee County--Fiscal Year 1982-1983

	Bowling Green	Wauchula	Zolfo Springs
Revenues			
-Property Taxes	$124,067	$ 224,755	$ 77,774
-Licenses & Permits	1,707	11,917	1,651
-Intergovernmental Revenue	217,630	195,705	142,908
-Charges for Services	217,970	3,994,352	86,505
-Fines and Forfeitures	15,017	28,030	10,952
-Miscellaneous	33,210	149,914	34,942
-Other Financing Sources	1,600	499,169	57,822
TOTAL	$611,201	$5,103,842	$412,554
Expenditures			
-General Governmental Services	92,829	241,316	76,216
-Public Safety	145,658	442,858	108,979
-Physical Environment	238,178	3,428,757	128,229
-Transportation	56,191	52,972	0
-Economic Environment	0	0	0
-Human Services	0	0	0
-Culture/Recreation	16,636	20,014	14,332
-Debt Service	36,887	251,923	23,692
-Other Financing Uses	17,390	661,741	70,815
TOTAL	603,769	5,099,581	422,263
Revenues Less Expenditures	(7,342)*	(4,261)	9,709

*Parentheses indicate expenditures exceeded revenues.

Sources: Florida Department of Banking and Finance, 1984.
ESE, 1984.

Table 10.1.5-3. Millage Rates for Hardee County and Municipalities

Category	Year						
	1978	1979	1980	1981	1982	1983	1984
County-Wide							
Board of County Commissioners	3.696	3.248	4.463	4.573	4.130	3.409	3.704
Board of Public Instruction	6.900	6.900	5.556	5.226	4.636	5.406	5.404
SWFWMD	0.100	0.080	0.900	0.050	0.070	0.260	0.200
Peace River Basin	0.190	0.170	0.240	0.140	0.170	—	0.210
County-Wide TOTAL	10.886	10.398	11.159	9.275	9.006	9.075	9.518
Municipal							
Wauchula	2.200	2.200	3.313	3.312	4.480	4.990	3.071
Bowling Green	7.248	6.031	6.487	6.656	4.864	4.990	4.920
Zolfo Springs	4.294	4.292	4.129	3.837	2.535	3.980	2.589

Sources: Hardee County Tax Assessor, 1984.
ESE, 1984.

Municipal government expenditures were for public works activities such as water, sewer, and solid waste services, and other miscellaneous financing uses.

For the fiscal year 1982-1983, Hardee and Manatee Counties incurred expenditures greater than revenues earned. The remaining counties had revenue surpluses. Bowling Green and Wauchula experienced revenue shortages in 1982-1983.

10.1.6 CULTURAL RESOURCES

10.1.6.1 OVERVIEW

Hardee County is located between two discrete and well-defined culture regions. One region, the coastal portion of Manatee and Sarasota Counties, was the southern extent of the various cultures which inhabited the peninsular Florida Central Gulf Coast from about 2000 B.C. to the historic period. The other region, to the southeast, is the Belle Glade culture region, centered in the Lake Okeechobee Basin, but extending an unknown distance northward up the Kissimmee River drainage and west along the Caloosahatchee River (Sears, 1974). The latter region was occupied intensively from about 500 B.C. into the historic period. Hardee County, as well as the coastal strand and Lake Okeechobee Basin, contains Archaic sites dating back at least to 5000 B.C. Paleo-Indian materials dated to 8000 B.C. have also been found in the county and both regions.

Because of the relative sparseness of its habitats after about 2000 B.C., Hardee County served as a buffer zone between the Gulf coastal cultures and the cultures of the Lake Okeechobee Basin. Previous to that time, the county and both regions were occupied only sporadically by small populations of nomadic Paleo-Indian and Archaic hunters. At no time during the prehistoric period was the Hardee County area an important culture area.

The period of white and historic Seminole occupation of Hardee County began just previous to the mid-nineteenth century. By a treaty negotiated in 1839 with the Seminole Indians, certain populations of Seminoles agreed to move east and south of the Peace River, leaving Hardee County open to settlement (Mahon, 1967). The year after the Seminole war ended (1843), preliminary surveys of what is now the county were begun and gradually a few settlers moved into the region. However, by 1850 fewer than 12 families lived in what is now Hardee County (Plowden, 1929).

Fort Green, a non-military fortified homestead, was built between 1854 and 1856 by James Green (Plowden, 1929). The log structure was located west of present-day Fort Green Springs, most likely just north of SR 62 in the southeast 1/4 of the southeast 1/4 of the northeast 1/4 of Section 22.

Other forts in present-day Hardee County included Fort Choconicla, established October 26, 1849, next to a trading post at the confluence of Payne Creek and the Peace River, and Fort Hartstuff, built in 1851, 2 miles southwest of the present location of Wauchula, forming the center near which the town later grew.

In the 1880s, a railroad was built, tying eastern present-day Hardee County to northern Florida. By the 1890s, several small towns sprang up and, by 1900, large-scale cultivation of vegetables and citrus began near the Peace River. In 1912, the Charlotte Harbor and Northern Railroad was built through the proposed mine property. This is the present-day Seaboard Systems Railroad which bisects the proposed mine site.

In the 1920s, Hardee County participated in the south Florida economic boom. Vegetables, citrus, and hogs were exported north along the railroads. Cattle also became an important export. Modern Hardee County was founded in 1921.

10.1.6.2 ON-SITE RESOURCES

A cultural resource survey of the proposed mine site was conducted in 1976 (University of South Florida, Department of Anthropology, 1976). The survey revealed 7 sites which contained archaeologic resources (see Figure 10.1-1 for locations). Descriptions of the 7 sites are as follows:

Brushy Creek Site (8-Hr-8)
Location: NE 1/4 of NE 1/4 of SW 1/4 of S34, T33S, R23E

The Brushy Creek Site is aboriginal and contains lithic scatter. Subsurface deposits were not intact; materials collected include white chert projectile point, chert flakes, and chert waste flakes.

Stuart Site (8-Hr-9)
Location: NW 1/4 of SW 1/4 of SW 1/4 of S36, T33S, R23E

The Stuart site contains extensive lithic scatter (aboriginal site). Materials collected include projectile points and fragments, scrapers and fragments, blades, knives, cones, retouched flakes, waste flakes, and drill.

Cowboy Mound Site (8-Hr-15)
Location: NW 1/4 of NW 1/4 of NW 1/4 of S17, T33S, R24E

Cowboy Mound Site is an artificial mound of unknown use. The unaltered mound contains ceramics (pottery) and worked flint tools.

Welch Mound Site (8-Hr-16)
Location: SW 1/4 of NE 1/4 of SW 1/4 of S34, T33S, R24E

Welch Mound site is also an artificial mound of unknown use. Ceramics and flint materials were found in context.

Ona Road Mound Site (8-Hr-17)
Location: SW 1/4 of NE 1/4 of NW 1/4 of Section 29, T33S, R24E

Ona Road Mound Site is an artificial mound of undetermined use. Only one flint blade and one projectile point were recovered in limited testing.

Bretan Mound Site (8-Hr-18)
Location: SW 1/4 of NE 1/4 of NW 1/4 of S30, T33S, R24E

Bretan Mound site is an artificial mound. One flint chip was recovered during limited testing.

Little Mound Site (8-Hr-19)
Location: NE 1/4 of NE 1/4 of SW 1/4 of S30, T33S, R24E

Little Mound Site is an artificial mound, containing flint chips and pottery sherds throughout.

10.1.7 VISUAL RESOURCES

The visual resources in the area of the proposed mine site can be identified through a description of the physical environment. Human perception of this particular environment is then estimated, utilizing typical view points, distances between viewer and object, frequency and duration of view, and special use area views.

The existing topography of the proposed mine site is nearly flat to slightly rolling. Several creeks traverse the property, creating variations in relief. Vegetation characteristics also vary, breaking the landscape into segmented parts. Irregular-shaped clusters and bands of trees are interspersed throughout the site, especially along creeks

and certain wetland areas. Wetlands themselves provide variety to the terrain. Improved pastures and canals or ditches, as well as citrus groves adjacent to the site, are indicative of past cultural activity. Several one-story homes and agricultural outbuildings exist on-site, and additional homes, outbuildings, and several commercial structures exist along SR 62, especially in and around Fort Green Springs.

At present, the only public viewpoints that provide views of the proposed mine site are SR 62, CR 663 where it terminates in Fort Green Springs, and Fort Green-Ona Road. Views of the site from along these roads are occasionally obstructed by either vegetation (including citrus groves) or occasional structures adjacent to SR 62. Open areas provide unobstructed views; however, the flat terrain prevents long, sweeping vistas.

The greatest number of viewers would observe the site while driving along SR 62. Except for the commercial establishments in Fort Green Springs, there are no designated places to stop and view the site. In addition to highway travelers, local residents in Fort Green Springs and along SR 62 have the opportunity to view the site.

The recreation facilities nearest the proposed mine site occur in and around Wauchula. The Peace River, which is a designated canoe trail and is listed as a potential nominee for scenic river status, is located east of Wauchula, approximately 3.5 miles from the nearest portion of the mine site. Views of the proposed mine site from these recreational areas are not possible due to vegetative obstructions and distance.

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APPENDIX A--GROUND WATER QUALITY MONITORING DATA

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-1

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/20	9/15	10/5	11/16	12/10	1-5	2-8	3-23	4-14	5-12	6-14
TEMPERATURE (FIELD) °C	24.0	23.5	24.0	24.0	24.5	23.5	22.5	23.5	23.5	23.0	23.5	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.2	7.1	6.4	6.3	6.3	6.6	7.0	6.6	6.3	7.1	6.5	5.9
AMMONIA (NH_3)	0.06	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.08	0.10	0.05	0.62
NITRITE (NO_2) ppb	1	3	0	6	1	0	1	1	1	2	6	2
NITRATE (NO_3)	0.02	0.02	0.07	0.15	0.17	0.10	0.04	0.02	0.01	0.06	0.06	0.03
ORTHOPHOSPHATE	0.4	0.3	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.3
TOTAL PHOSPHORUS	1.0	0.9	0.2	2.0	1.4	2.6	0.5	3.2	1.1	2.8	0.6	1.0
SULPHATE (SO_4)	2.5	4.1	1.5	3.4	3.1	2.8	2.0	1.0	1.6	3.9	1.1	0.5
BICARBONATE ALKAL. AS $CACO_3$	72.2	104.5	13.0	10.1	8.9	7.4	12.7	21.2	13.0	8.9	8.9	17.0
SILICA (SiO_2)	12.2	14.1	8.8	7.2	8.1	8.6	8.4	8.3	8.7	8.1	8.5	8.0
TDS (RESIDUE)	96	132	23	108	37	39	43	171	44	121	58	62
FLUORIDE	0.43	0.56	0.08	0.08	0.09	0.06	0.08	0.13	0.08	0.08	0.09	0.04
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	175	210	61	56	17	68	100	100	80	80	90	80
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				2.3						23.2		
MAGNESIUM				0.8						13.8		
SODIUM				6.8						33.0		
POTASSIUM				0.4						0.4		
CHLORIDE				7.7						18.3		
IRON				0.1						0.6		
STRONTIUM				0.0						0.2		
RADIUM 226 pCi/L										0.10		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-2

	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/27	8/20	9/15	10/05	11/16	12/10	1-5	2-8	3-23	4-14	5-11	6-14
TEMPERATURE (FIELD) °C	25.5	23.5	26.5	26.5	26.0	25.0	24.0	23.5	23.5	23.5	24.0	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	5.8	6.8	6.4	5.8	5.7	5.8	7.0	5.7	6.2	5.9	6.4	6.9
AMMONIA (NH_3)	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.14	0.05	0.08
NITRITE (NO_2) ppb	3	7	1	14	8	11	1	18	1	5	6	1
NITRATE (NO_3)	0.01	0.00	0.02	0.01	0.01	0.01	0.01	0.03	0.01	0.36	0.01	0.03
ORTHOPHOSPHATE	0.3	0.2	0.2	0.2	0.3	0.3	0.3	0.2	0.3	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.6	0.3	0.3	1.6	0.9	1.2	0.7	1.0	0.6	1.6	0.5	0.5
SULPHATE (SO_4)	20.1	19.9	12.3	9.0	16.8	19.2	12.0	25.5	17.9	9.9	12.3	14.6
BICARBONATE ALKAL. AS $CACO_3$	13.9	13.7	13.7	12.5	12.5	12.2	13.0	1.1	13.9	11.3	12.2	10.8
SILICA (SIO_2)	6.4	6.3	7.9	7.2	6.6	6.2	5.7	4.7	6.3	5.1	6.6	6.0
TDS (RESIDUE)	64	77	66	2	78	63	84	170	78	135	75	9
FLUORIDE	0.36	0.38	0.39	0.36	0.58	0.36	0.35	0.34	0.36	0.36	0.39	0.34
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	130	140	118	120	52	120	120	120	110	110	110	120
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				4.8						24.3		
MAGNESIUM				2.3						19.8		
SODIUM				8.6						32.5		
POTASSIUM				0.9						0.3		
CHLORIDE				12.7						12.8		
IRON				0.2						0.2		
STRONTIUM				0.0						0.2		
RADIUM 226 pCi/L										1.87		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-3

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/27	8/20	9/24	10/5	11/16	12/15	1-5	2-8	3-23	4-14	5-12	6-14
TEMPERATURE (FIELD) °C	24.0	24.0	24.5	26.0	23.5	22.5	22.0	22.0	22.0	22.5	24.0	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.3	7.0	6.7	6.5	6.0	6.7	6.8	6.4	6.8	6.3	6.8	6.5
AMMONIA (NH_3)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.13	0.07	0.05	0.05
NITRITE (NO_2) ppb	5	7	5	3	8	2	6	9	2	1	10	4
NITRATE (NO_3)	0.01	0.00	0.02	0.01	0.01	0.01	0.03	0.01	0.05	0.01	0.01	0.02
ORTHOPHOSPHATE	1.0	0.5	0	0.0	0.0	0.0	0.3	0.3	0.4	0.1	0.5	0.3
TOTAL PHOSPHORUS	1.3	0.6	1.8	1.7	6.4	2.9	2.0	3.2	1.6	1.8	1.2	1.4
SULPHATE (SO_4)	17.4	8.5	14.0	11.2	12.5	16.4	17.4	27.3	15.0	25.6	18.4	20.9
BICARBONATE ALKAL. AS $CACO_3$	7.2	7.7	11.0	7.4	5.0	11.3	4.6	5.3	6.2	2.6	6.2	6.0
SILICA (SIO_2)	7.9	8.5	10.1	9.4	9.1	7.2	7.7	7.4	8.5	6.8	9.1	8.0
TDS (RESIDUE)	128	109	91	53	115	110	58	191	114	163	120	49
FLUORIDE	0.37	0.37	0.41	0.39	0.29	0.31	0.33	0.34	0.35	0.35	0.37	0.37
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	175	170	150	160	84	150	170	160	160	150	170	170
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				11.4						30.3		
MAGNESIUM				1.6						11.4		
SODIUM				10.5						35.9		
POTASSIUM				0.3						1.4		
CHLORIDE				27.7						26.1		
IRON				0.1						0.2		
STRONTIUM				0.0						0.5		
RADIUM 226 pCi/L										0.18		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-4

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/20	9/15	10/5	11/16	12/10	1-5	2-8	3-23	4-14	5-12	6-14
TEMPERATURE (FIELD) °C	23.5	24.0	24.0	24.0	23.5	23.0	22.5	22.5	23.0	22.0	23.0	24.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.4	6.2	7.0	7.1	6.0	5.8	6.8	5.8	6.2	6.5	6.2	6.5
AMMONIA (NH_3)	0.05	0.05	0.06	0.05	0.05	0.05	0.05	0.05	0.06	0.06	0.05	0.05
NITRITE (NO_2) ppb	1	0	2	0	1	1	1	1	1	1	2	6
NITRATE (NO_3)	0.01	0.00	0.04	0.01	0.03	0.01	0.01	0.01	0.11	0.01	0.03	0.01
ORTHOPHOSPHATE	0.7	0.4	0.6	1.0	0.7	0.6	0.7	0.5	0.6	0.5	0.5	1.3
TOTAL PHOSPHORUS	1.1	0.4	0.7	1.7	1.1	1.7	1.0	1.1	0.9	1.1	0.8	1.6
SULPHATE (SO_4)	10.0	9.9	2.8	11.8	7.4	13.3	9.2	10.7	6.6	12.7	12.5	11.2
BICARBONATE ALKAL. AS $CACO_3$	6.0	9.4	21.4	12.5	6.2	1.7	3.1	2.8	6.0	5.0	6.0	11.5
SILICA (SIO_2)	8.6	9.4	14.3	12.2	11.5	10.2	8.6	8.3	10.8	11.2	11.1	10.9
TDS (RESIDUE)	50	67	27	37	86	48	99	137	58	123	72	44
FLUORIDE	0.33	0.38	0.56	0.46	0.33	0.31	0.31	0.33	0.39	0.45	0.42	0.55
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	80	110	120	110	34	80	90	90	80	100	110	110
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				8.6						26.7		
MAGNESIUM				1.4						12.5		
SODIUM				7.1						29.9		
POTASSIUM				0.3						0.4		
CHLORIDE				12.3						11.7		
IRON				0.3						0.9		
STRONTIUM				0.0						0.6		
RADIUM 226 pCI/L										0.10		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-5

PARAMETER	THIRD QUARTER - 1981			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/20	9/16	10/6	11/9	12/15	1-7	2-8	3-23	4-13	5-11	6-24
TEMPERATURE (FIELD) °C	25.0	24.0	25.0	25.0	25.0	24.0	24.5	24.5	24.5	25.0	25.0	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	7.8	7.9	6.9	7.7	6.5	8.1	8.1	7.3	7.6	7.3	7.8	7.0
AMMONIA (NH_3)	0.05	0.05	0.11	0.05	0.05	0.05	0.05	0.14	0.06	0.28	0.05	0.05
NITRITE (NO_2) ppb	82	18	22	15	24	13	6	22	8	5	31	15
NITRATE (NO_3)	0.07	0.06	0.34	0.56	0.13	0.01	0.05	0.02	0.08	0.14	0.11	0.03
ORTHOPHOSPHATE	0.5	0.3	1.0	2.2	1.8	0.4	1.0	1.5	0.7	0.6	0.3	1.3
TOTAL PHOSPHORUS	1.4	0.5	2.3	2.5	2.0	2.3	5.1	2.1	2.0	1.7	1.5	1.7
SULPHATE (SO_4)	6.9	7.2	1.8	5.1	12.2	8.4	9.9	5.6	1.8	6.1	1.6	0.3
BICARBONATE ALKAL. AS $CACO_3$	127.7	54.7	52.6	55.4	103.9	159.4	199.6	242.9	270.7	269.3	276.7	61.9
SILICA (SiO_2)	19.3	12.5	14.1	17.7	15.2	18.4	16.4	17.4	20.1	20.2	19.6	13.9
TDS (RESIDUE)	198	210	73	136	144	252	259	388	420	457	322	72
FLUORIDE	0.83	0.83	0.89	0.83	0.89	0.86	1.16	1.00	1.02	1.03	1.02	0.82
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	280	130	130	160	210	280	340	370	400	420	430	100
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-6

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/28	8/20	9/25	10/6	11/16	12/14	1-7	2-8	3-23	4-14	5-11	6-24
TEMPERATURE (FIELD) °C	25.0	23.5	25.0	25.0	24.5	24.0	25.0	24.0	24.0	24.0	25.5	24.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	7.1	7.2	7.9	7.7	7.6	7.8	8.2	7.2	7.2	7.0	7.0	8.5
AMMONIA (NH_3)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.11	0.05	0.09
NITRITE (NO_2) ppb	4	1	0	0	1	0.0	1	1	1	7	5	1
NITRATE (NO_3)	0.04	0.00	0.00	0.01	0.11	0.01	0.04	0.01	0.01	0.01	0.01	0.01
ORTHOPHOSPHATE	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.6	0.5	0.3	0.2	0.4	0.6	1.1	0.4	0.3	0.5	0.3	0.4
SULPHATE (SO_3)	2.5	6.9	1.0	2.3	0.3	2.0	0.8	2.1	2.0	3.6	1.5	0.1
BICARBONATE ALKAL. AS $CACO_3$	38.6	41.5	123.1	179.3	220.3	223.4	210.5	162.8	132.7	55.0	62.4	177.1
SILICA (SIO_2)	12.9	13.9	16.3	19.4	29.8	34.8	33.1	29.8	28.6	17.4	17.0	23.5
TDS (RESIDUE)	104	145	146	171	50	224	215	271	162	163	120	244
FLUORIDE	0.15	0.34	0.28	0.30	0.28	0.29	0.30	0.28	0.26	0.19	0.22	0.33
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	120	130	280	340	23	360	370	280	230	140	180	320
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.7
CALCIUM				42.6						30.9		
MAGNESIUM				14.9						27.8		
SODIUM				7.6						28.4		
POTASSIUM				0.5						1.7		
CHLORIDE				13.2						14.9		
IRON				0.0						0.3		
STRONTIUM				0.1						0.6		
RADIUM 226 pCI/L										0.32		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-7

	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/20	9/16	10/6	11/9	12/14	1-7	2-8	3-19	4-13	5-13	6-24
TEMPERATURE (FIELD) °C	24.5	23.0	24.0	25.0	24.5	23.5	29.0	24.0	24.5	24.5	24.0	24.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.2	4.9	6.9	6.3	5.6	6.1	5.8	5.5	5.3	5.7	5.9	7.2
AMMONIA (NH_3)	0.05	0.05	0.44	0.27	0.12	0.05	0.05	0.05	0.05	0.05	0.08	0.09
NITRITE (NO_2) ppb	6	6	38	24	25	16	11	26	4	2	12	33
NITRATE (NO_3)	0.04	0.03	0.04	0.04	0.03	0.02	0.26	0.07	2.64	6.20	1.99	0.03
ORTHOPHOSPHATE	0.0	0.0	1.7	7.6	3.0	0.9	0.9	0.6	0.2	0.2	0.1	4.9
TOTAL PHOSPHORUS	0.4	0.1	3.3	7.7	4.6	3.6	2.4	1.5	0.9	0.5	0.7	5.6
SULPHATE (SO_4)	24.5	22.5	14.8	17.8	24.2	13.2	26.0	22.0	29.4	28.6	29.8	10.9
BICARBONATE ALKAL. AS $CACO_3$	5.5	2.0	18.0	12.2	7.2	3.6	19.4	4.3	1.7	0.7	3.1	26.2
SILICA (SIO_2)	8.5	8.4	18.2	27.7	9.3	10.3	8.1	9.2	11.9	15.4	13.4	28.6
TDS (RESIDUE)	160	206	177	236	194	194	179	245	188	308	253	178
FLUORIDE	0.21	0.17	0.69	0.67	0.58	0.49	0.42	0.40	0.26	0.32	0.28	0.72
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	220	220	170	190	230	220	230	200	180	230	210	150
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-8

PARAMETER	THIRD QUARTER - 1981			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/14	8/31	9/17	10/8	11/9	12/14	1-8	2-5	3-19	4-13	5-13	6-24
TEMPERATURE (FIELD) °C	25.0	24.0	25.0	25.0	24.5	24.5	23.5	23.0	24.0	25.0	24.5	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.3	6.3	6.5	6.1	6.1	6.6	6.4	6.2	6.1	6.7	6.7	7.4
AMMONIA (NH_3)	0.08	0.06	0.05	0.05	0.08	0.05	0.05	0.05	0.05	0.05	0.15	0.13
NITRITE (NO_2)	12	94	80	8	13	31	37	15	15	8	16	3
NITRATE (NO_3)	0.00	0.02	0.01	0.03	0.01	0.01	0.05	0.01	0.09	0.04	0.02	0.02
ORTHOPHOSPHATE	0.0	0.4	0.1	0.1	0.0	0.2	1.0	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	5.1	2.7	2.2	5.1	5.2	6.3	5.0	5.3	5.9	3.8	5.1	5.5
SULPHATE (SO_4)	41.1	39.0	25.0	20.2	39.0	24.3	36.7	36.2	42.6	38.8	38.6	9.4
BICARBONATE ALKAL. AS $CACO_3$	24.0	16.3	28.8	61.9	17.3	13.0	26.6	26.2	27.6	22.1	29.5	47.0
SILICA (SIO_2)	12.3	15.2	15.7	17.3	13.2	12.2	13.5	13.6	10.7	9.4	8.7	15.4
TDS (RESIDUE)	116	172	63	125	58	119	134	162	129	216	160	54
FLUORIDE	0.52	0.82	0.62	0.65	0.50	0.48	0.51	0.49	0.46	0.50	0.47	0.61
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	170	160	160	200	150	160	190	160	150	160	160	130
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				18.4						26.4		
MAGNESIUM				4.5						13.6		
SODIUM				10.3						38.5		
POTASSIUM				0.3						0.3		
CHLORIDE				16.8						12.2		
IRON				0.6						33.3		
STRONTIUM				0.0						0.2		
RADIUM 228 pCI/L										0.09		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-9

PARAMETER	THIRD QUARTER – 19 81			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/20	9/16	10/8	11/9	12/15	1-8	2-8	3-19	4-13	5-13	6-24
TEMPERATURE (FIELD) °C	24.5	23.0	24.0	25.0	25.0	24.0	24.5	24.0	24.0	24.0	25.0	25.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.2	6.0	6.2	6.3	5.5	6.0	5.9	5.6	6.0	5.6	6.3	6.9
AMMONIA (NH_3)	0.28	0.10	0.26	0.05	0.08	0.05	0.05	0.05	0.05	0.05	0.06	0.36
NITRITE (NO_2) ppb	13	27	18	7	8	19	9	31	12	7	16	13
NITRATE (NO_3)	0.01	0.01	0.15	0.01	0.02	0.02	0.02	0.01	0.01	0.13	0.01	0.36
ORTHOPHOSPHATE	0.1	0.1	0.8	1.2	0.4	0.5	0.2	0.1	0.2	0.2	0.3	1.1
TOTAL PHOSPHORUS	0.4	0.3	1.3	2.1	1.2	0.8	1.2	0.9	0.8	0.7	0.5	1.8
SULPHATE (SO_4)	12.3	4.3	9.2	15.9	17.3	13.2	13.0	14.8	19.2	16.4	18.4	6.9
BICARBONATE ALKAL. AS $CACO_3$	6.5	7.4	4.6	8.4	5.0	5.8	7.0	5.3	8.4	1.2	4.1	26.4
SILICA (SIO_2)	8.8	9.5	10.5	11.5	10.1	8.7	8.2	8.5	9.9	10.2	10.5	9.4
TDS (RESIDUE)	96	128	42	90	64	119	102	165	87	206	154	60
FLUORIDE	0.14	0.15	0.58	0.43	0.16	0.12	0.13	0.13	0.16	0.27	0.19	0.78
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	130	140	90	110	120	120	140	130	120	110	110	90
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCI/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-10

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/14	8/20	9/17	10/6	11/9	12/14	1-7	2-8	3-26	4-13	5-13	6-24
TEMPERATURE (FIELD) °C	25.0	23.0	24.5	25.0	25.0	24.5	24.5	24.0	25.0	24.5	24.5	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	7.5	7.0	7.5	8.2	6.8	7.3	7.2	6.5	7.7	6.9	7.1	7.2
AMMONIA (NH_3)	0.08	0.05	0.05	0.05	0.07	0.05	0.05	0.05	0.05	0.06	0.11	0.05
NITRITE (NO_2) ppb	1	19	32	7	26	22	9	28	20	13	20	29
NITRATE (NO_3)	0.02	0.00	0.00	0.02	0.05	0.01	0.02	0.03	0.07	0.01	0.01	0.04
ORTHOPHOSPHATE	0.0	0.0	0.2	0.1	0.4	0.2	0.2	0.1	0.2	0.1	0.1	0.4
TOTAL PHOSPHORUS	0.9	0.1	0.5	0.3	0.6	1.4	1.2	0.8	1.8	0.4	0.4	0.7
SULPHATE (SO_4)	2.3	2.5	1.6	9.4	7.9	2.8	4.9	9.2	13.8	10.0	12.0	3.8
BICARBONATE ALKAL. AS $CACO_3$	146.6	109.0	97.4	108.0	112.6	96.2	98.4	101.5	81.8	73.9	81.8	98.4
SILICA (SIO_2)	16.6	18.8	18.1	20.1	20.2	20.8	18.4	19.9	19.3	17.8	18.5	17.7
TDS (RESIDUE)	501	305	227	250	255	277	150	333	256	333	301	213
FLUORIDE	0.71	0.64	0.44	0.45	0.48	0.56	0.53	0.54	0.50	0.49	0.51	0.51
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	490	400	240	300	330	360	390	380	320	320	350	270
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-11

	THIRD QUARTER - 19 81			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/17	8/12	9/16	10/12	11/10	12/10	1-19	2-4	3-26	4-15	5-12	6-24
TEMPERATURE (FIELD) °C	25.0	24.5	24.5	24.0	24.0	24.0	24.5	24.0	24.0	24.0	25.0	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.5	8.4	8.0	7.4	7.9	7.9	7.8	7.6	7.9	7.7	8.0	7.9
AMMONIA (NH_3)	0.05	0.05	0.15	0.06	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
NITRITE (NO_2) ppb	0	0	11	0	0	0	1	1	1	1	2	7
NITRATE (NO_3)	0.06	0.04	0.63	0.01	0.16	0.13	0.09	0.03	0.22	0.08	0.01	0.01
ORTHOPHOSPHATE	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.6	0.3	0.3	0.1	0.2	0.8	0.2	0.6	1.0	3.2	0.1	0.4
SULPHATE (SO_4)	3.5	5.6	3.1	1.3	1.0	4.4	1.3	4.6	6.7	1.3	2.1	0.2
BICARBONATE ALKAL. AS $CACO_3$	206.4	271.9	318.0	307.0	326.9	341.5	342.5	339.5	321.8	441.8	336.5	305.5
SILICA (SIO_2)	34.6	27.2	38.6	41.4	43.0	43.2	42.3	40.1	41.3	40.6	42.1	37.0
TDS (RESIDUE)	380	301	290	362	347	351	331	445	351	397	375	460
FLUORICE	0.45	0.62	0.48	0.48	0.44	0.45	0.46	0.47	0.46	0.45	0.47	0.53
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	570	470	500	520	200	560	560	530	520	500	540	440
CARBONATE ALKAL. AS $CACO_3$	21.1	7.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-12

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/17	8/12	9/16	10/8	11/10	12/17	1-5	2-8	3-30	4-15	5-12	6-15
TEMPERATURE (FIELD) °C	24.5	24.5	25.0	25.0	25.0	24.0	24.5	24.0	--	24.0	24.5	25.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.7	7.6	6.7	7.0	7.1	6.8	7.7	7.5	6.4	6.4	6.8	5.5
AMMONIA (NH_3)	0.05	0.05	0.50	0.05	0.07	0.05	0.05	0.05	0.05	0.05	0.05	0.05
NITRITE (NO_2)	0	0	6	0	0	0	1	1	1	1	4	7
NITRATE (NO_3)	0.04	0.03	0.01	0.06	0.03	0.01	0.01	0.04	0.01	0.03	0.02	0.04
ORTHOPHOSPHATE	1.6	0.4	0.4	0.8	1.6	0.2	1.3	1.0	0.9	0.8	0.7	0.3
TOTAL PHOSPHORUS	3.0	0.9	0.8	2.6	2.3	2.4	2.3	2.6	5.2	3.0	1.7	1.5
SULPHATE (SO_4)	2.8	5.9	3.8	6.7	0.0	15.5	3.0	3.5	1.3	1.0	3.3	0.0
BICARBONATE ALKAL. AS $CACO_3$	25.2	17.8	7.2	16.1	20.9	22.9	23.0	22.3	23.0	19.2	15.8	1.2
SILICA (SiO_2)	19.2	21.0	11.2	17.3	18.6	20.3	19.6	17.8	19.9	17.4	19.5	9.5
TDS (RESIDUE)	98	50	20	55	40	67	73	126	63	85	61	162
FLUORIDE	0.73	0.57	0.26	0.45	0.56	0.42	0.64	0.64	0.58	0.55	0.52	0.16
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	80	80	50	60	40	75	80	90	90	90	90	70
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-13

	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/24	8/20	9/16	10/9	11/16	12/17	1-21	2-11	3-30	4-26	5-13	6-24
TEMPERATURE (FIELD) °C	24.5	24.0	24.5	25.0	23.5	24.0	24.5	24.5	23.0	24.0	24.5	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.4	7.0	6.4	6.4	6.5	5.5	5.9	6.0	5.5	6.0	6.6	5.7
AMMONIA (NH_3)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.10	0.13	0.05
NITRITE (NO_2) ppb	3	0	2	4	2	0	7	4	1	9	1	10
NITRATE (NO_3)	0.08	0.00	0.00	0.02	0.01	0.01	0.25	0.01	0.01	0.01	0.01	0.01
ORTHOPHOSPHATE	0.4	0.1	0.0	0.1	0.2	0.1	0.3	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.5	0.2	0.4	0.7	0.5	2.2	1.5	0.5	0.7	0.1	0.4	0.7
SULPHATE (SO_4)	1.0	4.3	2.0	1.6	0.3	10.5	3.8	0.5	1.0	0.7	10.4	0.3
BICARBONATE ALKAL. AS $CACO_3$	6.5	5.5	5.0	5.8	5.5	0.3	6.0	2.9	2.4	3.6	4.3	6.2
SILICA (SIO_2)	7.3	7.7	8.2	7.7	8.8	7.1	8.8	8.1	7.0	8.3	8.0	7.8
TDS (RESIDUE)	107	278	21	53	76	60	63	107	58	93	101	162
FLUORIDE	0.30	0.32	0.34	0.34	0.29	0.74	0.31	0.33	0.32	0.32	0.33	0.31
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	100	110	95	90	45	80	70	100	90	100	110	70
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. SA-14

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/24	8/12	9/25	10/12	11/16	12/17	1-19	2-4	3-30	4-26	5-13	6-24
TEMPERATURE (FIELD) °C	24.5	24.5	25.0	25.0	24.0	24.0	23.5	24.0	24.0	24.9	25.0	25.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	7.5	8.1	7.7	7.8	6.9	7.7	6.8	8.1	6.6	6.9	7.2	6.7
AMMONIA (NH_3)	0.09	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.06	0.05	0.05
NITRITE (NO_2)	3	3	4	3	1	3	2	1	1	2	1	16
NITRATE (NO_3)	0.21	0.09	0.02	0.01	0.02	0.02	3.00	0.01	0.01	0.01	0.13	0.04
ORTHOPHOSPHATE	1.6	0.6	1.5	1.8	1.7	0.2	1.7	1.3	1.2	1.6	1.5	1.9
TOTAL PHOSPHORUS	1.8	0.9	1.9	2.1	2.1	2.3	2.6	2.1	3.2	1.6	2.0	2.3
SULPHATE (SO_4)	2.8	0.5	0.7	2.1	0.3	2.6	1.6	2.6	1.2	1.5	4.8	0.1
BICARBONATE ALKAL. AS $CACO_3$	59.5	72.0	65.0	67.2	71.3	67.9	69.8	67.2	59.3	65.8	64.1	71.5
SILICA (SiO_2)	40.9	48.5	52.6	47.9	51.7	48.6	50.2	44.0	48.9	51.2	50.0	51.2
TDS (RESIDUE)	223	182	163	186	188	184	161	242	201	209	220	263
FLUORIDE	0.45	0.46	0.48	0.46	0.48	0.31	0.43	0.44	0.45	0.45	0.45	0.47
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	210	210	220	210	130	210	220	220	210	220	230	190
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-15

	THIRD QUARTER - 19 81			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/17	8/31	9/25	10/12	11/10	12/17	1-15	2-4	3-26	4-15	5-12	6-24
TEMPERATURE (FIELD) °C	25.5	26.0	26.5	26.0	25.5	24.5	23.0	23.5	23.0	23.5	24.5	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	6.8	7.0	7.4	6.6	7.6	7.3	6.6	6.6	6.4	6.6	6.8	6.6
AMMONIA (NH_3)	0.05	0.08	0.05	0.05	0.09	0.05	0.08	0.07	0.05	0.12	0.05	0.12
NITRITE (NO_2) ppb	36	79	24	24	27	44	53	57	22	39	36	66
NITRATE (NO_3)	0.00	0.01	0.03	0.04	0.05	0.05	0.03	0.03	0.06	0.05	0.04	0.04
ORTHOPHOSPHATE	1.5	1.0	0.1	1.5	1.6	0.3	1.1	1.8	0.6	1.4	1.6	1.7
TOTAL PHOSPHORUS	2.9	1.5	2.9	2.7	2.9	2.6	2.9	2.7	5.2	2.8	3.4	3.3
SULPHATE (SO_4)	1.0	2.0	0.7	1.5	0.0	2.8	2.8	2.0	1.8	0.7	1.0	0.2
BICARBONATE ALKAL. AS $CACO_3$	38.9	33.8	29.3	42.5	28.6	29.8	36.7	27.1	32.6	26.2	28.1	32.9
SILICA (SIO_2)	9.1	15.7	20.1	14.4	13.6	21.1	18.9	12.1	18.2	17.0	18.8	18.1
TDS (RESIDUE)	110	192	68	99	76	94	29	146	78	123	100	203
FLUORIDE	0.74	0.52	0.81	0.79	0.83	0.97	0.75	0.76	0.73	0.72	0.74	0.77
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	165	130	120	120	60	105	110	110	120	100	120	120
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCI/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-16

	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/17	8/12	9/24	10/12	11/10	12/17	1-15	2-11	3-26	4-15	5-12	6-24
TEMPERATURE (FIELD) °C	24.5	24.5	24.5	25.0	24.0	24.0	22.5	24.0	24.0	24.0	25.0	24.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	7.0	7.9	7.3	7.5	7.7	7.3	6.8	6.7	6.5	6.8	7.0	6.9
AMMONIA (NH_3)	0.05	0.06	0.16	0.07	0.21	0.09	0.05	0.05	0.05	0.05	0.05	0.05
NITRITE (NO_2) ppb	3	0	0	1	0	1	29	5	1	1	4	5
NITRATE (NO_3)	0.02	0.02	0.03	0.05	0.02	0.01	0.03	0.04	0.02	0.01	0.01	0.01
ORTHOPHOSPHATE	2.1	0.8	1.5	2.2	2.0	1.5	2.4	2.0	1.9	1.0	1.8	2.2
TOTAL PHOSPHORUS	3.3	1.4	3.2	3.6	4.2	3.3	3.4	2.8	4.0	1.8	2.6	3.1
SULPHATE (SO_4)	1.2	0.3	0.5	0.3	2.3	1.6	0.3	0.3	0.3	0.8	0.8	0.2
BICARBONATE ALKAL. AS $CACO_3$	34.9	49.7	53.5	19.2	67.7	61.2	34.3	37.7	41.3	38.2	38.4	52.3
SILICA (SIO_2)	12.1	17.9	18.4	15.5	16.2	18.2	16.9	18.4	18.8	15.7	17.6	19.4
TDS (RESIDUE)	100	78	59	91	87	99	97	122	80	107	78	183
FLUORIDE	0.83	0.90	0.94	0.89	1.06	0.30	0.91	0.90	0.89	0.79	0.82	0.89
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	135	130	160	130	100	135	110	120	120	110	110	110
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-17

	THIRD QUARTER – 19 81			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/23	8/31	9/22	10/13	11/10	12/17	1-15	2-11	3-28	4-15	5-12	6-24
TEMPERATURE (FIELD) °C	24.0	25.0	25.0	25.0	24.0	23.5	22.0	24.5	26.0	24.5	24.5	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	5.8	7.1	7.8	7.6	6.8	6.2	7.0	6.0	6.1	6.8	6.4	7.4
AMMONIA (NH_3)	0.10	0.05	0.05	0.05	0.08	0.05	0.05	0.05	0.05	0.05	0.10	0.10
NITRITE (NO_2) ppb	8	17	3	9	2	15	25	34	19	5	9	10
NITRATE (NO_3)	0.06	0.00	0.00	0.01	0.03	0.01	0.04	0.01	0.02	0.29	0.01	0.01
ORTHOPHOSPHATE	0.7	0.4	0.2	0.4	0.3	1.0	0.5	0.3	0.6	0.1	0.4	0.5
TOTAL PHOSPHORUS	2.8	0.5	0.9	0.9	1.3	1.1	1.2	0.8	1.1	0.4	0.8	1.0
SULPHATE (SO_4)	3.1	3.3	2.5	1.1	1.0	0.5	4.3	1.0	3.1	2.5	49.3	0.3
BICARBONATE ALKAL. AS $CACO_3$	11.8	13.9	90.0	19.9	8.2	8.6	3.6	7.8	15.4	14.4	9.8	133.9
SILICA (SIO_2)	8.6	9.5	8.9	9.6	9.8	9.9	11.3	10.9	12.2	10.4	10.7	11.2
TDS (RESIDUE)	81	153	118	72	34	59	3	103	179	105	130	258
FLUORIDE	0.27	0.36	0.91	0.48	0.46	0.55	0.26	0.27	0.30	0.31	0.35	0.80
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	66	82	180	100	25	57	20	70	80	90	70	200
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM				6.1						24.7		
MAGNESIUM				3.6						22.8		
SODIUM				5.6						25.6		
POTASSIUM				0.3						1.5		
CHLORIDE				9.5						10.6		
IRON				1.3						2.8		
STRONTIUM				0.0						0.8		
RADIUM 226 pCi/L										0.17		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. SA-18

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/27	8/20	9/24	10/9	11/17	12/17	1-21	2-11	3-30	4-26	5-13	6-24
TEMPERATURE (FIELD) °C	24.5	24.5	25.0	26.0	25.0	24.0	24.5	24.0	23.0	24.0	24.0	24.0
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.5	8.1	8.2	7.8	8.0	8.0	7.9	8.3	7.0	8.0	8.1	7.1
AMMONIA (NH_3)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.12	0.05	0.08
NITRITE (NO_2) ppb	2	0	0	1	1	0	7	28	1	10	1	17
NITRATE (NO_3)	0.01	0.00	0.01	0.01	0.01	0.01	0.18	0.03	0.10	0.08	0.01	0.01
ORTHOPHOSPHATE	0.0	0.0	0.0	0.0	0.0	0.3	0.1	0.1	0.1	0.1	0.1	0.3
TOTAL PHOSPHORUS	0.2	0.0	0.4	0.3	0.0	0.4	1.3	0.1	0.5	0.1	0.2	0.8
SULPHATE (SO_4)	3.6	3.6	1.1	1.6	7.2	0.8	2.0	0.7	123.3	3.4	12.5	0.3
BICARBONATE ALKAL. AS $CACO_3$	205.0	208.8	118.1	188.6	218.2	224.2	222.7	222.5	76.6	125.8	208.1	108.7
SILICA (SIO_2)	30.4	31.7	22.6	33.7	37.1	37.0	37.8	37.3	17.8	24.4	34.5	18.0
TDS (RESIDUE)	276	54	161	273	301	390	321	339	198	241	402	164
FLUORIDE	0.46	0.47	0.40	0.46	0.41	0.43	0.44	0.43	0.37	0.35	0.46	0.38
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	435	410	260	420	410	410	400	440	210	310	390	160
CARBONATE ALKAL. AS $CACO_3$	14.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 226 pCI/L												

ALL VALUES ARE IN PARTS PE (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. UF-2

PARAMETER	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/24	8/31	9/28	10/22	11/19		1-21	2-23	3-3	4-27	5-11	6-28
TEMPERATURE (FIELD) °C	25.5	24.5	25.0	25.0	24.5		24.5	25.0	26.5	25.0	24.0	25.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	11.7	11.3	11.3	11.1	11.4		11.6	11.9	11.5	10.9	11.6	11.1
AMMONIA (NH_3)	0.49	0.42	0.44	0.47	0.36		0.24	0.33	0.36	0.93	0.62	0.51
NITRITE (NO_2) ppb	0	0	0	0	1		3	3	1	1	1	1
NITRATE (NO_3)	0.03	0.00	0.00	0.00	0.01		0.02	0.01	0.01	0.02	0.01	0.01
ORTHOPHOSPHATE	0.0	0.3	0.0	0.0	0.0		0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.2	0.3	0.0	1.4	1.2		1.2	0.4	0.5	0.1	0.1	1.0
SULPHATE (SO_4)	35.3	37.6	32.1	30.1	34.0		32.7	38.8	43.7	38.1	11.0	28.4
BICARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0	0.0		0.0	0.0	0.0	0.0	0.0	0.0
SILICA (SIO_2)	4.0	7.0	4.9	4.4	4.6		4.7	7.1	7.9	7.6	4.4	7.2
TDS (RESIDUE)	872	735	761	941	844		874	729	398	507	1005	580
FLUORIDE	1.05	1.19	1.06	1.15	0.53		1.07	1.12	1.17	1.09	1.06	1.10
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	2250	1400	2000	2300	1400		2350	1360	1300	1500	2250	1300
CARBONATE ALKAL. AS $CACO_3$	155.6	92.6	78.7	149.3	92.1		93.1	128.6	151.8	106.1	294.7	140.2
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 228 pCI/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT

GROUND-WATER QUALITY MONITORING DATA

WELL NO. UF-3

	THIRD QUARTER - 19 81			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/24	8/20	9/28	10/16	11/17	12/17	1-15	2-26	3-2	4-27	5-13	6-24
TEMPERATURE (FIELD) °C	24.0	23.0	23.5	24.0	23.0	23.5	23.5	26.0	26.0	24.0	24.5	25.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.6	8.2	8.2	8.2	8.0	8.3	8.3	8.1	8.2	8.5	8.5	8.0
AMMONIA (NH_3)	0.33	0.42	0.33	0.16	0.23	0.20	0.34	0.30	0.32	0.58	0.34	0.49
NITRITE (NO_2) ppb	4	0	0	0	1	0	78	22	2	1	26	1
NITRATE (NO_3)	0.03	0.00	0.00	0.00	0.01	0.01	0.06	0.05	0.01	0.01	0.01	0.09
ORTHOPHOSPHATE	0.0	0.0	0.0	0.2	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.0	0.0	0.0	0.2	0.1	0.7	0.3	0.4	0.4	0.1	0.1	0.2
SULPHATE (SO_4)	5.4	5.8	3.0	9.9	0.2	4.9	8.1	11.3	8.7	16.4	11.2	5.3
BICARBONATE ALKAL. AS $CACO_3$	309.6	308.6	296.9	269.3	306.5	306.0	306.7	303.8	300.2	289.2	278.9	301.0
SILICA (SIO_2)	40.9	41.3	45.3	45.5	45.9	45.3	45.7	47.2	47.2	47.5	47.7	46.7
TDS (RESIDUE)	437	460	385	371	414	393	319	502	464	427	489	505
FLUORIDE	2.04	2.06	1.95	2.06	1.85	1.99	2.04	2.03	2.10	2.02	2.06	2.13
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	640	620	640	620	580	580	620	580	540	600	600	520
CARBONATE ALKAL., AS $CACO_3$	29.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.4	20.2	0.0
CALCIUM												
MAGNESIUM												
SODIUM												
POTASSIUM												
CHLORIDE												
IRON												
STRONTIUM												
RADIUM 228 pCi/L												

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. UF-4

	THIRD QUARTER - 19 81			FOURTH QUARTER - 1981			FIRST QUARTER - 1982			SECOND QUARTER - 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/23	8/31	9/22	10/19			1-28	2-26	3-2	4-27	5-25	6-28
TEMPERATURE (FIELD) °C	24.0	24.0	25.0	24.5			24.0	24.0	25.0	24.5	25.0	24.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.1	8.2	8.3	8.2			8.1	8.6	8.1	8.3	7.8	8.3
AMMONIA (NH_3)	0.20	0.18	0.18	0.10			0.14	0.16	0.16	0.37	0.24	0.30
NITRITE (NO_2) ppb	69	5	0	0			1	4	1	1	1	1
NITRATE (NO_3)	0.18	0.01	0.06	0.00			0.01	0.02	0.01	0.01	0.01	0.03
ORTHOPHOSPHATE	0.0	0.1	0.0	0.0			0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	1.1	0.8	0.5	0.5			0.5	0.4	0.5	0.1	0.2	1.7
SULPHATE (SO_4)	11.5	4.6	6.1	11.0			2.8	12.0	11.7	14.0	6.1	1.0
BICARBONATE ALKAL. AS $CACO_3$	258.0	248.2	267.1	217.7			236.6	224.6	242.2	238.3	242.9	237.4
SILICA (SIO_2)	14.1	47.0	48.2	47.9			48.8	49.0	48.8	49.4	49.1	48.5
TDS (RESIDUE)	420	485	392	387			435	517	416	434	510	453
FLUORIDE	2.20	2.22	2.43	2.31			2.15	2.15	2.28	2.14	2.25	2.25
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIVITY (LAB) µmhos/CM	650	580	660	640			640	580	580	640	640	680
CARBONATE ALKAL. AS $CACO_3$	0.0	0.0	0.0	0.0			0.0	15.8	0.0	0.0	0.0	0.0
CALCIUM				49.3						49.8		
MAGNESIUM				18.5						45.3		
SODIUM				16.9						50.2		
POTASSIUM				1.5						9.6		
CHLORIDE				91.3						85.3		
IRON				0.1						0.2		
STRONTIUM				0.0						2.3		
RADIUM 226 pCi/L										6.37		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

CF MINING HARDEE COUNTY PHOSPHATE PROJECT
GROUND-WATER QUALITY MONITORING DATA
WELL NO. UF-5

	THIRD QUARTER – 1981			FOURTH QUARTER – 1981			FIRST QUARTER – 1982			SECOND QUARTER – 1982		
PARAMETER	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MAR.	APR.	MAY	JUN.
DATE SAMPLE COLLECTED	7/13	8/27	9/28	10/20	11/19		1-21	2-26	3-2	4-27	5-11	6-25
TEMPERATURE (FIELD) °C	25:5	21.5	24.5	24.5	24.0		24.0	24.0	24.0	25.0	24.0	25.5
TEMPERATURE (LAB) °C												
pH (FIELD)												
pH (LAB)	8.4	8.3	8.3	8.4	7.9		8.0	8.1	8.1	8.1	8.4	8.0
AMMONIA (NH_3)	0.24	0.24	0.23	0.13	0.22		0.13	0.20	0.18	0.45	0.30	0.37
NITRITE (NO_2) ppb	2	0	0	0	2		3	4	1	1	1	184
NITRATE (NO_3)	0.01	0.05	0.00	0.05	0.01		0.17	0.14	0.01	0.01	0.01	0.34
ORTHOPHOSPHATE	0.0	0.3	0.0	0.0	0.0		0.1	0.1	0.1	0.1	0.1	0.1
TOTAL PHOSPHORUS	0.2	1.3	0.1	0.1	0.5		1.2	0.4	0.5	0.1	0.1	0.2
SULFATE (SO_4)	29.1	4.8	1.1	10.5	7.4		14.1	16.4	12.2	7.9	28.1	8.4
BICARBONATE ALKAL. AS $CACO_3$	270.8	275.3	239.5	255.9	271.4		271.4	265.9	272.2	269.8	275.5	280.3
SILICA (SiO_2)	40.7	47.9	50.4	49.1	51.0		49.5	50.1	49.6	50.0	48.8	48.6
TDS (RESIDUE)	381	476	379	503	443		464	494	433	350	433	482
FLUORIDE	2.28	2.43	2.40	2.33	2.19		2.25	2.36	2.34	2.31	2.19	2.27
CONDUCTIVITY (FIELD) µmhos/CM												
CONDUCTIMTY (LAB) µmhos/CM	620	390	580	600	200		620	560	580	640	620	560
CARBONATE ALKAL. AS $CACO_3$	8.6	0.0	0.0	7.6	0.0		0.0	0.0	0.0	0.0	9.1	0.0
CALCIUM				51.4						47.9		
MAGNESIUM				21.2						46.7		
SODIUM				17.1						49.7		
POTASSIUM				1.8						10.9		
CHLORIDE				66.8						60.2		
IRON				0.0						0.8		
STRONTIUM				0.2						4.8		
RADIUM 226 pCI/L										8.44		

ALL VALUES ARE IN PARTS PER MILLION (PPM) UNLESS OTHERWISE INDICATED

APPENDIX B--SURFACE WATER QUALITY MONITORING DATA

ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF1 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS					
PARAMETERS	STORET #	WQ-5 118600	WQ-8 118601	WQ-9 118602	WQ-10 118603	WQ-11 118604	WQ-5D 118606
DATE		7/30/81	7/30/81	7/30/81	7/30/81	7/30/81	7/30/81
TIME		1650	1610	1345	1515	1115	1655
STREAM FLOW (CFS)	61	0.00	0.00	0.00	0.00	1.23	NA
COLOR (PCU)	80	100	100	400	150	250	100
SUSP.SOLIDS (MG/L)	530	18	10	24	<5	<5	18
TURBIDITY (NTU)	76	3.40	2.50	1.50	0.90	1.10	4.50
WATER TEMP (C)	10	29.0	30.0	32.0	29.0	NA	29.0
CHLORIDE (MG/L)	940	9	47	6	NA	26	11
FLUORIDE (MG/L)	951	0.65	0.32	0.19	0.26	0.17	0.63
SULFATE (MG/L)	945	<5	277	<5	13	35	<5
ALKALINITY (MG/L)	410	95	32	18	13	4	99
AMMONIA (MG/L-N)	610	0.06	0.53	0.25	0.05	0.05	0.06
AMMONIA,UNIONIZED	619	0.001	0.005	<0.001	<0.001	NA	<0.001
NO3 + NO2 (MG/L-N)	630	<0.004	0.004	0.017	<0.004	0.005	0.006
TKN (MG/L-N)	625	1.14	2.16	3.71	1.12	1.99	1.22
T. ORG. N. (MG/L-N)	605	1.08	1.63	3.46	1.08	1.93	1.16
T. PHOSPHOROUS(MG/L)	665	0.995	0.420	0.989	0.771	0.190	1.04
DISS. O-PO4 (MG/L-P)	671	0.596	0.287	0.592	0.390	0.107	0.636
SILICA, DISS(MG/L)	955	9.6	12.4	7.2	4.2	5.4	10.3
DISS. OXYGEN (MG/L)	299	NA	1.0	3.8	0.5	2.8	NA
BOD (5 DA.-MG/L)	310	6.0	4.4	4.2	4.4	2.4	8.2
ARSENIC,TOTAL(UG/L)	1002	<11	<11	NA	<11	NA	NA
BERYLLIUM (UG/L)	1012	<1.0	<1.0	NA	<1.0	NA	NA
CADMIUM,TOTAL(UG/L)	1027	<1.0	<1.0	NA	<1.0	NA	NA
CHROMIUM,TOTAL(UG/L)	1034	<3.0	5.2	NA	<3.0	NA	NA
COPPER,TOTAL(UG/L)	1042	5.1	1.9	NA	4.0	NA	NA
IRON,TOTAL(UG/L)	1045	429	182	NA	99	NA	NA
LEAD,TOTAL(UG/L)	1051	<11.0	<11.0	NA	<11.0	NA	NA
MERCURY,TOTAL(UG/L)	71900	0.7	0.5	NA	1.0	NA	NA
NICKEL (UG/L)	1067	<5.0	<5.0	NA	<5.0	NA	NA
SELENIUM,TOTAL(UG/L)	1147	<19	<19	NA	<19	NA	NA
SILVER,TOTAL(UG/L)	1077	<6.0	<6.0	NA	<6.0	NA	NA
ZINC,TOTAL(UG/L)	1092	33.0	24.0	NA	19.0	NA	NA
COLIFORM,FEC(#/100ML	31613	25	250	1400	180	980	20

OK,

ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF2 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS								
PARAMETERS	STORET #	WQ-5 122300	WQ-8 122301	WQ-9 122302	WQ-10 122303	WQ-11 122304	WQ-12 122305	WQ-5D 122306	MDW1 122307	MDW2 122308
DATE		8/25/81	8/25/81	8/25/81	8/25/81	8/25/81	8/25/81	8/25/81	8/25/81	8/25/81
TIME		1415	1350	1135	1235	945	1445	1415	1530	1530
STREAM FLOW (CFS)	61	0.00	0.00	0.00	4.34	14.4	0.00	NA	NA	NA
COLOR (PCU)	80	150	200	500	375	500	250	150	10	15
SUSP.SOLIDS (MG/L)	530	111	28	108	30	<5	208	69	30	31
TURBIDITY (NTU)	76	10.0	3.20	3.80	5.00	1.00	18.0	12.0	26.0	26.0
WATER TEMP (C)	10	27.6	26.5	26.8	25.4	27.5	30.6	27.6	31.2	31.2
CHLORIDE (MG/L)	940	29	22	8	15	18	49	31	15	17
FLUORIDE (MG/L)	951	0.46	0.36	0.16	0.37	0.30	0.22	0.46	2.41	2.42
SULFATE (MG/L)	945	110	31	<5	<5	<5	201	109	131	601
ALKALINITY (MG/L)	410	17	23	5	14	6	34	13	52	50
AMMONIA (MG/L-N)	610	0.07	0.10	0.08	0.04	<0.03	0.28	0.07	6.24	6.17
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	1.35	1.34
NO3 + NO2 (MG/L N)	630	0.061	0.091	0.013	0.014	0.010	0.011	0.057	0.087	<0.004
TKN (MG/L-N)	625	2.43	2.19	3.72	2.06	1.89	6.38	3.07	9.29	9.23
T. ORG. N. (MG/L-N)	605	2.36	2.09	3.64	2.01	1.88	6.09	3.00	3.05	3.05
T. PHOSPHOROUS(MG/L)	665	1.14	0.547	0.505	0.586	0.941	1.63	1.24	0.492	0.489
DISS. O-PO4 (MG/L-P)	671	0.534	0.357	0.348	0.410	0.841	0.597	0.557	0.030	0.032
SILICA, DISS(MG/L)	955	11.1	8.4	4.3	10.2	5.6	12.3	11.2	3.4	3.5
DISS. OXYGEN (MG/L)	299	1.6	1.6	1.3	3.1	1.1	1.2	1.6	13.6	13.6
BOD (5 DA.-MG/L)	310	5.4	3.6	5.4	3.2	2.2	4.4	7.2	7.3	7.3
COLIFORM,FEC(#/100ML	31613	500	160	420	390	60	>400	560	90	80

OK,

SLIST CF3

ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF3 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS							
		WQ-5	WQ-8	WQ-9	WQ-10	WQ-11	WQ-12	MDW1	MDW2
PARAMETERS	STORET #	125200	125201	125202	125203	125204	125205	125207	125208
DATE		9/22/81	9/22/81	9/22/81	9/22/81	9/22/81	9/22/81	9/22/81	9/22/81
TIME		1829	1810	1435	1710	1213	1046	1623	1630
STREAM FLOW (CFS)	61	0.49	3.45	5.75	0.48	120	<0.01	NA	NA
COLOR (PCU)	80	375	375	250	375	250	375	10	10
SUSP.SOLIDS (MG/L)	530	<5	<5	5	<5	<5	13	19	11
TURBIDITY (NTU)	76	1.50	1.60	0.70	1.00	0.70	1.70	12.0	8.00
WATER TEMP (C)	10	19.7	23.5	24.8	25.5	24.6	24.0	NA	NA
CHLORIDE (MG/L)	940	21	14	9	14	9	70	14	14
FLUORIDE (MG/L)	951	0.48	0.40	0.24	0.32	0.23	0.35	1.97	1.98
SULFATE (MG/L)	945	<1	<1	<1	<1	<1	125	285	108
ALKALINITY (MG/L)	410	48	32	4	26	4	5	67	68
AMMONIA (MG/L-N)	610	0.05	0.03	0.03	0.05	0.02	0.09	6.07	6.66
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
NO3 + NO2 (MG/L-N)	630	0.010	0.008	0.022	0.013	0.006	0.043	0.042	0.038
TKN (MG/L-N)	625	1.51	1.47	1.31	1.19	0.92	1.83	9.59	9.90
T. ORG. N. (MG/L-N)	605	1.46	1.44	1.27	1.14	0.91	1.73	3.52	3.24
T. PHOSPHOROUS(MG/L)	665	1.07	0.825	0.630	0.704	0.300	0.668	0.325	0.336
DISS. O-PO4 (MG/L-P)	671	0.930	0.741	0.626	0.677	0.277	0.566	0.043	0.096
SILICA, DISS(MG/L)	955	12.2	6.9	4.9	7.8	2.3	13.3	3.9	4.0
DISS. OXYGEN (MG/L)	299	3.0	1.8	3.1	3.0	2.4	4.3	NA	NA
BOD (5 DA.-MG/L)	310	<1.0	1.1	1.5	1.5	1.0	1.8	3.9	3.5
COLIFORM,FEC(#/100ML	31613	96	188	241	1100	265	>1600	84	48

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ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF4 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-1 126700	WQ-2 126701	WQ-3 126702	WQ-4 126703	WQ-7 126705	WQ-13 126706	WQ-14 126707	WQ-10 126708	WQ-5 126710	WQ-8 126711
DATE		9/29/81	9/29/81	9/29/81	9/29/81	9/29/81	9/29/81	9/29/81	9/29/81	9/29/81	9/29/81
TIME		1255	1347	1448	1610	1545	1050	935	1255	1130	1136
STREAM FLOW (CFS)	61	4.80	7.08	11.0	2.01	3.04	19.8	32.7	NA	NA	NA
COLOR (PCU)	80	25	50	150	250	50	100	100	50	NA	NA
SUSP.SOLIDS (MG/L)	530	<5	<5	<5	<5	<5	<5	<5	<5	NA	NA
TURBIDITY (NTU)	76	5.30	1.70	2.00	1.30	2.00	2.00	2.50	5.50	NA	NA
WATER TEMP (C)	10	27.8	25.8	26.0	25.1	25.4	23.9	23.8	27.8	NA	NA
SP.CONDUCT.,FIELD	94	316	304	261	148	270	259	283	316	NA	NA
CYANIDE (MG/L)	720	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	NA	NA
CHLORIDE (MG/L)	940	14	14	17	23	15	17	17	14	NA	NA
FLUORIDE (MG/L)	951	1.57	1.51	1.22	0.38	1.37	1.12	1.25	1.55	NA	NA
SULFATE (MG/L)	945	41	59	49	2	29	42	37	38	NA	NA
ALKALINITY (MG/L)	410	95	62	52	17	76	53	62	91	NA	NA
PH	400	7.50	7.20	6.80	6.10	7.00	6.80	6.90	7.50	NA	NA
AMMONIA (MG/L-N)	610	0.02	0.03	0.02	0.05	0.02	0.04	0.02	0.03	NA	NA
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	NA	NA
NO3 + NO2 (MG/L-N)	630	0.037	0.172	0.213	0.433	0.483	0.655	0.946	0.040	NA	NA
TKN (MG/L-N)	625	1.18	0.86	1.30	1.49	0.89	0.86	0.78	1.40	NA	NA
T. ORG. N. (MG/L-N)	605	1.17	0.83	1.27	1.44	0.87	0.82	0.76	1.37	NA	NA
T. PHOSPHOROUS(MG/L)	665	0.488	0.700	0.731	0.742	0.566	0.742	0.885	0.481	NA	NA
DISS. O-PO4 (MG/L-P)	671	0.265	0.623	0.639	0.653	0.485	0.755	0.774	0.277	NA	NA
SILICA, DISS(MG/L)	955	0.8	4.4	5.4	7.2	3.3	6.0	4.6	0.8	NA	NA
DISS. OXYGEN (MG/L)	299	7.4	7.4	5.8	4.5	5.9	7.0	6.8	7.4	NA	NA
BOD (5 DA.-MG/L)	310	5.3	2.0	2.2	1.9	3.0	2.0	1.4	5.8	NA	NA
ARSENIC,TOTAL(UG/L)	1002	<15	<15	<15	<15	<15	<15	<15	<15	<15	<15
BERYLLIUM (UG/L)	1012	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
CADMIUM,TOTAL(UG/L)	1027	1.5	1.1	1.9	1.7	0.8	2.9	0.5	0.9	<0.2	<0.2
CHROMIUM,TOTAL(UG/L)	1034	4.8	3.2	17	6.0	5.8	3.4	9.8	14	8.1	8.4
COPPER,TOTAL(UG/L)	1042	10.7	2.8	<1.0	<1.0	3.4	<1.0	<1.0	1.4	4.0	<1.0
IRON,TOTAL(UG/L)	1045	227	281	606	1170	257	568	308	264	3440	911
LEAD,TOTAL(UG/L)	1051	15.9	6.2	5.1	3.3	11.3	<3.0	<3.0	6.8	9.1	<3.0
MERCURY,TOTAL(UG/L)	71900	0.3	0.2	<0.1	<0.1	<0.1	0.2	0.3	0.2	0.3	0.3
NICKEL (UG/L)	1067	9.2	8.8	7.8	<6.0	<6.0	7.2	<6.0	7.4	9.6	6.3
SELENIUM,TOTAL(UG/L)	1147	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<1.0	<1.0
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	0.4	0.4
ZINC,TOTAL(UG/L)	1092	145.0	125.0	102.0	68.0	92.0	38.0	41.0	98.0	83.0	100.0
COLIFORM,FEC(#/100ML	31613	32	80	20	12	315	24	56	44	NA	NA

ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF4 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410

PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE

FIELD GROUP LEADER

SAMPLE NUMBERS

PARAMETERS	STORET #	WQ-10 126712
DATE		9/29/81
TIME		1150
STREAM FLOW (CFS)	61	NA
COLOR (PCU)	80	NA
SUSP.SOLIDS (MG/L)	530	NA
TURBIDITY (NTU)	76	NA
WATER TEMP (C)	10	NA
SP.CONDUCT.,FIELD	94	NA
CYANIDE (MG/L)	720	NA
CHLORIDE (MG/L)	940	NA
FLUORIDE (MG/L)	951	NA
SULFATE (MG/L)	945	NA
ALKALINITY (MG/L)	410	NA
PH	400	NA
AMMONIA (MG/L-N)	610	NA
AMMONIA,UNIONIZED	619	NA
NO3 + NO2 (MG/L-N)	630	NA
TKN (MG/L-N)	625	NA
T. ORG. N. (MG/L-N)	605	NA
T. PHOSPHOROUS(MG/L)	665	NA
DISS. O-PO4 (MG/L-P)	671	NA
SILICA, DISS(MG/L)	955	NA
DISS. OXYGEN (MG/L)	299	NA
BOD (5 DA.-MG/L)	310	NA
ARSENIC,TOTAL(UG/L)	1002	<15
BERYLLIUM (UG/L)	1012	<1.0
CADMIUM,TOTAL(UG/L)	1027	<0.2
CHROMIUM,TOTAL(UG/L)	1034	4.3
COPPER,TOTAL(UG/L)	1042	1.1
IRON,TOTAL(UG/L)	1045	1320
LEAD,TOTAL(UG/L)	1051	4.5
MERCURY,TOTAL(UG/L)	71900	0.3
NICKEL (UG/L)	1067	<6.0
SELENIUM,TOTAL(UG/L)	1147	<1.0
SILVER,TOTAL(UG/L)	1077	0.4
ZINC.TOTAL(UG/L)	1092	65.0
COLIFORM,FEC(#/100ML	31613	NA

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ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CFS STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-1 129300	WQ-2 129301	WQ-3 129302	WQ-4 129303	WQ-7 129305	WQ-8 129306	WQ-10 129307	WQ-13 129308	WQ-14 129309	MDW1 129310
DATE		10/28/81	10/28/81	10/28/81	10/28/81	10/28/81	10/28/81	10/28/81	10/28/81	10/28/81	10/28/81
TIME		1600	1500	1700	1845	1745	1115	1215	1015	850	1415
STREAM FLOW (CFS)	61	1.16	7.64	9.34	0.00	0.62	0.00	0.00	12.0	16.6	NA
COLOR (PCU)	80	10	15	20	50	50	150	250	20	20	10
METHY.B.A. SUBST.	38260	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
OIL & GREASE (MG/L)	556	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
SUSP.SOLIDS (MG/L)	530	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
TURBIDITY (NTU)	76	1.80	0.70	1.20	0.60	1.60	2.40	2.50	0.50	0.60	12.0
WATER TEMP (C)	10	27.0	25.2	25.0	23.8	24.0	24.3	23.8	23.4	23.1	26.0
SP.CONDUCT.,FIELD	94	275	223	260	234	312	125	128	180	345	230
CYANIDE (MG/L)	720	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
CHLORIDE (MG/L)	940	15	15	15	28	16	34	17	17	18	17
FLUORIDE (MG/L)	951	1.71	2.05	1.83	0.49	1.57	0.39	0.34	1.57	1.38	2.59
SULFATE (MG/L)	945	37	103	96	26	29	37	1	78	61	136
ALKALINITY (MG/L)	410	99	69	66	35	105	45	27	64	61	69
PH	400	8.20	8.00	7.80	7.30	7.80	7.40	7.10	7.60	7.60	8.50
AMMONIA (MG/L-N)	610	0.004	0.007	0.01	0.02	0.03	0.13	0.07	0.01	0.03	6.57
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	0.001	0.002	<0.001	<0.001	<0.001	1.06
NO3 + NO2 (MG/L-N)	630	0.041	0.109	0.164	0.458	0.509	0.774	0.008	0.598	1.97	0.258
TKN (MG/L-N)	625	1.44	0.58	0.68	0.76	1.94	2.02	3.63	0.68	1.35	10.7
T. ORG. N. (MG/L-N)	605	1.44	0.57	0.67	0.73	1.90	1.89	3.56	0.67	1.32	4.14
T. PHOSPHOROUS(MG/L)	665	0.352	0.794	0.708	0.420	0.729	0.476	1.21	0.642	0.690	0.602
DISS. O-PO4 (MG/L-P)	671	0.199	0.730	0.646	0.403	0.646	0.340	0.898	0.603	0.645	0.285
SILICA, DISS(MG/L)	955	<0.1	4.2	4.3	10.2	3.2	5.6	6.3	3.2	3.5	4.1
DISS. OXYGEN (MG/L)	299	7.9	7.4	6.7	4.7	5.2	2.3	0.4	7.1	6.4	10.0
BOD (5 DA.-MG/L)	310	4.0	1.8	2.0	1.1	3.0	2.6	3.7	1.8	3.6	5.4
ARSENIC,TOTAL(UG/L)	1002	<21	<21	<21	<21	<21	<21	<21	<21	<21	<21
BERYLLIUM (UG/L)	1012	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
CADMIUM,TOTAL(UG/L)	1027	<0.2	<0.2	<0.2	<0.2	<0.2	1.1	<0.2	<0.2	0.3	<0.2
CHROMIUM,TOTAL(UG/L)	1034	30	7.6	6.3	7.4	12	6.7	6.7	6.9	8.0	6.7
COPPER,TOTAL(UG/L)	1042	5.1	15.0	3.1	6.2	9.2	5.8	7.7	6.7	8.7	5.8
IRON,TOTAL(UG/L)	1045	176	71	92	227	281	518	1200	84	116	223
LEAD,TOTAL(UG/L)	1051	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0	<13.0
MERCURY,TOTAL(UG/L)	71900	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
NICKEL (UG/L)	1067	<8.0	18.0	<8.0	<8.0	<8.0	<8.0	13.0	<8.0	<8.0	<8.0
SELENIUM,TOTAL(UG/L)	1147	<25	<25	<25	<25	<25	<25	<25	<25	<25	<25
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
ZINC,TOTAL(UG/L)	1092	44.0	10.0	53.0	68.0	82.0	57.0	120.0	74.0	81.0	68.0
COLIFORM,FEC(#/100ML	31613	24	108	116	48	1080	880	140	140	550	4

ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82

FIELD GROUP CF5 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410

PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE

FIELD GROUP LEADER

SAMPLE NUMBERS

PARAMETERS	STORET #	MDW2 129311	WQ-2D 129313
DATE		10/28/81	10/28/81
TIME		1350	1500
STREAM FLOW (CFS)	61	NA	NA
COLOR (PCU)	80	10	15
METHY.B.A. SURST.	38260	<0.50	<0.50
OIL & GREASE (MG/L)	556	<5	<5
SUSP.SOLIDS (MG/L)	530	<5	<5
TURBIDITY (NTU)	76	11.0	0.40
WATER TEMP (C)	10	27.7	25.2
SP.CONDUCT.,FIELD	94	214	223
CYANIDE (MG/L)	720	<0.005	<0.005
CHLORIDE (MG/L)	940	16	15
FLUORIDE (MG/L)	951	2.61	2.00
SULFATE (MG/L)	945	137	90
ALKALINITY (MG/L)	410	76	72
PH	400	8.60	8.00
AMMONIA (MG/L-N)	610	6.04	0.01
AMMONIA,UNIONIZED	619	1.30	<0.001
NO3 + NO2 (MG/L-N)	630	0.252	0.118
TKN (MG/L-N)	625	9.59	0.55
T. ORG. N. (MG/L-N)	605	3.54	0.54
T. PHOSPHOROUS(MG/L)	665	0.556	0.755
DISS. O-PO4 (MG/L-P)	671	0.271	0.727
SILICA, DISS(MG/L)	955	4.4	4.2
DISS. OXYGEN (MG/L)	299	15.0	7.4
BOD (5 DA.-MG/L)	310	7.7	4.1
ARSENIC,TOTAL(UG/L)	1002	<21	<21
BERYLLIUM (UG/L)	1012	<1.0	<1.0
CADMIUM,TOTAL(UG/L)	1027	<0.2	<0.2
CHROMIUM,TOTAL(UG/L)	1034	5.6	5.6
COPPER,TOTAL(UG/L)	1042	2.3	5.0
IRON,TOTAL(UG/L)	1045	79	115
LEAD,TOTAL(UG/L)	1051	<13.0	<13.0
MERCURY,TOTAL(UG/L)	71900	<0.2	<0.2
NICKEL (UG/L)	1067	<8.0	<8.0
SELENIUM,TOTAL(UG/L)	1147	<25	<25
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4
ZINC.TOTAL(UG/L)	1092	52.0	64.0
COLIFORM,FEC(#/100ML	31613	40	NA

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ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF7 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-1 135700	WQ-2 135701	WQ-3 135702	WQ-4 135703	WQ-5 135704	WQ-7 135705	WQ-8 135706	WQ-10 135707	WQ-13 135708	WQ-14 135709
DATE		11/23/81	11/23/81	11/23/81	11/23/81	11/23/81	11/23/81	11/23/81	11/23/81	11/23/81	11/23/81
TIME		1325	1440	1550	1230	1000	1620	930	905	1045	700
STREAM FLOW (CFS)	61	1.80	4.34	5.08	0.31	0.00	0.46	0.00	0.00	7.71	10.7
COLOR (PCU)	80	20	15	15	50	150	75	75	250	20	20
SUSP. SOLIDS (MG/L)	530	11	6	9	<5	52	11	5	5	<5	<5
TURBIDITY (NTU)	76	3.90	0.60	0.50	0.60	1.10	3.00	0.90	0.90	0.70	0.50
WATER TEMP (C)	10	19.0	13.8	13.9	11.3	12.8	13.5	11.6	9.3	11.1	10.9
SP. CONDUCT., FIELD	94	189	177	167	149	272	316	261	54.0	210	348
CHLORIDE (MG/L)	940	15	15	18	35	19	17	45	19	17	20
FLUORIDE (MG/L)	951	1.40	1.70	1.67	0.38	0.70	1.70	0.35	0.33	1.55	1.32
SULFATE (MG/L)	945	39	92	92	30	7	30	42	<1	79	35
ALKALINITY (MG/L)	410	103	70	72	38	114	105	53	35	73	74
PH	400	7.00	7.30	7.50	7.00	6.90	7.50	6.70	6.40	7.50	7.30
AMMONIA (MG/L-N)	610	0.13	0.01	0.01	0.02	0.06	0.08	0.10	0.10	0.01	0.01
AMMONIA, UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.030	0.065	0.309	1.55	0.013	0.203	0.600	0.007	0.927	2.69
TKN (MG/L-N)	625	0.89	0.36	0.35	0.51	1.46	1.22	1.02	2.03	0.42	0.46
T. ORG. N. (MG/L-N)	605	0.76	0.35	0.34	0.49	1.40	1.14	0.92	1.93	0.40	0.45
T. PHOSPHORUS(MG/L)	665	0.268	0.830	0.835	0.265	1.11	0.594	0.149	0.748	0.677	0.676
DISS. O-PO4 (MG/L-P)	671	0.088	0.765	0.792	0.238	0.705	0.452	0.120	0.681	0.641	0.631
SILICA, DISS(MG/L)	955	<0.2	2.5	2.9	7.7	23.5	2.6	13.5	9.4	2.8	3.3
DISS. OXYGEN (MG/L)	299	6.7	9.8	9.8	8.6	3.9	8.3	2.8	2.3	9.8	8.8
BOD (5 DA.-MG/L)	310	3.9	<1.0	<1.0	<1.0	2.2	3.5	1.8	2.0	<1.0	<1.0
COLIFORM, FEC(#/100ML	31613	24	92	124	540	84	1720	420	36	285	660

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ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CFG STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS								
PARAMETERS	STORET #	WQ-1 135800	WQ-2 135801	WQ-3 135802	WQ-4 135803	WQ-5 135804	WQ-7 135805	WQ-8 135806	WQ-13 135808	WQ-14 135809
DATE		12/17/81	12/16/81	12/16/81	12/16/81	12/16/81	12/16/81	12/16/81	12/17/81	12/17/81
TIME		1200	1600	1400	1215	1700	1500	1645	1010	1100
STREAM FLOW (CFS)	61	5.30	2.74	3.42	0.48	0.00	1.72	0.00	7.29	14.6
COLOR (PCU)	80	20	20	25	75	150	50	75	40	30
SUSP.SOLIDS (MG/L)	530	11	<5	<5	<5	<5	9	32	<5	<5
TURBIDITY (NTU)	76	3.80	0.80	0.70	0.60	3.00	1.80	4.50	0.70	0.70
WATER TEMP (C)	10	16.2	14.5	14.8	13.4	15.8	13.7	13.1	12.2	12.4
SP.CONDUCT.,FIELD	94	150	292	301	237	303	330	365	280	320
CHLORIDE (MG/L)	940	16	14	20	34	17	17	50	21	16
FLUORIDE (MG/L)	951	1.70	1.18	1.06	0.39	0.73	1.75	0.40	1.15	1.25
SULFATE (MG/L)	945	48	59	62	30	<1	38	41	49	48
ALKALINITY (MG/L)	410	96	66	56	30	122	104	51	75	71
PH	400	6.40	6.80	6.50	5.90	6.50	7.20	6.10	6.80	6.90
AMMONIA (MG/L-N)	610	0.02	0.01	0.01	0.02	0.02	<0.01	0.06	<0.01	<0.01
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.034	0.077	0.557	1.42	0.006	0.073	1.44	0.992	2.13
TKN (MG/L N)	625	1.14	0.61	0.67	0.61	1.24	1.32	1.28	1.70	0.70
T. ORG. N. (MG/L-N)	605	1.11	0.60	0.65	0.59	1.22	1.32	1.22	1.69	0.70
T. PHOSPHOROUS(MG/L)	665	0.114	0.860	0.715	0.363	0.867	0.509	0.276	0.516	0.821
DISS. O-PO4 (MG/L-P)	671	0.050	0.602	0.556	0.300	0.501	0.400	0.113	0.471	0.677
SILICA, DISS(MG/L)	955	0.9	1.9	2.8	6.9	23.2	1.5	13.8	1.9	1.9
DISS. OXYGEN (MG/L)	299	7.1	9.7	9.2	6.9	6.2	9.0	1.3	10.4	9.1
BOD (5 DA.-MG/L)	310	3.5	2.8	1.5	1.7	2.4	2.6	2.2	1.1	1.2
COLIFORM,FEC.(#/100ML	31613	8	172	276	234	88	1900	136	230	460

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ENVIRONMENTAL SCIENCE & ENGINEERING 07/30/82 FIELD GROUP CF9 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER

		SAMPLE NUMBERS								
PARAMETERS	STORET #	WQ-1 135900	WQ-2 135901	WQ 3 135902	WQ-4 135903	WQ-5 135904	WQ-7 135905	WQ-8 135906	WQ-13 135908	WQ-14 135909
DATE		1/12/82	1/12/82	1/12/82	1/12/82	1/12/82	1/12/82	1/12/82	1/12/82	1/12/82
TIME		1310	1130	1415	1030	730	1500	800	830	915
STREAM FLOW (CFS)	61	4.98	5.14	5.59	0.34	0.00	1.84	0.00	8.91	12.3
COLOR (PCU)	80	15	15	20	50	100	25	100	20	20
SUSP.SOLIDS (MG/L)	530	8	<5	<5	<5	<5	<5	<5	<5	<5
TURBIDITY (NTU)	76	4.40	0.50	1.60	3.80	3.90	2.50	2.00	2.30	0.70
WATER TEMP (C)	10	15.5	7.9	10.0	5.5	6.8	9.1	9.5	7.1	7.1
SP.CONDUCT.,FIELD	94	235	392	338	102	285	340	350	169	349
CHLORIDE (MG/L)	940	16	16	18	35	24	18	49	20	22
FLUORIDE (MG/L)	951	1.74	1.77	1.68	0.35	0.67	1.71	0.37	1.51	1.28
SULFATE (MG/L)	945	53	73	85	24	15	36	28	76	47
ALKALINITY (MG/L)	410	109	98	96	34	115	106	76	85	79
PH	400	7.10	7.50	7.40	6.80	7.00	7.40	6.70	7.80	7.80
AMMONIA (MG/L-N)	610	0.10	0.03	<0.01	<0.01	0.05	<0.01	0.58	<0.01	<0.01
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.011	0.193	0.297	1.49	<0.004	0.132	0.009	0.733	2.45
TKN (MG/L-N)	625	1.13	0.45	0.47	0.57	1.22	0.98	5.10	0.64	0.75
T. ORG. N. (MG/L-N)	605	1.04	0.42	0.46	0.56	1.17	0.97	4.53	0.64	0.74
T. PHOSPHOROUS(MG/L)	665	0.291	0.596	0.565	0.313	1.61	0.425	0.479	0.573	0.592
DISS. O-PO4 (MG/L-P)	671	0.058	0.554	0.535	0.298	0.898	0.362	0.404	0.535	0.572
SILICA, DISS(MG/L)	955	1.0	1.8	2.0	6.5	21.1	1.1	12.7	2.0	2.7
DISS. OXYGEN (MG/L)	299	7.3	10.7	10.5	9.1	2.5	9.9	0.2	10.4	9.8
BOD (5 DA.-MG/L)	310	1.6	<1.0	<1.0	<1.0	1.8	2.2	2.4	1.8	1.1
COLIFORM,FEC(#/100ML	31613	12	430	120	640	330	820	12	665	580

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Not found. SLSISLIST (std$cp)
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ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF10 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER R. ELLIOTT

PARAMETERS	STORET #	SAMPLE NUMBERS WQ-1 151200	WQ-2 151201	WQ-3 151202	WQ-4 151203	WQ-5 151204	WQ-7 151205	WQ-8 151206	WQ-13 151208	WQ-14 151209	MDW1 151210
DATE		2/9/82	2/9/82	2/9/82	2/9/82	2/9/82	2/9/82	2/9/82	2/9/82	2/9/82	2/9/82
TIME		1320	1200	1420	1550	1630	1453	1030	915	800	1130
STREAM FLOW (CFS)	61	10.3	11.8	13.0	0.66	0.03	7.93	0.00	19.8	28.6	NA
COLOR (PCU)	80	21	22	28	88	240	28	165	34	31	22
METHY.B.A. SURFT.	38260	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
OIL & GREASE (MG/L)	556	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
SUSP.SOLIDS (MG/L)	530	9	5	5	5	21	6	90	5	5	23
TURBIDITY (NTU)	76	2.40	0.25	0.60	0.60	2.50	1.10	7.90	0.80	0.60	0.60
WATER TEMP (C)	10	22.3	22.3	22.9	23.1	23.8	22.9	20.8	21.1	21.0	22.4
SP.CONDUCT./FIELD	94	381	481	453	268	275	376	353	396	388	537
CYANIDE (MG/L)	720	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
CHLORIDE (MG/L)	940	13	15	17	32	31	15	47	19	19	16
FLUORIDE (MG/L)	951	1.58	1.85	1.64	0.44	0.65	1.93	0.39	1.61	1.56	2.92
SULFATE (MG/L)	945	54	116	128	21	22	50	24	76	75	71
ALKALINITY (MG/L)	410	108	88	69	44	50	104	56	78	77	86
PH	400	8.10	7.20	7.10	6.60	6.20	6.30	5.90	7.10	7.10	7.50
AMMONIA (MG/L-N)	610	<0.01	0.02	0.01	0.03	<0.01	0.03	0.09	0.01	0.16	9.62
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.142
NO3 + NO2 (MG/L-N)	630	<0.004	0.204	0.216	0.854	0.008	0.144	0.108	0.451	1.15	0.342
TKN (MG/L-N)	625	0.96	0.59	0.55	0.67	1.88	0.99	7.96	0.71	0.98	15.5
T. ORG. N. (MG/L-N)	605	0.95	0.57	0.54	0.64	1.87	0.96	7.87	0.70	0.82	5.89
T. PHOSPHOROUS	665	0.268	0.843	0.845	0.936	1.92	0.477	1.32	0.672	0.728	1.58
DISS. O-PO4 (MG/L-P)	671	0.101	0.771	0.793	0.858	1.41	0.404	0.351	0.635	0.680	0.556
SILICA, DISS(MG/L)	955	1.0	1.5	2.0	5.3	18.0	0.8	12.7	3.1	1.9	2.1
DISS. OXYGEN (MG/L)	299	9.5	7.7	6.9	5.6	2.5	7.2	0.9	7.3	6.6	7.5
BOD (5 DA.) MG/L)	310	3.6	<1.0	<1.0	<1.0	1.6	1.3	16.8	<1.0	<1.0	10.8
ARSENIC,TOTAL(UG/L)	1002	<24	<24	<24	<24	<24	<24	<24	<24	<24	<24
BERYLLIUM (UG/L)	1012	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	42
CADMIUM,TOTAL(UG/L)	1027	<0.2	<0.2	0.2	0.4	0.3	<0.2	0.5	0.3	0.3	0.4
CHROMIUM,TOTAL(UG/L)	1034	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	<6.0	7.5
COPPER,TOTAL(UG/L)	1042	<2.0	<2.0	3.8	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
IRON,TOTAL(UG/L)	1045	240	84	22	460	3910	74	1810	57	47	502
LEAD,TOTAL(UG/L)	1051	<2.0	<2.0	<2.0	<2.0	11.1	<2.0	3.1	<2.0	<2.0	<2.0
MERCURY,TOTAL(UG/L)	71900	0.2	0.2	0.2	2.2	2.4	<0.2	0.3	0.2	<0.2	0.2
NICKEL (UG/L)	1067	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0
SELENIUM,TOTAL(UG/L)	1147	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9	<0.9
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
ZINC,TOTAL(UG/L)	1092	<2.0	<2.0	<2.0	5.0	<2.0	<2.0	3.6	<2.0	3.0	<2.0
COLIFORM,FEC(#/100ML	31613	100	90	144	84	1020	196	80	319	480	545

ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF10 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER R. ELLIOTT

SAMPLE NUMBERS

		MDW2
PARAMETERS	STORET #	151211
DATE		2/9/82
TIME		1115
STREAM FLOW (CFS)	61	NA
COLOR (PCU)	80	24
METHY.B.A. SUBST.	38260	<0.50
OIL & GREASE (MG/L)	556	<5
SUSP.SOLIDS (MG/L)	530	18
TURBIDITY (NTU)	76	0.50
WATER TEMP (C)	10	22.0
SP.CONDUCT.,FIELD	94	548
CYANIDE (MG/L)	720	<0.005
CHLORIDE (MG/L)	940	17
FLUORIDE (MG/L)	951	2.78
SULFATE (MG/L)	945	72
ALKALINITY (MG/L)	410	87
PH	400	7.30
AMMONIA (MG/L-N)	610	11.3
AMMONIA,UNIONIZED	619	0.103
NO3 + NO2 (MG/L-N)	630	0.300
TKN (MG/L-N)	625	14.8
T. ORG. N. (MG/L-N)	605	3.43
T. PHOSPHOROUS	665	0.942
DISS. O-PO4 (MG/L-P)	671	0.819
SILICA, DISS(MG/L)	955	2.1
DISS. OXYGEN (MG/L)	299	6.7
BOD (5 DA.-MG/L)	310	33.0
ARSENIC,TOTAL(UG/L)	1002	<24
BERYLLIUM (UG/L)	1012	<1.0
CADMIUM,TOTAL(UG/L)	1027	0.2
CHROMIUM,TOTAL(UG/L)	1034	<6.0
COPPER,TOTAL(UG/L)	1042	<2.0
IRON,TOTAL(UG/L)	1045	364
LEAD,TOTAL(UG/L)	1051	<2.0
MERCURY,TOTAL(UG/L)	71900	0.2
NICKEL (UG/L)	1067	<9.0
SELENIUM,TOTAL(UG/L)	1147	<0.9
SILVER,TOTAL(UG/L)	1077	<0.4
ZINC.TOTAL(UG/L)	1092	<2.0
COLIFORM,FEC(#/100ML	31613	40

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ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF11 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER R. ELLIOTT

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-1 157500	WQ-2 157501	WQ-3 157502	WQ-4 157503	WQ-5 157504	WQ-7 157505	WQ-8 157506	WQ-10 157507	WQ-13 157508	WQ-14 157509
DATE		3/10/82	3/10/82	3/10/82	3/10/82	3/10/82	3/10/82	3/10/82	3/10/82	3/10/82	3/10/82
TIME		1015	900	1300	1130	1345	1340	1425	1445	1240	1145
STREAM FLOW (CFS)	61	8.26	12.2	14.3	1.56	0.05	6.56	0.00	0.00	34.2	48.0
COLOR (PCU)	80	50	60	90	100	220	80	180	160	120	100
SUSP.SOLIDS (MG/L)	530	14	6	<5	10	20	18	14	16	18	12
TURBIDITY (NTU)	76	3.40	0.80	0.70	0.70	3.70	1.40	2.50	5.20	1.20	1.00
WATER TEMP (C)	10	19.4	17.3	18.4	16.6	19.0	18.9	16.0	17.1	17.0	16.5
SP.CONDUCT.,FIELD	94	351	390	383	214	239	326	289	604	351	336
CHLORIDE (MG/L)	940	14	16	20	29	31	14	39	40	23	23
FLUORIDE (MG/L)	951	1.63	1.55	1.27	0.38	0.59	1.62	0.35	1.37	1.07	1.08
SULFATE (MG/L)	945	39	102	87	28	14	41	21	249	80	65
ALKALINITY (MG/L)	410	113	80	67	32	50	102	49	7	55	58
PH	400	7.50	7.10	7.00	6.50	6.20	7.20	6.30	5.40	7.10	7.00
AMMONIA (MG/L-N)	610	0.01	0.01	0.02	0.04	<0.01	0.02	0.12	0.03	0.03	0.05
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.006	0.080	0.282	0.915	0.008	0.122	0.217	0.005	0.529	1.22
TKN (MG/L-N)	625	0.99	0.50	0.67	1.10	1.57	0.92	1.50	1.04	0.81	0.82
T. ORG. N. (MG/L-N)	605	0.98	0.48	0.65	1.07	1.56	0.90	1.38	1.01	0.78	0.77
T. PHOSPHORUS	665	0.304	0.505	0.548	0.810	1.67	0.393	0.519	0.861	0.590	0.636
DISS. O-PO4 (MG/L-P)	671	0.065	0.438	0.503	0.788	1.48	0.330	0.444	0.646	0.549	0.558
SILICA, DISS(MG/L)	955	0.8	2.2	3.5	6.3	18.4	0.9	11.3	7.0	4.4	4.4
DISS. OXYGEN (MG/L)	299	7.4	7.6	8.0	6.7	4.7	8.1	2.4	3.0	8.6	8.5
BOD (5 DA.-MG/L)	310	3.0	<1.0	1.0	<1.0	1.9	1.8	2.1	1.9	1.3	<1.0
COLIFORM,FEC(#/100ML	31613	14	60	52	189	96	52	108	124	52	228

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ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF12 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER R. ELLIOTT

PARAMETERS	STORET #	SAMPLE NUMBERS WQ-1 161200	WQ-2 161201	WQ-3 161202	WQ-4 161203	WQ-5 161204	WQ-7 161205	WQ-8 161206	WQ-10 161207	WQ-13 161208	WQ-14 161209
DATE		4/7/82	4/6/82	4/6/82	4/7/82	4/7/82	4/6/82	4/7/82	4/7/82	4/7/82	4/7/82
TIME		936	1120	1245	825	1130	1400	1100	750	1200	1315
STREAM FLOW (CFS)	61	17.4	8.91	11.2	0.98	0.00	33.9	0.00	0.00	42.1	55.1
COLOR (PCU)	80	50	45	90	250	275	100	175	200	75	80
METHY.B.A. SURST.	38260	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50	<0.50
OIL & GREASE (MG/L)	556	<5	<5	<5	<5	<5	<5	<5	<5	<5	<5
SUSP.SOLIDS (MG/L)	530	10	<5	7	6	12	8	5	10	6	8
TURBIDITY (NTU)	76	3.10	0.95	5.20	1.00	2.90	1.40	1.50	2.90	1.00	0.95
WATER TEMP (C)	10	22.6	23.9	23.7	17.6	20.3	24.5	19.3	18.3	21.7	21.6
SP.CONDUCT.,FIELD	94	356	325	304	180	259	353	318	239	338	335
CYANIDE (MG/L)	720	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
CHLORIDE (MG/L)	940	13	12	15	23	23	13	35	28	15	15
FLUORIDE (MG/L)	951	1.97	1.54	1.42	0.39	0.76	2.20	0.40	1.16	1.94	1.84
SULFATE (MG/L)	945	52	70	55	19	12	50	38	42	56	55
ALKALINITY (MG/L)	410	107	70	61	30	82	94	60	20	81	82
PH	400	7.50	7.10	6.90	6.40	6.20	6.90	6.00	5.80	7.20	7.20
AMMONIA (MG/L-N)	610	0.02	0.01	0.03	0.04	<0.01	0.09	0.20	0.05	0.05	0.03
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.006	0.053	0.226	1.07	0.021	0.162	0.084	0.010	0.513	0.955
TKN (MG/L-N)	625	1.09	0.49	1.07	1.14	1.34	1.04	1.34	1.03	0.83	0.78
T. ORG. N. (MG/L-N)	605	1.07	0.48	1.05	1.10	1.33	0.96	1.14	0.98	0.78	0.75
T. PHOSPHOROUS	665	0.395	0.623	0.809	0.870	1.67	0.420	0.379	0.843	0.490	0.500
DISS. O-PO4 (MG/L-P)	671	0.211	0.502	0.619	0.625	1.30	0.329	0.274	0.650	0.403	0.424
SILICA, DISS(MG/L)	955	2.3	0.8	3.2	5.8	6.4	1.3	4.0	7.4	2.0	2.2
DISS. OXYGEN (MG/L)	299	6.2	7.1	6.7	6.7	5.9	6.4	1.4	2.1	7.8	8.2
BOD (5 DA.-MG/L)	310	3.5	1.1	1.8	<1.0	1.6	2.0	2.4	1.6	<1.0	1.0
ARSENIC,TOTAL(UG/L)	1002	<26	<27	<27	<27	<27	<27	<27	<27	<27	<27
BERYLLIUM (UG/L)	1012	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
CADMIUM,TOTAL(UG/L)	1027	0.6	0.5	0.2	0.3	0.4	0.3	0.4	0.4	0.6	0.3
CHROMIUM,TOTAL(UG/L)	1034	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0	<9.0
COPPER,TOTAL(UG/L)	1042	6.7	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0	<3.0
IRON,TOTAL(UG/L)	1045	180	<30	92	384	1380	<30	251	469	<30	<30
LEAD,TOTAL(UG/L)	1051	<2.0	4.8	<4.0	<4.0	10.5	<4.0	<4.0	<4.0	<4.0	<4.0
MERCURY,TOTAL(UG/L)	71900	0.3	0.3	0.5	0.4	0.8	0.4	1.0	0.5	1.0	0.4
NICKEL (UG/L)	1067	<17.0	<17.0	<17.0	<17.0	<17.0	<17.0	<17.0	<17.0	<17.0	<17.0
SELENIUM,TOTAL(UG/L)	1147	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4
ZINC,TOTAL(UG/L)	1092	16.0	2.3	1.6	9.0	14.5	22.1	4.1	<1.0	<1.0	10.2
COLIFORM,FEC(#/100ML	31613	12	48	72	152	52	88	480	205	32	48

ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82

FIELD GROUP CF12 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410

PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE

FIELD GROUP LEADER R. ELLIOTT

SAMPLE NUMBERS

PARAMETERS	STORET #	MDW1 161210	MDW2 161211
DATE		4/6/82	4/6/82
TIME		0	0
STREAM FLOW (CFS)	61	NA	NA
COLOR (PCU)	80	100	100
METHY.B.A. SUBST.	38260	<0.50	<0.50
OIL & GREASE (MG/L)	556	<5	<5
SUSP.SOLIDS (MG/L)	530	21	18
TURBIDITY (NTU)	76	7.80	5.70
WATER TEMP (C)	10	23.8	23.6
SP.CONDUCT.,FIELD	94	420	420
CYANIDE (MG/L)	720	<0.005	<0.005
CHLORIDE (MG/L)	940	13	13
FLUORIDE (MG/L)	951	2.89	2.98
SULFATE (MG/L)	945	113	115
ALKALINITY (MG/L)	410	68	67
PH	400	8.40	8.30
AMMONIA (MG/L-N)	610	1.45	1.66
AMMONIA,UNIONIZED	619	0.169	0.155
NO3 + NO2 (MG/L-N)	630	0.147	0.138
TKN (MG/L-N)	625	3.89	3.68
T. ORG. N. (MG/L-N)	605	2.44	2.02
T. PHOSPHOROUS	665	0.712	0.634
DISS. O-PO4 (MG/L-P)	671	0.233	0.224
SILICA, DISS(MG/L)	955	2.7	2.7
DISS. OXYGEN (MG/L)	299	9.2	8.2
BOD (5 DA.-MG/L)	310	15.6	3.4
ARSENIC,TOTAL(UG/L)	1002	<27	<27
BERYLLIUM (UG/L)	1012	<1.0	<1.0
CADMIUM,TOTAL(UG/L)	1027	0.5	0.6
CHROMIUM,TOTAL(UG/L)	1034	<9.0	<9.0
COPPER,TOTAL(UG/L)	1042	<3.0	<3.0
IRON,TOTAL(UG/L)	1045	<30	<30
LEAD,TOTAL(UG/L)	1051	<4.0	<4.0
MERCURY,TOTAL(UG/L)	71900	0.3	<0.2
NICKEL (UG/L)	1067	<17.0	<17.0
SELENIUM,TOTAL(UG/L)	1147	<1.0	<1.0
SILVER,TOTAL(UG/L)	1077	<0.4	<0.4
ZINC,TOTAL(UG/L)	1092	8.7	9.8
COLIFORM,FEC(#/100ML	31613	20	48

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ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF13 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER R. ELLIOTT

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-2 166701	WQ-3 166702	WQ-4 166703	WQ-5 166704	WQ-7 166705	WQ-8 166706	WQ-10 166708	WQ-13 166709	WQ-1 166710	WQ-14 166711
DATE		5/6/82	5/6/82	5/6/82	5/5/82	5/6/82	5/5/82	5/5/82	5/5/82	5/6/82	5/5/82
TIME		1150	925	830	1345	1010	1400	1430	1300	1050	1200
STREAM FLOW (CFS)	61	845	9.69	0.39	0.00	6.79	0.00	0.00	20.3	5.94	29.7
COLOR (PCU)	80	25	35	25	180	50	100	105	50	30	50
SUSP.SOLIDS (MG/L)	530	<5	<5	<5	5	<5	6	<5	<5	<5	<5
TURBIDITY (NTU)	76	0.40	0.50	0.80	2.60	0.80	1.90	3.30	0.50	2.90	0.50
WATER TEMP (C)	10	21.8	21.2	18.8	21.5	21.7	20.7	22.2	21.9	24.1	21.7
SP.CONDUCT.,FIELD	94	358	344	184	256	335	310	344	344	353	340
CHLORIDE (MG/L)	940	12	13	26	21	14	33	27	16	14	16
FLUORIDE (MG/L)	951	1.12	1.30	0.37	0.71	1.87	0.35	2.55	1.54	1.96	1.40
SULFATE (MG/L)	945	61	83	20	9	40	34	76	56	48	52
ALKALINITY (MG/L)	410	78	70	26	75	95	50	10	65	103	64
PH	400	7.40	7.00	6.30	6.20	7.00	5.90	5.40	7.10	7.90	7.10
AMMONIA (MG/L-N)	610	<0.01	<0.01	0.02	<0.01	0.01	0.10	0.02	<0.01	<0.01	<0.01
AMMONIA,UNIONIZED	619	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.005	0.051	0.999	0.007	0.203	0.028	0.007	0.777	0.006	1.76
TKN (MG/L-N)	625	0.24	0.41	0.82	1.37	0.71	1.69	0.94	0.69	1.18	1.14
T. ORG. N. (MG/L-N)	605	0.24	0.41	0.80	1.36	0.70	1.59	0.92	0.69	1.18	1.14
T. PHOSPHOROUS	665	0.346	0.386	0.519	1.55	0.376	0.289	0.648	0.445	0.419	0.474
DISS. O-PO4 (MG/L-P)	671	0.318	0.366	0.484	1.26	0.321	0.146	0.492	0.410	0.315	0.435
SILICA, DISS(MG/L)	955	3.4	3.3	5.9	17.9	1.3	9.2	6.6	2.0	<0.2	2.5
DISS. OXYGEN (MG/L)	299	8.4	7.3	6.4	1.5	6.3	0.5	3.8	8.5	6.6	8.5
BOD (5 DA.-MG/L)	310	1.8	2.4	2.1	5.7	3.0	4.2	3.6	3.0	4.2	2.4
COLIFORM,FEC(#/100ML	31613	108	32	152	<4	112	4	<4	<4	8	<4

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ENVIRONMENTAL SCIENCE & ENGINEERING 08/01/82 FIELD GROUP CF14 STATUS IS PRELIMINARY

PROJECT NUMBER 81714410 PROJECT NAME CF INDUSTRIES

PROJECT MANAGER KAREN TUTTLE FIELD GROUP LEADER RON ELLIOTT

		SAMPLE NUMBERS									
PARAMETERS	STORET #	WQ-1 173400	WQ-2 173401	WQ-3 173402	WQ-4 173403	WQ-5 173404	WQ-7 173405	WQ-8 173406	WQ-10 173407	WQ-13 173408	WQ-14 173409
DATE		6/4/82	6/3/82	6/8/82	6/4/82	6/4/82	6/8/82	6/3/82	6/3/82	6/4/82	6/4/82
TIME		1240	930	1300	1030	1430	1245	1335	1230	900	750
STREAM FLOW (CFS)	61	18.7	104	115	50.1	1.84	43.0	18.4	13.5	320	391
COLOR (PCU)	80	50	450	400	470	500	70	500	400	400	400
SUSP.SOLIDS (MG/L)	530	14	<5	<5	<5	<5	7	5	<5	<5	<5
TURBIDITY (NTU)	76	6.90	2.50	1.30	0.80	1.00	1.10	1.10	1.00	1.90	1.90
WATER TEMP (C)	10	28.3	25.7	27.0	26.4	25.8	28.0	26.0	25.2	25.9	25.8
SP.CONDUCT.,FIELD	94	291	130	160	73.0	104	290	82.0	83.0	128	151
CHLORIDE (MG/L)	940	13	12	15	9	12	14	9	9	12	12
FLUORIDE (MG/L)	951	1.85	0.70	0.69	0.21	0.27	1.82	0.23	0.31	0.59	0.67
SULFATE (MG/L)	945	40	20	4	<1	1	38	<1	<2	18	22
ALKALINITY (MG/L)	410	88	27	33	21	22	78	14	11	20	29
PH	400	8.70	5.80	6.50	5.30	5.70	7.00	5.30	5.30	5.80	6.00
AMMONIA (MG/L-N)	610	<0.01	0.03	0.12	0.03	0.03	0.08	0.02	0.02	0.05	0.05
AMMONIA,UNIONIZED	619	<0.003	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
NO3 + NO2 (MG/L-N)	630	0.005	0.012	0.062	0.045	0.013	0.312	0.013	0.013	0.275	0.311
TKN (MG/L-N)	625	1.19	1.42	1.94	1.47	1.86	1.40	1.88	1.49	1.49	1.46
T. ORG. N. (MG/L-N)	605	1.18	1.40	1.82	1.44	1.84	1.32	1.86	1.47	1.44	1.42
T. PHOSPHOROUS	665	0.507	1.12	1.60	0.871	0.932	0.531	0.810	0.506	1.02	1.05
DISS. O-PO4 (MG/L-P)	671	0.248	0.972	0.787	0.829	0.932	0.440	0.802	0.439	0.992	0.889
SILICA, DISS(MG/L)	955	0.6	4.3	5.9	3.7	7.1	<0.2	5.2	4.0	4.5	4.2
DISS. OXYGEN (MG/L)	299	8.2	3.9	2.4	2.8	4.3	4.9	2.5	3.2	4.5	4.7
BOD (5 DA.-MG/L)	310	2.8	4.8	2.4	1.3	1.5	4.2	4.8	5.4	1.2	<1.0
COLIFORM,FEC(#/100ML	31613	84	440	420	248	200	195	76	116	20	44

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*U. S. Government Printing Office 1988: 533-376/60671