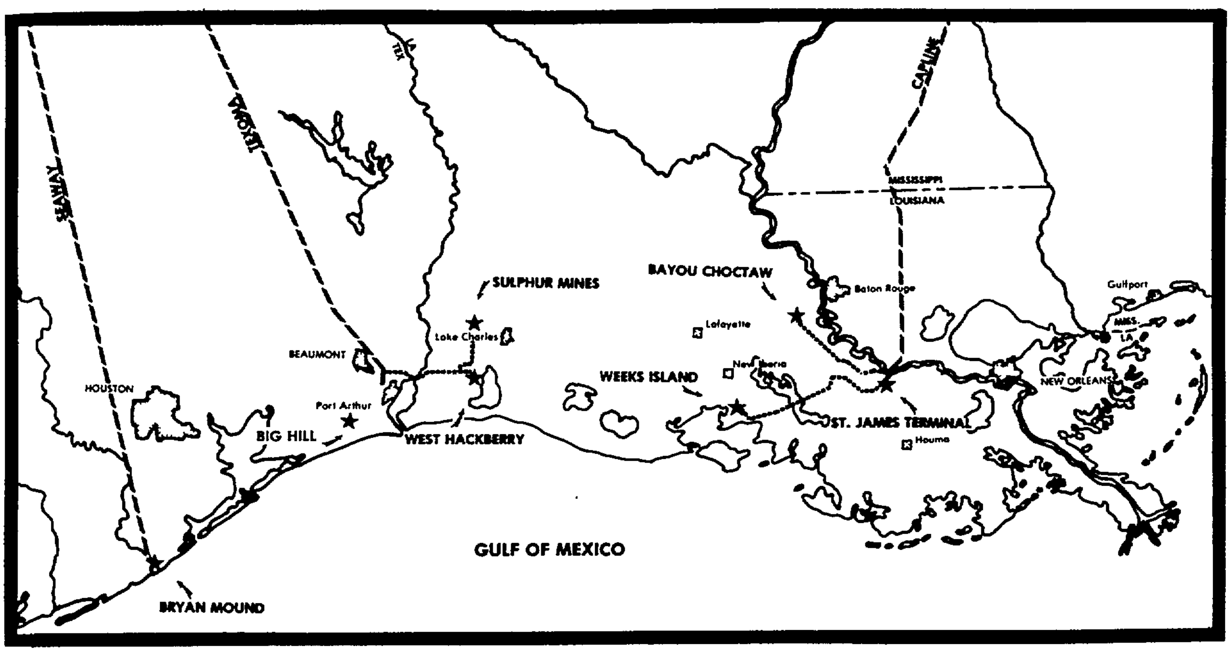
STRATEGIC PETROLEUM RESERVE

ANNUAL ENVIRONMENTAL MONITORING REPORT

Publication 124-84-AS-001

1983



POSSI

Kaneb

Petroleum Operations and Support Services, Inc.
850 South Clearview Parkway
New Orleans, Louisiana 70123

TABLE OF CONTENTS

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

TABLE OF CONTENTS
(continued)

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

TABLE OF CONTENTS
(continued)

LIST OF FIGURES

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

1. INTRODUCTION

The creation of the Strategic Petroleum Reserve (SPR) was mandated by Congress in Title 1 Part B of the Energy Policy and Conservation Act (P.L. 94-163) and approved on December 22, 1975. Its purpose is to provide the United States with sufficient petroleum reserves to minimize the effects of an oil supply interruption.

The SPR consists of five Gulf Coast underground salt dome oil storage complexes (four in Louisiana and one in Texas) and a marine terminal facility at St. James, Louisiana. The SPR made use of existing storage capacity early in the project by utilizing four sites with previously solution mined cavities or, as with Weeks Island, a conventional underground salt mine. Additional space has been and is being created by solution mining at four sites.

The sites are centered around three major inland pipeline systems which transport U.S. and foreign crude oil from the Gulf Coast to refineries in the Midwest. The inland pipeline terminals used by the SPR are the Seaway Pipeline Terminal (Freeport, Texas), the Texoma Pipeline Terminal (Nederland, Texas), and the Capline Pipeline Terminal (St. James, Louisiana).

1.1 BAYOU CHOCTAW

The Bayou Choctaw site is located on the west side of the Mississippi River 12 miles southwest of Baton Rouge, in Iberville Parish, Louisiana. The site consists of four existing solution mined caverns. Solution mining of a fifth cavern is in progress.

The area surrounding the site is a freshwater swamp. Elevation ranges from approximately 5 to 10 feet above sea level. Although there are no clear topographic expressions in the area, major surface subsidence has occurred creating substantial areas of bottomland hardwoods and swamp with interconnecting waterways. The site proper is normally dry. However, flooding may occur during the spring in portions of the site. The collapse of a solution mined cavity in 1955 resulted in the formation of a 12-acre lake (Cavern Lake) on the north side of the site.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

The site is located near the intersection of several major bayous and waterways. The Intracoastal Waterway (Port Allen Canal) passes in a north-south direction west of the site. The Intracoastal Waterway extends to the north and then turns eastward through the Port Allen Canal to enter the Mississippi River at Baton Rouge. In the area of the site, the Intracoastal Waterway is part of Choctaw Bayou, a natural waterway.

Bayou Grosse Tete enters from the northwest and intersects the Intracoastal Waterway south of the site with an interconnecting crossover almost due west of the site. Bayou Bourbeaux enters the area from the northeast and passes through Cavern Lake to form the North-South Canal through the site. The East-West (or Wilbert) Canal extends in a generally east-west direction on the southern side of the site to intersect the Intracoastal Waterway near its intersection with Bayou Grosse Tete.

Bottomland hardwood forest and deciduous swamps are predominant at the Bayou Choctaw site. The overstory vegetation at the site includes bald cypress and water tupelo (characteristic of lowland areas), bull tongue, and spike rushes. Water oak is also present but not abundant.

The deciduous swamp is the most widespread habitat type found at the site. It provides resources for a large number of wildlife. Bird species common at Bayou Choctaw are herons, egrets, woodpeckers, wood duck, thrushes, and American woodcock. Inhabitants of the bottomland forest and swamp include opossum, squirrels, nutria, mink, raccoon, swamp rabbit, white-tailed deer, alligator, and snakes.

1.2 BRYAN MOUND

The Bryan Mound site is located in Brazoria County, about 65 miles due south of Houston, Texas on the east bank of the Brazos River Diversion Channel near its juncture with the Gulf of Mexico, and three miles southwest of Freeport, Texas.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

The site is in the southwest apex of a triangle formed by the Brazos River Diversion Channel, the old Brazos River, and the Intracoastal Waterway. A U.S. Army Corps of Engineers silt gate controls the flow between the Intracoastal Waterway and the Diversion Channel. The Bryan Mound site is situated atop a salt dome, which creates a surface expression in the terrain by rising about 15 feet above the surrounding wetlands. The levees protecting the town of Freeport to the northeast form a second triangular pattern within the triangle formed by the rivers. A levee parallels the Brazos River to the west of the site. A second levee north of and parallel to the Intracoastal Waterway essentially bisects the site, intersecting the Brazos River levee and proceeding northeast.

The major nearby water bodies are Blue Lake, north of the site, and Mud Lake to the south. These water bodies generally define the mounded aspect of the dome upon which Bryan Mound is located. Blue Lake is within the 3.4-square-mile protective triangle formed by the levee system. Although Blue Lake is essentially isolated by the levees (the excess rain water is drained off by two large pump stations operated by the city of Freeport), there is some drainage through culverts southward into the Intracoastal Waterway. Mud Lake, on the other hand, is directly connected with the Intracoastal Waterway.

The marsh and prairie areas surrounding Bryan Mound are typical of those found throughout this region of the Texas Gulf Coast and have no unique natural or scenic features. In all low-lying areas, brackish marshland dominates the site with the exception of the northern area of the site where the coastal prairie ecosystem extends along the levees paralleling the Brazos River Diversion Channel. The coastal prairie is covered with medium to very tall grasses which form a moderate to dense cover for wildlife. These grasses are usually found in the site area where soil moisture extends to a great depth. Those areas periodically inundated by seawater are dominated by gulf cordgrass.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

A diverse range of habitats is created by the water bodies surrounding Bryan Mound. Marshes and tidal pools, such as Mud Lake and Bryan Lake, which connect with the Gulf of Mexico by way of the Intracoastal Waterway or the Brazos River, are ideal habitats for a variety of birds, aquatic life, and mammals. On the site and in surrounding areas of Bryan Mound, the common egret, snowy egret, migratory waterfowl, great blue heron, least tern and black-necked stilt (both state protected species), killdeer, nutria, raccoon, skunk, rattlesnakes, turtles, and frogs can be found.

In Mud Lake, larval shrimp and fish, adult crabs, trout, flounder, and redfish can be found during various seasons of the year. Black drum, mullet, gar, and blue crabs are found in Blue Lake.

1.3 ST. JAMES TERMINAL

The St. James Terminal is located on the west bank of the Mississippi River approximately halfway between New Orleans and Baton Rouge, Louisiana. It lies approximately 1.9 miles north of the town of St. James on Louisiana Highway 18. The terminal consists of six aboveground storage tanks, two tanker docks on the Mississippi River, and associated piping and pumping equipment.

Tankships transfer oil to the terminal from the two docks (Dock 1 and Dock 2) located on the west bank of the river. A fire water dock is located next to upstream Dock 1. The docks are connected to the terminal by way of pipelines which pass over Louisiana Highway 18 and then underground to the terminal. The site is bordered on the north by the Capline terminal and on the south by the LOOP Offshore Capline (LOCAP) terminal, which connects to the Louisiana Offshore Oil Port (LOOP) salt cavern storage facility in southern Louisiana.

The terminal itself is essentially enclosed by facilities or structures which block all land flow away from the site (the Texas and Pacific Railroad to the west, the above-mentioned terminal facilities to the north and south, and the Mississippi River levee on the east between Highway 18 and the river).

The area adjacent to the Mississippi River at the St. James docks is considered a fresh water wetland (batture land). Much of the land area surrounding the terminal is used for pasture and sugar cane cultivation. This land is covered by a mixture of introduced cool and warm season grasses and legumes. Frogs, snakes, turtles, rabbit, raccoon, armadillo, muskrat, opossum, nutria, squirrels, egrets, ibis, and herons can be found on the site and in the surrounding areas.

1.4 SULPHUR MINES

The Sulphur Mines site is located in Calcasieu Parish, 1.5 miles west of the town of Sulphur, Louisiana. The site is divided into two areas, the quadrangular primary site and the figure-eight shaped secondary area. The primary site area is bordered on the east by several large bodies of water. The secondary site area is bordered on the west and northwest by water bodies. Most of these bodies of water are interconnected and drained by one creek flowing eastward from the site to Bayou D'Inde. A floodwater canal is located 1/4 mile east of the site. Changes in elevation throughout the site are minor, with most of the site 15 to 20 feet above sea level. The site proper is normally dry. However, high waters in the spring season sometimes flood portions of it. The lowest elevations are over the center of the dome where subsidence has occurred. Much of the surrounding area is covered with a mixed pine and deciduous forest.

Mammals on site and in the surrounding areas are white-tailed deer, raccoon, fox squirrel, cottontail rabbit, opossum, striped skunk, armadillo, nutria, southern flying squirrel, white-footed mouse, and bobcat. Snakes, turtles, alligator, frogs, and toads can also be found. Crappie, large mouth bass, sunfish, gar, carp, bowfin, and catfish inhabit the shallow ponds on the Sulphur Mines site.

1.5 WEEKS ISLAND

The Weeks Island salt mine is a conventional underground mine in the Weeks Island salt dome. This geological feature borders Vermilion Bay, which opens to the Gulf of Mexico. Weeks Island is located in Iberia Parish, Louisiana,

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

about 14 miles south of New Iberia, Louisiana. Two large underground areas have been excavated, resulting in two levels of "rooms and pillars" with total storage capacity of 74.5 million barrels.

The surface expression over the salt dome which forms the island includes the highest elevation (171 feet) in southern Louisiana. The area surrounding the island is a combination of swamp, marsh, bayous, manmade canals, and bays contiguous with the Gulf of Mexico. The SPR site is located on the southwest slope of the island above the mine previously mentioned.

The vegetation on Weeks Island is quite varied. The island is characterized by lowland hardwood species which exist here because of the higher elevation afforded by the island and the presence of very fertile loam as a soil base. The dominant trees are oak, magnolia, and hickory, which extend down to the surrounding marsh. Pecan trees are also present. The coastal wetlands found at the Weeks Island site include the manmade Intracoastal Waterway and saline and brackish marshes and bayous. Gulls, terns, herons, and egrets are commonly found in and around the marshes. Mink, nutria, otter, raccoon, and alligator are the most common inhabitants of the intermediate marshes. Others found in the environs of Weeks Island are opossum, bats, squirrels, swamp rabbit, bobcat, white-tailed deer, bear, and coyote.

The water bodies surrounding Weeks Island are a vast estuarine nursery ground for an array of commercially and recreationally important finfish and shellfish.

1.6 WEST HACKBERRY

The West Hackberry site is located in Cameron Parish 12 miles southwest of Lake Charles, Louisiana and 16 miles north of the Gulf of Mexico.

The site is situated on 290 acres of land on top of the West Hackberry salt dome. The dome itself is covered by a distinct mounded overburden on its western portion with elevations up to 21 feet (the highest point in Cameron

Parish). The rest of the dome, an area of 890 acres, is elevated about five feet above sea level.

The bordering waterways include Calcasieu Lake and the Calcasieu Ship Channel approximately three miles to the east, and the Intracoastal Waterway approximately four miles north of the site. Water bodies in the area of the site are connected to the Intracoastal Waterway by the north-south-running Alkali Ditch. Black Lake, a brackish water lake, borders the "island" formed by the upwelling of the dome on the northern and western sides. Numerous canals and natural waterways, including Black Lake Bayou, connect Black Lake to the Alkali Ditch on the eastern side of the site. Black Lake Bayou wanders in a generally easterly direction from Black Lake, eventually connecting with the Calcasieu Ship Channel northeast of the town of Hackberry. A site canal that runs northeast to southwest connects Alkali Ditch directly with the eastern side of the site.

The western part of Cameron Parish consists of marshland with natural ridges extending in a generally east-west direction. These ridges, or cheniers, are stranded former beach lines, and they play a role in directing water flow through the marshes. The cheniers typically support grasses and trees. In many areas, lakes, bayous, and canals are concentrated so that the marsh may not seem to be a land mass at all but rather a large region of small islands. Marshes closest to the coast generally have the highest salinity levels and lowest species diversity. Vegetation found on site and in the surrounding area of the West Hackberry facility is dominated by Chinese tallow, bay, crape myrtle, live oak, and various species of marsh grass and upland crop grasses. Red fox, alligator, snakes, egrets, herons, roseate spoonbill, raccoon, nutria, opossum, rabbit, white-tailed deer, migratory waterfowl, and red-tailed hawk can be found on and in the area surrounding the West Hackberry facility. Aquatic inhabitants of Black Lake include crabs, drum, croaker, spot, sheepshead, shrimp, mullet, gar, redfish, oysters, and catfish.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

2. PROGRAM OVERVIEW

The Petroleum Operations and Support Services, Inc. (POSSI) Environmental Plan is designed to support the SPR's mission through the implementation of programs aimed at avoiding or minimizing adverse environmental effects on the SPR sites, surrounding lands, and water bodies.

The monitoring and inspection program was developed using the Department of Energy (DOE) SPR Programmatic Environmental Action Report, Site Environmental Action Reports, and DOE Orders. The program includes monitoring permitted National Pollutant Discharge Elimination System (NPDES) outfalls, monitoring air emissions, and making other required federal and state inspections as well as regular sampling and analysis of site-associated surface water quality. This makes possible the assessment of environmental impacts and early detection of surface water quality degradation that may occur as a result of SPR operations.

The results of air quality monitoring and reporting, NPDES compliance, and water quality monitoring for calendar year 1983 are discussed in sections 3, 4, and 5.

2.1 ASSOCIATED PROGRAMS

Associated programs developed to support the SPR Environmental Plan include Spill Reporting Procedures, site-specific Oil Spill Contingency Plans, site-specific Spill Prevention Control and Countermeasures Plans, an Underground Injection Control Program, a Solid Waste Management Plan, and a Fugitive Emissions Monitoring Plan. Compliance with federal, state, and local laws, regulations, and permits has been accomplished by implementation of these programs.

2.2 TRAINING

Site Environmental and Emergency Response Team personnel have received training in support of the Environmental Plan and associated programs. Site management personnel were briefed on the implementation of the Environmental Plan, Spill Reporting Procedures, the site-specific Oil Spill

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Contingency Plans, the site-specific Spill Prevention Control and Countermeasures Plans, and compliance awareness.

Training in the Environmental Plan and associated programs was accomplished at a meeting of the New Orleans staff and site Environmental personnel. Compliance awareness training was conducted by the New Orleans staff at each of the SPR sites. During this training, site personnel learned about the SPR environmental program's applicable regulatory requirements. In addition, a two-day seminar on Environmental Laws and Regulations was sponsored by POSSI. Attendees included site management and staff personnel along with numerous DOE and other contractor employees.

Selected Emergency Response Team personnel from all sites have attended the Texas A&M University Oil Spill School. Personnel from all sites have participated in onsite training in oil spill cleanup and control conducted by the U.S. Coast Guard Gulf Strike Team. Consequently, site personnel are trained to respond rapidly and effectively in the containment and cleanup of oil spills.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

3. AIR QUALITY MONITORING AND REPORTING

During 1983, the operation of all SPR sites was carried out in accordance with appropriate state air quality permits. The semiannual Status of Construction Reports required by the Louisiana Air Control Board in the Certificates of Approval for Air Emissions were submitted for each applicable site in accordance with specific permit requirements. Construction of St. James Terminal and Weeks Island was certified complete during 1983. Reports of actual air emissions under the construction phase were prepared for these sites and the Air Emission Inventory Questionnaires were updated. These reports demonstrated that hydrocarbon and sulphur dioxide emissions were considerably less than projected in the Application for Approval of Emissions submitted for St. James Terminal and Weeks Island before construction.

The quarterly reports required by the Texas Air Control Board permit for Bryan Mound were prepared and submitted on schedule throughout 1983. An internally conducted fugitive hydrocarbon emissions monitoring program was fully implemented during 1983 at Bryan Mound. All monitoring data indicated negligible fugitive emissions of volatile organic carbon (VOC) compounds during 1983.

The Department of Energy (DOE) initiated an onshore baseline characterization of the SPR sites beginning October 1, 1982. This study focused on air quality and meteorological monitoring at all six SPR sites. Monitoring continued through September 30, 1983, except at Weeks Island. There, a sensor to detect the presence of hydrochlorous acid was added to the array identified below, and data for all parameters were collected through December 31, 1983. Specific parameters monitored included:

- Total suspended particulates (TSP)
- Ozone (O_3)
- Nonmethane hydrocarbons
- Wind direction
- Standard deviation of wind direction (sigma theta)
- Wind speed
- Temperature
- Barometric pressure

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Short wave solar radiation
Rainfall

In addition to atmospheric monitoring, this baseline study included a quantitative and qualitative speciation of the flora at the West Hackberry site. This phase of the baseline study began during 1983. The final report is scheduled to be delivered to DOE by April 30, 1984.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

4. OIL SPILLS AND NPDES COMPLIANCE

In calendar year 1983, the total amount of oil received in the SPR project was in excess of 85.3 million barrels. In that period of time, a total of 21 oil spills of 1 barrel or more occurred. Those spills totalled 2,396 barrels or .0028 percent of the oil received. This was a 45-percent reduction in the total volume of oil spilled compared to 1982, or a 40-percent reduction in the percent of oil received which was spilled during 1983 as compared to 1982. One oil spill of 1,625 barrels reached a navigable waterway and required a report to the National Response Center. However, this spill was contained and cleaned up with no long-term environmental impact (see paragraph 5.3.6). The remaining oil spills were contained within the system containment devices and recovered for authorized disposal.

In calendar year 1983, approximately 2,370 NPDES-permitted and other monitored discharges were made at the SPR facilities. Of these, approximately 694 were associated with brine disposal to the Gulf of Mexico. There were 23 occurrences of permit noncompliance reported. Therefore, the SPR was in compliance with the NPDES permit requirements for 99.0 percent of the discharges conducted during this report period.

5. WATER QUALITY MONITORING

5.1 INTRODUCTION

A primary goal of POSSI and DOE is to prevent damage to the environment resulting from SPR construction, operation, and maintenance activities. An effectual water quality monitoring program provides a mechanism for assessing the impact of SPR activity on the aquatic environs. The site water quality monitoring programs were developed as management tools for the purpose of allowing control and mitigation of unwarranted aquatic impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

During 1983, the surface waters of the Bayou Choctaw, Bryan Mound, Sulphur Mines, and West Hackberry SPR sites were sampled and monitored for general water quality. Each site's water quality program was conducted by site environmental and laboratory personnel. The unique ecological characteristics and diverse history of the SPR sites preclude a standard water quality monitoring program. Thus the frequency and types of water quality measurements conducted in fulfillment of the water quality monitoring programs are a reflection of each site's activity and environmental characteristics.

Surface water quality monitoring was not conducted at St. James Terminal or Weeks Island because of the lack of potentially impacted surface waters on or near these two sites.

A discussion of the water quality at each of the SPR sites follows. These discussions proceed by water quality parameter describing trends and anomalies and discussing causal relationships, including operation of site outfalls. To facilitate effective evaluation of the site water quality data, the following SPR site water quality criteria were established and used:

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

pH	6.5 - 8.5 standard units
Salinity	Significant variation from ambient
Temperature	32°C maximum
Total Suspended Solids*	10 mg/l or 30 mg/l
Total Dissolved Solids	500 mg/l
Dissolved Oxygen	5 mg/l
Biochemical Oxygen Demand*	10 mg/l or 30 mg/l
Total Organic Carbon	40 mg/l

*10 mg/l for the Bayou Choctaw site is based on Louisiana average discharge limitations into the classified stressed environment.

These criteria are based on Federal, Louisiana, and Texas water quality criteria, discharge permit limitations, environmental literature, and the professional judgment of POSSI's Environmental Control Group.

The site discussions regarding salinity refer to the Venice system of classifying marine waters. According to this system, the surface waters throughout the SPR may be classified on the basis of salinity as polyhaline (30 to 18 ppt), mesohaline (18 to 5 ppt), oligohaline (5 to 0.5 ppt), or limnetic (less than 0.5 ppt).

Several additional parameters, such as macronutrients and major ions, are discussed in the text based on relative concentrations rather than absolute criteria.

5.2 BAYOU CHOCTAW

Water quality monitoring of the Bayou Choctaw surface waters was generally conducted on a monthly basis throughout 1983. No water quality data were collected during June, July, or August. Specific monitoring stations are identified in Figure 5-1 by station A in Bayou Bourbeaux just north of Cavern Lake; stations B and C in Bayou Bourbeaux between

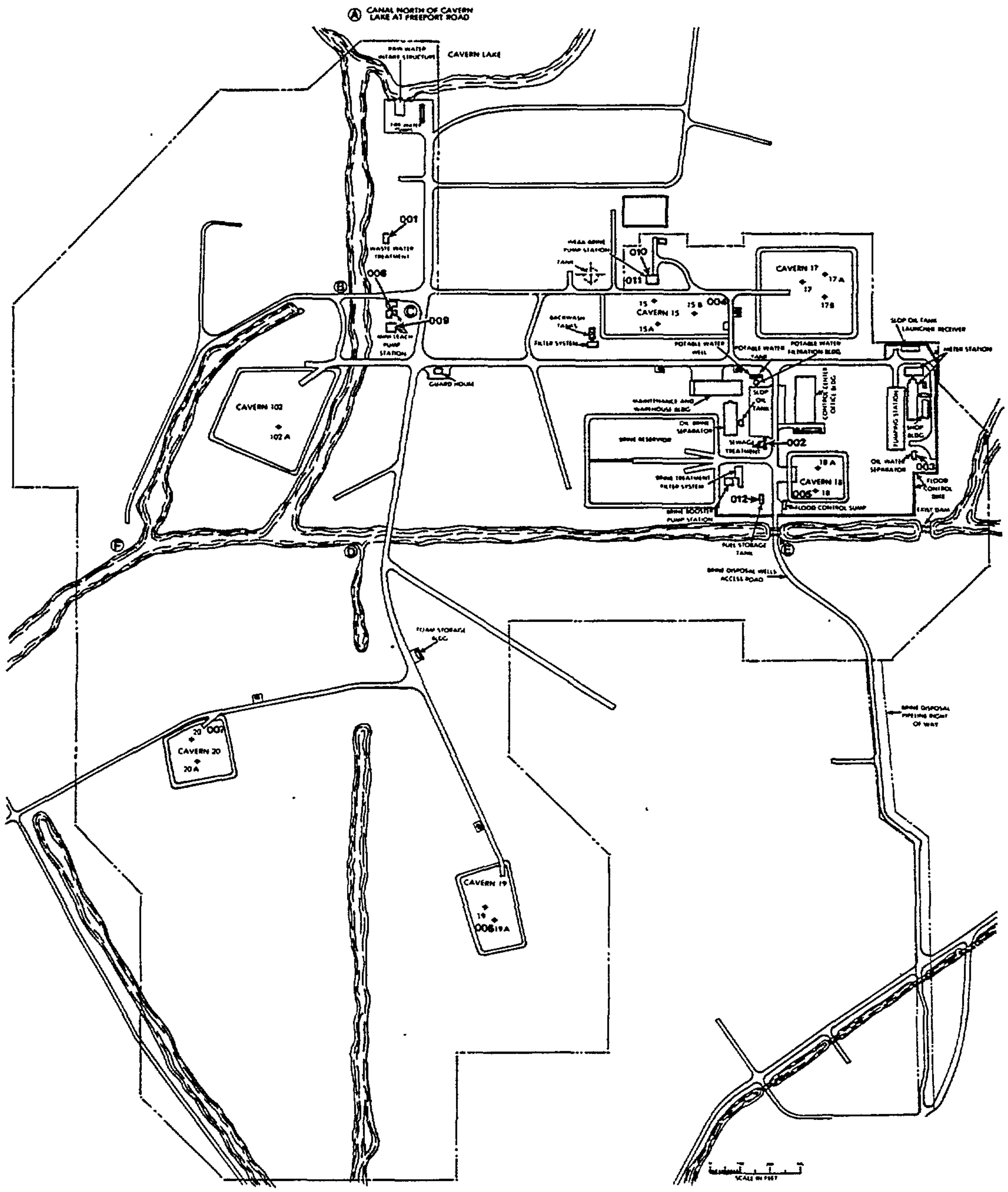


Figure 5-1 (Sheet 1 of 2). Bayou Choctaw Environmental Monitoring Stations

Discharge Monitoring Stations

001	Discharge from the Sewage Treatment Plant at the Trailer Complex
002	Discharge from the Sewage Treatment Plant at the Administration Building
003	Discharge Point from the Oil/Water Separator at the High-Pressure Pump Pad/Meter Prover
004	Well Pad 15 Discharge Point
005	Well Pad 18 Discharge Point
006	Well Pad 19 Discharge Point
007	Well Pad 20 Discharge Point
008	Northern Mini-Leach Fuel Tank Pad
009	Southern Mini-Leach Fuel Tank Pad
010	Weak Brine Pump Pad
011	Weak Brine Fuel Tank Pad
012	Emergency Generator Fuel Tank Pad

Water Quality Monitoring Stations

A	Canal North of Cavern Lake at Freeport Road
B	North-South Canal at Bridge to Cavern Pads 10, 11, and 13
C	Culvert South of Intersection of North-South Road and Weak Brine Area
D	East-West Canal at North-South Road
E	East-West Canal at Intersection of Road to Brine Disposal Wells
F	East-West Canal at Freeport Road Bridge

Figure 5-1 (Sheet 2 of 2). Bayou Choctaw Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Cavern Lake and the East-West Canal; and stations D, E, and F in the East-West (Wilbert) Canal. On November 29, 1983, stations B and D were eliminated to facilitate efficient monitoring of site water quality. Parameters monitored in the Bayou Choctaw surface waters during 1983 include pH, salinity, total suspended solids (TSS), temperature, dissolved oxygen (DO), biochemical oxygen demand (BOD), and oil and grease. These parameters are discussed in turn and compared with 1982 monitoring data. The discussions are followed by summary observations.

5.2.1 Hydrogen Ion Activity (pH)

The hydrogen ion activity, or pH, was consistently basic (pH greater than 7). Measured pH's ranged from 7.0 to 8.2, with the pH exceeding 8.0 only in October and November. This moderately basic pH is characteristic of slightly hard natural waters with inorganic carbon predominantly in the carbonate ion form. The degree of toxicity or solubility of many compounds, such as hydrogen sulfide and aluminum, are enhanced by a low pH; thus, a slightly basic pH is beneficial to the aquatic ecology in terms of reducing the toxicity of indigenous or contaminating compounds. Additionally, moderately hard natural waters generally have increased buffering capacity to protect against pH fluctuations.

During 1982, the pH was observed to fluctuate between 7.1 and 8.8. Thus, the 1983 data suggest a slight decrease in ambient pH which could be attributed to a variety of environmental factors such as the increase in rainfall or aquatic system flushing.

5.2.2 Salinity

A zero salinity was observed at stations A, B, C, and F throughout 1983. Station D deviated from its zero salinity in January (1.0 ppt), and station E's salinity was nonzero during January (1.0 ppt), May (1.0 ppt), September (2.5 ppt), and October (3.5 ppt). Stations D and E are located on the East-West Canal to the south of the brine pond. Station E is in close proximity to the southeast corner of the brine pond, the main site wastewater treatment plant discharge, and the flood control system discharge. All of these factors may contribute to this slightly elevated salinity.

During 1982, elevated salinities were observed at stations D, E, and F, averaging 5.7 ppt. These elevated salinities were partially attributed to construction at the flood control levee, reconstruction of the brine pond, and the relatively stagnant nature of the East-West Canal. The intermittent presence of an elevated salinity at station E during 1983 suggests that slightly elevated salinities will continue in the East-West Canal in the vicinity of the brine pond because of residual brine seepage from the surrounding substrate.

5.2.3 Total Suspended Solids (TSS)

The 1983 TSS data showed an elevated TSS throughout all of the Bayou Choctaw surface waters. The stressed environment criterion of 10 mg/1 applicable to Bayou Choctaw was exceeded in 94 percent of the observations, and a nonstressed environment criterion of 30 mg/1 was exceeded in 26 percent of the observations. A high of 98 mg/1 was observed at station E in May with a 1983 station E average of 37.9 mg/1 as compared with a stationwide annual TSS average of 25.9 mg/1. Outfall 002, which discharges in the vicinity of station E, was out of compliance for TSS in February and March; however, the station E February through April TSS data (averaging 25.1 mg/1) indicated this water was not significantly affected by the noncompliances.

During 1982, TSS was observed as consistently high, exceeding the 10 mg/1 criterion for 88 percent of the determinations. This is in close agreement with the high levels of TSS observed throughout 1983. Thus, high TSS levels appear to be indigenous to the waters and activities surrounding the Bayou Choctaw facility. Accordingly, state discharge limitations from the Bayou Choctaw facility are predicated on the surrounding area being a stressed environment.

5.2.4 Temperature

All temperature observations fell below the site's maximum criterion of 32°C, ranging from a low of 9.5°C in January to a high of 27°C in October. Temperatures were consistently observed above 20°C from May through October. The 1983 observed temperatures were cooler than the 11°C to 31.5°C range of temperatures observed during 1982. This, however, was consistent with local weather conditions.

5.2.5 Dissolved Oxygen (DO)

The DO was observed below the minimum criterion of 5 mg/l throughout 1983 for 29 percent of the observations. Depressed DO was observed on four occasions at station F, three occasions at station A, two occasions at station E, and one occasion at station B. This depressed DO appeared to be independent of BOD and temperature and unrelated to site effluent water quality. The observed low DOs at station A, the site control station, suggest that the cause of the low DO is not site specific. The low DO observed in the Bayou Choctaw surface waters is therefore attributed to an external source or the local drainage basin morphology and flow characteristics.

5.2.6 Biochemical Oxygen Demand (BOD)

The observed five-day BOD ranged from 0.6 mg/l to 6.5 mg/l, well within the criterion maximum of 10 mg/l. This is indicative of low organic loading in the Bayou Choctaw surface waters. The depressed DO previously discussed is apparently not attributable to decomposition of organic matter or aerobic metabolism. The low surface water BODs for 1983 are consistent with the low BODs observed at Bayou Choctaw during 1982 and are apparently characteristic of the local surface waters.

5.2.7 Oil and Grease

Oil and grease was not detected at any of the water quality monitoring stations during 1983. This is consistent with the oil and grease observations during 1982. The lack of detectable oil and grease in the Bayou Choctaw surface waters demonstrates the effectiveness of environmental

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

controls incorporated in operational procedures at Bayou Choctaw and surrounding facilities.

5.2.8 General Observations

Based on the above discussion, the following general observations have been made regarding the quality of Bayou Choctaw surface waters.

a. The moderately basic pH of Bayou Choctaw's surface waters is indicative of a healthy aquatic ecosystem.

b. The observed salinities were essentially zero for all stations except E. The slightly elevated salinities observed at station E (0 ppt to 3.5 ppt) may be attributed to residual soil contamination from the brine pond before its reconstruction in 1982 during which salinities of up to 5.2 ppt were observed. Because of its low and intermittent nature, the observed salinity at station E is not a significant ecological perturbation; however, it shall continue to be monitored.

c. The consistently high TSS levels observed reflect ambient surface water conditions at Bayou Choctaw. Such conditions limit the depth of the photic zone and tend to smother invertebrates, thus damaging the base of the food chain. These conditions are not attributed to SPR operations, but rather appear indigenous to the area.

d. Relatively low levels of DO were observed throughout 1983, as compared with acceptable levels of DO characteristic of 1982. This decline of DO was not attributed to site activity but rather to a broader effect because of similar observations at the control station.

e. The consistently low BOD and nondetectable oil and grease levels suggest that site oil spills and wastewater treatment plants are effectively managed, minimizing the impact on the Bayou Choctaw environs.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.3 BRYAN MOUND

The surface waters surrounding the Bryan Mound site were monitored throughout 1983. Blue Lake was sampled monthly throughout 1983. Mud Lake was sampled monthly in February and from April through October of 1983. Because of wind and tidal induced flushing, no sampling could be performed in Mud Lake during January, March, November, and December.

Specific monitoring stations are identified in Figure 5-2. Stations A through C and E through G are located along the Blue Lake shoreline to facilitate monitoring the impact of site runoff. Station D is located farther out in Blue Lake and serves as a control station. Stations H and I are located along the Mud Lake shoreline to monitor site runoff impacts. Station J is located farther out in Mud Lake and also serves as a control station.

Specific parameters monitored in the Bryan Mound surface waters include pH, alkalinity, salinity, temperature, dissolved oxygen, total organic carbon, chemical oxygen demand, nitrite, nitrate, orthophosphate, soluble iron, calcium, and magnesium. The parameters are discussed in turn with some comparisons to 1982 monitoring data. The discussions are followed by summary observations.

5.3.1 Hydrogen Ion Activity (pH)

The hydrogen ion activity, or pH, was moderately basic, ranging from 7.7 in January to 10.2 in August in Blue Lake and 7.3 in May to 8.8 in June in Mud Lake. The upper pH criterion of 8.5 was exceeded 52 percent of the time by Blue Lake stations A-G and 12 percent of the time by Mud Lake stations H-J. The control stations for Blue Lake and Mud Lake exceeded the upper criterion pH of 8.5 for 50 percent and 8.4 percent of the observations respectively. The pH dropped below 8.0 for only 2 percent of the observations in Blue Lake (January and February) and 21 percent of the observations in Mud Lake (February, May, and July). This is indicative of natural waters devoid of carbon dioxide and generally hard in regard to mineral content. Furthermore, the pH fluctuation may be affected

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

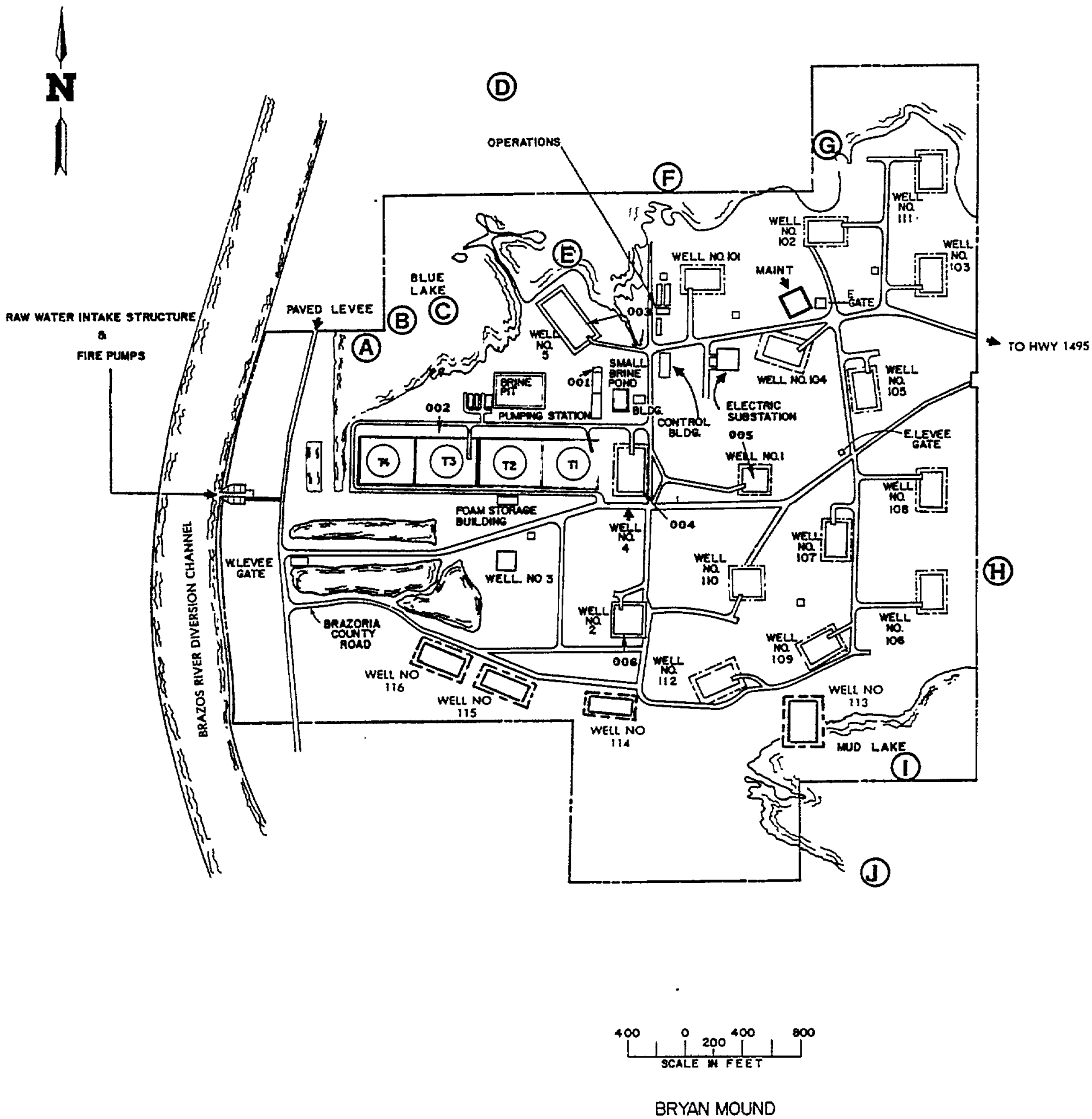


Figure 5-2 (Sheet 1 of 2). Bryan Mound Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Discharge Monitoring Stations

001 Discharge from Brine Surge Pit
002 Stormwater Runoff from Surge Tank Area (Corresponds to TX Water Comm. Permit No. 02271 Discharge 001)
003 Stormwater Runoff from Well Pad 5
004 Stormwater Runoff from Well Pad 4
005 Stormwater Runoff from Well Pad 1
006 Stormwater Runoff from Well Pad 2
101 Stormwater Runoff from Well Pad 101
102 Stormwater Runoff from Well Pad 102
103 Stormwater Runoff from Well Pad 103
104 Stormwater Runoff from Well Pad 104
105 Stormwater Runoff from Well Pad 105
106 Stormwater Runoff from Well Pad 106
107 Stormwater Runoff from Well Pad 107
108 Stormwater Runoff from Well Pad 108
109 Stormwater Runoff from Well Pad 109
110 Stormwater Runoff from Well Pad 110
111 Stormwater Runoff from Well Pad 111
112 Stormwater Runoff from Well Pad 112

Water Quality Monitoring Stations

A Blue Lake
B Blue Lake
C Blue Lake
D Blue Lake-Control Point 1
E Blue Lake
F Blue Lake
G Blue Lake
H Mud Lake
I Mud Lake
J Mud Lake-Control Point 2

Figure 5-2 (Sheet 2 of 2). Bryan Mound Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

seasonally by the rate of carbon dioxide uptake directly related to low primary productivity (low pH) in winter months and high primary productivity (higher pH) during summer months.

During 1982, the pH measurements in Blue Lake and Mud Lake were observed to range from 7.7 to 10.1, in good agreement with the 1983 data. Thus, the pH fluctuation in the Bryan Mound surface waters appears to be a result of seasonal weather and tidal variations rather than site activity.

5.3.2 Alkalinity

Alkalinity is the capacity of water to neutralize an acid and generally reflects the activity of calcium carbonate in the water. The alkalinity in Blue Lake ranged from 43 mg/l in August to 154 mg/l as $CaCO_3$ in March, and the alkalinity in Mud Lake ranged from 87 mg/l in September to 184 mg/l as $CaCO_3$ in June. These levels of alkalinity provide some buffering capacity in the Bryan Mound waters and are in general agreement with the 1982 observations.

5.3.3 Salinity

The salinity in Blue Lake ranged from 3.0 ppt in September to 11.6 ppt in January. Blue Lake was oligohaline (0.5 to 5 ppt) in March and April and from September through December, and mesohaline (5 to 18 ppt) during the remaining months of 1983. This fluctuation in salinity was predominantly temporal with little spatial variation, suggesting it is seasonally or meteorologically induced rather than attributable to site operations. The salinities were generally lower during 1983 than during 1982, further suggesting that variation is at least partially attributable to meteorological factors.

The salinity in Mud Lake ranged from 7 ppt in June to 20 ppt in May. Mud Lake was mesohaline during all of 1983 with the exception of May when salinity in Mud Lake was polyhaline (18 to 30 ppt). The wider variation in Mud Lake salinity during 1983 as well as 1982 is attributed to the strong

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

tidal and wind influence on this lake. Such variable conditions are expected to severely limit the species diversity in Mud Lake.

5.3.4 Temperature

The temperature in Blue Lake ranged from 12.0°C in January to 32°C in July. The temperature in Mud Lake ranged from 15.1°C in February to 32°C in July. The spatial temperature variation within each lake was generally limited to 1°C to 2°C suggesting no site operationally induced thermal effects.

Comparable temperatures were observed during 1982 when Blue Lake ranged from 17.3°C in December to 32.8°C in August, and Mud Lake ranged from 16.3°C in December to 31°C in June. These historical data show the same seasonal temperature changes during 1982 and 1983.

5.3.5 Dissolved Oxygen (DO)

The DO concentration in Blue Lake ranged from 16.6 mg/l in February to 3.0 mg/l in July. Only station F dipped below the 5 mg/l criterion to 3.0 mg/l in July; however, during this month Blue Lake averaged 6.7 mg/l DO with a range of 6.0 mg/l to 10.0 mg/l excluding station F. The low DO at station F in July is attributed to a combination of seasonally warm and dry weather and the shallowness of this station. An abundance of rooted vegetation at station F further inhibited hydrologic circulation contributing to the development of anoxic conditions in the bottom waters. The observed July chemical oxygen demand in drainage water from the high-pressure pump pad, which discharges in the vicinity of station F, was typical for 1983. Thus, this operational factor is not likely to be the cause of the depressed DO at station F during July.

The DO in Mud Lake ranged from 15.3 mg/l in February to 4 mg/l in September. The DO dipped below the 5 mg/l criterion only at station J in September. Because station J is the Mud Lake control station located the farthest from any SPR activity in the vicinity of Mud Lake, this low DO is attributed to seasonal factors and the tidal waters and morphology in Mud Lake.

The observed dissolved oxygen levels in both Blue Lake and Mud Lake were generally in excess of the minimum criterion of 5 mg/1. DO dropped below this level on two isolated occasions. Because the drop in DO occurred only at one station in Blue Lake and one station in Mud Lake, the ecological impact should have been localized and therefore minimal. Only immotile aerobic organisms would have been affected by the temporary oxygen decline; however, this impact appears to have been short lived and moderate.

5.3.6 Total Organic Carbon (TOC)

The TOC concentration in Blue Lake was relatively low, ranging between 9 mg/1 and 15 mg/1 throughout 1983 with the exception of February, March, and April. During this period, the TOC peaked at 17.5 mg/1 to 39 mg/1 for stations G, C, E, F, A, B, and D in ascending order of TOC concentration. On March 11, 1983, 1,625 barrels of oil overflowed sump 62 with a large portion flowing into the western end of Blue Lake (stations A, B, and C). Inadequate cleanup and adverse impact would be expected to manifest themselves in elevated levels of TOC and oil and grease. All stations except D showed the annual peak TOC concentration during the March 8, 1983 sampling, three days before the spill. The only significantly elevated TOC observed during April was at control station D which is located outside of the March spill impact area.

The elevated TOC concentration observed in Blue Lake during March and April is attributed to the spring phytoplankton bloom. The presence of plankton, and the soluble organic compounds they extrude during rapid growth, would be expected to raise the level of dissolved and particulate organic carbonaceous matter in Blue Lake. This in turn would result in elevated levels of TOC such as those observed. A similar elevation in TOC was observed in Blue Lake during May 1982. Thus, we do not attribute the

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

impact of the March oil spill to any significant effect on the observed concentrations of TOC in Blue Lake.

The TOC concentration in Mud Lake remained relatively low throughout 1983 ranging from 7.2 mg/l to 13.0 mg/l. This stability is somewhat unexpected for the tidal Mud Lake; however, data were available for only five months.

The TOC concentration in both Blue Lake and Mud Lake in no case exceeded the TOC maximum criterion of 40 mg/l. This relatively stable and low TOC is indicative of a healthy ecosystem with a stable oxygen demand.

5.3.7 Chemical Oxygen Demand (COD)

The chemical oxygen demand in Blue Lake ranged from nondetectable levels (less than 25 mg/l) in February, April, October, and November to 725 mg/l in May. Stations A, B, C, and D exhibited CODs of 100 mg/l or more from May through August. These elevated COD levels during the warmer summer months are in agreement with the COD data observed during 1982. This indicates that the oxygen demand attributable to chemically oxidizable matter increased during the more productive summer months.

The COD observed in Mud Lake ranged from 64.5 mg/l in February to 400 mg/l in August. Considerable temporal and spatial variability was observed throughout 1983, but to a lesser extent than the variability observed in Mud Lake during 1982. This variability is again attributed to the tidal and morphological characteristics of Mud Lake.

5.3.8 Macronutrients

The macronutrients nitrate and nitrite nitrogen and orthophosphate were monitored in Blue Lake and Mud Lake throughout 1983. These parameters provide an indication of eutrophication in natural waters.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Nitrate is a necessary nutrient to the metabolism of plants. This nitrogen form is oxidized from the nitrite nitrogen intermediate. The nitrate concentration in Blue Lake ranged from 0.5 mg/l in July to 5.0 mg/l in September. The nitrate concentration in Mud Lake ranged from 1.0 mg/l in April and May to 3.0 mg/l in June, July, and October. These concentrations are sufficiently low so as not to be of concern for contact waters, but sufficiently high to ensure the production of protein during primary production. Nitrite concentrations were generally low with nondetectable concentrations (less than 0.01 mg/l) occurring during April and December in Blue Lake and during September and October in Mud Lake. The detectable concentrations ranged from 0.02 mg/l to 0.04 mg/l in both lakes.

Phosphate is a necessary nutrient to plant metabolism functioning in biochemical energy transfer. Phosphate is generally found in small quantities in natural waters and is commonly the limiting factor to plant growth (primary production). Phosphate was observed to range from 1.0 mg/l to 3.0 mg/l from January through July in both Blue Lake and Mud Lake. Elevated levels of phosphate were observed in Blue Lake and Mud Lake from August through the remainder of 1983 with a maximum of 25 mg/l in Blue Lake in October and 15 mg/l in Mud Lake in September. These elevated levels of phosphate are attributed to coots, ducks, geese, and pelicans which began frequenting Blue Lake and Mud Lake during August 1983. The phosphate concentration in natural waters is generally less than those concentrations observed in either Blue Lake or Mud Lake throughout 1983. The atypically high levels of phosphate observed without a sustained phytoplankton bloom are indicative of primary production being limited by a factor other than phosphate.

5.3.9 Cations

The total soluble iron, calcium, and magnesium cations were monitored throughout 1983. Total soluble iron was observed at less than 1 mg/l for Blue Lake and between 0.2 mg/l and 4.0 mg/l for Mud Lake. The low iron levels observed in Blue Lake are typical for natural waters and sufficient to support the indigenous organisms. The iron levels observed in Mud Lake are high for natural waters but consistent with the 1982 Mud Lake observations which averaged 2.6 mg/l. The iron levels in Mud Lake are attributed to its basin geochemistry and the water influx from the Intracoastal Waterway.

Calcium and magnesium are essential micronutrients to plants and animals and are commonly the principal contributors to water hardness. Calcium ranged from 83 mg/l (November) to 207 mg/l (July) in Blue Lake and 117 mg/l (February) to 309 mg/l (August) in Mud Lake. This distribution of relative calcium concentrations is in general agreement with the temporal distribution of pH during 1983. The pH induced shift of inorganic carbon from the bicarbonate to carbonate form and the seasonally induced biochemical utilization of calcium may account for the observed calcium ion fluctuations. Magnesium ranged from 93 mg/l (September) to 214 mg/l (August) in Blue Lake and 183 mg/l (September) to 659 mg/l (August) in Mud Lake. These relatively high concentrations of calcium and magnesium are consistent with observations during 1982.

5.3.10 General Observations

Based on the above discussion, the following general observations have been made regarding the quality of Bryan Mound surface waters.

a. September was the first sampling period after Hurricane Alicia struck. General declines in surface water temperatures and pH were observed during September relative to August and October. The drop in temperature is attributed to rain and general cooling whereas the drop in pH may be attributed to winds mixing carbon dioxide into the surface waters and a decline in primary productivity.

b. The observed pH was high but stable in Blue Lake and Mud Lake. This is consistent with the alkalinity and relative water hardness observed. These factors would tend to buffer any pH related pollution incidents.

c. The March oil spill into Blue Lake appears to have had no measurable impact on that ecosystem. Specific water quality parameters showed little temporal or spatial variation attributable to this spill and suggests that response and cleanup were effective.

d. Mud Lake appeared to be of lesser quality than Blue Lake as suggested by elevated macronutrient and micronutrient levels in Mud Lake. The communication of Mud Lake with the Intracoastal Waterway, and the frequent wind and tidal induced flushing, are considered causative factors in the data variability in Mud Lake.

5.4 ST. JAMES TERMINAL

St. James Terminal is located in a low-lying agricultural area outside of the west levee of the Mississippi River. All precipitation is effectively drained from the terminal and surrounding sugar cane fields by a series of ditches. There are no permanent natural water bodies in the vicinity of St. James Terminal. Thus, the lack of potentially impacted surface waters precludes the need for surface water quality monitoring at St. James.

The two St. James docks are located on the west bank of the Mississippi River. They are curbed, with all runoff pumped to the terminal's stormwater treatment system and retention pond. The site retention pond, which also collects stormwater runoff from the six storage tank containment areas, is discharged intermittently through outfall 001 (Figure 5-3) into the Mississippi River. A wastewater treatment plant, installed in 1983 and serving the site control and maintenance buildings, also discharges through outfall 001 into the Mississippi River.

At St. James, the Mississippi River has a large flow volume, a high current, and a strong assimilative capacity. Thus, the intermittent nature of discharges from outfall 001, the characteristic hydrographic features of the Mississippi River at that point, and an ongoing state-conducted water quality monitoring program preclude the need for water quality monitoring in the Mississippi River.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

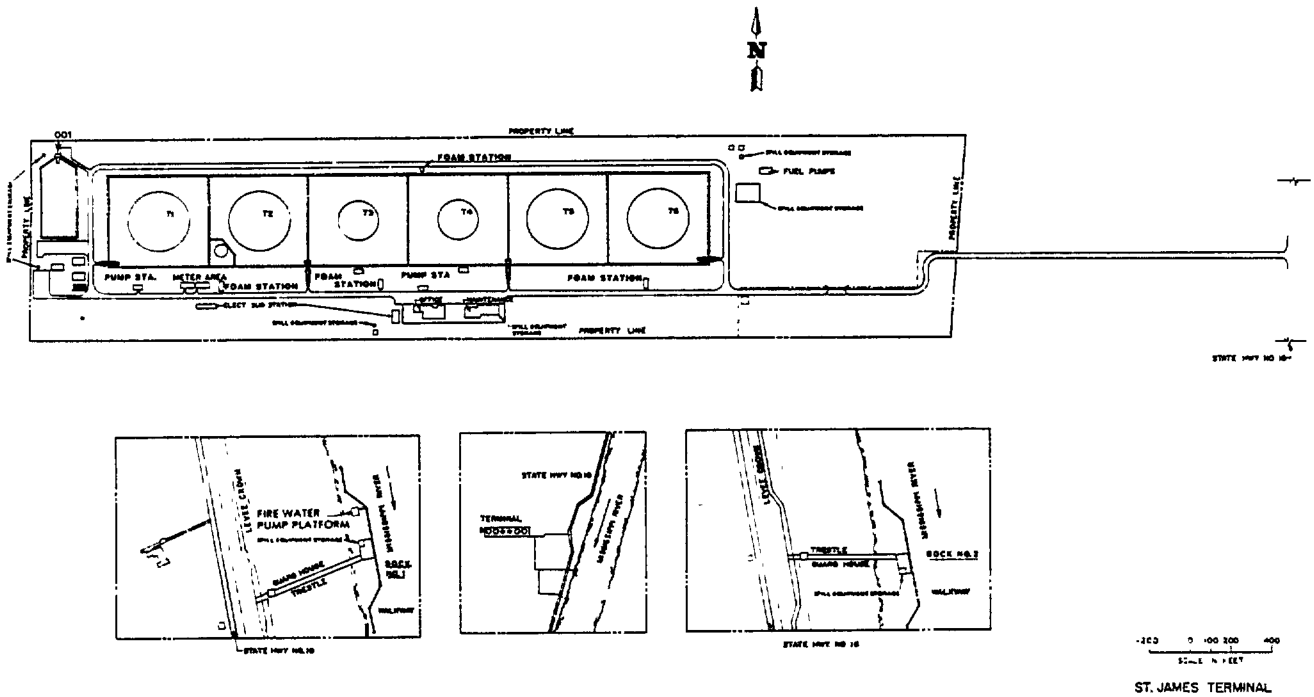


Figure 5-3 (Sheet 1 of 2). St. James Terminal Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

Discharge Monitoring Stations

001 Discharge from Retention Pond
Discharge from Contractor's Sewage Treatment Plant

Figure 5-3 (Sheet 2 of 2). St. James Terminal Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.5 SULPHUR MINES

Water quality monitoring at the Sulphur Mines site was generally conducted on a weekly to monthly basis throughout 1983. To ensure temporal consistency across data comparisons, the weekly data were reduced to monthly averages. (The pH was reduced to monthly minimums and maximums.) Specific monitoring stations are identified in Figure 5-4 by stations A and B in site drainage, station C in the subsidence area, stations D and E in site impoundments, and station F at the site raw water intake structure. Specific parameters monitored in the Sulphur Mines surface waters include pH, salinity, total dissolved solids, total suspended solids, temperature, and oil and grease. Oil and grease was not measured at stations A and D. These parameters are discussed in turn, including comparisons of 1982 with 1983 data, followed by summary observations.

5.5.1 Hydrogen Ion Activity (pH)

The median pH was 6.0 and ranged from a low of 3.6 at station A in June to a high of 8.5 at station E in March. This pH range is in close agreement with the pH ranges of 3.5 at station A to 8.5 at station E during 1982. The general pH tended to be slightly acidic at station A with the median pH of 6.4, and slightly basic at stations B, C, D, E, and F with respective median pH's of 7.2, 7.4, 7.2, 7.8, and 7.1. The individual pH's dropped below the minimum criterion of 6.5 for 7.2 percent of the observations. These low pH's occurred predominantly (71 percent) at station A from May through September.

Low pH is characteristic of natural waters dominated by the carbon dioxide and bicarbonate forms of inorganic carbon. Such waters may generally be characterized as soft in regard to mineral content. The characteristically low pH at station A was observed to become more extreme during low flow in this drainage ditch. This suggests that pH is affected by a geochemical process or through the addition of pollutants. Outfall 004, the site sewage treatment plant which discharges upstream of station A, was out of compliance for low pH on November 15, with a pH of 5.97. However, the

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

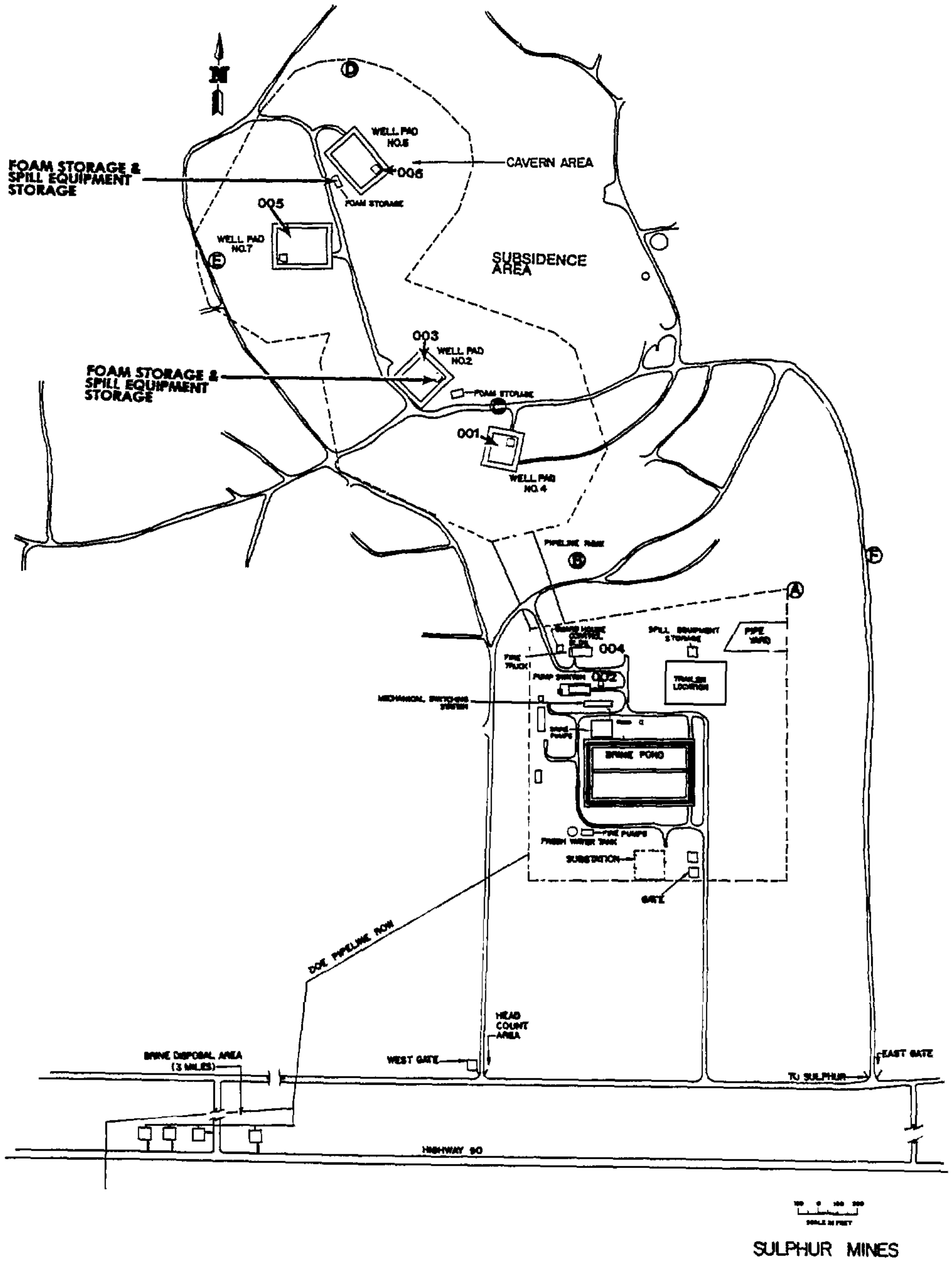


Figure 5-4 (Sheet 1 of 2). Sulphur Mines Environmental Monitoring Stations

Discharge Monitoring Stations

001	Stormwater Runoff from Well Pad 4
002	Stormwater Runoff from Pump Station
003	Stormwater Runoff from Well Pad 2
004	Discharge from Sewage Treatment Plant
005	Stormwater Runoff from Well Pad 7
006	Stormwater Runoff from Well Pad 6

Water Quality Monitoring Stations

A	Drainage Ditch at Northeast Corner of Primary Site
B	Creek North of Primary Site
C	Subsidence Area
D	Impoundment North of Cavern 6
E	Impoundment West of Cavern 7
F	Intake Structure

Figure 5-4 (Sheet 2 of 2). Sulphur Mines Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

pH at station A exceeded the minimum pH criterion of 6.5 from November 14 through the remainder of 1983. This suggests that the noncompliance from outfall 004 had no adverse effect on its receiving waters.

5.5.2 Salinity

The average salinity of the surface waters at Sulphur Mines was generally oligohaline (0.5 to 5 ppt), except for station F which was limnetic (less than 0.5 ppt) throughout 1983. Mesohaline (5 to 18 ppt) salinities were observed only when the average salinity of station C reached 5.8 ppt in September and station A reached 7.2 ppt in March. The high average salinity in March at station A resulted from a seal leak on the high-pressure pump pad which produced an observed maximum salinity of 18.0 ppt. This elevated salinity was temporary with no observed long-term impact.

The limnetic waters observed at station F throughout 1983 were consistent with the 1982 observations. These waters are part of the local flood control canal system and are separate from the Sulphur Mines surface drainage. Stations A through E averaged 1.95 ppt throughout 1983 with the highest annual average salinity observed at station C, the subsidence area. This was consistent with 1982 observations and is attributed to the years of mining activity at this salt dome dating to development of the first Frasch sulphur mine at this location.

5.5.3 Total Dissolved Solids (TDS)

TDS levels were observed at 1 to 11 times the fresh water criterion (500 mg/1) for stations A through E. The limnetic station F did not exceed the fresh water TDS criterion throughout 1983. This indicates that the high TDS levels at stations A through E are at least partially attributable to salinity. Least squares regression analysis produced a correlation (r=0.55, n=55) supporting the contention that salinity contributes to the observed TDS concentration. A similar relationship was observed during 1982.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.5.4 Total Suspended Solids (TSS)

The TSS levels exceeded the site criterion of 30 mg/l nine times (13 percent of the determinations) by an average of 15.4 mg/l during 1983. This is consistent with TSS observations made during 1982. Station A, which receives treated sewage from outfall 004, had the highest observed level of TSS (88.6 mg/l) during July 1983. Review of the discharge monitoring data for outfall 004 during that month revealed typical effluent with characteristics meeting NPDES compliance requirements. Station B, the other station monitoring site drainage, had its highest observed level of TSS (43.6 mg/l) also during July. Stations A and B maximum TSS levels coincided temporally and may be attributed to a common event, perhaps meteorological, having occurred during the first week in July.

5.5.5 Temperature

The observed temperatures of the Sulphur Mines surface waters were within the site criterion of 32°C throughout 1983. The maximum station temperatures (averaging 26.5°C) were observed during June, July, and August, and the minimum temperatures (averaging 13.2°C) were observed during January, February, and December. This temperature distribution corresponds to the 1982 observations and may be considered moderate.

5.5.6 Oil and Grease

Nondetectable levels of oil and grease (less than 5 mg/l) were observed on all but three occasions during 1983. Stations C and E had detectable levels of 6.0 mg/l and 7.4 mg/l oil and grease respectively during the third week in June. Discharge data from all site outfalls during June were nondetectable for oil and grease, eliminating site discharges as the cause of the observed elevated level of oil and grease. Station E also had a detectable level of oil and grease (6.7 mg/l) during the first week in February; however, all site outfalls exhibited nondetectable levels of oil and grease throughout January and February 1983. The detected oil and grease at station E during February is attributed to an oil loss from activities at the Sulphur Mines Union Texas Petroleum facility.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.5.7 General Observations

Based on the above discussion, the following general observations have been made regarding the quality of Sulphur Mines surface waters.

a. The only discharge noncompliance for 1983 was for a low pH at outfall 004. However, examination of the water quality data for receiving waters at outfall 004 showed no measurable impact to pH.

b. A temporary impact to surface waters, resulting from a brine leak from the high-pressure pump pad, was observed.

c. The high TDS level observed at Sulphur Mines was attributed to the characteristic oligohaline waters.

d. Detectable levels of oil and grease were observed on three occasions during 1983. Examination of site discharge data showed that not one of the elevated oil and grease levels was attributable to SPR site activity.

5.6 WEEKS ISLAND

The Weeks Island site is located on the Weeks Island salt dome approximately 100 feet above sea level. The surrounding topography is of rather sharp relief with several small lakes. None of the SPR outfalls discharge into these lakes. The other surface waters at this site are intermittent in nature, draining rapidly and thoroughly after any precipitation. The site outfalls (001A, 001B, and 002, shown on Figure 5-5) discharge small volumes into surface drainage a substantial distance from surface bodies of water. Thus, this lack of potentially impacted surface waters precludes the need for surface water quality monitoring at the Weeks Island site.

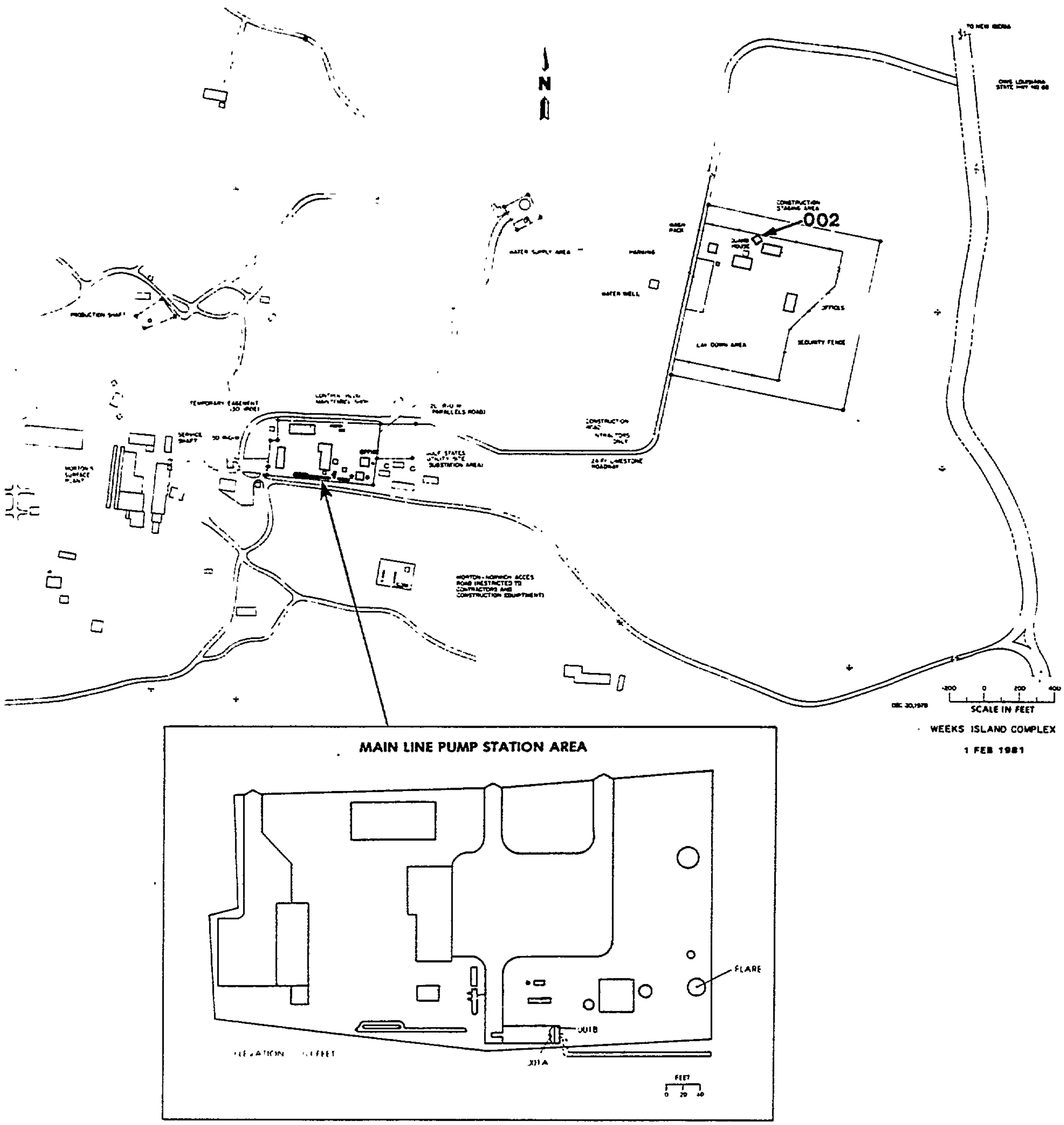


Figure 5-5 (Sheet 1 of 2). Weeks Island Environmental Monitoring Stations

Discharge Monitoring Stations

001A	Stormwater Runoff
001B	Discharge from Sewage Treatment Plant
002	Discharge from Sewage Treatment Plant (laydown yard)

Figure 5-5 (Sheet 2 of 2). Weeks Island Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.7 WEST HACKBERRY

The West Hackberry surface waters were monitored on a weekly basis throughout 1983. To allow monthly data correlations ensuring temporal consistency, all weekly data were reduced to monthly averages. (The pH was reduced to monthly minimums and maximums.) All discussions of water quality data are based on these monthly averages. Specific monitoring stations are identified in Figure 5-6. Stations A, B, and C are located in Black Lake. (Station B is just offshore of a site drainage ditch leading from the high-pressure pump pad.) Station D is located in the southeast drainage ditch, and station E is at the discharge draining the high-pressure pump pad to Black Lake. Specific parameters monitored in the West Hackberry surface waters include pH, salinity, total dissolved solids, total suspended solids, temperature, and oil and grease. Oil and grease was not monitored at station D. These parameters are discussed in turn, and the discussions are followed by summary observations.

5.7.1 Hydrogen Ion Activity (pH)

The pH ranged from a fairly neutral 7.1 to a somewhat basic 8.3. No stations exceeded the site water quality range criterion. The upper range of the monthly pH, on a station basis, exceeded 8.0 for 23 percent of the observations, which is less than the 45 percent recorded last year. Natural waters which are devoid of carbon dioxide and are medium hard to hard with regard to mineral content are characteristically slightly basic. Some compounds such as hydrogen cyanide and hydrogen sulfide increase in toxicity to the degree of dissociation, resulting in increasing compound toxicity to aquatic life with reduced pH. Considering this, a mildly basic pH is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

5.7.2 Salinity

Salinity ranged from 0.4 to 43.2 ppt for stations A through E. Stations A, B, and C (Black Lake) ranged from 1.0 to 16.0 ppt with an increase in May, then a three-month decline in salinity which was followed by a steady rise in salinity values from August through December. This compares with a

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

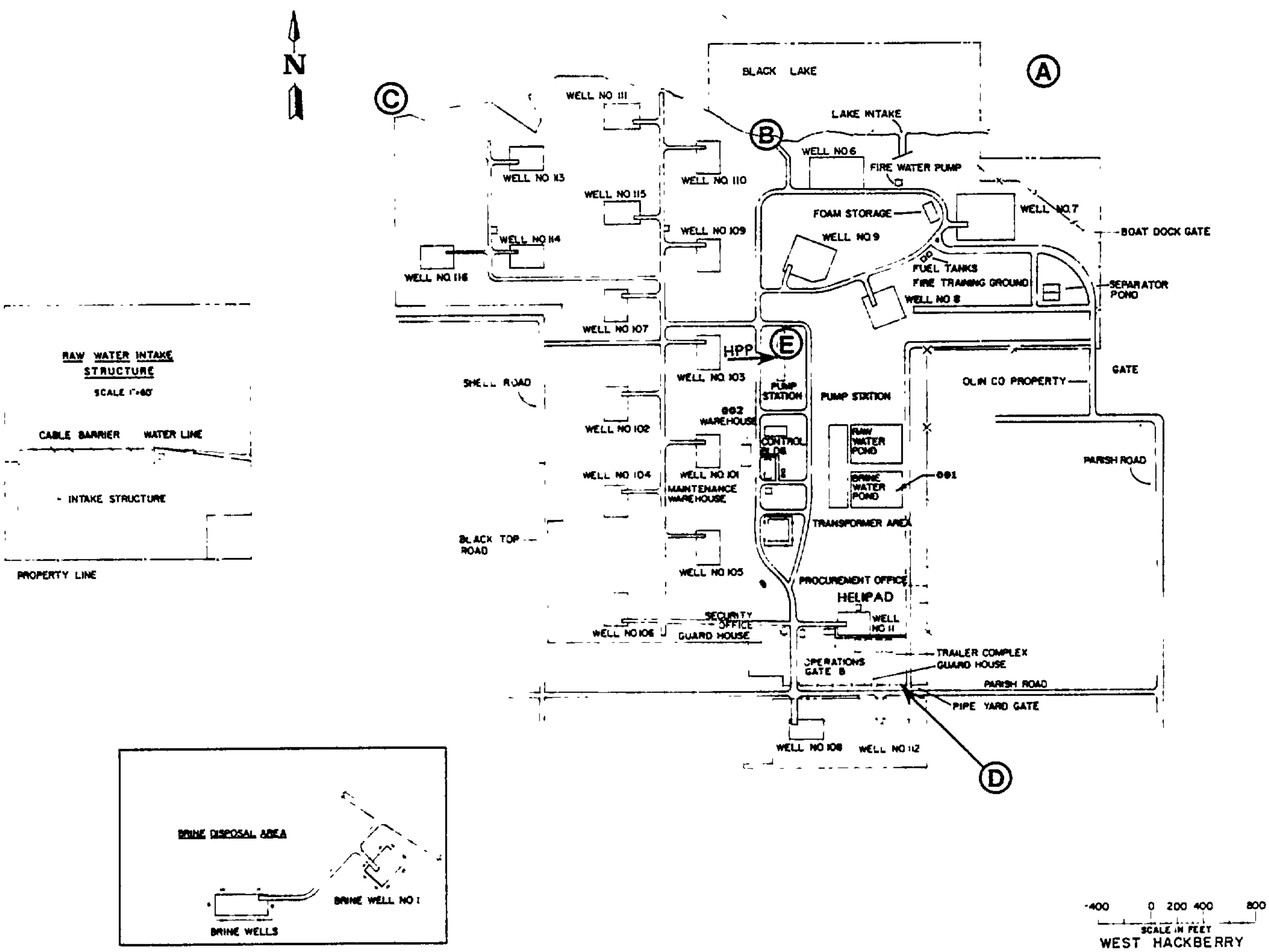


Figure 5-6 (Sheet 1 of 2). West Hackberry Environmental Monitoring Stations

Discharge Monitoring Stations

001	Brine Disposal
002	Discharge from Sewage Treatment Plant
Well Pad 6	Stormwater Runoff from Well Pad 6
Well Pad 7	Stormwater Runoff from Well Pad 7
Well Pad 8	Stormwater Runoff from Well Pad 8
Well Pad 9	Stormwater Runoff from Well Pad 9
Well Pad 11	Stormwater Runoff from Well Pad 11
Well Pad 101	Stormwater Runoff from Well Pad 101
Well Pad 102	Stormwater Runoff from Well Pad 102
Well Pad 103	Stormwater Runoff from Well Pad 103
Well Pad 104	Stormwater Runoff from Well Pad 104
Well Pad 105	Stormwater Runoff from Well Pad 105
Well Pad 106	Stormwater Runoff from Well Pad 106
Well Pad 107	Stormwater Runoff from Well Pad 107
Well Pad 108	Stormwater Runoff from Well Pad 108
Well Pad 109	Stormwater Runoff from Well Pad 109
Well Pad 110	Stormwater Runoff from Well Pad 110
Well Pad 111	Stormwater Runoff from Well Pad 111
Well Pad 112	Stormwater Runoff from Well Pad 112
Well Pad 113	Stormwater Runoff from Well Pad 113
Well Pad 114	Stormwater Runoff from Well Pad 114
Well Pad 115	Stormwater Runoff from Well Pad 115
Well Pad 116	Stormwater Runoff from Well Pad 116
HPP	Stormwater and Pump Flush from High-Pressure Pump Pad

Water Quality Monitoring Stations

A	Black Lake	D	Southeast Drainage Ditch
B	Black Lake	E	High-Pressure Pump Pad
C	Black Lake		

Figure 5-6 (Sheet 2 of 2). West Hackberry Environmental Monitoring Stations

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

steady increase in salinity from May through November in 1982. Between-station comparisons were similar and demonstrated a highly positive correlation.

Wind, tide, and rainfall contributed to the salinity variation in Black Lake. Using the Venice system for marine water classification, Black Lake can be classified as mesohaline (5 to 18 ppt). The salinity range limits Black Lake to euryhaline organisms or to those with sufficient motility to avoid salinity stresses.

Salinities at station D, the southeast drainage ditch, ranged from 0.8 to 43.2 ppt. The individual spikes in the data, resulting in abnormally high values, are directly attributable to brine loss from the low-pressure pump pad.

Monthly salinity values at station E, the high-pressure pump pad (HPP) runoff, ranged from 0.4 to 24.2 ppt. The high salinity readings at this station are attributable to mechanical failures of parts of the brine system on the HPP. The HPP runoff is discharged into Black Lake near the vicinity of station B. Spill cleanup activity during these occurrences was excellent. For instance, a reading of 24.2 ppt was recorded at station E; however, the discharge entering Black Lake as recorded at station B was only 4.0 ppt, and the readings of stations A and C were 3.8 and 4.1 ppt respectively. Salinities at station B were between those of stations A and C for 75 percent of the observations. During three months, station B exceeded the salinity observed at stations A and C by 0.4, 1.8, and 0.1 ppt, exhibiting no significant salinity difference.

The similarity in salinities among stations A, B, and C can be related to the elimination (during the latter part of 1982) of the chronic, leaking flanges on the brine line at the HPP and the associated reduction in salinity, rather than to the change in location of station B which was previously considered to be a contributing factor.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.7.3 Total Dissolved Solids (TDS)

The TDS levels ranged from 1.3 to 37 times the site water criterion (500 mg/l) on a monthly and station basis. TDS was compared to salinity at each station on a monthly basis by least squares regression analysis. This produced a very high correlation (r=0.93, n=61), demonstrating that statistically about 87 percent ($=r^2$) of the TDS variability can be attributed to salinity. In 1982, there was a correlation of r=0.99. The slight change in correlation could be based on fewer samples in 1982, the change in data collection frequency starting in May 1982 from monthly to weekly, or a change in the composition of TDS at West Hackberry.

5.7.4 Total Suspended Solids (TSS)

The TSS levels exceeded the site criterion 19 times (32 percent of the determinations) during the 1983 sampling year. The flowing water stations D and E had excessive suspended solids in only 12 percent of the determinations whereas the lake stations A, B, and C had excessive solids in 44 percent of the determinations. Elevated levels of TSS occurred in the three lake stations 12 times from July through November. The TSS level at station E exceeded the site criterion only in March. Its value, slightly lower than the lake stations, did correspond to excessive TSS levels in the lake that month. Because this was a single occurrence, it suggests that the excessive TSS levels measured at station E, the high-pressure pump pad, did not contribute to the frequent high levels of suspended solids in the lake. The TSS level for outfall 002, the site biological waste treatment plant, was in compliance for the entire year. Because of its relatively low flow rate and the distance from Black Lake, no TSS impact on the lake would even be expected.

The annual comparison of TSS data between 1982 and 1983 shows a positive correlation. It is suggested that the occurrences of relatively high TSS were a result of natural phenomena, unrelated to site activities.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

5.7.5 Temperature

Temperature was below the site maximum criterion of 32°C throughout 1983 at all sampling stations. The temperature in Black Lake ranged from 12.4°C to 27.0°C. The highest temperatures for all stations were recorded in July and August, and the lowest temperatures were recorded in January and then again in December. This correlates well with last year's data except that November and December in 1982 were the coldest months.

5.7.6 Oil and Grease

Oil and grease was observed at concentrations of less than 5 mg/l at all stations except the high-pressure pump pad station E. There it exceeded 5.0 mg/l on two occasions, once in April (6.5 mg/l) and once in October (5.2 mg/l). Neither occasion resulted in noncompliances. These slightly elevated levels of oil and grease could be attributed to some leakage of pump lubricating oil. There were no oil spills associated with this station during 1983.

Stations A, B, and C showed no elevated oil and grease levels in 1982. However, there was chronic detection of oil and grease at station E. This was attributed to leaking pump seals and an improperly operating oil/water separator. The separator was thoroughly cleaned and restored during 1983. Additionally, throughout 1983 as was done in 1982, a weir system along with the regular use of sorbent material mitigated the impact of any oil contamination.

5.7.7 General Observations

The following observations are made, based on the above discussion, concerning operational impacts on the West Hackberry aquatic environs.

a. Runoff from the high-pressure pump pad did not contribute to any significant increases in Black Lake's salinity at station B when compared with stations A and C. This is a positive change compared with 1982 and could be based on the change in the data base or the more positive mitigation of brine leaks from the high-pressure pump pad.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

b. Although TDS levels were excessive at all stations relative to fresh water criteria, statistical analysis demonstrated that ambient salinity was the primary cause of elevated TDS levels at West Hackberry.

c. TSS levels exceeded the site criterion in one out of every three determinations. However, based on the uniform temporal-spatial distribution of TSS on site, the high TSS levels in Black Lake could not be attributed to specific site point source discharges.

d. The two data points indicating oil and grease levels over 5.0 mg/l from the high-pressure pump pad were minimal and effectively mitigated because there were no detections of elevated oil and grease levels in any of the Black Lake stations.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983—675-343/53

LIST OF REFERENCES

American Public Health Association, American Water Works Association, and Water Pollution Control Federation. Standard Methods for the Examination of Water and Wastewater. 15 ed. Washington, D.C.: American Public Health Association, 1980.

Faust, Samuel D. and Osman M. Aly. Chemistry of Natural Waters. Ann Arbor: Ann Arbor Science Publishers, 1981.

Louisiana Stream Control Commission. "State of Louisiana Water Quality Criteria." 1977.

Reid, George K. and Richard D. Wood. Ecology of Inland Waters and Estuaries. 2d ed. New York: D. Van Nostrand Company, 1976.

Swedish Ministry of Agriculture, Environment '82 Committee. Acidification Today and Tomorrow. A study prepared for the Stockholm Conference on Acidification of the Environment, 1982.

Texas Department of Water Resources. Texas Surface Water Quality Standards. April 1981.

U. S. Department of Energy. Final Environmental Impact Statement, Strategic Petroleum Reserve, Capline Group Salt Domes. 4 vols. July 1978; available from National Technical Information Service.

_________. Final Environmental Impact Statement, Strategic Petroleum Reserve, Seaway Group Salt Domes. 3 vols. June 1978; available from National Technical Information Service.

_________. Final Environmental Impact Statement, Strategic Petroleum Reserve, Sulphur Mines Salt Domes. March 1978; available from National Technical Information Service.

_________. Final Environmental Impact Statement, Strategic Petroleum Reserve, Texoma Group Salt Domes. 5 vols. November 1978; available from National Technical Information Service.

_________. Final Supplement to Final Environmental Impact Statements, Strategic Petroleum Reserve, Phase III Development, Texoma and Seaway Group Salt Domes. October 1981; available from National Technical Information Service.

U. S. Environmental Protection Agency. Quality Criteria for Water. July 1976; available from Government Printing Office.

☆ U.S. GOVERNMENT PRINTING OFFICE: 1983--675-343/53