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STRATEGIC PETROLEUM RESERVE

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Boeing Petroleum Services, Inc.

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FOR THE

STRATEGIC PETROLEUM RESERVE

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ABBREVIATIONS AND ACRONYMS

AFFF	AQUEOUS FILM FORMING FOAM-
BOD_5	five day biochemical oxygen demand
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
Ci	Curies
COE	United States Army Corps of Engineers
DO	dissolved oxygen
DOE	United States Department of Energy
EPA	United States Environmental Protection Agency
ERT	Emergency Response Team
F&WS	United States Fish and Wildlife Service
LDEQ	Louisiana Department of Environmental Quality
LDHHR	Louisiana Department of Health and Human Resources
LDNR	Louisiana Department of Natural Resources
LDOTD	Louisiana Department of Transportation and Development
LDWF	Louisiana Department of Wildlife and Fisheries
m/sec	meters per second
mCi	millicuries NEPA
m	meters NESHAP- NAT'L EMISSIONS STDS FOR HAZARDOUS AIR POLLUTANTS
mg/l	milligrams per liter (= PPM)
MOM	management, operations, and maintenance
NEPA	National Environmental Policy Act
NPDES	National Pollutant Discharge Elimination System
ppt	parts per thousand
RCT	Railroad Commission of Texas
SPR	Strategic Petroleum Reserve
TACB	Texas Air Control Board
TDH	Texas Department of Health
TDH&PT	Texas Department of Highways and Public Transportation
TDS	total dissolved solids
TOC	total organic carbon
TLV	TRESHOLD LIMIT VALUE
TSD	TREATMENT STORAGE & DISPOSAL
POTW	PRIVATELY OWNED TREATMENT WORK
BNA	BUREAU OF NAT'L AFFAIRS

ABBREVIATIONS AND ACRONYMS
(continued)

TSS	total suspended solids
TWC	Texas Water Commission (EX-TDWR)
UIC	Underground Injection Control
UST	underground storage tank(s)
VOC	volatile organic compound
FIFRA	FEDERAL INSECTICIDE, FUNGICIDE & RODENTICIDE ACT.
VELASCO	

EXECUTIVE SUMMARY

This report provided annually in accordance with DOE Order 5484.1 summarizes monitoring data collected to assess SPR impact on the environment. The report serves as a management tool for mitigating such impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

Included in this report is a description of site environment, an overview of the SPR environmental program, and a recapitulation of special environmental activities and events associated with each SPR site during 1987. The active permits and the results of the environmental monitoring program (i.e., air, surface water, ground water, and water discharges) are discussed by site. The quality assurance program is presented which includes results from laboratory and field audits and studies performed internally and by regulatory agencies.

In general, findings indicate that no adverse environmental impact resulted from any SPR activities during 1987. It was also concluded that the SPR continues to maintain an excellent environmental record.

1. INTRODUCTION

The creation of the Strategic Petroleum Reserve (SPR) was mandated by Congress in Title I Part B of the Energy Policy and Conservation Act (P.L. 94-163), of 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 six Gulf Coast underground salt dome oil storage complexes (four in Louisiana and two in Texas), a marine terminal facility (in Louisiana), and an administrative facility (in Louisiana). Figure 1-1 is a regional map showing the relative location of SPR facilities. The SPR used four sites with existing solution-mined caverns and an underground room-and-pillar salt mine early in the project. Additional space has since been created by solution mining at four sites.

The sites were originally constructed around three major inland pipeline systems capable of transporting U.S. and foreign crude oil from the Gulf Coast to refineries in the Midwest. The inland pipeline terminals planned for use by the SPR are the ARCO Terminal (Texas City, Texas), the Sunoco Pipeline Terminal (Nederland, Texas), and the Capline Pipeline Terminal (St. James, Louisiana). The sites are also capable of distributing crude oil via tankships. The ARCO pipeline connecting the Bryan Mound site with the Texas City, Texas, docks and area refineries was completed in 1987. A second pipeline connecting the West Hackberry site to refineries in Lake Charles, Louisiana is planned to enhance distribution capabilities. Access to additional dockage is planned for St. James Terminal with the installation of a short segment of pipeline connecting the nearby Koch facility.

1.1 BAYOU CHOCTAW

The Bayou Choctaw site is located on the west side of the Mississippi River 19.3 kilometers southwest of Baton Rouge in Iberville Parish, Louisiana. The site consists of main and brine disposal areas which occupy approximately 67 and 81 hectares respectively. The area surrounding the site is rural, with a number of people living in small settlements along the nearby highways. The nearest communities are Addis to the northeast and Plaquemine to the southeast. Baton Rouge, the major source of housing and services for the site, is within easy commuting distance.

The habitat surrounding the site is a freshwater swamp. Elevation ranges from approximately 1.5 to 3.0 meters 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 and protected from spring flooding by the site's flood control levees and pumps. The collapse of a solution-mined cavern in 1954 resulted in the formation of a 4.9 hectare lake (Cavern Lake) on the north side of the site.

Bottomland hardwood forest and deciduous swamps are predominant at the Bayou Choctaw site. The overstory vegetation at the site includes baldcypress, sweetgum, tupelo (characteristic of lowland areas), bulltongue, and spikerushes. 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, ibis, egrets, woodpeckers, wood duck, thrushes, American anhinga, and American woodcock. Inhabitants of the bottomland forest and swamp include opossum, squirrels, nutria, mink, river otter, raccoon, swamp rabbit, white-tailed deer, American alligator, and snakes.

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. Smaller canals and bayous, such as the North-South Canal and the East-West Canal, enter the site area and continue to Bull Bay and the Intracoastal Waterway.

1.2 BIG HILL

The Big Hill site is located in Jefferson County, Texas, approximately 109 kilometers east of Houston, 37 kilometers southwest of Port Arthur, and 14 kilometers north of the Gulf of Mexico. Only small unincorporated communities are located near the site. The rural area around the site is used primarily for rice farming, cattle grazing, and oil and gas production. The permanent work force is supplied in small part from the local area, with the remainder moving into the area or commuting from Beaumont or Port Arthur. During the current construction phase, much of the transient skilled labor is brought in from Houston, Galveston, or Lake Charles.

The site is situated on approximately 111 hectares of land on the Big Hill salt dome with surface elevations of up to 10 meters above sea level (the highest elevations in the region). The agricultural and pasture land uses around Big Hill are typical of the region.

Approximately one kilometer south of the dome is the northern boundary of fresh to intermediate marsh which grades into brackish and saline marsh towards the Gulf of Mexico. The nearby waterways include Spindletop Ditch approximately five kilometers south of the site, which connects to the Intracoastal Waterway located three kilometers further south and oriented in a northeast to southwest direction. Freshwater impoundments are located south of the site. Numerous sloughs, bayous, and lakes, including Willow Slough Marsh, Salt Bayou, Star Lake, and Clam Lake, connect with the Intracoastal Waterway. Natural ridges (cheniers) paralleling the coastline isolate the marsh from the Gulf of Mexico.

Existing habitats in the vicinity of the site are related to agricultural use, although there are petroleum-related industrial operations on and off the salt dome. There are two ponds present on the eastern edge of the dome, one of which is on SPR property.

The upland habitat, which comprises the majority of the site, consists of many tall grasses such as bluestem, indiangrass, switchgrass, and prairie wildgrass. Several 150 year old live oak trees are present on site. Fauna typical in the area include coyote, rabbits, raccoon, rodents, snakes, turtles, and numerous upland game birds and passerines. The nearby ponds and marsh south of the site provide excellent alligator habitat. The McFadden National Wildlife Refuge located south of the site provides important habitat for overwintering waterfowl.

1.3 BRYAN MOUND

The Bryan Mound site is located in Brazoria County, about 104 kilometers due south of Houston, Texas, and five kilometers southwest of Freeport, Texas, on the east bank of the Brazos River Diversion Channel, near the Gulf of Mexico. The area is highly industrialized, and includes several petrochemical related facilities. Approximately 50 percent of the area population are between 20 and 55 years of age and work in the local area, although many commute in to work from outside the immediate vicinity.

The site occupies 237 hectares 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 of water between the Intracoastal Waterway and the Diversion Channel. The levees protecting the town of Freeport form a second 5.5 square kilometer triangular pattern within the triangle formed by the rivers. A levee parallels the Diversion Channel in a southern direction from Freeport until due west of the site. The levee then turns east essentially bisecting the site.

The major water bodies near the site are Blue Lake to the north, and Mud Lake to the south. These water bodies generally define the mounded aspect of the Bryan Mound dome, which creates a surface expression in the terrain by rising approximately five meters above the surrounding wetlands. Although Blue Lake is within the protective triangle formed by the levee system (with excess rain water 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. Brackish marshland dominates the low-lying portions of the site in all but the northern area, where the coastal prairie ecosystem extends along the levee 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 also occur in unmowed site areas. Those areas periodically inundated by seawater are dominated by cordgrasses.

A diverse range of habitats is created by 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. The common egret, snowy egret, migratory waterfowl, great blue heron, killdeer, least tern, and black-necked stilt (the latter two being state-protected species), as well as nutria, raccoon, skunk, rattlesnakes, turtles, and frogs can be found on and in the area surrounding Bryan Mound.

Shrimp, crabs, trout, flounder, and redfish are abundant in Mud Lake during various seasons of the year. Black drum, mullet, gar, and blue crab are found in Blue Lake.

1.4 ST. JAMES TERMINAL

The St. James Terminal consists of 6 aboveground storage tanks and two tanker docks. The tank farm area occupies 42.5 hectares and the docks occupy 19.4 hectares. The site is located on the west bank of the Mississippi River, approximately halfway between New Orleans and Baton Rouge, Louisiana, and 3.1 kilometers north of the town of St. James, on Louisiana Highway 18. The area around the site is rural with a number of people living in small settlements along Highway 18, the major thoroughfare in the area. Although some of the work force may commute from New Orleans or Baton Rouge, the majority of the workers are from local labor pools.

The terminal is bounded by the Texas and Pacific Railroad to the west, commercial facilities to the north and south, and the Mississippi River levee on the east between Louisiana Highway 18 and the river. The area adjacent to the Mississippi River at the St. James docks is the batture and is a freshwater wetland. Much of the land area surrounding the terminal is used for pasture and sugar cane cultivation. Frogs, snakes, turtles, rabbits, raccoon, armadillo, muskrat, opossum, nutria, squirrels, egrets, ibis, and herons can be found on the site and in the surrounding areas.

1.5 SULPHUR MINES

The Sulphur Mines site (approximately 71 hectares) is located in Calcasieu Parish, 2.4 kilometers west of the town of Sulphur, Louisiana. There has been considerable industrial activity on and near the site since the late 1800's. The greater part of the work force comes from the town of Sulphur, with the remainder from outlying communities and the major urban area of Lake Charles.

The site is divided into the quadrangular primary site area and the figure eight shaped secondary area. The secondary site area is bordered on the west, northwest, and north 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 0.4 kilometers east of the site. Changes in elevation throughout the site are minor, with most of the site four to six meters above sea level. The site proper is normally dry except in the spring season or during heavy rains when high waters sometimes flood portions of it. The lowest elevations are over the center of the dome, where subsidence has occurred as a result of prior sulfur mining activity. Much of the surrounding area is covered with a mixed pine/hardwood forest.

Mammals on site and in the surrounding area include 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, largemouth bass, sunfish, gar, carp, bowfin, and catfish inhabit shallow ponds on the site. Many bird species including egrets, killdeer, herons, and migratory waterfowl are present.

1.6 WEEKS ISLAND

The aboveground facility occupies approximately three hectares and is located in Iberia Parish, Louisiana, about 22 kilometers south of New Iberia. The surrounding area is sparsely populated. New Iberia, the closest major urban center, supplies the greater part of the labor force. The major employment sectors within the parish are mineral production, manufacturing, construction, and agriculture.

The Weeks Island salt dome borders Vermilion Bay, which opens to the Gulf of Mexico. The Weeks Island salt mine, developed in the early 1900's by room-and-pillar mining, operated continuously until 1981, at which time operations were moved to another part of the same dome. The surface expression over the salt dome, caused by domal upthrusting, forms the "island" and includes the highest elevation 52 meters above sea level 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 vegetation communities on Weeks Island are diverse. Lowland hardwood species proliferate in the very fertile loam soil base common at the higher elevations. The predominant tree species are oak, magnolia, and hickory, which extend down to the surrounding marsh. Pecan trees are also present. The coastal wetlands at the Weeks Island site include the manmade Intracoastal Waterway, brackish marshes, and bayous. Gulls, terns, herons, and egrets are common in the marsh area. Mink, nutria, river otter, raccoon, and alligator are the most common inhabitants of the intermediate marshes. Others mammals found at Weeks Island are opossum, bats, squirrels, swamp rabbit, bobcat, white-tailed deer, black bear, and coyote. The water bodies surrounding Weeks Island provide a vast estuarine nursery ground for an array of commercially and recreationally important finfish and shellfish.

1.7 WEST HACKBERRY

The West Hackberry site is located in Cameron Parish 29 kilometers southwest of Lake Charles, Louisiana and 26 kilometers north of the Gulf of Mexico. Cameron Parish is the largest and least populous parish in Louisiana. The population derives its economy from fishing, shrimping, rice farming, and petroleum production. The work force at the site is derived from local residents of the Hackberry community, the towns of Sulphur and Lake Charles, in Calcasieu Parish, and from recent arrivals to the area.

$\frac{229}{.4047}$ = 565.85 ACRES.

The site is situated on 229 hectares of land on top of the West Hackberry salt dome. The dome is covered by a distinct mounded overburden on its western portion, with elevations up to nearly seven meters (the highest point in Cameron Parish). The majority of the dome is approximately 1.5 meters above sea level.

Waterways near the site include Calcasieu Lake and the Calcasieu Ship Channel approximately five kilometers to the east, and the Intracoastal Waterway approximately six kilometers north of the site. Black Lake, a brackish water lake, borders the dome on the northern and western sides. Numerous canals and natural waterways, including Black Lake Bayou, connect Black Lake to Alkali Ditch and then to the Intracoastal Waterway on the eastern side of the site. Black Lake Bayou, referred to locally as Kelso Bayou, continues wandering in a generally easterly direction from Black Lake, eventually connecting with the Calcasieu Ship Channel northeast of the town of Hackberry.

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, which affect 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, but rather a large region of small islands. Marshland closest to the coast generally has 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, willow, various oak species, and numerous species of marsh and upland grasses. American alligator, snakes, egrets, herons, roseate spoonbill, migratory waterfowl, red-tailed hawk, red fox, raccoon, nutria, opossum, rabbits, and white-tailed deer inhabit the area surrounding the West Hackberry site. Aquatic inhabitants of Black Lake include crabs, shrimp, drum, croaker, spot, sheepshead, mullet, gar, redfish, and catfish.

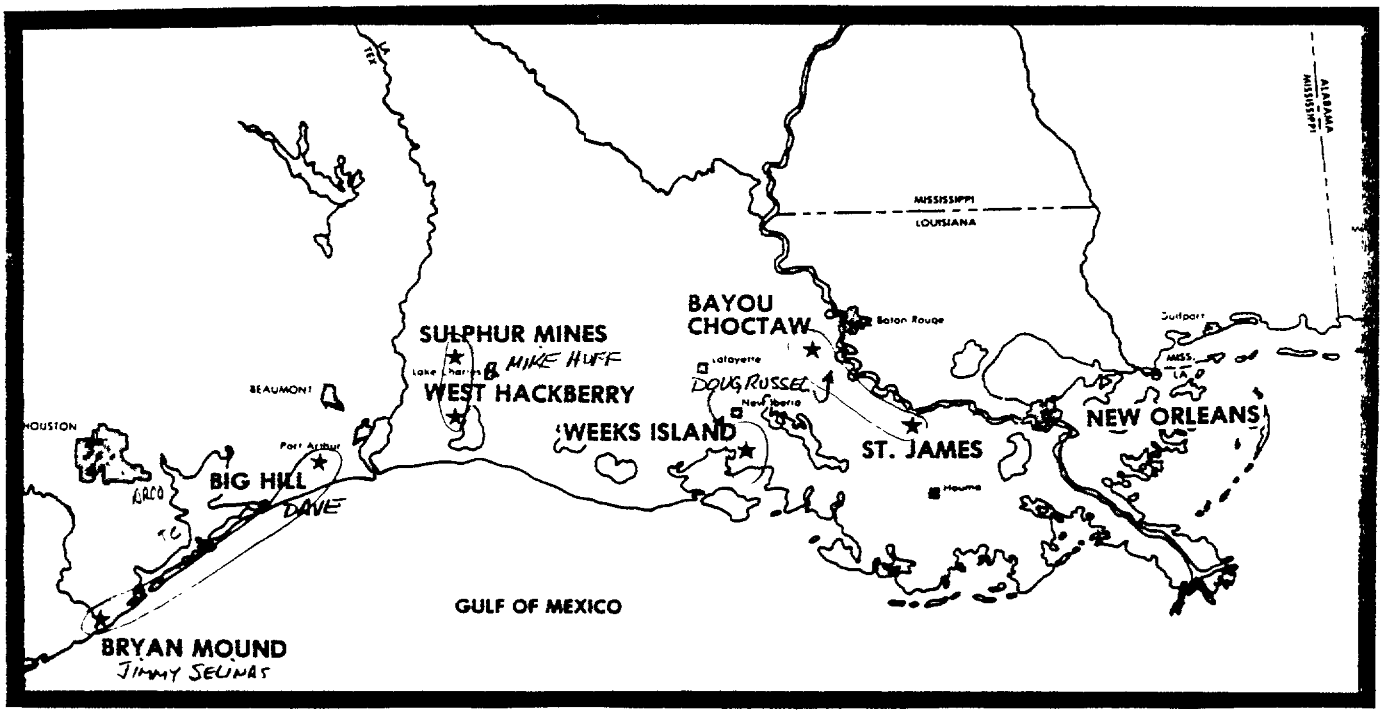

Figure 1-1. SPR Site Locations

2. PROGRAM OVERVIEW

The environmental program is implemented by the management, operations and maintenance (MOM) contractor for the SPR on behalf of the Department of Energy (DOE). DOE, however, has the ultimate responsibility as owner and operator, in accordance with the understanding reached between the MOM contractor and DOE. The environmental program is designed to support the SPR through tasks aimed at avoiding or minimizing adverse environmental effects from the SPR on surrounding lands and water bodies.

The monitoring and inspection program area was developed under guidance of the SPR Programmatic Environmental Action Report, Site Environmental Action Reports, and DOE Orders. This area includes monitoring permitted National Pollutant Discharge Elimination System (NPDES) outfalls and air emissions, conducting other required federal and state inspections, and 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 from SPR operations.

The results of the individual program areas such as air quality monitoring and reporting, NPDES compliance, and water quality monitoring for 1987 are discussed in section 3.

2.1 ASSOCIATED PLANS AND PROCEDURES

Associated plans and procedures developed to support the SPR environmental program include group-specific Spill Contingency Plans with spill reporting procedures, site-specific Spill Prevention, Control, and Countermeasures Plans, and the Environmental Programs and Procedures that includes an underground injection control plan, 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 plans and procedures.

2.2 TRAINING

Site Environmental and Emergency Response Team (ERT) personnel have received training in environmental plans and procedures. Site management personnel have been briefed on the implementation of environmental procedures, spill reporting procedures, the group-specific Spill Contingency Plans, the site-specific Spill Prevention, Control, and Countermeasures Plans, and compliance awareness. Compliance awareness training is conducted by the individual site environmental specialists at each of the SPR sites. During this training, site personnel learn about applicable regulatory requirements.

ERT personnel from all sites participate in annual spill response training at the Lamar University Fire and Safety Institute. Onsite training is also provided in oil spill cleanup and control. Site response personnel are trained to rapidly and effectively contain and cleanup oil, brine, and hazardous substance spills under the special circumstances unique to each SPR site.

2.3 REPORTING

Proper operation of the SPR with respect to the environment involves several types of reports and reporting procedures. The basic reports are summarized briefly in this section.

2.3.1 Spill Reports

The spill reporting procedures described in the spill contingency plans identify the procedures for reporting spills to the MOM contractor, DOE, and appropriate regulatory agencies. Specific reporting procedures are dependent upon several key factors including the quantity and type of material spilled, immediate and potential impacts of the spill, and spill location (e.g., wetland or waterbody). Any spill considered significant at the site is first verbally reported to site management and then to MOM contractor management in New Orleans and the onsite DOE representative. These procedures have been simplified and condensed to a credit card-like document for attachment to iden tification badges and to a laminated placard for handy desk reference. Verbal notification of the appropriate regulatory agencies follows when necessary. Written reports from the site are usually submitted after cleanup, unless otherwise directed by the DOE or appropriate regulatory agency.

2.3.2 Discharge Monitoring Reports

Wastewater discharges from SPR sites are authorized by the Environmental Protection Agency (EPA) through the NPDES Program. Depending on site specific permit requirements, discharge sample analyses are reported to the state and EPA monthly (Big Hill, Bryan Mound, and West Hackberry), and quarterly (Bayou Choctaw, Saint James, Sulphur Mines, and Weeks Island). Included in the report is an explanation of the cause and actions taken to correct any noncompliance or bypass.

2.3.3 Other Reports

The MOM contractor provides several other reports to, or on behalf of, DOE as required. These reports include:

a. Fugitive air emissions for Bryan Mound (quarterly);

b. Emission Inventory Questionnaire Status update for St. James Terminal, Sulphur Mines, and Weeks Island (annually);

c. Air Quality Construction Status Report for West Hackberry (semi-annually);

d. Permit Tracking System review and update (annually and quarterly);

e. Monthly Noncompliance and Spill Report with an annual summary for all sites;

f. Environmental Audit Reports for each site (annually);

g. Water Usage for Bryan Mound and Big Hill (annually);

h. Raw Water Usage and Brine Discharge Data for Big Hill, Bryan Mound and West Hackberry (monthly); and

i. Special study reports, as required.

2.4 OIL SPILLS: RECAPITULATION

In 1987, the total amount of oil moved (received and transferred internally) was in excess of 11.4 million cubic meters (72.1 million barrels). The oil spills involving quantities in excess of 0.16 cubic meters (one barrel) that occurred during 1987 are discussed in Table 2-1. Two spills were caused by gasket/flange leaks, two to equipment failures, and one to operator/ maintenance. Spill containment was excellent in that no oil entered any waterway.

The total number of spills, total volume spilled, and the percent volume spilled of total volume moved are shown below for each year from 1982 through 1987.

Year	Total Spills	Volume Spilled m^3 (barrels)	Percent Spilled of Total Throughput
1982	24	847.0 (5,328)	0.00704
1983	21	380.9 (2,396)	0.00281
1984	13	134.8 (848)	0.00119
1985	7	85.4 (537)	0.00122
1986	5	1232.5 (7,753)	0.01041
1987	5	2.5 (16)	0.00002

The total number of spills has dropped consistently since 1982 with the exception of 1986 and 1987 which were similar. The amount spilled during 1987 decreased by more than 99 percent as compared to 1986 in which one major spill involved 1,192.3 cubic meters (7,500 barrels) or.99 percent of that year's total.

2.5 BRINE SPILLS: RECAPITULATION

The SPR disposed 33.7 million cubic meters (212.0 million barrels) of brine (saturated sodium chloride solution) during 1987. Approximately 85.2% of the brine was disposed in the Gulf of Mexico via the Bryan Mound (8.8%), West Hackberry (51.2%), and Big Hill (25.2%) brine disposal pipelines. The remainder was disposed in saline aquifers via injection wells at the West Hackberry (8.3%), Bayou Choctaw (6.2%), and Sulphur Mines (approximately 0.3%) sites, and at offsite disposal wells (less than 0.01%).

The brine spills involving quantities in excess of 0.16 cubic meters (one barrel) during 1987 are discussed in Table 2-2. Six spills were caused by corrosion/erosion of piping, five to gasket/flange failures, four to equipment malfunctions, four to operator error, and three to miscellaneous causes.

The total number of spills, total volume spilled, and the percent volume spilled of total volume disposed are shown below for each year from 1982.

Year	Total Spills	Volume Spilled m^3 (barrels)	Percent Spilled of Total Disposed
1982	43	443.8 (2,792)	0.0005
1983	44	259.4 (1,632)	0.0002
1984	17	314.0 (1,975)	0.0003
1985	16	96,494.8 (607,000)	0.1308
1986	7	275.6 (1,734)	0.0017
1987	22	96.5 (608)	0.0003

The substantial decrease in the amount spilled during 1987 as compared to previous years is partially attributed to ERT training and spill response efforts. No observed environmental impact was observed from any SPR brine spills as evidenced by subsequent surveys and water quality monitoring.

2.6 WASTEWATER DISCHARGE COMPLIANCE

In 1987, a total of 8,293 analyses were performed to monitor wastewater discharge quality from the SPR in accordance with NPDES and corresponding state permits. Although 18 noncompliances were reported, the SPR was in compliance with permit requirements for approximately 99.8% of the analyses performed. Ten of the noncompliances involved site sewage treatment plants, seven resulted from failure to take samples, and one was associated with brineline operations. A special study to identify and resolve SPR sewage treatment plant problems causing permit noncompliances was initiated during 1986. The resulting SPR Sewage Treatment Plant Analysis Final Report recommended 27 actions to improve permit compliance as well as operations and maintenance of each treatment plant. Most of these actions were implemented during 1987.

2.7 SPECIAL ENVIRONMENTAL ACTIVITIES

During 1987, there were no major spills that would have prompted additional studies to assess and monitor impact. Follow-up monitoring studies were continued during the year in response to a failed cavern 111 wellhead component at West Hackberry that sprayed approximately 1,192 cubic meters (7,500 barrels) of crude oil onto the well pad, adjacent marshland, and surface waters of Black Lake in July, 1986. To date, monitoring results indicate a short term impact limited to the area surrounding the well pad.

Another significant activity was the environmental baseline survey of the SPR that was sponsored by DOE Washington, D.C. Phase I of the survey included a thorough review of the SPR environmental program as well as an onsite inspection of Big Hill, Bryan Mound, West Hackberry, and Sulphur Mines. Phase II will include inspections of the other SPR sites in 1988. Preliminary findings of the survey were generally complimentary. All findings were categorized as being of low significance and most of the findings noted had been previously identified and duly documented through independent efforts of the SPR environmental program.

Proper methods for disposing aqueous fire fighting foam (AFFF) were investigated and discussed with the appropriate state regulatory agencies. Discussions continue with regulatory agencies with resolution expected in 1988.

Well log data were collated for all SPR water wells, monitoring wells, and boreholes. The wells at Weeks Island were registered with the Louisiana Department of Transportation and Development as required. The remaining SPR wells and holes as applicable are scheduled for registration in 1988.

A special study of the requirements and status of potable water use at the SPR was initiated in 1987. Results of the study were instrumental in identifying existing problems and recommending corrective actions being implemented through a project directive (BPS PD-110).

Use of fluorescent dye proved successful in evaluating the integrity of stormwater containment dikes for cavern 113 at Bryan Mound and the brine and anhydrite pond liners at Big Hill. In both instances, leak sources were identified and immediately repaired.

Elevated salinities were noted in the brine pond underdrain system at Sulphur Mines and in the monitoring well associated with the West Hackberry brine pond. The Sulphur Mines pond liner was successfully repaired within months of first suspecting a leak. A soil resistivity study indicated elevated salinities in the area suspected to be from either the brine pond or an abandoned cavern at West Hackberry. Additional monitoring wells are scheduled to be drilled in 1988 near the West Hackberry brine pond to determine the actual source of the brine. The appropriate regulatory agencies have concurred with the plan developed to locate the leak source.

In accordance with DOE Order 5480.14 (presently a defunct order), Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), Phase II, confirmation sampling of selected SPR sites was completed in 1987. Sampling results indicate an absence of hazardous levels in the materials tested. Additional heavy metal testing of brine in several caverns at Big Hill coincided with the start of leaching at the facility in October 1987. Additional brine sampling is scheduled into early 1988 to ensure that proper disposal practices are followed.

The controlled evacuation committee (CEC) program was fully implemented during 1987. This program involves evaluating strategies for mitigating any environmental and safety problems possibly resulting from construction, maintenance, or numerous other activities.

A survey of drums and containers was initiated to identify any problems pertaining to their use, storage, and disposal. Corrective actions are scheduled for development and implementation in 1988.

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
01/02/87	BM	0.32 m^3 (2 barrels)	Pressure gauge fitting on wellhead 5A failed allowing oil to spray on well pad. Closed appropriate valves to halt flow. Oil contained on well pad and removed by sorbent pads and vacuum trucks.
02/12/87	BM	0.64 m^3 (4 barrels)	Loose flange bolts on 30-inch pipeline near cavern 106 resulted in an underground spill. Depressured pipeline and excavated area to locate spill source. Replaced flange gasket and tightened bolts. Oil confined to soil immediately around leak. Soil cleaned prior to refilling excavated area.
06/10/87	SJ	0.64 m^3 (4 barrels)	Blind flange and valves leaked during tank cleaning by subcontractor. Placed drums under leaks and vacuumed oil. Contaminated soil disposed offsite.
08/06/87	BM	0.16 m^3 (1 barrel)	Failure of a wellhead oil valve. Relieved pressure on wellhead and wrapped valve with sorbent to minimize spray. Washed and vacuumed area.
12/27/87	BM	0.79 m^3 (5 barrels)	Failure of pressure relief valve allowed oil to spray on well pad 5. Oil confined to swale area in well pad. Washed and vacuumed area. Relief valve repaired.

Table 2-1. 1987 Oil Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
01/06/87	BM	15.90 m^3 (100 barrels)	Check valve gasket and valves 2016 and 20B7 failed. Closed appropriate valves to halt flow. Brine contained in well pad moat. Washed and vacuumed area.
02/19/87	WH	3.97 m^3 (25 barrels)	Annubar flow meter dislodged completely from brine line while performing maintenance work. Absence of safety retention nuts, presumably lost by prolonged vibration, caused the dislodgment allowing brine to spew out of the line. Line shut down and meter hole plugged. Brine contained in adjacent ditch. Washed and vacuumed area.
03/31/87	BC	0.79 m^3 (5 barrels)	Cavern pressure encountered when pulling packer from wellhead 17. All brine confined to ditch and sump on well pad. Washed and vacuumed area.
04/02/87	BC	0.16 m^3 (1 barrel)	Loose grease fitting on brine line valve BD20F2. All brine confined to swale located below valve. Tightened fitting. Washed and vacuumed area.
04/03/87	BM	8.74 m^3 (55 barrels)	Brine line valve 11520D failed to close entirely when performing piping repairs. Flow stopped by closing an upstream valve. Spillage confined to immediate area below valve and stopped before entering drainage ditches. Washed and vacuumed area.
05/05/87	BM	6.36 m^3 (40 barrels)	Corrosion/erosion of 36-inch brine return pipeline resulted in underground leak. Evacuated, excavated, and replaced pipeline. Washed and vacuumed area.
05/11/87	WH	2.38 m^3 (15 barrels)	Weld failed on piping for wellhead 106 due to corrosion/erosion. Reduced pressure in piping. Replaced piping. Washed and vacuumed area.

Table 2-2 (Sheet 1 of 4). 1987 Brine Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
05/18/87	BC	0.32 m^3 (2 barrels)	Flexible, connector between low pressure pump pad and filtration system failed after recently being replaced allowing a small quantity of brine to enter the East-West Canal. Washed and vacuumed area.
05/19/87	BC	0.32 m^3 (2 barrels)	Brine sump pump BCT-4 failed to operate when at high level due to a tripped circuit breaker. Operator corrected problem by resetting breaker. Brine confined to limestone area on pump pad. Washed and vacuumed area.
05/27/87	WH	3.78 m^3 (20 barrels)	Flange failed at the disposal wells. Amount spilled reduced by reopening valves to the wells. Washed and vacuumed area.
06/04/87	BM	3.78 m^3 (20 barrels)	Corrosion/erosion of the old brine disposal line resulted in leak at north side of brine pond. Shut down brine disposal. Contained brine to drainage swale. Washed and vacuumed area.
06/26/87	WH	0.16 m^3 (1 barrel)	Opened blowout preventer to remove kink in wireline. Brine confined to well pad. Washed and vacuumed area.
08/05/87	WH	0.79 m^3 (5 barrels)	Residual brine in pipeline belched out during replacement of faulty valve. Washed and vacuumed area.
08/24/87	BH	0.32 m^3 (2 barrels)	Loose inspection door on rented frac tank allowed brine to flow out tank. Stopped pumping into tank and tightened inspection door bolts. Washed and vacuumed area.

Table 2-2 (Sheet 2 of 4). 1987 Brine Spills

DATE	LOCATION	AMOUNT	CAUSE/CORRECTIVE ACTION
10/05/87	BM	11.92 m^3 (75 barrels)	Gasket failed on 36-inch flanged pipe for raw water flush system at south side of brine pond. Pipeline depressured, replaced gasket. Washed and vacuumed area.
10/09/87	BC	23.85 m^3 (150 barrels)	Frac tank crossover line ruptured when filling due to closure of a tank valve. Pad surface was being excavated for conduit installation, allowing brine to soak into limestone fill beneath clay lining on pad.
10/16/87	BH	0.48 m^3 (3 barrels)	Subcontractor personnel vented brine from wellheads and manifold onto the ground at well pads 101-105. Brine soaked rapidly into ground preventing collection. Personnel now discharge into drums when performing such tests.
10/20/87	WH	3.78 m^3 (20 barrels)	Corrosion/erosion of the 16-inch brine return line at junction tee for cavern 117. Pipeline depressured and plugged hole. Washed and vacuumed area. Piping section replaced.
11/01/87	WH	0.32 m^3 (2 barrels)	Corrosion/erosion of 36-inch brine return pipeline to low pressure pump pad. Considerable amount of excavation required to locate leak. Site shut down to repair leak after locating. Washed and vacuumed area.
12/05/87	WH	7.95 m^3 (50 barrels)	Corrosion/erosion at weld on 36-inch brine return pipeline. Small amount entered marsh surrounding Black Lake. Isolated leaking section and contained spillage. Washed and vacuumed area.

Table 2-2 (Sheet 3 of 4). 1987 Brine Spills

3. ENVIRONMENTAL PROGRAM

3.1 INTRODUCTION

A primary goal of DOE and the MOM contractor is to ensure that all SPR activities are conducted in accordance with sound environmental practices.

Effective environmental monitoring provides a mechanism for assessing the impact of SPR activity on air, surface water, and ground water. Site monitoring programs were developed as management tools for the purpose of allowing control and mitigation of unwarranted environmental impacts, thus serving the public interest by ensuring environmentally sound operation of the SPR.

3.1.1 Air Quality

During 1987, air emissions were monitored through measurements and calculations from operating data. Volatile hydrocarbons (VO vapors) arising from valves, pumps, tanks, tankers, and brine ponds are the predominant type of air emissions from SPR facilities. The quantity of hydrocarbon emissions is generally dependent on the volume of oil throughput, with minimal emissions occurring during periods of static storage. Small amounts of hydrogen sulfide are associated with some crude oils handled and stored by the SPR. Emissions associated with the SPR were generally lower during 1987 as compared to 1982 through 1986 due to the reduction in fill activity. Dust emissions from most site roads have been mitigated through paving or application of dust control agents.

3.1.2 Surface Water Quality Monitoring

During 1987, the surface waters of the Bayou Choctaw, Bryan Mound, Sulphur Mines, and West Hackberry SPR sites were sampled and monitored for general water quality. This monitoring is separate from the water discharge permit monitoring program and is not required by any federal or state regulatory agency. Surface water quality monitoring was not conducted at St. James Terminal or Weeks Island because of the low potential to impact surface waters on these two sites. Surface water quality monitoring at Big Hill will be initiated in 1988.

3.1.3 Water Discharge Permit Monitoring

The water discharge permit monitoring program fulfills the requirements of the EPA NPDES, and corresponding state programs. All SPR point source discharges are conducted in compliance with these federal and state programs.

SPR personnel regularly conducted point source discharges from all sites during 1987. These discharges are grouped as:

a. brine discharge to the Gulf of Mexico,
b. stormwater runoff from tank, well, and pump pads
c. effluent from package sewage treatment plants.

Parameters monitored varied by site and discharge. Table 3-1 identifies frequency of specific parameters measured at each SPR site. The variations in data are discussed by site following the water quality monitoring discussions.

3.1.4 Environmental Permits

The active environmental permits required by regulatory agencies to construct and maintain the SPR are discussed by site. The discussion of site permits includes the number and type of noncompliances (if any) experienced at each site.

3.1.5 Hydrology and Ground Water Monitoring

Ground water monitoring is performed at West Hackberry. Monitoring wells at Bayou Choctaw are no longer functional. Various indicator parameters are monitored depending upon the individual site, although well monitoring is not required by any federal or state regulations or permits.

Background information is not available on the construction and installation of some of the existing monitoring wells which presents problems when interpreting data. The ground water characteristics of each site are discussed within each site section.

3.1.6 Radioactivity

There are no radioactive process effluents from any SPR facility. Only sealed sources of radioactive material are in use.

A total of 132 SGH Model Nos. 5190, 5191, and 5202 nuclear density gauges are located on pipelines within the Bayou Choctaw, West Hackberry, Sulphur Mines, and Bryan Mound sites. The gauges are used for monitoring fluid density changes (oil versus brine) in pipelines. Each gauge unit contains between 100 and 400 millicuries (mCi) of cesium 137. Wipe tests are performed every three years as recommended by the manufacturer. No radiation leakage has been detected to date. The DOE is a general licensee under the manufacturer, Texas Nuclear.

Princeton Gamma Tech Model 100 sulfur analyzers are used in the Bryan Mound, West Hackberry, and St. James laboratories for analyzing sulfur concentrations in oil samples. The radioisotope within the analyzer contains 50 mCi of iron 55. No radiation leakage from the analyzer has been detected from semiannual wipe tests. The DOE is a general licensee under Princeton Gamma Tech.

There are three self-luminating signs, Brandhurst, Inc. Model No. B100N10, located at Bayou Choctaw. Each unit contains 8.7 Ci of tritium. Results from wipe tests performed immediately after the signs were installed were negative. Additional leak tests are not required. The DOE is a general licensee under Brandhurst.

3.2 BAYOU CHOCTAW

The Bayou Choctaw site will be used to store 10.4 million cubic meters (66 million barrels) of crude oil. Currently, there are five solution-mined caverns with one additional cavern in development. Raw water is provided from Cavern Lake and brine is transported via pipeline to 12 brine disposal wells located approximately two miles south of the site. There is a 91-centimeter (36-inch) crude oil pipeline connecting the site to the St. James Terminal.

3.2.1 Air Quality

During 1987, Bayou Choctaw operated in accordance with air quality regulatory requirements. During the past year, the existing Emissions Inventory Questionnaire was updated and submitted to the Louisiana Department of Environmental Quality. A separate air permit for the facility was acquired after the updated EIQ was submitted. Previously, the permit had been part of the permit for the St. James Terminal, which was inconsistent with all other permits for the SPR. Total emissions from the facility were calculated to be less than 9 metric tons/year (a "nonsignificant facility" as noted in the air quality regulations for Louisiana). Nonsignificant facilities are exempt from vapor monitoring requirements. There were no configurational changes which would have resulted in additional air emissions during 1987. Bayou Choctaw is located in a nonattainment area for ozone.

3.2.2 Surface Water Quality Monitoring

Samples collected once monthly at each monitoring station were used to monitor surface water quality. Specific monitoring stations are identified in Figure 3-1. Parameters monitored in the

Bayou Choctaw surface waters included pH, salinity, total suspended solids (TSS), temperature, dissolved oxygen (DO), five-day biochemical oxygen demand (BOD_5), and oil and grease. A discussion of each parameter follows.

3.2.2.1 Hydrogen Ion Activity (pH)

The hydrogen ion activity, or pH, was slightly greater than 7.0 in most cases. The pH ranged from 6.4 to 7.9 falling below 7.0 in 38% of the samples analyzed. Median pH level was 7.1. A 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, is enhanced by a low pH. Thus, a slightly basic pH is beneficial to the aquatic environment in terms of reducing the toxicity of certain indigenous or contaminating compounds. Additionally, moderately hard natural waters generally have increased buffering capacity which protects against pH fluctuations.

The pH ranged from 7.1 to 8.8, 7.0 to 8.2, 6.6 to 8.4, 6.8 to 8.6, and 6.5 to 8.9 during 1982, 1983, 1984, 1985, and 1986 respectively. The 1982 through 1987 data have remained relatively constant in terms of median pH and range, although a slight drop in pH range was observed in 1987 as compared to 1982 through 1986. The slight fluctuations observed are attributed to a variety of environmental and seasonal factors such as variations in rainfall or aquatic system flushing.

3.2.2.2 Salinity

Salinity means at stations A, B, C, and D were 0.3, 3.4, 2.9, and 0.5 parts per thousand (ppt) respectively. Salinity at station A remained below 0.5 ppt throughout 1987. At station B, salinity ranged from 0.5 ppt in March to 5.5 ppt in July. Salinities at stations C and D ranged from 0.5 to 6.7 ppt and

0.1 to 1.0 ppt respectively. Station B, located in the North-South Canal, is a surface drainage ditch crossing SPR property, but receiving no SPR discharges. The elevated salinities observed at station B were noted during periods of low or no flow and were not due to SPR activities.

Station C, located on the East-West Canal to the southeast of the brine pond, has shown a slightly elevated level of salinity. This is partially attributed to station proximity to the brine pond, the wastewater treatment outfall, flood control system discharges, and residue from brining activities conducted by prior tenants of Bayou Choctaw. Station D salinities are strongly influenced by Bull Bay and the Intracoastal Waterway. Salinities at stations B, C, and D were highest during 1985 when salinities reach 9.0, 5.0, and 4.0 ppt respectively, which corresponded to a long period of dry weather reducing flushing activity.

3.2.2.3 Total Suspended Solids

Average annual TSS levels at stations A, B, C, and D were 19.2, 20.3, 42.1, and 21.9 milligrams per liter (mg/l) respectively. The highest TSS level (132.5 mg/l) was observed during April at control station C, which monitors the receiving water from the sewage treatment plant. Peak TSS levels were also observed during April and May at all other stations including those receiving effluent from SPR sewage treatment plant. No SPR out fall exceeded the permit limitation for TSS during 1987. Thus, the elevated levels observed were probably due to natural phenomena not associated with SPR activity. Data are consistent with the high levels of TSS observed at these stations during previous years.

3.2.2.4 Temperature

Temperatures ranged from 12°C at stations C and D during December to 27°C at these same stations during June and July. Temperatures for all stations averaged 19°C. Temperatures above 20°C were consistently observed at all stations from May through September. The temperature range varied by 15°C in 1987 as compared to the 20, 19, 20, 13, and 19°C ranges observed during 1982, 1983, 1984, 1985, 1986 respectively. Ambient temperatures during 1987 appeared similar to all years when monitoring was performed with the exception of 1985, which had unusually moderate weather conditions. Temperature fluctuations are attributed solely to meteorological conditions since Bayou Choctaw produces no thermal discharges.

3.2.2.5 Dissolved Oxygen

The DO ranged from 1.2 mg/l at station A during August to 10.8 mg/l at station B during April and December. Levels were below 5.0 mg/l at stations A, B, C, and D during 12, 3, 2, and 10 months respectively. The DO levels at station C, the area draining the sewage treatment plant, ranged from 3.6 and 9.5 mg/l. Mean DO levels at stations A, B, C, and D were 2.6, 7.2, 6.2, and 3.9 mg/l respectively. Lower DO levels were noted at stations A and D which are located away from all SPR outfalls. This observation would suggest that SPR runoff and discharges do not significantly reduce the DO of receiving waters. The low levels observed at various times of the year are attributed to low flow and minimal flushing typically observed at those times.

3.2.2.6 Biochemical Oxygen Demand

The five-day BOD_5 ranged from 1.0 to 17.9 mg/l. Mean BOD_5 levels at stations A, B, C, and D were 2.9, 5.8, 7.8 and 3.8 mg/l respectively. Ranges observed during previous years were <1.0 to 10.0 mg/l, which is similar to the 1987 data. Such data are typical for backwater areas. These data indicate low organic loading in the Bayou Choctaw surface waters supporting the contention that the observed depressed DO levels, discussed above, are not due to organic decomposition originating from an inefficient sewage treatment plant.

3.2.2.7 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all monitoring stations throughout 1987. This is consistent with data collected since 1982. These data favorably reflect on continued good site housekeeping and effective site spill prevention, control, and response efforts.

3.2.2.8 General Observations

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

a. The surrounding surface waters continue to have a slightly elevated pH which is normal for the area.

b. The observed salinities were generally low. Those slightly elevated salinities observed were not attributed to SPR activity.

c. The moderately high TSS levels observed reflect ambient surface water conditions at Bayou Choctaw. Such conditions reduce the depth of the photic zone and may smother invertebrates. These conditions are not attributed to SPR operations, but rather appear indigenous to the area as demonstrated by consistently high TSS observations over a five year period at both site and control stations.

d. Low levels of DO were observed on one or more occasions at each station. This phenomenon is attributed to low flow and minimal flushing typically observed at these stations during summer months.

e. The consistently low BOD_5 and nondetectable oil and grease levels observed since 1982 indicate that site oil spills and wastewater treatment plants are effectively managed, minimizing the impact on the Bayou Choctaw environs.

3.2.3 Water Discharge Permit Monitoring

The major permit monitoring is related to water discharges regulated under the EPA (NPDES) permit and a corresponding permit issued by the Louisiana Department of Environmental Quality (LDEQ) Office of Water Resources. These permits were renewed during 1987. Four outfalls which have not been used were eliminated and five outfalls were included as a special condition (i.e., stormwater reporting in Part III). Discharges are from two package sewage treatment plants and stormwater runoff from well pads and pump pads (containment areas).

Parameters for these discharge permits are described below.

Location/Discharge	Parameter	Compliance Range
sewage treatment plants	flow	(report only)
	BOD_5	≤ 45 mg/l
	TSS	≤ 45 mg/l
	pH	6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	≤ 15 mg/l
	pH	6.0 - 9.0

A total of 358 analyses (20.7% for sewage and 79.3% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES and state permit compliance during 1987. The four noncompliances (Table 3-2) in 1987 involved high BOD_5 levels in the site sewage treatment plants and were associated with mechanical problems. All other required analyses conducted on the site discharges were within permit limitations resulting in a 98.9% compliance level for 1987.

3.2.4 Active Permits

Table 3-3 lists the active permits at Bayou Choctaw. The cavern engineering department obtains individual work permits from the Louisiana Underground Injection Control Division for each well workover performed. State inspectors regularly visit the site to observe drilling operations and document well certifications.

3.2.5 Ground Water

The Plaquemine Aquifer is the main source of fresh water for the site and several surrounding municipalities. It is located approximately 18 meters below the surface and extends to a depth of 150 to 182 meters. The upper 18 meters of sediments consist of Atchafalaya clay. The interface of freshwater and saline water occurs at a depth of 122 to 150 meters below the surface. Ground water in the Plaquemine Aquifer communicates with the Mississippi River flowing away from it during the high river stage and towards the river in the low stage.

There are no functioning monitoring wells at the Bayou Choctaw facility.

3.2.6 Other Significant Environmental Activity

Phase II CERCLA testing was completed during 1987. Samples from previously abandoned caverns 1, 2, 3, 8A, and 13 and boreholes 1 and 2 were analyzed and determined to be nonhazardous. Cavern 10, which had been found to contain caustic brine with a high lead level in a wellhead sample, was sampled at five depths. The caustic was determined to be confined to the interior of the casing pipe and hazardous levels of lead were not found. These caverns and holes are scheduled for plugging in late 1989.

Considerable effort was provided for developing new filtration techniques for removing anhydrite particles from brine prior to deep well injection. The techniques developed appear successful in reducing the frequency for well workovers or the need for drilling additional injection wells.

3.3 BIG HILL

The Big Hill site is planned for the storage of 25.4 million cubic meters (160 million barrels) of crude oil in 14 caverns. Appurtenant facilities include a raw water intake structure on the Intracoastal Waterway with a 107-centimeter (48-inch) pipeline extending to the site a 107-centimeter (48-inch) brine disposal pipeline extending five miles offshore in the Gulf of Mexico; and a 91-centimeter (36-inch) pipeline for transporting crude oil between the site and the Sunoco Terminal in Nederland, Texas.

Drilling and construction commenced in 1983 at the site. Actual leaching (solution mining) of the oil storage caverns began in October 1987.

3.3.1 Air Quality

The Big Hill facility operated in accordance with applicable air quality regulatory requirements and all conditions of the air quality permit. This included sprinkling plant roads with water and dust abatement chemicals to control fugitive dust emissions. Hydrocarbon emission monitoring as required by the permit will commence when actual crude oil storage is initiated.

3.3.2 Surface Water Quality Monitoring

Beginning in 1988, selected locations will be established as monitoring stations to assess site-associated surface water quality and to provide early detection of any surface water quality degradation that may result from SPR operations. Parameters such as pH, salinity, alkalinity, temperature, total organic carbon, (TOC), dissolved oxygen (DO), total dissolved solids (TDS), and total suspended solids (TSS) will be monitored.

3.3.3 Water Discharge Permit Monitoring

Water discharges at Big Hill are regulated and enforced through the EPA NPDES permit program and the similar TWC discharge permit program. The discharges at the facility involve brine to the Gulf of Mexico, hydroclone blowdown into the Intracoastal Waterway, effluent from the sewage treatment plant, and stormwater from well pads and pump pads. Figure 3-2 shows the existing outfalls and the proposed water quality monitoring locations.

There were no discharges during 1987 from the hydroclone blowdown system. Parameters for the three active discharges are described below.

Location/Discharge	Parameter	Compliance Range
brine to Gulf	flow	0.27 million m^3/day velocity $\geq$ 6.1 m/sec)
	oil and grease	$\leq$ 15 mg/l
	TDS	(report only)
	TSS	15 mg/l (TWC only)
	pH	6.0-9.0
stormwater	oil and grease	$\leq$ 15 mg/l
	TOC	$\leq$ 75 mg/l (EPA only)
	pH	6.0-9.0
sewage treatment plant	flow	< 18.9 m^3/day
	BOD_5	$\leq$ 45 mg/l $\leq$ 0.38 kg/day (TWC only)
	TSS	$\leq$ 45 mg/l $\leq$ 0.38 kg/day (TWC only) only)
	chlorine	$\geq$ 1.0 mg/l (TWC only)
	pH	6.0-9.0

A total of 677 analyses were performed to monitor NPDES and state discharge permit compliance during 1987. Brine discharges to the Gulf accounted for 55.5% of these analyses. Analyses of stormwater and sewage treatment plant discharges accounted for 36.4% and 8.1% respectively. There were 3 noncompliances during

1987 (Table 3-4) resulting in a 99.6% site compliance performance level.

The Big Hill site has a second TWC permit for appropriating state waters for the leaching, site utility, and fire protection systems. The permit requires a yearly report of water quantities used. In 1987, the site appropriated 8.87 million cubic meters of water from the Intracoastal Waterway. This represents 3.0% of the total volume permitted.

3.3.4 Active Permits

Table 3-5 lists the active permits at Big Hill.

3.3.5 Ground Water

The three major subsurface hydrological units in the Big Hill area are the Chicot and Evangeline aquifers and the Burkville aquiclude. The major source of fresh water is the Chicot Aquifer which is compressed over the Big Hill salt dome. Fresh water in the upper Chicot Aquifer at Big Hill is limited from near the surface to a depth of -30 meters mean sea level.

The town of Winnie uses fresh water from the upper Chicot Aquifer. Beaumont and Port Arthur draw ground water from the lower Chicot Aquifer.

Six monitoring wells were installed around the brine disposal pond system and were sampled for the first time in December 1987. Continued monthly sampling of pH, TOC, and salinity is planned. Initial pH ranges from these wells were 6.0 to 7.3. Salinity levels ranged from 0 to 13.3 ppt and TOC levels ranged from 3 to 12 mg/l. With a lack of historical data these findings represent baseline information against which subsequent data will be compared.

3.3.6 Other Significant Environmental Activity

Dye tests performed in the anhydrite and brine ponds were effective in assuring liner integrity prior to actual use.

Phase II CERCLA testing was completed in 1987. Twenty-eight caverns were sampled for hazardous substances. As a result of these analyses, an Administrative Order was issued by the EPA and an Emergency Order by TWC requiring five wells to be flushed prior to leaching and monthly inorganic analysis of the brine being discharged to the Gulf through start of leach of all caverns. In 1987, two of the five wells were flushed. Analysis showed the flushed brine to be nonhazardous, and it was disposed in oilfield waste (Class II) injection wells. Remaining fluids were found to meet salt water criteria on discharge for all 61 measured constituents. The other three will be flushed in 1988.

A coordinated effort to resolve the use of brackish water during site fire drills and acceptance tests was initiated in 1987. This problem will be resolved through modifications of the firewater system which will include substituting fresh for brackish water while maintaining adequate water for emergencies.

A comprehensive spill contingency plan was prepared for the site and its associated oil and brine pipelines. A spill prevention, control and countermeasure plan (SPCC) was also prepared in fulfillment of Title 40 part 112 of the Code of Federal Regulations.

3.4 BRYAN MOUND

The Bryan Mound site is planned for a total capacity of 35.9 million cubic meters (226 million barrels) of crude oil in 20 solution-mined caverns. Appurtenant facilities include a

91-centimeter (36-inch) brine disposal pipeline extending 20.1 kilometers into the Gulf of Mexico; a raw water intake structure adjacent to the site on the Brazos River Diversion Channel, two 76-centimeter (30-inch) crude oil pipelines connecting the site to the Jones Creek Tank Farm 4.8 kilometers northwest of the site, and the Phillips docks 6.4 kilometers northeast of the site. In addition, the 102-centimeter (40-inch) crude oil pipeline from the site to Arco Refinery in Texas City became operational in 1987.

3.4.1 Air Quality

The Bryan Mound facility, located in a nonattainment area for ozone, operated in accordance with all air quality regulatory requirements throughout 1987. The ongoing fugitive emissions monitoring program as required by the Texas Air Control Board (TACB) includes leakchecking for fugitive volatile organic compound (VOC) emissions from valves and seals on an annual basis using a VOC detector. The program also includes monthly calculations of emissions based on crude oil throughout for each storage tank. No leaks of hydrocarbon vapors from valves or pump seals were detected during 1987. Hydrocarbon emissions from surge tanks were calculated at 1.5 metric tons during 1987, or 27.3% of the permitted limit (5.5 metric tons per year). A TACB inspection conducted during 1987 found no deficiencies in SPR air quality compliance.

3.4.2 Surface Water Quality Monitoring

The surface waters surrounding the Bryan Mound site were monitored throughout 1987. Blue Lake was sampled once monthly at each station. Mud Lake was sampled once monthly except during August and September when low tides restricted access to the lake.

Specific surface water monitoring stations are identified in Figure 3-3. Stations A through C and E through G are located along the Blue Lake shoreline to monitor effects of site runoff. Station D, located farther away from the site in Blue Lake, serves as a control. Stations H and I are located along the Mud Lake shoreline to monitor effects of site runoff. Station J, located away from the shoreline in Mud Lake, serves as a control.

Specific parameters monitored in the Bryan Mound surface waters include pH, alkalinity, salinity, temperature, DO, TOC, chemical oxygen demand (COD), nitrite, nitrate, orthophosphate, calcium, and magnesium. The parameters are discussed and compared to 1982 through 1985 monitoring data.

3.4.2.1 Hydrogen Ion Activity

The hydrogen ion activity, or pH, was moderately basic, ranging from 8.0 in December to 9.9 in September in Blue Lake and 7.7 in June to 8.7 in January in Mud Lake. Median pH levels in Blue Lake and Mud Lake were 8.7 and 8.5 respectively. The consistently basic conditions indicate natural waters devoid of carbon dioxide and generally hard in regard to mineral content. Marine and estuarine waters, such as those in Blue Lake and Mud Lake, typically have somewhat elevated pH levels and high mineral contents. The pH is believed to fluctuate directly with the rate of carbon dioxide uptake as related to low primary productivity (lower pH) during cool periods and high primary productivity (higher pH) during warm periods.

During 1982, 1983, 1984, 1985, and 1986 the pH measurements in Blue Lake and Mud Lake ranged from 7.7 to 10.1, 7.7 to 10.2, 7.2 to 9.9, 7.9 to 9.8, and 7.7 to 9.9 respectively, in general agreement with the 1987 data. There were no known pH inducing impacts to Mud Lake during 1987 or previous years as indicated by these comparisons. Thus, pH fluctuations in the Bryan Mound surface waters appear to be the result of seasonal weather and tidal variations rather than site activity.

3.4.2.2 Alkalinity

Alkalinity, the capacity of water to neutralize an acid, generally reflects the activity of calcium carbonate ($CaCO_3$) in water. The alkalinity in Blue Lake ranged from 49 mg/l in November to 159 mg/l as $CaCO_3$ in September, while the alkalinity in Mud Lake ranged from 69.6 mg/l in June to 154.7 mg/l as $CaCO_3$ in July. Mean alkalinity levels were 91.6 and 116.5 mg/l for Blue Lake and Mud Lake respectively. These levels of alkalinity, which provide some buffering capacity in the Bryan Mound waters, are in general agreement with data from previous years.

3.4.2.3 Salinity

Mean salinity levels were 5.6 and 10.3 ppt in Blue Lake and Mud Lake respectively. The salinity in Blue Lake ranged from 3.0 ppt in June to 10.0 ppt in December. Salinities were highest (8.0 to 10.0 ppt) during December. Salinities were generally higher in 1986 and 1983 than during 1982, 1984, 1985, and 1987. Salinity fluctuations are attributed to meteorologically induced conditions rather than site operations, since salinities observed at control sample points consistently equal that found along the site shoreline.

The salinity in Mud Lake ranged from 1.5 ppt in June to 22 ppt in October. Mud Lake salinities were generally higher from 1982 through 1985 and in 1987 than during 1986. The wider salinity variations in Mud Lake relative to Blue Lake are primarily attributed to the strong tidal and wind influence on the Lake and its more direct link with the Gulf of Mexico.

3.4.2.4 Temperature

The temperature in Blue Lake ranged from 8°C in December to 30°C in August. The temperature in Mud Lake ranged from 13°C in December to 28°C in July. No measurements were taken in Mud Lake during August and September. Mean temperature readings during 1987 were 18.2 and 21.3°C in Blue Lake and Mud Lake respectively. Temperature variation within each lake between sampling locations was generally limited to 2°C suggesting no measurable site induced thermal effects.

Comparable temperatures were observed during previous years. Blue Lake ranged from lows of 9°C in January 1983 and 1984, and 17°C in December 1982 and 1986, and to highs of 33°C in August 1982, and 32°C in July 1983 and September 1984. Mud Lake ranged from lows of 13°C in December 1986, 16°C in December 1982, 15°C in February 1983, 22°C in April 1984, and 9°C in December 1985 to highs of 32°C in July 1983 and 1986, 31°C in June 1982, 29°C in July 1984, and 30°C in June and July 1985.

3.4.2.5 Dissolved Oxygen

Mean DO concentrations were 8.4 and 8.2 mg/l in Blue Lake and Mud Lake respectively. The DO concentration in Blue Lake ranged from 4.7 mg/l in July to 13.0 mg/l in January. The DO in Mud Lake ranged from 5.1 mg/l in July (no sampling during February and March) to 15.0 mg/l in January. The DO levels in 1987 were consistent with that observed since 1982. The DO ranges observed are considered beneficial to the aquatic organisms inhabiting these lakes. Fluctuations in DO levels were partially attributed to the inverse relationship between temperature and DO as well as seasonal fluctuations in primary productivity, and meteorological factors such as wind driven mixing.

3.4.2.6 Total Organic Carbon

The TOC concentration in Blue Lake remained low, averaging 8.5 mg/l and ranging from 3.0 to 16.0 mg/l during 1987. The elevated concentrations attributed to natural phytoplankton blooms from 1982 through 1984 were not observed in 1985, 1986, or 1987.

The TOC concentration in Mud Lake remained low, averaging 8.5 mg/l and ranging from 1.8 mg/l in November to 8.9 mg/l in October. The low TOC levels observed in both lakes are consistent with healthy conditions and a stable oxygen demand.

3.4.2.7 Chemical Oxygen Demand

The COD in Blue Lake averaged 40.7 mg/l and ranged from 9.3 mg/l in October to 159.1 mg/l in September. The levels observed during 1987 were consistent with 1986 (9.9 to 159.1 mg/l) and 1985 (25 to 90 mg/l), but considerably lower (by a factor of 2) during 1982 through 1984. Elevated levels during the warmer summer months of 1987 were similar to those noted during previous years.

The COD in Mud Lake averaged 81.5 mg/l and ranged from 16.7 mg/l in October to 257.8 mg/l in April. Levels were generally similar to those observed in previous years (1982 through 1985) and during 1986 (9.2 to 24.3 mg/l). Variation in COD between the lakes is attributed to the tidal and morphological differences.

3.4.2.8 Macronutrients

The macronutrients, nitrate, nitrite, and orthophosphate, were monitored in Blue Lake and Mud Lake throughout 1987. These parameters provide an indication of eutrophication in natural waters.

Nitrate is a necessary nutrient to the metabolism of plants. The nitrate concentration in Blue Lake averaged 2.8 mg/l and ranged from nondetectable during July, August, and November to 6.6 mg/l in September. The nitrate concentration in Mud Lake averaged 3.1 mg/l and ranged from 2.2 mg/l in March through November to 6.6 mg/l in January. These concentrations are low for contact waters, but sufficiently high to ensure the production of protein during primary production. Nitrite concentrations were very low in both lakes, ranging from nondetectable concentrations to 0.05 mg/l. Average nitrite concentrations were 0.01 and 0.05 mg/l in Blue Lake and Mud Lake respectively. Such low concentrations are consistent with expectations for natural waters.

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 a common limiting factor to plant growth (primary production). Phosphate in Blue Lake averaged 1.0 mg/l and ranged from 0.1 mg/l in January and March to 3.0 mg/l during April. Mud Lake phosphate levels averaged 0.5 mg/l and ranged from nondetectable in May and June to 5.0 mg/l in April. The elevated phosphate levels observed during 1983 and 1984 were attributed to resident and migratory waterfowl populations rafting in open water areas. Waterfowl moved from the open water sample station in 1985 but still congregate in the marshy northwest corner of Blue Lake due to a change in hunting pressure. This change in habitat use has affected the level of observable phosphate. Stability of other parameters, such as DO, TOC, and COD, from 1985 through 1987 is consistent with these phosphate observations.

3.4.2.9 Cations

Calcium and magnesium, essential micronutrients to plants and animals, are commonly the principal contributors to water hardness. Calcium concentrations averaged 123 mg/l and ranged from 54 mg/l (February) to 165 mg/l (October) in Blue Lake. Calcium concentrations averaged 188 mg/l and ranged from 55 mg/l (February) to 382 mg/l (October) in Mud Lake. Magnesium ranged from 105 mg/l (February) to 310 mg/l (December) in Blue Lake and 55 mg/l (December) to 980 mg/l (September) in Mud Lake. Average magnesium concentrations were 178 and 445 mg/l in Blue Lake and Mud Lake respectively. Concentrations of calcium and magnesium observed in Blue Lake during 1987 were similar to previous year's observations. With the exception of a slight decrease in calcium levels observed from 1986 to 1987, concentrations of both magnesium and calcium in Mud Lake, have steadily increased (for unknown reasons) since 1982.

3.4.2.10 Additional Water Quality Monitoring

Visual surveys of adjacent water bodies were performed periodically to monitor those phenological events and environmental perturbations that may affect the SPR either directly or by association.

3.4.2.11 General Observations

Based on the above discussions, the following general observations are made regarding the quality of Bryan Mound surface waters.

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

b. Salinity levels in Blue Lake and Mud Lake were generally consistent with that observed during previous years. Salinity fluctuations during and among years are attributed to meteorologically induced conditions rather than site operations.

c. Levels of TOC, DO, and COD remained moderate and fairly constant throughout the year. These data indicate stable continued primary production.

d. Mud Lake experiences more acute changes in water quality than Blue Lake. The more direct link of Mud Lake with the Gulf of Mexico and the frequent wind and tidal induced flushing are responsible for dramatic seasonal changes in water quality.

3.4.3 Water Discharge Permit Monitoring

Water discharges at Bryan Mound are regulated and enforced through the EPA NPDES Permit Program and the similar TWC discharge permit program for state waters. The three categories of discharges are brine to the Gulf of Mexico; stormwater from the tank farm, well pads, and pump pads; and package sewage treatment plant effluent.

Parameters for the three discharges are described below.

Location/Discharge	Parameter	Compliance Range
brine to Gulf (EPA only)	flow	0.17 m^3/day (nozzle exit velocity $\geq$ 6.1 m/sec)
	oil and grease	$\leq$15 mg/l
	TDS	(report only)
	TSS	(report only)
	pH	6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	TOC	$\leq$75 mg/l (EPA only)
	pH	6.0 - 9.0
	COD	$\leq$200 mg/l (TWC only)
sewage treatment plant	flow	$\leq$22.7 m3/day
	BOD_5	$\leq$45 mg/l $\leq$0.38 kg/day (TWC only)
	TSS	$\leq$45 mg/l $\leq$0.38 kg/day (TWC only)
	chlorine	$\geq$ 1.0 mg/l (TWC only)
	pH	6.0 - 9.0

A total of 2,376 analyses were performed on permitted outfalls for the purpose of monitoring NPDES and state discharge permit compliance during 1987. The brine discharges to the Gulf of Mexico accounted for 24.6% of these analyses. Most analyses (43.7%) were performed on stormwater and pump pad discharges.

There were four noncompliances during 1987 (Table 3-6) resulting in a 99.8% site compliance performance level.

The Bryan Mound site has a second TWC permit for the appropriation of state waters for the leaching program, site utility, and fire protection systems. The permit requires a yearly report of the quantity of water used. In 1987, the site appropriated 1.44 million cubic meters of water from the Brazos River Diversion Channel. A total of 145.88 million cubic meters of water has been appropriated to date for site activities which represents 55.0% of the total volume permitted.

3.4.4 Active Permits

Table 3-7 lists the active permits for the Bryan Mound site.

3.4.5 Ground Water

The Chicot and Evangeline Aquifers provide fresh and slightly saline water to the Bryan Mound area. Fresh water for Brazoria County is obtained from the upper portions of the Chicot Aquifer. Fresh water is thought to occur in the upper 24 meters of the aquifer over the salt dome with slightly saline water from -24 to approximately -69 meters. However, the wells drilled on site for rig water are all brackish.

There are three monitoring wells on site. These wells have not been sampled for nearly two years due to manpower constraints.

3.4.6 Other Significant Environmental Activity

Phase II CERCLA testing was completed in 1987. Analytical results of samples collected from the tarry area near cavern 101 indicated nonhazardous trace levels of heavy metals typical of weathered oil. These low levels found are not an environmental or public safety threat. Cleanup and disposal of the tarry material as an oil field waste is planned to be completed by late 1988.

Purple martin bird houses were installed around the site to enhance bird populations and thereby decrease annoying mosquito populations through biological control. Such control practices limit the need for insecticide use in the area.

A 6.4 liter spill of PCB-contaminated oil that occurred December 4, 1987 was properly cleaned up and disposed. The material was spilled on cement and some soil. Follow-up sampling of the spill area verified that PCBs were completely removed.

Dye tests performed in well pad 113 were effective in locating dike leaks which impacted stormwater retention capabilities of the pad as required by the NPDES and TWC water discharge permits. As an interim measure, the pad was lined with high density polyethylene to eliminate leakage until the permanent fix is implemented which is scheduled for 1989.

3.5 ST. JAMES TERMINAL

The St. James Terminal has six aboveground storage tanks (total capacity 0.3 million cubic meters or two million barrels) and two tanker docks. The terminal has separate pipelines connected to Weeks Island and Bayou Choctaw.

3.5.1 Air Quality

St. James Terminal operated in accordance with all air quality permit and regulatory requirements during 1987. Oil movements of approximately 0.2 million cubic meters (1.5 million barrels) were limited to pipeline transfer operations and 18 ships unloading crude oil. Hydrocarbon emissions were well below the levels projected in the Emission Inventory Questionnaire (866 metric tons/year for loading operations and 541 metric tons/year for unloading operations). Seals on all six external floating roofs were visually inspected during 1987 and found to require repair for compliance with state air quality regulations. Seal repair work commenced in 1987 and is scheduled for completion in 1989. St. James is located in a nonattainment area for ozone.

3.5.2 Surface Water Quality Monitoring

St. James Terminal is located in a low-lying agricultural area beyond 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.

The two St. James docks are located on the west bank of the Mississippi River. They are curbed with all runoff pumped to the stormwater treatment system and retention pond. The site retention pond, which also collects stormwater runoff from the six crude oil storage tank containment areas, is discharged intermittently through outfall 001 (Figure 3-4) into the Mississippi River. Two wastewater treatment plants, which serve the site-control and maintenance buildings, discharge as state outfalls 002 and 003 through outfall 001 into the Mississippi River.

At St. James, the Mississippi River has a large flow volume and rapid currents providing a strong assimilative capacity. The intermittent nature of discharges from site outfalls, the characteristic hydrographic features of the Mississippi River, and a state-conducted water quality monitoring program limit the value of a site-directed water quality monitoring program in the Mississippi River. There are no other surface waters to monitor around the site.

3.5.3 Water Discharge Permit Monitoring

The stormwater from the site retention pond (outfall 001) is the only water discharge regulated by EPA under the NPDES permit. The LDEQ has also issued a water discharge permit which includes outfall 001 with 002 and 003. The latter two are outfalls from the two site package sewage treatment plants. All individual discharges are through a common pipe to the Mississippi River.

Parameters for the outfalls are described below.

Location/Discharge	Parameter	Compliance Range
retention pond	flow	(report only)
	oil and greas	≤15 mg/l
	pH	6.0 - 9.0
	TOC	≤55 mg/l (EPA)
		≤50 mg/l (LDEQ)
sewage treatment plants	flow	(report only)
	BOD_5	≤45 mg/l
	TSS	≤45 mg/l
	pH	6.0 - 9.0

A total of 86 analyses (37.2% for stormwater and 62.7% for sewage discharges) were performed on permitted outfalls to monitor NPDES and state discharge permit compliance during 1987. Two noncompliances (Table 3-8) in 1987 involved high BOD_5 levels in sewage treatment plant effluent. All other required analyses conducted on the site discharges were within permit limitations resulting in a 97.7% compliance level for 1987.

3.5.4 Active Permits

Table 3-9 lists the active permits at St. James Terminal.

3.5.5 Ground Water

The Chicot Aquifer is the principal regional aquifer at St. James. The upper strata of the Chicot Aquifer is in direct hydrologic contact with the Mississippi River. Most of the ground water contained in this aquifer is slightly brackish. In the St. James area only the uppermost units contain fresh water.

3.5.6 Other Significant Environmental Activity

The St. James crude oil laboratory became operational in early 1987. It is the only SPR laboratory equipped to analyze oil components. Eighteen tankers were unloaded without an environmental incident. Repair of the severely worn crude oil storage tank roof seals was initiated in 1987. Completion of seal work on all tanks is scheduled for 1989. A computerized system for tracking drums and other containers was developed in response to findings from a related survey. The system is being maintained to track the condition and status of all drums entering and leaving the site. All deficiencies with the potable water system were resolved, which included installing a back-flow preventer at the water main connection and disinfecting the system after the preventer was installed.

3.6 SULPHUR MINES

Sulphur Mines stores 4.1 million cubic meters (26 million barrels) of crude oil in five existing solution-mined caverns three of which form a single gallery. The site is connected to the Sunoco Terminal in Nederland by way of a 40-centimeter (16-inch) crude oil pipeline which connects to the West Hackberry 107-centimeter (42-inch) line at the Gulf Intracoastal Waterway. Brine disposal is via injection into four brine disposal wells located approximately two miles southwest of the site.

3.6.1 Air Quality

Sulphur Mines operated in accordance with all air quality permit and regulatory requirements during 1987. No configurational or operational changes affecting emission rates occurred at Sulphur Mines. Hydrocarbon emissions were well below levels in the Emissions Inventory Questionnaire (0.2 metric tons/year for standby (static) mode of operation). No air quality monitoring using actual monitoring equipment was required or conducted during 1987. This SPR site is located in a nonattainment area for ozone.

3.6.2 Surface Water Quality Monitoring

Samples collected once monthly at each monitoring station were used to monitor surface water quality. Specific monitoring stations are identified in Figure 3-5. Station C was not monitored during 1987 due to access problems associated with construction activities by an adjacent land owner. Specific parameters monitored in the Sulphur Mines surface waters were pH, salinity, TSS, temperature, oil and grease, and DO. These data are summarized and compared to data collected since 1982.

3.6.2.1 Hydrogen Ion Activity

The median pH was 7.4 ranging from a low of 5.6 at station A in December to a high of 9.5 at station G in April. The median pH has increased slightly each year as compared to 1982 (6.0), 1983 (6.1), 1984 (6.4), 1985 (7.2), and 1986 (7.3). The minimum and maximum pH occurred during June and March respectively during 1982, 1983, 1984, and 1986. In 1985, low and high values occurred in August and February. The pH was slightly more acidic at station A with a median pH of 6.7. Stations B, D, E, F, and G were neutral to a slightly elevated pH with an overall respective median pH of 7.6.

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. Outfall 004 from the site sewage treatment plant discharges upstream of station A, was within compliance for pH as well as all other parameters throughout 1987. Thus, the low pHs are not attributed to the sewage plant. Contamination of stormwater runoff by residual sulfur from past mining activities is considered the primary cause for relatively acidic surface waters in the area. Frasch mining activity occurred in the area from 1896 to 1924 and again in the late 1960's.

3.6.2.2 Salinity

The salinity of the surface waters at Sulphur Mines averaged 1.3 ppt and ranged from nondetectable to 4.1 ppt. Salinity levels were lowest at station F (averaged 0.1 ppt). These levels are consistent with data from previous years. These waters are part of the local flood control canal system and are distinct from the local Sulphur Mines surface drainage. The highest salinities were observed at station G (averaged 1.9.). This level is consistent with that observed in previous years. This subsidence area drains an area where considerable Frasch sulfur mining activity occurred.

3.6.2.3 Total Suspended Solids

Monthly TSS levels averaged 22.6 mg/l and ranged from nondetectable (<0.5mg/l) to 615.0 mg/l during 1987. TSS levels were generally lower than previous years. All site point source discharges were within permit limitations for TSS throughout 1987. The generally high and variable TSS levels observed in the surrounding waters are not attributed to any point source discharge from the site.

3.6.2.4 Temperature

The observed temperatures of the Sulphur Mines surface waters were generally conducive to supporting aquatic life throughout 1987. Maximum station temperatures as high as 30°C were observed from July through September, while the minimum temperatures (as low as 14°C) were observed during December. The average temperature for all stations was 22°C. Slightly warmer temperatures were observed during 1986 as compared to temperatures observed each year since 1982.

3.6.2.5 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all monitoring stations throughout 1987. These data reflect favorably on the site spill prevention, control, and response efforts during 1987. These results are consistent with that collected during previous years.

3.6.2.6 Dissolved Oxygen

Dissolved oxygen monitoring was performed only at station A throughout 1987. This station is located in a relatively stagnant drainage ditch that receives effluent from the site package sewage treatment plant. The DO levels averaged 5.6 mg/l and ranged from 1.3 mg/l during May to 10.9 mg/l during July. The sewage plant operated in compliance throughout 1987. The DO levels were higher in 1986 (averaged 7.5 mg/l) than during 1985 (averaged 4.5 mg/l) when six BOD_5 noncompliances occurred. Although the sewage plant effluent may have been contributory, the low DO levels are related to natural organic loading and limited flushing caused by low rainfall.

3.6.2.7 General Observations

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

a. The generally consistent temporal and spatial pH distribution from 1982 through 1987 suggests that the slightly acidic water quality conditions at Sulphur Mines are attributable to geochemical and meteorological conditions.

b. Changes in water temperature observed during years since 1982 are attributed to meteorological variation since the SPR conducts no thermal discharges.

c. The higher DO levels observed during 1987 and 1986 as compared to 1985 were attributed to natural factors as well as low BOD_5 levels in effluent from the site sewage treatment plant.

3.6.3 Water Discharge Permit Monitoring

The six water discharge points at Sulphur Mines are regulated through the EPA NPDES program. Five of the discharges are stormwater runoff from the well and pump pads (outfalls 001, 002, 003, 005, and 006). The sixth (outfall 004) is the effluent from the sewage treatment plant.

Parameters for stormwater and wastewater discharges are described below.

Location/Discharge	Parameter	Compliance Range
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	pH	6.0 - 9.0
sewage treatment plant	flow	(report)
	BOD_5	$\leq$45 mg/l
	TSS	$\leq$45 mg/l
	pH	6.0 - 9.0

A total of 303 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1987. Approximately 93.3% of the analyses performed were for monitoring stormwater runoff with the remainder for sewage treatment plant effluent analyses. There were no noncompliances during 1987 resulting in a compliance performance level of 100%.

3.6.4 Active Permits

Table 3-10 lists the active permits at Sulphur Mines. The brine disposal wells are routinely exercised, and all state underground injection control certifications are current. The required one-time work authorizations for the individual wells were obtained by the cavern engineering department. State inspectors regularly visit the site to observe underground injection operations.

3.6.5 Ground Water

The main aquifers in the vicinity of Sulphur Mines are the Chicot, Evangeline, and Jasper. The Chicot Aquifer provides a fresh water source for public and industrial use to the towns of Hackberry, Lake Charles, and Sulphur. The Evangeline and Jasper Aquifers are saline. The Evangeline Aquifer is used for salt water disposal in the Lake Charles area.

There are no ground water monitoring wells on the Sulphur Mines site.

3.6.6 Other Significant Environmental Activity

Water collecting in the brine pond underdrain system was monitored at monthly intervals. Weekly sampling was performed when leaks in the pond liner were suspected. The pH was relatively constant (range 5.5 to 7.1). Salinity levels averaged 127.0 ppt and ranged between 0.8 and 243.0 ppt. The high salinities were caused by leaks in the pond liner, which were repaired during 1987.

In cooperation with the U.S. Soil Conservation Service, a program for revegetating barren soil areas at the site was investigated, a plan to correct the problem was developed, and application of dolomite was made.

3.7 WEEKS ISLAND

The Weeks Island site consists of a large mechanically excavated (room and pillar type) salt mine with 11.6 million cubic meters (73 million barrel) of crude oil storage capacity. In addition to normal site facilities, there is a 108 kilometer long 91 centimeter (36-inch) crude oil pipeline connecting the site to the St. James Terminal.

3.7.1 Air Quality

Weeks Island operated in accordance with all air quality permit and regulatory requirements during 1987. No significant configurational or operational changes affecting emission rates occurred at the facility. Hydrocarbon emissions were well below levels shown in the Emissions Inventory Questionnaire (i.e., 0.2, 0.6, and 0.8 metric tons per year for filling, withdrawal and recirculation operations respectively). Air quality monitoring using actual monitoring equipment was neither required nor conducted during 1987.

3.7.2 Surface Water Quality Monitoring

The Weeks Island site is located on the Weeks Island salt dome approximately 30 meters above sea level. The surrounding topography is of rather sharp relief with several small lakes. None of the SPR outfalls discharge directly into these lakes. Other surface waters at this site are intermittent in nature, draining rapidly and thoroughly after any precipitation. The site outfalls 01A, 01B, and 002 (Figure 3-6) discharge small volumes into surface drainage at a substantial distance from receiving waters. The lack of potentially impacted surface waters precludes the need for surface water quality monitoring at the Weeks Island site.

3.7.3 Water Discharge Permit Monitoring

The water discharges at Weeks Island are regulated and enforced in accordance with the EPA NPDES permit program. There are separate outfalls (01B and 002) for each package sewage treatment plant. Outfall 01A consists of stormwater runoff collected in an onsite retention pond.

The various parameters for the monthly samples of all three discharges are listed below with their maximum limits.

Location/Discharge	Parameter	Compliance Range
stormwater	flow	(report only)
	oil and grease	≤15 mg/l
	pH	6.0 - 9.0
sewage treatment plant	flow	(report only)
	BOD_5	≤45 mg/l
	TSS	≤45 mg/l
	fecal coliforms	≤400 colonies/100 ml
	pH	6.0 - 9.0

A total of 125 analyses (80.8% for sewage and 19.2% for stormwater discharges) were conducted on permitted outfalls to monitor NPDES compliance during 1987. There were no noncompliances in 1987. The site experienced a compliance performance level of 100%.

3.7.4 Active Permits

The active permits for Weeks Island are listed in Table 3-11. All applicable permits for activities at the facility are current.

3.7.5 Ground Water

The Chicot formation is the principal aquifer in the Weeks Island area. The aquifer surface is at approximately sea level near Weeks Island and slopes slightly northwest towards a cone of depression attributed to heavy withdrawals in the Lake Charles area. The fresh water sand layers provide water for the local area.

There are no ground water monitoring stations at Weeks Island.

3.7.6 Other Significant Environmental Activity

Although several recirculation and drawdown exercises were performed, no reportable spills occurred at the facility. An improved system for handling and storing brine condensate removed from the mine was implemented during 1987. An investigation was initiated to determine the cause(s) for substantial amounts of brine found in the mine. This involves dewatering the mine at the fill hole and disposing the collected brine at an approved offsite facility. An explanation of the brine source is expected in 1988.

3.8 WEST HACKBERRY

The West Hackberry site is planned for storage of 34.8 million cubic meters (219 million barrels) of crude oil in 22 solution-mined caverns. Brine is transported and disposed either by injection into eight active brine disposal wells located approximately three kilometers southeast of the site or to the Gulf of Mexico through a 91-centimeter (36-inch) pipeline at an area 11 kilometers south of Holly Beach. A series of 55 brine diffuser nozzles are operated to promote brine dispersion. Raw water is brought to the site via pipeline from the Intracoastal Waterway and crude oil is transported between the site and the Sunoco Terminal in Nederland via a 107-centimeter (42-inch) crude oil pipeline.

3.8.1 Air Quality

West Hackberry operated in accordance with all air quality permit and regulatory requirements during 1987. Hydrocarbon emissions were well below the 50.4 metric tons permitted for filling operations. Air quality monitoring using actual monitoring equipment was neither required nor conducted during 1987. There were no construction or configurational changes which would have resulted in additional emissions during 1987. The facility is located in a nonattainment area for ozone.

3.8.2 Surface Water Quality Monitoring

West Hackberry surface water quality was monitored by sampling once monthly at each station throughout 1987. Specific monitoring stations are indicated and identified in Figure 3-7. Specific parameters monitored in the West Hackberry surface waters include pH, salinity, TSS, temperature, TOC, and oil and grease. The TOC was monitored only at station E corresponding to the NPDES permit requirement regarding stormwater discharges. Each parameter is discussed in the following sections.

3.8.2.1 Hydrogen Ion Activity

The pH ranged from 6.9 to 8.6 for all stations. The median pH was 7.8. Less variation in pH was observed during 1987 than any year since 1983. The upper range of the monthly pH, on a station basis, exceeded 8.0 for 27% of the observations, which is generally consistent with that observed in 1986 (38%), 1985 (20%), 1984 (22%), 1983 (23%), and 1982 (45%). Natural waters low in or devoid of carbon dioxide are medium hard to hard, with regard to mineral content, and characteristically slightly high pH. Some compounds, such as hydrogen cyanide and hydrogen sulfide, increase in toxicity with the degree of dissociation, resulting in increasing aquatic toxicity with reduced pH. In this regard, a mildly high pH is beneficial to aquatic life and consistent with an environmentally sound ecosystem.

3.8.2.2 Salinity

Salinity averaged 6.0 ppt and ranged from 0.2 to 21.0 ppt for stations A through F. This range is identical to that observed in 1986. Stations A, B, and C (Black Lake) ranged from 2.4 to 21.0 ppt with the highest levels occurring in October. The Black Lake data compare well with a steady monthly increase in salinity observed from May through November since 1982. Comparisons among stations for each month were consistent.

Wind, tide, and rainfall contributed to the salinity variation in Black Lake. The broad salinity range observed in Black Lake is more conducive to supporting euryhaline organisms or those with sufficient mobility to avoid salinity stresses with such seasonal changes.

Salinities at station D, the southeast drainage ditch, averaged 1.7 ppt and ranged from 0.2 ppt to 7.3 ppt, which is consistent with data collected since 1982. Monthly salinity values at station E, runoff from the high pressure pump pad, averaged 1.6 ppt and ranged from 0.8 to 6.2 ppt. Station E is generally less saline than Black Lake and fluctuates independently of Black Lake stations suggesting there is little to no impact to the lake from this SPR runoff.

3.8.2.3 Total Suspended Solids

TSS averaged 32.4 mg/l and ranged from nondetectable to 1,724.0 mg/l. The lowest range occurred at station E (nondetectable (<0.5) to 52.0) which averaged 12.0 mg/l. Similar ranges were found at stations A (averaged 32.4 mg/l), B (averaged 29.6 mg/l), and C (averaged 28.1 mg/l) in Black Lake (9.0 to 73.5 mg/l). Slightly higher levels were observed at station F (8.5 to 82.0 mg/l). Average levels at this station were 42.7 mg/l. The highest range was found at station D (0.5 to 1,724.0 mg/l), which averaged 260.4 mg/l. Although the high TSS level reported at station D was noted only once, this station is located in the southeast drainage ditch, and has historically shown high TSS levels due to routine cleaning activities performed to keep the ditch free of weeds.

Elevated TSS levels (>60 mg/l) occurred in the three lake stations during December. This phenomenon is attributed to wind and wave driven mixing in the shallow lake. The TSS level at stations E and F were elevated during June and July when all three lake stations were high. It appears that the high pressure pump pad did not significantly contribute to the higher levels of suspended solids in the lake. The consistently high TSS levels at station F (raw water intake structure on the Intracoastal Waterway) is expected for a high traffic shallow waterway. The 1987 TSS observations were generally similar to previous year's data suggesting that occurrence of relatively high TSS levels are typical for this water body.

3.8.2.4 Temperature

The temperature in Black Lake averaged 23.2°C and ranged from 10.0 to 31.5°C. The highest temperatures were recorded during July. The temperature ranges were consistent with previous years, except 1985 when the ranges were 14.2 to 27.0°C. These data are consistent with observations at other sites indicative of regional climatic effects.

3.8.2.5 Oil and Grease

Oil and grease levels were below detectable levels (<5 mg/l) at all stations throughout 1987. These data are consistent with oil and grease data collected since 1982.

3.8.2.6 Total Organic Carbon

TOC is an NPDES permit-required parameter for discharges from the high pressure pump pads as well as other stormwater discharges. Surface water quality monitoring involving TOC included station E only, the drainage area for the high pressure pump pad. The TOC levels at this station averaged 3.3 mg/l and ranged from nondetectable (<0.01 mg/l) to 8.0 mg/l. These low levels indicate that effluent from the pad did not contribute to TOC loading in the lake. These low TOC levels are generally acceptable for an area dominated by industrial runoff. The small observed fluctuation in TOC is not significant.

3.8.2.7 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 was of lower salinity than the Black Lake receiving waters. This demonstrates continuing good control of brine leaks and spills as has been observed since 1982.

b. TSS levels have fluctuated widely at all stations since 1982. High levels of TSS in Black Lake did not appear to be related to site discharges or runoff, but to natural phenomena.

c. Oil and grease levels were nondetectable in Black Lake throughout 1987.

3.8.3 Water Discharge Permit Monitoring

The water discharges at the West Hackberry site are regulated and enforced in accordance with the EPA NPDES permit program. The Louisiana Stream Control Commission (currently the Office of Water Resources in LDEQ) authorized discharge of stormwater and sanitary wastewater effluents.

The three categories of discharges at West Hackberry are brine disposal, sewage treatment plant effluent, and stormwater runoff from well and pump pads. The various parameters for from these discharges are listed below with their maximum limits.

Location/Discharge	Parameter	Compliance Range
brine to Gulf	flow	$\leq$0.17 million m^3/day (nozzle exit velocity $\geq$ 25 f/s)
	oil and grease	$\leq$15 mg/l
	TSS	(report only)
	TDS	(report only)
	pH	6.0 - 9.0
	DO	detectable levels
sewage treatment plant	flow	(report only)
	BOD_5	$\leq$15 mg/l
	TSS	$\leq$45 mg/l
	fecal coliform	(report only)
	pH	6.0 - 9.0
stormwater	flow	(report only)
	oil and grease	$\leq$15 mg/l
	TOC	$\leq$75 mg/l
	pH	6.0 - 9.0

A total of 4,368 analyses were conducted on permitted outfalls to monitor NPDES compliance during 1987. Discharges from the sewage treatment plant and brine disposal pipeline accounted for 1.1% and 44.9% respectively of total analyses performed. The majority of the analyses (57.0%) involved well and pump pad runoff.

Permit noncompliances were identified on five occasions (Table 3-12). All five resulted from of not collecting a sample. These 1987 noncompliances, on a per analysis basis, resulted in a site compliance performance level of 99.9%.

3.8.4 Active Permits

Active permits for West Hackberry are listed in Table 3-13.

3.8.5 Ground Water

There are three shallow aquifers fourd in the vicinity of the West Hackberry site. The Chicot Aquifer, which flows closest to the surface in the Hackberry area, is predominantly fresh water with salinity increasing with proximity to the coast. The Evangeline Aquifer flows under the Chicot and the Jasper Aquifer.

The majority of the ground water pumping from the Chicot Aquifer takes place in the Lake Charles area. The pumping is so great that a cone of depression has been created in some areas. The fresh/saline water interface is approximately 200 meters below the surface.

There are four monitoring wells (Figure 3-7) on the West Hackberry site. These monitoring wells have been sampled monthly since 1982. Well log histories and background information on construction and installation are lacking for three wells.

Mean salinity levels in wells PB1, P8, P9, and P11 were 89.8, 0.9, 2.4, and 2.2 ppt respectively. Salinities ranged from 0.8 ppt at P8 during much of the year to 113.5 ppt at PB1 in December. Salinity levels in monitoring wells P8, P9, and P11 showed only slight fluctuations during 1987 as compared to levels noted during previous years. Data from monitoring well PB1 showed a substantial increase in levels during the year (ranged from 20.1 to 113.5 ppt). These data prompted additional ground water investigations including a soil resistivity study to determine the salinity source. Notifications of the high salinity observations were made to the appropriate regulatory agencies. An investigation to determine the likely salinity source is underway.

The ground water pH values observed from the monitoring wells P8, P9, and P11 ranged from 6.0 to 7.3, which is consistent with previously collected data. The pH in monitoring well PB1 ranged from 3.2 to 6.1. Low pH levels were also noted in 1986 (ranged from 3.4 to 4.7).

3.8.6 Other Significant Environmental Activity

Monitoring of several apparently stressed oak trees located near the property line continued in an effort to assess their general health. The continued presence of abundant new growth indicates the trees are recovering.

Environmental assessment of impact in the Black Lake area from the 1986 Cavern 111 crude oil spill continued. Analysis of water and mud from the lake indicate the overall impact from the spill was confined to a small area around the wellpad and effects were short-lived.

Additional laboratory equipment was acquired or put into use to expedite wastewater analyses. Equipment includes a respirometer to monitor BOD_5 in the sewage treatment plant and an infrared spectrometer for oil and grease analysis. Comparison tests between the spectrometer and conventional methods were performed to gain EPA approval which is expected in 1988.

Clam shells were deposited at Long Point near the area in West Cove where repairs were performed to the West Hackberry brine disposal pipeline. The shells will serve as seed beds for oysters thereby mitigating disturbances caused by the pipeline repair activity.

Elaborate brine sampling was performed on the brine disposal pipeline to ensure that dissolved oxygen levels remained detectable at the outfall when oxygen scavenger is used for reducing corrosion of the pipeline.

As initiated in 1986, the site beautification program, which includes planting flowers around buildings and on top of barricades, continues with excellent results for improving site appearance.

3.9 CONCLUSION

No adverse environmental impact resulting from SPR activities was observed during 1987. The SPR continues to maintain an excellent environmental record at all facilities.

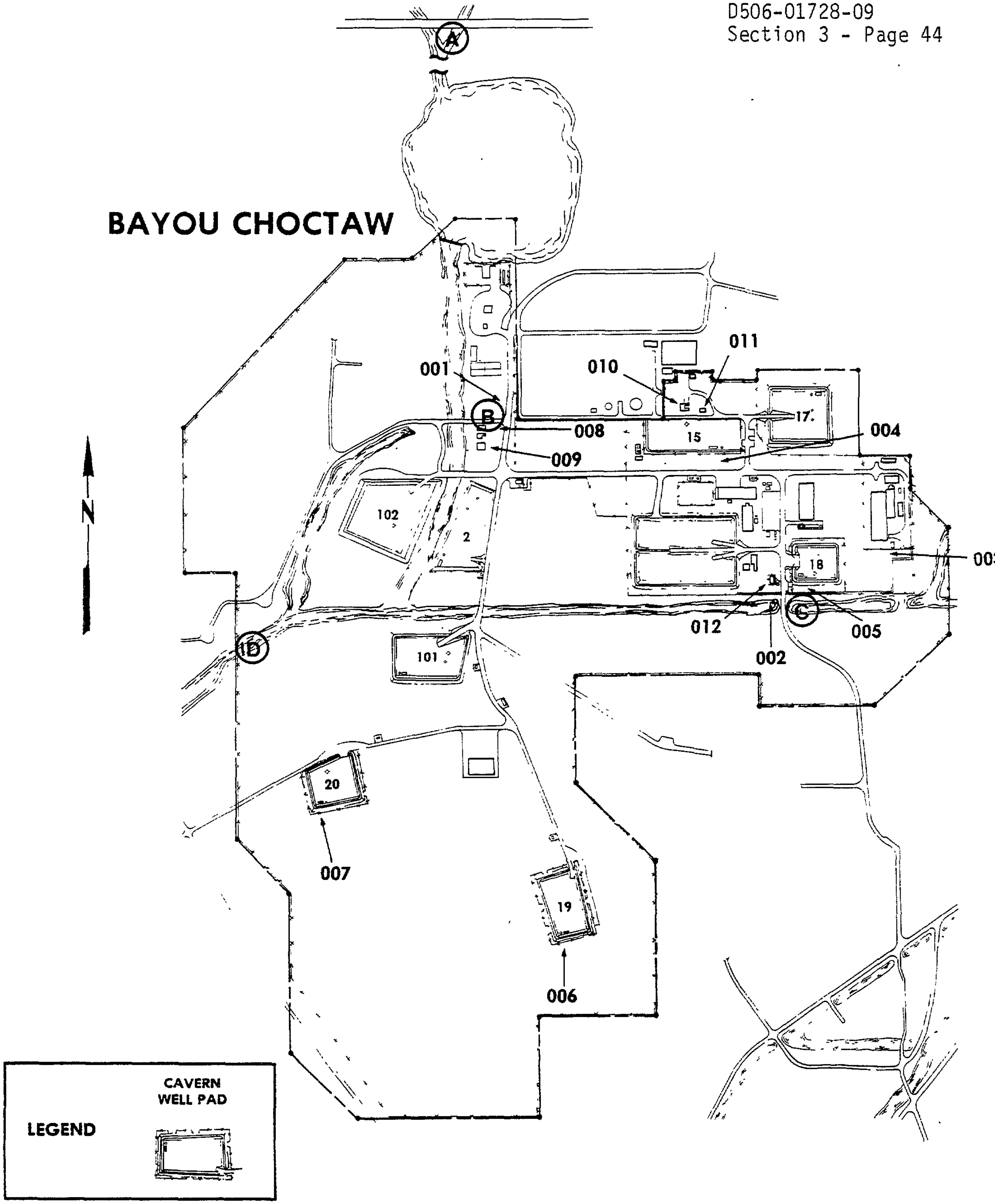

Figure 3-1 (Sheet 1 of 2). Bayou Choctaw Environmental Monitoring Stations

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	Stormwater from Well Pad 15
005	Stormwater from Well Pad 18
006	Stormwater from Well Pad 19
007	Stormwater from Well Pad 20
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

* With the permit renewal of 10/87, outfalls 008-012 which have not been used were eliminated and outfalls 003-007 and the newly constructed well pads were included in Part III.

Water Quality Monitoring Stations

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

Figure 3-1 (Sheet 2 of 2). Bayou Choctaw Environmental Monitoring Stations

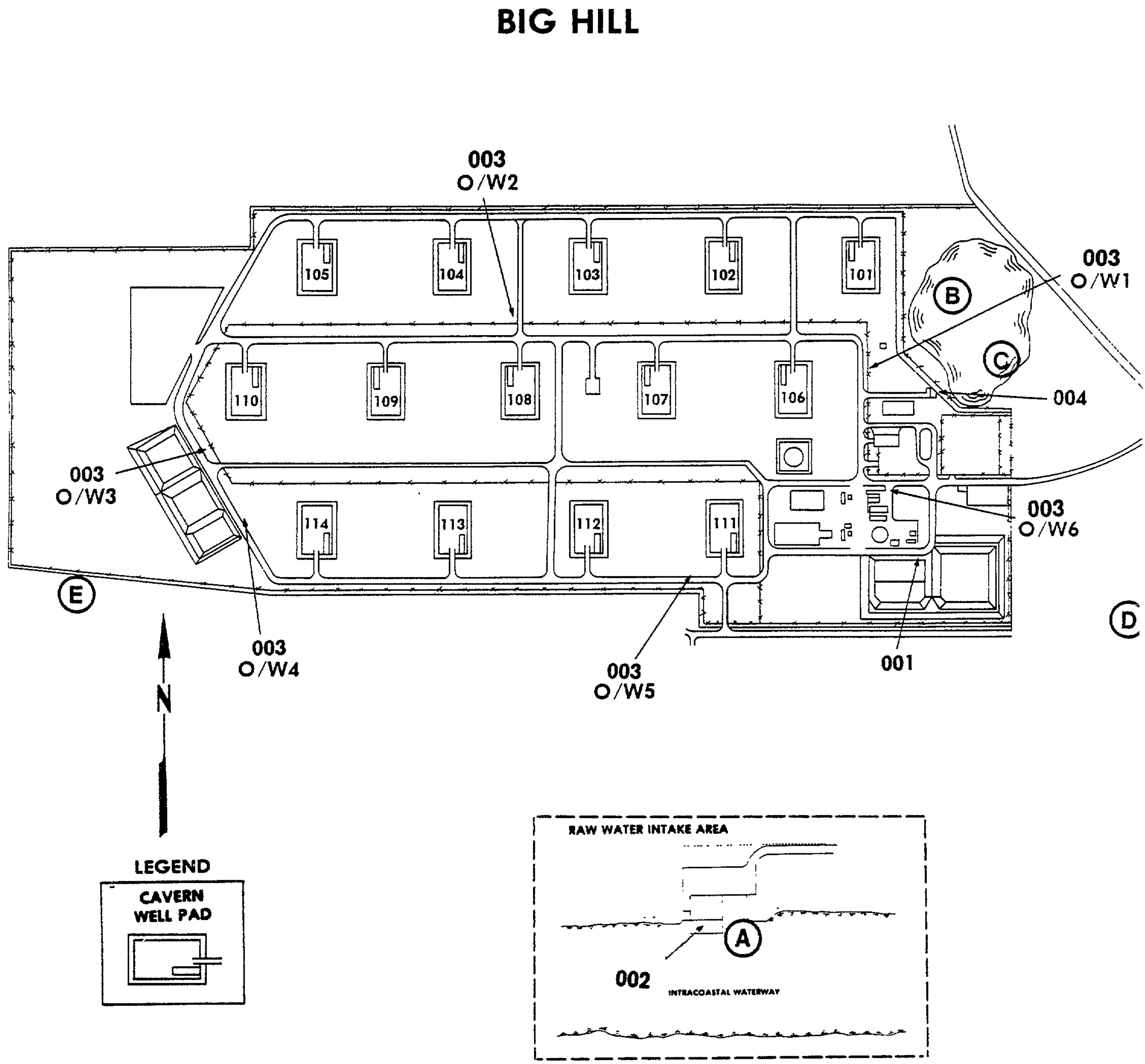

Figure 3-2 (Sheet 1 of 2). Big Hill Environmental Monitoring Stations

Discharge Monitoring Stations

001 Brine Disposal

002 Hydroclone and Blowdown at Raw Water Intake Structure

003 Stormwater Discharges

- O/W1 Stormwater from Well Pads 101, 102, 106, 107
- O/W2 Stormwater from Well Pads 108, 109, 110
- O/W3 Stormwater from Well Pads 111, 112
- O/W4 Stormwater from Well Pads 113, 114
- O/W5 Stormwater from Well Pads 103, 104, 105
- O/W6 Stormwater from Pump Pads
- O/W7 Stormwater from Meter Pads

004 Discharge from Sewage Treatment Plants (TWC only)

Proposed Water Quality Stations

A Gulf Intracoastal Waterway
B Ten-Acre Pond
C Ten-Acre Pond
D Ditch Southeast of Site
E Ditch Southwest of Site

Figure 3-2 (Sheet 2 of 2). Big Hill Environmental Monitoring Stations

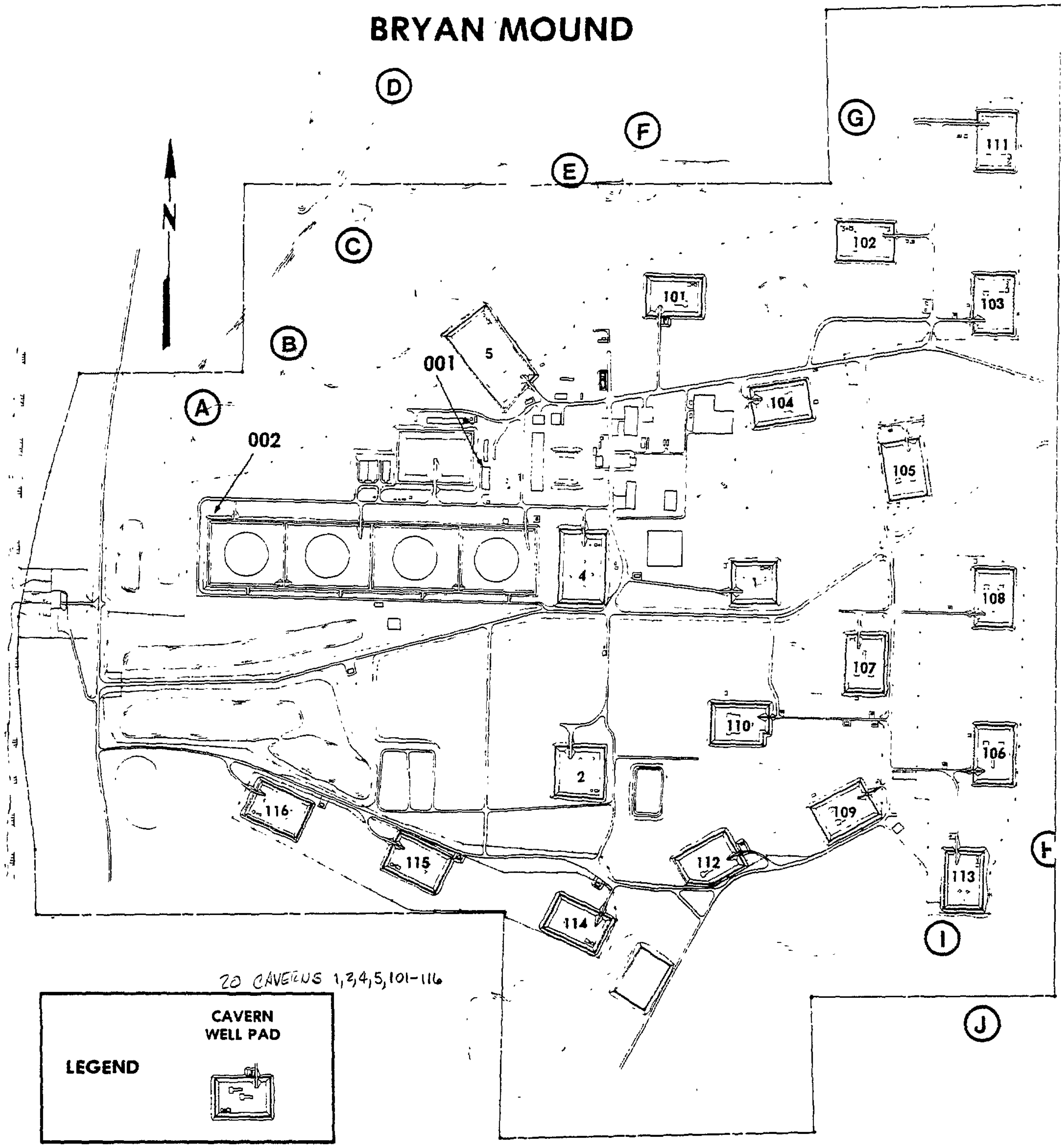

Figure 3-3 (Sheet 1 of 2). Bryan Mound Environmental Monitoring Stations

Discharge Monitoring Stations

001 Brine Disposal

Stormwater Runoff from Surge Tank Area (Corresponds to TX Water Comm. Permit No. 02271 Discharge 001)

002 Discharge from the Sewage Treatment Plant

Stormwater Discharges
Stormwater Runoff from Well Pads 1, 2, 4, 5, and 101-116

Stormwater Runoff from the High-Pressure Pump Pad

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 3-3 (Sheet 2 of 2). Bryan Mound Environmental Monitoring Stations

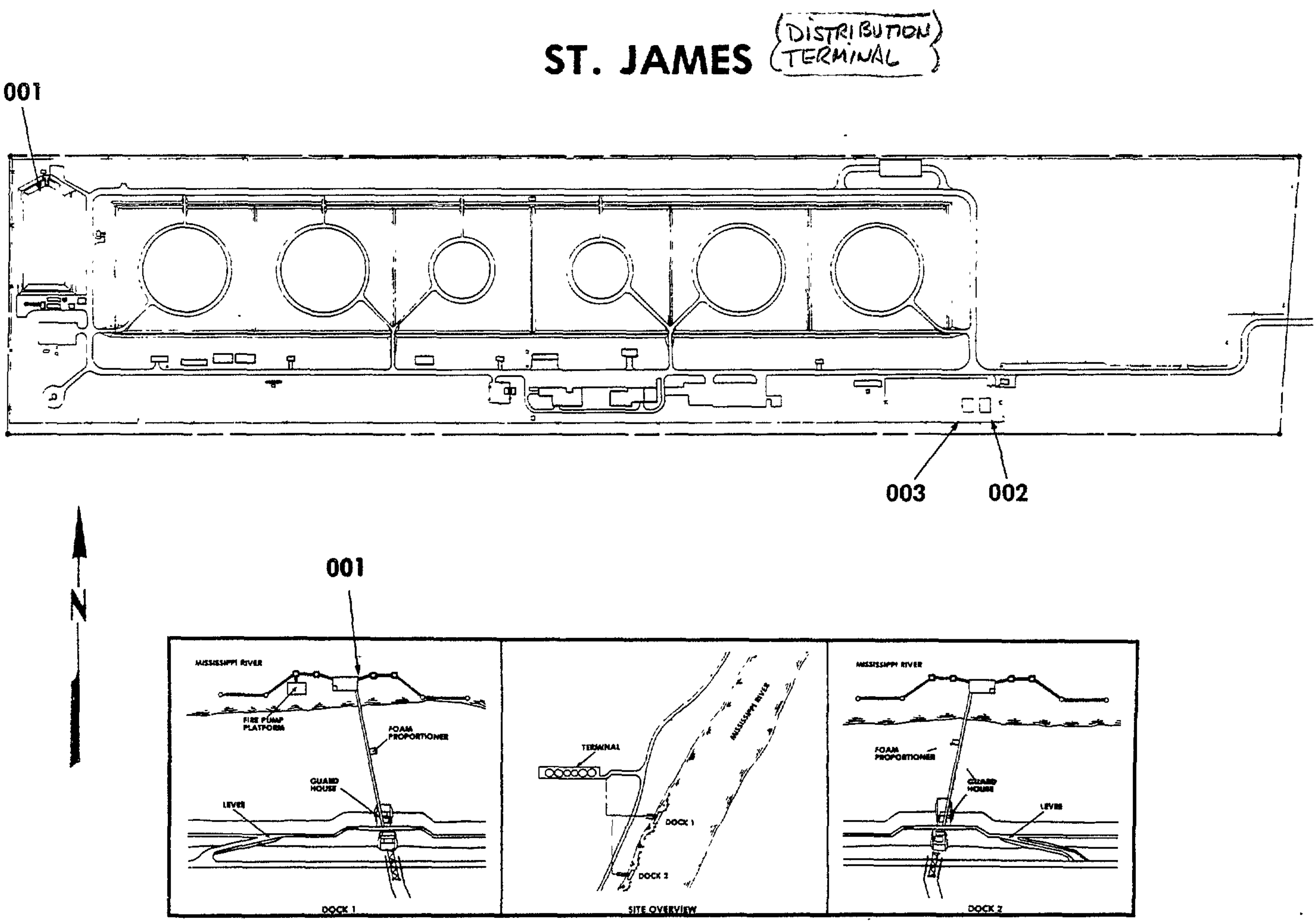

Figure 3-4 (Sheet 1 of 2). St. James Terminal Environmental Monitoring Stations

Discharge Monitoring Stations

001	Discharge from Retention Pond
002*	Discharge from Package Sewage Treatment Plant
003*	Discharge from Package Sewage Treatment Plant

* State discharge permit outfall numbers.

Figure 3-4 (Sheet 2 of 2). St. James Terminal Environmental Monitoring Stations

SULPHUR MINES

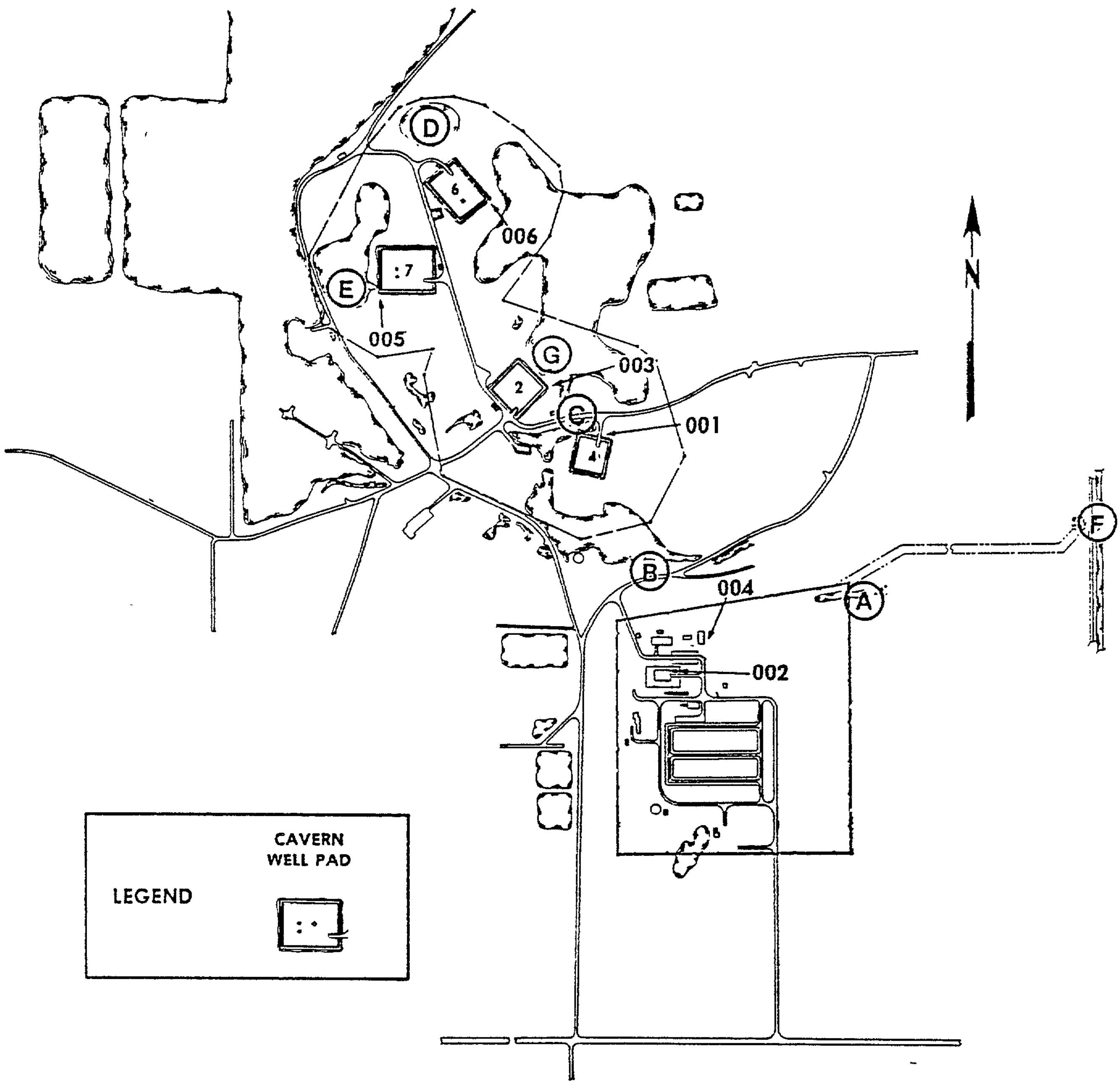

Figure 3-5 (Sheet 1 of 2). Sulphur Mines Environmental Monitoring Stations

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 (Pump)
D Impoundment North of Cavern 6
E Impoundment West of Cavern 7
F Intake Structure
G Subsidence Area

Figure 3-5 (Sheet 2 of 2). Sulphur Mines Environmental Monitoring Stations

WEEKS ISLAND

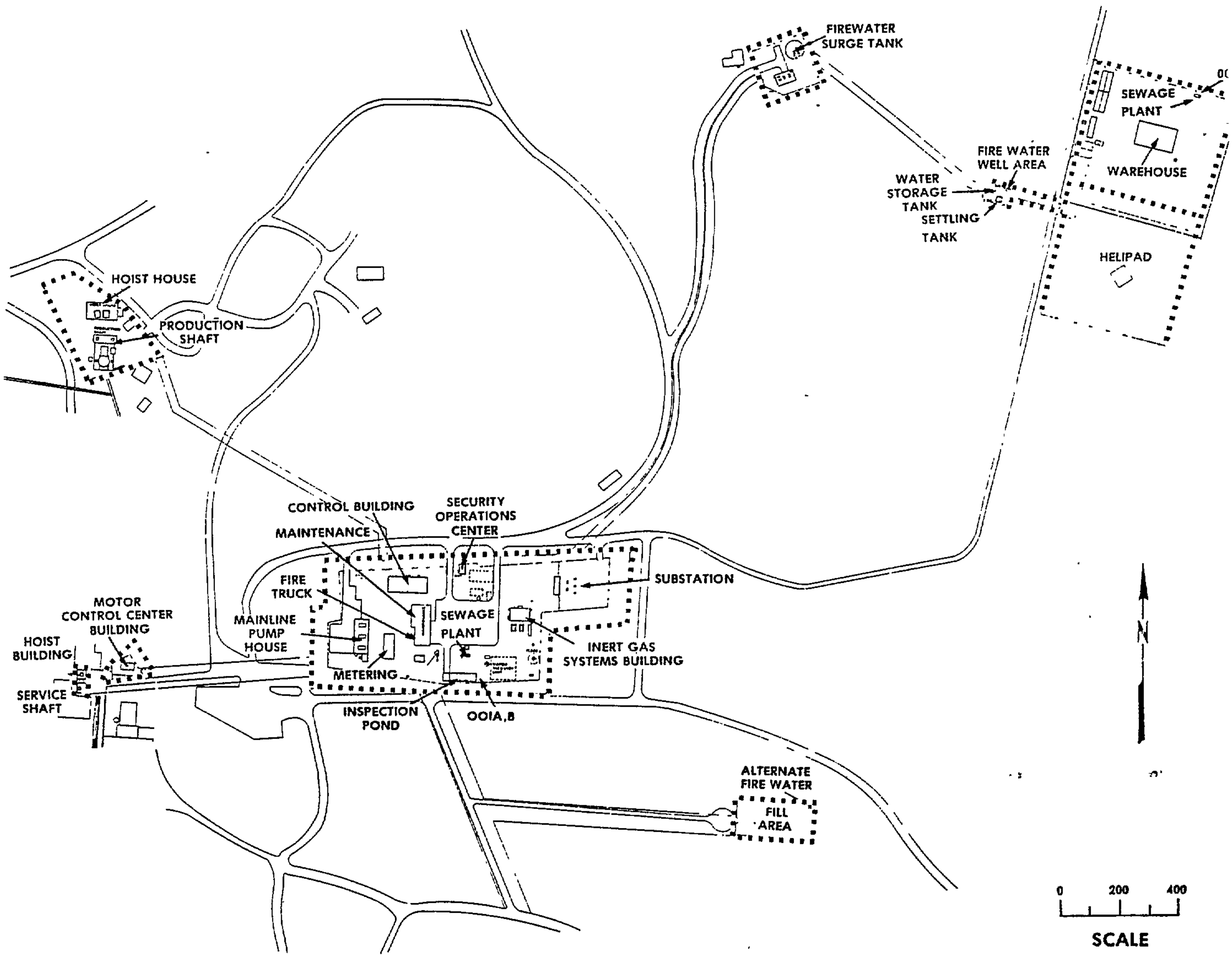

Figure 3-6 (Sheet 1 of 2). Weeks Island Environmental Monitoring Stations

Discharge Monitoring Stations

01A	Stormwater Runoff
01B	Discharge from Sewage Treatment Plant
002	Discharge from Sewage Treatment Plant

Figure 3-6 (Sheet 2 of 2). Weeks Island Environmental Monitoring Stations

WEST HACKBERRY

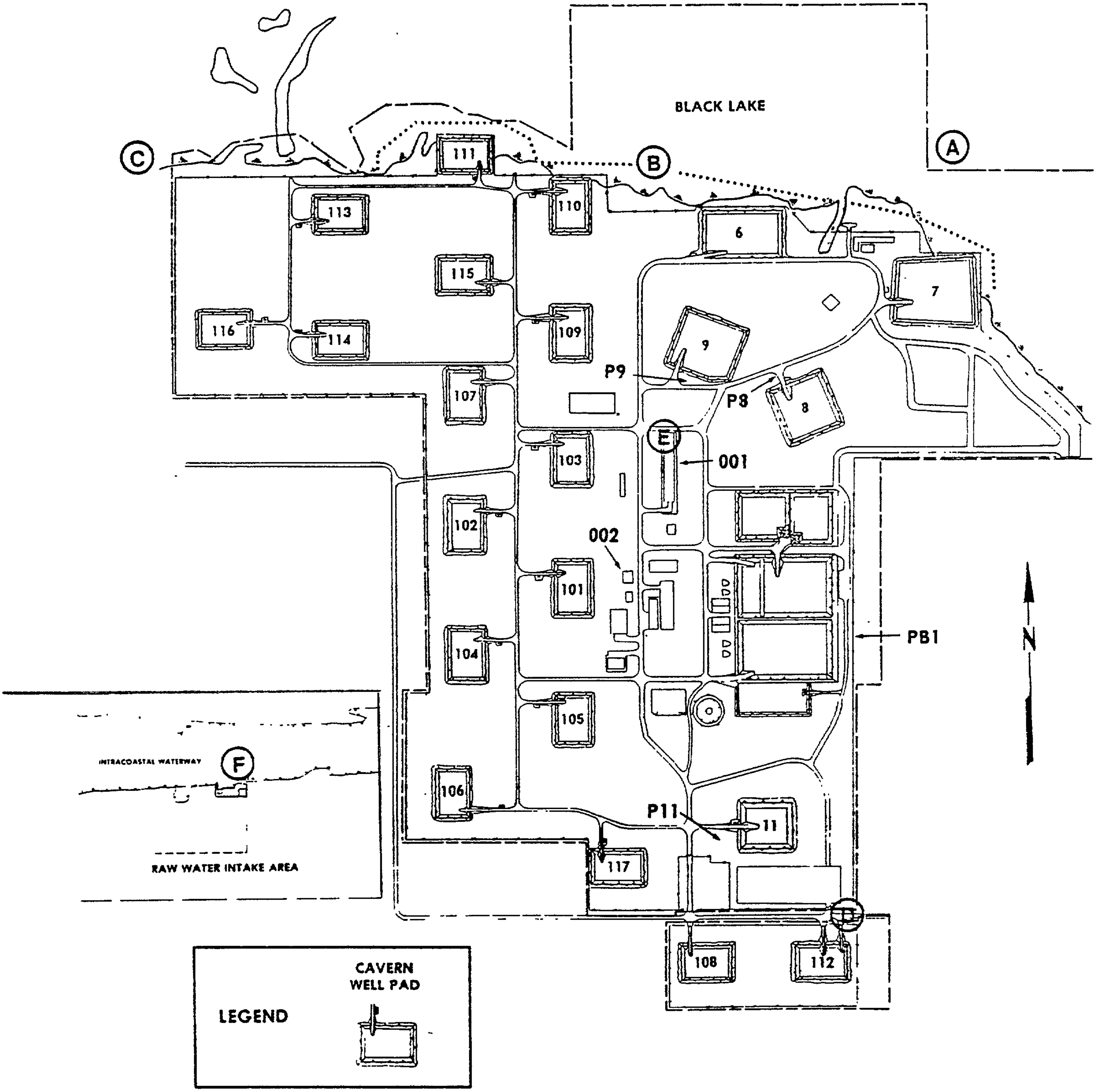

Figure 3-7 (Sheet 1 of 2). West Hackberry Environmental Monitoring Stations

Discharge Monitoring Stations

001	Brine Disposal
002	Discharge from Sewage Treatment Plant
	Stormwater Discharges
	Stormwater and Pump Flush from High-Pressure Pump Pad
	Stormwater Runoff from Well Pads 6-9, 11, and 101-117

Water Quality Monitoring Stations

A	Black Lake
B	Black Lake
C	Black Lake
D	Southeast Drainage Ditch
E	High-Pressure Pump Pad
F	Raw Water Intake Structure

Ground Water Monitoring Stations

PB1	East of Brine Pond #1
P8	North of Cavern 8
P9	South of Cavern 9
P11	West of Cavern 11

Figure 3-7 (Sheet 2 of 2). West Hackberry Environmental Monitoring Stations

PHYSICO-CHEMICAL PARAMETERS	SAMPLE IDENTIFICATION AND FREQUENCY BY SITE																
	DAILY						WEEKLY			MONTHLY							QUARTERLY
	BC	BH	BM	SJ	SM	WH	BH	BM	SM	BC	BH	BM	SJ	SM	WI	WH	SJ
pH	003- 012	003	001 101- 116, 1,2, 4,5 TX- 001 002	001	001 002 003 005 006	001 6-9, 11 101- 117 HPP			004	001 002 A-D	001 002 004	A-J		A-G	01A 01B 002	002 A-F	002 003
SALINITY		001	001			001 HPP				A-D		A-J		A-G		A-F	
SPECIFIC CONDUCTIVITY										A-D		A-J		A-G		A-F	
TEMPERATURE		001	001			001				A-D		A-J		A-G		A-F	
TOTAL DISSOLVED SOLIDS (TDS)						001	001	001						A-G		A-F	
TOTAL SUSPENDED SOLIDS (TSS)						001	001 002	001	004	001 002 A-D	004	002*		A-G	01B 002	002 A-F	002 003
CHLORIDE (CL)	010 011																
DISSOLVED OXYGEN (DO)						001				A-D		A-J			A-F		
BOD_5									004	001 002 A-D	004	002*			01B 002	002	002 003
COD			002 TX- 001 1,2, 4,5, 101- 116									A-J					
OIL & GREASE	003- 012	001 003	001 002 101- 116 1,2, 4,5, TX- 001	001	001 002 003 005 006	001 6-9, 11 101- 117 HPP				A-D				A-G	01A	A-C E-F	
TOC				001		6-9 11 101- 117 HPP		001		A-D	003	A-J				E	
FECAL COLIFORM															01B 002	002	
RESIDUAL CHLORINE		004	002														
FLOW	001- 012	001	TX- 001 001 002 1,2, 4,5, 101- 116	001	001 002 003 005 006	HPP 001 6-9	002 004**		004	001 002	001		002 003		01A 01B 002	002	

* Sampling performed twice per indicated period.
**) Sampling performed 5 days/week.

NOTE: Water Quality Stations (lettered stations) are sampled for possible detection of any adverse environmental condition on and in the waters surrounding the SPR sites.

Table 3-1. Physicochemical Parameters

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
001	BOD_5 (monthly avg.)	35.0 mg/l / 30.0 mg/l	Circuit breaker for aeration blower motor tripped when a faulty backpressure preventer valve strained the blower motor.
001	BOD_5	67.0 mg/l / 45.0 mg/l	Sewage treatment plant recovery slow due to anaerobic conditions resulting from the circuit breaker problem noted above.
001	BOD_5	73.8 mg/l / 45.0 mg/l	Sewage treatment plant recovery slow apparently still due to anaerobic conditions resulting from the circuit breaker problem noted above.
002	BOD_5	220.0 mg/l / 45.0 mg/l	Stuck toilet valve coupled with heavy use of system during a security exercise and failure of one aeration blower.

Table 3-2. 1987 Noncompliances/Bypasses at Bayou Choctaw

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053040	EPA	Water	8/9/81	3/12/83	(1)
WP0179	LDEQ	Water	7/22/83	7/21/88	
None	LDNR	Injection	1/11/83	Open	(2)
LMNOD-SP (Bayou Plaquemine)17	COE	Constr. Maint.	9/26/77 9/26/77	9/25/80 9/25/87	(3), (6)
LMNOD-SP (Bull Bay)3	COE	Constr. Maint.	1/30/79 1/30/79	1/29/82 1/29/89	(4), (6)
LMNOD-SE General Permit	COE	Constr.	8/31/85	8/31/90	(5), (6)

(1) Submitted for renewal (2/2/83 and 11/9/87).
(2) Letter of financial responsibility to plug and abandon injection wells.
(3) Install and maintain 36-inch crude oil pipeline.
(4) Dredge and maintain Bull Bay.
(5) Excavate and fill to construct and maintain well pad 17.
(6) Recorded with applicable Registrar of Deeds.

* COE - U.S. Army Corps of Engineers
EPA - Environmental Protection Agency
LDEQ - Louisiana Department of Environmental Quality.
LDNR - Louisiana Department of Natural Resources.

Table 3-3. Active Permits at Bayou Choctaw

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
001	TSS		No sample collected (TWC noncompliance only).
004	chlorine residual	0.7 mg/l / >1.0 mg/l	Low flow rates allowed chlorine to dissipate before reaching sampling location (TWC noncompliance only).
004	pH, TSS, BOD_5		No sample collected (TWC noncompliance only).

Table 3-4. 1987 Noncompliances/Bypasses at Big Hill

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0092827	EPA	Water	1/18/84	1/17/89	
SWGCO-RP 16536	COE	Constr.	1/11/84	12/31/88	(1)
P-7	F&WS	Constr. Operate	7/31/86 7/31/86	7/31/88 7/29/2036	(2)
C-9256	TACB	Air	5/17/83	Open	(3)
02937,8&9	RCT	Operate	11/28/83	Open	(4)
0048295-0048320	RCT	Operate	5/9/83 6/23/83	Open Open	(5)
02638	TWC	Water	6/23/87	6/22/92	(6)
4045	TWC	Water	11/11/83	5/8/88	(7)

(1) Completion of raw water, brine disposal, and crude oil pipeline extended. Amended to install offshore pipeline by trenching.
(2) Completion of pipeline construction extended.
(3) Under construction. Conversion to operations permit should be made 7 months prior to site reaching full status.
(4) Valid until ownership changes, system changes, or other physical changes are made in the system.
(5) Permits to create, operate, and maintain an underground hydrocarbon storage facility consisting of 14 caverns.
(6) Corresponds to TX0092827.
(7) Permit expires after consumption of 239,000 acre-feet of water or end of project.

* F&WS - U.S. Fish and Wildlife Service
RCT - Railroad Commission of Texas
TACB - Texas Air Control Board
TWC - Texas Water Commission

Table 3-5. Active Permits at Big Hill

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
001	Oil & Grease	88.9 mg/l / 15.0 mg/l	Unknown, but suspect resumption of leaching after brief shutdown could have agitated a small quantity of crude oil in the brine pond which was sampled while passing through the brine line.
002	TSS	70.0 mg/l / 45.0 mg/l	High concentration of disinfectant entered sewage plant.
002	TSS (monthly avg.)	29.5 mg/l / 20.0 mg/l	Sewage treatment plant recovery slow from effects of disinfectant as noted above.
001	Oil & Grease		Improper sample container and less than adequate sample volume collected to allow for proper analysis.

Table 3-6. 1987 Noncompliances/Bypasses at Bryan Mound

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
TX0074012	EPA	Water	2/3/84	2/2/89	
SWGCO-RP-12347(1)	COE	Dredging	2/22/78	12/31/94	(1)
3-67-782 (Docket#)	RCT	Injection	8/21/78	Open	(2)
P001447 & 8	RCT	Constr.	7/3/85	Open	(3)
001447	RCT	Operate	10/30/84	Open	(4)
001448	RCT	Operate	10/30/84	Open	(4)
3-70-377 (Docket#)	TWC	Injection	12/18/78	Open	(2)
3681A	TWC	Water	7/30/79	Open	(5)
02271	TWC	Water	2/3/84	2/2/89	(6)
C-6176B	TACB	Air	7/20/79	Open	(7)
82-8475	TDH&PT	Constr.	1/1/83	Open	(8)

(1) Maintenance dredging of raw water intake extended.
(2) Approval of oil storage and salt disposal program.
(3) Authority to construct anhydrite pit.
(4) Authority to operate brine ponds.
(5) Permit expires after consumption of 367,088 acre-feet of water or project ends.
(6) Corresponds with TX0074012.
(7) Modification to existing permit submitted for converting to an operations permit.
(8) Corresponds with SWGCO-RP-16177.

* TDH&PT - Texas Department of Highways and Public Transportation

Table 3-7. Active Permits at Bryan Mound

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0054674	EPA	Water	7/12/85	7/11/90	
LMNOD-SP (Mississippi River) 998	COE	Constr.	3/20/78	3/19/88	(1)(2)
WP 0929	LDEQ	Water	9/26/84	9/26/89	
983	LDEQ	Air	7/25/78	Open	(3)

(1) Amended to install riprap and buoy mooring.
(2) Permit and all amendments recorded with Registrar of Deeds in St. James Parish.
(3) Requires annual operating report.

Table 3-9. Active Permits at St. James Terminal

OUTFALL LOCATION	PERMIT PARAMETER	VALUE / LIMIT	CAUSE
002	BOD_5	57.2 mg/l / 45.0 mg/l	Unknown, but suspect stabilizing problems resulted when plant cleaned out as recommended by a state inspector.
003	BOD_5	87.4 mg/l / 45.0 mg/l	Unknown, but suspect stabilizing problems resulted when plant cleaned out as recommended by a state inspector.

Table 3-8. 1987 Noncompliances/Bypasses at St. James Terminal

PERMIT NUMBER	ISSUING* AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LMNOD-SP (LTCS)20	COE	Constr.	7/24/78	7/24/88	(1)
LA0055786	EPA	Water	4/19/85	4/18/90	(2)
1042	LDEQ	Air	9/26/78	Open	(3)
None	LDOTD	Water	1/01/87	12/31/87	(4)
None	LDNR	Injection	1/11/83	Open	(5)
SDS-6	LDNR	Injection	7/20/78	Open	(6)

(1) Renewal submitted 8/13/85 for erosion control work on the Intracoastal Waterway. Recorded permit and amendments with applicable Parish Registrars of Deeds.
(2) Expiration extended pending issuance of new permit in response to March 1985 renewal application.
(3) Requires annual operating report.
(4) Water purchase agreement (renewed annually).
(5) Letter of financial responsibility to close, plug, and abandon any and all injection wells.
(6) Approval for use of salt dome cavities for storage of liquid hydrocarbons.

* LDOTD - Louisiana Department of Transportation and Development

Table 3-10. Active Permits at Sulphur Mines

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0056243	EPA	Water	6/30/79	10/13/87	(1)
LMNOD-SP (Atchafalaya Floodway) 251	COE	6/12/78	Maint.	6/1/88	(2)
1105	LDEQ	Air	1/30/78	Open	(3)
SDS-8	LDNR	Injection	2/16/79	Open	(4)
None	LDEQ	Water	7/12/79	Open	

(1) Submitted for renewal 10/15/87.
(2) Recorded permit and amendments with applicable Parish Registrars of Deeds.
(3) Requires annual operating report.
(4) Approval for use of salt dome cavities for storage of liquid hydrocarbons.

Table 3-11. Active Permits at Weeks Island

OUTFALL LOCATION	PERMIT PARAMETER	VALUE LIMIT	CAUSE
001	Oil & Grease (O&G)		No sample taken.
001	O&G, TSS, TDS		No sample taken.
HPP	O&G, TOC, pH		No sample taken.
001	O&G		No sample taken.
001	O&G, TSS, TDS		No sample taken.

Table 3-12. 1987 Noncompliances/Bypasses at West Hackberry

PERMIT NUMBER	ISSUING AGENCY	PERMIT TYPE	EFFECTIVE DATE	EXPIRATION DATE	COMMENTS
LA0053031	EPA	Water	8/22/84	8/21/89	
LMNOD-SP (LTCS)26	COE	Dredging	2/8/79	2/7/89	(1)
LMNOD-SP (Black Lk)31	COE	Dredging	10/26/82	10/25/92	(2)
LMNOD-SP (Black Lk)43	COE	Constr.	7/26/84	7/25/87	(3)
LMNOD-SP (Gulf of Mexico) 2574	COE	Constr.	5/29/86	8/31/87	(4)
None	LDNR	Injection	8/7/79	Open	(5)
971198-9	LDNR	Injection	10/6/83	Open	(6)
None	LDEQ	Water	3/30/79	Open	
1048	LDEQ	Air	10/26/78	Open	(7)

(1) Maintenance dredging for raw water intake.
(2) Maintenance dredging for fire water canal.
(3) Construction of erosion control dike completed in 1986.
(4) Amended to install parallel pipeline at Mile 9.
(5) Approval to create 16 additional salt dome cavities.
(6) Approval to construct and operate wells 117A and B.
(7) Requires semi-annual status-of-construction report.

Table 3-13. Active Permits at West Hackberry

4. QUALITY ASSURANCE

The SPR sites undergo periodic evaluation throughout the year in the form of internal audits as well as audits by outside federal and state agencies. The Bryan Mound and West Hackberry laboratories participated in the seventh annual EPA Discharge Monitoring Report Quality Assurance Study during 1987. The SPR also continued conducting its own internal laboratory quality assurance through analysis of blanks, spikes, and standards. The structured laboratory quality assurance program has continued through the systematic application of acceptable accuracy and precision criteria at all SPR laboratories. Compliance with this and other environmental program requirements was reviewed and evaluated at each site by means of the MOM contractor's annual audits and audits at select sites by state and federal environmental agencies.

4.1 EPA DISCHARGE MONITORING REPORT QUALITY ASSURANCE STUDY

The EPA entered the seventh year of its Discharge Monitoring Report Quality Assurance program. Through this program EPA provides analytical laboratories of major NPDES dischargers blind samples of permit parameters for analysis. The permittee analyzes these samples and submits the data to EPA for evaluation of analytical accuracy relative to the performance of EPA referee laboratories. The Bryan Mound and West Hackberry laboratories each participated in this program during 1987 for the seventh time in as many years. The Big Hill facility participated in the Quality Assurance study for the second time through the Bryan Mound laboratory.

The analytical data submitted to EPA by the Bryan Mound laboratory was also for Big Hill and was well within acceptance limits for all but one parameter. TSS was initially unacceptable due to reporting with a misplaced decimal. After correcting the reporting error the data was found to fall well within the acceptance limits. West Hackberry data fell outside of the acceptance criteria for one parameter. This excursion occurred for TSS which missed the acceptance criteria by 14%. Unconditional acceptability is defined as falling within ± 1.5 standard deviations of the statistically correct value. Those values falling within ± 2.0 to 1.5 standard deviations are acceptable with warning. The EPA results for Big Hill, Bryan Mound, (after correction) and West Hackberry, expressed as variation in standard deviations are:

Parameter	Big Hill	Bryan Mound	West Hackberry
pH (std. units)	+1.2	+1.2	-0.8
TSS (mg/l)	-0.9	-0.9	-2.3
Oil and Grease (mg/l)	+0.6	+0.6	+0.4
TOC (mg/l)	-0.2	-0.2	+1.6
BOD_5 (mg/l)	-1.7	-1.7	-1.9
Residual Cl^- (mg/l)	+1.0	+1.0	N/A

4.2 SPR LABORATORY ACCURACY AND PRECISION PROGRAM

The SPR Laboratory quality assurance program is based on the U.S. EPA **Handbook for Analytical Quality Control in Water and Waste Water Laboratories** (EPA-600/4-79-019). This program focuses on the use of analyses of field and laboratory spikes, standard recoveries, split samples, and blanks at regular intervals to determine the accuracy and precision of analyses. Several thousand of these quality assurance analyses were performed in addition to the 1987 discharge compliance analyses to verify the continuing high quality of SPR laboratory data.

The EPA quality control document advocates use of quality control charts to maintain and evaluate accuracy and precision data. The SPR has developed software for the Hewlett-Packard 41CX handheld computer to allow rapid and exact determinations of accuracy and precision without the necessity of quality control chart preparation. This software has been implemented at each SPR laboratory. During 1987, regulatory and DOE auditors examined the SPR laboratories' precision and accuracy data and found this data, the program, and methodology in order.

4.3 ENVIRONMENTAL AUDITS

In addition to federal and state regulatory agency audits, the MOM contractor conducts an annual environmental audit at each site. Each audit is performed over a one to two-day period followed by an outbriefing with site management and preparation of a formal audit report with specific recommendations as appropriate. Audit areas include environmental records, laboratory procedures and records, site housekeeping, operating procedures, training, environmental response equipment, and permit regulatory compliance. A general field inspection of the site environs is also conducted to assess the general site conditions, changes attributable to site impacts, and the effects of planned and proposed site construction modifications.

The 1987 environmental audit at each SPR site showed the overall implementation and execution of the SPR Environmental Program to be outstanding. Similar findings were reported during 1987 by those state and federal regulatory agencies that performed compliance inspections and by the environmental baseline survey team sponsored by DOE Washington D.C. Such positive findings are attributed to the high level of environmental awareness exhibited among all site personnel and the emphasis SPR management has placed on fulfilling the intent and conditions of the SPR Environmental Program.

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DISTRIBUTION

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