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# Strategic Petroleum Reserve. Statement for Cote Blanche Mine

Federal Energy Administration, Washington, D C

Jan 77

# Strategic Petroleum Reserve



## Final Environmental Impact Statement for Cote Blanche Mine

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16. Abstracts

The Federal Energy Administration (FEA) proposes to implement the Strategic Petroleum Reserve, Title I, Part B, of the Energy Policy and Conservation Act of 1975 (P.L. 94-163). The purpose of the Reserve is to mitigate the social and economic aspects of any future interruptions of petroleum imports to the United States of America. The Reserve will store 150 million barrels of oil by December of 1978 in the Early Storage Reserve (ESR), and 500 million barrels by 1982 under the entire program. Petroleum will be stored underground in conventional mines or solution-mined salt cavities, or aboveground in conventional tanks. The present action would be part of the ESR and would involve storage of 27 million barrels of oil in a conventional salt mine located at Cote Blanche Island in St. Mary's Parrish, Louisiana. This site-specific Environmental Impact Statement (EIS) has identified particularly sensitive environmental parameters that have been investigated in detail for the Cote Blanche, Louisiana Early Storage Reserve site.

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i.

Federal Energy Administration
Strategic Petroleum Reserve Office
Washington, D.C.

Final Environmental Impact Statement
Pursuant to Section 102(2)(C), P.L. 91-190

## A. SUMMARY

Statement Type: ( ) Draft (X) Final Environmental Statement

Prepared By : The Stategic Petroleum Reserve Office
Federal Energy Administration, (CO-05-60472-00)
Washington, D.C. 20461
(202) 254-8986

1. Type of Action: (X) Administrative ( ) Legislative

2. Brief Description of the Proposed Action

The Federal Energy Administration (FEA) proposes to implement the Strategic Petroleum Reserve, Title I, Part B, of the Energy Policy and Conservation Act of 1975 (P.L. 94-163). The purpose of the Reserve is to mitigate the social and economic aspects of any future interruptions of petroleum imports to the United States of America. The Reserve will store 150 million barrels of oil by December of 1978 in the Early Storage Reserve (ESR), and 500 million barrels by 1982 under the entire program. Petroleum will be stored underground in conventional mines or solution-mined salt cavities, or aboveground in conventional tanks. The present action would be part of the ESR and would involve storage of 27 million barrels of oil in a conventional salt mine located at Cote Blanche Island in St. Mary's Parrish, Louisiana. The storage of oil at Cote Blanche Mine would be implemented at an existing underground salt mine presently owned and operated by Domtar Chemicals, Inc.

3. Summary of Environmental Impacts and Adverse Environmental Effects

This site-specific Environmental Impact Statement (EIS) has identified particularly sensitive environmental parameters that have been investigated in detail for the Cote Blanche, Louisiana Early Storage Reserve site. The most sensitive parameters to be affected by oil storage development at this site appear to be water quality, air quality, and socio-economic factors.

The adverse impacts to the physical environment that could result from the program include: degradation of surface water quality due to erosion from runoff during construction and dredging activities; a significant increase in hydrocarbon emissions during the filling of barges or other petroleum-carrying vessels; and the potential for an increase in the frequency of oil spills along the transportation corridors. Changes in water quality would have a short-term impact on the aquatic organisms in local areas. The loading and offloading of crude oil from barges and the hydrocarbon vapor losses from oil storage tanks would increase the amount of hydrocarbons (in the form of volatile vapors) released to the atmosphere in the Cote Blanche area. Hydrocarbon emissions to the atmosphere could cause increased photochemical reactivity and ozone concentrations in southern Louisiana. The most significant adverse socioeconomic impacts would be those related to the temporary influx of large numbers of construction workers to the area and the possible dislocation of a substantial number of Domtar employees if the salt mine were closed temporarily.

4. Alternatives Considered

Alternative Storage Sites

- Bayou Choctaw Salt Dome
- Bryan Mound Salt Dome
- West Hackberry Salt Dome
- Weeks Island Mine

Structural Alternatives

- Alternative Storage Methods
- Alternative Mine Sites
- Permanent Shutdown of Domtar Mine
- Alternative Oil Transportation Systems
- Increased Cavern Fill Rate

No Action

5. Comments on the Draft EIS were received from the following agencies, companies, and organizations

Federal:

- Advisory Council on Historic Preservation
- Environmental Protection Agency
- Federal Power Commission
- Tennessee Valley Authority
- Department of Transportation
- Department of the Treasury
- U.S. Army Corps of Engineers

State:

- Louisiana Air Control Commission
- Louisiana Geological Survey
- Louisiana State Soil and Water Conservation Commission

Local:

No comments were received from local government agencies

Others:

No other comments received

6. Date Final EIS made available to CEQ and the Public

This Final EIS was made available to the Council on Environmental Quality and to the public in January 1977.

TABLE OF CONTENTS

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

TABLE OF CONTENTS - continued

## LIST OF TABLES

LIST OF TABLES - continued

LIST OF TABLES - continued

LIST OF TABLES - continued

LIST OF TABLES - continued

LIST OF TABLES - continued

LIST OF TABLES - continued

LIST OF FIGURES

LIST OF FIGURES - continued

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SECTION 1.0

# BACKGROUND

This document is a site specific Environmental Impact Statement (EIS) for the proposed storage of crude oil at the Cote Blanche salt mine located in St. Mary Parish, Louisiana. This project is part of the Strategic Petroleum Reserve (SPR) program currently being planned by the Federal Energy Administration (FEA). Creation of the SPR was mandated by Congress in Title I, Part B of the Energy Policy and Conservation Act of 1975, P. L. 94-163 (the Act) for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any future oil supply interruption. The Act requires that within seven years the SPR contain a reserve equal to the volume of crude oil imports during the three consecutive highest import months in the 24 months preceding December 22, 1975 (approximately 500 million barrels). The Act further requires the creation within three years of an Early Storage Reserve (ESR) of 150 million barrels as the initial phase of the SPR to provide early protection from near-term disruptions in the supply of petroleum products.

A draft programmatic EIS (DES 76-2) addressing the effects of the SPR program as a whole was filed with the Council on Environmental Quality and made available to the public on June 25, 1976. That statement considers several different types of storage facilities, including the use of existing solution-mined cavities in salt formations and conventional mines, the construction of new solution-mined cavities and conventional mines, the use of existing and the construction of new conventional surface tankage, and the use of surplus tanker ships. The draft programmatic EIS should be consulted for a description of each of these storage methods and the potential impacts which might result from its use. The programmatic EIS also assesses the cumulative impacts which could be expected from use of various combinations of the different facility types.

Because of the severe time constraints placed upon the ESR completion schedule by the Act, FEA will use sites which have existing capacity that may be converted to oil storage for this initial phase of the SPR (see Early Storage Reserve Plan, FEA, April 1976). Potential ESR sites include existing solution-mined cavities in salt domes, and existing conventional mines which can be converted into storage facilities in a relatively short time. A total of eight candidate ESR sites have been selected by means of a screening process involving the application of a series of six criteria.* Of these eight candidate sites, only five are alternatives to one another for the purpose of selecting ESR storage sites to supply oil to refineries on the Gulf Coast, on the East Coast, and in the Caribbean. The other three candidate sites can only supply the inland refineries.

In addition to the Cote Blanche salt mine, the four other alternative candidate sites able to supply the Gulf Coast, East Coast and Caribbean market areas, include the West Hackberry salt dome (Cameron Parish, Louisiana), the Bayou Choctaw salt dome (Iberville Parish, Louisiana), the Bryan Mound salt dome (Brazoria County, Texas), and the Weeks Island salt mine (Iberia Parish, Louisiana. Section 7.1 includes a more detailed discussion of the rationale supporting the selection of the five alternative sites and a brief summary of the impacts associated with each of the other four sites besides the Cote Blanche salt mine. Environmental Impact Statements on all five alternative candidate sites (DES 76-4 through DES 76-8, September 1976) have been filed with the Council on Environmental Quality and made available to the public on the same day so that the environmental impacts associated with the possible use of these sites may be compared with one another. EISs are also in preparation for the other three sites and will be made available prior to any subsequent site selection, as described in Section 7.1.

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*These criteria are capacity, distribution accessibility, technical feasibility, potential environmental concerns, ease of acquisition and cost. Section II.E.1 of the programmatic EIS describes in detail how the criteria were applied to approximately 300 salt domes and approximately 300 existing mines to select 32 candidate SPR sites, including the eight candidate ESR sites.

SECTION 2.0

## DESCRIPTION OF THE PROPOSED ACTION

### 2.1 INTRODUCTION

The Cote Blanche Salt Mine is located on Cote Blanche Island in St. Mary Parish, southcentral Louisiana. Cote Blanche is a coastal "island" about 90 miles southwest of New Orleans and on the north shore of West Cote Blanche Bay (Figure 2.1-1). The "island" is surrounded on three sides by brackish water marshland; on the north it is separated from the mainland by the Intracoastal Waterway. Cote Blanche Island is approximately circular, with a diameter of about 1.5 miles. The highest point on the island has an elevation of about 100 feet above sea level. Cote Blanche is the topographic expression of one of a series of salt domes on the Louisiana coast known as the Five Islands.

At present, approximately 1 to 1.25 million tons of rock salt are mined annually from the salt dome under the island. FEA is considering purchase of the existing underground caverns, together with sufficient surface area, for conversion of the caverns into a crude oil storage facility, to be part of the Strategic Petroleum Reserve. The present underground mining activities can be relocated to another portion of the salt dome.

Major construction activities would include sinking a production shaft and drilling a service shaft at the new mine site; sinking a pump shaft at the old mine site (if salt production is not to be interrupted); relocation of head-frame and hoisting equipment to the new mine site; installation of salt processing and handling facilities within the new mine and a new conveyor system to carry the crushed and screened salt to the barge facilities; excavation of a 1300-foot long, 200-foot wide, 11.5-foot deep barge slip in the location of the existing slip; installation of oil pipelines, pumps, manifolds and metering equipment between the barge dock and the pump shaft; installation of an electrical power substation; and construction of four barge loading platforms at the enlarged barge slip. No extensive pipeline or utility corridors would be required under present plans. Thus, all development activities would be confined to the immediate vicinity of the existing salt mine in the southwest corner of Cote Blanche Island (Figure 2.1-2).

Two possible methods are under consideration for developing the oil storage facility. With the first, modification of the existing cavern to receive oil would be delayed to prevent disruption of salt mining while the new mine is being developed. With the second, modification would be made without delay so as to place oil in storage as soon as possible. This would result in shutting down salt production for approximately 1½ years while the new mine is being developed. Both development strategies are addressed in the EIS.

During construction of the project, from 100 to 350 workers would be required. During standby storage, manpower requirements would be limited to perhaps two or three personnel for security and equipment inspection. For planning purposes, the 27 million barrels of crude oil are assumed to be withdrawn approximately once every 5 years, under emergency conditions in response to an oil supply interruption. The cavern would be filled again as soon thereafter as practical. Approximately 15 employees would be required during oil transfer. Filling the cavern with oil would require an estimated 45 weeks; withdrawal would require 150 days.

Waste associated with mine conversion, construction, and operation would consist primarily of overburden and salt removed in constructing the necessary shafts and an estimated 250,000 cubic yards of spoil excavated from the barge slip. All waste salt materials would be disposed of inside the existing mine; other overburden from shaft excavation (totalling about 15,000 cubic yards) would be placed either in a 2-acre landfill at the site or at the disposal site to be used for the dredged spoil. All other construction waste would be removed. Gaseous wastes would be limited to engine exhausts and hydrocarbons vented and flared during cavern filling. Liquid wastes would include sanitary effluent disposed of in a septic tank .

The mine conversion and new mine construction would be designed to comply with all MESA and OSHA requirements. The Cote Blanche salt dome has been selected in part on the basis of its excellent geologic suitability for both mining and oil storage. The new mine workings would be located 300 feet above the oil storage cavern to provide sufficient clearance for safety considerations. Possible accident modes are recognized and accounted for in designing the storage and transportation facilities.

The oil storage and new mine facilities are presently in the preliminary design stage. Engineering feasibility analyses have been prepared as the basis for evaluation of the socio-economic and environmental impacts of the project (FEA, 1976a). Future studies will provide detailed information on equipment design, construction methodology, and operational procedures. For the purpose of this EIS, project development is assumed to follow standard industry practice, consistent with good engineering principles and a concern for environmental values. Wherever reasonable doubt exists about the ultimate performance characteristics or environmental effects of any phase of the project, a worst case analysis of potential impacts is provided.

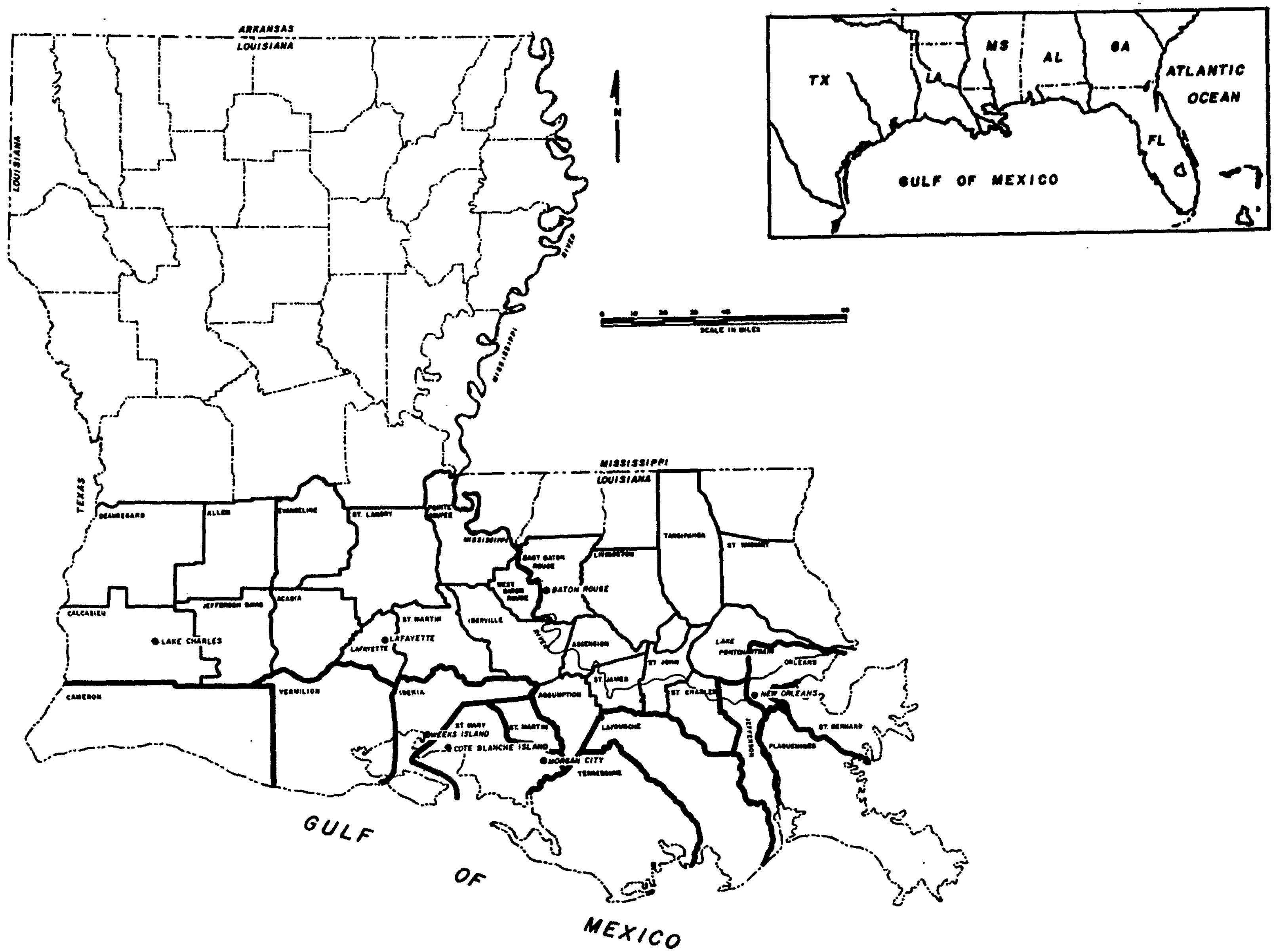


FIGURE 2.1-1. Map of Louisiana highlighting the general study area.

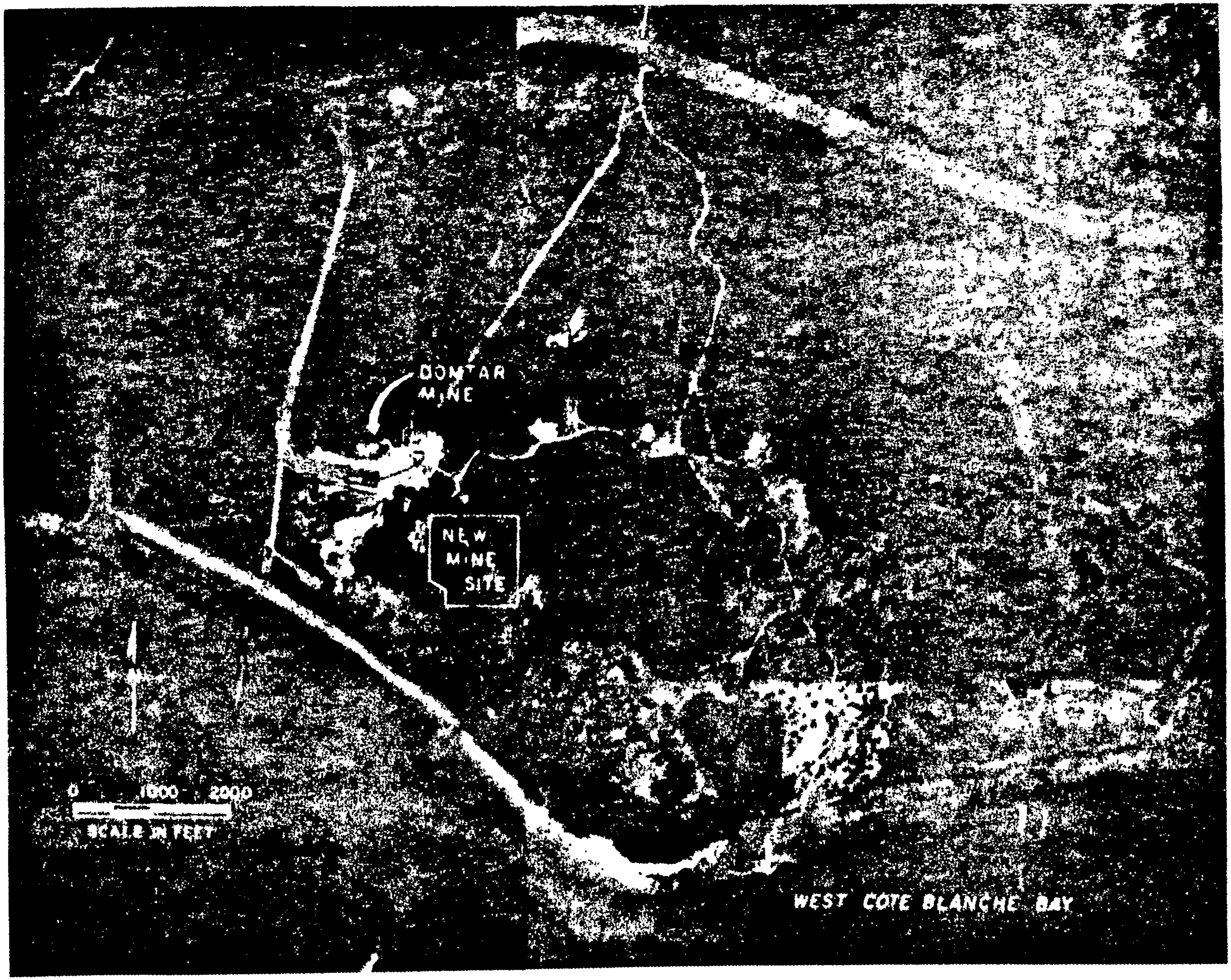


FIGURE 2.1-2. Aerial view of Cote Blanche Island.

## 2.2 EXISTING MINE FACILITIES

The Cote Blanche Mine is owned and operated by Domtar Chemicals, Inc., Sifto Salt Division, with corporate headquarters in Montreal, Canada. Domtar purchased the mine from Carey Salt Company in 1973 and has a 99-year lease on the island and all mineral rights (the island is privately owned). The mine has been in operation since 1965 and currently produces approximately 1 million tons of rock salt per year (depending on market conditions). Total potential oil storage volume is 27 million barrels. The mine is located just north of West Cote Blanche Bay in south central Louisiana (Figure 2.2-1).

Salt is mined underground by the room and pillar (dry) method at a depth of approximately 1300 feet below mean sea level (MSL). Crushed and screened rock salt is hoisted to the surface by means of skips through a 14-foot diameter production shaft, transported by conveyor to dock facilities and loaded onto barges for transportation to the market area (generally, chemical plants in southeastern Louisiana). The mine facilities and shaft entrance are located approximately 37 feet above MSL.

### 2.2.1 Aboveground Facilities

Surface facilities at the Cote Blanche Mine, including the barge loading docks, encompass approximately 20 acres. Prominent aboveground structures include headframe and hoisting equipment at the production and service shafts, an elevated conveyor leading to the barge slip, barge docks, various office, maintenance, and employee buildings and an unpaved parking lot. All crushing and screening processes are conducted within the mine.

Vehicle access to the mine is by an unpaved road from Louisiana State Highway 83, and transfer by ferry across the Intracoastal Waterway. Barge access is through the Intracoastal Waterway and adjoining canals (Figure 2.1-2). Controlling dimensions in the single barge slip are approximately 150 feet in width and 8 feet in depth (at MSL). Considerable bank erosion and siltation require maintenance dredging of the slip every 1.5 to 2 years.

Water supply for the mine is obtained from a ground water aquifer located at a depth of 250 feet below the surface. Electric power is obtained from the Central Louisiana Electric Company 138,000-volt transmission line north of the island which supplies power to the area. A small substation and transformer are located at the mine site; the distribution line crosses the center of Cote Blanche Island to a point just northeast of the mine.

The only significant by-products generated at the mine are miscellaneous solid wastes and sanitary sewage. Salt fines unsuitable for sale are stock-piled in nonworking caverns within the mine. Salt spilled during the barge loading operation is hosed into the barge slip. Small amounts of solid wastes (sheet metal, tires, and so forth) are burned in a surface dump near the barge dock. Sanitary wastes are piped to a septic tank and drain field system.

### 2.2.2 Underground Facilities

The Cote Blanche salt dome rises from a source depth of several miles below sea level to within 400 feet of the island surface at its maximum elevation. The lateral extent of the dome at elevation -1000 feet varies from approximately 1 mile in an east-west direction to 1.4 miles from north to south. Above the salt are several hundred feet of interbedded sands, gravels, silts, and clays containing sizeable ground water aquifers (see section 3.2 for more detail on salt dome structure and island lithology).

Present access to the mine is through two shafts: a 14-foot diameter production shaft and an 8-foot diameter service shaft, both of which extend to a depth of 1350 feet below MSL. The production shaft is concrete-lined to the bottom; the service shaft is lined from the surface down 200 feet into the salt. Underground equipment and production methods are described in section 2.2.3.

Room and pillar mining is used to excavate the rock salt. Rooms are developed at a single level (floor elevation 1370 feet below MSL) and range in height from 25 to 80 feet and in width from 50 to 70 feet. Pillars of salt approximately 100 feet square are left for roof support. Figure 2.2-2 shows the existing mine plan. The workings extend (at a maximum) approximately 0.7 mile to the east of the existing production and service shafts and 0.3 mile to both the north and south (see Figures 2.2-3 and 2.2-4). Several depleted oil wells have been drilled through the dome. Areas around the wells are not excavated; a 150-foot radius pillar of salt is left around the wells as a safety precaution.

The mine has generally level floors and excellent structural stability; despite normal amounts of spalling, no roof falls have occurred. There are no faults or jointed zones within the mine and no ground water enters the mine. Occasionally, small pockets of connate water and gas (hydrogen sulfide or methane) have been encountered. The salt is 99 percent pure sodium chloride. No roof supports are used; some minor pillar spalling occurs, requiring mechanical removal every few months.

### 2.2.3 Mine Operation

Salt mining and processing at Cote Blanche are primarily underground operations. Once the geometry of the rooms to be excavated is determined, mining begins on the appropriate working face. Horizontal blast holes are drilled with specially mounted drills at 5-foot intervals 15 feet deep into the salt bed. A 4-inch high cut is then made at floor level across the width of the working face. Ammonium nitrate is loaded into the holes. At the end of the work shift the explosives are detonated to break up 20,000 cubic feet of salt into blocks, chips and fine grains. Front-end loaders and large trucks are then used to transport the salt to primary and secondary crushers; then an underground conveyor belt system transports the salt to screening equipment and to stockpile areas. Finally the salt is loaded onto a large "skip" (several ton capacity) and hoisted to the surface where a surface conveyor carries the salt to the barge dock for loading and shipment.

After a 25-foot-high room is mined out, similar excavation is carried out on an additional 50-foot section below (benching). Holes are drilled vertically into the salt for this operation. Upon completion, the "room" is approximately 75 to 80 feet high and 50 to 70 feet wide.

The underground workers (approximately 100) normally work in three 8-hour shifts, 5 days a week. A fourth shift allows seven-day-a-week processing during peak periods. Excavation is carried out only during the day shift Monday through Friday. In addition, there are 19 staff personnel working a single shift in the office buildings aboveground.

Annual salt production is from 1 to 1.25 million tons, depending on market requirements. Production slows considerably in the winter (January through March). Since salt is not stockpiled, barge traffic varies according to the salt production rate. Traffic is highest during the summer months (four barges per day) and lowest in winter (two barges per day).

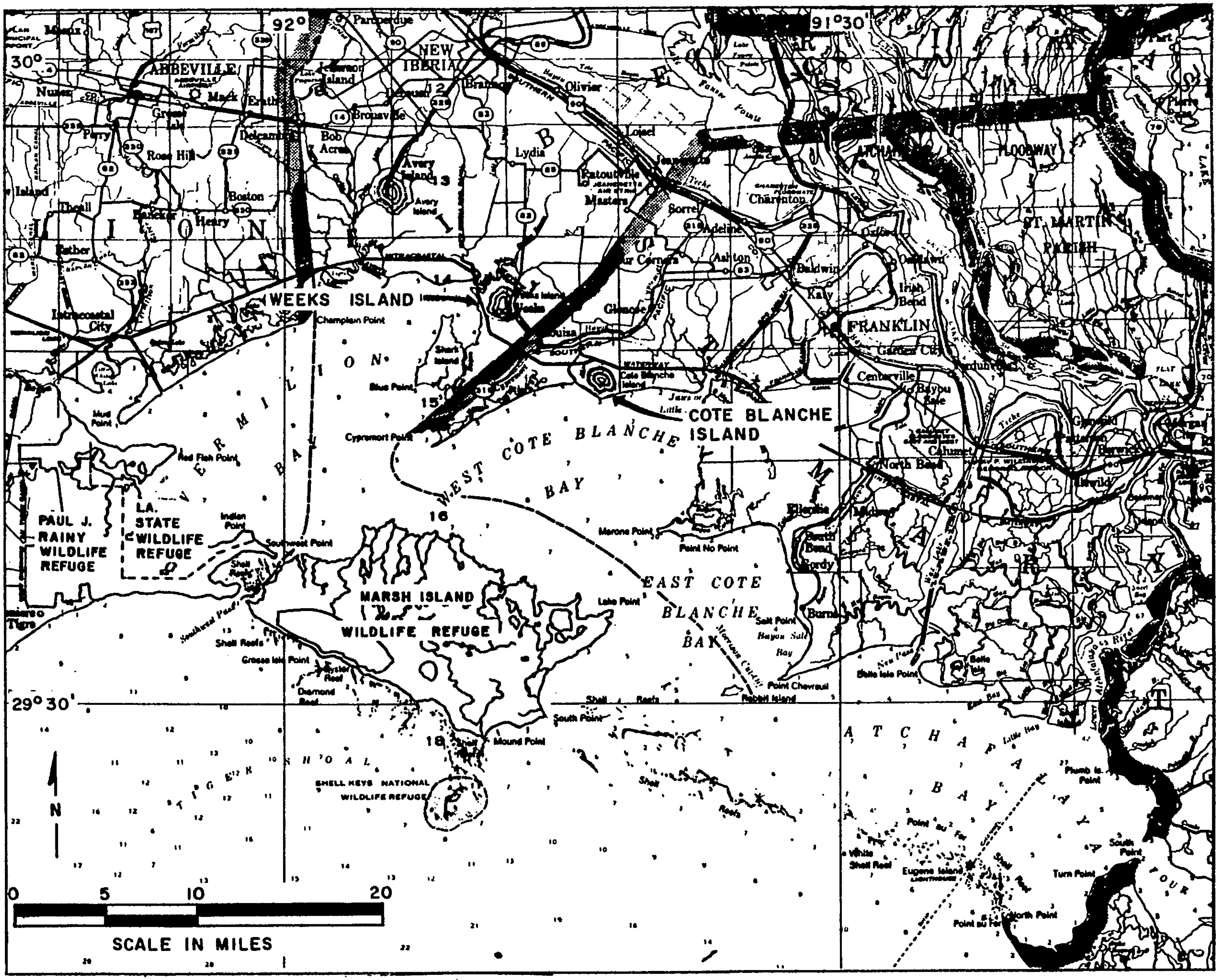


FIGURE 2.2-1 Regional map of south central Louisiana.

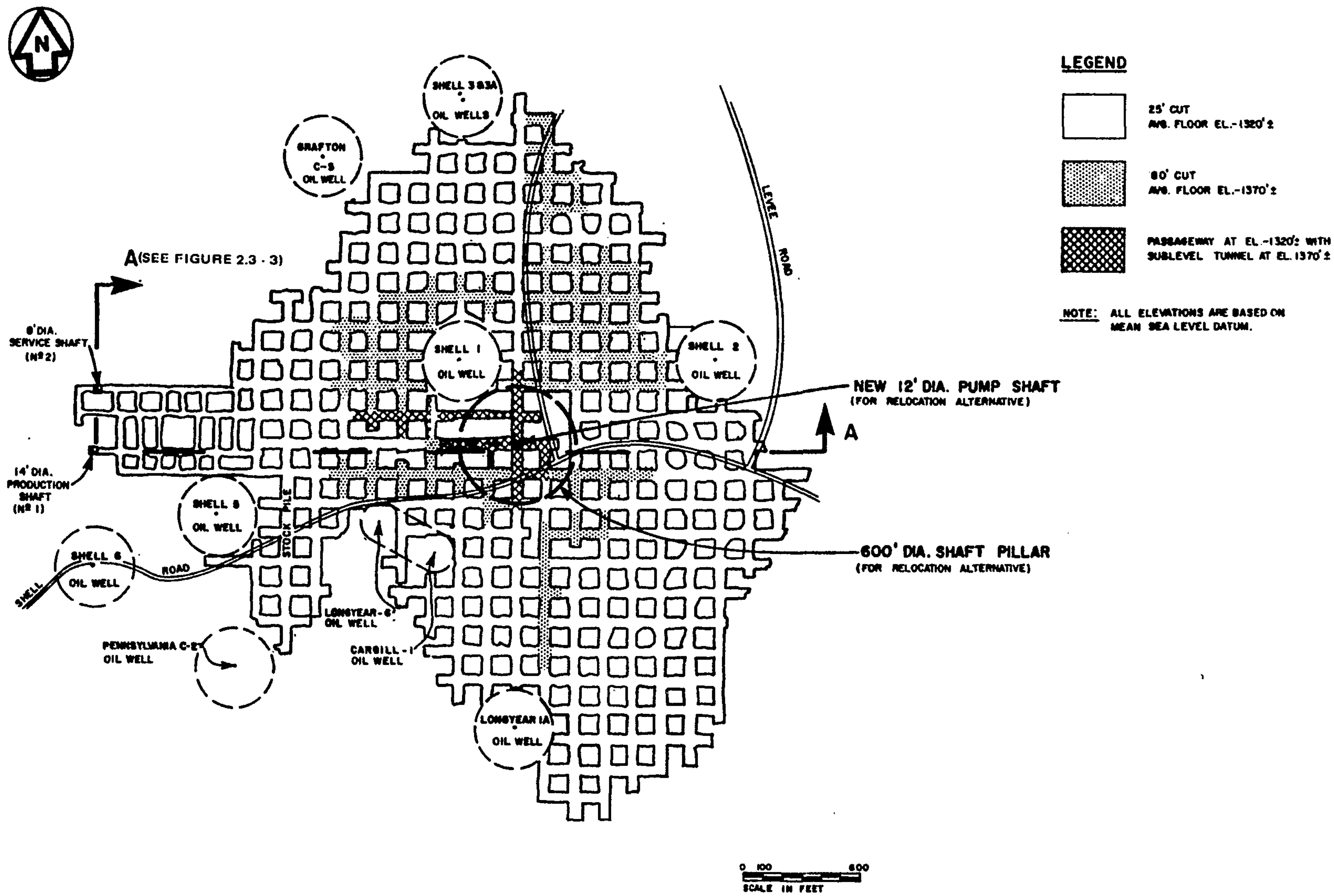


FIGURE 2.2-2 Mine plan - Cote Blanche mine, Cote Blanche Island, Louisiana.

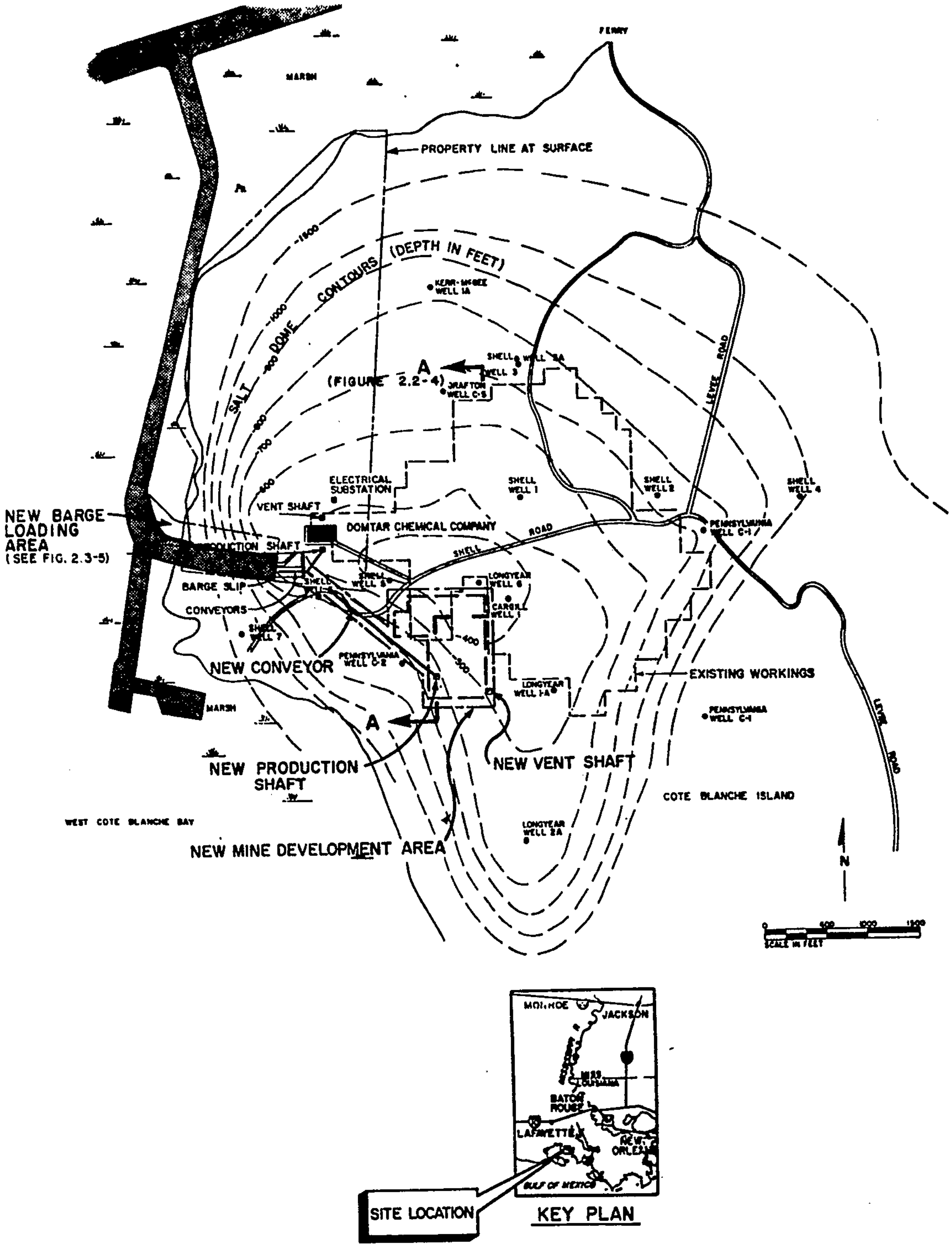


FIGURE 2.2-3 Site plan - Cote Blanche mine, Cote Blanche Island, Louisiana.

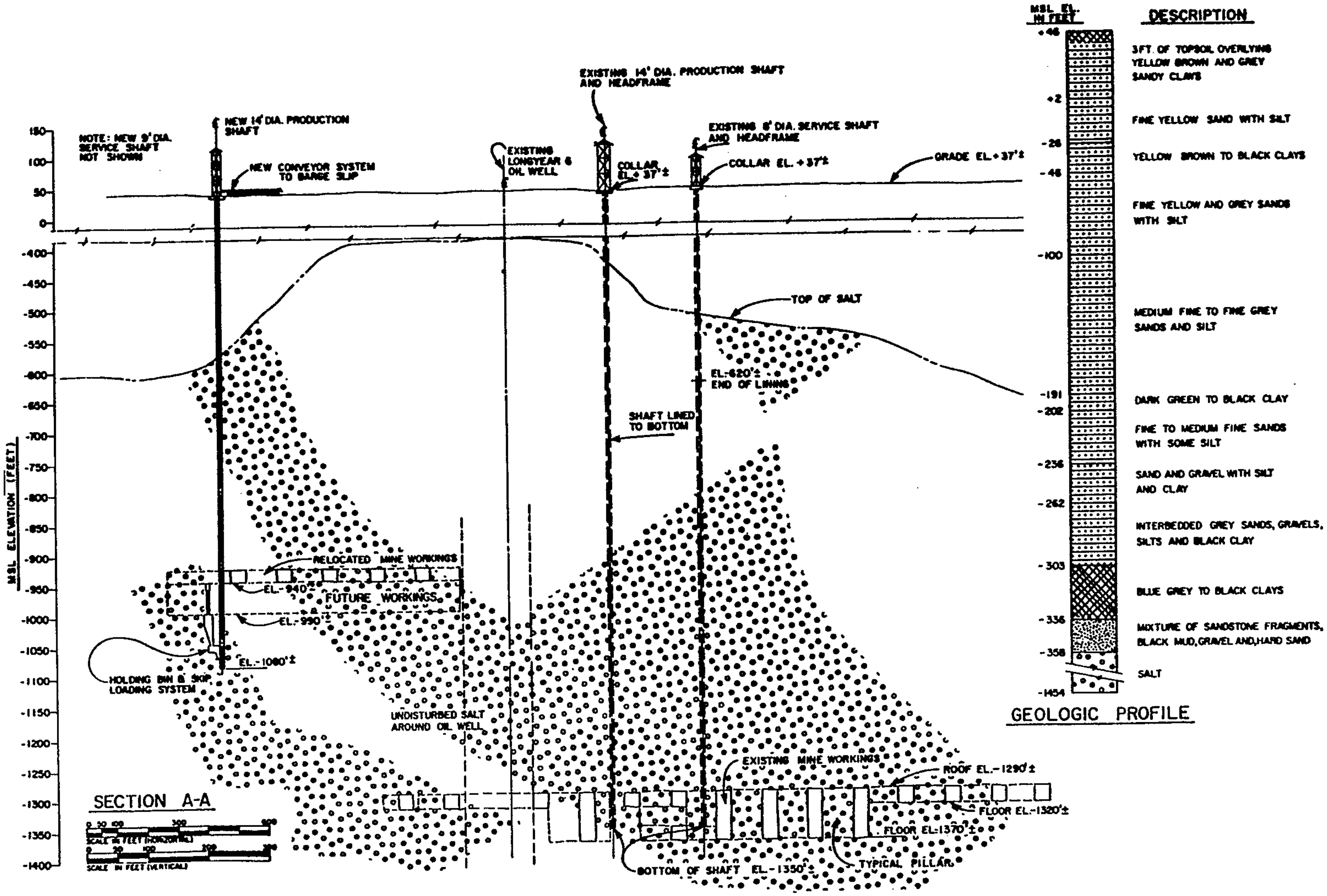


FIGURE 2.2-4. Sections and details Cote Blanche mine, Cote Blanche Island, Louisiana.

## 2.3 MINE CONVERSION

The single most dominant factor to successful underground storage of crude oil is the effective containment of the oil itself. The importance of underground containment involves not only costs of oil losses, but also includes the resultant potential hazards, associated with oil migration, to safety and other environmental impacts. Oil migration requires both a driving force and a passageway. Potential driving forces consist of pressures induced from decreased available volume, buoyant uplift by insurgent ground water, or simple downward gravitational migration of the oil. Decreased oil volume could result from temporary overpressures due to large local barometric pressure increases, tidal gravimetric changes, earthquake-generated seismic pulses, mine closure, and intrusion into the cavern by water or gas. Volume decreases in the stored oil due to barometric, tidal, and seismic causes, as well as long-term cavern closure, would be very small compared to the total volume stored. However, these decreases involve extraordinarily high pressures. Uncushioned, such pressures could readily open or rupture unprotected or weak-links in the system, such as valves and seals of pipes to the surface. The pressure could also result in dynamic ejection of the relatively incompressible oil at the surface. This hazard could be mitigated by maintaining sufficient compressible space within the storage area so that the pressures exerted on the oil can be reduced to manageable levels.

Oil migration associated with gravitational leakage or cavern insurgence by water or gas pressures depends directly on the relative impermeability of the storage medium. The natural permeability of rock is highly variable, and involves interconnected granular spaces, such as those of incompletely cemented sandstones, and/or networks of interconnected joints or other natural fractures.

A few natural materials, such as rock salt, lack both forms of permeability. Many other lithologies, including most igneous, metamorphic and well-consolidated sedimentary varieties of rock lack intergranular porosities, but typically display some form of jointing or fracturing. Commonly, these fractures are naturally rehealed or are sufficiently tight or laterally discontinuous so that their natural permeabilities are comparable to salt.

Clearly, a naturally impermeable storage medium provides a simple direct means of assuring product containment. However, such impermeability is not essential if: 1) the permeable passages are saturated with water; 2) the hydrostatic head of that water exceeds the internal containment pressures of the cavern; 3) the resultant water inflow is sufficiently small to allow its periodic removal; or 4) that the flows can be reduced to such levels by grouting. Given these conditions, the oil will float on a bed of inflowing water, preventing downward escape, while the hydrostatic pressures of the waters saturating the roof and sides prevent lateral migration of oil, as well as upward seepage of fumes. Worldwide experience shows that petroleum products can be successfully and economically stored under these conditions.

There is extensive experience in underground oil product, crude oil, and liquified petroleum gas (LPG) storage in Europe and the United States. For example, through 1970 there were more than 170 million barrels of LPG stored underground in 25 states. These systems have proven to be both economical and reliable. A selected list of references relating to underground storage is provided in section 2.5.

Conversion of the existing Cote Blanche Mine for crude oil storage involves primarily the removal of the existing shaft equipment, sinking a new pump shaft (if salt production is not to be interrupted), installation of oil pumps and casings, sealing of existing production and service shafts, and construction of the necessary oil distribution facilities. One option for developing Cote Blanche oil storage capacity would avoid or minimize the disruption of salt mine production activities; for this option mine conversion has been scheduled to phase smoothly with the new salt mine development. The corresponding schedule of construction activities is given on Figure 2.3-1; required manpower is given in Table 2.3-1.

The second option for developing Cote Blanche oil storage capacity provides the most rapid means of getting oil into storage. For this option, mine conversion is accomplished using the existing production shaft and requiring shutdown of Domtar salt production for a period of approximately 74 weeks, until the new mine can be developed. This option places an additional 17 million barrels of oil in storage by January 1, 1979, compared to the other option. The corresponding schedule of construction activities is given on Figure 2.3-2; required construction manpower is given in Table 2.3-2.

## 2.3.1 Underground Conversion

### 2.3.1.1 Pump System

Cote Blanche Mine has an existing 8-foot diameter service shaft and a 14-foot diameter production shaft. The service shaft is too small to accommodate the required pumping equipment; therefore, if the facility is to be developed in such a manner as to avoid halting salt production, a new 12-foot diameter pump shaft would be sunk into the lowest area of the mine. (This would save the 43 weeks required to convert the production shaft to a pump shaft.) If the option is chosen to shut down production, conversion of the production shaft to a pump shaft can begin immediately.

The 12-foot diameter pump shaft would be excavated by conventional mining methods. To minimize problems with ground water and shaft collapse during sinking, ground freezing techniques would be employed in the overburden above the salt. With this method, calcium chloride brine is circulated from a refrigeration plant at the surface through a series of 6-inch pipes installed in vertical holes drilled in a circle 10 to 20 feet outside the planned perimeter of excavation. After the ground is frozen, some variant of the conventional drill and blast process is applied to excavate the shaft.

The pump shaft would probably be lined with concrete about 200 feet into the salt. Potentially toxic materials (such as salt) would be disposed of within the mine cavern. Excavated gravels, sand, silts and clays would be placed in a surface landfill on the island.

Pumping equipment would be installed in a pipe casing for protection and support, and to allow the pumps to be withdrawn for maintenance. Three 1200-horsepower submersible oil booster pumps would be required for withdrawal of the oil from storage. Each pump is sized to provide a flow of 3300 barrels per hour at pressures adequate for metering and mainline pump suction. No standby or backup pump units would be provided because of the anticipated short periods for operation during emergency withdrawal of the oil, inherent pump reliability, and the assumption that repairs can be made to the pumps within a matter of days.

A cross section of the pump shaft system is provided on Figure 2.3-3. Major system components are: three 22-inch diameter oil pump (discharge) casings; a 12-inch diameter dewatering (or sludge) discharge casing; a small instrument casing; a 30-inch diameter man-way opening; and a 16-inch diameter oil fill casing. The pump casing and tubing string would be supported at two points, with the majority of the weight carried at the surface by a concrete bulkhead seal supported on adjacent foundations around the shaft collar. Above the roof of the cavern, a second concrete bulkhead would be constructed to provide support for the lower casings. The lower bulkhead would be keyed well into the rock to provide a vapor seal. Vapor pressures in the cavern are expected to be between 0.5 and 1.5 atmospheres. However, European practice allows for an overpressure of 10 atmospheres to account for abnormal conditions. This approach has been adopted for the project. The lower seal would be positioned above the roof of the cavern in order to provide adequate thickness of support rock below the concrete, while minimizing the casing weight supported. The casings would be provided with a vapor seal through the concrete bulkhead. Immediately above the bulkhead, expansion joints would be installed to allow for temperature-induced movements in the upper casings. To provide lateral support for the casings, steel beams coated with epoxy (concrete beams could be selected in the final design phase) would be installed at regular intervals. These lateral supports would also provide platforms that would be useful in providing access for monitoring of the ground water condition behind the shaft lining. Concrete bulkheads would be installed in the service and production shafts at approximately the same position as the lower bulkhead in the pump shaft. A manhole and vent pipe, used for venting the cavern during filling, would be provided in the concrete bulkhead seal of the two existing shafts.

If the option is chosen to temporarily shut down salt production, conversion of the existing 14-foot diameter production shaft would begin without delay in week 47 (Figure 2.3-2). The shaft would have to be deepened and a tunnel excavated from the lower floor level to the shaft bottom. The service shaft would be left open for ventilation and emergency use until the underground work is complete, and then would be sealed. Both of the shafts would be sealed with double concrete bulkheads, one placed a short distance above the roof of the existing mine and the other at the surface. Landings would be provided at the levels of the intermediate supports for inspection of the shaft and monitoring of possible seepage behind the lining. The same pumpshaft components described previously (for use in a new pumpshaft) would be installed in the converted production shaft (see Figure 2.3-3).

2.3.1.2 Mine Caverns

Within the mine, only minimal cavern preparation would be necessary to accommodate oil storage. The objective of this activity is to get the oil to the sump and minimize the amount of debris, sludge, and other oil impurities that can get into the intakes of the pumps. Since the mine floors are generally level, some grading and channeling would be necessary. A sump would be excavated and lined directly below the pump shaft. A screen would be placed around the pump sump area to prevent debris from entering the sump. In addition, a concrete curb would be placed around the sump to contain the sludge and water that accumulate in the cavern. Rock bolts and wire mesh would be used in the area above the pump sump and into the shaft between the roof of the mine and the lower concrete bulkhead to prevent any rubble from falling into the sump area. Materials in shop areas, wooden boxes and crates, and wood-frame type buildings located in the mine would have to be either removed or secured by fencing off a room. Additional survey of the mine area would be required to assess the exact extent of debris removal work.

At Cote Blanche, a large quantity of fine salt that cannot be sold is stored in the mine. In those areas where waste salt is situated such that it might restrict oil flow or be carried into the sump, the material would be spread out and sprayed with water or a gunite and water mixture. The spray will crystalize the surface salt, forming chunks that would not erode. A survey would be required to locate these waste salt areas.

No rock bolting, bulkheading, grouting, or other structural preparation of the walls or roof of the caverns would be required before oil storage. The caverns are watertight as a result of the impermeable nature of the salt. No faults or joints exist that might affect the integrity of the storage system.

When the cavern conversion process has been completed, the production and service shafts would be sealed except for a vent pipe through the bulkhead of one of them.

2.3.2 Aboveground Conversion

Only a minimum of surface grading would be necessary to prepare the aboveground area for oil storage. In the immediate vicinity of the pump shaft, approximately 1 acre would be required for a new pump station. A plan, showing the proposed substation, powerhouse, manifolding, meter proving loop, and metering system, is presented on Figure 2.3-4. Dashed lines on the plan indicate the arrangement of a possible system for delivery to a distribution pipeline, should this alternative be pursued (Section 8.2.4).

A common set of turbine flow meters would be used to measure crude volumes pumped in and out of the cavern and also to detect pipeline leaks. A separate system of oil level gauges would be used as an independent check to inventory oil in the cavern. Design details for this system are currently being developed.

Electrical power would be provided from an existing 138,000-volt Central Louisiana Electric Company transmission line located north of Cote Blanche Island. Minor modifications to the existing distribution system used by Domtar, and installation of a new 3750 kva electrical substation and transformer would be adequate to provide the necessary power supply for oil transfer and storage operations.

In order to accommodate the barge traffic required to withdraw all 27 million barrels of Cote Blanche oil within 150 days, the existing barge slip would have to be enlarged considerably. A 1300-foot long, 200-foot wide slip would be excavated from the access canal east to the present barge dock location (Figure 2.3-5); depth would be sufficient to handle 26,000-barrel barges with 9.5-foot drafts. An estimated 250,000 cubic yards of material would be excavated from the banks and bottom of the existing barge slip and placed in a spoil disposal area approved by the U.S. Army Corps of Engineers.

Four abutment-type barge docks (Figure 2.3-5) are planned at the mine barge slip. Each dock would be capable of handling barges with capacities of up to 26,000 barrels. The manifold, pumps, and meters would require approximately 6 acres adjacent to the barge slip.

Four barge loading and unloading pipelines would be buried between the cavern pump shaft and the barge docks, a distance of approximately 1500 feet. To meet the proposed storage fill schedule, four 75-horse-power booster pumps would be required to supplement the transfer capacity of the barge pumps. The piping and instrument diagram shown on Figure 2.3-6 indicates the equipment arrangement, oil flow direction, and preliminary control and monitoring equipment required for cavern fill and withdrawal using barges. (Pump station piping could be used for pipeline delivery is shown with dashed lines.)

The design of the storage cavern pumping facilities is based upon expected average rates of fill and withdrawal given in section 2.3.3. The preliminary design for all oil handling and distribution facilities was based on ANSI B31.4, Liquid Petroleum Transport Systems, and other applicable codes or standards currently being used by the petroleum industry in the United States. The design of pipelines and all equipment was based on crude oil having the following characteristics:

1. API Gravity: $27^{o}$ API
2. Specific Gravity: 0.893 @ $60^{o}F$
3. Viscosity: 200 SSU @ $60^{o}F$, 43.33 centistokes @ $60^{o}F$
4. Sulfur Content: less than 1 percent by weight
5. Reid Vapor Pressure: 3 psi @ $60^{o}F$
6. Basic sediment and water content between 0.5 and 1 percent.

All pipelines would be protected from corrosion and hydrostatically tested to 150 percent of the maximum working pressure prior to filling with oil.

Basic security for the storage facilities would consist of a 6-foot chain link fence around the cavern and dockside pump stations. The facility will be manned 24 hours a day.

Salt production in the existing mine would be terminated to allow for final oil filling preparations (see Figures 2.3-1 and 2.3-2). Hoist equipment and headframes at the original site would be dismantled, and a portion of the old conveyor system would be removed. Existing buildings and other facilities at the site would be retained for utilization with production at the new mine wherever possible.

2.3.3 Operation

The proposed fill and withdrawal procedure for the Cote Blanche facility would utilize barge transport. For purposes of analyzing schedules for fill, withdrawal and refill, a 24-hour-per day operation at 4 Cote Blanche docks has been assumed. Contingency downtime (due to weather and schedule delays) is estimated to be 15 percent for an operation that involves barge/tanker transfer on the Mississippi River near Venice, barge transport up and down the Mississippi River, crossing through the Algiers locks at New Orleans and transport back and forth across the ICW between the Mississippi River and the site. It has been calculated that the round trip cycle time (including downtime) would be 123 hours. The barges are expected to be transported in tandem (two barges per tug).

The Cote Blanche facility would be designed to handle oil, during both fill and withdrawal, at a maximum rate of 180,000 barrels per day (BPD). This rate would allow the facility to be either filled or emptied within the desired 150 days.

Recently, the supply of barges in coastal Louisiana has exceeded demand and, consequently, as many as 80 barges with an average capacity of 25,000 barrels could be made available for the SPR at present. Thirty-six of these barges would be required over the 150-day period (7.2 barges/day) to attain the maximum fill rate of 180,000 BPD.

However, the actual fill rate is uncertain at present. Moreover, following an oil supply interruption, there likely would be an insufficient amount of oil and barges available for refill at a rate as high as 180,000 BPD. Therefore, for purposes of analysis of impacts, a lower fill rate of 85,000 BPD was chosen.

The assumed fill and refill schedule may be summarized as follows:

Barge Capacity Required 429,000 barrels (17 barges)

| | |
|---|---|
| Tugs Required | 11-1,800 HP |
| Average Rage | 85,000 BPD (3.4 calls per day) |
| Elapsed Time | 45 weeks |

The types of impacts from a greater fill rate would be similar, but of shorter duration, as discussed in section 8.2.

Industry experts estimate that a minimum of 80 barges (25,000 bbl equivalent) should be available for oil withdrawal during an oil supply interruption. Only 36 of these would be needed to achieve the desired withdrawal rate of 180,000 BPD, with a withdrawal time of 150 days. The withdrawal schedule information would be as follows:

| | |
|---|---|
| Barge Capacity Required | 907,500 bbl (36 barges) |
| Tugs Required | 20-1,800 HP |
| Average Rate | 180,000 BPD (7.2 calls per day) |
| Elapsed Time | 150 days |

It should also be mentioned that, because of the limited number of barges available, the maximum fill and withdrawal rate of the Cote Blanche facility would be lower if the proposed nearby facility at the Weeks Island salt dome is also developed (see section 4.5).

The oil storage facility is assumed to be emptied and refilled once every 5 years to meet national emergency conditions. Oil stored within salt caverns has unlimited storage life.

To maintain a state of operational readiness, it would be necessary to maintain a trained crew available to carry out oil transfer activities. A total of 15 men should be sufficient; only 3 of these need be familiar enough with overall operations to act in a supervisory capacity.

During standby storage periods, a total of 2 or 3 men would be sufficient to man the Cote Blanche storage facilities. Duties would include security, routine maintenance, and equipment monitoring.

Pollution generated at the storage facility would be minor and local. A temporary flare system will be used during fill periods for combustion of hydrocarbon and hydrogen sulfide vapors vented from the cavern. The venting would prevent excessive buildup of vapor pressure within the cavern. Approximately 150 pounds per day of hydrocarbons will be emitted during this period; flaring is a standard method of reducing concentrations of combustible gases and $SO_2$ in the mine vicinity. After the cavern is filled, the vent system would be sealed and the flare system removed. During standby storage, vapor pressures within the cavern will not exceed 1.5 atmospheres and no escape route for the vapors will exist.

Minor amounts of liquid wastes would be generated at the site. Sanitary sewage would be disposed of in a suitably designed septic tank system. Only during fill and withdrawal would significant numbers of workers be present. No ground water seepage occurs in the existing mine. However, should small amounts of ground water gradually accumulate in the cavern, the water can be periodically pumped to the surface and barged to suitable facilities for removal of oil, gas, and salts.

Oil spillage is the only significant potential source of pollution at the storage facility. An oil spill contingency plan is described in section 4.3.8.8.

Small amounts of sludge and other impurities may accumulate in the sump within the cavern over a period of time. These materials would be pumped to the surface and disposed of in suitable landfill disposal sites off the island.

Water supply for domestic purposes would be taken from the existing Cote Blanche well. No other significant quantities of water would be required.

### 2.3.4 Termination and Abandonment

When the nation has developed sufficient independence from foreign oil suppliers, the oil storage capacity at Cote Blanche Island would be longer be needed. If other useful purposes for the facilities cannot be found, operations would be terminated and the facility abandoned.

At present, it is intended to put the facility to some beneficial use, rather than seal it off with concrete. Beneficial uses might include disposal of wastes, such as dredge spoil, slurried fly ash or other polluted or toxic materials. Another possibility is to develop a compressed air storage facility for peak power use. The final selection of an abandonment plan would likely depend on the economic and environmental trade-offs and regulations that are in effect at the time of termination.

### 2.3.5 Costs

Cost estimates have been generated for mine conversion excluding acquisition and abandonment of the mine site and purchase of oil. Capital costs, expressed in 1976 dollars, regionally adjusted, and not including interest or escalation during construction, are given for the two development options in Table 2.3-3. Costs are approximately $2.8 million higher for the option of no mine shutdown because of the need to sink a new pump shaft. Operating costs, including labor required for inspection of the mine shafts and all oil distribution facilities, maintenance of equipment, instrumentation and shafts, taxes, insurance, and power, are estimated to be between $240,000 and $284,000 per year for static storage, plus an additional $837,000 barge and tug lease costs per month for filling, and $1,655,000 per month for withdrawal.

TABLE 2.3-1 Estimate of employment and earnings, mine conversion and replacement mine construction, for no mine shutdown, Cote Blanche site

| | | | | | Number of Workers by Place of Permanent Residence | | Earnings by Place of Permanent Residence | |
|---|---|---|---|---|---|---|---|---|
| Week | Average No. of Workers per Week | | Average Annual Wage | Total Earnings | Within Commuting District | Beyond Commuting District | Within Commuting District | Beyond Commuting District |
| 47-70 (23 weeks) | Specialists (25%) | 75 | $ 22,000 | $ 726,000 | -- -- | (100%) 75 | $ -- | $ 726,000 |
| | Skilled (35%) | 105 | 18,000 | 831,600 | (60%) 63 | (40%) 42 | 498,960 | 332,640 |
| | Nonskilled (40%) | 120 | 12,000 | 633,600 | (100%) 120 | -- -- | 633,600 | -- |
| | Total | 300 | | $ 2,191,200 | 183 | 117 | $ 1,132,560 | $ 1,058,640 |
| 70-110 (40 weeks) | Specialists | 88 | $ 22,000 | $ 1,490,720 | -- -- | (100%) 88 | $ -- | $ 1,490,720 |
| | Skilled | 122 | 18,000 | 1,690,920 | (60%) 73 | (40%) 49 | 1,014,552 | 676,368 |
| | Nonskilled | 140 | 12,000 | 1,293,600 | (100%) 140 | -- -- | 1,293,600 | -- |
| | Total | 350 | | $ 4,475,240 | 213 | 137 | $ 2,308,152 | $ 2,167,088 |
| 110-150 (40 weeks) | Specialists | 25 | $ 22,000 | $ 423,500 | -- -- | (100%) 25 | $ -- | $ 423,500 |
| | Skilled | 35 | 18,000 | 485,100 | (60%) 21 | (40%) 14 | 291,060 | 194,040 |
| | Nonskilled | 40 | 12,000 | 369,600 | (100%) 40 | -- -- | 369,600 | -- |
| | Total | 100 | | $ 1,278,200 | 61 | 39 | $ 660,660 | $ 617,540 |
| | | | | $ 7,944,640 | | | $ 4,101,372 | $ 3,843,268 |

TABLE 2.3-2 Estimate of employment and earnings, mine conversion and replacement mine construction, for temporary mine shutdown, Cote Blanche site

| Week | Average No. of Workers per Week | | Average Annual Wage | Total Earnings | Number of Workers by Place of Permanent Residence: Within Commuting District | Number of Workers by Place of Permanent Residence: Beyond Commuting District | Earnings by Place of Permanent Residence: Within Commuting District | Earnings by Place of Permanent Residence: Beyond Commuting District |
|---|---|---|---|---|---|---|---|---|
| 47-70 (23 weeks) | Specialists (25%) | 63 | $22,000 | $ 610,000 | -- -- | (100%) 63 | $ -- | $ 610,000 |
| | Skilled (35%) | 87 | 18,000 | 689,000 | (80%) 70 | (20%) 17 | 554,000 | 135,000 |
| | Nonskilled (40%) | 100 | 12,000 | 528,000 | (100%) 100 | -- -- | 528,000 | -- |
| | Total | 250 | | $ 1,827,000 | 170 | 80 | $1,082,000 | $ 745,000 |
| 70-110 (40 weeks) | Specialists | 63 | $22,000 | $ 1,060,000 | -- -- | (100%) 63 | $ -- | $ 1,060,000 |
| | Skilled | 87 | 18,000 | 1,200,000 | (80%) 70 | (20%) 17 | 966,000 | 234,000 |
| | Nonskilled | 100 | 12,000 | 919,000 | (100%) 100 | -- -- | 919,000 | -- |
| | Total | 250 | | $ 3,179,000 | 170 | 80 | $1,885,000 | $ 1,294,000 |
| 110-130 (20 weeks) | Specialists | 50 | $22,000 | $ 423,500 | -- -- | (100%) 50 | $ -- | $ 423,500 |
| | Skilled | 70 | 18,000 | 485,100 | (80%) 56 | (20%) 14 | 388,000 | 97,100 |
| | Nonskilled | 80 | 12,000 | 369,600 | (100%) 80 | -- -- | 369,600 | -- |
| | Total | 200 | | $ 1,278,200 | 136 | 64 | $ 757,600 | $ 520,600 |
| | | | | $ 6,284,200 | | | $3,724,600 | $ 2,559,600 |

TABLE 2.3-3 Cost summary for Cote Blanche mine project

| Construction Costs[a] | No Mine Shutdown Option | Temporary Mine Shutdown Option |
|---|---|---|
| Mine Conversion | $ 7,133,000[b] ($0.26/bbl) | $ 4,303,000[c] ($0.16/bbl) |
| New Mine Development | $21,004,000 ($0.78/bbl) | $21,004,000 ($0.78/bbl) |
| Oil Handling and Distribution Facilities | $ 4,200,000 | $ 4,200,000 |
| Total Construction Costs | $32,337,000 ($1.20/bbl) | $29,507,000 ($1.09/bbl) |

Operation and Maintenance Costs

| Annual Storage[d] | | Monthly During[e] | |
|---|---|---|---|
| No Mine Shutdown | Temporary Mine Shutdown | Filling (10.4 Months) | Withdrawal (5 Months) |
| $284,000($0.01/bbl) | $240,000($0.009/bbl) | $837,000 ($8.4 million per fill or $0.31/bbl) | $1,655,000 ($8.1 million per withdrawal or $0.30/bbl) |

[a] Excludes acquisition and abandonment of mine site and purchase of oil.

[b] Includes construction of new pump shaft and sump.

[c] Includes conversion of existing production shaft and construction of sump.

[d] Static storage costs do not include costs of new mine operation.

[e] Transportation costs do not include tanker transfer costs or tanker transportation to Venice. Transportation costs are independent of mine development option.

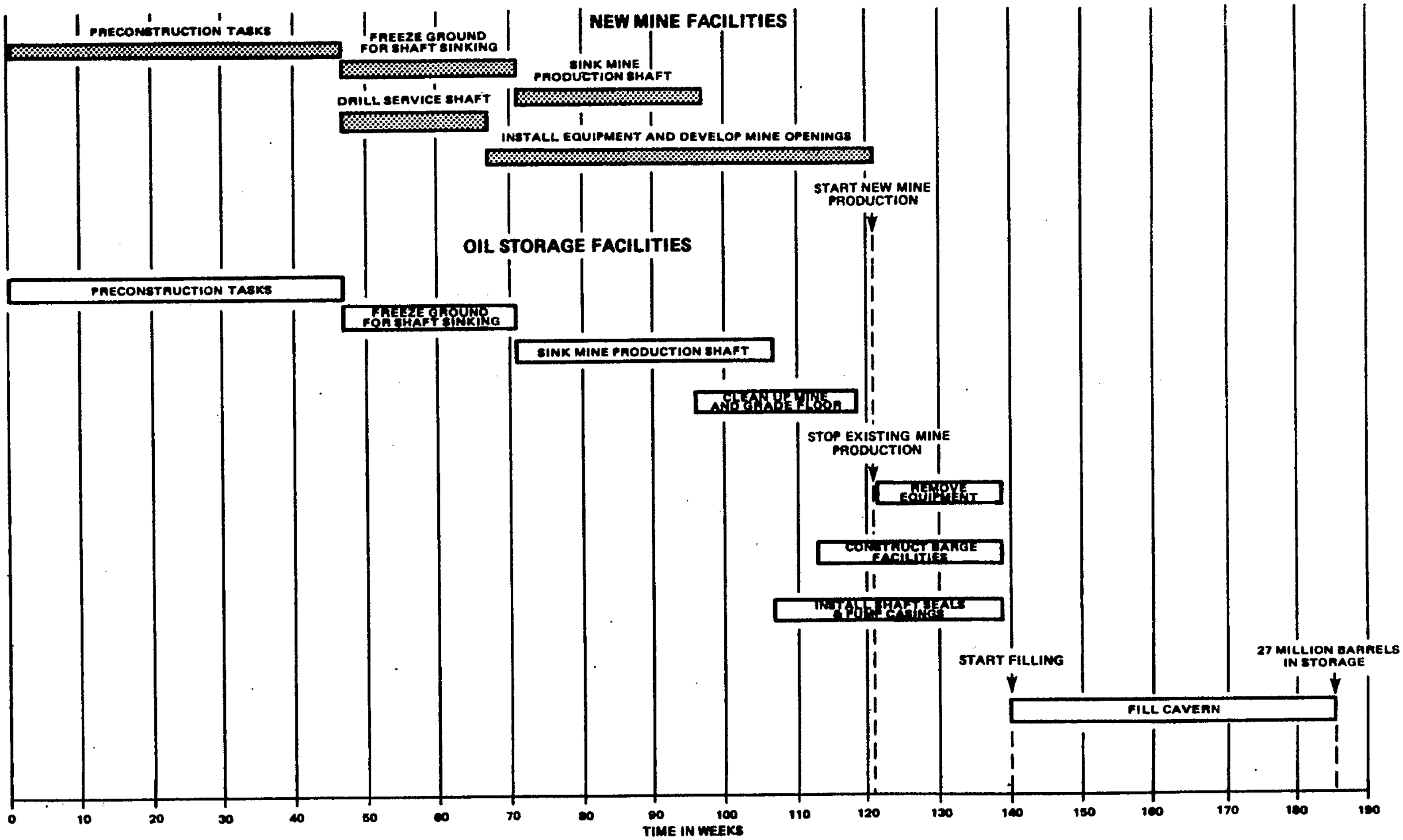


FIGURE 2.3-1 Construction schedule for oil storage project development without salt mine shutdown, Cote Blanche Island.

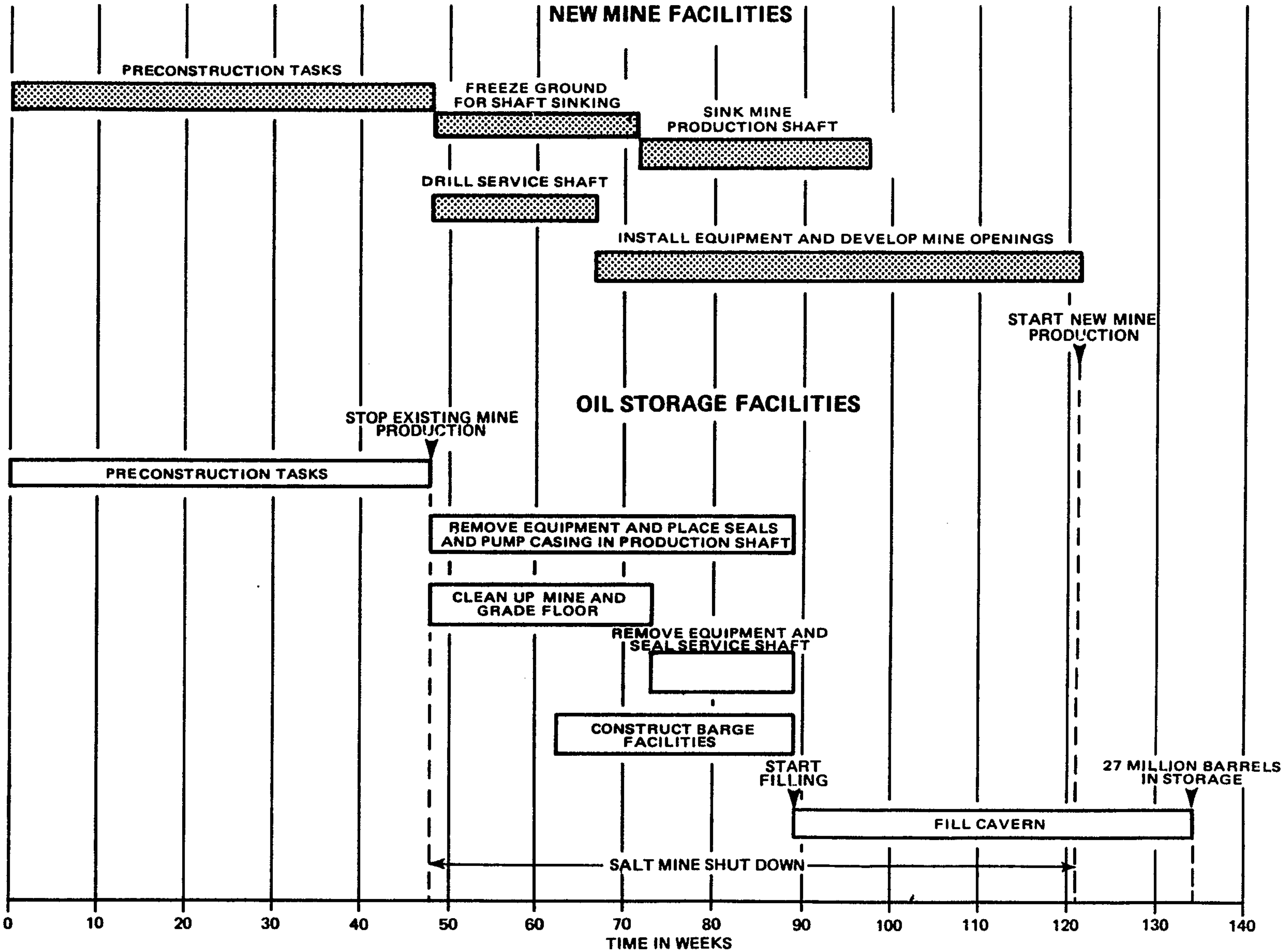


FIGURE 2.3-2 Construction schedule for oil storage project development with temporary salt mine shutdown, Cote Blanche.

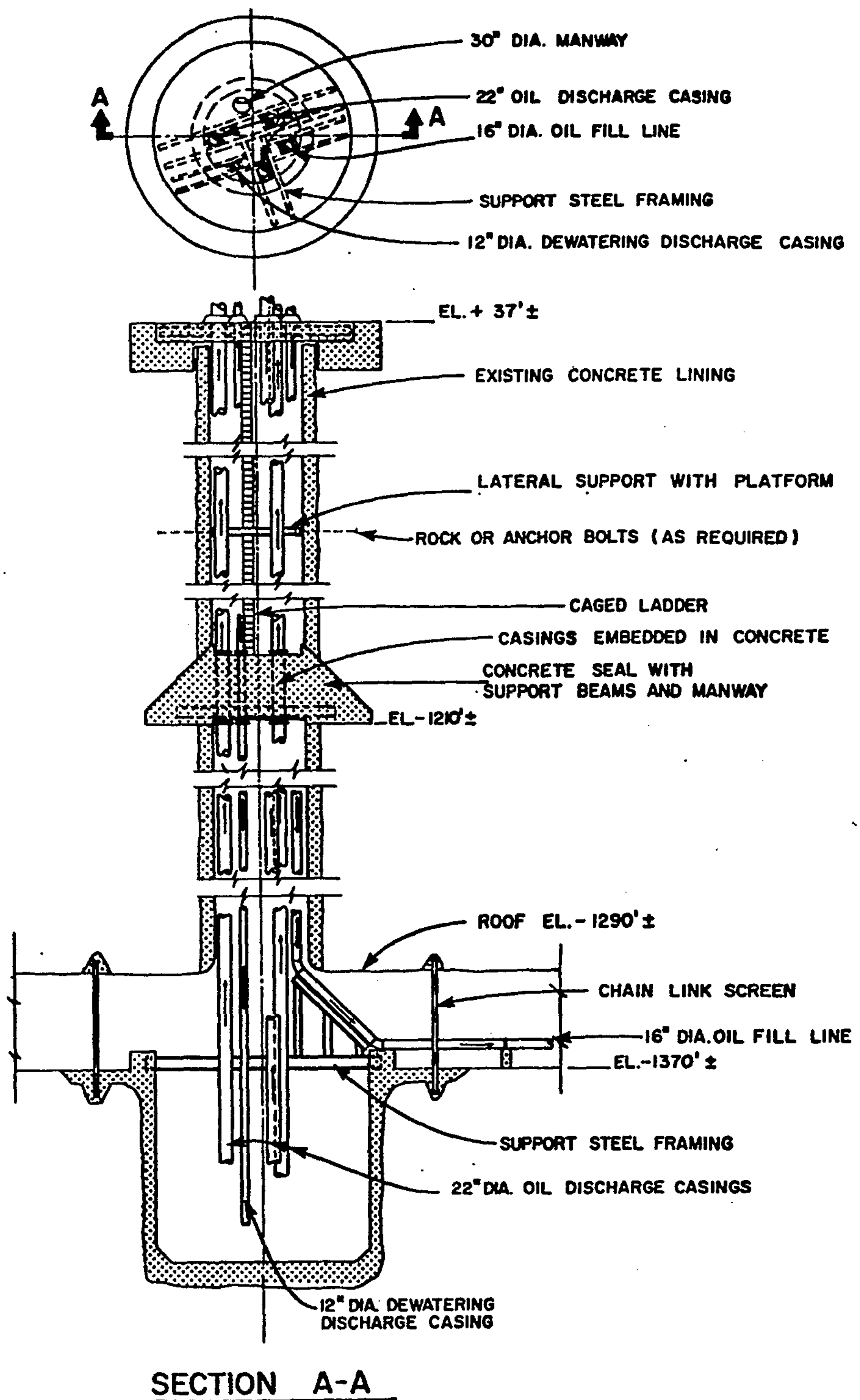


FIGURE 2.3-3. Pump shaft details Cote Blanche mine Cote Blanche Island, Louisiana.

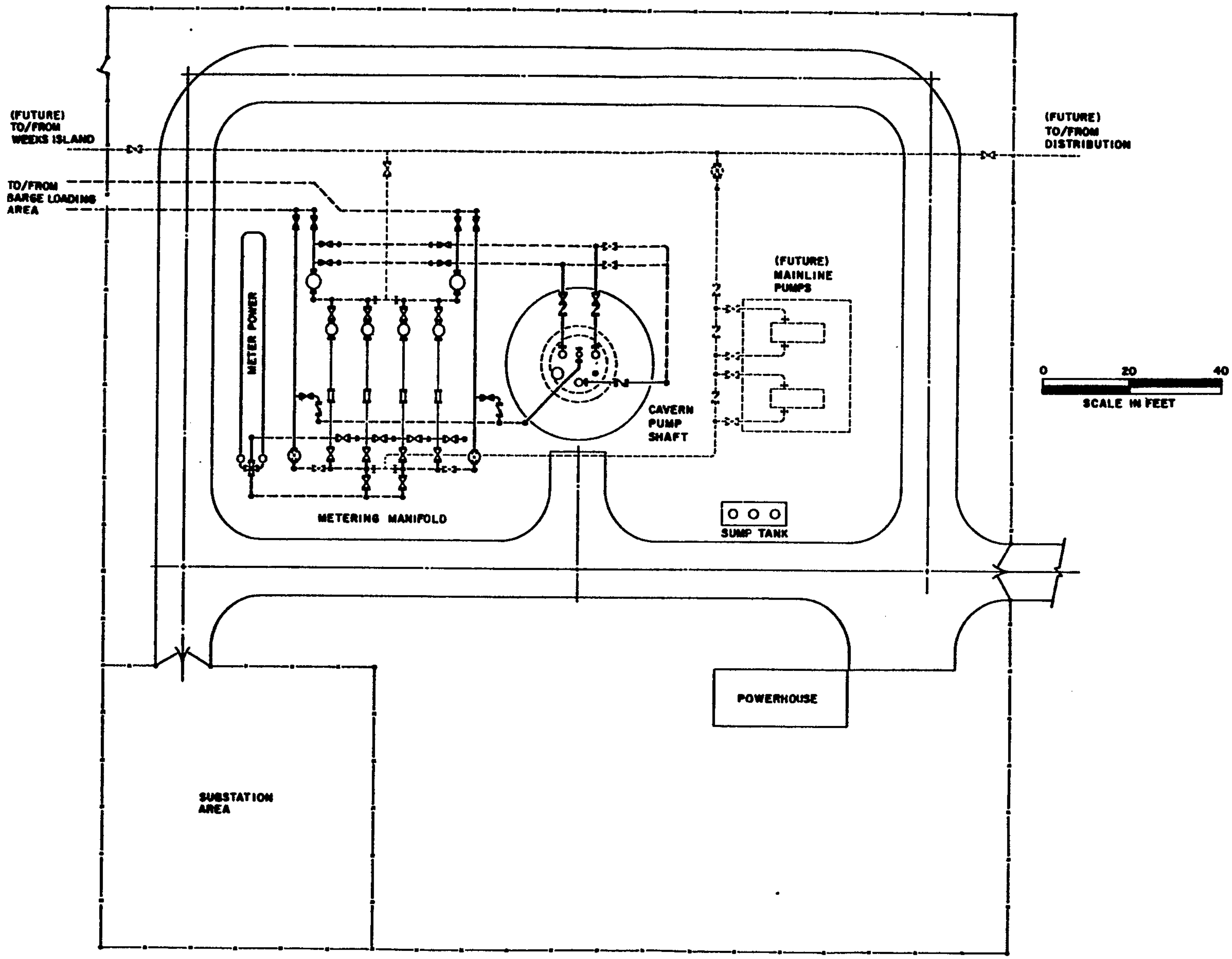


FIGURE 2.3-4 General arrangement plan. Storage site and pump shaft area, Cote Blanche system.

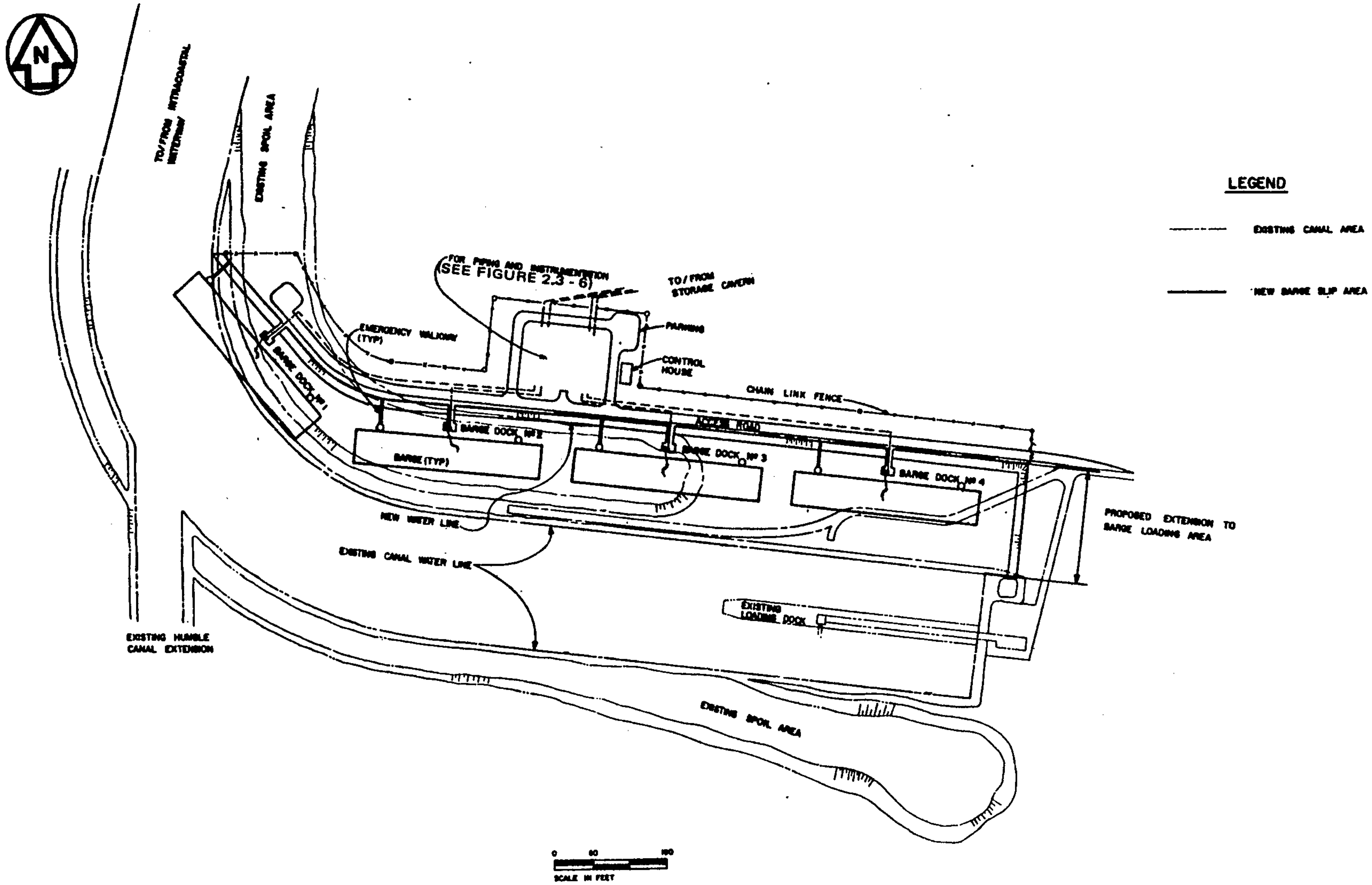


FIGURE 2.3-5 General arrangement plan, storage site - barge loading area, Cote Blanche system.

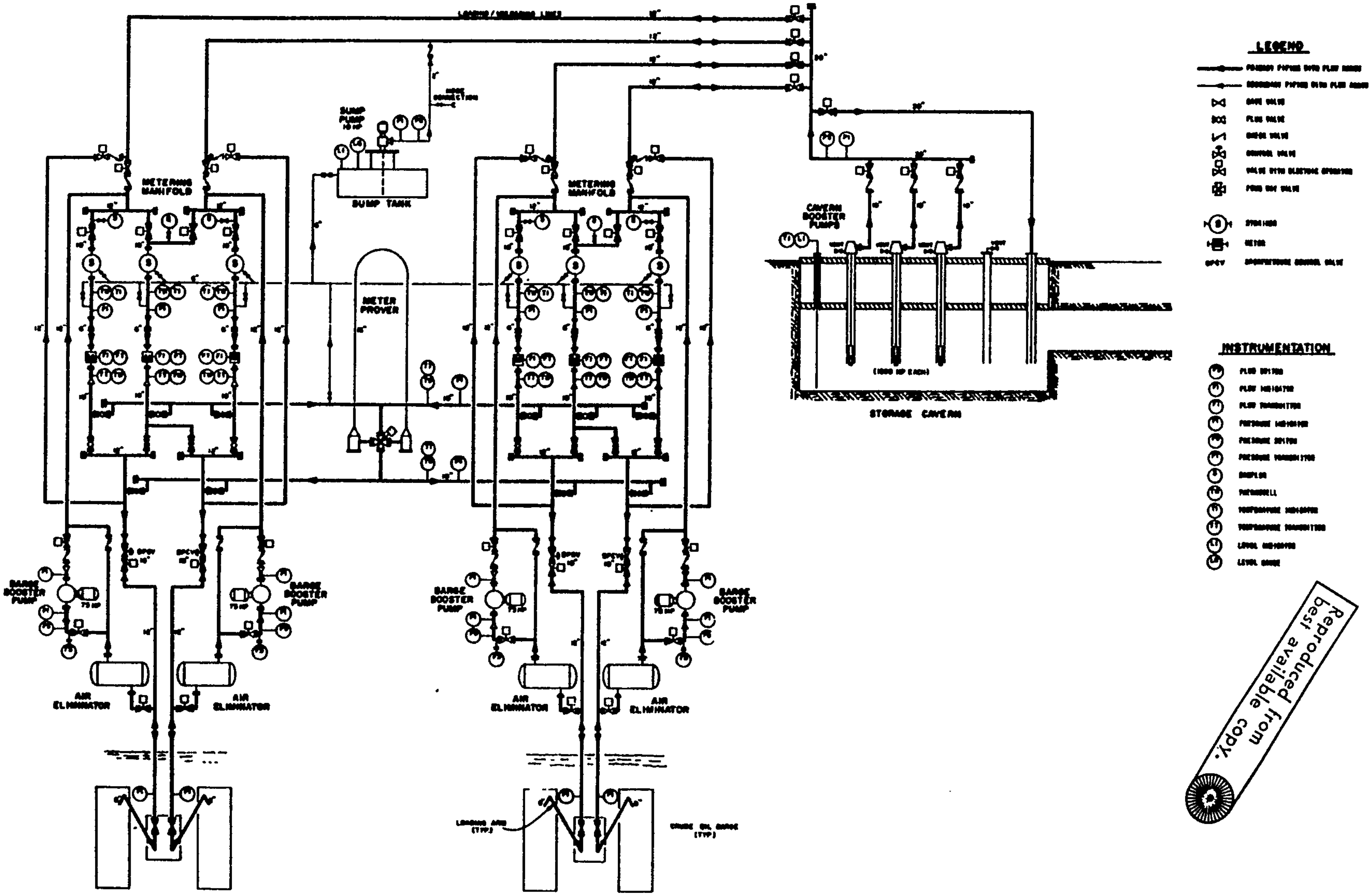


FIGURE 2.3-6 Piping and instrument diagram - storage and barge loading site, Cote Blanche system.

## 2.4 NEW MINE DEVELOPMENT

As a Federal agency, FEA is required under the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. 4601 et seq.) to pay the actual reasonable expenses associated with moving a business when such a move is required as a result of acquisition for a Federal program. FEA is also required to pay the actual reasonable expenses of searching for a replacement business. There exists ample space on Cote Blanche Island to relocate the current mining operations, and it is assumed that Domtar would develop a new mine under the provisions of this law. However, the question of when the new facilities will be constructed with respect to the conversion of the existing mine for storage purposes remains undecided at this time.

FEA is considering two possible plans for scheduling the new mine construction. Figures 2.3-1 and 2.3-2 indicate the anticipated construction and fill schedules for each of these plans. One plan allows the completion of the new mine prior to closing the existing mine. This would avoid any disruption of salt production, but would require a delay of 50 weeks in converting the existing mine. Such a delay could reduce the storage capability of the facility within the time frame of the SPR (January 1979) from its full potential of 27 million barrels to about 10 million barrels or less, depending upon when construction begins. The second plan provides for conversion of the existing mine in the most expeditious manner possible, including shut down of production operations at a point in time that would not delay the conversion effort. Although new mine construction could occur concurrently with conversion activities, this plan would result in a suspension of salt production for about 74 weeks. This could impact significantly upon the socioeconomic environment (see section 4.2.7). A summary of the required manpower (and associated earnings) for conversion and new mine construction under each of the plans is given in Tables 2.3-1 and 2.3-2.

The decision to construct the new mine and the final design and construction activity itself would be the responsibility of Domtar. However, a new mine design is presented in this section for purposes of impact analysis.

The minimum vertical distance between the new mine and the oil storage facility has been assumed to be 300 feet. Historically, the coal mining industry has used this separation distance in locating new mines adjacent to abandoned (flooded) mines. Because of the greater structural integrity of the salt structure at Cote Blanche compared to that in most coal mines, this is considered to be a conservative design.

Shaft designs for the relocated mine duplicate the shafts at the existing facilities with regard to thickness, type and depth of lining, diameter, and shaft fixtures. Foundations for head frame, hoist equipment, and shaft collars were calculated to support the same hoisting loads and handling equipment that are being used at the existing mine. The relatively large diameter of the production shaft dictates that the sinking method of excavation would have to be used. The service shaft diameter was chosen so that it could meet the ventilation requirements and be drilled. There is some disagreement among contractors as to the maximum diameter shaft that can be drilled. Therefore, at the time of final design the service shaft diameter could be increased. Shaft installation by drilling is much faster than using conventional sinking methods.

Based on the existing Cote Blanche Mine layout, the shaft arrangement includes a low extraction ratio in the area of the shaft. This ratio was noted to be much less than in the working area of the mine. Also, it was noted that the shafts are separated by several hundred feet. These factors were included in the layouts of the relocated mine.

In selecting the space requirements for the new mine, the production rate, the mining cycle, and the owner's requirements were used to determine the number of working faces needed. Additional space was also provided for the storage of salt appropriate to mine requirements, for shop areas, for haulways, and for the crushing and screening equipment.

Material handling and production equipment used in the existing mine would be duplicated in the new mine.

## 2.4.1 Underground

Following a geotechnical exploration program at the surface and within the dome to locate the optimum shaft sites, a 14-foot diameter production shaft and a 9-foot diameter service shaft would be provided in the new area (see Figures 2.2-3 and 2.2-4). The production shaft would be sunk using ground freezing techniques and the service shaft would be drilled. Each of the shafts would be lined at least 200 feet into the salt and provided with ground water seepage monitoring equipment similar to that installed in the pump shaft. The new mine level is at elevation 990 feet below MSL, though the production shaft would be extended to 1080 feet below MSL to accommodate the holding bin and skip loading system (Figure 2.2-4). The new shafts are separated by 500 feet and due consideration was given to the extraction ratio used around shafts in the existing mine. The new production shaft is located approximately 1400 feet away from the existing shaft. Sufficient vertical clearance (300 feet) has been allowed for development of the new mine directly above the storage area, leaving at least a 150-foot radius column of salt around the shafts and oil wells.

Opening the new mine is essentially a three-phase process.

Phase 1 - Belling out and initial excavation around the foot of the service shaft.

Phase 2 - Excavation of a tunnel between the two shafts. Upon completion of the tunnel, the volume of excavation should be sufficient to meet production requirements of the mine. Relocation of the mining operations can begin at this time.

Phase 3 - Completion of the mine development would include areas for a shop, storage of salt, a haulway for conveyors, crushers, and space for other materials handling equipment. Fourteen working faces are planned for in space computations.

The production potential at Cote Blanche is approximately 1,380,000 tons annually. Prior to being hoisted, primary and secondary crushing and screening of the rock are done. The same facilities were included in the plans for the new mine. Based on present equipment used in the existing mine, and on production requirements, the following new equipment would be required to open the new mine:

1. An undercutter.
2. A drill jumbo with drills.
3. A loader, approximately 4 to 5 cubic yards.
4. A blasting platform.

Underground crushers with associated hoppers and a main production conveyor with a handling capacity to match the existing production rate will be provided. A storage bunker conveyor system would also be included.

### 2.4.2 Aboveground

The hoist equipment and head frames at the top of the shaft would be designed to handle the present production rate. After the excavated rock is hoisted to the surface, it would be transported to the barge docks (or existing conveyor) by a new belt conveyor system.

Existing office buildings, storage areas and parking lots would be retained for use with the new mine if at all possible. The existing barge docks and loading system would not be affected by the project.

### 2.4.3 Operation

Production at the new Cote Blanche Mine would continue unchanged by the oil storage project (except for the possible temporary shutdown associated with one of the development options). Production potential, employment level, and working conditions would remain unaltered.

### 2.4.4 Costs

Construction costs for developing the new mine are estimated to be $0.78 per barrel storage capacity, or $21 million. Total project costs are thus $1.20 per barrel storage capacity, or $32.3 million, for the option of no mine shutdown and $1.09 per barrel capacity, or $29.5 million, for the option of temporary mine shutdown. These totals do not include mine acquisition, abandonment, or oil purchase.

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SECTION 3.0

## DESCRIPTION OF THE EXISTING ENVIRONMENT

### 3.1 INTRODUCTION AND SUMMARY

#### 3.1.1 Existing Site Environment

Cote Blanche Salt Mine has been proposed as a potential crude oil storage facility suitable for the National Strategic Petroleum Reserve Program. This section summarizes the existing physical, biological and human environment surrounding the mine site. Detailed site information is provided in sections 3.2 through 3.9.

Cote Blanche Mine is located on Cote Blanche Island in the coastal region of southwestern St. Mary Parish, Louisiana. The island formed as a result of salt dome formation deep in the earth followed by piercement of the salt to within several hundred feet of sea level. This movement resulted in the upward displacement of the overlying sediments. Many salt domes are scattered across the central Gulf Coast in Louisiana and Texas, but only a few domes are located as close to the earth's surface as the dome found at Cote Blanche. The salt dome measures more than a mile across near its peak. The interior of the dome is mined by dry, room and pillar techniques, since it is effectively isolated from ground water aquifers by the impermeable and fault-free nature of the salt structure.

Cote Blanche Island is located on the northern edge of the extensive Atchafalaya-Vermilion Bay estuarine complex. This complex consists of several bays: Atchafalaya Bay, East and West Cote Blanche Bays and Vermilion Bay. The bays are generally shallow and are rimmed by brackish, intermediate, and fresh marshes on the north and by predominantly brackish marsh on the south. Marshlands in this portion of the state do not extend as far inland as they do farther to the east near the Mississippi Delta. Because of the protection provided by Marsh Island to the south and a strong flow of fresh water from the Atchafalaya River on the east, the bay waters are brackish. Salt concentrations (salinity) are seldom greater than 10 parts per thousand (ppt).

In the immediate vicinity of the island, the bays and canals are used extensively by the oil and gas industry and for coastal barge and ship traffic. An extensive oil and gas field lies just south of Cote Blanche Island in West Cote Blanche Bay. The Intracoastal Waterway passes just to the north of the island.

Most development in the region is confined within the banks of man-made and natural levees because of the periodic flooding and high water tables in the marsh and swampland. Extensive sugar cane fields are located along Bayou Cypremort, north of Cote Blanche. Urban development is almost exclusively confined to the wide levee banks of Bayou Teche. Towns along the levee are of moderate size and generally have populations less than 10,000 (Figure 2.2-1).

Cote Blanche Island has gently rolling slopes, covered for the most part with a second growth of deciduous forest. Parts of the island have been cleared for sugar cane and cattle grazing and several dry oil wells have been sunk. The salt mine facilities are confined to the southwest corner of the island (Figure 2.1-2). No active farming or agricultural land is on the island, but approximately 300 cattle and several sheep graze on the cleared or wooded areas. The island is isolated from the mainland by canals and the Intracoastal Waterway. Access to the island is restricted to mine employees and other authorized persons so that no public usage for recreation or other purposes occurs.

Climate in the area is typical of the Gulf Coast, being generally warm and humid. Air quality is generally good because of the low population density and absence of heavy industry. However, local short-term air quality problems occur as a result of intentional burning of marsh grass and sugar cane fields.

The coastal marshland supports abundant wildlife, and is particularly important for migratory birds using the Mississippi Flyway or for coastal shore birds. The marsh also supports large populations of nutria, muskrat and other furbearers, as well as alligators. Upland species find suitable habitat on the high salt dome islands and underdeveloped levees in the area. The bays and marshes around Cote Blanche provide habitat and food supply for many aquatic species, including shrimp, crabs, and menhaden.

The local economy is more dependent on mining, manufacturing, transportation and other various trades than on agriculture or fisheries for employment. Most farming occurs in Lafayette Parish to the north; fishing fleets are primarily based in Morgan City to the east (Figure 2.1-1).

### 3.1.2 Future Conditions in the Area Without the Proposed Action

St. Mary Parish is not expected to undergo significant development during the next 10 to 20 years. Small growth in population, land development and employment will occur, principally along Bayou Teche. However, this growth is not expected to change the generally rural character of the area.

Oil and gas production activities in the adjacent marshes and bays should decline. Present field reserves are not large and new discoveries are unlikely since little exploration is taking place. Barge traffic in the Intracoastal Waterway should remain high, however, and even increase.

On Cote Blanche Island it is unlikely that any significant change from current conditions will occur. Future salt mine operations will depend on market conditions. However, there is a large volume of high quality salt that is easily accessible to sustain current production levels for several decades. Other mining levels in the cavern could be developed in the near vicinity of present activities and in a similar manner as that proposed for the oil storage program.

Since most of the island is under private ownership, it is possible that certain sections could be sold and developed for recreation or residential uses. The unique isolation and upland character of the island provides potential of a type uncommon to this portion of the state. However, there is no apparent reason for such an action to take place, particularly since the island has been under the same ownership for many years without such development occurring.

Future conditions without the project are therefore projected to remain little changed from present conditions. These conditions include air and water quality, noise levels, wetland quality and the character of nearby communities.

### 3.1.3 Organization of the Section

The following sections present details of the existing environment in the region around and on Cote Blanche Island. The sections have been developed to include the various physical, chemical, biological, and socioeconomic factors important to the development of Cote Blanche as a Strategic Petroleum Reserve site.

## 3.2 GEOLOGICAL CHARACTERIZATION OF THE REGION AND MINE SITE

### 3.2.1 Physiography

Cote Blanche lies in the Gulf Coastal Plain physiographic province of the United States. With the exception of erosional scarps and salt domes, the plain is generally a flat or gently sloping sedimentary one of low relief. The Gulf Coastal Plain is coextensive with the Atlantic Coastal Plain, and averages about 250 miles in width. Figure 3.2-1 shows the physiographic subdivisions of the region.

The island is roughly circular in form and about 1.5 miles in diameter. The highest point is about 100 feet above sea level. A wave-cut bluff about 50 feet high forms the southern border of the island; east of the bluff, a long arm of marsh runs into the island. Slopes tend to be smooth with gently undulating hills, and the surface drainage pattern of the island is radial (Figure 3.2-2).

Cote Blanche is one of a series of salt domes known as the Five Islands. The islands are aligned in a northwest-southeast direction and include Jefferson, Avery, Weeks, Cote Blanche (all about 5 miles apart), and Belle Isle, which is 24 miles to the southeast of Cote Blanche (Figure 3.2-1).

### 3.2.2 Regional Geologic Setting

The dominant geologic feature of southern Louisiana is the Gulf Coast Geosyncline. The axis of this geosyncline generally corresponds with the present coastlines of Texas, Louisiana, Mississippi, Alabama, and Florida (Figure 3.2-3). The stratigraphic record indicates that the geosyncline has been slowly and more or less continuously subsiding since Cretaceous times. The area of subsidence received voluminous deltaic accumulations of sediments, which are derived from broad portions of central North America. These accumulations are expressed as a large wedge of Mesozoic and Cenozoic sediments that progressively thicken toward the south. In the vicinity of the coast, the wedge is reported to be about 40,000 feet thick (King, 1969). Individual stratigraphic units also thicken and dip southward. The same depositional processes are still active.

Another dominant feature of the region is the large number of salt domes scattered along the Gulf coast (Figure 3.2-3). Typically, these domes are roughly cylindrical in shape, 1 to 5 miles in diameter, and extend from a few tens or hundreds of feet to several thousand feet below the surface. The domes are believed to be derived from the thick Louann Salt Formation of probable Jurassic age which rests near the base of the wedge sediments. Aided by buoyancy provided by the relatively low specific gravity of salt, local portions of the deep salt layer have plastically protruded upwards and pierced the overlying strata. In response to this upward flow, the adjacent strata are locally upturned and create excellent traps for petroleum accumulation.

Cote Blanche Island and each of the other Five Islands are the topographic expressions of such salt domes.

### 3.2.3 Stratigraphy

In central and northern Louisiana, most of the various strata that compose the northern and thinner portion of the geosyncline are fairly well known and documented from either surface exposures or petroleum exploration. However, near the coast, data are sparce and are limited principally to petroleum well logs. The deepest of these logs only extends to mid Tertiary strata; therefore, the nature of deeper sediments is virtually unknown. Also, due in large part to marked lateral variations that characterize the units, the explored portions of the stratigraphic column are known only in a general manner.

In the coastal vicinity of the Five Islands, petroleum exploration presently extends to about 15,000 feet below sea level (Johnson and Bredeson, 1971), just barely into the top of the Oligocene (Figure 3.2-4). Johnson and Bredeson show the top portion of the Oligocene to be composed of deepwater shales, and suggest that these and other shales may compose a thickness of several thousand feet.

The entire 15,000-foot section above the Oligocene is composed of variable thicknesses of alternating sands, silts, and clays. The lower two-thirds is Miocene-Pliocene, comprised principally of interbedded transitional and shallow marine facies. Partly because of the lateral lithologic variability, these facies are formationally undifferentiated.

The Pleistocene strata apparently are more laterally continuous and have been divided into four regionally recognizable formations (Figure 3.2-5). From deepest to shallowest, they are the Williana, Bentley, Montgomery, and Prairie Formations. Each corresponds with a landward time-equivalent terrace of the same name. McFarlan (1962, in Murray, 1961) reported that all four formations are lithologically similar, each one composed of a thick basal unit of sands with gravels, grading upwards to clays with silts and minor sands.

### 3.2.4 Structure

The major regional structure is the Gulf Coast Geosyncline described in section 3.2.2. Superimposed on the geosyncline are several minor structures (Figure 3.2-3). The most noticeable minor structure is a major fault system that approximately parallels the geosynclinal axis. Faults composing the system are typically normal and downthrown to the south. The faulting associated with this system is believed to have occurred gradually but concurrently with the geosynclinal development. The only fault of the system that is believed to be active is the Baton Rouge Fault (Figure 3.2-3). Many other smaller faults are locally associated with individual salt domes. Reportedly, they have resulted from salt plug emplacement (Johnson and Bredeson, 1971).

Another minor structural feature is the Five Islands Syncline. The axis of the syncline is a mile or so northwest of, and parallel to, a line connecting the Five Islands salt domes. Seglund (1974) related the formation of this syncline to subsidence caused by deep lateral withdrawal of salt.

### 3.2.5 Regional Seismicity

Cote Blanche Mine is situated in an area that has experienced only very minor earthquake activity. Figure 3.2-6 shows the locations of all earthquake epicenters of Intensity V or larger known or suspected within 200 miles of the site. Table 3.2-1 lists these earthquakes. (Refer to Table 3.2-2 for a description of the earthquake intensity scale.)

The largest recorded earthquake within a 200-mile radius of Cote Blanche Island was Intensity VI (Table 3.2-1). The epicenter of this earthquake was about 35 miles south of Baton Rouge and approximately 50 miles northeast of the island (No. 2 on Figure 3.2-6). The quake occurred in 1930 and was felt in towns as close to Cote Blanche as Franklin, 12 miles to the northeast. The greatest structural damage that resulted from this earthquake was chimney and window damage at Napoleonville, 44 miles northeast of Cote Blanche Island.

A second epicenter of Intensity V (No. 3 on Figure 3.2-6) is shown near Baton Rouge. These two epicenters are most likely associated with the Baton Rouge Fault System.

A cluster of six epicenters (sites of seven earthquakes) was recorded on the northwest Louisiana-Texas border. These epicenters (Nos. 5 through 11 on Figure 3.2-6) are all located at the southern edge of the Sabine Uplift, a structural feature covering the northwest corner of Louisiana and the adjacent area in Texas. They all registered a maximum of Intensity V, except for No. 10, which had an unknown intensity.

Two epicenters indicated on Figure 3.2-6 as Nos. 1 and 4 were located offshore, but their intensities are unknown.

### 3.2.6 Mineral Resources

Cote Blanche Island area contains three mineral resources of economic importance: salt, oil, and gas. The salt is mined from the dome by the Domtar Chemical Company. Exploration for salt began on the island in 1862, but the resource was not discovered until 1922 (Stern, 1955), and salt production did not begin until 1965.

Oil and gas resources occur in the strata that flank the dome. Most of this production comes from under the north flank overhang of the dome (Figure 3.2-7). Oil and gas production began on the island in 1948 (Halbouty, 1967). Currently, 29 wells on or adjacent to the island are producing oil. In 1975, production of crude oil on Cote Blanche Island was 3.64 million barrels. Cumulative production was 82.64 million barrels. An estimated 47.36 million barrels of oil reserves remain (Oil & Gas Journal, 1976).

Salt domes are also commonly capped with economic deposits of sulfur, calcite, gypsum, and/or anhydrite. However, at Cote Blanche, cap rock is absent. No marketable sand and gravel deposits are known to exist on the island.

### 3.2.7 Site Geology

The dominant geologic feature of Cote Blanche Island is the salt dome, which lies directly beneath it. The salt plug is roughly elliptical in shape. At a depth of 10,000 feet, the plug is 3.5 miles by 2 miles across; the long axis runs north to south (Stern, 1955). The plug is flattened on the top and overhangs the north flank (Figure 3.2-7). The thickness of the salt overhang is between 9,000 and 14,000 feet (Johnson and Bredeson, 1971). Large oil and gas-condensate accumulations exist in sand units directly underneath the overhang (Stern, 1955).

At least two major faults cut across the Oligocene-Miocene sediments adjacent to the deep portions of the dome. According to Johnson and Bredeson (1971), both of these features resulted from differential movement between the salt and the sediments, and occurred simultaneously with the deposition of these flanking sediments. Therefore, both faults are geologically old and neither penetrates the salt core. Johnson and Bredeson suggest that minor faulting of similar nature has also occurred along the outer margins of the dome.

A different kind of fault was found by Vaughn (1925) at the surface near the west end of the island. This fault is downthrown to the northwest. Vaughn attributes the fault to slumping of sediments that resulted from the solution of salt from below.

The detailed shape of the top portions of the dome are shown on Figures 3.2-7 and 2.2-4. The thickness of sedimentary materials over the dome varies from about 450 to 650 feet. The surficial materials of the island are mostly brownish-yellow loamy silts and clays. These soils represent an oxidized Pleistocene Prairie Terrace Formation (Vaughn, 1925; Russell, 1955).

Deeper strata include three thick beds of sand containing silt or gravelly layers. The sands are separated by stiff clay beds ranging in thickness from 4 to 44 feet.

Logs do not reveal cap rock or anhydrite in any of the borings or wells, and no cavities are indicated above the salt. However, gas accumulations (largely methane gas) in a boring near the production shaft were encountered from 715 to 845 feet below the surface in a porous interval of salt. Initially the gas pressure was sufficient to expel the drilling fluids from the hole. The pressure diminished in 2 or 3 days, suggesting a small and isolated occurrence of this gas (E. J. Longyear Company, 1959). Also, mud circulation was lost in a porous and fractured salt zone located at depths from 487 to 505 feet. This zone also appeared to be local, and was sealed off with cement.

The mine workings are stable, and rock bolting is not used. Minor spalling occurs on the vertical walls and pillars, but no heaving or cracking is apparent in the mine that would indicate presently active closure. A wooden bulkhead bulged shortly after installation 10 years ago, due to a 1.5 to 2-foot roof closure. This bulge is the only visible evidence of salt movement in the mine. No change has subsequently recurred in the bulkhead or the salt near it. The rate of plastic closure of the mine has not been measured because this does not appear to present a problem. No faults or shears are known in the mine (FEA, 1976a).

Except for occasional, small, isolated pockets of connate water, all mine workings are dry. On rare occasions, gas has been encountered in the mine usually emitted from minor fractures or drill holes. In all cases the gas has bled off in a few hours.

TABLE 3.2-1 Earthquake epicenter within 200 miles of Cote Blanche, Louisiana

| No. | Year | Mo | Da | Hr | Mn | Lat. | Long. | Intensity |
|---|---|---|---|---|---|---|---|---|
| 1. | 1929 | 07 | 28 | 17 | 00 | 29.0N | 89.4W | ? |
| 2. | 1930 | 10 | 19 | 12 | 17 | 30.0N | 91.0W | VI |
| 3. | 1958 | 11 | 19 | 12 | 15 | 30.3N | 91.1W | V |
| 4. | 1963 | 11 | 05 | 22 | 45 | 27.8N | 92.4W | ? |
| 5. | 1964 | 04 | 24 | 01 | 20 | 31.5N | 93.8W | V |
| 6. | 1964 | 04 | 24 | 07 | 33 | 31.6N | 93.8W | V |
| 7. | 1964 | 04 | 28 | 00 | 30 | 31.5N | 93.8W | V |
| 8. | 1964 | 04 | 28 | 15 | 19 | 31.7N | 93.6W | V |
| 9. | 1964 | 04 | 28 | 21 | 18 | 31.2N | 93.9W | V |
| 10. | 1964 | 06 | 03 | 02 | 27 | 31.3N | 94.0W | ? |
| 11. | 1964 | 08 | 16 | 05 | 36 | 31.4N | 93.8W | V |

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Source: National Oceanographic and Atmospheric Administration, Environmental Data Service, Earthquake Data File, January 21, 1976.

TABLE 3.2-2 Modified Mercalli intensity (damage) scale of 1931 (Abridged)

I. Not felt except by a very few under especially favorable circumstances. (I Rossi-Forel Scale.)

II. Felt only by a few persons at rest, especially on upper floors of building. Delicately suspended objects may swing. (I to II Rossi-Forel Scale.)

III. Felt quite noticeably indoors, especially on upper floors of buildings, but many people do not recognize it as an earthquake. Standing motorcars may rock slightly. Vibration like passing of truck. Duration estimated. (III Rossi-Forel Scale.)

IV. During the day felt indoors by many, outdoors by few. At night some awakened. Dishes, windows, doors disturbed; walls make creaking sound. Sensation like heavy truck striking building. Standing motorcars rocked noticeably. (IV to V Rossi-Forel Scale.)

V. Felt by nearly everyone, many awakened. Some dishes, windows, etc., broken; a few instances of cracked plaster; unstable objects overturned. Disturbances of trees, poles, and other tall objects sometimes noticed. Pendulum clocks may stop. (V to VI Rossi-Forel Scale.)

VI. Felt by all, many frightened and run outdoors. Some heavy furniture moved; a few instances of fallen plaster or damaged chimneys. Damage slight. (VI to VII Rossi-Forel Scale.)

VII. Everybody runs outdoors. Damage negligible in buildings of good design and construction; slight to moderate in well-built ordinary structures; considerable in poorly built or badly designed structures; some chimneys broken. Noticed by persons driving motorcars. (VIII Rossi-Forel Scale.)

VIII. Damage slight in specially designed structures; considerable in ordinary substantial buildings with partial collapse; great in poorly built structures. Panel walls thrown out of frame structures. Fall of chimneys, factory stacks, columns, monuments, walls. Heavy furniture overturned. Sand and mud ejected in small amounts. Changes in well water. Persons driving motorcars disturbed. (VIII+ to IX Rossi-Forel Scale.)

IX. Damage considerable in specially designed structures; well-designed frame structures thrown out of plumb; great in substantial buildings, with partial collapse. Buildings shifted off foundations. Ground cracked conspicuously. Underground pipes broken. (IX+ Rossi-Forel Scale.)

TABLE 3.2-2 Continued

X. Some well-built wooden structures destroyed; most masonry and frame structures destroyed with foundations; ground badly cracked. Rails bent. Landslides considerable from river banks and steep slopes. Shifted sand and mud. Water splashed (slopped) over banks. (X Rossi-Forel Scale.)

XI. Few, if any, (masonry) structures remain standing. Bridges destroyed. Broad fissures in ground. Underground pipelines completely out of service. Earth slumps and land slips in soft ground. Rails bent greatly.

XII. Damage total. Waves seen on ground surface. Lines of sight and level distorted. Objects thrown upward into the air.

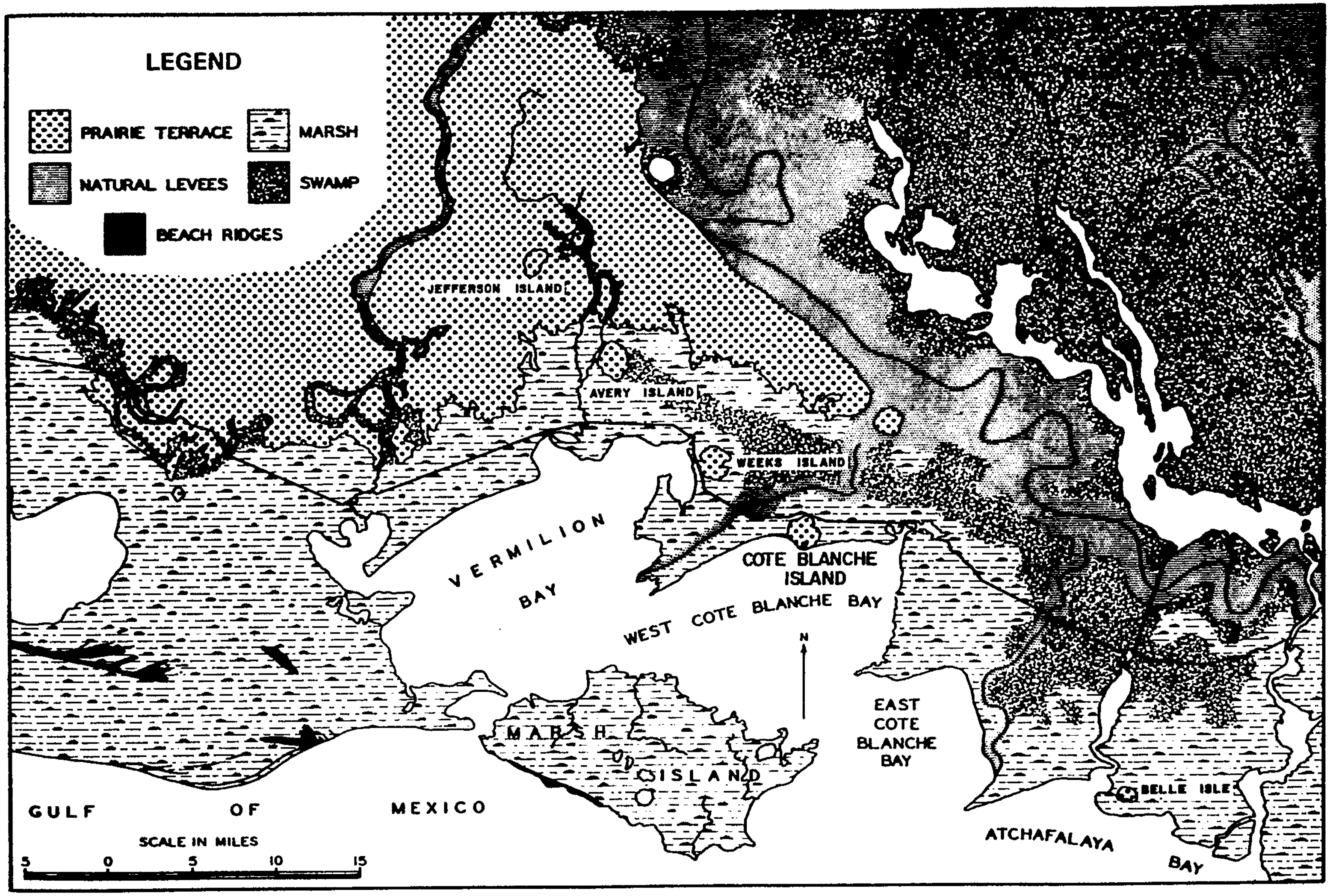



FIGURE 3.2-1 Physiographic map of central coastal Louisiana. (Modified from Van Lopik, 1955.)

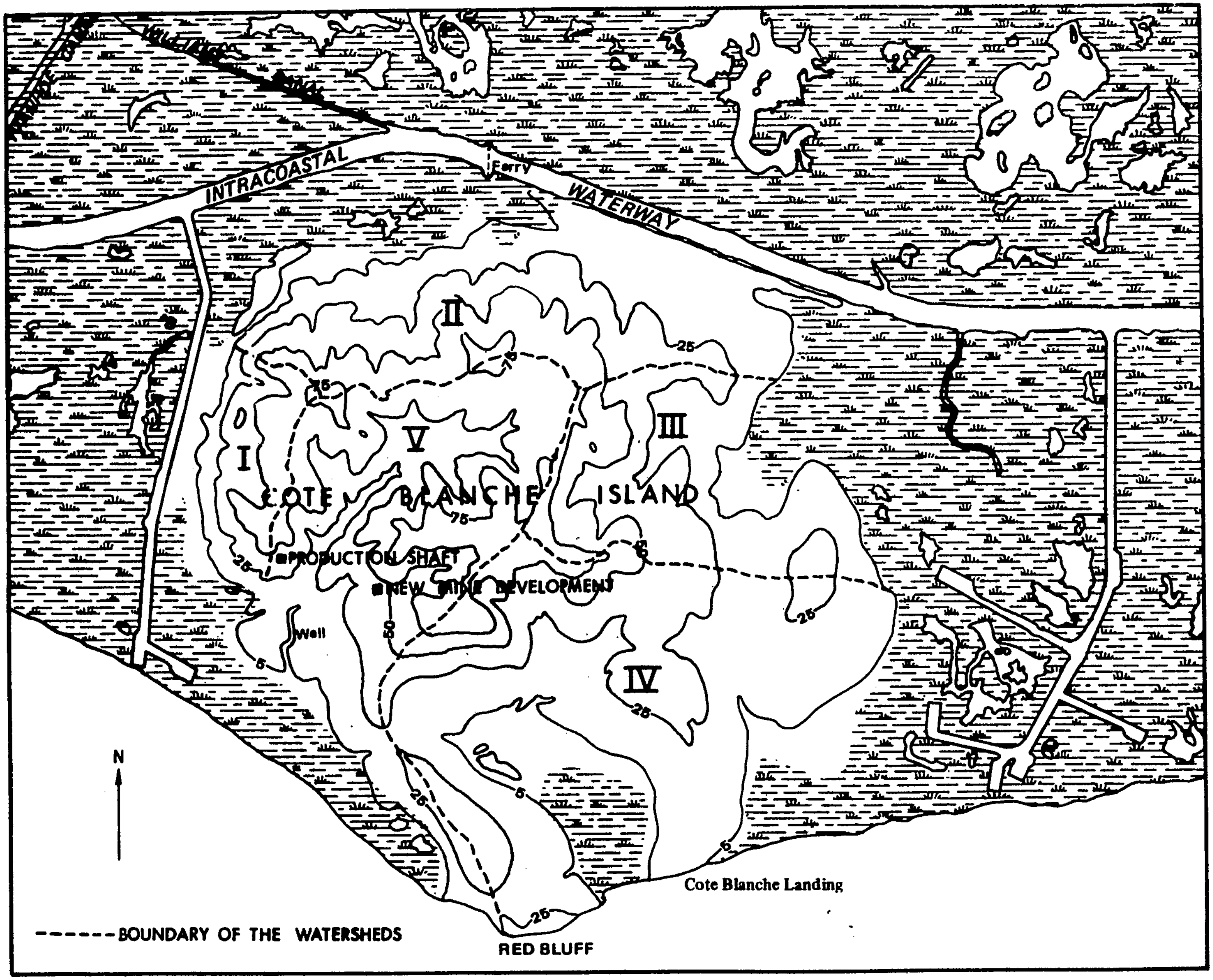



FIGURE 3.2-2. Cote Blanche topography and watershed boundries.

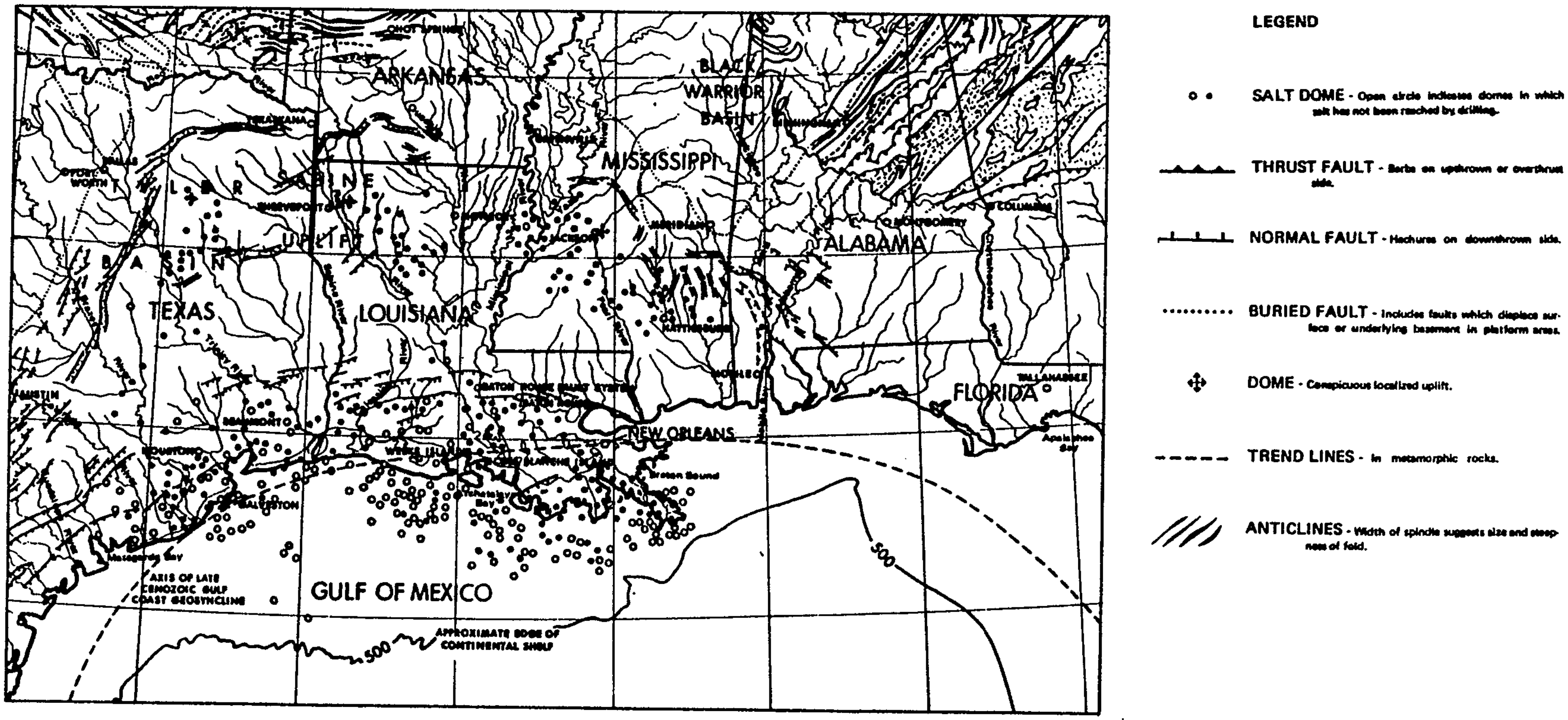



FIGURE 3.2-3 Regional geologic structure. (Modified from King, Philip B., 1969, Tectonic Map of North America: USGS.)

| ERA | PERIOD | EPOCH | MILLIONS YRS. B.P. | NOTES |
|---|---|---|---|---|
| Cenozoic | Quaternary | Holocene<br>Pleistocene | 2 | Wedge of sediments (thickening seaward) deposited in Gulf of Mexico/Mississippi Embayment 30,000 feet + near coast |
| | Tertiary | Pliocene<br>Miocene<br>Oligocene<br>Eocene<br>Paleocene | 65 | |
| Mesozoic | Cretaceous | | 136 | 10,000 feet + near coast |
| | Jurassic | | 190 | Louann salt deposited |
| | Triassic | | 225 | |
| Paleozoic | Permian | | 280 | extensive salt beds in south and central U.S. |
| | Cambrian | | 570 | |
| | PRECAMBRIAN | | 4500 | |

FIGURE 3.2-4 Generalized geologic time chart.

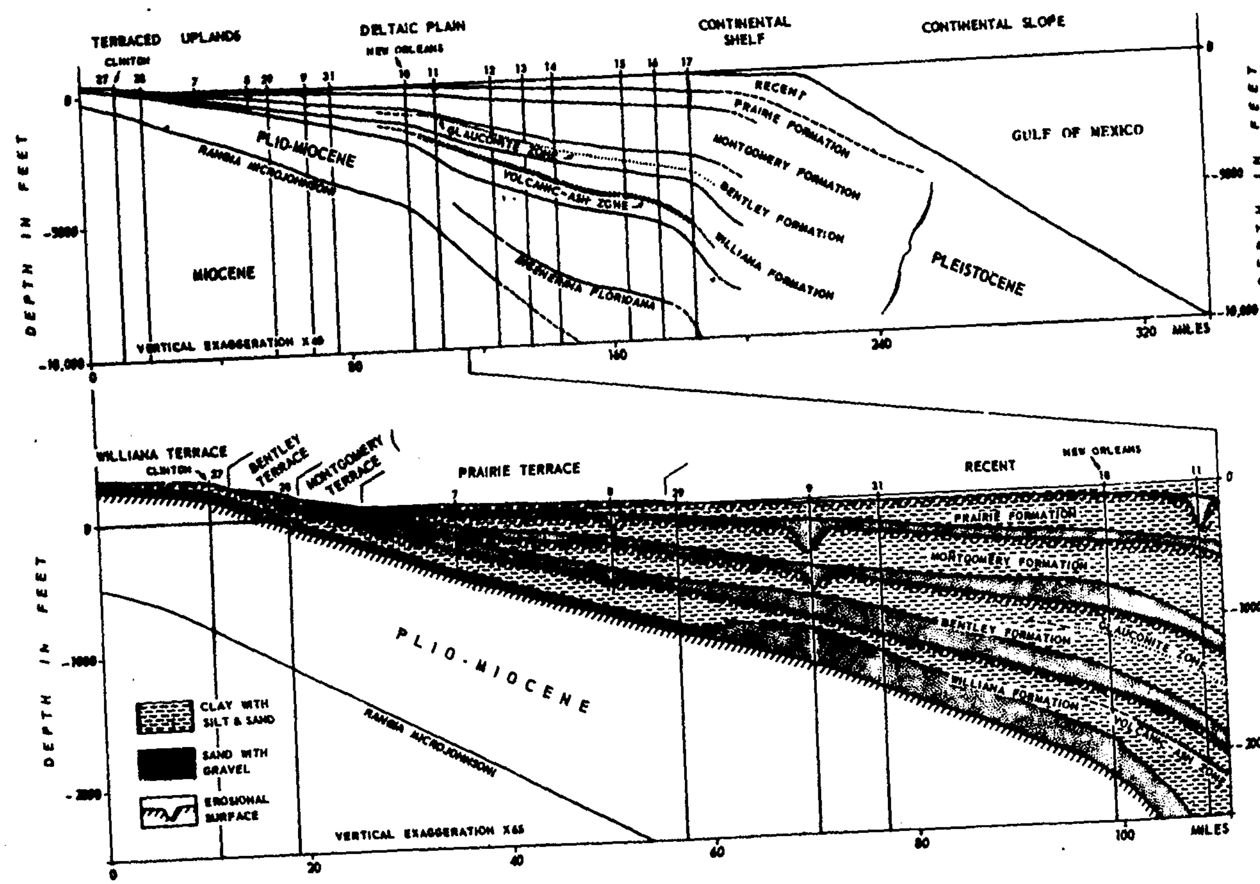



FIGURE 3.2-5. Subsurface Quaternary stratigraphic units and their relation to the surface deposits of the terraced uplands. (McFarlan, 1962 in Murray, 1961.)

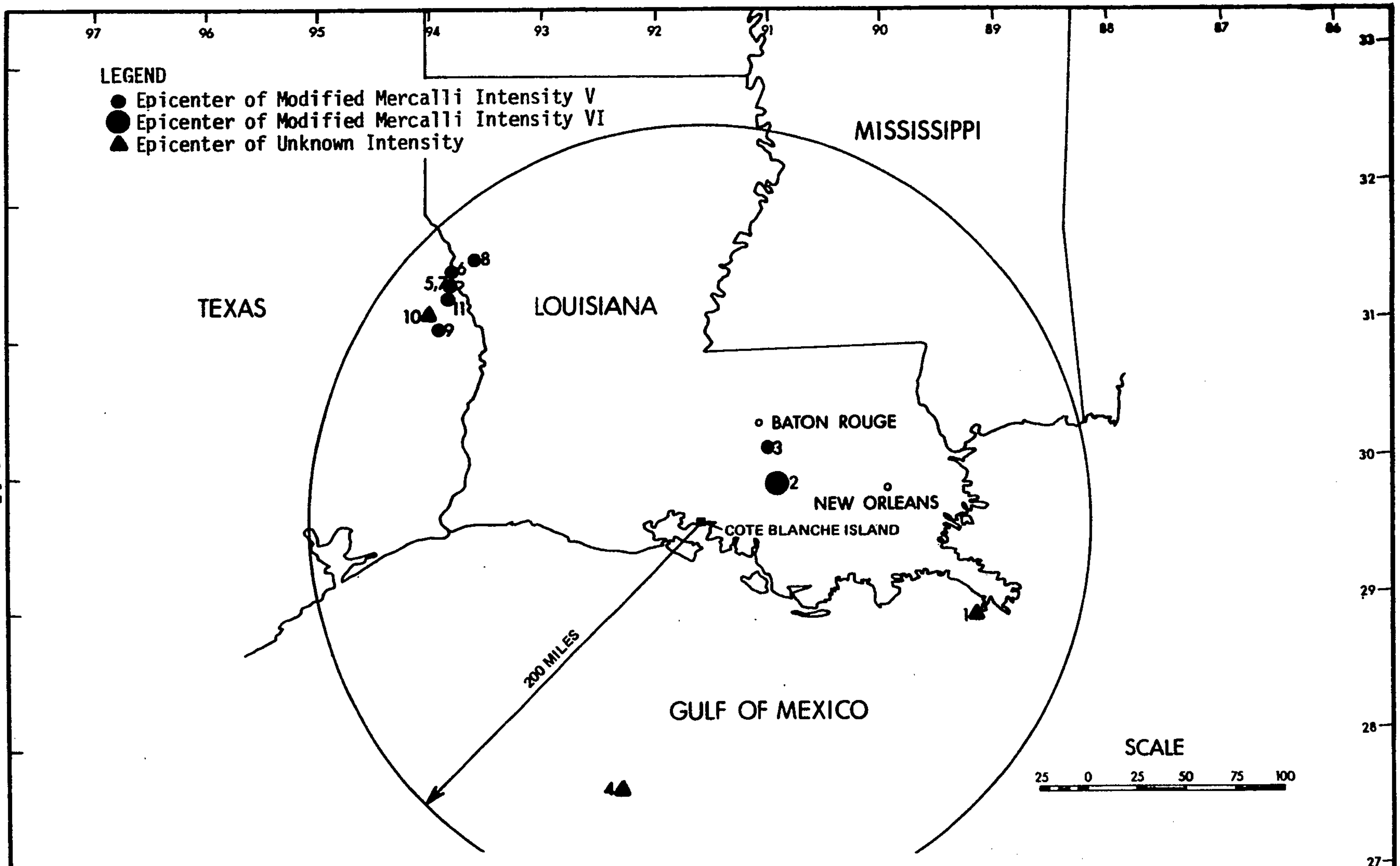



FIGURE 3.2-6. Earthquake epicenters within 200 miles of Cote Blanche Island. (Modified from the Tectonic Map of the U.S., 1944, American Association of Petroleum Geologists.)

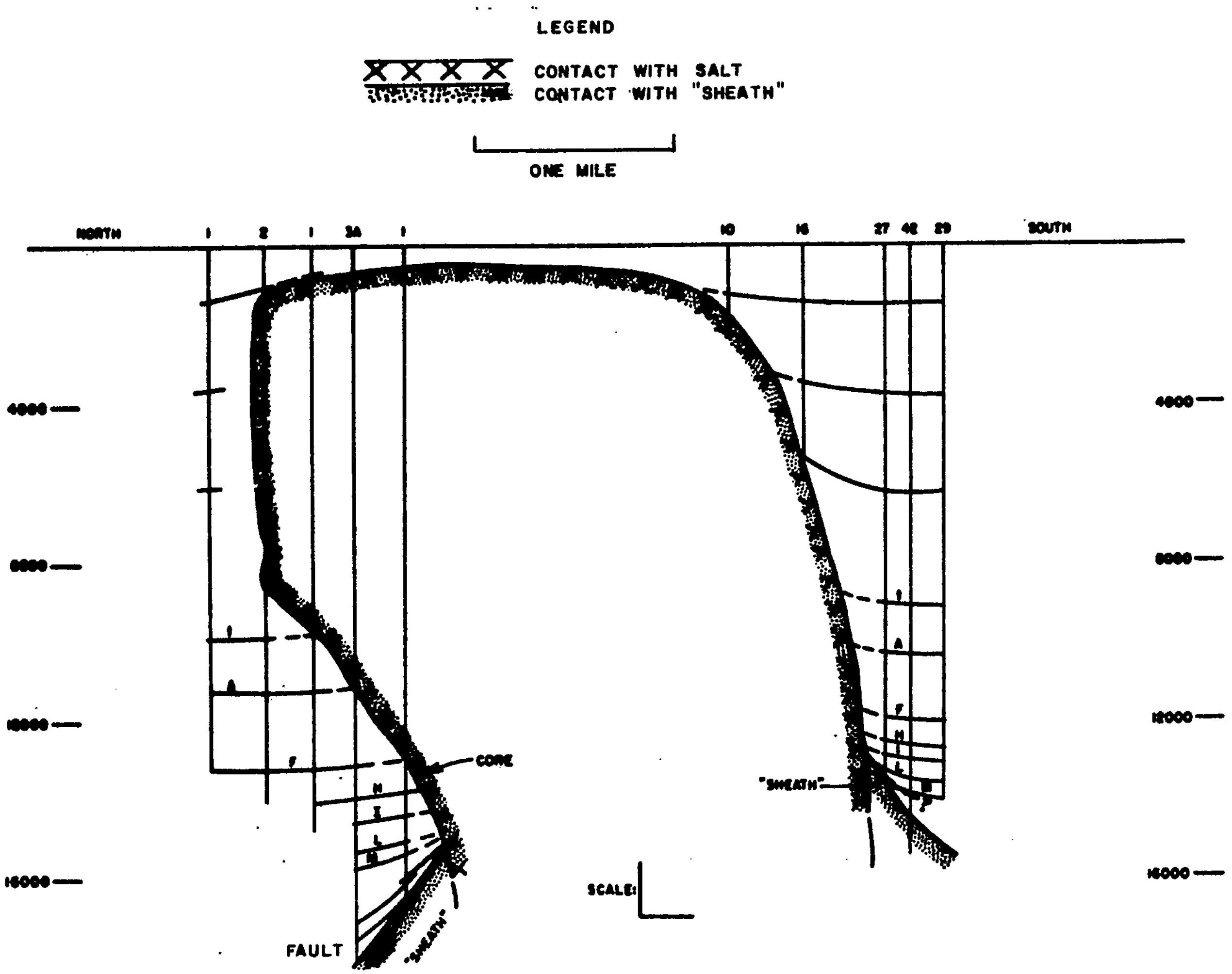



FIGURE 3.2-7. Cross section of Cote Blanche salt dome. (Modified from Johnson and Bredeson, 1971.)

## 3.3 HYDROLOGY AND SEDIMENTOLOGY

### 3.3.1 Regional Surface Water Characteristics

#### 3.3.1.1 Watershed and Waterways

Cote Blanche Island is located in a large watershed that includes parts of Vermilion, Iberia, and St. Mary Parishes from the levees of Bayou Teche on the north, to the Gulf of Mexico on the south, and from the Atchafalaya River on the east to Freshwater Bayou on the west. Major estuaries included in the watershed are Atchafalaya Bay, East Cote Blanche Bay, West Cote Blanche Bay, and Vermilion Bay (Figure 2.2-1). The Vermilion Bay - Atchafalaya Bay Complex is a shallow estuarine system, with an average depth of about 5 to 7 feet. However, a maximum depth of 175 feet is reached at Southwest Pass. The Bay Complex is bounded on four sides by navigable waterways. Several other navigational canals cut through the area in a north to south direction.

The Atchafalaya River is the closest major river to the Cote Blanche Mine. There is a deep water port on the river at Morgan City. The Atchafalaya is a distributary of the Mississippi River (located 50 miles to the east of Cote Blanche) and is maintained by the U.S. Army Corps of Engineers for navigation and flood control purposes. In the latter function, the Atchafalaya is used to divert water from the Mississippi during periods of high flooding. The river has an average discharge of 149,824 cubic feet per second (cfs).

A smaller but also important navigable waterway is the Vermilion River. This river is a major source of freshwater discharge into the western portion of the Bay Complex and discharges a calculated average of 160 cfs into the northwestern part of Vermilion Bay. The river is also utilized by commercial and sport fishermen. Industrial and domestic discharges into the Vermilion River have been cited as possible causes for the 1973 closing of the oyster reefs in Vermilion Bay to commercial fishermen. Large commercial vessels dock at the port facilities located at Intracoastal City, Louisiana. Other important ports on the Vermilion River are Abbeville and Lafayette, Louisiana.

The most important navigational body in the area is the Intracoastal Waterway (ICW), which is used as a protected waterbody by east-west Gulf coast traffic. Traffic levels in the ICW are given in section 3.9.

Other major navigable waterways are:

1. Bayou Sale, a direct link to the ICW and the Charenton Drainage and Navigational Canal.

2. The New Iberia Drainage Canal, a direct short route from New Iberia to the ICW.

3. The Delcambre Canal, which is heavily utilized by commercial fishermen who dock at Delcambre, Louisiana.

3.3.1.2 Precipitation and Surface Water Runoff

Almost all precipitation that occurs in coastal Louisiana is in the form of rain (see section 3.4). Air flow from the Gulf of Mexico provides abundant rainfall (annually about 58 inches recorded at New Iberia). Rainfall extremes occur during all four seasons, but occasionally high amounts of rain are recorded. On June 28, 1947, 16.01 inches fell within a 24-hour period; on August 28-29, 1962, 13.02 inches fell within 12 hours.

Average monthly precipitation figures for Lake Charles, Louisiana, are presented in Table 3.3-1. Precipitation norms, means, and extremes are given in Table 3.3-2.

The expected extremes of precipitation (as point rainfall at New Orleans) for different duration periods were derived from intensity-duration-frequency curves as presented in the U. S. Weather Bureau Technical Paper No. 25. These extremes are given on Table 3.3-3.

Average annual surface water runoff for the north part of the region is presented on Figure 3.3-1. Assuming 20 inches annual runoff as representative, the runoff coefficient is estimated to be about 35 percent.

3.3.1.3 Flooding

Coastal Louisiana is subject to flooding primarily because of high river flows or storm surges brought about by tropical storms or hurricanes. The Atchafalaya River receives flood waters from the Mississippi River through drainage structures and floodways controlled by the Corps of Engineers. During the period of 1887 to 1971, maximum flood discharge (measured at Lettworth, Point Coupee Parish) was 661,000 cfs; the flood stage elevation was 53.4 feet. In 1927, the river flooded almost the entire coastal flood plain, except for areas with high elevations like Cote Blanche Island (Figure 3.3-1).

3.3.1.4 Surface Water Availability and Uses

Total land and water area estimates and water volumes are given in Table 3.3-4. No fresh surface water measurement data have been published for the coastal region. Surface water withdrawals in the area (Table 3.3-5) for all uses amounted to 431 million gallons per day in 1970. Of this total, an estimated 40 percent (172 million gallons per day) was eventually returned to the withdrawal area. However, water withdrawn or pumped for livestock and irrigation purposes is usually not returned as a point source to a water body but is discharged to the ground and allowed to percolate into the soil over a wide area. Eighty percent of the water used for industrial and municipal supplies (64 million gallons per day) and 95 percent (38 billion gallons) pumped for electrical power production is returned as a point source. Evaporation and transit losses of water used for condenser cooling and boiler-fee makeup in electrical power production and industry account for most of the consumptive water use.

3.3.1.5 Tides and Surface Currents in Vermilion and West Cote Blanche Bays

The tide is chiefly diurnal along the central Louisiana coast. The average diurnal range of the tide in Vermilion and West Cote Blanche Bays is about 1.6 feet. Local winds will significantly alter tidal heights, which generally have a maximum range of from 3.6 feet below to 4.0 feet above MSL.

Tidal currents have been measured at three stations in the Vermilion Bay/West Cote Blanche Bay system (U.S. Corps of Engineers, 1959): 1) at the northern end of Southwest Pass; 2) off Cypremort Point (the boundary between Vermilion Bay and West Cote Blanche Bay; and 3) off Marone Point (the boundary between West Cote Blanche Bay and East Cote Blanche Bay; see Figure 2.2-1). Current speeds at the Southwest Pass station ranged from slightly over 4.0 feet/second (2 knots) at the surface to about 2.0 feet/second (1 knot) near the bottom. Current speeds at the Cypremort Point and Marone Point stations were approximately 1.0 foot/second (0.6

knots). The data show a preponderance of ebb tide at the Southwest Pass station indicating a net outflow through that channel, while there appears to be a net flood tide at the other stations. Thus, a counter-clockwise net flow appears to exist in the Vermilion Bay/West Cote Blanche Bay system.

Significant freshwater inflow into the Vermilion/West Cote Blanche Bays system is contributed not only from Atchafalaya and East Cote Blanche Bays, but also through the Vermilion River, Weeks and Petite Anse Bayous, and the Charenton Canal. The total freshwater inflow from those sources will cause a net seaward flux of water from the Vermilion/West Cote Blanche Bay system.

3.3.1.6 Louisiana Water Quality Standards

In April 1973, the Louisiana Stream Control Commission issued revised Water Quality Criteria for the state in order to comply with the provisions of Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972). Pertinent sections of the publication setting forth the criteria along with specific stream criteria are reproduced in Appendix A. General criteria contained within these standards are provided below.

The following general criteria are applicable to the surface waters of the state of Louisiana and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena.

Natural waters may, on occasion, have characteristics outside the limits established by these criteria; in which case these criteria do not apply. The criteria adopted herein relate to the condition of water as affected by waste discharges of man's activities.

These general criteria do not supersede specific exceptions to any one or more of the following if the exception is specifically stated in a specific water quality standard. All waters of the state shall be capable of supporting desirable diversified aquatic life.

Aesthetics

The present and future use of all streams and water bodies are considered in these criteria. The waters of the state shall be maintained in an aesthetically attractive condition and shall meet the generally accepted aesthetic qualifications.

Color

True color shall not be increased to the extent that it will interfere with present usage and projected future use of the streams and water bodies.

Floating, Suspended and Settleable Solids

All waters of the state shall be free from substances that will produce distinctly visible turbidity, solids or scum, nor shall there be any formation of slimes, bottom deposits, or sludge banks attributable to waste discharges from municipal, industrial, or other sources, including agricultural practices.

Taste and Odor

Taste- and odor-producing substances shall be limited to concentrations in the waters of the state that will not interfere with the production of potable water by reasonable water treatment methods, or impart unpalatable flavor to food fish, including shellfish, or result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the waters.

Toxic Substances

No substances may be present in quantities that alone or in combination will be toxic to animal or plant life. In all cases, the level shall not exceed the $TLM_{96/10}$. Bioassay techniques will be used in evaluating toxicity, using methods and species of test organisms suitable to the purpose at hand. In cases where the stream is used as a public water supply, the level of toxic substances shall not exceed the levels established by the latest edition of U.S. Public Health Service drinking water standards.

Oils and Greases

There shall be no free or floating oil or grease present in sufficient quantities to interfere with the designated uses, nor shall emulsified oils be present in sufficient quantities to interfere with the designated uses.

Foaming or Frothing Materials

Foaming or frothing materials of a persistent nature must not be present.

Nutrients

The naturally occurring nitrogen-phosphorus ratio shall be maintained. On completion of detailed studies on the naturally occurring levels of the various macro and micro nutrients, the state will establish numerical limits on nutrients where possible.

Turbidity

There shall be no substantial increase in turbidity from ambient conditions due to waste discharges.

Other Materials

Limits on other substances not specified in these revised water quality standards shall be in accordance with recommendations set by the Louisiana Stream Control Commission and/or the Louisiana Health and Social and Rehabilitation Services Administration for municipal raw water sources.

Specific water quality criteria for several bodies of water in the vicinity of Cote Blanche Island are given in Table 3.3-6.

### 3.3.2 Regional Ground Water Characteristics

Ground water in southern Louisiana is supplied largely from the Chicot and Atchafalaya aquifers. According to Jones and others (1956), the Atchafalaya aquifer is a graveliferous unit that partly fills pre-Recent scour trenches beneath the flood plain of the Mississippi River. It is hydrologically continuous with the Chicot aquifer, which underlies the rest of southern Louisiana. As mapped by Jones and others (1956), the Chicot stratigraphically corresponds to all four formations that comprise the Pleistocene section of the region. As mentioned in section 3.2, the Pleistocene sequence is composed of alternating beds of clays, silts, sands, and gravels that dip and thicken toward the Gulf to more than 7000 feet. Northward they thin to less than 100 feet and merge with the inland Pleistocene Terraces. Individual sand beds usually contain fine sand at the top, grading to coarse sand and gravel at the base. The coefficient of permeability of the aquifer ranges from about 900 to 2000 gallons per day (gpd) per square foot ($ft^2$) and averages about 1500 gpd per $ft^2$. Coefficients of transmissibility of individual beds range from 75,000 to 1,000,000 gpd per ft. In southwestern Louisiana, the Chicot is the sole major source of fresh water; 75 percent of the ground water withdrawn is used to irrigate rice fields.

Inland, the Chicot aquifer is composed mainly of sand and gravel with only a few localized clay layers. However, towards the Gulf, the clay beds increase in number and thickness and serve as aquitards that divide the Chicot into several distinct hydrologic units (Harder and others, 1967). In the coastal area, the most important of these is the so-called "upper sand unit" (Whitman and Kilburn, 1963), shown by the cross section of Figure 3.3-2. (The section is oriented east-west, located about 2 miles south of Cote Blanche.) As shown, the "upper sand unit" does not outcrop in the coastal area; it is recharged by rainfall on the outcrops in Beauregard, Allen, Evangeline, Vernon, Rapides, and Avoyelles Parishes (Zack, 1971).

### 3.3.3 Hydrology of Cote Blanche Island

#### 3.3.3.1 Island Runoff

Cote Blanche Island has a total surface area of 2.34 square miles; there are five main watersheds (Figure 3.2-2):

1. West Watershed (I)
2. North Watershed (II)
3. East Watershed (III)
4. South Watershed (IV)
5. Southwest Watershed (V)

West Watershed (I)

The total catchment area is about 0.16 square miles, and the average slope is 7.2 percent. Most of Watershed I is covered with vegetation. Considering the steep slopes and high intensity rains with short durations, it is estimated that the runoff coefficient is about 85 percent. (Note.- The Soil Conservation Service runoff estimate is 80 percent for the entire island.) On the basis of these assumptions, the annual runoff from this watershed is calculated to be about 420 acre-feet. The general direction of flow is westward.

North Watershed (II)

Watershed II has almost the same hydrologic characteristics as Watershed I. The catchment area is about 0.46 square miles with an average slope of 3.3 percent. The estimated runoff coefficient is about 82 percent, giving a 1220 acre-feet annual runoff. The flow direction is generally northward.

East Watershed (III)

Hydrologically, Watershed III is similar to Watersheds I and II. The catchment area is about 0.33 square miles with an average slope of 2.3 percent. The runoff coefficient for Watershed III is estimated to be 80 percent, yielding an annual runoff of about 810 acre-feet. Runoff flows generally in the eastward direction.

South Watershed (IV)

Compared to the other watersheds, Watershed IV has the least vegetative cover on the island. The largest pond on the island is located in this basin. The catchment area is about 0.84 square miles and has an average slope of 1.9 percent. The direction of runoff is generally toward the south. The estimated runoff coefficient and annual average runoff are 75 percent and 1950 acre-feet, respectively.

Southwest Watershed (V)

Watershed V has more vegetation than Watershed IV. The salt mine is located in the western part of this watershed. The catchment area is about 0.55 square miles. Although the slope of the basin changes significantly, depending on location, the average slope is about 1.3 percent. The average annual runoff is about 1700 acre-feet, and the flow direction is toward the southwest.

3.3.3.2 Local Flooding at Cote Blanche Island

The most important area on Cote Blanche Island that could be affected by floods would be the mine shafts. The shafts are located in the southwest catchment area, which covers about 0.55 square miles. The mine shafts are located at an elevation of 37 feet above mean sea level (MSL). Under the extreme conditions of the 100-year flood, runoff would not exceed 500 cfs. Therefore, a flood of this volume would only flood the small valley to the east of the mine (Figure 3.2-2) with a few feet of water and thus not endanger the mine shafts.

The numerous significant tropical storms and hurricanes that have affected the Vermilion Bay and West Cote Blanche Bay areas since 1837 are listed in Table 3.3-7. During the period between 1837 and 1971, the highest recorded flood level in this area was +9.5 feet above MSL. The water levels presented in Table 3.3-7 represent high water marks estimated from debris location or damaged structures. Thus, these elevations also include the effects of storm surge wave runup and overstate still-water levels.

The 100-year return flood level (stillwater) for the area surrounding Weeks Island and Cote Blanche Island is predicted to be 11.6 feet above MSL (U.S. Army Corps of Engineers, 1970). In contrast, the highest predicted astronomical tide for this area is 4.0 to 4.5 feet above MSL (National Ocean Survey, 1963).

The 100-year flood level, as predicted for these islands by the U.S. Army Corps of Engineers, should not be adjusted unless a detailed analysis is conducted. Experience with combined event analyses (i.e., storm surge plus precipitation-runoff flooding) leads us to believe that the effect of precipitation should be negligible, when considering the maximum stillwater level. There will be a phase lag between the maximum storm surge level and the peak runoff that will prevent the maximum storm surge from being exceeded.

During the 100-year storm event, significant waves in excess of 100 feet high could be generated in the open ocean waters of the Gulf of Mexico. When these waves are propagated to the shallower near- coastal region (continental shelf), they would become unstable, and break far seaward of the coastline and therefore be of small consequence to Cote Blanche Island. The waves that would most severely affect either island are those that could be propagated inland across the low-lying marsh and shallow bay areas and break along the flooded island's perimeter. The largest significant wave height that would break along either island would vary from approximately 5 to 6 feet high. These waves would not run up to elevations greater than 20 feet above MSL on either island.

Since the production shaft collar elevation on Cote Blanche Island is 37 feet above MSL, the mine and associated shafts would be unaffected during the 100-year storm.

3.3.3.3 Surface Water Loss

Surface water loss is the amount of precipitation that does not contribute to surface runoff. Generally this loss can be attributed to percolation of the rain into the subsoils, evaporation by the sun, and transpiration of water by the local vegetation. The generally abundant vegetative cover throughout the area transpires a considerable amount of water from the soils. There are no perennial streams on the island.

Soils around Cote Blanche may be divided into two general categories:

1. The well drained "Memphis" soils that occur on the highest elevations and steep slopes.
2. The poorly drained "frost" soils found in gentle valleys and footslopes.

Evaporation in the vicinity of Cote Blanche Island is high. Mean annual (Class A pan) evaporation is 67 inches. Mean annual lake evaporation is 50 inches.

3.3.3.4 Surface Water Uses

The total surface water available on Cote Blanche Island is about 6100 acre-feet annually. This water is distributed over five catchments and is discharged mostly to the surrounding marshlands and, in part, directly to West Cote Blanche Bay.

Other than domestic cattle and sheep, there are no surface water users on the island.

3.3.3.5 Surface Water Quality

Surface water quality in the Cote Blanche area may be described in two general categories: fresh surface water (rivers) and estuarine bay waters.

## Fresh Surface Water Quality

Although Cote Blanche Island contains several freshwater ponds and lakes, no surface water quality analyses have been conducted on the Island. In the region, only one water quality station is maintained on the Atchafalaya River; two stations are located on the Vermilion River.

Atchafalaya River - A water quality station is located at Krotz Springs, Louisiana (Figure 3.3-1). Although several water quality analyses were conducted as early as 1952, they were not continued. Water quality analysis results are shown in Table 3.3-8 for one complete year (October 1971 to September 1972). By comparing data in this table with specific water quality criteria for this location (Table 3.3-6), it can be concluded that water quality at this station in the Atchafalaya River generally satisfies the appropriate criteria. No criteria for chloride or sulfate or total dissolved solids have been specified for this location.

The recommended dissolved oxygen (DO) criteria for the river are at least 4.0 ppm. However, no DO analyses are taken at this station. The measured pH range is 6.9 to 7.7; recommended criteria are 6.5 to 9.0. The temperature at the river station ranges from 8.0°C to 29.5°C, compared to the maximum criteria of 35°C. The maximum specific conductance at the station, 540 micromhos, was measured on October 15, 1971; the minimum value of 220 micromhos occurred on January 11 and 16, 1972.

Vermilion River - Two water quality stations are established on Vermilion River. The upstream station is located inland at Lafayette, Louisiana; the downstream station is at Abbeville, Louisiana, about 10 miles upstream from river's discharge into Vermilion Bay (Figure 3.3-1). Chemical analyses for these stations for October 1971 to September 1972 (water year 1972) are presented in Tables 3.3-9 and 3.3-10.

During the 1972 water year, the chloride concentration at both stations exceeded the set criteria maximum of 230 milligrams per liter (mg/l). The chloride concentration reached 270 mg/l at the Lafayette station on September 21, 1972 and 600 mg/l for the Abbeville station on July 20, 1972. On the same day, the dissolved sulfate concentration at Abbeville was 76 mg/l, which is well above the limit of 36 mg/l set by the established criteria.

Total dissolved solids were high in December 1971 and in July and September 1972 at the Lafayette station. At the Abbeville station, total dissolved solids reached 1200 mg/l in April 1972 and in July 1972.

Dissolved oxygen is not measured at Vermilion station. At Lafayette, dissolved oxygen ranged from 0.6 (during summer low-flow conditions) to 8.7 mg/l. The criteria recommend concentrations greater than or equal to 5.0 mg/l. Nine samples out of fifteen recorded the dissolved oxygen at this station to be less than 5.0 mg/l. In Table 3.3-9, the daily maximum, minimum, and mean dissolved oxygen concentrations at the Lafayette station are shown for water year 1972.

Water temperatures at both stations were generally within the established criteria (maximum of 32°C), except for the first 3 days of July where temperatures of 32.5°C were recorded at the Lafayette station.

The range of values for specific conductance was generally between 100 to 500 micromhos at both stations. However, short periods with unacceptably high specific conductance occurred during September 20 to 26, 1972. At the Lafayette station, the average value was 970 and maximum was 1080. During July 1972 at the Abbeville station, the average value was 2696 and maximum value was 6200.

Estuarine Bay Waters

The Louisiana Wildlife and Fisheries Commission has recently conducted a 2-year (1972-1974) water quality study in the Vermilion and Atchafalaya Bay Complex; the results are presented in "Technical Bulletin No. 13".

The water quality station locations are indicated in Table 3.3-11 and on Figure 3.3-3.

Water quality criteria for the bay stations are:

1. Dissolved Oxygen (mg/l) (not less than) 4.0
2. pH range 6.5-9.0
3. Temperature °C (not greater than) 35

In the Bay Complex, the temperatures and salinities of the waters are strongly influenced by discharges from the Atchafalaya River and from the Wax Lake Outlet. Stations nearer the mouth of the Atchafalaya River and Wax Lake Outlet were generally cooler throughout the year than stations farther to the west (see Table 3.3-12). Salinities were generally higher in the western Bay (see Table 3.3-13). North-south differences in water temperature and salinity varied only slightly.

Water quality chemistry analyses are provided for each station by month in Juneau (1975). Water chemistry parameters tabulated include nitrates, nitrites, phosphates, total phosphates, sulfates, calcium, alkalinity, turbidity, total solids, dissolved solids, suspended solids, and water depth at which the sample was collected.

Average water temperatures for all stations combined were lowest during December (11.7°C); warmest water temperatures occurred in July and August (29.5°C and 29.3°C, respectively). The average annual water temperature for all stations combined was 21.2°C.

Salinity concentrations were highest at the westernmost stations and lowest at stations in the eastern portion of the estuary. The lowest average salinity was at Point Chevreuil and the Gulf Intracoastal Waterway at Wax Lake Outlet (0.3 ppt). Freshwater Bayou had the highest average annual salinity with 9.7 ppt. Highest salinity average for all stations combined was recorded during July (6.2 ppt). Lowest salinities were measured during April and May (1.2 ppt). These low values coincided with periods of high river discharges. The average annual salinity for all stations combined was 2.0 ppt.

Average dissolved oxygen readings in the estuary were approximately the same for all stations, about 8.1 parts per million (ppm). The lowest average dissolved oxygen concentration was calculated for the Gulf Intracoastal Waterway at Wax Lake Outlet. This station had an average DO of 7.0 ppm. The highest average values were measured at Bird Island Bayou and Oyster Lake (8.7 ppm).

### 3.3.3.6 Ground Water

As shown on Figure 3.3-4, the altitude of the piezometric surface of the Chicot aquifer is approximately at sea level near Cote Blanche, and slopes slightly northwestward towards the inland depression recently caused by heavy withdrawals, particularly at the city of Lake Charles.

Harder and others (1967) show that in coastal areas, the fresh water of the Chicot gradually becomes saline at depths in the range of 300 to 600 feet. Whitman and Kilburn (1963) further show that many of the smaller localized shallow sands that overlie the "upper sand unit" are also saline. However, some are not; these provide valuable freshwater sources in some coastal localities.

The shallow sand aquifers are probably represented by the three water bearing units above the salt at Cote Blanche located between depths of about 0 to -30, -60 to -200 and -230 to -265 feet below sea level, respectively (E. J. Longyear Company, 1959). The uppermost unit is a gravelly sand containing fresh water, and its upper surface corresponds to the local ground water table. The middle unit contains brackish water (approximately 900 ppm of chloride), and is comprised of fine and medium fine sands sealed off from other water bearing horizons by clay layers, thus restricting the hydrostatic head from being continuous from sea level. The lower unit is coarse gravel underlain by medium to fine sand and provides the water supply for the salt works.

3.3.3.7 Sedimentology

Sediments in the region are finer grained than those in any of the other major water bodies in coastal Louisiana. The average size of the sediments in the bay ranges from fine to very fine silt. In the other coastal areas of Louisiana, the size varies from medium to fine silt.

The major source of sediments in the estuary is the Atchafalaya River, although the Vermilion River contributes sediments to western Vermilion Bay.

There is a predominantly westward drift of sediments in the coastal waters in the area due to the net influx of the Atchafalaya River on the east and the net efflux through deep Southwest Pass outlet on the west. As a result of this drift effect, sediments grade westward from coarse to fine. There is also a coarse to fine grading of sediments in a north to south direction. The coarse particles are found near the discharge points of the major rivers; the finer particles are located to the south away from the outlets of the rivers.

The size classification and the composition limits of sediment types are presented in Table 3.3-14.

The waters in the estuary are extremely turbid as a result of the large amount of sediments emptied into the bay by the Atchafalaya River. The shallow water depths also allow wave action to reach the bottom and resuspend the fine sediments.

The sediments in the bays are unconsolidated sediments. The predominant grain size is fine silt with the most abundant sediment types being silty clay and clayey silt. Sediment type distribution of the region is presented on Figure 3.3-5. The most abundant sediment type in each of the major bays is as follows:

Atchafalaya Bay - clayey silt
East Cote Blanche Bay - clayey silt
West Cote Blanche Bay - silty clay
Vermilion Bay - clay

The sedimentary characteristics of these bays are presented in Table 3.3-15.

Mean sediment grain sizes are coarsest in Atchafalaya Bay near the discharge points of the Atchafalaya River. The highest percentage of sand and lowest percentage of clay is also found in this bay. Grain sizes generally decrease westward toward Vermilion Bay. Vermilion Bay has slightly coarser grained sediments compared to West Cote Blanche Bay due to the larger size particles contributed to the bay by the Vermilion River. The Vermilion Bay sediments grade from coarse to fine from west to east. The clay area in Vermilion Bay (Figure 3.3-5) is the largest clay area in coastal Louisiana.

TABLE 3.3-1 Recorded average monthly precipitation at Lake Charles, Louisiana meteorological station. Latitude N30°07'; Longitude W93°12'

(in inches)

| YEAR | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP | OCT | NOV | DEC | ANNUAL |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1934 | 6.62 | 7.04 | 9.21 | 3.62 | 3.19 | 0.45 | 8.31 | 3.29 | 6.44 | 2.47 | 7.84 | 2.67 | 61.35 |
| 1935 | 2.37 | 3.44 | 6.84 | 3.29 | 4.48 | 8.87 | 6.72 | 5.69 | 2.87 | 1.44 | 4.60 | 7.85 | 58.46 |
| 1936 | 3.09 | 3.93 | 1.27 | 1.77 | 4.65 | 0.02 | 6.24 | 6.46 | 4.73 | 1.96 | 3.99 | 4.68 | 42.79 |
| 1937 | 8.06 | 1.43 | 3.76 | 1.16 | 1.57 | 4.11 | 2.73 | 6.38 | 4.03 | 5.60 | 1.66 | 2.22 | 42.71 |
| 1938 | 6.47 | 1.78 | 2.89 | 5.95 | 2.78 | 3.99 | 5.32 | 4.37 | 3.98 | 2.11 | 3.08 | 2.49 | 45.21 |
| 1939 | 3.75 | 2.82 | 1.61 | 1.56 | 1.75 | 2.03 | 6.68 | 2.25 | 3.34 | 1.41 | 1.93 | 2.53 | 31.66 |
| 1940 | 1.71 | 4.57 | 1.89 | 15.30 | 0.85 | 8.22 | 4.97 | 14.56 | 2.44 | 1.54 | 8.54 | 8.24 | 72.83 |
| 1941 | 3.34 | 2.69 | 3.99 | 1.92 | 12.24 | 5.57 | 9.56 | 3.52 | 8.09 | 5.97 | 1.92 | 11.68 | 70.49 |
| 1942 | 1.14 | 3.70 | 5.30 | 5.30 | 4.51 | 10.93 | 8.66 | 6.98 | 4.02 | 3.00 | 0.76 | 6.67 | 60.97 |
| 1943 | 4.79 | 7.72 | 8.74 | 1.73 | 2.71 | 5.19 | 9.99 | 1.95 | 11.83 | 1.03 | 6.38 | 6.95 | 69.01 |
| 1944 | 8.37 | 2.30 | 4.61 | 5.89 | 6.99 | 0.68 | 1.92 | 6.58 | 5.17 | 4.75 | 9.97 | 4.83 | 62.06 |
| 1945 | 2.61 | 3.98 | 4.10 | 3.21 | 4.93 | 5.01 | 12.72 | 5.85 | 3.67 | 5.11 | 2.80 | 7.54 | 61.51 |
| 1946 | 9.44 | 3.64 | 4.99 | 2.62 | 14.28 | 5.12 | 7.20 | 2.68 | 6.63 | 4.98 | 5.97 | 2.26 | 69.81 |
| 1947 | 6.07 | 3.27 | 6.65 | 4.32 | 6.17 | 17.90 | 2.82 | 4.53 | 1.19 | 0.63 | 5.06 | 6.45 | 65.06 |
| 1948 | 6.07 | 4.97 | 2.86 | 3.04 | 2.48 | 1.68 | 1.18 | 4.52 | 3.71 | 0.93 | 5.99 | 2.52 | 39.95 |
| 1949 | 3.62 | 8.03 | 9.67 | 4.98 | 1.94 | 8.38 | 9.21 | 2.09 | 3.64 | 11.15 | 0.88 | 5.77 | 69.36 |
| 1950 | 3.17 | 5.22 | 4.84 | 3.59 | 7.53 | 12.87 | 5.98 | 2.73 | 5.45 | 2.35 | 1.45 | 4.19 | 59.37 |
| 1951 | 7.28 | 2.18 | 7.75 | 1.18 | 0.87 | 1.61 | 1.94 | 1.00 | 4.63 | 0.65 | 2.21 | 6.08 | 37.38 |
| 1952 | 2.32 | 7.96 | 3.56 | 9.75 | 6.48 | 3.28 | 17.83 | 1.36 | 1.77 | T | 4.90 | 8.79 | 68.01 |
| 1953 | 1.95 | 5.03 | 1.03 | 6.33 | 11.13 | 1.18 | 11.73 | 3.25 | 0.65 | 2.66 | 4.82 | 5.74 | 55.50 |
| 1954 | 2.26 | 0.44 | 2.37 | 1.65 | 4.05 | 1.78 | 3.65 | 2.43 | 0.70 | 3.62 | 4.25 | 2.88 | 30.08 |
| 1955 | 5.74 | 7.35 | 0.12 | 6.43 | 3.42 | 4.85 | 6.57 | 8.81 | 1.57 | 2.49 | 4.09 | 3.89 | 55.33 |
| 1956 | 2.94 | 4.56 | 4.68 | 1.27 | 5.25 | 1.94 | 0.48 | 3.77 | 0.07 | 1.69 | 2.29 | 10.43 | 39.37 |
| 1957 | 0.96 | 2.13 | 7.08 | 13.71 | 1.59 | 11.46 | 2.92 | 2.35 | 6.35 | 5.21 | 10.35 | 4.05 | 68.16 |
| 1958 | 3.51 | 3.87 | 4.01 | 4.94 | 4.57 | 3.58 | 9.02 | 9.41 | 10.04 | 1.45 | 1.57 | 3.22 | 59.19 |
| 1959 | 4.89 | 10.67 | 1.97 | 4.16 | 5.85 | 3.49 | 17.94 | 4.72 | 1.21 | 4.62 | 2.98 | 5.55 | 68.05 |
| 1960 | 3.79 | 4.35 | 0.84 | 5.92 | 0.42 | 1.44 | 5.05 | 6.25 | 2.58 | 5.17 | 4.32 | 7.83 | 27.96 |
| 1961 | 4.39 | 7.75 | 2.58 | 3.47 | 4.11 | 5.31 | 8.43 | 4.04 | 3.48 | 1.92 | 14.09 | 4.03 | 63.60 |
| 1962 | 4.01 | 0.80 | 1.39 | 3.11 | 1.73 | 5.33 | 0.48 | 17.36 | 1.01 | 2.70 | 4.40 | 4.01 | 46.33 |
| 1963 | 5.07 | 4.13 | 0.55 | 0.64 | 0.57 | 4.60 | 5.28 | 1.87 | 8.78 | T | 4.70 | 3.36 | 39.55 |
| 1964 | 5.49 | 3.05 | 4.02 | 1.84 | 2.12 | 5.87 | 4.86 | 5.58 | 6.14 | 0.30 | 2.06 | 5.84 | 47.17 |
| 1965 | 2.49 | 3.86 | 3.34 | 0.96 | 4.05 | 1.49 | 1.85 | 6.79 | 3.43 | 0.32 | 1.22 | 5.00 | 34.80 |
| 1966 | 6.48 | 6.17 | 0.75 | 8.59 | 6.30 | 5.10 | 4.90 | 6.63 | 3.54 | 2.96 | 4.45 | 3.78 | 59.65 |
| 1967 | 1.70 | 2.26 | 1.05 | 5.63 | 8.59 | 1.64 | 5.47 | 6.21 | 4.21 | 4.57 | 0.11 | 13.27 | 54.71 |
| 1968 | 3.89 | 2.68 | 2.76 | 2.39 | 3.16 | 8.90 | 7.82 | 3.59 | 3.11 | 2.38 | 5.83 | 4.73 | 51.24 |
| 1969 | 1.13 | 6.75 | 4.27 | 9.53 | 6.65 | 0.84 | 10.06 | 1.97 | 3.23 | 4.42 | 0.70 | 5.57 | 55.12 |
| 1970 | 2.16 | 2.68 | 5.25 | 1.81 | 7.11 | 4.28 | 0.97 | 3.56 | 4.13 | 17.28 | 1.78 | 4.10 | 55.20 |
| 1971 | 0.78 | 3.45 | 0.27 | 0.93 | 5.78 | 2.23 | 4.45 | 6.31 | 5.38 | 2.64 | 1.64 | 9.90 | 43.76 |
| 1972 | 7.73 | 2.24 | 2.23 | 1.58 | 4.53 | 0.93 | 7.75 | 6.64 | 5.82 | 6.44 | 4.30 | 5.47 | 55.66 |
| 1973 | 4.14 | 2.94 | 7.40 | 10.95 | 7.48 | 3.86 | 2.96 | 3.29 | 19.96 | 4.12 | 3.01 | 4.80 | 75.03 |
| RECORD MEAN | 3.95 | 4.29 | 3.68 | 4.58 | 4.92 | 4.82 | 6.38 | 5.01 | 4.59 | 3.44 | 3.99 | 5.71 | 55.36 |

Source: U. S. Department of Commerce, NOAA, Asheville, North Carolina, 1974.

TABLE 3.3-2 Monthly mean and extreme precipitation observed at Lake Charles, Louisiana

| Month | Precipitation in Inches - Water Equivalent: Normal[a] Mean | Monthly[b] Max | Monthly[b] Min | 24 Hour[b] Max | Snow: Monthly[b] Max | 24 Hour[b] Max |
|---|---|---|---|---|---|---|
| Jan. | 4.04 | 12.69 | 0.78 | 3.60 | 4.0 | 0.4 |
| Feb. | 4.47 | 6.75 | 0.80 | 3.28 | 0.3 | 0.3 |
| Mar. | 3.84 | 7.40 | 0.27 | 4.91 | T | T |
| Apr. | 4.33 | 10.95 | 0.64 | 5.50 | 0.0 | 0.0 |
| May | 5.06 | 11.01 | 0.57 | 4.20 | 0.0 | 0.0 |
| June | 5.04 | 8.90 | 0.84 | 4.98 | 0.0 | 0.0 |
| July | 6.55 | 10.06 | 0.84 | 4.98 | 0.0 | 0.0 |
| Aug. | 4.75 | 17.36 | 1.87 | 14.10 | 0.0 | 0.0 |
| Sept. | 4.13 | 19.96 | 1.01 | 7.88 | 0.0 | 0.0 |
| Oct. | 3.48 | 17.28 | T | 7.24 | 0.0 | 0.0 |
| Nov. | 4.08 | 7.30 | 0.11 | 3.51 | 0.0 | 0.0 |
| Dec. | 5.70 | 13.27 | 3.36 | 6.88 | T | 0.0 |
| YEAR | 55.47 | 19.96 | T | 14.10 | 4.0 | 0.4 |

[a] Based on 30 years (1945-1974) of Climatic Data, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

[b] Based on 13 years (1962-1974) of Climatic Data. U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: maximum monthly precipitation 21.45 in May 1907; maximum precipitation in 24 hours 16.01 in June 1947; maximum monthly snowfall 5.0 in February 1960; maximum snowfall in 24 hours 5.0 in February 1960.

TABLE 3.3-3 Calculated precipitation (inches per hour) for different return periods (New Orleans meteorological station)

| Duration | Return Period (Years) | | | | | |
|---|---|---|---|---|---|---|
| | 2 | 5 | 10 | 25 | 50 | 100 |
| 5 minutes | 6.1 | 7.4 | 8 | 9.2 | 10 | 11 |
| 10 minutes | 5.1 | 6.1 | 6.9 | 7.9 | 8.5 | 9 |
| 15 minutes | 4.4 | 5.3 | 6.0 | 6.8 | 7.5 | 8 |
| 20 minutes | 3.9 | 4.7 | 5.3 | 6.0 | 6.6 | 7.2 |
| 30 minutes | 3.2 | 3.9 | 4.5 | 5.0 | 5.5 | 6.0 |
| 40 minutes | 2.7 | 3.4 | 3.8 | 4.4 | 4.8 | 5.3 |
| 50 minutes | 2.4 | 3.0 | 3.4 | 3.9 | 4.4 | 4.8 |
| 60 minutes | 2.1 | 2.6 | 3.1 | 3.5 | 4.0 | 4.3 |
| 2 hours | 1.3 | 1.8 | 2.0 | 2.4 | 2.6 | 3.0 |
| 3 hours | 1.0 | 1.4 | 1.6 | 1.8 | 2.2 | 2.4 |
| 4 hours | 0.8 | 1.2 | 1.4 | 1.6 | 1.8 | 2.0 |
| 5 hours | 0.7 | 0.9 | 1.2 | 1.4 | 1.6 | 1.8 |
| 6 hours | 0.6 | 0.9 | 1.0 | 1.2 | 1.4 | 1.5 |
| 8 hours | 0.5 | 0.7 | 0.8 | 1.0 | 1.1 | 1.3 |
| 10 hours | 0.4 | 0.6 | 0.7 | 0.9 | 1.0 | 1.1 |
| 12 hours | 0.35 | 0.53 | 0.62 | 0.7 | 0.9 | 1.0 |
| 18 hours | 0.26 | 0.4 | 0.5 | 0.6 | 0.67 | 0.75 |
| 24 hours | 0.21 | 0.33 | 0.4 | 0.5 | 0.55 | 0.6 |

TABLE 3.3-4 Regional total land and water quantities

| | |
|---|---|
| Land Area | 260,148 Acres |
| Water Area | 469,290 Acres |
| Water Volume | 2,533,202 Acre/feet |
| Length of Bayous & Passes | 817.7 Miles |
| Length of Canals & Channels | 261.5 Miles |
| Major Water Bodies | |
| Atchafalaya Bay | 134,679 Acres |
| East Cote Blanche Bay | 82,314 Acres |
| Vermilion Bay | 121,604 Acres |
| West Cote Blanche Bay | 89,902 Acres |

Totals at 3-Foot Intervals

| Depth | Acres | Acres/ft. |
|---|---|---|
| 0 - 3 | 80,337 | 120,546 |
| 3 - 6 | 214,229 | 964,119 |
| 6 - 9 | 159,569 | 1,198,019 |
| 9 - 12 | 7,036 | 76,754 |
| Over 12 | 8,119 | 173,764 |

Source: Louisiana Wildlife and Fisheries Commission, 1970. Project 2-22-R of P.L. 88-309.

TABLE 3.3-5 Pumpage of water (million gallons per day) in 1970

| PARISH | PUBLIC SUPPLIES | | INDUSTRIAL | | THERMOELECTRIC | | RURAL | | | IRRIGATION | | | | TOTAL | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | Domestic | Livestock | | Rice | | Other | | | | |
| | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Ground | Surface | Ground | Surface | Ground | Surface | Ground | Surface | Total |
| St. Martin | 1.12 | 0 | 4.09 | 4.63 | 0 | 0 | 1.73 | .08 | .16 | 1.89 | 8.07 | 0 | 0 | 8.91 | 12.86 | 21.77 |
| St. Mary | .09 | 5.31 | 5.21 | 42.27 | 0 | 39.95 | 0.20 | .01 | .02 | 0 | 7.00 | 0 | 0 | 5.51 | 94.55 | 100.06 |
| Vermilion | 2.85 | 0 | 4.73 | 1.18 | 0 | 0 | 1.06 | .20 | .53 | 53.65 | 287.65 | 0 | 0 | 62.49 | 288.89 | 351.38 |
| Iberia | 4.70 | 0 | 8.91 | 26.09 | 0 | 0 | 1.44 | .16 | .04 | 5.84 | 8.74 | 0 | 0 | 21.05 | 34.87 | 55.92 |
| Total by Source | 8.76 | 5.31 | 22.94 | 74.17 | 0 | 39.95 | 4.43 | .45 | .75 | 61.38 | 310.99 | 0 | 0 | 97.96 | 431.17 | 529.13 |
| Total by Category | 14.07 | | 97.11 | | 39.95 | | 4.43 | 1.20 | | 372.37 | | 0 | | 529.13 | | |

Source: Louisiana Geological Survey, 1970, Water Resources Pamphlet No. 26.

TABLE 3.3-6 Specific water quality criteria - State of Louisiana

| SEGMENT | | WATER USES | | | | CRITERIA | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Agency I.D. Number | Description | Primary Contact Recreation | Secondary Contact Recreation | Propagation of Fish and Wildlife | Domestic Raw Water Supply | Cloride (mg/l) not to exceed | Sulfate (mg/l) not to exceed | Dissolved Oxygen (mg/l) not less than | pH range | Coliform | Temperature C | Total Dissolved Solids (mg/l) not to exceed |
| 040120 | Vermilion River - Origin to Intracoastal waterway | x | x | x | | 230 | 36 | 5.0 | 6.0-8.5 | 200 | 32 | 260 |
| 040150 | Lake Peigneur (Tidal) | | x | x | | - | - | 4.0 | 6.0 | - | 35 | - |
| 040140 | Bayou Tigre - Origin to Vermilion Bay (Tidal) | | x | x | | - | - | 4.0 | 6.5-9.0 | 1000 | 35 | - |
| 040210 | Bayou Teche - Keystone Locks and Dam to Charenton Canal | x | x | x | x | 80 | 50 | 5.0 | 6.0-8.5 | 200 | 32 | 350 |
| 040225 | Charenton Canal - Bayou Teche to Intra-coastal waterway | x | x | x | | 250 | 75 | 5.0 | 6.0-8.5 | 200 | 32 | 500 |
| 040220 | Bayou Teche - Charenton Canal to Wax Lake | x | x | x | x | 125 | 68 | 5.0 | 6.0-8.5 | 200 | 32 | 500 |
| 010010 | Atchafalaya River - Headwaters (Barbre Landing) to Mile 118 (1.2 miles below mouth of Bayou Beuf) (includes Grando Lake and Six Mile Lake) | x | x | x | | 65 | 70 | 5.0 | 6.5-8.5 | 200 | 33 | 440 |
| 010030 | Atchafalaya River - Mile 118 to Atchafalaya Bay (Tidal) | x | x | x | | - | - | 4.0 | 6.5-9.0 | 200 | 35 | - |
| 040226 | Charento Canal - Intracoastal Waterway to West Cote Blanche Bay (Tidal) | x | x | x | | - | - | 4.0 | 6.5-9.0 | 200 | 35 | - |
| 040270 | Intracoastal Waterway (East-West) - Vermilion Lock to Wax Lake (Tidal) | | x | x | | - | - | 4.0 | 6.5-9.0 | 1000 | 35 | - |
| 040130 | Vermilion River - Intracoastal water-way to Vermilion Bay (Tidal) | | x | x | | - | - | 4.0 | 6.5-9.0 | 1000 | 35 | - |
| 040260 | Intracoastal Waterway (East-West) - Calcasion Lock to Vermilion Lock | | x | x | | 250 | 75 | 5.0 | 6.0-8.5 | 1000 | 32 | 500 |
| 040270 | Intracoastal Waterway (East-West) - Vermilion Lock to Wax Lake | | x | x | | - | - | 4.0 | 6.5-9.0 | 1000 | 35 | - |
| 010050 | Intracoastal Waterway (East-West) - Bayou Boeuf Locks to Wax Lake Outlet | | x | x | | 150 | 75 | 5.0 | 6.0-8.5 | 1000 | 32 | 500 |
| 010060 | Wax Lake outlet (Tidal) | | x | x | | - | - | 4.0 | 6.5-9.0 | 1000 | 35 | - |

Source: U. S. Army Corps of Engineers, New Orleans, "Inventory of Basic Environmental Data", 1973.

TABLE 3.3-7 Storm flood occurrence. Vermilion Bay - West Cote Blanche Bay

| STORM DATE | FLOOD LEVEL FEET (MSL) |
|---|---|
| Sept. 27 - Oct. 10, 1837 | * |
| Oct. 8 - Oct. 13, 1886 | * |
| Aug. 10 - Aug. 13, 1897 | * |
| Sept. 12 - Sept. 25, 1898 | * |
| Sept. 16 - Sept. 18, 1908 | * |
| June 7 - June 15, 1912 | * |
| Aug. 5 - Aug. 24, 1915 | 6.0 - 9.5 |
| Aug. 1 - Aug. 6, 1918 | * |
| Oct. 13 - Oct. 17, 1923 | * |
| Sept. 18 - Sept. 21, 1932 | * |
| Oct. 7 - Oct. 18, 1932 | * |
| July 21 - July 25, 1934 | * |
| Sept. 29 - Oct. 3, 1937 | * |
| Aug. 9 - Aug. 14, 1938 | * |
| Aug. 2 - Aug. 10, 1940 | * |
| Sept. 19 - Sept. 24, 1940 | * |
| Sept. 11 - Sept. 16, 1941 | * |
| Aug. 17 - Aug. 22, 1942 | * |
| July 25 - July 28, 1943 | * |
| Sept. 15 - Sept. 19, 1943 | * |
| June 13 - June 16, 1946 | * |
| Sept. 27 - Oct. 6, 1949 | * |
| June 25 - June 28, 1957 | 7.7 - 9.0 |
| May 28 - June 2, 1959 | * |
| Sept. 4 - Sept. 14, 1961 | 5.2 - 5.4 |
| Sept. 28 - Oct. 5, 1964 | 2.6 - 3.0 |
| Sept. 3 - Sept. 13, 1971 | * |
| Sept. 5 - Sept. 17, 1971 | * |

* Not Recorded

Source: U.S. Army Corps of Engineers, 1972.

TABLE 3.3-8 Mississippi River Delta
3815 - Atchafalaya River at Krotz Springs, Louisiana

LOCATION - Latitude N30°32'48", Longitude W91°45'04"

DRAINAGE AREA - Indeterminate

PERIOD OF RECORD - Chemical analyses: Water years 1952-1955, 1966 (partial record stations), October 1966 to September 1972 (discontinued).
Water Temperature: August 1952 to September 1955.

EXTREMES - 1971-1972:
Specific conductance: Maximum daily, 540 micromhos October 15; minimum daily, 220 micromhos January 11, 16.

REMARKS - Conductance recorded with probe 6 ft. in depth at low water; daily mean values are reported in the daily conductance table.

CHEMICAL ANALYSES, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

| DATE | DISCHARGE (CFS) | DISSOLVED SILICA ($SiO_2$) (MG/L) | IRON (Fe) (MG/L) | CALCIUM (Ca) (MG/L) | MAGNESIUM (Mg) (MG/L) | DISSOLVED SODIUM (Na) (MG/L) | DISSOLVED POTASSIUM (K) (MG/L) | BICARBONATE ($HCO_3$) (MG/L) | DISSOLVED SULFATE ($SO_4$) (MG/L) | DISSOLVED CHLORIDE (Cl) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| Oct. 12 | -- | 5.0 | 280 | 47 | 14.0 | 46 | 3.2 | 149 | 78 | 39 |
| Nov. 5 | -- | 4.0 | 0 | 42 | 10.0 | 33 | 2.9 | 140 | 54 | 32 |
| Dec. 13 | -- | 6.2 | 10 | 37 | 9.6 | 34 | 2.9 | 132 | 47 | 36 |
| Jan. 12 | -- | 6.4 | 290 | 28 | 5.8 | 16 | 2.8 | 92 | 28 | 19 |
| Feb. 18 | -- | 6.9 | -- | 30 | 8.0 | 19 | 2.4 | 92 | 36 | 24 |
| Mar. 7 | -- | 6.6 | 60 | 30 | 8.5 | 16 | 2.3 | 92 | 41 | 20 |
| Apr. 10 | -- | 6.1 | 80 | 37 | 9.6 | 17 | 3.2 | 108 | 46 | 23 |
| May 12 | -- | 7.2 | 150 | 39 | 7.4 | 12 | 2.9 | 102 | 45 | 14 |
| June 12 | -- | 4.6 | 30 | 51 | 14.0 | 22 | 1.7 | 153 | 71 | 24 |
| July 17 | -- | 6.1 | 10 | 37 | 12.0 | 24 | 3.2 | 103 | 80 | 23 |
| Aug. 17 | -- | 6.9 | 30 | 44 | 11.0 | 24 | 3.3 | 128 | 62 | 24 |
| Sept. 8 | -- | 8.0 | 10 | 51 | 12.0 | 29 | 1.4 | 155 | 60 | 32 |

TABLE 3.3-8 Continued

| DATE | FLUORIDE (F) (MG/L) | NITRATE (N) (MG/L) | DISSOLVED SOLIDS (RESIDUE AT 180° C) (MG/L) | DISSOLVED SOLIDS (SUM OF CONSTITUENTS) (MG/L) | HARDNESS (Ca, Mg) (MG/L) | NON-CARBONATE HARDNESS (MG/L) | SPECIFIC CONDUCTANCE (MICROMHOS) | TEMPERATURE (DEG C) | COLOR (PLATINUM COBALT UNITS) | pH (UNITS) |
|---|---|---|---|---|---|---|---|---|---|---|
| Oct. 12 | 0.3 | 0.40 | 303 | 302 | 180 | 54 | 531 | 23.5 | 10 | 7.7 |
| Nov. 5 | 0.3 | 0.50 | 275 | 249 | 150 | 32 | 441 | 21.0 | 15 | 7.4 |
| Dec. 15 | 0.2 | 0.30 | 244 | 239 | 130 | 24 | 416 | 13.0 | 20 | 7.7 |
| Jan. 12 | 0.2 | 0.70 | 187 | 154 | 94 | 19 | 267 | 10.0 | 20 | 7.5 |
| Feb. 18 | 0.1 | 0.50 | 221 | 174 | 110 | 33 | 310 | 8.0 | 50 | 7.4 |
| Mar. 7 | 0.2 | 0.90 | 194 | 174 | 110 | 35 | 298 | 10.5 | 30 | 7.3 |
| Apr. 10 | 0.1 | 1.1 | 222 | 200 | 130 | 43 | 342 | 14.0 | 20 | 7.3 |
| May 12 | 0.2 | 1.3 | 200 | 183 | 130 | 44 | 329 | 19.0 | 20 | 7.5 |
| June 12 | 0.2 | 0.50 | 276 | 266 | 180 | 57 | 452 | 27.0 | 5 | 7.4 |
| July 17 | 0.2 | 0.40 | 235 | 230 | 140 | 56 | 390 | -- | 10 | 6.9 |
| Aug. 17 | 0.2 | 0.30 | 244 | 240 | 160 | 50 | 421 | 28.5 | 10 | 6.9 |
| Sept. 8 | 0.3 | 0.30 | 294 | 271 | 180 | 49 | 492 | 29.5 | 10 | 7.4 |

TABLE 3.3-8 Continued

Specific conductance (micromhos at 25°C), water year October 1971 to September 1972

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 410 | 430 | 450 | 235 | 240 | 320 | 285 | 310 | 330 | 445 | 380 | 385 |
| 2 | 410 | 435 | 455 | 235 | 240 | 320 | 295 | 305 | 335 | 450 | 385 | 385 |
| 3 | 415 | 445 | 470 | 230 | 240 | 320 | 300 | 300 | 345 | 445 | 390 | 390 |
| 4 | 420 | 445 | 430 | 230 | 245 | 315 | 300 | 300 | 360 | 445 | 400 | 400 |
| 5 | 435 | 440 | 390 | 240 | 245 | 305 | 310 | 305 | 360 | 440 | 400 | 400 |
| 6 | 445 | 440 | 385 | 240 | 245 | 285 | 310 | 305 | 360 | 430 | 405 | 405 |
| 7 | 460 | 445 | 325 | 240 | 250 | 285 | 310 | 305 | 365 | 425 | 405 | 425 |
| 8 | 475 | 440 | 300 | 240 | 250 | 275 | 310 | 285 | 375 | 420 | 400 | 440 |
| 9 | 480 | 445 | 295 | 235 | 250 | 265 | 310 | 285 | 380 | 420 | 400 | 440 |
| 10 | 490 | 435 | 300 | 225 | 250 | 265 | 315 | 285 | 390 | 415 | 390 | 435 |
| 11 | 505 | 430 | 335 | 220 | 250 | 265 | 340 | 285 | 405 | 410 | 380 | 425 |
| 12 | 520 | 425 | 380 | 230 | 250 | 270 | 340 | 290 | 420 | 420 | 375 | 430 |
| 13 | 520 | 425 | 390 | 240 | 250 | 265 | 340 | 295 | 435 | 410 | 360 | 440 |
| 14 | 530 | 440 | 395 | 240 | 250 | 260 | 340 | 295 | 435 | 390 | 360 | 450 |
| 15 | 540 | 445 | 370 | 230 | 260 | 255 | 340 | 285 | 445 | 360 | 370 | 460 |
| 16 | 535 | 445 | 340 | 220 | 270 | 245 | 345 | 285 | 440 | 360 | 375 | 455 |
| 17 | 520 | 440 | 310 | 225 | 280 | 250 | 350 | 285 | 445 | 360 | 390 | 440 |
| 18 | 500 | 445 | 280 | 230 | 290 | 255 | 355 | 285 | 450 | 360 | 395 | 455 |
| 19 | 485 | 440 | 270 | 235 | 290 | 260 | 344 | 285 | 445 | 365 | 390 | 475 |
| 20 | 485 | 445 | 260 | 235 | 285 | | 355 | 280 | 435 | 375 | 405 | 495 |
| 21 | 500 | 445 | 265 | 240 | 285 | 265 | 355 | 285 | 450 | 380 | 405 | 495 |
| 22 | 510 | 430 | 265 | 245 | 285 | 255 | 355 | 295 | 440 | 370 | 400 | 490 |
| 23 | 510 | 430 | 280 | 250 | 290 | 260 | 355 | 295 | 425 | 365 | 410 | 490 |
| 24 | 495 | 425 | 290 | 250 | 305 | 270 | 355 | 295 | 425 | 360 | 405 | 485 |
| 25 | 485 | 425 | 285 | 245 | 325 | 280 | 340 | 295 | 425 | 360 | 410 | 480 |
| 26 | 475 | 435 | 280 | 240 | 345 | 300 | 325 | 295 | 425 | 360 | 395 | 465 |
| 27 | 480 | 450 | 275 | 230 | 240 | 305 | 315 | 305 | 430 | 365 | 390 | 455 |
| 28 | 560 | 455 | 275 | 230 | 325 | 300 | 310 | 310 | 435 | 375 | 400 | 420 |
| 29 | 460 | 455 | 265 | 235 | 325 | 285 | 310 | 315 | 445 | 380 | 405 | 415 |
| 30 | 430 | 470 | 255 | 235 | --- | 275 | 310 | 315 | 455 | 380 | 390 | 430 |
| 31 | 435 | --- | 235 | 245 | --- | 275 | --- | 320 | --- | 380 | 380 | --- |

Source: U.S. Army Corps of Engineers, New Orleans, "Inventory of Basic Environmental Data", 1973.

TABLE 3.3-9 Mississippi River Delta
3869 - Vermilion River at State Highway 3073, near Lafayette, Louisiana

LOCATION - Latitude N30°04'40", Longitude W92°03'20", Lafayette Parish, at bridge on State Highway 3073, 4.1 miles downstream from Coulee Mine, 5.1 miles downstream from Pinhook Bridge, and 4.8 miles southwest of Central School at Lafayette.

DRAINAGE AREA - Indeterminate.

PERIOD OF RECORD - Chemical analyses: October 1969 to September 1972.
Water Temperature: October 1970 to September 1972.

REMARKS - Continuous records are collected at this station. Probes are 2 ft. from river bottom.

Chemical Analyses, Water Year October 1971 to September 1972

| DATE | DISCHARGE (CFS) | DISSOLVED SILICA ($SiO_2$) (MG/L) | IRON (FE) (MG/L) | CALCIUM (CA) (MG/L) | MAGNESIUM (MG) (MG/L) | DISSOLVED SODIUM (NA) (MG/L) | DISSOLVED POTASSIUM (K) (MG/L) | BICARBONATE ($HCO_3$) (MG/L) | DISSOLVED SULFATE ($SO_4$) (MG/L) | DISSOLVED CHLORIDE (Cl) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| Nov. 4 | -- | 13.0 | 30 | 20.0 | 6.6 | 28.0 | 5.2 | 96 | 15.0 | 31 |
| Dec. 1 | -- | 13.0 | 20 | 26.0 | 7.3 | 65.0 | 4.4 | 127 | 14.0 | 82 |
| Jan. 4 | -- | 7.4 | -- | 11.0 | 3.5 | 16.0 | 4.1 | 49 | 12.0 | 20 |
| Jan. 20 | -- | 7.7 | -- | 11.0 | 2.1 | 10.0 | 3.1 | 44 | 7.8 | 12 |
| Feb. 14 | -- | 5.1 | 30 | 8.4 | 1.7 | 7.6 | 3.1 | 32 | 5.6 | 10 |
| Mar. 3 | -- | 6.1 | 60 | 12.0 | 3.4 | 15.0 | 3.1 | 48 | 5.0 | 22 |
| Apr. 13 | -- | 9.5 | 50 | 21.0 | 6.7 | 19.0 | 2.8 | 99 | 9.4 | 24 |
| Apr. 28 | -- | 10.0 | 40 | 29.0 | 8.6 | 22.0 | 3.5 | 127 | 9.4 | 30 |
| May 15 | -- | 6.8 | 60 | 9.0 | 2.1 | 11.0 | 3.3 | 32 | 7.2 | 14 |
| June 2 | -- | 11.0 | 120 | 24.0 | 7.8 | 14.0 | 3.1 | 102 | 12.0 | 19 |
| July 20 | -- | 15.0 | 0 | 26.0 | 9.7 | 62.0 | 4.2 | 119 | 13.0 | 94 |
| Aug. 16 | -- | 15.0 | 20 | 29.0 | 9.9 | 42.0 | 4.1 | 130 | 16.0 | 55 |
| Aug. 31 | -- | 16.0 | 0 | 23.0 | 6.7 | 48.0 | 4.0 | 105 | 14.0 | 66 |
| Sept. 14 | -- | 18.0 | 10 | 25.0 | 7.4 | 53.0 | 4.0 | 112 | 20.0 | 68 |
| Sept. 21 | -- | 20.0 | 40 | 28.0 | 12.0 | 180.0 | 3.6 | 137 | 14.0 | 270 |
| Sept. 28 | -- | -- | -- | -- | -- | -- | -- | -- | -- | -- |

TABLE 3.3-9 Continued

| DATE | FLUORIDE (F) (MG/L) | NITRATE (N) (MG/L) | DISSOLVED SOLIDS (RESIDUE AT 18°C) (MG/L) | SOLIDS (SUM OF CONSTITUENTS) (MG/L) | HARDNESS (CA, MG) (MG/L) | NON-CARBONATE HARDNESS (MG/L) | SPECIFIC CONDUCTANCE (MICROMHOS) | TEMPERATURE (DEG C) | COLOR (PLATINUM-COBALT UNITS) | pH (UNITS) |
|---|---|---|---|---|---|---|---|---|---|---|
| Nov. 4 | 0.2 | 0.90 | 175 | 170 | 77 | 0 | 282 | -- | 50 | 7.0 |
| Dec. 1 | 0.2 | 0.50 | 278 | 277 | 95 | 0 | 490 | 14.0 | 20 | 7.3 |
| Jan. 4 | 0.1 | 0.40 | 128 | 100 | 42 | 2 | 160 | 17.5 | 80 | 6.6 |
| Jan. 20 | 0.2 | 0.40 | 120 | 78 | 36 | 0 | 125 | 14.5 | 80 | 7.0 |
| Feb. 14 | 0.2 | 0.30 | 86 | 59 | 28 | 2 | 97 | 12.5 | 50 | 6.8 |
| Mar. 3 | 0.2 | 0.50 | 106 | 93 | 44 | 5 | 163 | 16.0 | 50 | 6.8 |
| Apr. 13 | 0.2 | 0.60 | 164 | 144 | 80 | 0 | 250 | 24.0 | 30 | 7.1 |
| Apr. 28 | 0.2 | 0.70 | 194 | 179 | 110 | 4 | 330 | 23.0 | 15 | 7.4 |
| May 15 | 0.3 | 0.70 | 64 | 73 | 31 | 5 | 128 | 23.0 | 50 | 7.3 |
| June 2 | 0.2 | 0.20 | 171 | 142 | 92 | 8 | 257 | 26.0 | 20 | 6.8 |
| July 20 | 0.2 | 0.60 | 299 | 286 | 100 | 7 | 545 | 30.0 | 10 | 7.3 |
| Aug. 16 | 0.2 | 0.40 | 245 | 237 | 100 | 6 | 423 | 29.5 | 10 | 7.3 |
| Aug. 31 | 0.2 | 0.70 | 246 | 231 | 85 | 0 | 425 | 29.0 | 15 | 6.8 |
| Sept. 14 | 0.2 | 0.10 | 269 | 251 | 93 | 1 | 452 | 29.5 | 30 | 6.9 |
| Sept. 21 | 0.3 | 0.07 | 614 | 595 | 120 | 6 | 1130 | 29.5 | 30 | 7.4 |
| Sept. 28 | -- | -- | -- | -- | -- | -- | 446 | 26.5 | -- | -- |

TABLE 3.3-9 Continued

| DATE | DISSOLVED OXYGEN (DO) (MG/L) | BIO-CHEMICAL OXYGEN DEMAND (BOD) (MG/L) | CHEMICAL OXYGEN DEMAND (COD) (MG/L) | AMMONIA NITROGEN (N) (MG/L) | PHOSPHATE ($PO_4$) (MG/L) | SUSPENDED SOLIDS (MG/L) | COLIFORM (COLONIES PER 100 ML) | STREPTOCOCCI (COLONIES PER 100 ML) | FECAL COLIFORM (COLONIES PER 100 ML) |
|---|---|---|---|---|---|---|---|---|---|
| Nov. 4 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| Dec. 1 | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| Jan. 4 | 3.5 | -- | -- | -- | -- | -- | -- | -- | -- |
| Jan. 20 | 8.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| Feb. 14 | 8.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| Mar. 3 | 7.5 | -- | -- | -- | -- | -- | -- | -- | -- |
| Apr. 13 | 2.2 | -- | -- | -- | -- | -- | -- | -- | -- |
| Apr. 28 | 4.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| May 15 | 3.3 | -- | -- | -- | -- | -- | -- | -- | -- |
| June 2 | 2.8 | -- | -- | -- | -- | -- | -- | -- | -- |
| July 20 | 8.7 | -- | -- | -- | -- | -- | -- | -- | -- |
| Aug. 16 | 0.6 | -- | -- | -- | -- | -- | -- | -- | -- |
| Aug. 31 | 5.0 | -- | -- | -- | -- | -- | -- | -- | -- |
| Sept. 14 | 5.1 | -- | -- | -- | -- | -- | -- | -- | -- |
| Sept. 21 | 2.4 | -- | -- | -- | -- | -- | -- | -- | -- |
| Sept. 28 | 1.0 | -- | -- | -- | -- | -- | -- | -- | -- |

TABLE 3.3-9 Continued

Specific conductance (micromhos at 25°C), water year October 1971 to September 1972

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 165 | 285 | 432 | 131 | 82 | 254 | 120 | 234 | 296 | 306 | 265 | 485 |
| 2 | 180 | 318 | 197 | 165 | 96 | 192 | 127 | 201 | 284 | 319 | 247 | 525 |
| 3 | 175 | 345 | 153 | 167 | 103 | 202 | 118 | 152 | 281 | 331 | 264 | 544 |
| 4 | 196 | 285 | 99 | 141 | 106 | 165 | 135 | 121 | 298 | 347 | 312 | 564 |
| 5 | 236 | 290 | 81 | 128 | 116 | 152 | 149 | 157 | 286 | 247 | 274 | 539 |
| 6 | 219 | 285 | 47 | 120 | 112 | 182 | 205 | 210 | 279 | 261 | 295 | 538 |
| 7 | 217 | 360 | 49 | 135 | 119 | 174 | 228 | 232 | 294 | 345 | 379 | 545 |
| 8 | 237 | 455 | 52 | 250 | 144 | 159 | 267 | 211 | 327 | 353 | 308 | 544 |
| 9 | 223 | 430 | 48 | 139 | 115 | 159 | 258 | 217 | 324 | 258 | 301 | 513 |
| 10 | 174 | 466 | 67 | 123 | 114 | 126 | 269 | 184 | 348 | 372 | 335 | 484 |
| 11 | 199 | 485 | 76 | 150 | 109 | 145 | 250 | 200 | 445 | 396 | 436 | 461 |
| 12 | 259 | 530 | 69 | 166 | 122 | 140 | 281 | 216 | 440 | 414 | 422 | 457 |
| 13 | 232 | 469 | 71 | 196 | 117 | 140 | 266 | 163 | 475 | 552 | 410 | 449 |
| 14 | 272 | 481 | 68 | 172 | 105 | 207 | 279 | 122 | 434 | 475 | 410 | 474 |
| 15 | 308 | 513 | 77 | 138 | 120 | 200 | 293 | 122 | 394 | 453 | 410 | 504 |
| 16 | 331 | 514 | 73 | 135 | 140 | 135 | 293 | 141 | 381 | 454 | 410 | 525 |
| 17 | 164 | 533 | 84 | 123 | 219 | 107 | 304 | 151 | 166 | 550 | 376 | 521 |
| 18 | 104 | 543 | 110 | 124 | 194 | 100 | 318 | 141 | 162 | 626 | 427 | 506 |
| 19 | 117 | 598 | 106 | 201 | 167 | 102 | 309 | 144 | 171 | 565 | 402 | 548 |
| 20 | 113 | 624 | 99 | 132 | 151 | 107 | 327 | 132 | 206 | 515 | 250 | 628 |
| 21 | 123 | 613 | 105 | 100 | 157 | 126 | 339 | 131 | 169 | 464 | 372 | 1040 |
| 22 | 128 | 522 | 94 | 113 | 159 | 116 | 352 | 144 | 185 | 309 | 939 | 1020 |
| 23 | 131 | 576 | 98 | 118 | 181 | 124 | 371 | 176 | 198 | 247 | 395 | 1040 |
| 24 | 170 | 736 | 95 | 118 | 214 | 126 | 372 | 192 | 272 | 262 | 279 | 1080 |
| 25 | 160 | 807 | 85 | 120 | 240 | 134 | 366 | 214 | 304 | 288 | 369 | 1140 |
| 26 | 168 | 800 | 88 | 121 | 246 | 102 | 345 | 233 | 323 | 413 | 404 | 843 |
| 27 | 178 | 704 | 90 | 123 | 225 | 110 | 384 | 279 | 304 | 513 | 420 | 647 |
| 28 | 218 | 611 | 96 | 125 | 213 | 124 | 299 | 278 | 300 | 454 | 384 | 567 |
| 29 | 250 | 451 | 107 | 145 | 216 | 123 | 171 | 265 | 294 | 383 | 364 | 529 |
| 30 | 247 | 459 | 150 | 103 | --- | 115 | 204 | 270 | 339 | 397 | 388 | 311 |
| 31 | 262 | --- | 235 | 106 | --- | 120 | --- | 271 | --- | 573 | 429 | --- |

TABLE 3.3-9 Continued

Dissolved oxygen (DO), in milligrams per liter, water year October 1971 to September 1972

| | OCTOBER | | | NOVEMBER | | | DECEMBER | | | JANUARY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAY | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN |
| 1 | 1.2 | 1.1 | 1.2 | 1.4 | 1.1 | 1.2 | 7.7 | 2.4 | 5.3 | --- | --- | --- |
| 2 | 1.2 | 1.1 | 1.2 | 1.3 | 1.2 | 1.2 | 10.7 | 7.0 | 8.9 | --- | --- | --- |
| 3 | 1.2 | 1.1 | 1.2 | 1.9 | 1.1 | 1.4 | 10.7 | 8.8 | 9.9 | --- | --- | --- |
| 4 | 1.5 | 1.1 | 1.2 | 1.7 | 1.2 | 1.4 | 11.1 | 10.3 | 10.7 | --- | --- | --- |
| 5 | 3.0 | 1.1 | 2.0 | 1.9 | 0.9 | 1.4 | 11.8 | 10.2 | 10.8 | --- | --- | --- |
| 6 | 2.4 | 1.5 | 2.0 | 1.8 | 1.2 | 1.2 | 11.7 | 10.5 | 11.2 | --- | --- | --- |
| 7 | 2.1 | 1.2 | 1.8 | 1.5 | 1.2 | 1.3 | 10.4 | 8.4 | 9.7 | --- | --- | --- |
| 8 | 2.3 | 1.1 | 1.5 | 1.7 | 1.3 | 1.4 | 8.5 | 8.0 | 8.2 | 6.3 | 5.1 | 5.8 |
| 9 | 2.1 | 1.5 | 1.7 | 1.4 | 1.3 | 1.3 | 8.0 | 7.4 | 7.7 | 6.8 | 6.1 | 6.5 |
| 10 | 2.9 | 1.9 | 2.3 | 1.6 | 1.3 | 1.3 | 7.4 | 6.6 | 7.0 | 7.7 | 6.4 | 6.8 |
| 11 | 2.4 | 1.6 | 2.0 | 1.5 | 1.2 | 1.3 | 6.7 | 6.2 | 6.4 | 7.1 | 6.2 | 6.6 |
| 12 | 1.8 | 1.2 | 1.4 | 1.3 | 1.2 | 1.2 | 6.2 | 5.8 | 6.1 | 7.1 | 6.0 | 6.5 |
| 13 | 1.8 | 1.1 | 1.3 | 1.4 | 1.2 | 1.3 | 5.8 | 4.9 | 5.3 | 5.8 | 4.8 | 5.2 |
| 14 | 1.5 | 1.2 | 1.3 | 1.4 | 1.2 | 1.3 | 4.9 | 4.8 | 4.9 | 5.4 | 4.8 | 5.2 |
| 15 | 1.8 | 1.2 | 1.3 | 1.3 | 1.2 | 1.3 | 4.8 | 4.4 | 4.6 | 6.4 | 5.4 | 6.0 |
| 16 | 3.8 | 1.2 | 1.6 | 1.3 | 1.2 | 1.2 | 4.4 | 4.1 | 4.3 | 7.3 | 6.4 | 7.0 |
| 17 | 5.0 | 3.7 | 4.7 | 1.5 | 1.2 | 1.3 | 4.1 | 3.6 | 3.9 | 7.5 | 7.1 | 7.3 |
| 18 | 4.8 | 3.1 | 3.9 | 2.7 | 1.2 | 1.8 | 3.2 | 2.9 | 3.1 | 7.7 | 7.4 | 7.5 |
| 19 | 3.7 | 3.1 | 3.4 | 2.0 | 1.1 | 1.5 | 3.2 | 3.0 | 3.1 | --- | --- | --- |
| 20 | 3.3 | 2.8 | 3.1 | 1.2 | 1.0 | 1.1 | 4.5 | 3.1 | 3.9 | --- | --- | --- |
| 21 | 2.8 | 2.3 | 2.6 | 1.1 | 1.1 | 1.1 | 4.2 | 3.6 | 3.8 | 9.1 | 6.0 | 7.6 |
| 22 | 2.5 | 2.1 | 2.4 | 1.4 | 1.1 | 1.2 | 3.5 | 3.1 | 3.3 | 6.7 | 5.8 | 6.2 |
| 23 | 2.6 | 2.2 | 2.4 | 1.8 | 1.2 | 1.4 | 3.1 | 2.8 | 3.0 | 5.8 | 5.0 | 5.3 |
| 24 | 2.7 | 2.4 | 2.5 | 1.7 | 1.0 | 1.3 | 2.8 | 2.6 | 2.7 | 5.2 | 4.8 | 4.9 |
| 25 | 2.5 | 1.8 | 2.2 | 1.3 | 0.2 | 1.1 | --- | --- | --- | 5.3 | 4.9 | 5.1 |
| 26 | 1.9 | 1.2 | 1.6 | 1.5 | 1.1 | 1.2 | --- | --- | --- | 5.1 | 4.8 | 5.0 |
| 27 | 2.0 | 1.2 | 1.5 | 1.1 | 1.0 | 1.1 | --- | --- | --- | 5.1 | 4.4 | 4.8 |
| 28 | 1.9 | 1.4 | 1.6 | 2.7 | 1.1 | 1.5 | --- | --- | --- | 4.9 | 4.5 | 4.7 |
| 29 | 1.9 | 1.2 | 1.5 | 3.3 | 1.2 | 2.3 | --- | --- | --- | 6.3 | 4.6 | 4.8 |
| 30 | 1.4 | 1.2 | 1.3 | 6.8 | 3.2 | 5.2 | --- | --- | --- | 10.1 | 6.6 | 8.5 |
| 31 | 1.4 | 1.2 | 1.2 | --- | --- | --- | --- | --- | --- | 10.8 | 9.2 | 10.2 |

TABLE 3.3-9 Continued

Dissolved oxygen (DO), in milligrams per liter, water year October 1971 to September 1972

| | FEBRUARY | | | MARCH | | | APRIL | | | MAY | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAY | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN |
| 1 | 10.7 | 10.3 | 10.5 | 4.7 | 2.1 | 3.8 | 4.9 | 4.0 | 4.6 | 3.0 | 2.2 | 2.7 |
| 2 | 10.3 | 8.9 | 9.6 | 7.7 | 3.2 | 6.3 | 4.6 | 4.2 | 4.4 | 4.8 | 1.8 | 2.9 |
| 3 | 8.8 | 8.5 | 8.7 | 7.5 | 5.3 | 6.8 | 4.9 | 4.4 | 4.6 | 3.7 | 1.4 | 1.9 |
| 4 | 8.4 | 8.0 | 8.1 | 6.9 | 6.3 | 6.7 | 4.5 | 3.3 | 4.2 | --- | --- | --- |
| 5 | 8.4 | 8.1 | 8.3 | 6.3 | 6.1 | 6.3 | 4.9 | 4.4 | 4.7 | --- | --- | --- |
| 6 | 9.4 | 8.3 | 8.7 | 6.3 | 5.5 | 6.1 | 4.6 | 3.2 | 3.9 | --- | --- | --- |
| 7 | 9.2 | 7.7 | 8.4 | 6.5 | 5.8 | 6.2 | 3.8 | 2.7 | 3.2 | --- | --- | --- |
| 8 | 9.6 | 8.3 | 8.9 | 7.4 | 5.7 | 6.6 | 3.9 | 2.9 | 3.5 | --- | --- | --- |
| 9 | 8.3 | 6.8 | 7.7 | 7.7 | 6.8 | 7.3 | 3.9 | 1.8 | 3.1 | --- | --- | --- |
| 10 | 8.4 | 7.5 | 8.1 | 6.8 | 6.0 | 6.5 | 2.5 | 1.7 | 2.1 | --- | --- | --- |
| 11 | 8.0 | 7.9 | 8.0 | 6.6 | 5.6 | 6.2 | 2.5 | 0.6 | 1.6 | --- | --- | --- |
| 12 | 9.7 | 8.0 | 8.9 | 6.1 | 5.3 | 5.8 | 3.0 | 2.1 | 2.6 | --- | --- | --- |
| 13 | 10.5 | 9.8 | 10.2 | 5.6 | 4.5 | 5.3 | 4.1 | 1.6 | 2.7 | --- | --- | --- |
| 14 | 9.8 | 7.4 | 8.5 | 4.7 | 4.1 | 4.5 | 3.5 | 2.3 | 2.9 | --- | --- | --- |
| 15 | 7.7 | 6.6 | 7.1 | 6.4 | 3.9 | 4.9 | 3.9 | 2.0 | 2.9 | --- | --- | --- |
| 16 | 8.6 | 7.4 | 7.9 | 7.8 | 6.0 | 7.0 | 3.9 | 2.2 | 3.0 | 3.9 | 3.3 | 3.8 |
| 17 | 7.9 | 7.0 | 7.5 | 6.5 | 1.0 | 5.5 | 4.0 | 2.5 | 3.4 | 3.9 | 3.3 | 3.6 |
| 18 | 7.1 | 6.4 | 6.8 | 5.4 | 4.7 | 5.1 | 3.2 | 1.8 | 2.5 | 3.8 | 3.6 | 3.7 |
| 19 | 7.2 | 6.9 | 7.0 | 4.7 | 4.3 | 4.5 | 3.5 | 2.1 | 2.6 | 4.0 | 3.5 | 3.7 |
| 20 | 7.0 | 6.5 | 6.8 | 4.7 | 4.3 | 4.5 | 3.1 | 2.1 | 2.6 | 4.0 | 3.6 | 3.8 |
| 21 | 6.6 | 6.2 | 6.4 | 5.9 | 4.6 | 5.4 | 2.7 | 0.8 | 1.6 | 3.9 | 3.5 | 3.7 |
| 22 | 6.4 | 5.9 | 6.2 | 6.0 | 4.2 | 5.0 | 2.6 | 0.7 | 1.6 | 2.5 | 2.4 | 2.4 |
| 23 | 6.2 | 5.7 | 6.0 | 4.7 | 4.2 | 4.4 | 2.7 | 0.9 | 1.8 | 3.4 | 2.5 | 3.1 |
| 24 | 5.7 | 5.2 | 5.5 | 4.4 | 3.9 | 4.2 | 2.3 | 1.1 | 1.8 | 3.3 | 2.9 | 3.1 |
| 25 | 5.4 | 4.7 | 5.1 | 6.1 | 4.4 | 4.5 | 3.4 | 1.9 | 2.6 | 3.2 | 2.9 | 3.1 |
| 26 | 5.1 | 4.3 | 4.7 | 6.3 | 5.1 | 5.8 | 2.2 | 0.8 | 1.3 | 3.5 | 2.8 | 3.1 |
| 27 | 4.9 | 4.1 | 4.6 | 5.0 | 4.5 | 4.8 | 2.5 | 0.6 | 1.8 | 3.3 | 2.9 | 3.1 |
| 28 | 4.3 | 3.6 | 3.9 | 4.5 | 3.5 | 4.0 | 6.0 | 1.9 | 4.3 | 3.7 | 2.2 | 3.1 |
| 29 | 3.7 | 2.0 | 3.2 | 4.1 | 3.3 | 3.7 | 5.1 | 2.3 | 3.5 | 3.3 | 2.5 | 3.0 |
| 30 | --- | --- | --- | 4.6 | 4.1 | 4.3 | 3.2 | 2.2 | 2.9 | 3.3 | 1.7 | 2.8 |
| 31 | --- | --- | --- | 4.6 | 4.2 | 4.5 | --- | --- | --- | 3.4 | 1.6 | 2.9 |

TABLE 3.3-9 Continued

Dissolved oxygen (DO), in milligrams per liter, water year October 1971 to September 1972

| | JUNE | | | JULY | | | AUGUST | | | SEPTEMBER | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DAY | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN | MAX | MIN | MEAN |
| 1 | 3.3 | 2.1 | 2.8 | 4.3 | 0.9 | 2.4 | 2.8 | 1.6 | 2.4 | 9.1 | 3.1 | 5.3 |
| 2 | 3.3 | 2.7 | 3.1 | 5.0 | 1.1 | 2.7 | 2.1 | 1.3 | 1.7 | 9.3 | 4.4 | 5.8 |
| 3 | 3.9 | 3.1 | 3.4 | 7.3 | 2.0 | 3.9 | 1.6 | 0.8 | 1.1 | 8.4 | 3.9 | 5.7 |
| 4 | 3.5 | 3.0 | 3.3 | 3.3 | 1.1 | 2.6 | 1.2 | 0.8 | 1.0 | 8.5 | 3.6 | 5.8 |
| 5 | 3.6 | 2.4 | 3.2 | 5.2 | 0.8 | 2.6 | 1.8 | 0.7 | 1.0 | 10.5 | 3.8 | 7.0 |
| 6 | 3.1 | 1.6 | 2.7 | 8.3 | 1.3 | 4.4 | 3.1 | 0.7 | 1.1 | 8.4 | 3.8 | 6.3 |
| 7 | 2.9 | 1.5 | 2.3 | 6.1 | 2.3 | 4.3 | 3.5 | 0.8 | 1.4 | 7.6 | 4.7 | 6.2 |
| 8 | 2.6 | 1.0 | 1.8 | 5.7 | 2.8 | 4.1 | 2.3 | 0.7 | 1.1 | 7.7 | 4.2 | 5.3 |
| 9 | 2.4 | 0.9 | 1.4 | 5.6 | 1.5 | 3.4 | 1.7 | 0.6 | 1.0 | 8.9 | 3.0 | 4.9 |
| 10 | 2.4 | 0.5 | 1.1 | 5.8 | 1.6 | 2.9 | 2.9 | 0.8 | 1.6 | 11.6 | 1.7 | 5.2 |
| 11 | 4.6 | 0.5 | 2.3 | --- | --- | --- | 3.9 | 1.6 | 2.2 | 15.0 | 5.3 | 8.0 |
| 12 | 6.3 | 1.4 | 3.0 | --- | --- | --- | --- | --- | --- | 15.0 | 6.9 | 9.5 |
| 13 | 4.4 | 3.0 | 3.5 | --- | --- | --- | --- | --- | --- | 11.6 | 5.8 | 8.6 |
| 14 | 4.5 | 1.5 | 2.8 | --- | --- | --- | --- | --- | --- | 9.2 | 4.0 | 6.1 |
| 15 | 2.1 | 0.5 | 1.4 | --- | --- | --- | --- | --- | --- | 5.5 | 3.0 | 3.8 |
| 16 | 3.9 | 1.0 | 2.0 | --- | --- | --- | --- | --- | --- | 3.3 | 2.2 | 2.8 |
| 17 | 3.6 | 1.8 | 2.6 | --- | --- | --- | 3.0 | 1.0 | 1.6 | 3.8 | 2.0 | 2.6 |
| 18 | --- | --- | --- | --- | --- | --- | 3.1 | 1.0 | 1.5 | 6.2 | 2.2 | 3.0 |
| 19 | --- | --- | --- | --- | --- | --- | 3.2 | 0.9 | 1.6 | 10.1 | 2.0 | 4.0 |
| 20 | --- | --- | --- | --- | --- | --- | 2.8 | 0.8 | 1.6 | 9.2 | 2.2 | 4.2 |
| 21 | 2.0 | 1.1 | 1.6 | 4.7 | 1.7 | 2.6 | 2.2 | 0.7 | 1.2 | 14.9 | 2.3 | 6.5 |
| 22 | 2.1 | 0.9 | 1.7 | 7.1 | 0.8 | 2.5 | 2.8 | 0.9 | 1.5 | 15.0 | 2.3 | 6.4 |
| 23 | 2.1 | 0.7 | 1.3 | 7.7 | 1.0 | 2.8 | 3.2 | 0.9 | 1.8 | 9.1 | 3.1 | 6.5 |
| 24 | 3.2 | 0.8 | 1.7 | 8.2 | 0.9 | 3.5 | 4.3 | 1.1 | 2.7 | 10.6 | 4.4 | 7.2 |
| 25 | 4.5 | 0.9 | 2.1 | 9.2 | 0.9 | 4.5 | 6.1 | 1.6 | 3.5 | 8.4 | 1.1 | 4.3 |
| 26 | 5.2 | 1.1 | 2.7 | 7.3 | 1.9 | 4.7 | 9.2 | 3.1 | 4.7 | 2.0 | 0.9 | 1.3 |
| 27 | 6.6 | 1.1 | 3.2 | 11.2 | 3.1 | 6.7 | 6.1 | 1.0 | 3.1 | 2.8 | 0.9 | 1.0 |
| 28 | 7.3 | 1.2 | 3.6 | 12.3 | 3.4 | 7.5 | 5.4 | 1.1 | 2.4 | 1.2 | 0.7 | 0.9 |
| 29 | 5.7 | 1.6 | 3.3 | 10.3 | 4.0 | 6.1 | 6.2 | 1.7 | 2.8 | 1.7 | 0.8 | 1.2 |
| 30 | 4.6 | 1.5 | 3.2 | 4.5 | 2.8 | 3.6 | 6.2 | 1.5 | 3.1 | 2.0 | 0.9 | 1.4 |
| 31 | --- | --- | --- | 2.7 | 0.9 | 1.9 | 11.5 | 2.1 | 4.8 | --- | --- | --- |

TABLE 3.3-9 Continued

Temperature ($^{o}C$) of water, water year October 1971 to September 1972

| DAY | OCT | NOV | DEC | JAN | FEB | MAR | APR | MAY | JUN | JUL | AUG | SEP |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 26.0 | 24.0 | 14.0 | 20.0 | 9.0 | 19.5 | 17.5 | 23.5 | 28.0 | 32.5 | 25.0 | 29.0 |
| 2 | 26.0 | 24.5 | 12.5 | 19.5 | 9.5 | 18.0 | 18.0 | 23.5 | 27.0 | 32.5 | 25.5 | 29.5 |
| 3 | 26.5 | 24.5 | 11.0 | 17.5 | 10.0 | 16.0 | 19.0 | 23.5 | 26.5 | 32.5 | 26.5 | 29.5 |
| 4 | 26.0 | 22.0 | 10.0 | 17.0 | 9.5 | 15.0 | 20.0 | 23.0 | 27.0 | 31.5 | 27.0 | 30.0 |
| 5 | 25.0 | --- | 11.0 | 16.0 | 9.5 | 16.0 | 19.5 | 23.5 | 27.0 | 30.5 | 28.5 | 30.5 |
| 6 | 25.0 | --- | 13.5 | --- | 11.0 | 15.5 | 20.0 | 22.5 | 27.5 | 30.0 | 29.0 | 30.0 |
| 7 | 25.0 | --- | 14.0 | 11.0 | 13.5 | 15.5 | 21.0 | 21.5 | 28.0 | 29.0 | 29.5 | 29.5 |
| 8 | 26.0 | 18.5 | 15.5 | 11.0 | 11.0 | 17.0 | 22.0 | 22.5 | 28.5 | 29.0 | 29.5 | 29.5 |
| 9 | 25.0 | 17.5 | 15.5 | --- | 10.5 | 17.0 | 21.5 | 23.5 | 29.0 | 29.5 | 29.5 | 29.5 |
| 10 | 24.0 | 17.5 | 16.5 | --- | 10.5 | 16.5 | 22.0 | 24.0 | 29.0 | 30.0 | 29.5 | 29.5 |
| 11 | 22.5 | 16.5 | 16.0 | --- | 11.5 | 16.5 | 22.5 | 23.0 | 29.0 | 30.0 | 29.5 | 29.5 |
| 12 | 22.0 | 16.5 | 16.0 | 16.0 | 11.5 | 18.0 | 23.0 | 22.5 | 29.0 | 29.0 | 29.5 | 29.5 |
| 13 | 22.0 | 17.0 | 16.5 | 16.0 | 12.0 | 18.5 | 24.0 | 22.0 | 18.5 | 29.5 | 29.5 | 29.5 |
| 14 | 22.0 | 17.5 | 17.0 | 16.5 | 12.5 | 20.0 | 25.0 | 22.0 | 28.5 | 30.0 | 29.5 | 29.0 |
| 15 | 23.0 | 18.5 | 17.5 | 14.0 | 12.5 | 20.5 | 25.0 | 23.5 | 28.0 | 30.5 | 29.5 | 29.0 |
| 16 | 23.5 | 19.0 | 17.5 | 11.0 | 14.5 | 19.5 | 25.5 | 23.5 | 27.0 | 30.5 | 29.5 | 29.0 |
| 17 | 23.5 | 19.0 | 18.0 | 10.0 | 14.5 | 19.5 | 26.0 | 24.0 | 25.0 | 30.0 | 29.0 | 29.0 |
| 18 | 23.0 | 20.0 | 17.5 | 10.5 | 15.0 | 20.0 | 25.5 | 24.5 | 26.0 | 30.0 | 29.5 | 29.0 |
| 19 | 24.0 | 20.5 | 16.0 | 11.5 | 14.5 | 20.0 | 25.5 | 25.0 | 27.0 | 30.0 | 29.5 | 29.0 |
| 20 | 24.0 | 19.0 | 16.5 | 16.0 | 13.5 | 19.5 | 26.5 | 25.0 | 28.0 | 29.5 | 29.5 | 29.5 |
| 21 | 23.5 | 18.0 | 17.0 | 16.5 | 14.0 | 19.5 | 27.0 | 25.5 | 29.0 | 28.0 | 30.0 | 29.5 |
| 22 | 23.5 | 17.0 | 17.5 | 16.0 | 15.0 | 20.0 | 27.0 | 26.0 | 29.0 | 28.0 | 30.5 | 29.5 |
| 23 | 23.5 | 15.5 | 17.0 | 17.0 | 16.5 | 20.5 | 26.5 | 26.5 | 29.5 | 28.5 | 30.5 | 29.5 |
| 24 | 23.0 | 15.5 | 16.5 | 17.5 | 17.0 | 20.5 | 27.0 | 27.5 | 30.5 | 29.0 | 30.0 | 29.0 |
| 25 | 23.0 | 14.5 | 16.5 | 17.5 | 18.0 | 20.5 | 27.0 | 28.0 | 31.0 | 29.5 | 29.5 | 28.0 |
| 26 | 22.5 | 14.5 | 16.5 | 17.0 | 19.5 | 19.0 | 25.5 | 28.5 | 31.0 | 29.5 | 29.5 | 24.5 |
| 27 | 22.5 | 15.0 | 16.5 | 16.0 | 19.5 | 19.0 | 25.0 | 29.0 | 31.5 | 29.5 | 29.5 | 26.0 |
| 28 | 23.5 | 15.5 | 17.0 | 16.5 | 19.0 | 19.5 | 22.5 | 29.0 | 32.0 | 29.5 | 29.0 | 26.0 |
| 29 | 23.5 | 16.0 | 18.0 | 16.5 | 19.0 | 22.0 | 22.0 | 29.0 | 32.0 | 29.5 | 29.0 | 26.0 |
| 30 | 23.5 | 15.0 | 19.5 | 14.0 | --- | 19.5 | 22.5 | 29.0 | 32.0 | 26.5 | 29.0 | 26.0 |
| 31 | 24.0 | --- | 20.5 | 10.5 | --- | 17.5 | --- | 29.0 | --- | 26.0 | 29.0 | --- |

Source: U.S. Army Corps of Engineers, New Orleans, "Inventory of Basic Environmental Data", 1973.

# TABLE 3.3-10 Mississippi River Delta
## 3869 - Vermilion River at Perry, Louisiana

LOCATION -- Lat 29°57'04", long 92°09'22", Vermilion Parish, at bridge on State Highway 82 at Perry, and 2.0 miles south of Abbeville.

DRAINAGE AREA -- Indeterminate.

PERIOD OF RECORD -- Chemical analyses: November 1965 to September 1972.

EXTREMES -- 1971-72:
Specific conductance: Maximum daily, 6,200 micromhos July 11; minimum daily, 35 micromhos Dec. 7.

Period of record:
Specific conductance (1966-72): Maximum daily 6,200 micromhos July 11, 1972; minimum daily, 35 micromhos Dec. 7, 1971.

REMARKS -- Conductance recorder with probe 2 ft. from stream bottom; daily mean values are reported in the daily conductance table.

CHEMICAL ANALYSES, WATER YEAR OCTOBER 1971 TO SEPTEMBER 1972

| DATE | DISCHARGE (CSF) | DISSOLVED SILICA (S102) (MG/L) | IRON (FE) (UG/L) | CALCIUM (CA) (MG/L) | MAGNESIUM (MG) (MG/L) | DISS. SODIUM (NA) (MG/L) | DISSOLVED POTASSIUM (K) (MG/L) | BICARBONATE (HC03) (MG/L) | DISSOLVED SULFATE (S04) (MG/L) | DISSOLVED CHLORIDE (CL) (MG/L) |
|---|---|---|---|---|---|---|---|---|---|---|
| Nov. 9 | -- | 10 | 160 | 14 | 3.9 | 19 | 5.1 | 66 | 8.6 | 24 |
| Jan. 31 | -- | 5.5 | 90 | 5.6 | 1.5 | 5.3 | 3.3 | 25 | 3.8 | 5.6 |
| Mar. 3 | -- | 5.5 | 40 | 7.8 | 2.1 | 11 | 2.6 | 29 | 5.0 | 16 |
| Mar. 29 | -- | 4.3 | 60 | 8.6 | 2.6 | 10 | 3.7 | 40 | 6.8 | 13 |
| Apr. 28 | -- | 9.1 | 90 | 18 | 8.5 | 78 | 5.2 | 86 | 19 | 120 |
| June 20 | -- | 7.2 | 40 | 13 | 3.8 | 16 | 3.7 | 55 | 6.6 | 21 |
| July 20 | -- | 5.1 | 20 | 67 | 17 | 340 | 15 | 68 | 76 | 600 |
| Aug. 31 | -- | 12 | 60 | 20 | 7.8 | 36 | 4.0 | 102 | 13 | 50 |
| Sept.28 | -- | 17 | 220 | 22 | 7.3 | 48 | 6.2 | 104 | 18 | 60 |

| DATE | FLUORIDE (F) (MG/L) | NITRATE (N) (MG/L) | DISSOLVED SOLID (RESIDUE AT 180 C) (MG/L) | DISSOLVED SOLIDS (SUM OF CON-STITUENTS (MG/L) | HARDNESS (CA. MG) (MG/L) | NON-CAR-BONATE HARDNESS (MG/L) | SPECIFIC CON-DUCTANCE (MICRO-MHOS) | TEM-PERATURE (DEG C) | COLOR (PLATIMUN-COBALT UNITS) | PH (UNITS) |
|---|---|---|---|---|---|---|---|---|---|---|
| Nov. 9 | 0.1 | 0.60 | 130 | 120 | 51 | 0 | 205 | 22.5 | 60 | 7.1 |
| Jan. 31 | .2 | .40 | 82 | 45 | 20 | 0 | 71 | 10.5 | 60 | 6.6 |
| Mar. 3 | .2 | .50 | 80 | 66 | 28 | 4 | 119 | 15.0 | 50 | 6.5 |
| Mar. 29 | .2 | .20 | 90 | 70 | 32 | 0 | 116 | 21.5 | 50 | 6.6 |
| Arp. 28 | .2 | .40 | 317 | 302 | 80 | 9 | 576 | 22.0 | 30 | 7.3 |
| June 20 | .2 | .10 | 103 | 98 | 45 | 0 | 184 | 28.5 | 20 | 7.4 |
| July 20 | .2 | .40 | 1200 | 1160 | 240 | 180 | 2200 | 28.0 | 20 | 6.6 |
| Aug. 31 | .2 | .20 | 206 | 194 | 82 | 0 | 354 | 29.0 | 30 | 6.9 |
| Sept.28 | .2 | .50 | 236 | 234 | 85 | 0 | 416 | 27.0 | 45 | 7.1 |

TABLE 3.3-10 Continued

Specific conductance (micromhos at 25°C), water year October 1971 to September 1972

| DAY | OCT. | NOV. | DEC. | JAN. | FEB. | MAR. | APR. | MAY | JUN. | JUL. | AUG. | SEP. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 185 | 205 | 405 | 260 | 105 | 200 | 135 | 165 | 200 | 800 | 260 | 345 |
| 2 | 190 | 205 | 320 | 180 | 95 | 170 | 135 | 200 | 215 | 2,700 | 420 | 350 |
| 3 | 185 | 220 | 105 | 160 | 100 | 110 | 140 | 160 | 230 | 3,700 | 430 | 345 |
| 4 | | 225 | 140 | 180 | 105 | 180 | 145 | 140 | 235 | 3,300 | 305 | 345 |
| 5 | 190 | 205 | 105 | 165 | 110 | 150 | 150 | 140 | 215 | 3,200 | 295 | 330 |
| 6 | 210 | 210 | 50 | 155 | 125 | 160 | 160 | 140 | 215 | 3,400 | 305 | 330 |
| 7 | 240 | 235 | 35 | 155 | 80 | 155 | 160 | 155 | 210 | 4,200 | 310 | 325 |
| 8 | 210 | 245 | 50 | 160 | 95 | 160 | 165 | 100 | 220 | 4,900 | 320 | 320 |
| 9 | 230 | 235 | 65 | 170 | 145 | 125 | 165 | 130 | 225 | 4,800 | 340 | 325 |
| 10 | 220 | 255 | 75 | 180 | 125 | 150 | 160 | 145 | 220 | 5,500 | 360 | 345 |
| 11 | 220 | 250 | 85 | 155 | 120 | 135 | 160 | 180 | 220 | 6,200 | 370 | 325 |
| 12 | 235 | 250 | 90 | 135 | 115 | 130 | 165 | 120 | 250 | 5,200 | 375 | 330 |
| 13 | 235 | 255 | 95 | 160 | 105 | 145 | 160 | 80 | 380 | 2,750 | 480 | 335 |
| 14 | 225 | 250 | 95 | 175 | 125 | 155 | 170 | 100 | 320 | 1,950 | 450 | 345 |
| 15 | 230 | 255 | 100 | 180 | 100 | 145 | 290 | 120 | 255 | 1,950 | 425 | 350 |
| 16 | 235 | 265 | 105 | 180 | 100 | 125 | 295 | 120 | 260 | 2,650 | 360 | 350 |
| 17 | 245 | 255 | 110 | 185 | 80 | 100 | 215 | 135 | 220 | 3,350 | 330 | 360 |
| 18 | 210 | 250 | 120 | 190 | 160 | 100 | 240 | 150 | 150 | 3,300 | 335 | 375 |
| 19 | 130 | 290 | 140 | 185 | 160 | 90 | 245 | 150 | 170 | 2,400 | 340 | 385 |
| 20 | 155 | 310 | 145 | 175 | 165 | 100 | 270 | 145 | 180 | 2,200 | 335 | 400 |
| 21 | 155 | 320 | 130 | 95 | 150 | 80 | 320 | 150 | 175 | 1,850 | 355 | 445 |
| 22 | 165 | 305 | 130 | 95 | 145 | 90 | 310 | 145 | 185 | 1,650 | 355 | 465 |
| 23 | 180 | 310 | 125 | 120 | 145 | 115 | 295 | 145 | 195 | 1,500 | 355 | 420 |
| 24 | 180 | 390 | 130 | 135 | 150 | 115 | 305 | 150 | 210 | 1,350 | 360 | 400 |
| 25 | 180 | 370 | 335 | 135 | 130 | 155 | 125 | 310 | 155 | 1,300 | 355 | 395 |
| 26 | 190 | 325 | 135 | 130 | 160 | 120 | 380 | 160 | 200 | 1,450 | 370 | 440 |
| 27 | 205 | 375 | 140 | 140 | 165 | 105 | 700 | 160 | 200 | 1,600 | 375 | 450 |
| 28 | 210 | 365 | 145 | 145 | 175 | 105 | 500 | 170 | 210 | 1,800 | 360 | 410 |
| 29 | 195 | 330 | 160 | 145 | 175 | 115 | 120 | 175 | 215 | 1,450 | 355 | 420 |
| 30 | 210 | 370 | 165 | 130 | --- | 130 | 155 | 185 | 230 | 850 | 350 | 600 |
| 31 | 205 | --- | 185 | 80 | --- | 135 | --- | 195 | --- | 320 | 345 | --- |
| AVERAGE | 202 | 278 | 130 | 156 | 129 | 130 | 237 | 147 | 221 | 2,696 | 358 | 379 |

Source: U. S. Army Corps of Engineers, New Orleans, "Inventory of Basic Environmental Data", 1973.

TABLE 3.3-11 Biological and hydrological sampling stations

| Sta. No. | Location Name | N. Lat. | W. Long. | Salinity | Temperature | Oxygen | Trawl. | Seine | Chemical | Plankton |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | East Bay - Big Hog Bayou | 29°30'50" | 91°21'30" | X | X | X | X | | X | X |
| 2 | Point Chevreuil | 29°31'00" | 91°33'10" | X | X | X | X | | X | |
| 3 | Point Marone | 29°38'45" | 91°40'00" | X | X | X | X | | X | |
| 4 | East Cote Blanche Bay | 29°36'40" | 91°40'00" | X | X | X | | | X | X |
| 5 | South Point - Marsh Island | 29°29'00" | 91°45'45" | X | X | X | X | | X | |
| 6 | Pelican Point | 29°48'00" | 91°51'45" | X | X | X | X | | X | |
| 7 | Blue Point | 29°44'48" | 91°52'27" | X | X | X | | X | X | |
| 8 | Bird Island Bayou | 29°37'24" | 91°52'09" | X | X | X | X | | X | |
| 9 | Oyster Lake | 29°31'18" | 91°52'36" | X | X | X | X | | X | |
| 10 | Vermilion Bay (Dry Reef) | 29°40'39" | 91°58'33" | X | X | X | X | | X | |
| 11 | Southwest Pas-Marsh Island | 29°34'48" | 92°02'30" | X | X | X | X | | X | X |
| 12 | Lighthouse Point | 29°34'09" | 92°02'00" | X | X | X | | X | X | |
| 13 | Vermilion River Cutoff | 29°44'48" | 92°06'00" | X | X | X | X | | X | |
| 14 | Fearman Bayou | 29°40'24" | 92°08'45" | X | X | X | X | | X | |
| 15 | Freshwater Bayou | 29°31'57" | 92°18'06" | X | X | X | X | | X | X |
| 16 | Intracoastal Canal Wax Lake Outlet | 29°38'54" | 91°23'45" | X | X | X | | | X | |
| 17 | Intracoastal Canal Boston Canal | 29°49'18" | 92°02'42" | X | X | X | | | X | |

TABLE 3.3-12 Average water temperature by station by month for the two-year sampling period combined, °C

| Sta. | Year | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 72/74 | 21.2 | 22.1 | 27.8 | 28.2 | 29.5 | 28.9 | 24.6 | 17.1 | 9.9 | 8.1 | 11.8 | 12.2 | 20.1 |
| 2 | 72/74 | 16.7 | 21.7 | 26.9 | 28.8 | 28.9 | 28.3 | 24.4 | 17.3 | 9.7 | 9.3 | 11.1 | 13.2 | 19.7 |
| 3 | 72/74 | 19.0 | 23.6 | 28.6 | 29.5 | 29.7 | 28.4 | 24.7 | 17.5 | 10.5 | 10.2 | 12.9 | 12.9 | 20.6 |
| 4 | 72/74 | 22.1 | 23.9 | 28.9 | 28.8 | 29.2 | 28.3 | 24.0 | 19.3 | 12.0 | 11.9 | 10.9 | 17.6 | 21.4 |
| 5 | 72/74 | 18.7 | 23.2 | 27.7 | 28.9 | 29.5 | 28.5 | 25.1 | 17.8 | 11.2 | 12.0 | 14.1 | 12.8 | 20.8 |
| 6 | 72/74 | 19.6 | 23.7 | 28.9 | 30.9 | 29.4 | 28.9 | 26.1 | 18.9 | 12.3 | 13.1 | 16.4 | 13.2 | 21.8 |
| 7 | 72/74 | 19.8 | 25.9 | 29.7 | 31.1 | 28.6 | 29.1 | 23.9 | 20.6 | 15.3 | 11.6 | 12.2 | 14.8 | 21.9 |
| 8 | 72/74 | 20.8 | 23.8 | 29.4 | 29.7 | 29.4 | 29.7 | 26.7 | 19.9 | 9.1 | 14.1 | 16.9 | 11.5 | 21.8 |
| 9 | 72/74 | 22.0 | 24.0 | 29.3 | 29.3 | 29.3 | 28.9 | 27.5 | 21.2 | 12.8 | 13.9 | 16.4 | 11.6 | 22.2 |
| 10 | 72/74 | 21.9 | 22.8 | 28.1 | 28.7 | 28.3 | 28.8 | 26.7 | 17.5 | 9.5 | 12.7 | 15.5 | 12.5 | 21.1 |
| 11 | 72/74 | 22.5 | 24.5 | 28.1 | 28.5 | 28.2 | 28.9 | 24.8 | 17.1 | 11.2 | 13.4 | 15.3 | 14.1 | 21.5 |
| 12 | 72/74 | 19.0 | 25.0 | 28.4 | 28.8 | 29.1 | 28.6 | 23.7 | 21.2 | 14.9 | 14.7 | 14.0 | 14.3 | 21.9 |
| 13 | 72/74 | 20.6 | 22.8 | 29.4 | 30.9 | 29.6 | 29.3 | 25.1 | 18.5 | 11.7 | 12.3 | 13.6 | 13.7 | 21.5 |
| 14 | 72/74 | 21.2 | 24.7 | 29.6 | 30.3 | 29.3 | 28.6 | 25.1 | 15.4 | 11.3 | 13.9 | 16.4 | 14.7 | 21.7 |
| 15 | 72/74 | 21.7 | 25.2 | 28.9 | 29.1 | 29.6 | 29.1 | 24.9 | 17.9 | 11.1 | 12.8 | 15.9 | 15.2 | 21.8 |
| 16 | 72/74 | 23.4 | 23.7 | 29.0 | 28.6 | 29.8 | 27.5 | 19.9 | 17.4 | 11.6 | 7.3 | 9.0 | 15.1 | 20.1 |
| 17 | 72/74 | 21.2 | 25.3 | 29.1 | 30.1 | 30.3 | 27.7 | 22.1 | 17.0 | 16.2 | 13.9 | 11.9 | 16.4 | 21.8 |
| ALL | 72/74 | 20.6 | 23.9 | 28.7 | 29.5 | 29.3 | 28.7 | 24.6 | 18.3 | 11.7 | 12.1 | 13.8 | 13.9 | 21.2 |

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

TABLE 3.3-13 Average salinity by station by month for the two-year sampling period combined, ppt

| Station | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Jan | Feb | Mar | All |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 0.2 | 0.1 | 0.3 | 4.5 | 0.2 | 0.4 | 0.3 | 0.3 | 0.5 | 0.3 | 0.7 | 0.2 | 0.5 |
| 2 | 0.3 | 0.1 | 0.6 | 0.2 | 0.2 | 0.4 | 0.5 | 0.4 | 0.6 | 0.2 | 0.2 | 0.4 | 0.3 |
| 3 | 0.2 | 0.2 | 0.2 | 5.1 | 0.8 | 1.3 | 1.4 | 1.0 | 3.1 | 5.1 | 0.3 | 0.2 | 1.1 |
| 4 | 0.2 | 0.2 | 1.1 | 3.9 | 1.8 | 2.9 | 4.2 | 2.9 | 1.3 | 0.5 | 0.6 | 0.4 | 1.9 |
| 5 | 0.5 | 0.2 | 0.4 | 5.3 | 1.6 | 2.3 | 4.9 | 2.8 | 1.8 | 0.9 | 0.5 | 0.5 | 1.5 |
| 6 | 0.9 | 0.5 | 0.4 | 3.6 | 6.5 | 5.3 | 4.2 | 4.2 | 3.7 | 1.6 | 1.5 | 0.8 | 2.7 |
| 7 | 1.2 | 0.3 | 0.4 | 1.5 | 6.8 | 5.2 | 4.7 | 3.3 | 3.0 | 1.4 | 3.7 | 0.5 | 3.0 |
| 8 | 1.0 | 2.0 | 0.3 | 9.5 | 5.2 | 4.3 | 4.2 | 3.3 | 2.9 | 2.1 | 1.8 | 1.3 | 2.7 |
| 9 | 0.7 | 1.2 | 0.9 | 4.9 | 6.2 | 5.2 | 4.3 | 4.3 | 3.4 | 2.7 | 2.1 | 1.6 | 3.0 |
| 10 | 0.6 | 0.2 | 0.4 | 9.0 | 7.2 | 6.5 | 4.3 | 3.2 | 4.4 | 2.3 | 2.1 | 1.8 | 3.4 |
| 11 | 3.5 | 4.8 | 5.9 | 12.2 | 10.9 | 7.4 | 8.5 | 7.1 | 5.9 | 3.4 | 4.3 | 3.2 | 6.1 |
| 12 | 4.4 | 1.0 | 0.1 | 8.5 | 15.0 | 6.3 | 6.9 | 11.9 | 2.7 | 1.5 | 5.2 | 0.9 | 5.4 |
| 13 | 0.5 | 0.3 | 0.5 | 6.9 | 7.6 | 3.6 | 3.4 | 1.3 | 1.0 | 1.1 | 0.9 | 1.0 | 2.4 |
| 14 | 1.3 | 0.8 | 0.5 | 7.0 | 7.1 | 4.9 | 3.8 | 3.8 | 2.4 | 2.9 | 1.4 | 1.8 | 2.9 |
| 15 | 4.1 | 2.5 | 7.1 | 22.1 | 16.9 | 6.4 | 10.4 | 13.4 | 6.8 | 6.6 | 9.2 | 8.9 | 9.7 |
| 16 | 0.3 | 0.1 | 0.9 | 0.2 | 0.2 | 0.4 | 0.3 | 0.4 | 0.4 | 0.2 | 0.2 | 0.3 | 0.3 |
| 17 | 0.1 | 0.1 | 3.5 | 0.7 | 4.4 | 3.5 | 2.4 | 0.3 | 0.8 | 0.8 | 0.4 | 0.9 | 1.5 |
| ALL | 1.2 | 1.2 | 1.3 | 6.2 | 5.8 | 3.9 | 4.0 | 3.8 | 2.6 | 2.0 | 2.1 | 1.5 | |

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

TABLE 3.3-14 Composition limits and size classification of sediment types

| Wentworth Sediment Class | | Phi | mm |
|---|---|---|---|
| Granules | | -1 | 2.0 |
| Sand | Very Coarse | 0 | 1.0 |
| | Coarse | 1 | 0.5 |
| | Medium | 2 | 0.25 |
| | Fine | 3 | 0.125 |
| | Very Fine | 4 | 0.0625 |
| Silt | Coarse | 5 | 0.0313 |
| | Medium | 6 | 0.0156 |
| | Fine | 7 | 0.0078 |
| | Very Fine | 8 | 0.0039 |
| Clay | | 9 | 0.00195 |
| | | 10 | 0.00098 |
| | | 11 | 0.00049 |
| | | 12 | 0.00024 |
| | Colloids | >12 | <0.00024 |

Classification of sediment types

| Sediment Type | Composition limits (percent by weight) Sand | Silt | Clay |
|---|---|---|---|
| Sand | 75.0-100.0 | 0.0- 25.0 | 0.0- 25.0 |
| Silty sand | 33.5- 75.0 | 12.5- 50.0 | 0.0- 33.5 |
| Clayey sand | 33.5- 75.0 | 0.0- 33.5 | 12.5- 50.0 |
| Silt | 0.0- 25.0 | 75.0-100.0 | 0.0- 25.0 |
| Sandy silt | 12.5- 50.0 | 33.5- 75.0 | 0.0- 33.5 |
| Clayey silt | 0.0- 33.5 | 33.5- 75.0 | 12.5- 50.0 |
| Clay | 0.0- 25.0 | 0.0- 25.0 | 75.0-100.0 |
| Sandy clay | 12.5- 50.0 | 0.0- 33.5 | 33.5- 75.0 |
| Silty clay | 0.0- 33.5 | 12.5- 50.0 | 33.5- 75.0 |

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

TABLE 3.3-15 Summary of sedimentary characteristics of bays in the region

| Water Body | Mean Grain Size phi | Standard Deviation phi | Skewness | Kurtosis | Percent Sand | Percent Silt | Percent Clay |
|---|---|---|---|---|---|---|---|
| Atchafalaya Bay | 7.1 | 2.56 | 0.24 | 0.78 | 7.4 | 56.4 | 36.2 |
| East Cote Blanche Bay | 7.7 | 2.71 | -0.07 | 0.77 | 6.6 | 43.0 | 50.4 |
| West Cote Blanche Bay | 8.4 | 2.67 | -0.28 | 0.77 | 6.1 | 38.3 | 55.6 |
| Vermilion Bay | 7.9 | 2.38 | -0.15 | 0.95 | 4.9 | 42.3 | 52.8 |

Source: Louisiana Wildlife and Fisheries Commission, Technical Bulletin No. 13, April, 1975.

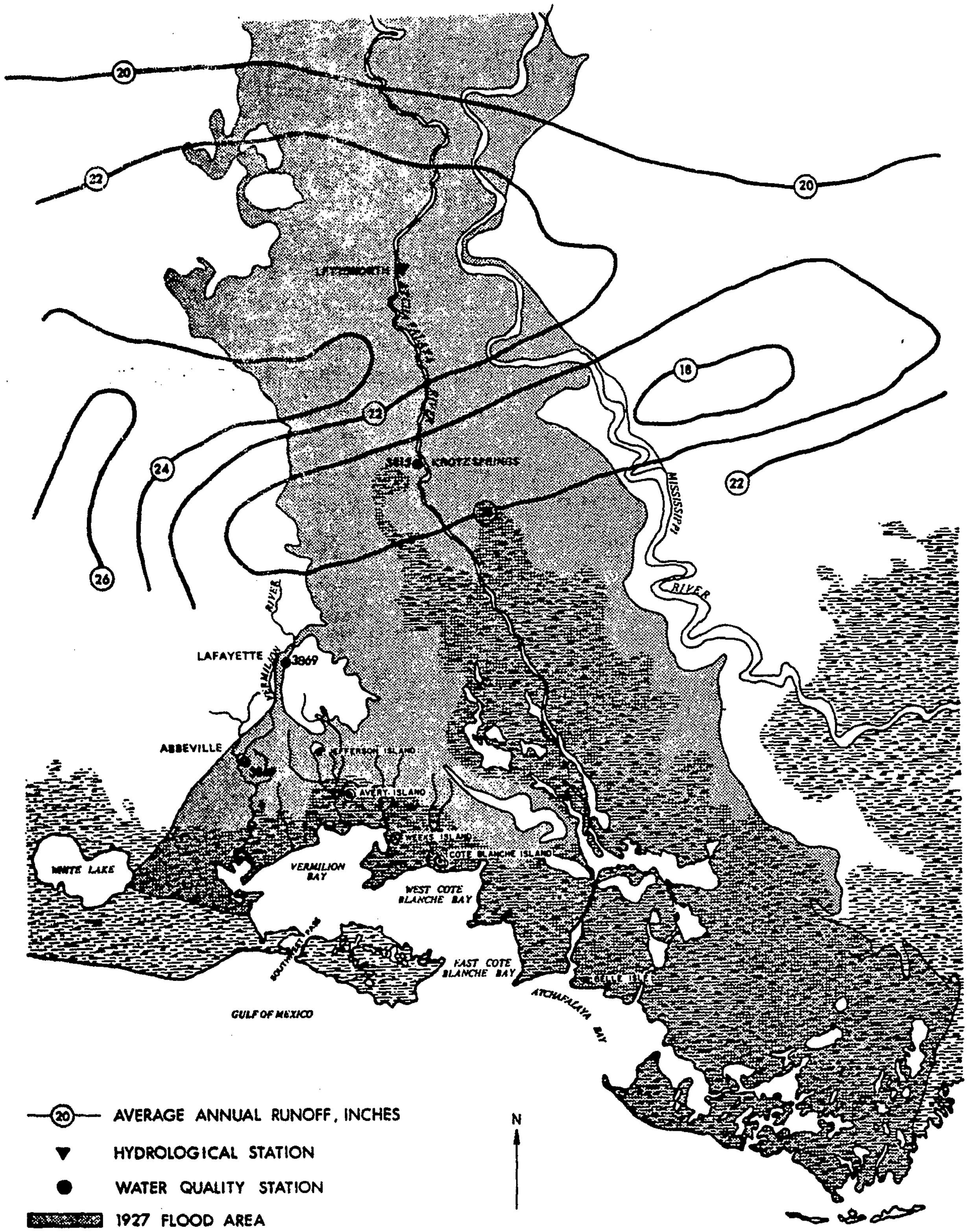
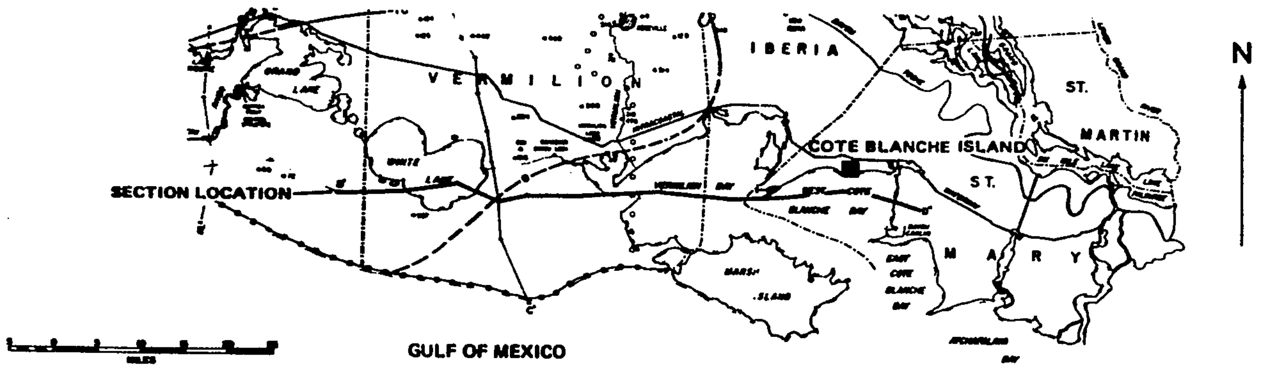
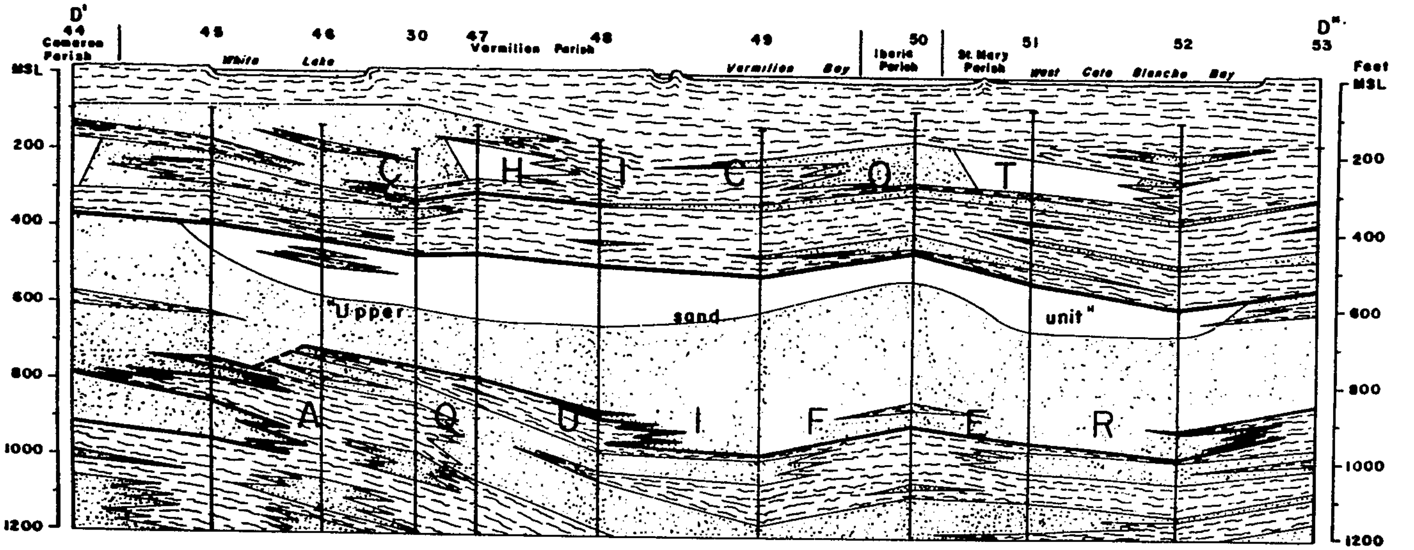



FIGURE 3.3-1. General hydrological map.



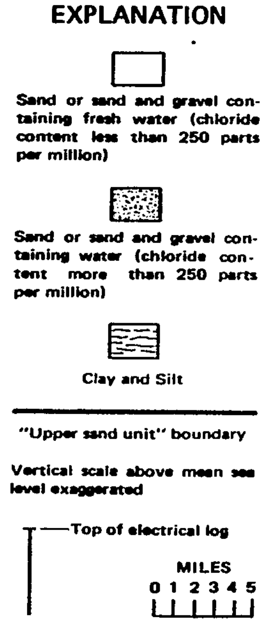




FIGURE 3.3-2. East-west geologic section, Cameron Parish to St. Mary Parish, Louisiana. (Modified from Kilburn and Whitman, 1962.)

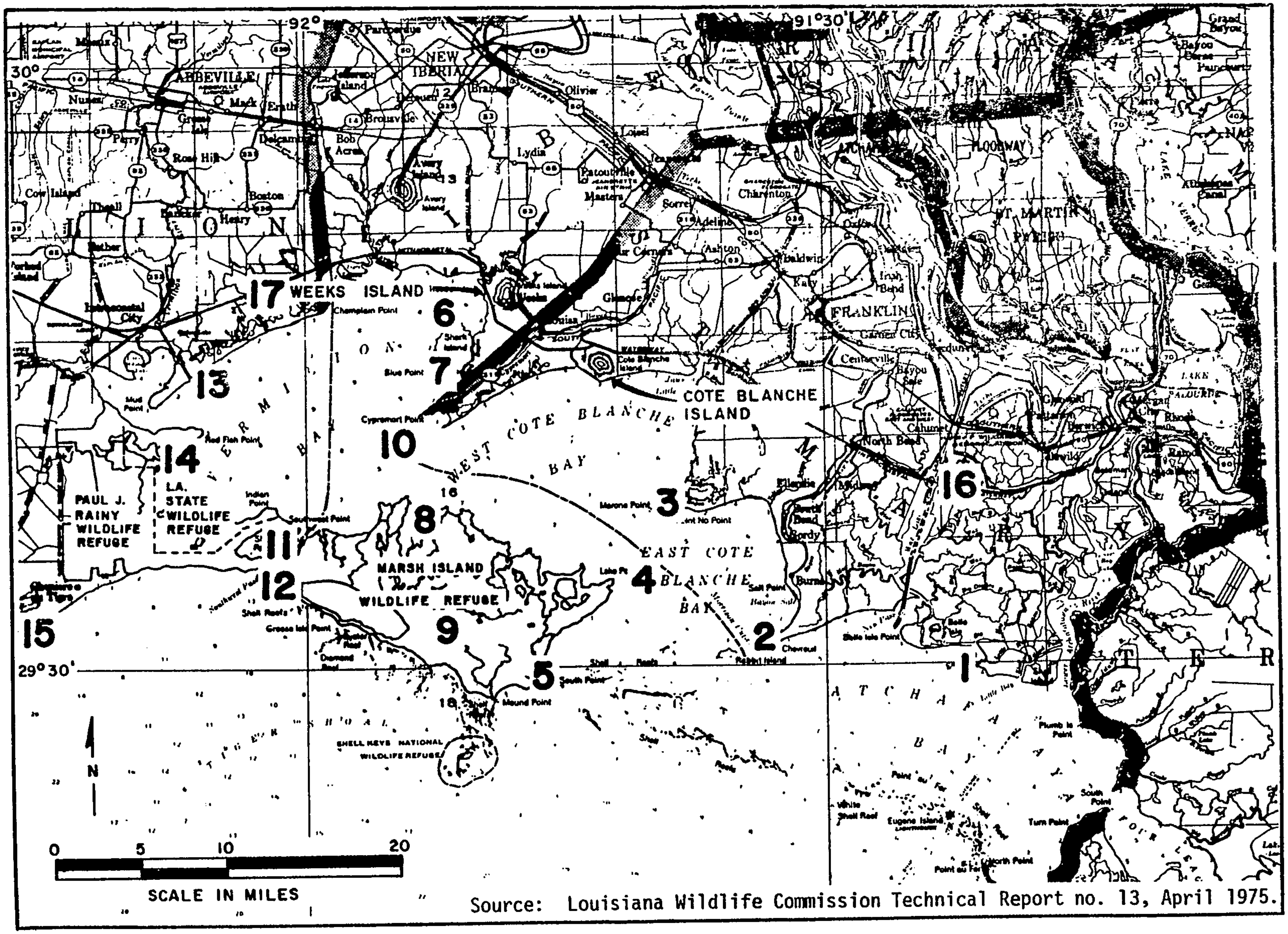



FIGURE 3.3-3 Water quality stations in the bays.

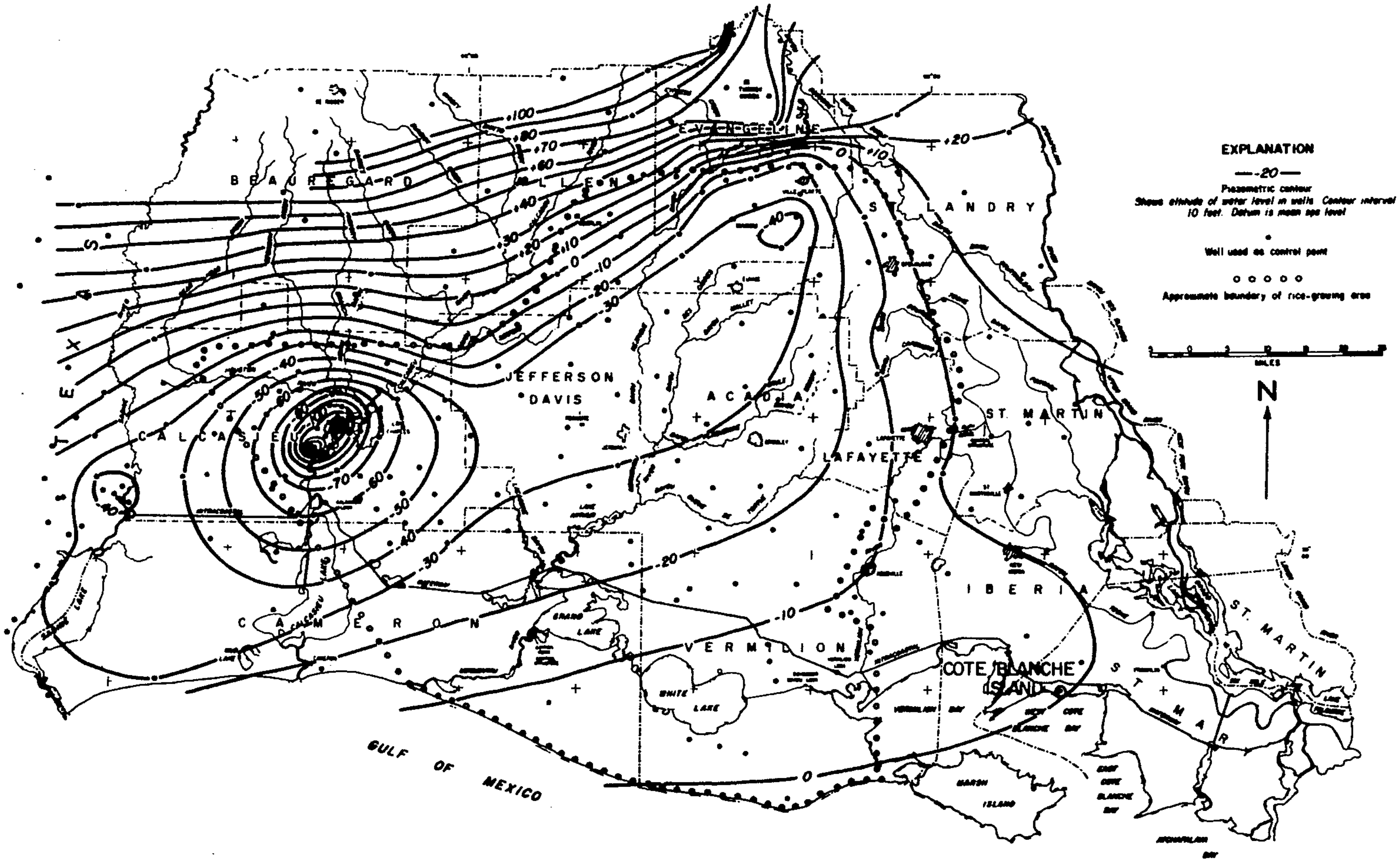
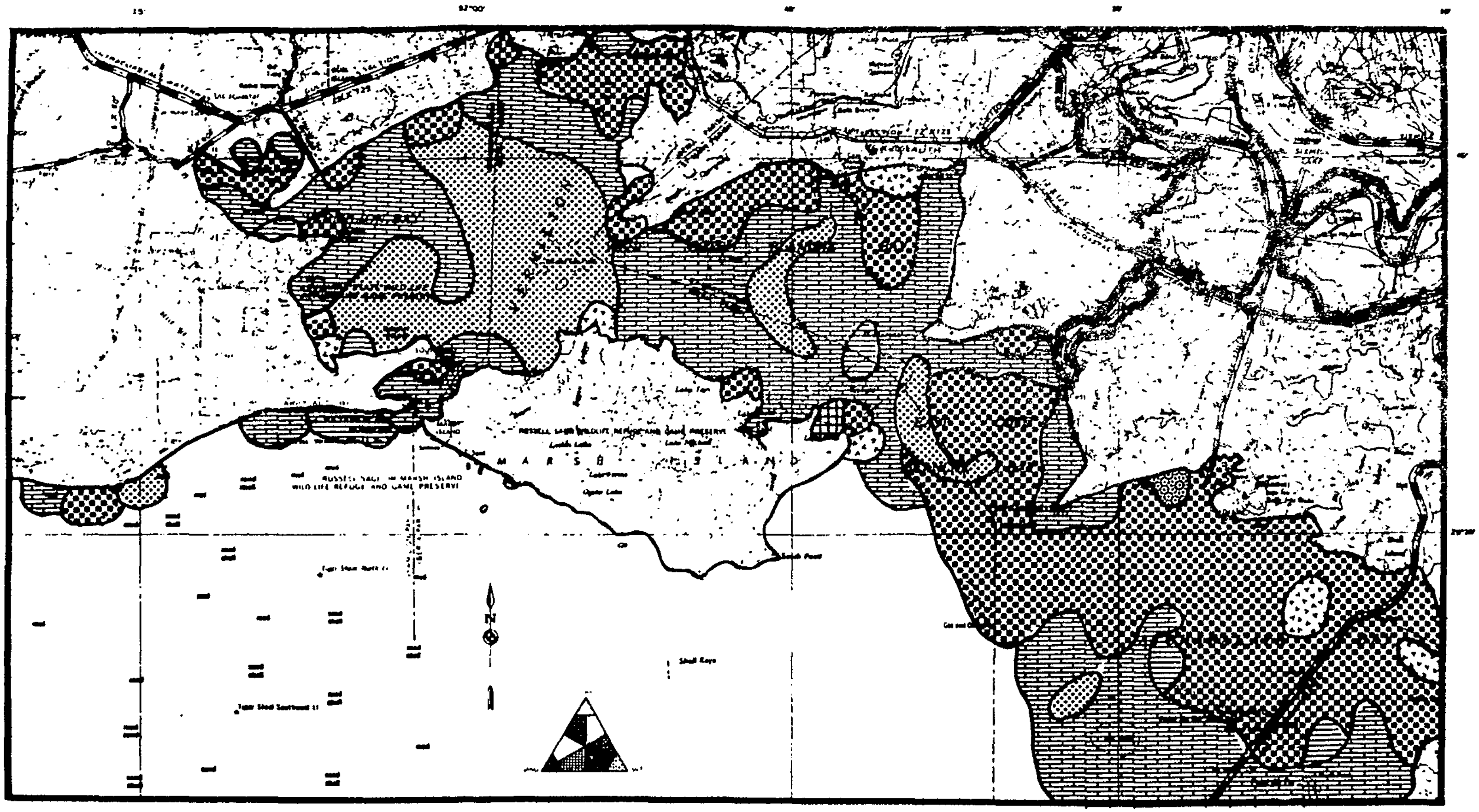



**FIGURE 3.3-4** Map showing altitude of piezometric surface in the Chicot aquifer in southwestern Louisiana, Spring 1970. (Modified from Zack, 1971.)



Source: Louisiana Wildlife and Fisheries Commission, Technical Report no. 13, April 1975.

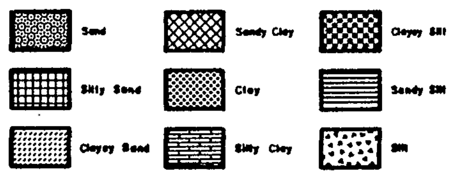



FIGURE 3.3-5 Sediment type distribution in the bays.

## 3.4 CLIMATOLOGY AND AIR QUALITY

### 3.4.1 Regional Climatology

#### 3.4.1.1 Air Masses, Weather Systems, and Surface Features Affecting Area Climatology

The climate of southern Louisiana is largely determined by several factors: the huge continental land mass lying to the north and west; the subtropical latitude; the influence of the persistent Atlantic high-pressure system (Bermuda-Azores); and the warm waters of the Gulf of Mexico.

The coastal climate is classified as "humid subtropical with a strong maritime character." Long, warm and humid summers and mild "winters" of short duration prevail along the Louisiana Coast. The most common air masses affecting the area are of a maritime tropical nature, due to exposure of the air to the warm waters of the Gulf of Mexico and also to the prevailing southeasterly direction of air flow. The southeasterly flow is the result of inflow to the region of the westernmost edge of a clockwise flowing Atlantic subtropical high pressure system (Bermuda High).

During summer months, tropical continental air masses may occasionally approach the coast from the southwestern United States or northern Mexico. On these occasions very high temperatures and low humidity extend eastward along the Gulf Coast.

During the winter season when the polar front lies to the south of the Gulf Coast, modified continental air exerts the predominant influence, but this air is often replaced by influxes of tropical air. The continental air is most often the result of a cold front that has pushed as far south as the coast. The cold air behind these fronts, though modified by the southward journey, occasionally brings sudden and large temperature reductions.

Weather systems affecting southern Louisiana are both of the tropical and extra-tropical type. During the winter when the major storm tracks push to their southernmost positions, the Gulf area is affected by extra-tropical cyclones and anticyclones that migrate across the United States. During these months, cold fronts associated with the low pressure systems often affect southern Louisiana during the winter and bring showers and cooler weather for 1 or 2 days at a time. Although an occasional squall line can accompany a traveling front bringing heavy showers and thundershowers, the squall line phenomenon is more common during summertime cyclonic activity.

During the summer, less cyclonic activity is observed as the major storm tracks have shifted to more northerly latitudes. The southerly flow associated with a combination of land mass heating and the Atlantic subtropical high exerts its influence over the area bringing more air mass disturbances (convective activity) and less frontal activity. In the late summer, easterly waves and tropical storms increase in the Gulf of Mexico, reaching a peak in September. They begin to affect the weather in the Gulf with the principal paths of tropical storms coming from the Straits of Florida and the Yucatan Channel. Over half of these tropical storms become hurricanes.

The terrain of the southern portion of Louisiana is very flat. With the exception of scattered hills and bluffs, the elevation ranges from 0 to 100 feet above sea level. Therefore, the effects of surface features upon synoptic scale (100 to 1000 km) or mesoscale (10 to 100 km) meteorological processes are negligible. There is a land or sea breeze effect that is most noticeable along the coast during the spring, summer and fall seasons. During the daytime, a land breeze (southerly flow) is usually observed, and during the late evening and early morning hours, a sea breeze (northerly flow) often occurs. As one moves inland, the land-sea breeze phenomena becomes less noticeable.

### 3.4.1.2 Temperature

The summer months in coastal Louisiana are consistently quite warm, but maximum temperatures rarely exceed 100°F. This is because of the uniformly high humidity of the dominant maritime tropical air mass, and the moderating effects of cloudiness and scattered convective showers and thunderstorms, which are primary meteorological features of the weather during these months. Meteorological surface data recorded at Lake Charles (located 110 miles west-northwest of the site) are used to describe regional weather conditions. Lake Charles data are considered to be representative of the site because of the proximity to the coast, the near-constant prevailing wind pattern observed in the region, and the homogeneity of the surrounding terrain (U.S. Department of Commerce, 1974).

Periods of as long as 10 years have occurred without the temperature reaching 100°F. July is the warmest month; at Lake Charles, the monthly average temperature is 82.4°F (91.2°F monthly mean maximum and 73.6°F monthly mean minimum.) Temperatures in the spring are usually mild and pleasant, typical temperatures range from 50°F to 70°F. The temperatures in autumn from late September to December are also generally pleasant. The winter months are normally mild with cold spells usually of short duration. January is the coldest month. The mean temperature at Lake Charles during this month is 52.3°F (61.6°F mean monthly maximum, 42.9°F mean monthly minimum.) The typical pattern is weather turning cold with rain one day, reaching the lowest temperatures after the sky is clear on the second, and warming on the third day. Usually the temperature drops to freezing or below at Lake Charles about 11 days each year. Individual years have ranged from 3 to 32 days on which freezing temperatures occurred. The annual mean temperature based on 30 years of climatic data is 68.3°F (U.S. Department of Commerce, 1974).

Table 3.4-1 presents the monthly mean and extreme temperatures observed at Lake Charles, Louisiana. The lowest temperature ever recorded was 12°F in January 1948; the highest was 104°F in August 1951.

3.4.1.3 General Wind Conditions

Table 3.4-2 presents the monthly mean and extreme wind speed and direction at Lake Charles, Louisiana (U.S. Department of Commerce, 1974). The prevailing winds are southerly. Seasonally, they vary to south-southwesterly in late spring and summer and to northeasterly in the fall and winter. The highest mean wind speeds are observed during the winter and early spring seasons, when the jet stream over North America is at its southernmost location. At this time the area is more frequently affected by traveling cyclonic disturbances. During the summer when the jet stream has retreated to a more northerly position and when smaller pressure gradients prevail, the area experiences slower mean surface wind speeds.

Tables 3.4-3 through 3.4-6 are joint wind speed and direction tables from the months of January, April, July, and October from Port Sulphur, Louisiana (approximately 110 miles east of Cote Blanche). The tables reflect similar trends of wind speed and direction as the Lake Charles data (Dames & Moore, 1972).

3.4.1.4 Precipitation

The precipitation in southern Louisiana is fairly heavy, primarily because of the large moisture supply from the Gulf of Mexico and the surrounding wetlands with abundant surface waters. Rain is distributed throughout the year with slight maxima occurring during the winter and summer months as a result of the increased frontal cyclonic activity in winter and the increase in convective shower activity during the summer (Trewartha, 1966).

Table 3.4-7 lists the monthly mean and extreme precipitation observec at Lake Charles. Monthly extremes range from a trace on October 1963 to 19.96 inches in September 1973. July is the wettest month, averaging 6.55 inches of rain, with December being a secondary maxima with 5.70 inches. October has the lowest monthly mean rainfall of 3.48 inches. The maximum precipitation observed in 24 hours in the area was at Lake Charles, which had 16.01 inches in June 1947; this exceeded the 100-year occurrence of rainfall by 2.5 inches (U.S. Weather Bureau, 1961).

Figure 3.4-1 presents the rainfall rate versus rainfall duration for a variety of return intervals computed from data from New Orleans (U.S. Weather Bureau, 1955). The potentially heavy rainfall rates indicated are typical for this portion of Louisiana. Extremes of precipitation occur at all seasons but torrential rain is infrequent and is associated with tropical storms. Showers fall in any given area (several square miles) on an average of 1 day out of 3 during the summer months.

3.4.1.5 Ice and Snow

The occurrence of snow is quite rare in southern Louisiana. Traces of snow have been recorded at Lake Charles in December and March; January and February are the only months when reasonable amounts have been recorded. The maximum monthly snowfall over a 13-year period (1962-1974) was 4 inches in January 1973 at Lake Charles. Surprisingly, however, the heaviest snow storm of record in Louisiana (February 1895) deposited as much as 2 feet of snow in the south central portion of the state (U.S. Department of Commerce, 1974). Ice storms occur so infrequently in southern Louisiana that this is a negligible form of precipitation. Because of the high temperatures of the region, most accumulations of ice will not persist for more than a day.

3.4.1.6 Evaporation

The mean annual lake evaporation of the area surrounding the site is 50 inches of water. The National Weather Service class A type pan evaporation is 67 inches. Approximately 65 percent of the annual evaporation occurs between the months of May through October (U.S. Department of Commerce, 1974). The annual peak of evaporation is usually realized during the months of September and October when the surfaces of the water bodies are their warmest and skies are relatively clear.

3.4.1.7 Sky Cover

Because of the high available moisture and low altitude surface heating, the region surrounding the site is subject to frequent cloud cover. The area experiences the highest percentage of cloud cover during the winter at which time the surface receives only 50 percent of possible sunshine. During the spring and summer, the area experiences 60 percent of possible sunshine. The fall is the sunniest season, receiving about 70 percent of possible sunshine (NOAA, 1968). Table 3.4-8 gives the monthly mean cloud cover observed at Lake Charles, plus the mean number of days of clear, partly cloudy, and cloudy days (USDC, 1974).

3.4.1.8 Fog

Fog is a frequent meteorological phenomenon in southern Louisiana. In this region, fog occurs primarily as a result of either "radiation fog" or "advection fog". Radiation fog develops as a result of nocturnal cooling of low level air over land, particularly during nights relatively free of wind and cloud cover and when the humidity is relatively high. Fog results when the temperatures near the ground fall to the dew point.

Advection fog develops when moist air traveling over a relatively cool surface is cooled to its dew point. This type of fog occurs in the Delta region in the winter and early spring as a result of moist air flowing over coastal waters cooled by the Mississippi River.

Table 3.4-9 presents the number of days each month with heavy fog (visibility less than 1/4 mile at Lake Charles). Although heavy fog occurs there on an average of just 48 times a year, the frequency of fog with higher visibilities in southern Louisiana is obviously greater.

3.4.1.9 Relative Humidity

Table 3.4-10 presents the monthly mean diurnal trends of relative humidity measured at Lake Charles during the past 10 years. The highest relative humidities are observed during the early morning hours when the daytime temperatures are lowest. The humidity is usually near 90 percent at this time of day. The relative humidity drops to its lowest daytime values (60 to 70 percent) by mid-day. Seasonally, the relative humidity is the highest during the cooler months of the year, averaging about 80 percent, and is the lowest during the summer season when readings of 70 percent are common (USDC, 1974).

3.4.1.10 Severe Weather Conditions

Thunderstorms and Hail

Thunderstorms may occur each month of the year; they are most frequent in July and August, occurring on almost half of the days in these months. The annual average number of days thunderstorms are reported is 74 at Lake Charles. The average monthly distribution for this location is shown in Table 3.4-11. The thunderstorms are most often convective in nature rather than of a frontal squall-line type origin and are rarely as destructive as thunderstorms that occur in the central plains. Hail storms have occurred in all seasons; but large hailstones of a damaging nature rarely occur. Figure 3.4-2 gives the number of hail reports 3/4 inches and greater by 1° squares for a 12-year period (1955-1967) as tabulated by Pautz (undated).

Tornadoes

The occurrence of tornadoes in southern Louisiana is rare. An important condition that nearly always exists in conjunction with tornadoes is that of strong moisture advection in the lowest 200 millibars (mb), or so, of the atmosphere with much lower-humidity air above this. These conditions occur most frequently with strong frontal lifting in association with developing extra-tropical cyclones in mid-continental regions. Most strong cold fronts dissipate, however, before reaching as far south as the Louisiana Coast. When there is frontal passage, the lifting effects are usually considerably weakened relative to those in mid-latitudes. The proximity of the region to the warm Gulf of Mexico keeps humidities rather high at all elevations. In addition, the mid-level jet stream circulation favorable to the outbreak of severe weather events in the spring has weakened and shifted north of the Gulf Coast by June. At times during the summer months, funnel clouds are common. Some of these reach the ground or water, usually causing little or no damage. Figure 3.4-3 gives the number of tornadoes observed by $1^{o}$ squares in the United States during 1955 through 1967 after Pautz (undated). In the $1^{o}$ square surrounding the site, there were seven tornadoes reported during the period of study.

Tropical Cyclones

The tropical cyclone is the most dramatic meteorological phenomena that is observed in this region. These generally occur during July through September, with a lesser frequency during June and October. These migratory cyclonic systems are associated with the general southerly and southeasterly air flow; they occasionally develop into tropical storms or hurricanes because the warm Gulf of Mexico and Carribean tropical waters are ideal breeding and intensification regions for these storms. Located as it is on the low, flat coastal terrain, the site is exposed to these storms. From 1900 to 1971, 85 storms of hurricane or tropical strength have struck or threatened the coast of Louisiana. Twenty-one tropical storms crossed a 100-mile stretch of coast in the vicinity of the site during this period (USDI, 1975).

Damage from hurricanes results from high winds and, particularly in the coastal areas, the storm surge or tide, which is an abnormally high rise in the water level. In the marsh areas, extensive and prolonged inundation and ponding occurs, resulting in damage or loss of habitat and man-made structures.

Maximum storm surge height at any location is dependent on many factors, including bottom topography, coastline configuration, and storm intensity. The storm surge at Pass Christian, Mississippi, associated with hurricane Camille in 1969 was 25 feet, and that associated with Betsy in 1965 reached nearly 20 feet at Bayou Lafourche (U.S. Department of the Army, 1973). Hurricane Camille was the most severe hurricane in recent Gulf history, with top winds estimated at 201.5 miles per hour (mph), and barometric pressure in the calm eye as low as 26.61 inches of mercury. (See section 3.3.3.2 for estimated flood surge at Cote Blanche Island.)

Strong Winds

Unlike the more northerly middle latitudes where strong frontal activity, such as squall lines and severe thunderstorms, or well-developed extra-tropical synoptic systems occur frequently, the site region only very rarely experiences strong winds. Excluding the rare occurrence of tornadoes, high winds in the region occur almost invariably in conjunction with tropical storms or hurricanes.

Almost 80 percent of hourly wind speeds observed during the year are 12 miles per hour or less. The highest average wind speeds are observed during the months of January through April when the monthly averages are greater than 10 mph. The strongest wind reported from 1940 through 1971 was 69 mph (exclusive of tropical storms; USDC, 1974). The American National Standard (ANSI, 1972) for the fastest mile of wind (30-foot level) is 95 mph for a 50-year recurrence interval and 110 mph for a 100-year interval, which also agrees with Thom (1968). According to Pautz (undated), there were 203 reports of wind gusts 50 knots or greater occurring in 140 days in the state of Louisiana from 1955 to 1967.

### 3.4.2 Other Climatological Factors Affecting Dispersion

#### 3.4.2.1 High Air Pollution Potential

The meteorological conditions that are generally conducive to high air pollution potential are light winds, stable layers aloft, and surface based temperature inversions. The southern Louisiana region is characterized by frequent summertime afternoon thunderstorms, high solar insulation and associated instability in the lower layers, and frequent sea breeze winds. These meteorological conditions do not contribute to a high air pollution potential. In addition the topographical characteristics of southern Louisiana are unfavorable for high air pollution potential because the flat low-lying terrain allows uninterrupted wind flow and, thus, good ventilation.

Since high air pollution is most often a city-related problem, Holzworth (1972) studied urban meteorological and pollution characteristics. The Cote Blanche site is in a rural area; therefore, Holzworth's study is more qualitatively than quantitatively applicable (especially with respect to morning dispersion). Hence, the study is used to qualitatively evaluate the air pollution potential for the site relative to most of the United States.

3.4.2.2 Mean Mixing Heights

One key index to air pollution potential is mixing height, which indicates the depth of atmosphere available for the distribution of pollutants. The higher the mixing height, the lower is pollution potential. Using U.S. radiosonde station temperature and wind data, Holzworth derived average urban morning minimum and afternoon maximum mixing heights (incorporating an urban nocturnal heat island effect) and mean wind speeds within these layers throughout the contiguous United States. Mean morning and afternoon urban mixing heights in the general vicinity of the site were 800 and 1000 meters, respectively. The morning height is nearly the highest in the contiguous United States. The afternoon height, in contrast, is nearly the lowest. This indicates the important role that many nearby water bodies, especially the Gulf of Mexico, play at the site. At night, the high average water vapor content of the air prevents frequent intense radiational inversions from occurring, thus tending to keep Holzworth's mixing height relatively high. The afternoon low mixing height is mainly due to the ameliorating effect of the Gulf of Mexico on afternoon maximum surface temperatures. Mean annual winds in both the morning and afternoon mixing layer were found to be between 5 and 6 meters per second. Fortunately, low afternoon mixing heights are usually associated with thermally-induced winds, which tend to disperse potential pollutants.

The episodic occurrence of limited atmospheric dispersion conditions in the United States has also been studied by Holzworth (1974). The most limiting dispersion condition that Holzworth considers is a period of 2 or more consecutive days with mixing depths (H) less than or equal to 500 meters, transport wind speeds (u, the unweighted mean of the surface plus upper wind speeds through the mixing layer) less than or equal to 2 meters per second, and no significant precipitation (because of its cleansing effects). The calculation of atmospheric dilution episodes is based on the product, H X u, which can be considered a ventilation factor. The product, H X u, is expressed in $m^2$/sec, and represents the volumetric rate per unit distance normal to the wind direction at which clean and polluted air within the mixing layer is transported across the upwind and downwind sides of a given area. Holzworth's data present the frequency of slowest dispersion (worst stagnation) episodes lasting 1, 2, 3, 4, and 5 consecutive days at each of 62 National Weather Service stations. The various episodes of least dilution are not necessarily those which would result in the most undesirable transport and diffusion of pollutants from a single source. The information is most appropriate for determining the potential for a general pollution problem for areas that are of the size of large urban complexes.

The results of Holzworth's study indicate that the southernmost region of Louisiana is a favorable location relative to other locations in the United States for four of the five episode dispersion periods. Calculation of H X u values for five different air stagnation periods at Lake Charles (the nearest station to the site) shows that Lake Charles ranked 13th best out of 62 stations for the 1-day episode period, 7th best for the 2-day episode period, 9th for the 3-day episode period, 15th for the 4-day episode, and 14th for the 5-day episode period. The favorable conditions can be attributed to the high convective activity and mixing depths of the southern United States to the flat surface features of the area, which do little to retard the wind flow in the lower layers of the atmosphere. There was only one occurrence during the 5-year period of a limited dispersion condition with mixing heights less than 250 meters and transport wind less than 6 m/sec; there were two occurrences of the less severe condition of 500 meters mixing height with transport wind speeds less than 6 m/sec.

3.4.2.3 Stability

The system of classifying stability in this region is based upon the Turner Method, which uses net solar radiation and wind speed to determine the stability classes. The stability classes are as follows: (a) extremely unstable, (b) unstable, (c) slightly unstable, (d) neutral, (e) slightly stable, (f) stable and (g) extremely stable. Since many urban areas do not become as stable in the lower layers as nonurban areas, stability classes e, f, and g are combined into a single class.

Table 3.4-12 lists the seasonal and annual distribution of stability classes for Baton Rouge and Port Arthur, Texas, the two closest sites for which stability data were available. At either of the sites, during the winter and spring seasons, there is a relatively high occurrence of neutral conditions. The stability frequency becomes slightly more evenly distributed over all the stability classes during the summer and fall months. Port Arthur displays a tendency for a higher percentage of neutral conditions than Baton Rouge. However, there is a relatively small percentage of unstable conditions at both sites, which seems unusual for areas that experience strong solar heating at the surface. This is due to the high atmospheric moisture content and associated cloud cover, which moderate the surface heating so that a smaller percentage of unstable conditions is realized. On a diurnal basis most of the atmosphere instability occurs during the mid-day, followed by stable conditions at night. It is noteworthy that the method used in this determination of stability will, in most instances, fail to detect extreme surface inversion (stable) or lapse (unstable) conditions in the lowest several hundred feet, which would probably be apparent from instrumented tower data.

3.4.3 Air Quality

3.4.3.1 Existing Air Quality

Following passage of the Clean Air Act (1970) and pursuant to regulations promulgated by the Environmental Protection Agency (EPA), the state of Louisiana submitted to the EPA its Implementation Plan (Louisiana

State Air Control Commission, 1972) for the control of air quality. The State Implementation Plan outlines the strategies for the estimation, protection and enhancement of the state's air quality. Table 3.4-13 presents the primary and secondary ambient air quality standards of the state of Louisiana for hydrocarbons, sulfur dioxide ($SO_2$), particulates, nitrogen dioxide ($NO_2$), and photochemical oxidants.

In its annual report (1974), the Louisiana Air Control Commission Laboratory presents the existing air quality measured at various stations. Figure 3.4-4 shows the location of the monitoring stations in relation to the site. Three stations (Donaldsonville, Lafayette, and Lake Charles) are used to estimate air quality for the Cote Blanche site. It should be noted that the Donaldsonville site is near the more heavily populated areas of the state; thus, the ambient air quality at that site should be considered a conservative estimate for the site.

Figures 3.4-5 through 3.4-7 present the measured levels of suspended particulates, $SO_2$, and $NO_2$. Current measurement of hydrocarbons is not available. Lafayette and Lake Charles are below the 24-hour and annual standards for suspended particulates, whereas Donaldsonville exceeds the standards slightly. For nitrogen dioxide and sulfur dioxide, all sites were well under the primary ambient air standards.

Neither EPA nor the state of Louisiana monitor hydrocarbons in southern Louisiana. However, data are available as a result of a short-term ambient air quality study performed in Lafourche Parish (Kem-Tech Laboratories, 1975). In this study air quality was monitored continuously during two weekly periods in non urban areas of coastal Louisiana. One site was in a fresh marsh area of Lafourche Parish, 90 miles east of Cote Blanche; the other was within five miles of the Gulf of Mexico, 110 miles southeast of Cote Blanche. The samples indicated that the national ambient air quality standard (NAAQS) for non-methane hydrocarbons (160 $\mu g/m^3$ during a 3-hour period) was exceeded 39 percent of the time in September and 16 percent in December. Maximum concentrations ranged from a high of 812 $\mu g/m^3$ to a low of 83 $\mu g/m^3$; average hourly concentrations ranged from a high of 518 $\mu g/m^3$ to a low of 71 $\mu g/m^3$. The report concluded that, though based on limited data, the NAAQS for non-methane hydrocarbons is probably exceeded quite frequently in southern Louisiana (as is true for much of the nation). The hydrocarbons were felt to be generally of the non-reactive (not precursors of ozone) type, however.

Table 3.4-14 lists the photochemical oxidant levels for 1975 at New Orleans, Baton Rouge and Lake Charles, the three closest stations for which the most recent photochemical oxidant levels were available. The data show that all three stations exceeded the state 1 hour standard of 0.08 ppm more than once during 1975, whereas all sites fell under the state and national annual arithmetic mean standard of 0.03 ppm. It can be assumed that background photochemical oxidant levels would be lower in rural areas such as the oil storage site because of lower background levels of hydrocarbons, which react with the sunlight and other product emissions to form the photochemical oxidants.

3.4.3.2 Predicted Air Quality

Predicted Hydrocarbons

The Southern Louisiana-Southeast Texas Air Quality Control Region (Sample Region 106) was classified Priority 1 as a result of the July-September 1971 sampling study conducted jointly by the Environmental Protection Agency and the State. This classification is subject to change if future air samples indicate a decrease in pollutant concentrations.

The control strategy for hydrocarbons necessitated sufficient regulation to result in a reduction of 40 percent in reactive hydrocarbon concentration by 1975. The application of federal transportation emission standards and Louisiana's revised regulations will result in an estimated 54 percent reduction in reactive hydrocarbon emissions. Although the state does not monitor hydrocarbon levels in southern Louisiana at the present time, recent violations of photochemical oxidant standards have initiated a requirement for future submittal of a new control strategy for attainment of photochemical oxidants standards which would also affect future hydrocarbon levels. Therefore an accurate prediction of future levels of hydrocarbons cannot be made at this time.

Predicted Levels of $SO_2$

The Southern Louisiana-Southeast Texas Air Quality Control Region (Sample Region 106) was classified Priority 1 for sulfur dioxide by the Regional Office of the EPA and the State.

Data available to the State confirmed that the Federal secondary ambient air standard for sulfur dioxide can be achieved within 3 years even if a limited number of variances are granted to those industries that cannot reduce emissions enough to meet state regulations. These industries would be expected to reduce emissions to the extent dictated by best available technology. Secondary ambient air standards should be reached within a reasonable time after attainment of primary standards (Louisiana State Air Control Commission, 1972).

Table 3.4-15 presents the highest measured ambient values of $SO_2$ in the region based on 1972 data with the exception of Baton Rouge. The measured values for the locations are considerably below the air quality standards for $SO_2$; consequently a reduction in emissions is not needed but will nevertheless be obtained by application of Louisiana's Rules and Regulations as set forth in 1972, State Implementation Plan. It should be noted that these $SO_2$ levels must be conservative estimates for a rural site such as Cote Blanche.

Predicted Levels of Particulates

The Southern Louisiana-Southeast Texas Air Quality Control Region (Sample Region 106) was classified Priority II for particulates as a result of the July-September 1971 sampling study conducted jointly by the EPA and the state.

Data available to the state confirmed that the Federal secondary ambient air standard for particulate matter could be achieved by 1976. As outlined in the State Implementation Plan, secondary ambient air standards would be reached within a reasonable time after attainment of primary standards.

Because of recent air quality data which indicated violations of secondary particulate standards, the current control strategy (Table 3.4-16) has been challenged by the EPA. Although the violations which initiated the question concerning the control strategy are being disputed by the State of Louisiana, it is doubtful that maintainment of the secondary particulate standards can be accomplished in the future in the Southern Louisiana region under the present control strategy.

Predicted Levels of Photochemical Oxidants

Because the levels of photochemical oxidants are related to the amounts and types of hydrocarbons in the air, the state views the problems of control of photochemical oxidant emissions and of future levels of photochemical oxidants to be similar to those of hydrocarbons. Because of violations of the standards indicated from the most recent field data, the EPA has determined that the control strategy for photochemical oxidants be revised. Until the state submits and puts into effect a new control plan, it is not possible to predict when the Federal and State standards can be attained.

Predicted Levels of Nitrogen Dioxide

The Southern Louisiana-Southeast Texas Air Quality Control Region (Sample Region 106) was classified Priority III for nitrogen dioxide as a result of the July-September 1971 sampling study conducted jointly by the EPA and the state.

The control strategy for nitrogen dioxide will be the existing permit system, new Federal and State regulations and emission standards. This has been adequate to maintain existing ambient levels of nitrogen dioxide and prevent them from exceeding the Federal ambient air standard. Therefore, unless future air samplings indicate increases in pollutant concentrations, there are no foreseeable problems in maintaining levels at or below the Federal standards (Louisiana State Air Control Commission, 1972).

TABLE 3.4-1 Monthly mean and extreme temperatures observed at Lake Charles, Louisiana

| | Normals[a] | | | Extremes[b] | |
|---|---|---|---|---|---|
| Month | Daily Max | Daily Min | Monthly mean | Record Highest | Record Lowest |
| Jan. | 61.6 | 42.9 | 52.3 | 79 | 20 |
| Feb. | 64.6 | 45.5 | 55.1 | 83 | 26 |
| Mar. | 70.0 | 50.5 | 60.3 | 86 | 29 |
| Apr. | 78.2 | 59.5 | 68.9 | 92 | 34 |
| May | 84.3 | 66.0 | 75.2 | 93 | 50 |
| June | 89.6 | 71.8 | 80.7 | 98 | 58 |
| July | 91.2 | 73.6 | 82.4 | 99 | 61 |
| Aug. | 91.2 | 73.2 | 82.2 | 97 | 61 |
| Sept. | 87.9 | 68.8 | 78.4 | 96 | 47 |
| Oct. | 81.6 | 58.4 | 70.0 | 91 | 36 |
| Nov. | 71.1 | 49.2 | 60.2 | 86 | 25 |
| Dec. | 64.2 | 44.3 | 54.3 | 82 | 24 |
| ANNUAL | 78.0 | 58.6 | 68.3 | 99 | 20 |

[a] Based on 30 years (1948-1974) of Climatic Data, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

[b] Based on 10 years (1965-1974) of Climatic Data, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

Means and extremes above are existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: highest temperature 104 in August 1951; lowest temperature 12 in January 1948.

TABLE 3.4-2 Monthly mean and extreme wind speed and direction at Lake Charles, Louisiana*

| Month | Direction | Mean Speed (mph) | Fastest Mile | | |
|---|---|---|---|---|---|
| | | | Direction | Speed | Year |
| Jan. | N | 10.4 | NW | 58 | 1962 |
| Feb. | S | 10.6 | WSW | 40 | 1971 |
| Mar. | S | 10.7 | S | 40 | 1973 |
| Apr. | S | 10.4 | ENE | 44 | 1973 |
| May | S | 9.0 | NW | 43 | 1973 |
| June | SSW | 7.5 | SSE | 38 | 1974 |
| July | SSW | 6.5 | ESE | 35 | 1974 |
| Aug. | SSW | 6.2 | ESE | 46 | 1964 |
| Sept. | ENE | 7.4 | N | 40 | 1971 |
| Oct. | ENE | 7.6 | W | 33 | 1973 |
| Nov. | ENE | 9.3 | NNW | 31 | 1962 |
| Dec. | NE | 9.4 | NW | 32 | 1973 |
| ANNUAL | S | 8.8 | NW | 58 | 1962 |

* Based on 13 years (1962-1974) of Local Climatic Data, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

TABLE 3.4-3 Percentage frequencies of wind direction and speed Port Sulphur, Louisiana

January

| Direction | Hourly Observations of Wind Speed (mph) 0- 3 | 4- 7 | 8-12 | 13-18 | 19-23 | 24+ | Total | Average Wind Speed (mph) |
|---|---|---|---|---|---|---|---|---|
| N | 1.4 | 3.1 | 4.5 | 2.7 | 0.2 | 0.0 | 11.9 | 9.3 |
| NNE | 1.5 | 2.5 | 2.9 | 1.6 | 0.0 | 0.0 | 8.5 | 8.3 |
| NE | 1.7 | 2.5 | 2.0 | 0.8 | 0.0 | 0.0 | 7.1 | 7.1 |
| ENE | 1.5 | 2.7 | 2.0 | 0.4 | 0.0 | 0.0 | 6.6 | 6.7 |
| E | 2.4 | 4.0 | 2.4 | 0.5 | 0.0 | 0.0 | 9.3 | 6.4 |
| ESE | 1.2 | 2.8 | 1.4 | 0.3 | 0.0 | 0.0 | 5.7 | 6.6 |
| SE | 1.0 | 1.9 | 0.8 | 0.1 | 0.0 | 0.0 | 3.8 | 6.0 |
| SSE | 1.0 | 1.3 | 1.2 | 0.4 | 0.0 | 0.0 | 3.7 | 7.0 |
| S | 1.2 | 1.8 | 1.7 | 0.9 | 0.1 | 0.0 | 5.7 | 8.0 |
| SSW | 0.7 | 1.2 | 1.2 | 0.8 | 0.0 | 0.0 | 3.9 | 8.3 |
| SW | 0.5 | 0.7 | 0.6 | 0.3 | 0.0 | 0.0 | 2.1 | 7.6 |
| WSW | 0.5 | 0.7 | 0.9 | 0.3 | 0.1 | 0.0 | 2.5 | 8.1 |
| W | 0.8 | 1.1 | 1.0 | 0.3 | 0.0 | 0.0 | 3.3 | 7.4 |
| WNW | 0.5 | 0.6 | 0.8 | 0.3 | 0.0 | 0.0 | 2.3 | 7.8 |
| NW | 0.5 | 0.9 | 1.4 | 0.8 | 0.0 | 0.0 | 3.7 | 9.0 |
| NNW | 0.6 | 1.2 | 2.3 | 1.9 | 0.2 | 0.0 | 6.2 | 10.6 |
| CALM | 13.7 | | | | | | 13.7 | 0.0 |
| TOTAL | 30.7 | 29.1 | 27.0 | 12.4 | 0.8 | 0.0 | 100.0 | 6.8 |

TABLE 3.4-4 Percentage frequencies of wind direction and speed
Port Sulphur, Louisiana

April

| Direction | Hourly Observations of Wind Speed (mph) 0- 3 | 4- 7 | 8-12 | 13-18 | 19-23 | 24+ | Total | Average Wind Speed (mph) |
|---|---|---|---|---|---|---|---|---|
| N | 1.1 | 1.5 | 1.9 | 0.5 | 0.0 | 0.0 | 4.9 | 7.4 |
| NNE | 1.0 | 1.2 | 1.1 | 0.3 | 0.0 | 0.0 | 3.6 | 6.8 |
| NE | 0.9 | 1.0 | 0.6 | 0.1 | 0.0 | 0.0 | 2.5 | 6.0 |
| ENE | 0.6 | 0.9 | 0.7 | 0.2 | 0.0 | 0.0 | 2.4 | 6.6 |
| E | 1.8 | 2.2 | 2.1 | 0.3 | 0.0 | 0.0 | 6.3 | 6.5 |
| ESE | 1.8 | 3.1 | 2.6 | 0.3 | 0.0 | 0.0 | 7.9 | 6.7 |
| SE | 2.5 | 3.5 | 2.5 | 0.5 | 0.0 | 0.0 | 9.1 | 6.4 |
| SSE | 2.7 | 4.2 | 3.7 | 1.2 | 0.1 | 0.0 | 11.9 | 7.3 |
| S | 2.4 | 4.3 | 4.5 | 2.1 | 0.1 | 0.0 | 13.3 | 8.1 |
| SSW | 1.1 | 2.0 | 2.1 | 0.8 | 0.0 | 0.0 | 6.2 | 8.0 |
| SW | 1.2 | 1.3 | 1.0 | 0.6 | 0.0 | 0.0 | 4.0 | 7.0 |
| WSW | 0.6 | 0.8 | 0.7 | 0.5 | 0.0 | 0.0 | 2.6 | 7.6 |
| W | 0.9 | 1.1 | 0.7 | 0.3 | 0.0 | 0.0 | 3.0 | 6.6 |
| WNW | 0.6 | 0.6 | 0.6 | 0.1 | 0.0 | 0.0 | 1.8 | 6.5 |
| NW | 0.6 | 0.7 | 0.6 | 0.3 | 0.0 | 0.0 | 2.2 | 7.2 |
| NNW | 0.6 | 1.1 | 1.1 | 0.4 | 0.0 | 0.0 | 3.3 | 8.0 |
| CALM | 15.0 | | | | | | 15.0 | 0.0 |
| TOTAL | 35.2 | 29.5 | 26.5 | 8.4 | 0.3 | 0.0 | 100.0 | 6.1 |

TABLE 3.4-5 Percentage frequencies of wind direction and speed
Port Sulphur, Louisiana

| | July | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | Hourly Observations of Wind Speed (mph) | | | | | | | Average Wind Speed |
| Direction | 0- 3 | 4- 7 | 8-12 | 13-18 | 19-23 | 24+ | Total | (mph) |
| N | 1.2 | 1.2 | 0.4 | 0.1 | 0.0 | 0.0 | 3.0 | 5.1 |
| NNE | 0.9 | 0.9 | 0.4 | 0.0 | 0.0 | 0.0 | 2.3 | 5.3 |
| NE | 1.3 | 1.2 | 0.5 | 0.0 | 0.0 | 0.0 | 3.1 | 5.0 |
| ENE | 0.8 | 1.1 | 0.4 | 0.0 | 0.0 | 0.0 | 2.4 | 5.3 |
| E | 1.5 | 1.8 | 0.8 | 0.0 | 0.0 | 0.0 | 4.2 | 5.3 |
| ESE | 1.4 | 1.3 | 0.6 | 0.1 | 0.0 | 0.0 | 3.3 | 5.2 |
| SE | 2.0 | 1.4 | 0.6 | 0.0 | 0.0 | 0.0 | 4.0 | 4.8 |
| SSE | 1.8 | 1.4 | 0.6 | 0.1 | 0.0 | 0.0 | 3.8 | 5.0 |
| S | 2.8 | 2.4 | 1.1 | 0.1 | 0.0 | 0.0 | 6.4 | 5.0 |
| SSW | 2.8 | 2.0 | 0.9 | 0.1 | 0.0 | 0.0 | 5.9 | 5.0 |
| SW | 2.9 | 2.2 | 0.8 | 0.1 | 0.0 | 0.0 | 6.0 | 4.9 |
| WSW | 2.1 | 2.0 | 0.9 | 0.0 | 0.0 | 0.0 | 5.0 | 5.1 |
| W | 3.2 | 2.9 | 1.2 | 0.1 | 0.0 | 0.0 | 7.4 | 5.0 |
| WNW | 1.2 | 1.6 | 0.4 | 0.0 | 0.0 | 0.0 | 3.3 | 5.0 |
| NW | 1.0 | 1.1 | 0.4 | 0.0 | 0.0 | 0.0 | 2.5 | 4.8 |
| NNW | 0.8 | 0.8 | 0.3 | 0.0 | 0.0 | 0.0 | 1.9 | 4.9 |
| CALM | 35.6 | | | | | | 35.6 | 0.0 |
| TOTAL | 63.3 | 25.5 | 10.2 | 1.0 | 0.1 | 0.0 | 100.0 | 3.2 |

TABLE 3.4-6 Percentage frequencies of wind direction and speed Port Sulphur, Louisiana

October

| Direction | Hourly Observations of Wind Speed (mph) | | | | | | | Average Wind Speed (mph) |
|---|---|---|---|---|---|---|---|---|
| | 0- 3 | 4- 7 | 8-12 | 13-18 | 19-23 | 24+ | Total | |
| N | 2.3 | 3.1 | 2.1 | 0.6 | 0.0 | 0.0 | 8.2 | 6.5 |
| NNE | 2.7 | 3.9 | 2.7 | 0.5 | 0.0 | 0.0 | 9.9 | 6.3 |
| NE | 2.6 | 3.7 | 2.2 | 0.4 | 0.0 | 0.0 | 8.9 | 6.1 |
| ENE | 1.8 | 2.9 | 3.0 | 0.5 | 0.1 | 0.0 | 8.3 | 7.2 |
| E | 2.3 | 3.4 | 2.4 | 0.5 | 0.1 | 0.0 | 8.7 | 6.6 |
| ESE | 1.2 | 1.9 | 1.3 | 0.2 | 0.0 | 0.0 | 4.6 | 6.4 |
| SE | 1.5 | 1.8 | 0.7 | 0.1 | 0.0 | 0.0 | 4.2 | 5.6 |
| SSE | 1.0 | 1.2 | 0.6 | 0.1 | 0.0 | 0.0 | 3.0 | 5.8 |
| S | 0.9 | 1.0 | 0.5 | 0.1 | 0.0 | 0.1 | 2.5 | 6.5 |
| SSW | 0.6 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 1.3 | 4.8 |
| SW | 0.7 | 0.3 | 0.2 | 0.0 | 0.0 | 0.0 | 1.2 | 5.3 |
| WSW | 0.5 | 0.5 | 0.2 | 0.0 | 0.0 | 0.0 | 1.1 | 4.7 |
| W | 0.9 | 0.8 | 0.4 | 0.1 | 0.0 | 0.0 | 2.1 | 5.4 |
| WNW | 0.6 | 0.6 | 0.3 | 0.0 | 0.0 | 0.0 | 1.5 | 5.7 |
| NW | 0.7 | 0.7 | 0.5 | 0.3 | 0.0 | 0.0 | 2.2 | 6.7 |
| NNW | 0.9 | 1.4 | 1.4 | 0.5 | 0.0 | 0.0 | 4.3 | 7.5 |
| CALM | 28.0 | | | | | | 28.0 | 0.0 |
| TOTAL | 49.2 | 27.7 | 18.6 | 4.0 | 0.4 | 0.2 | 100.0 | 4.6 |

TABLE 3.4-7 Monthly mean and extreme precipitation observed at Lake Charles, Louisiana

| | Precipitation in Inches - Water Equivalent | | | | Snow | |
|---|---|---|---|---|---|---|
| Month | Normal[a] Mean | Monthly[b] Max | Monthly[b] Min | 24 Hour[b] Max | Monthly[b] Max | 24 Hour[b] Max |
| Jan. | 4.04 | 12.69 | 0.78 | 3.60 | 4.0 | 0.4 |
| Feb. | 4.47 | 6.75 | 0.80 | 3.28 | 0.3 | 0.3 |
| Mar. | 3.84 | 7.40 | 0.27 | 4.91 | T | T |
| Apr. | 4.33 | 10.95 | 0.64 | 5.50 | 0.0 | 0.0 |
| May | 5.06 | 11.01 | 0.57 | 4.20 | 0.0 | 0.0 |
| June | 5.04 | 8.90 | 0.84 | 4.98 | 0.0 | 0.0 |
| July | 6.55 | 10.06 | 0.84 | 4.98 | 0.0 | 0.0 |
| Aug. | 4.75 | 17.36 | 1.87 | 14.10 | 0.0 | 0.0 |
| Sept. | 4.13 | 19.96 | 1.01 | 7.88 | 0.0 | 0.0 |
| Oct. | 3.48 | 17.28 | T | 7.24 | 0.0 | 0.0 |
| Nov. | 4.08 | 7.30 | 0.11 | 3.51 | 0.0 | 0.0 |
| Dec. | 5.70 | 13.27 | 3.36 | 6.88 | T | 0.0 |
| YEAR | 55.47 | 19.96 | T | 14.10 | 4.0 | 0.4 |

[a] Based on 30 years (1945-1974) of Climatic Data, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

[b] Based on 13 years (1962-1974) of Climatic Data. U.S. Dept. of Commerce, NOAA, Asheville, North Carolina

Means and extremes above are from existing and comparable exposures. Annual extremes have been exceeded at other sites in the locality as follows: maximum monthly precipitation 21.45 in May 1907; maximum precipitation in 24 hours 16.01 in June 1947; maximum monthly snowfall 5.0 in February 1960; maximum snowfall in 24 hours 5.0 in February 1960.

TABLE 3.4-8 Monthly mean and annual average cloud cover observed at Lake Charles, Louisiana*

| Month | Mean Sky Cover | Number of Days | | |
|---|---|---|---|---|
| | | Clear | Partly Cloudy | Cloudy |
| January | 7.2 | 6 | 5 | 20 |
| February | 6.0 | 9 | 5 | 14 |
| March | 6.4 | 7 | 9 | 15 |
| April | 6.6 | 6 | 9 | 15 |
| May | 5.9 | 8 | 12 | 11 |
| June | 5.4 | 9 | 13 | 8 |
| July | 6.4 | 4 | 16 | 11 |
| August | 5.9 | 6 | 15 | 10 |
| September | 5.6 | 9 | 11 | 10 |
| October | 4.5 | 14 | 9 | 8 |
| November | 5.3 | 10 | 9 | 11 |
| December | 6.6 | 7 | 8 | 16 |
| YEAR | 6.0 | 95 | 121 | 149 |

* Based on 13 years (1962-1974) of data

Source: Local Climatological Data, Lake Charles, Louisiana, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina.

TABLE 3.4-9 Monthly mean number of heavy fog occurrences observed at Lake Charles, Louisiana*

| Month | No. of Days |
|---|---|
| January | 9 |
| February | 5 |
| March | 6 |
| April | 3 |
| May | 2 |
| June | 1 |
| July | - |
| August | - |
| September | 3 |
| October | 5 |
| November | 8 |
| December | 8 |
| Year | 50 |

* Based on a 13-year (1962-1974) period of record

Source: Local Climatological Data, Lake Charles, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina.

TABLE 3.4-10 Monthly mean diurnal trends of relative humidity observed at Lake Charles, Louisiana*

| | Hour of Day | | | |
|---|---|---|---|---|
| Month | 00 | 06 | 12 | 18 |
| January | 88 | 89 | 71 | 79 |
| February | 85 | 86 | 61 | 68 |
| March | 87 | 89 | 62 | 69 |
| April | 88 | 90 | 62 | 68 |
| May | 89 | 91 | 62 | 68 |
| June | 89 | 91 | 59 | 65 |
| July | 91 | 93 | 63 | 70 |
| August | 91 | 93 | 64 | 71 |
| September | 90 | 93 | 64 | 75 |
| October | 89 | 91 | 56 | 73 |
| November | 87 | 89 | 59 | 76 |
| December | 89 | 90 | 69 | 81 |
| YEAR | 89 | 90 | 63 | 72 |

* Based on 10 years (1965-1974) of Climatological Data

Source: Local Climatological Data, Lake Charles, Louisiana, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina.

TABLE 3.4-11 Mean number of thunderstorms by month at Lake Charles*

| Month | Average No. |
|---|---|
| January | 2 |
| February | 3 |
| March | 4 |
| April | 4 |
| May | 8 |
| June | 9 |
| July | 14 |
| August | 14 |
| September | 9 |
| October | 3 |
| November | 2 |
| December | 3 |
| Year | 74 |

* Based on a 13-year (1962-1974) period of record

Source: Local Climatological Data, Lake Charles, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina.

TABLE 3.4-12 Frequency distribution of stability, Baton Rouge, Louisiana 1970-1974

| Stability | Dec/Jan/Feb | Mar/Apr/May | Jun/Jul/Aug | Sept/Oct/Nov | Annual |
|---|---|---|---|---|---|
| A | 0.1 | 0.7 | 2.8 | 0.7 | 1.1 |
| B | 2.8 | 7.3 | 12.4 | 6.6 | 7.3 |
| C | 8.3 | 10.5 | 14.3 | 13.1 | 11.6 |
| D | 26.3 | 19.3 | 16.5 | 17.1 | 19.8 |
| E | 32.4 | 26.9 | 7.6 | 18.6 | 21.3 |
| F | 11.5 | 14.9 | 15.4 | 13.0 | 13.7 |
| G | 18.6 | 20.2 | 31.0 | 30.1 | 25.2 |

Port Arthur, Texas

1967-1971

| Stability | Dec/Jan/Feb | Mar/Apr/May | Jun/Jul/Aug | Sept/Oct/Nov | Annual |
|---|---|---|---|---|---|
| A | 0.0 | 0.9 | 2.1 | 0.3 | 0.8 |
| B | 2.3 | 5.1 | 13.5 | 7.4 | 7.1 |
| C | 7.6 | 10.1 | 19.3 | 16.4 | 13.3 |
| D | 68.6 | 65.0 | 34.5 | 41.7 | 52.6 |
| E* | 21.6 | 18.8 | 30.5 | 34.1 | 26.2 |

* E stability at Port Arthur represents total frequency of E, F and G stabilities

Source: STAR DATA, Baton Rouge, Louisiana and Port Arthur, Texas, U.S. Dept. of Commerce, NOAA, Asheville, North Carolina.

TABLE 3.4-13 Primary ambient air quality standards

| Air Contaminant | Standards Maximum Permissible Concentration |
|---|---|
| Suspended Particulate | 75 μg/$m^3$ (Annual geometric mean)<br>260 μg/$m^3$ (Maximum 24 hour concentration not to be exceeded more than once per year) |
| Sulfur Dioxide ($SO_2$) | 80 μg/$m^3$ or 0.03 ppm (Annual arithmetic mean)<br>365 μg/$m^3$ or 0.14 ppm (Maximum 24-hour concentration not to be exceeded more than once per year) |
| Hydrocarbons (other than Methane) | 160 μg/$m^3$ (0.24 ppm) (Maximum 3 hour concentration between 6:00 a.m. and 9:00 a.m. not to be exceeded more than once per year) |
| Nitrogen Dioxide ($NO_2$) | 100 μg/$m^3$ (0.05 ppm) (Annual arithmetic mean) |
| Total (Photochemical) Oxidants | 58.8 μg/$m^3$ or 0.03 ppm (Annual arithmetic mean)<br>98.0 μg/$m^3$ or 0.05 ppm (4 hour maximum)<br>160 μg/$m^3$ or 0.08 ppm (Maximum 1 hour concentration not to be exceeded more than once per year). |

TABLE 3.4-13 Continued
Secondary ambient air quality standards

| Air Contaminant | Standards Maximum Permissible Concentration |
| --- | --- |
| Suspended Particulate | 60 μg/$m^3$ (Annual geometric mean)<br>150 μg/$m^3$ (Maximum 24-hour concentration not to be exceeded more than once per year) |
| Sulfur Dioxide ($SO_2$) | 60 μg/$m^3$ or 0.02 ppm (Annual arithmetic mean)<br>260 μg/$m^3$ or 0.10 ppm (Maximum 24-hour concentration not be be exceeded more than once per year)<br>1300 μg/$m^3$ (Maximum 3-hour concentration not to be exceeded more than once per year) |
| Hydrocarbons (other than Methane) | 160 μg/$m^3$ (0.24 ppm) (Maximum 3-hour concentration between 6:00 a.m. and 9:00 a.m. not to be exceeded more than once per year) |
| Nitrogen Dioxide ($NO_2$) | 100 μg/$m^3$ (0.05 ppm) (Annual arithmetic mean) |
| Total (Photochemical) Oxidants | 58.8 μg/$m^3$ or 0.03 ppm (Annual arithmetic mean)<br>98.0 μg/$m^3$ or 0.05 ppm (4 hour maximum)<br>160 μg/$m^3$ or 0.08 ppm (Maximum 1 hour concentration not to be exceeded more than once per year). |

TABLE 3.4-14 Photochemical Oxidants - 1975 Data[a]
(in parts per million)

| | 2nd Highest Hourly Concentration | Annual Arithmetic Mean |
|---|---|---|
| New Orleans | .094 | .011 |
| Lake Charles | .174 | .013 |
| Baton Rouge | .170 | .016 |
| Federal and State Standards | .08[b] | .03 |

[a]Lafayette, Louisiana and Donaldsonville, Louisiana data are not available.

[b]1 hour concentration not to be exceeded more than once per year.

Source: Medal, Leonard, 1976. Louisiana Air Quality Control Commission, personal communication, November 1976.

TABLE 3.4-15 Determination of existing highest measured $SO_2$ value in region (1972 data)

| $SO_2$ Concentrations New Orleans Civic Center | |
|---|---|
| August | .007 ppm |
| September | .021 ppm |
| October | .005 ppm |
| November | .016 ppm |
| Average | .012 ppm = 32 $\mu g/m^3$ |

| $SO_2$ Concentrations Lake Charles Health Unit | |
|---|---|
| August | .006 ppm |
| September | .003 ppm |
| October | .003 ppm |
| November | .090 ppm |
| Average | .025 ppm = 67 $\mu g/m^3$ |

| $SO_2$ Concentrations at Mississippi River Bridge in Baton Rouge | |
|---|---|
| June | .086 ppm |
| July | .068 ppm |
| August | .080 ppm |
| September | .081 ppm |
| Average | .080 ppm = 220 $\mu g/m^3$ |

Sulfur Dioxide Emissions

| Locale | Percent Reduction Required | Anticipated Percentage Reduction by Applying State Regulations |
|---|---|---|
| A. New Orleans | 0% | 47% Levels already below Federal Standards |
| B. Baton Rouge | 73% | 72% |
| C. Lake Charles | 0% | 12% Computer problems |

Source: 1972 State of Louisiana Implementation Plan, Baton Rouge, Louisiana

TABLE 3.4-16 Particulate emissions

| Locale | Percent Reduction Required | Anticipated Percentage Reduction by Applying State Regulations |
|---|---|---|
| Southern Louisiana Southeast Texas Air Quality Control Region | 50% to achieve Secondary Standards | |
| A. New Orleans | | 60% |
| B. Baton Rouge | | 84% |
| C. Lake Charles | | 54% |

Source: 1972 State of Louisiana Implementation Plan, Baton Rouge, Louisiana.

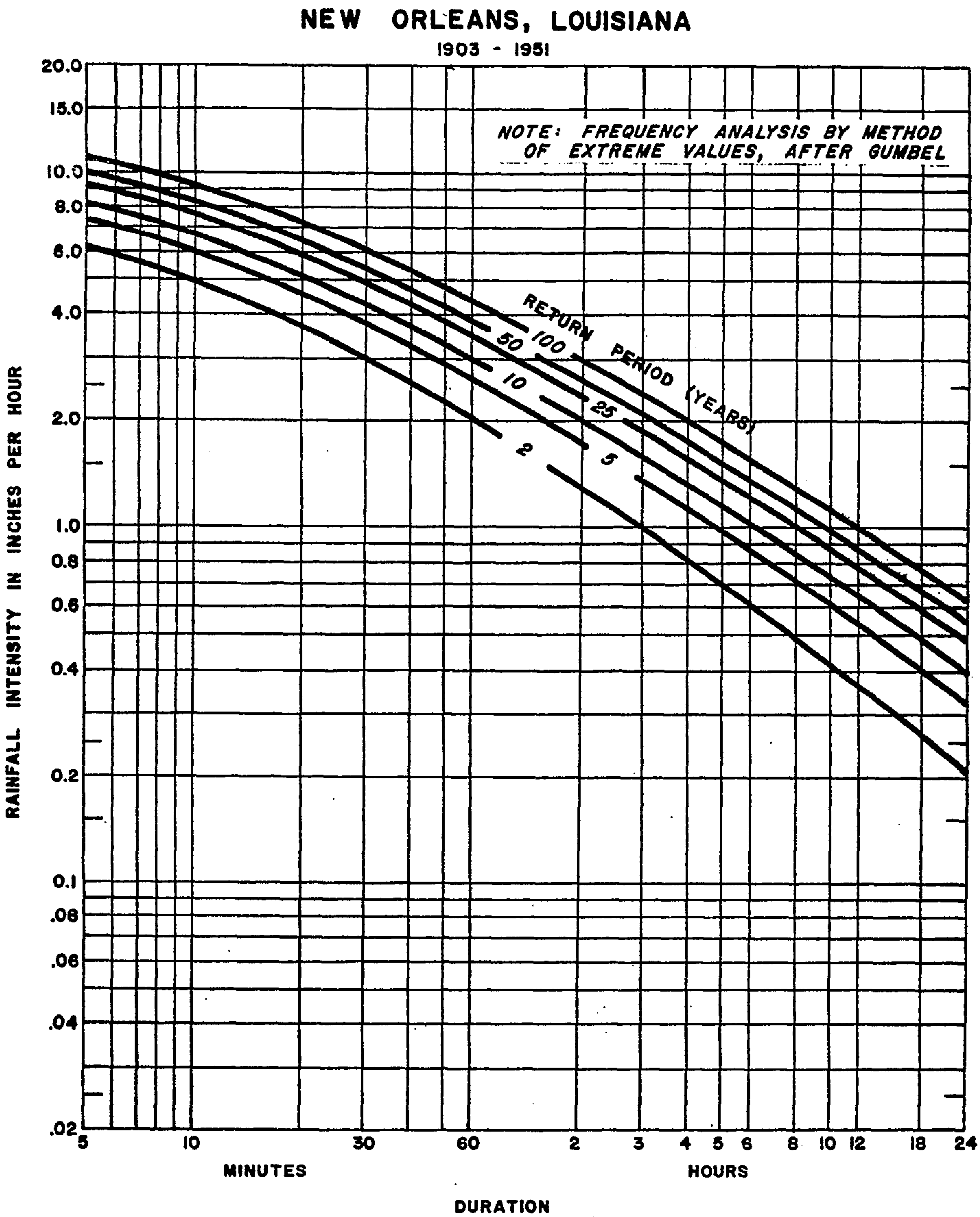



FIGURE 3.4-1 Rainfall intensity vs duration, New Orleans, Louisiana.

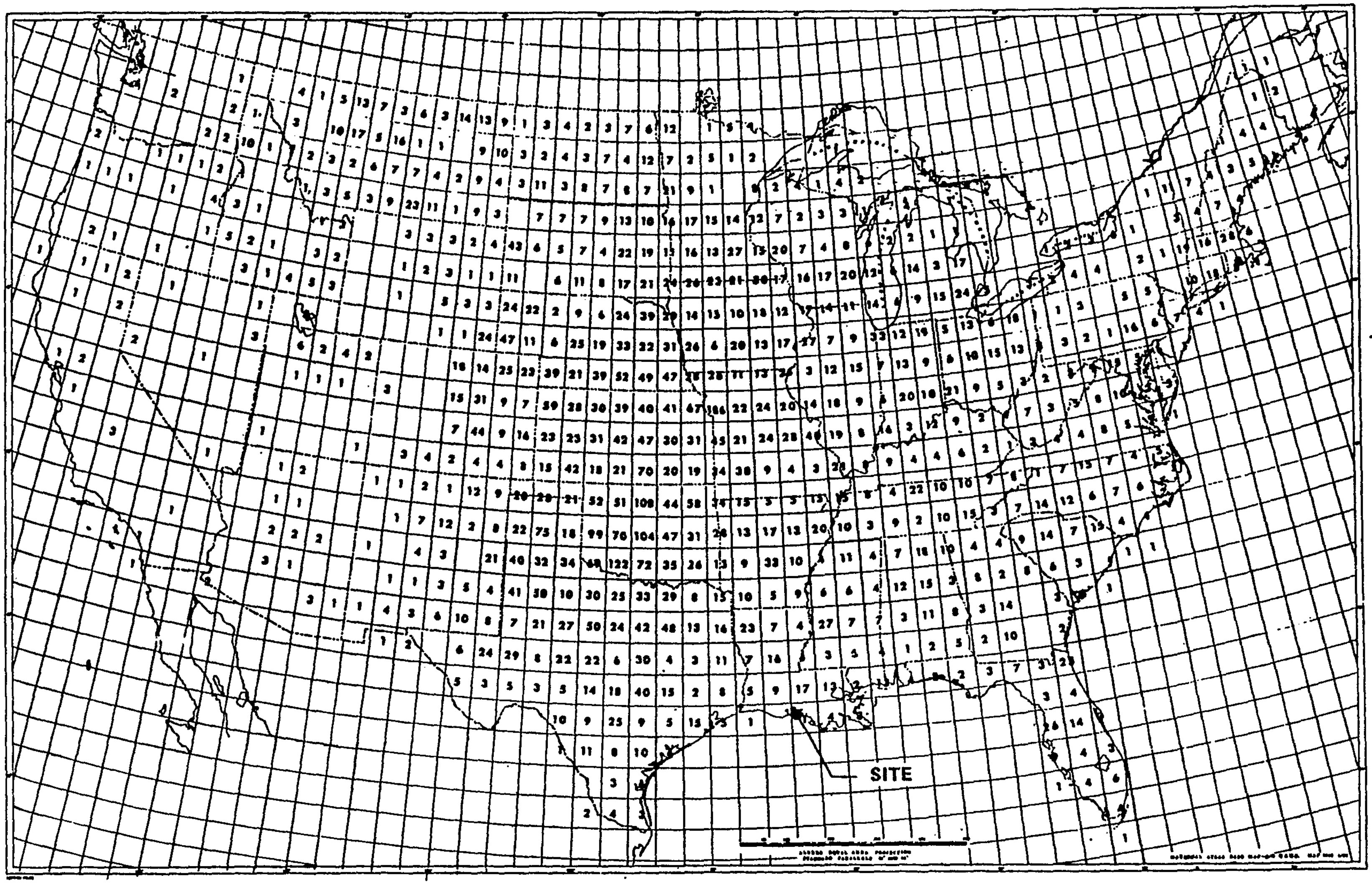



FIGURE 3.4-2. Total number of hail reports 3/4" & greater, 1955-1967 by 1° squares. (Based on SELS log).

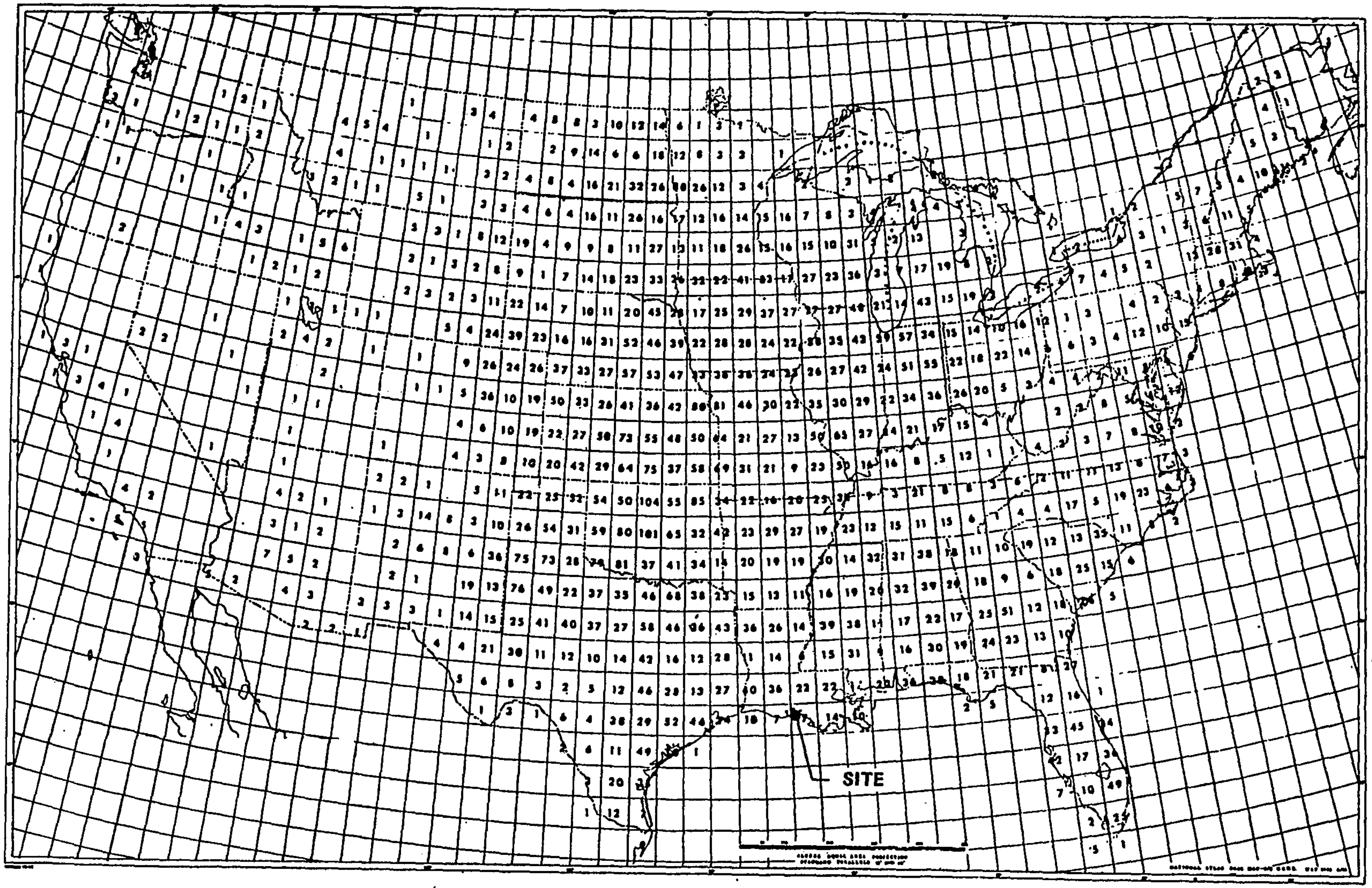



FIGURE 3.4-3. Total tornadoes 1955-1967 by 1° squares (Based on SELS log).

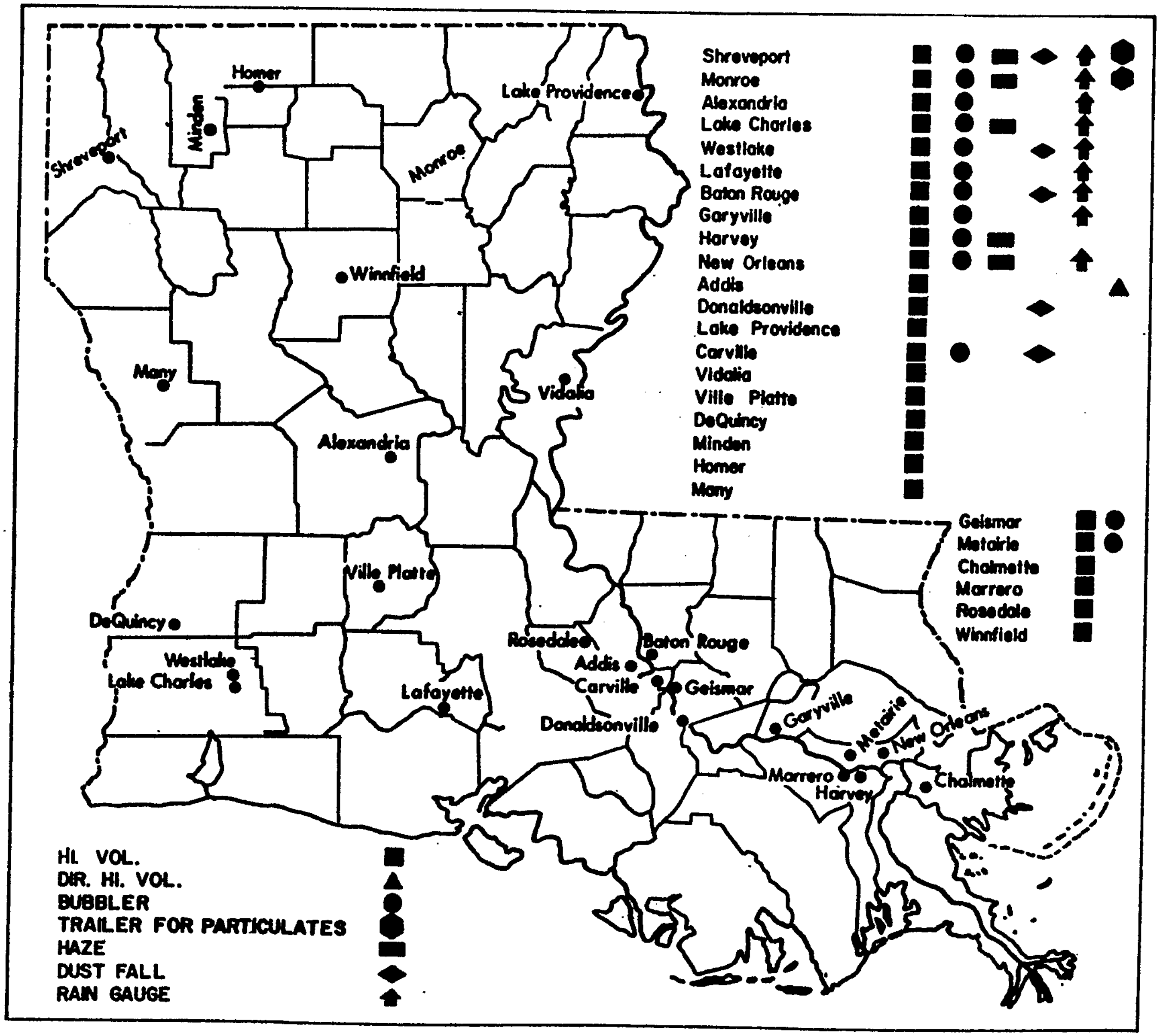



FIGURE 3.4-4. Louisiana air sampling network.

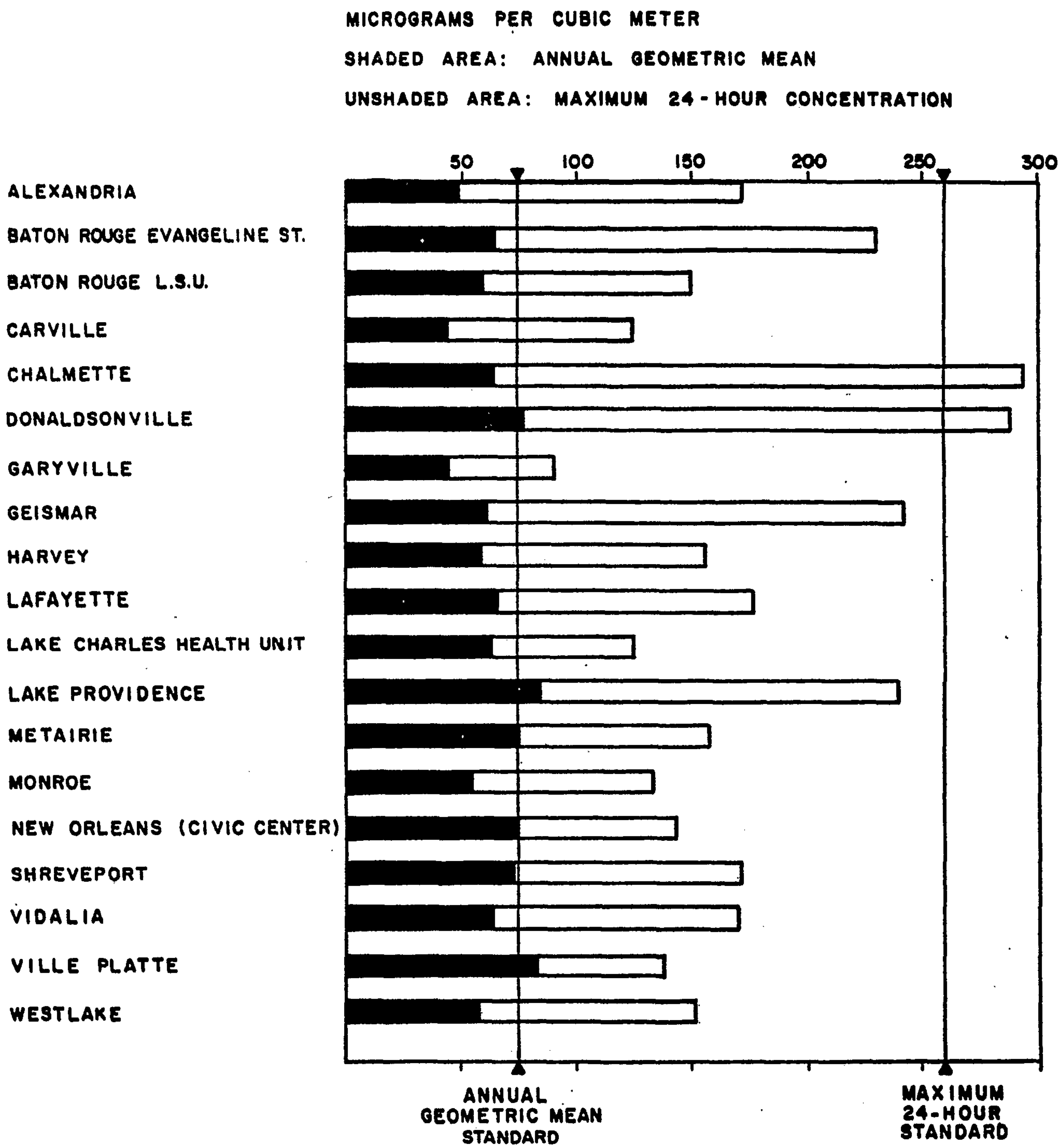



FIGURE 3.4-5. Suspended particulate, 1974.

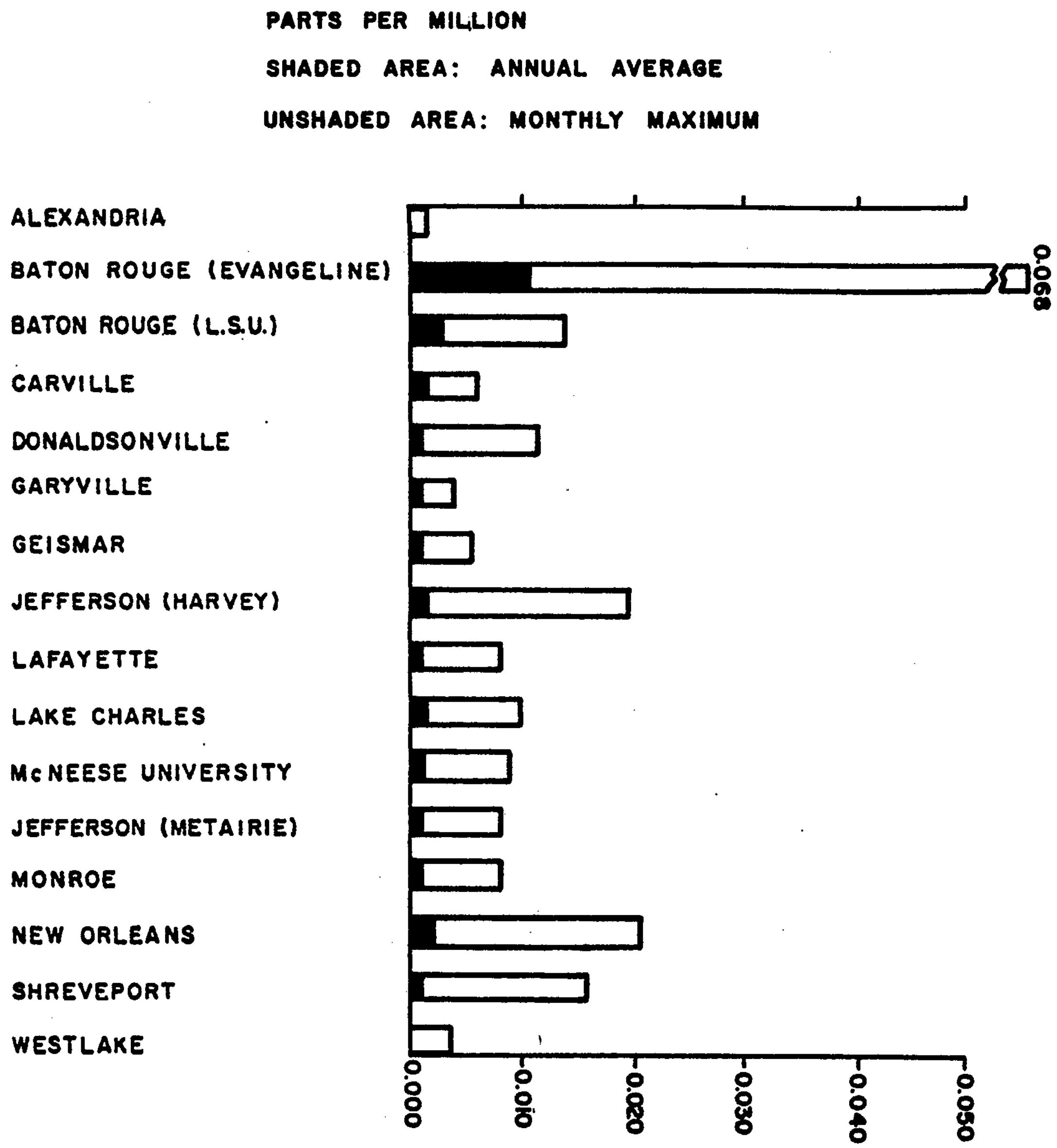



FIGURE 3.4-6. Sulfur dioxide, 1974.

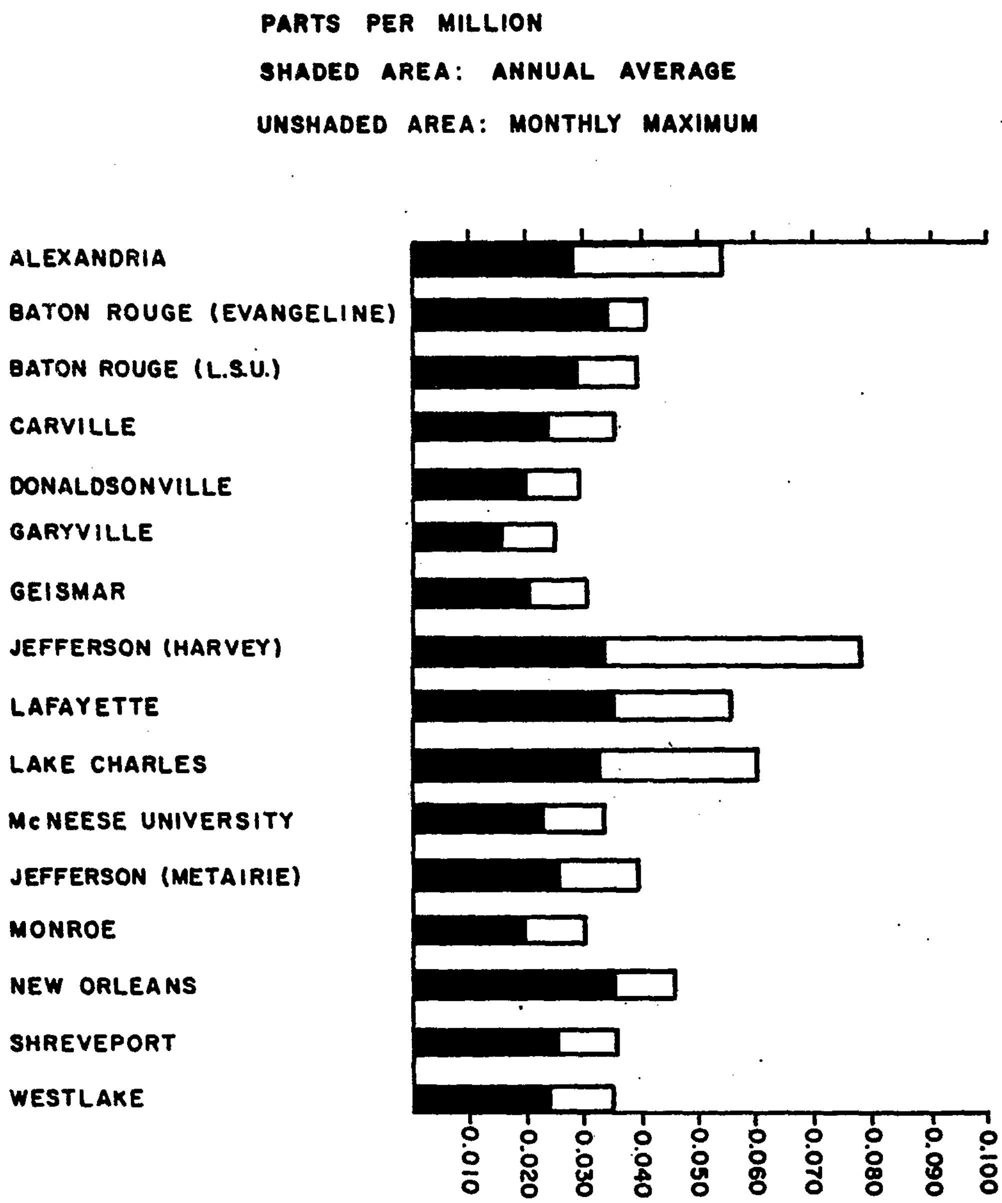



FIGURE 3.4-7. Nitrogen dioxide, 1974.

## 3.5 BACKGROUND AMBIENT SOUND LEVELS

It is important to estimate or document prefacility sound levels in order to properly assess the potential noise impact. An ambient sound survey was conducted on February 4 and 5, 1976 to provide preliminary sound data in the vicinity of Cote Blanche Island. The survey, which is described in detail in Appendix B, disclosed the background ambient sound levels at the following locations (Figure 3.5-1):

1. Center of Cote Blanche Mine site.
2. Along Intracoastal Waterway.
3. Undeveloped areas near the site.

4&5. Nearby noise-sensitive areas.

There are few sources of sound in the area on Cote Blanche Island. Only the salt mine facilities and occasional vehicle traffic disturb the background noise levels of the wind and bird life. Barge traffic and the ferry at Cote Blanche landing produce periodic noise on the ICW. Traffic on Highway 83 is relatively light. An occasional train passes through on the Southern Pacific Railroad line.

A summary of the background ambient sound levels in terms of $L_d$ (daytime), $L_n$ (nighttime), and $L_{dn}$ (day/night) at the above locations is presented in Table 3.5-1. (For a definition of the sound level terms used in this report, see Appendix B.) The values indicated in Table 3.5-1 may be compared with the levels identified by the Federal EPA as being requisite to protect public health and welfare (Appendix B).

TABLE 3.5-1 Summary of background ambient sound levels (dB)

| | $L_d$ | $L_n$ | $L_{dn}$ |
|---|---|---|---|
| Center of Site | 66 | 68 | 74 |
| Along Intracoastal Waterway | 59 | 54 | 61 |
| Undeveloped Areas | 55 | 39 | 53 |
| Noise Sensitive Land Uses | 58 | 39 | 56 |

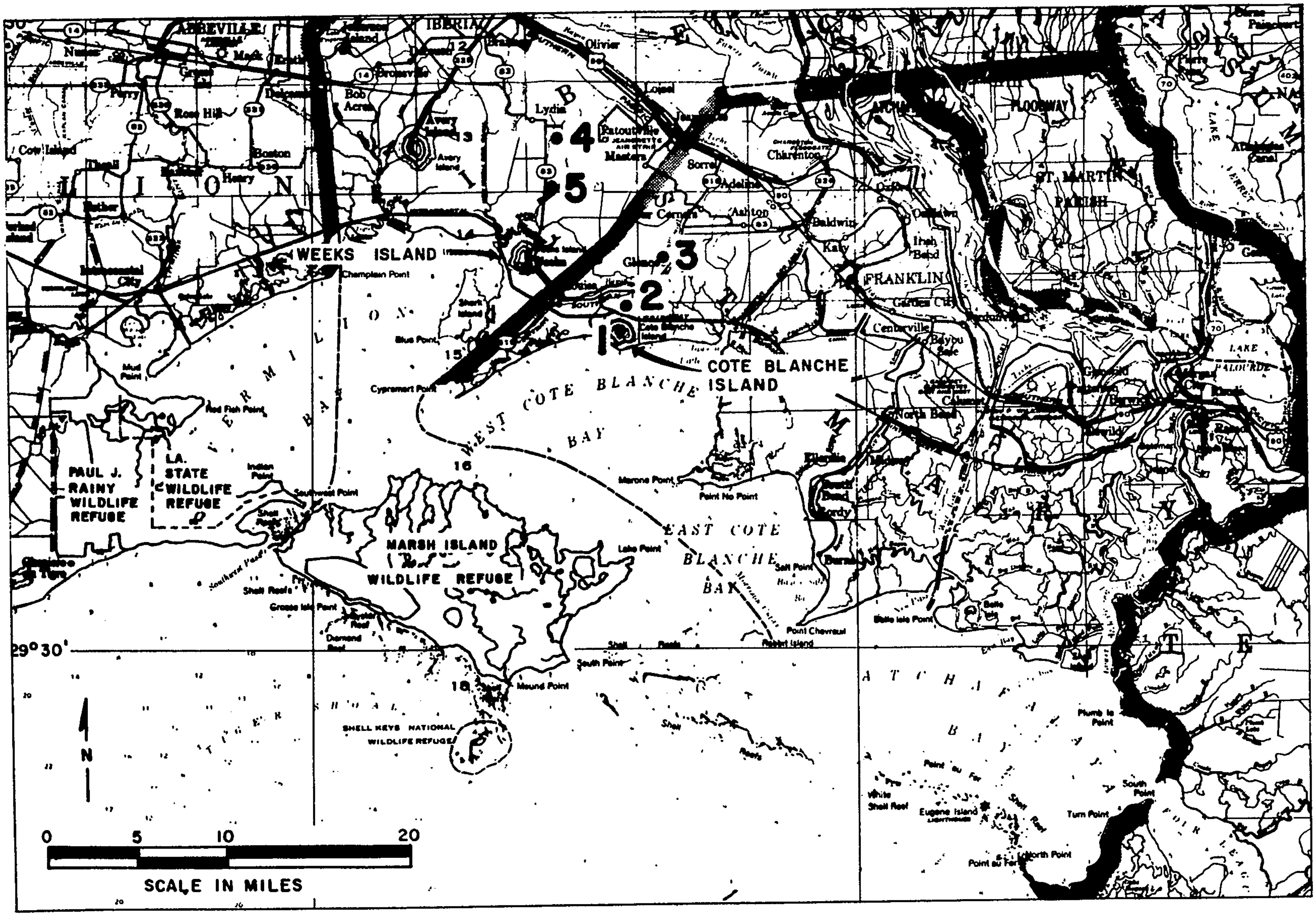



FIGURE 3.5-1 Background ambient sound level survey locations.

3.5-3

## 3.6 ECOLOGICAL CHARACTERIZATION AND BASELINE BIOLOGY

### 3.6.1 Introduction and Summary

Cote Blanche Mine is located in a section of the Gulf of Mexico that includes the "fertile fishing crescent" (Gunter, 1967) and in Louisiana is known as the coastal marshes. This marsh area covers more than 4,000,000 acres and includes parts of all 11 Louisiana parishes, which border the Gulf of Mexico (Figure 2.1-1). The main feature of the coastal area is, as the name implies, the marshland that accounts for 94.2 percent of the land area. Farm and forest lands account for the remaining 4.0 and 1.8 percent, respectively (St. Amant, 1959).

The coastal region of Louisiana is also interlaced with numerous lakes, ponds, large bays, rivers, streams, and man-made canals. These water bodies are important components of the aquatic ecosystem that acts as a large nursery ground and habitat for an array of recreationally and commercially important finfish and shellfish. Louisiana waters are very productive for shrimp, crabs, oysters, and several species of fish. The most important fisheries are located on either side of the Mississippi Delta.

Several major bays (estuaries) located adjacent to Cote Blanche Island include: Atchafalaya Bay (134,679 acres), East Cote Blanche Bay (82,314 acres), West Cote Blanche Bay (89,902 acres) and Vermilion Bay (121,604 acres; Figure 2.2-1).

During the past quarter century, the coastal habitat of Louisiana has been changing due to both natural and man-made causes such as hurricanes, river discharge, sedimentation, channelization, and canal construction. These changes may be sudden or gradual, permanent or temporary. Habitat change in turn tends to cause ecological change. For example, between the period of 1949 to 1972, Vermilion Bay changed from a predominantly coco or leafy three-cornered grass marsh to a brackish wire grass marsh (Juneau, 1975) except near the Atchafalaya River mouth where the habitat is mostly freshwater and consists of large stands of Sagittaria sp.

As one proceeds inland from the Gulf of Mexico, the coastal marshes may be divided into three distinct belts consisting of salt marsh, brackish marsh, or fresh marsh. These belts lie along the Louisiana coastline in varying widths. The spatial distribution of the marshes is determined to a large degree by geophysical factors such as surface elevation, soil characteristics, drainage, and tidal action. Each belt may be considered as a separate and unique ecosystem that produces tremendous amounts of plant and animal biomass (St. Amant, 1959).

The coastal marsh system and associated estuaries have long been noted for their diversity in both plants and animals and for their high production of organic matter and high nutrient concentrations. These nutrients are cycled through the ecosystems and are made available to the organisms in the system according to their position in the food chain. As a result, the marsh is also well known for its high production of fur-bearing animals, game animals and waterfowl. In addition, the water bodies and estuarine areas of this region are tremendous producers of aquatic organisms, thus directly supporting the abundant and commercially important shellfish and fisheries industries of Louisiana.

### 3.6.2 Regional Ecological Characteristics

The Louisiana coastal ecosystem is a complex organization of physical and biological elements. Physical characteristics such as surface elevation, drainage, and tidal dynamics control the basic form of habitats on a macroscale, while the actions of animals and vegetation are important on a smaller scale.

General types of ecosystems represented in coastal Louisiana are the swamp forest, freshwater marsh, brackish marsh, salt marsh, bays and estuaries, and open Gulf. These ecosystems are normally found in successive zones of varying widths throughout the region, depending on local surface elevation, hydrology, and salinity. Figure 3.6-1 shows the general distribution of marsh types along the coast.

From a systems ecology standpoint, each ecosystem type comprises various storages of organic matter (vegetation, animals, and their remains), nutrients, water, and soil. In coastal Louisiana, primary sources of energy and materials include sunlight, freshwater runoff, tidal flushing, migration, wind, rainfall, and the major rivers, all varying to some degree on daily, seasonal, and annual cycles. Within and between these ecosystem units flows a dynamic exchange of energy and materials that determine the structure, diversity, and productivity of the biota. Important processes include photosynthesis, grazing, predation, metabolism, decomposition, migration, reproduction, death, nutrient recycling, and physical actions such as flushing, mixing, and heat transfer.

Each system is important to the others. Swamps and fresh marshes store water during wet seasons for gradual release during droughts. Most organic matter in the swamp is stored in long-lived vegetation, which provides an extensive structural habitat for a fairly diverse group of organisms. Slightly lower elevations (more extensive surface flooding) in the fresh marsh prevent the growth of large trees, but the fairly constant physical conditions promote an abundant seasonal growth of edible grasses important to seasonal waterfowl migrants and to nutria, muskrat, and other animals. In areas where flushing action is not strong, nutrients may be recycled and organic matter decomposed or deposited within these habitats rather than being exported to other systems.

Surface drainage from the swamp and freshwater marsh mixes with small amounts of saltwater in the brackish marsh to create a habitat dominated by intermediate, though fluctuating, salinity. Again marsh grasses dominate the vegetation, though different and fewer species are prominent here than in the fresh marsh. Because of the often low velocity and two-way movement of water flow in the brackish marsh, nutrients and organic matter from upland and more saline habitats are imported and much peat is deposited in the sediments. Occasional storm tides can create highly saline conditions; upland flooding can flush most of the area with nearly fresh water. Local variations in topography can produce quite different communities under these stress conditions. The brackish marsh serves as a nursery, providing protection and a food supply for many juvenile estuarine species during the spring and early summer. Wildlife, particularly avifauna, is generally abundant, though fluctuating, as this is a type of edge habitat with shifting boundaries.

The salt marsh occupies the land immediately adjacent to the bays and open water of the Gulf and is subject to daily tidal ebb and flow. Fresh water drainage has less effect on salinity except as it affects the entire nearshore Gulf salinity regime. A fairly low diversity of marsh vegetation but great abundance of organisms live in the salt marsh year round. Vegetative productivity is high, but much of the partially decomposed litter (detritus) is flushed into the bays and open waters rather than accumulating in the marsh as peat. Many species of marine animals use the salt marsh periodically as a feeding and nursery ground. Fishing and wading birds are especially abundant adjacent to open water bodies.

The open bays, estuaries, and tidal passes provide habitat and migration routes for many species of nekton and benthos; intertidal and subtidal oyster beds are prominent structures forming microhabitat for many small organisms. Mud flats are rich in benthos. Receding tides flush detritus out of the salt marsh, into the bays, and out into the Gulf to enrich offshore waters.

Most spawning of estuarine-dependent species occurs offshore during fall and winter. Larvae often become part of the temporary zooplankton community until carried into the marshes during spring to feed on concentrated sources of detritus and other food supplies.

Other habitats, of less widespread occurrence, are important to the coastal ecosystem. Natural and man-made levees channel tidal and fresh water flows and restrict river bank flooding. The levees also provide dry land habitat for vegetation and wildlife and increase the regional diversity of environments. Barrier islands and mangrove forests protect the coastal marshes from the full force of storms and also add to habitat diversity.

Seasonal changes in physical conditions have programmed the behavior and life cycles of biota to make maximum use of resources available. Marsh grass, swamp forest, and epiphytic algal productivity are normally at a maximum in the spring, corresponding to the release of nutrients, rising temperatures, and longer hours of daylight. The spring pulse of detritus flushed from the marsh to the water bodies is met with an inmigration of estuarine nekton. During summer, reduced availability of nutrients slows onshore productivity somewhat, but the continually decomposing detritus provides nutrients for a bloom of phytoplankton in open waters. Adult forms of many aquatic species migrate back to the open Gulf. During fall, onshore vegetation biomass, decomposition rates, and benthos productivity are at a maximum. In winter, annual marsh grass growth dies, swamp forest trees drop their leaves, decomposition continues, and benthic and epiphytic algal productivity are high (due to low water levels). Wintering waterfowl arrive from the north; resident bird and animal species search for food supplies and suitable protective cover as they do throughout the year.

Thus conditions are continually changing in the coastal marsh. The influence of man is greatest on the levees and where draining and filling are practiced in wetlands. Physical conditions there are altered, and the biota either adjust or emigrate to new habitat. Since water quality, quantity, and elevation are of primary importance to the ecology, changes in these conditions and in the regional extent of the wetlands are of primary importance to a productive coastal ecosystem.

### 3.6.3 Area Biology

#### 3.6.3.1 Terrestrial Biology

The marsh in the immediate vicinity of Cote Blanche Island is classified as intermediate marsh while the marsh a short distance to the west is brackish. Cultivated crop land (sugar cane) is found a few miles north of the site; a bottomland deciduous forest occurs beyond the cropland (Figures 3.6-2 and 3.6-3).

The aquatic ecosystem of southern Louisiana has been subject to change over the past quarter century. O'Neil (1949) reported that aquatic emergent vegetation in the Vermilion Bay-Atchafalaya Bay Complex, which includes West Cote Blanche Bay, included mostly leafy three-cornered grass or coco with other outstanding plants such as black rush and brackish three-cornered grass (see Figure 2.2-1 and Table 3.6-1). He also reported a sea rim of shell and sand deposits at various locations along the beach from Freshwater Bayou eastward along the southern edge of Marsh Island and also from Point Chevreuil to Little Bay near the mouth of the Atchafalaya River. Nordern (1966) reported predominant marsh vegetation surrounding Vermilion Bay as being typical of a salt marsh. He reported wire grass, hogcane, black rush, and three-cornered grass occurring in the study area. Dugas (1970) described the marsh vegetation surrounding Vermilion Bay as predominantly brackish with extensive stands of wire grass, hogcane and black rush. Chabreck (1972) reported virtually no coco in the entire Vermilion Bay-Atchafalaya Bay Complex except near Southwest Pass at Marsh Island. Over half of the plants reported by Chabreck on Marsh Island and the peripheral edges of Vermilion Bay were wire grass. Most of the plants described near the mouth of the Atchafalaya River were freshwater species, 25 percent being bull tongue.

These investigators therefore depict somewhat of a change over the last 23 years from a predominantly coco or leafy three-cornered grass marsh to a wire grass brackish marsh except near the mouth of the Atchafalaya River, which is almost totally fresh with large stands of bull tongue.

The intermediate marsh surrounding the island is made up of such typical vegetation as wire grass, saw grass, wild millet, bullwhip and bull tongue. The intermediate marsh contains a greater diversity of plant life than the brackish marsh and is especially valuable to waterfowl and fur-bearers. All these plants are sensitive to salinity levels and while they are tolerant of some salinity, they prefer water nearer the fresh end of the scale. Salinity ranges from 5 to 10 ppt. Influxes of high salinity water during storms reduces seed germination and growth of these marsh plants. Plant growth is also disrupted by storms actually uprooting the plants (U.S. Army Corps of Engineers, 1973a).

The brackish marsh found to the west of Cote Blanche is characterized by wire grass, three-cornered grass, coco, and widgeongrass. While this marsh is exposed to the open water of West Coté Blanche Bay, it is influenced less by tides than if it were more exposed to the Gulf of Mexico. Salinity generally ranges between 10 and 20 ppt. The brackish marsh, like more saline marshes, serves as an important nursery and rearing area for many species of fish and shellfish. Waterfowl and furbearers use this marsh type quite heavily but not as heavily as they do the intermediate marsh (U.S. Army Corps of Engineers, 1973a).

North of Cote Blanche along either side of State Highway 83 is a strip of land planted in sugar cane. To the north of the cane fields is an area of swamp forest. This area is typical of much of the Atchafalaya Basin and contains bald cypress and water tupelo as the major tree species. Bald cypress is rather intolerant of shade and therefore tends to do better in wet (periodically flooded) areas where the high water excludes most other tree species.

Scattered throughout the swamp forest north of Highway 83 are islands of higher elevation that are forested with conifers. Four major southern pine species are represented on these islands: loblolly, slash, longleaf and shortleaf pine. Other tree species that may be found here are sweetgum, blackgum, hickories, and oaks. Ground cover is usually heavier on the islands than in the swamp forest because of the drier ground. The heavy ground cover of pine needles found in the island forests tends to keep other species from establishing themselves. The hardwoods in the forests usually form a significant middlestory, which affords browse for deer and other upland game animals.

3.6.3.2 Aquatic Biology

The area surrounding Cote Blanche Island contains many waterbodies such as freshwater lakes and ponds, large rivers and streams, estuaries, bays and canals. Collectively, these waterbodies are important components of a vast nursery ground for an array of commercially and recreationally important finfish and shellfish. The total coastal land area within the Louisiana Coastal Zone is nearly 3.7 million acres; the total surface water area amounts to nearly 3.2 million acres, which nearly equals the land area (Barrett, 1970).

The Gulf of Mexico borders the coast on the south. The open bays, estuaries and tidal passes along the coast provide habitat and migration routes for many marine species of nekton and benthos. Intertidal and subtidal mud flats and oyster beds are prominent biological features which form microhabitat for many small organisms. The mud flats are rich in benthos. Tidal movement and currents flush detritus out of the salt marsh, into the bays, and out into the Gulf to enrich offshore waters. Most spawning of estuarine-dependent species occurs offshore during fall and winter. Larvae often become part of the zooplankton community until carried into the marshes during spring to feed on concentrated sources of detritus and other food supplies.

Other habitats such as natural and man-made levees are important to the coastal ecosystems. These levees divert tidal and freshwater flows and also restrict river bank flooding.

3.6.4 Ecology of Louisiana Salt Dome "Islands"

There are five salt dome "islands" in Iberia and St. Mary Parishes (Figure 3.6-2). These domes, known as the Five Islands, are (from east to west) Belle Isle, Cote Blanche Island, Weeks Island, Avery Island and Jefferson Island. The island diameters range from approximately 1 to 2 miles. The maximum elevations vary from 50 to 180 feet above sea level. The high elevations make the islands unique in an area where the surrounding marshland has elevations usually of less than 5 feet above sea level. The islands provide habitat for plants that would normally not occur in the area if it were not for the increased elevation and the improved drainage of the island surface.

The Five Islands have a wide variety of vegetative types (Reese and Thieret, 1966) ranging from marsh to mature forest. The forests are of a type similar to upland hardwoods. Dominant trees on well-drained islands are hickory, pecan, magnolia and live oak. Yaupon and French mulberry are the major components of the understory in these areas. Dominant tree species in the more poorly drained woods are hackberry, sweetgum, water oak, and American elm. Other trees, shrubs, and vines found on the islands are listed in Appendix C. Several species of grasses, ferns, liverworts, and mosses are also found in the forest openings on the islands. Some of the ferns and mosses are unique in Louisiana, being normally found only in tropical America and Florida.

The fauna that utilize the five islands are as varied as the habitats with which they are associated. Marsh and water birds are found in the surrounding marsh, while upland species utilize the islands themselves. During the 1890's, E. A. McIlhenny observed ivory-billed woodpeckers nesting in the mature cypresses of Avery Island. Since that time, the ivory-bill has been observed only in the northern parishes of the state. Upland species like the black bear and bobcat are found on several of the islands, while marsh-dwelling mammals such as the muskrat and mink are in the adjacent marshes.

### 3.6.5 Ecology of Cote Blanche Island

#### 3.6.5.1 Terrestrial Ecology

Vegetation

The vegetation on Cote Blanche Island is quite varied. The island itself is characterized by upland hardwood species whose existence is made possible by the higher elevation afforded by the island's topography and the presence of very fertile loam as a soil base. Naturally occurring freshwater lakes are found in depressions on the island. Aquatic vegetation characteristic of a freshwater environment is found here.

The island is heavily forested with upland hardwoods, which occur primarily on moist sites. The dominant trees are live oak, magnolia and hickory with a conspicuous understory of yaupon, French mulberry and immature trees. The trees are quite large, many reaching heights of 60 to 70 feet and in many areas form a fairly closed canopy. The oak-hickory-magnolia association extends down to the surrounding marsh. There is no fringe of cypress near the marsh as is found on other upland areas. Vines and understory plants are quite dense along roadsides and transmission line corridors. Heavy accumulations of leaf litter do not occur on the island because high temperatures and abundant rainfall aid fast decomposition. However, the litter accumulation is substantial enough to discourage heavy ground cover such as grasses and forbs. Grasses are present along roadsides and corridors as well as the pasture area in the southeast portion of the island. Cattle and sheep are allowed to graze on the island and probably obtain most of their forage in the open areas of the island (see Figure 2.1-2).

The dominant, mature trees on Cote Blanche Island are of limited commercial importance. The hickories, magnolias and live oaks found here are not prime marketable species. Although they can be used in the timber industry to some extent, they are not abundant or important enough to warrant a lumber harvest on the island. In addition, the serious hurricanes that struck the Louisiana coast in 1964 (Hilda) and 1965 (Betsy) inflicted great damage to the forested portions of the island. The old tall trees, which were rooted in the soft loess-type soil, were uprooted in large numbers.

## Insects

The numerous habitats in the immediate Cote Blanche area offer a variety of niches for a host of insects. One important group of insects in the marsh areas surrounding Cote Blanche are primary consumers such as grasshoppers. These insects are grazers that remove significant amounts of herbaceous growth in marshlands. It has been estimated that grazing insects account for the removal of about 4 percent of the net primary production in the salt marshes of Georgia and 10 percent in fresh marsh systems (Teal, 1962). If the assumption that insects increase in functional importance as salinity decreases (Louisiana State University, 1975) is correct, then it may be assumed that insects in the brackish or intermediate marsh play an intermediate role in removal of herbaceous material and account for removal of approximately 7 percent of net primary production. There is no evidence to indicate that either more or less insect grazing occurs in Louisiana coastal marshes.

One point can be made regarding insects inhabiting brackish environments. A recent study of dragonflies (Odonates) in brackish waters found few endemic species in these areas because specialization in the habitat possibly limited permanence (Corbet, 1965). Brackish marshlands contain mixed invertebrate communities that have developed a wide range of salt tolerance.

There are numerous blood-sucking insects inhabiting the marshes and upland habitat on the island. These insects are considered pest species and are of direct importance to man. They may also be significant as vectors of arborviruses to animals and man. These insects (Table 3.6-2) include mosquitoes, biting midges and horseflies. The life cycles of these insects include an aquatic stage that makes the presence of wetland areas such as swamp forest and marshland important to their survival. Spiders and voracious insects such as dragonflies are important predators of pest insects as well as other insect species and thereby contribute to keeping these insects in check.

## Amphibians and Reptiles

The amphibians and reptiles that may inhabit Cote Blanche and the surrounding marshes are listed in Table 3.6-3. All of these species with the possible exception of the Gulf salt marsh snake and the diamond-back terrapin are probably residents of the island. Salamanders and newts eat fish fry, small crustaceans, and aquatic insects. Frogs, toads, and lizards consume enormous quantities of insects. Turtles in the marsh and wet areas of the island are primarily aquatic in nature and feed on tadpoles, crawfish, mollusks, insect larvae, and small fish. The snakes have quite varied diets according to their habitat preferences. The water snakes feed on insects, amphibians, and fish. Upland snakes such as the ribbon snake, yellow-bellied racer, and kingsnake eat insect larvae, birds, eggs, and small mammals. The Western cottonmouth is a voracious and often vicious snake that is extremely abundant in the swamps and bayous of Louisiana. This species has an especially varied diet which includes fish, frogs, salamanders, snakes, lizards, small turtles, baby alligators, birds, and small mammals (Conant, 1958).

The American alligator is an endangered species but appears to be doing quite well in the marshes of southwest Louisiana. Alligators prefer freshwater habitats where they prey on anything they can over-power. Food items range in size from crawfish and fish to birds and mammals as large as dogs and pigs. Alligator numbers are probably greater in the fresh marsh to the north of Cote Blanche than in the intermediate and brackish marshes immediately around the island. The freshwater lakes located on Cote Blanche itself are undoubtedly suitable habitat for alligators.

Birds

The unique range of habitats at Cote Blanche provides an assortment of living space to the bird population that uses the Louisiana coastline. For this reason, the birds of the area are one of the most numerous and important species that may inhabit the site. The marshland adjacent to the dome is classified as intermediate marsh, which is prime habitat for waterfowl. There are 30 species of ducks and 6 species of geese that overwinter in Louisiana (Table 3.6-4). At least five duck species are known to breed in the state including the mottled duck, blue-winged teal, wood duck, hooded merganser, and fulvous tree duck.

The duck species can be divided into dabbling ducks and diving ducks. Dabbling ducks are predominantly attracted to fresh marsh habitats but are found in low salinity intermediate marshes such as those in the area of Cote Blanche where the great diversity of plant life can support large numbers of ducks. The dabbling ducks, also known as puddle ducks, are the most prized species of waterfowl for the Louisiana hunter and comprise the most important segment of the state's waterfowl population (Louisiana Wildlife and Fisheries Commission, 1961).

The major dabbler species found in this area are the mallard, mottled duck, gadwall, pintail, green-winged teal, blue-winged teal, baldpate, and shoveler. The mallard is probably the most important duck species in the coastal Louisiana region.

Dabblers are migratory ducks, and the first fall flights start entering the state with the early arrival of blue-winged teal in August and September. Pintail arrive in early October and November; mallards arrive late appearing primarily in November and December (Louisiana Wildlife and Fisheries Commission, 1959). It is not clear what portion of the state's waterfowl population goes directly to the coast and what portions linger in north Louisiana. Once the ducks do reach the marsh areas, however, they tend to congregate and move to various feeding areas in the marsh. At no one time are ducks found over the entire marsh.

Dabbling ducks feed on many aquatic plants such as water lily, duckweed, pondweed, smartweed, and rushes. Seeds and tubers are relished by these ducks in addition to the vegetative parts.

Diving ducks also occur in the intermediate marsh and adjacent open water of West Cote Blanche Bay. These ducks include the redhead, ring-necked duck, canvasback, goldeneye, bufflehead, and scaup. Divers congregate in open water where they feed on submerged vegetation such as widgeon grass. Lesser scaup are found in great numbers in offshore areas, while ring-necked ducks are most common in the marshes. An estimate of waterfowl in the southwest Louisiana marshes during December 1972 showed 31,000 ringnecks and 4,000 scaup in the marsh with an additional 150,000 scaup offshore. Obviously, the Louisiana hunters have less success with divers than with dabblers. A study of hunter-kill by species in the coastal marshes shows divers accounting for 11 percent of the total kill, of which ringnecks amounted to 6 percent; dabblers accounted for 80 percent of the total kill with mallards estimated at 44 percent (Louisiana Wildlife and Fisheries Commision, 1959). In this same study, coots amounted to 4 percent of the kill and geese figured at 3 percent.

Snow geese are also quite abundant in the southwest Louisiana coastal marshes. The lesser snow goose is especially abundant in this area during winter and may congregate here in greater numbers than in any other place in the world. (The blue goose has recently been determined to be a dark color phase of the lesser snow goose; references to the lesser snow goose in this text correspond to statements about the blue goose in references cited herein.) Lesser snow geese gather in tremendous flocks and can overgraze to the extent of actually denuding areas in the marsh of all vegetation (O'Neil, 1949). These geese feed on root stocks and tubers of sedges and grasses with preference being shown for scirpus grasses. Canada geese are also found in this area of the state but their numbers have been declining for years and they are no longer a game species in Louisiana.

All of the above-mentioned waterfowl species may occur in the vicinity of Cote Blanche. Waterfowl hunting is quite popular in the marshes surrounding Cote Blanche, and permanent duck blinds have been established throughout the marsh. These blinds are in great demand and competition runs high for leasing them (Domtar Chemicals, Inc., personal communication). The blinds are accessible only by boat. No data are available on hunter success in this area. No hunting is allowed on the island itself.

Though especially important for waterfowl, the marshes serve as habitat for many shore and wading birds and resident passerine species. The common snipe is an abundant winter resident of the marshes and lake shores. Other common winter birds of the marsh are the marsh hawk, sora, gull-billed tern, tree swallow, short-billed marsh wren, and sharp- tailed sparrow. Less common birds seen in the winter are the pigeon hawk, Virginia rail, black rail, short-eared owl, and smooth-billed ani. The least bittern is common in the summer months; the reddish egret is uncommon to rare. Some birds such as the greater and lesser yellowlegs and the bank swallow are migrants through the marshes.

Many birds are year-round residents of the marshes. The willet is an abundant permanent resident of coastal Louisiana as are the boattailed grackle, red-winged blackbird, and fish crow. Other common residents include the great blue heron, common egret, snowy egret, Louisiana heron, black-crowned night heron, yellow-crowned night heron, American bittern, king rail, clapper rail, Caspian Tern, long-billed marsh wren, yellow-throat and seaside sparrow. The common gallinule is occasionally seen. The mottled duck is a resident of the marsh that utilizes both fresh and brackish marshes (U.S. Army Corps of Engineers, 1973b).

Although there are no expanses of sandy beach areas near the Cote Blanche site, it is quite likely that fishing and probing birds frequent the area. Forster's tern, the royal tern and the black skimmer are common residents. The brown pelican, an endangered species, is also a resident.

The ring-billed gull is an abundant winter visitor in the coastal area. A few immature birds and some very old ones occasionally do not migrate and may be seen throughout the summer. The herring gull is a common winter visitor; the common tern is seen occasionally and the white pelican is rare. In the summer, the least tern is common and the black tern and sandwich tern occasional. Franklin's gull is occasionally seen during migration (U.S. Army Corps of Engineers, 1973b).

The sand probers are very common shore birds. The short-billed dowitcher is a common resident; the Wilson plover, another resident, is seen occasionally. Many shore birds are seen only during migration: the semipalmated plover, semipalmated sandpiper, western sandpiper and white-rumped sandpiper are common migrants. The piping plover and the knot are occasionally seen during migration. Winter shore birds are the black-bellied plover, long-billed curlew, least sandpiper, dunlin and sanderling, all of which are common. The snowy plover, longbilled dowitcher and the burrowing owl are all occasionally seen in the winter. In the summer there are fewer shore birds; the residents are present plus the ruddy turnstone, which is common, and the American oystercatcher, which is rare (U.S. Army Corps of Engineers, 1973b).

The upland hardwood forest found on Cote Blanche Island itself is desirable habitat for a multitude of birds that would normally not be found this near the coast of Louisiana. Common residents known to live in wooded areas in south Louisiana are the red-headed, red-bellied, hairy and downy woodpeckers. The pileated woodpecker is less common but may be found on the island. Small birds such as the Carolina chickadee, tufted titmouse, brown-headed nuthatch, Carolina wren, and chirping sparrow are common year-round residents. Common winter visitors are yellow-bellied sapsucker, eastern phoebe, hermit thrush, ruby-crowned kinglet and solitary vireo. Winter visitors, which are only occasionally seen, are the pine siskin, slate-colored junco, woodcock, white-winged dove, red-breasted nuthatch, brown creeper and gold-crowned kinglet. Birds found only in the summer months are the parula, Kentucky and hooded warblers, eastern wood peewee, red-eyed vireo, and American redstart. Raptors that may be found on Cote Blanche include the Cooper's hawk, red-shouldered hawk, red-tailed hawk, sharp-shinned hawk, great horned owl, barn owl, screech owl and peregrine falcon.

Mammals

The Cote Blanche site and surrounding area provide habitat for a variety of mammal species. Each species generally finds its requirements in specific habitats; therefore, the mammals occurring on the site will be discussed according to the habitat types they may occupy.

Cote Blanche Island is forested for the most part with upland coastal hardwood species. Numerous herbivores ranging in size from small rodents to whitetail deer probably occur here. Table 3.6-5 provides a list of mammals that may occupy the Cote Blanche area. Rodents that find the habitat on Cote Blanche attractive include the white-footed mouse, cotton mouse, cotton rat, and eastern wood rat. These species have varied diets that frequently include insects but are primarily made up of seeds, fruits, tubers, and foliage. Rodents such as the roof rat, norway rat, and house mouse have been introduced by man and have become established worldwide. These species prefer to live in close proximity to man and probably occur around the cattle barns and buildings of Cote Blanche.

Several bats may be present on Cote Blanche. The most common bats here would be those that roost in trees rather than buildings. Inhabitants of the island, therefore, would more likely be yellow bats and evening bats rather than the free-tailed bats. These flying mammals would find incredible numbers of flying insects to feed on over the water bodies and grassland in the nearby marshes.

The armadillo is known to exist on Cote Blanche although it is not a native. This species has been expanding its range from central America for the past 100 years and is now found statewide in Louisiana. This interesting creature feeds on earthworms, insects, and insect larvae, which it locates by incessant digging in the top soil.

The swamp rabbit and gray squirrel are also present on the site. Rabbits eat succulent herbaceous vegetation, which may be found throughout the understory of the island. The squirrel has a very ample food supply in the numerous live oaks and hickories, which supply acorns and nuts, found on the island.

Other mammals on the island are raccoons, bobcats, mink, otter, nutria, white tail deer, and black bear. Raccoons are found in a variety of habitats but prefer to be near water. Their diet includes anything vegetable or animal that can be subdued. They relish crawfish, crabs, clams and fish when near fresh water and feed heavily on any fruit or nut in season as well as numerous insects, birds, small mammals and amphibians. Bobcats are carnivores and depend heavily on rabbit as well as squirrels, small rodents, and birds. The bobcat and the raccoon are basically nocturnal and prefer areas offering good concealment during the daylight hours.

The mink, nutria, and otter are fur-bearers living in aquatic habitats. The mink, otter and nutria prefer freshwater habitats and may be found in the vicinity of the lakes. The mink and otter are voracious carnivores feeding on fish, aquatic invertebrates and even birds and small mammals. The nutria is a vegetarian and eats huge amounts of aquatic grasses, rushes and other succulent plants. It was introduced from South America in the 1930's and is now found statewide and recently replaced the muskrat as the state's most important fur-bearer.

The whitetail deer is found throughout the eastern United States in a variety of habitats. It is a browser rather than a grazer like cattle. Preferred browse in Louisiana include French mulberry, several hollies, smilax, blackberry, and numerous vines all of which are available on Cote Blanche. Of special importance to deer are oak mast and wild pecans, which are also found on the site in the form of abundant live oaks and pecan trees. The relative protection afforded by the island gives the deer an almost ideal habitat on Cote Blanche.

The black bear is a large mammal that was once quite abundant in Louisiana. It still exists in many protected areas such as the deep swamps of the Atchafalaya Basin and inaccessible areas like the Five Islands, which include Cote Blanche. This large omnivore includes an occasional mouse or squirrel in its diet but feeds mostly on live oak mast, wild berries and fruits and honey. The abundance of live oaks and berry bushes together with the island's inaccessibility make the site very attractive to the bear.

Three hundred cattle and several sheep are grazed all over the island. The abundant ground cover as well as the pasture on the southeast side of the island afford sufficient food for these domestic species.

The marshes surrounding Cote Blanche are typical fur-bearer habitat. The intermediate marsh is fine habitat for nutria, mink, otter and raccoon. The brackish marsh is better suited for the muskrat, while raccoons and minks may also be found here. Rodents such as the rice rat and harvest mouse would also occur in the marsh areas.

Several bat species probably feed above the marshes and the swamp rabbit may be found in both marsh types. Although the whitetail deer is primarily a browser, it may venture out into the intermediate marsh to feed on succulent aquatic plants.

The sugar cane fields north of the site are prime habitat for all the rodent species named with the possible exception of the squirrel. The swamp rabbit as well as the eastern cottontail may also be found here.

The swamp forest north of Highway 83 is excellent habitat for many mammal species. Nearly every species already mentioned may occur here.

It is possible that the red and gray foxes are found here. This area is the southern extent of their range in the state, but it is typical fox habitat.

### 3.6.5.2 Important Terrestrial Species

#### Commercially Important Species

Fur-bearers - Louisiana leads all other states in fur production. More furs are taken here than in any other state (U.S. Army Corps of Engineers, 1973b). Twelve species of fur-bearing animals are commonly found in Louisiana: nutria, muskrat, mink, otter, raccoon, opossum, beaver, gray fox, red fox, striped skunk, bobcat and alligator. The first five species are considered the backbone of the fur industry and are found mostly in the swamps and marshes of coastal Louisiana. Nutria and muskrat are almost exclusively confined to the marsh; the majority of the mink and otter are taken from the marshes. Raccoon and opossum prefer bottomland hardwoods but are also taken in the marsh. The remaining animals, with the exception of the beaver and alligator, are found more or less evenly distributed over the upland portions of the state (St. Amant, 1959). The beaver was at one time extirpated from most of Louisiana but was reintroduced in the late 1930's and has reestablished itself in the northern half of the state (Lowery, 1974).

Fur-bearers are an important commercial item in Louisiana. Of the average 4327 trappers licensed each year since 1970, a majority reside in the coastal marshes. Most of these trappers make their living from fur production, and recent fur values indicate it could be a good living. Annual average fur value has fluctuated over the years but values since 1970 have averaged over 5 million dollars per year with fur values for the 1972-1973 season amounting to $9,628,831. The highest single year was attained during the 1945-1946 season when fur value reached $15,553,185. This last figure is for a total of 8,869,609 furs while the more recent 9 million dollar figure is for 2,180,332 furs (Lowery, 1974). Another source of income from fur-bearers is the commercial market for the carcass. The meat is used in pet food processing and in some areas for human consumption. Commercial income from these meat sales for the 1967-68 and 1968-69 seasons amounted to $854,000 and $1,100,000, respectively (Palmisano, 1971).

The American alligator is classified as a fur-bearing (hide-bearing) species in certain portions of Louisiana. This is of special significance as the alligator is listed as a rare and endangered reptile throughout the remainder of its range in the United States. Overhunting and habitat destruction had reduced populations to an all-time low in Louisiana during the 1950's. Conservation measures brought about by local, state, and Federal agencies closed the hunting season and helped control poaching. The result was that by the late 1960's, the alligator had made a dramatic comeback in many coastal areas. The alligator numbers increased to the point where an experimental hunting season was implemented to help control the overpopulation. Hunting seasons were opened in certain areas during 1972 and 1973 with satisfactory results (O'Neil and Linscombe, 1975). The Fish and Wildlife Service has officially reclassified the alligator in the parishes of Cameron, Vermilion, and Calcasieu in south-western Louisiana. The alligator is now considered threatened in these parishes (Federal Register, 1975). A state-controlled hunting season was instigated during the fall of 1975. The number of alligators harvested, location of hunting areas and sale of hides will be closely controlled by the State Wildlife and Fisheries Commission to insure that only the excess animals are harvested from these overpopulated parishes.

Game Species - Game species of major importance to the sportsman in the coastal marsh region are, in order of importance, the rabbit, waterfowl and squirrel. The coastal region is of primary importance to the waterfowl hunter and accounts for 75 to 80 percent of the state's harvest every year (Burts and Carpenter, 1975). Game species may be considered of commercial importance in terms of the revenue sportsmen generate through hunting activities, which include procuring hunting licenses, leasing hunting land, and purchasing food, clothing, lodging, and supplies while in the hunting area.

Recreationally Important Species

Game Species - Hunting and fishing are the main source of outdoor recreation in Louisiana. The state residents participate in these activities at much higher rates than the national average, but at lower rates than the national average in many other forms of recreation (U.S. Dept. of Interior, 1972).

Coastal Louisiana is ideally suited as a recreational resource due to its mild climate and abundance of certain game species. Much of the marsh areas are not fully utilized, however, because of their inaccessibility.

In terms of popularity, the number one game species in this region is the rabbit; waterfowl rank second and squirrel are third. Most rabbit hunting occurs in bottomland hardwoods and fresh and intermediate marsh types. The squirrel is hunted primarily in forested areas of the coastal region. Waterfowl are the main game species found primarily in the coastal marshes. The habitats provided in the marsh and adjacent water bodies and estuaries are important attractants to the 6 to 8 millions of waterfowl that annually overwinter in coastal Louisiana (Burts and Carpenter, 1975).

Waterfowl species available to Louisiana sportsmen include blue-winged teal, green-winged teal, mallard, gadwall, American widgeon, pintail, shoveller, lesser scaup, mottled duck, American coot, clapper rail, purple and common gallinules, and lesser snow goose.

The state wildlife management areas are one of the major waterfowl hunting areas in the region; the hunters are almost exclusively local residents. An idea of the intensity of waterfowl hunting that occurs in this region can be obtained from figures taken from the 1973-74 waterfowl season, which showed duck and geese hunting amounted to an estimated 284,400 and 72,400 man-days, respectively (Louisiana Wildlife and Fisheries Commission, 1974).

Threatened and Endangered Species

In 1966 the Endangered Species Conservation Act was passed to prohibit the taking or possession of native endangered fish and wildlife. Other legislation has given special protection to migratory birds (Migratory Bird Treaty Act of 1965), to eagles (Bald Eagle Act of 1940) and to marine mammals (Marine Mammal Protection Act of 1972).

Various states have placed certain resident wildlife species under special jurisdiction providing protection to the species as well as important habitat. Endangered plant species have received recognition only recently. The U.S. Fish and Wildlife Service published a listing of endangered plants by state during 1975. Data are being gathered to determine which plant species are endangered and, when sufficient data are recorded, a formal proposal will be made to list these species under the Endangered Species Act.

Three species of plants from Louisiana are currently under consideration for inclusion in the list of endangered and threatened wildlife and plants. All three are under consideration as an endangered species. (Table 3.6-6).

The coastal region of Louisiana is habitat for at least one species of endangered terrestrial mammal, the red wolf (Canis rufus; see Table 3.6-7). The red wolf has been extirpated from most of its former range, which included much of the southeastern United States. The only place where pure populations are known to occur is in the coastal prairie marshes of east Texas and southwestern parishes (Cameron and Vermilion) of Louisiana (U.S. Fish and Wildlife, 1973). The red wolf is present in other sections of the state, but it has probably hybridized with the coyote, since the coyote has expanded its territory into much of the southeastern United States.

Four species of birds listed as rare and endangered species have been known to occur in Louisiana coastal marshes: the eastern brown pelican, southern bald eagle, American peregrine falcon, and ivory-billed woodpecker. The brown pelican is the state bird of Louisiana and was formerly a common resident and bred along the coast. This pelican was extirpated in the early 1960's, but a new breeding stock of pelicans was brought from Florida to reestablish a nesting colony on Queen Bess Island in Barataria Bay. The colony seemed to be progressing quite favorably in 1974 when 200 adults and 100 nestlings were observed (Mabie, 1975). Recent observations reveal that this or a nearby colony experienced an unexplained die-off during the fall of 1975; the number of birds remaining through the winter season is currently unknown (J. B. Kidd, personal communication).

The southern bald eagle is found primarily in estuarine areas of the Atlantic and Gulf coasts. Eagle populations are generally decreasing throughout its range. Nesting pairs are still to be found along the

Louisiana coast. Eagles nest in the tops of large trees and commonly repair or rebuild nests in the same location for many years. The result is a tremendous accumulation of nest material weighing hundreds of pounds (Bent, 1961). The eagle feeds almost exclusively on fish, thus its presence in the marsh is determined to a large degree upon its fishing success.

The peregrine falcon may occur in the marsh but is also a resident of woodland areas as well. The falcon feeds primarily on other birds which range in size from nuthatches to mallards. This raptor commonly nests on high cliff faces but has been known to nest in trees in bottomland or in marsh habitats.

The ivory-billed woodpecker was reported on Avery Island during the 1890's by E. A. McIlhenny. The last observations of the ivory-bill in the state were from north Louisiana (Franklin and West Carroll Parishes) in the 1930's (Bent, 1964). This woodpecker prefers a habitat consisting of large tracts of mature timber where it can construct nest cavities and feed on wood-boring insects. It is quite doubtful that this species now occurs in the Louisiana marsh.

Twelve other species of birds that may occur in the coastal marsh are listed in the "Blue List" (Table 3.6-8), which is a list of birds experiencing difficulty in maintaining reasonable population numbers. This list is compiled and maintained by the American Ornithological Union. The birds thus listed are carefully watched and studied to determine their current status and future potential as a continuing species.

Four reptilian species that occur in the coastal region of Louisiana and are currently considered rare and endangered are the American alligator, the Atlantic Ridley turtle, the Atlantic Hawksbill turtle, and the Atlantic Leatherback turtle (see Aquatic section 3.6.5.5). The alligator has gained significant attention in recent years, especially in Louisiana. Originally the alligator was common along all water bodies in the southeastern United States. Overhunting (see Commercial Fur-bearers described previously), heavy poaching, and destruction of habitat caused its numbers to become greatly reduced during the 1950's. Strict law enforcement and conservation measures helped control poaching with the result that alligator numbers increased so much that by the late 1960's it reached pest status in portions of its range. During the 1970's, the Louisiana Wildlife and Fisheries Commission asked permission to open an experimental hunting season in areas of extreme overpopulation. Two such seasons were held in 1972 and 1973 with 1337 and 2916 alligators harvested in each respective year. The results were so favorable that the Fish and Wildlife Service reclassified the alligator in Calcasieu, Cameron and Vermilion Parishes as a threatened, rather than an endangered, species (Federal Register, 1975). A quota hunt was held this fall in these parishes with satisfactory results with the quota of 4000 alligators filled. As concerns the alligator in the remaining areas of Louisiana, this large reptile is found in most freshwater swamp and marsh regions of the state. Much of these areas is inaccessible except by pirogue and air boat and afford a degree of protection to the alligator. Some poaching undoubtedly does occur, but a lack of a suitable market for skins is probably curtailing this activity somewhat. Destruction of wetland habitat is still threatening the welfare of this species as more and more swamp and marshland is filled and converted to land more suitable for human use. Alligator numbers in the majority of the state still need close study and protection.

3.6.5.3 Aquatic Ecology

Cote Blanche Island contains four small (less than 2 acres) freshwater lakes or ponds. At present, none of the ponds are used for fishing or other purposes except for occasional wildlife or cattle watering. The lakes are located on Cote Blanche Island at elevations of 35 to 85 feet above sea level. Depth of the lakes is estimated to be less than 10 feet. The bottom sediments in the ponds appear to be of a fine texture and consist of a mixture of silt and sand. Water in the ponds was clear, but along the edges of the ponds, the water was fairly turbid and the bottom was not visible. Although no field studies have been conducted at these ponds and no published material is available to describe their flora and fauna, there does not appear to be any significant differences between any of the ponds. The ponds are surrounded by a large amount of vegetation including cattail (Typha), bullrush (Scirpus), broomsedge (Andropogon), and bluestem (Schizichiarium). The fauna in the ponds are expected to be representative of the typical shallow freshwater pond assemblage of fish in coastal Louisiana.

The main estuarine water body adjacent to Cote Blanche is the Vermilion Bay-West Cote Blanche Bay Complex (Figure 2.2-1). Total surface water encompassed by this complex amounts to approximately 293,820 surface acres (Barrett, 1970). Several oil and gas fields are located in each of the bays. The rich and productive coastal wetlands surrounding the Bay Complex support a large variety of plankton, benthos and nekton. This area is also rich in fish and shellfish of recreational and commercial importance.

The Bay Complex with its bordering marshes acts as a nutrient trap for terrestrial and river water runoff. The Bay is also an important habitat for phytoplankton, zooplankton, and benthic communities. Many commercially important fish and shellfish species spawn in the bay or migrate there as larvae or juveniles to take advantage of the rich food supply and protective habitats that the Bay can provide.

The three major estuaries adjacent to Cote Blanche are Vermilion Bay, West Cote Blanche Bay and East Cote Blanche Bay. Vermilion Bay is the largest estuary and extends over 121,604 surface acres; West Cote Blanche is the next largest with 89,902 acres; and East Cote Blanche is the smallest bay with 82,314 acres.

Generally speaking, the Bay Complex is a shallow water area with an average depth of about 5 feet. A maximum depth of about 175 feet has been reported at Southwest Pass (Juneau, 1975). This pass is a deep but narrow entrance connecting the Gulf of Mexico with Vermilion Bay.

The bottom characteristics of West Cote Blanche Bay are predominantly a clay-silt composition with a small percentage of sand (Table 3.3-15). The water temperature in West Cote Blanche Bay averages about 21¼C annually. The lowest temperatures are usually recorded in December and the highest readings are measured in July (Juneau, 1975). Salinity readings are reported to average slightly more than 2 parts per thousand (ppt) in the West Cote Blanche Bay area. However, during 1973, part of the study period was a flood year; therefore large volumes of fresh water entered the bay from the Atchafalaya drainage basin. This flooding had a diluting effect and thus lowered the average salinity concentrations reported for the Bay Complex (Juneau, 1975). During this same study period, dissolved oxygen content of the water averaged approximately 8.0 parts per million (ppm).

Most of the aquatic ecology in the following sections has been abstracted from Technical Bulletin No. 13 published by the Louisiana Wildlife and Fisheries Commission (1975) entitled "An Inventory and Study of the Vermilion Bay-Atchafalaya Bay Complex". This report covered a 2-year (April 1972 - March 1974) investigation of the plankton, benthic invertebrates, and fish of the study area. During this study, 78 species of fish were collected; 9 species of invertebrates were also captured. Many of the fish and invertebrates were taken during the study in larval or postlarval form.

Bottom Sediments

Bottom sediments in the Bay Complex are reported to be finer grained than those measured in other major water bodies of Louisiana. Average sediment size in the Bay is from fine to very fine silt as compared to medium to fine silt in other coastal areas. The main sediment source in the Complex is the Atchafalaya River, but the Vermilion River also contributes large quantities of sediments to western Vermilion Bay. Sediments in the estuaries grade from coarse to fine in a westerly direction, due to the predominant westward drift of the coastal waters. A north to south gradation also occurs in the Bay with coarser deposits located near the discharge points of the major rivers. Fine particles are found to the south away from the rivers and in more protected parts of the Bay.

Temperature

Surface and bottom water temperatures taken at various stations in the Bay Complex were often very similar or were exactly the same. Average water temperatures for all stations combined were lowest during the month of December (11$^{\circ}$C). Water temperatures were also usually low during January, February, and March. Warmest water temperatures were measured in July and August when readings of 29.5$^{\circ}$C and 29.3$^{\circ}$C were recorded. The average annual water temperature for all of the stations in the study combined was 21.2$^{\circ}$C.

Salinity

Salinity patterns followed the trend described for temperature. Salinity values at the surface and bottom were often similar. Salinity was usually highest in the western part of the bay and lowest in the eastern region. However, the 1973 study period was a flood year, therefore average values would be expected to be normally higher than those indicated. The lowest salinity average was located in the Intracoastal Waterway (at Wax Lake outlet) where 0.3 ppt was measured. Freshwater Bayou had the highest annual average salinity with 9.7 ppt. Southwest Pass also had a high salinity concentration with an annual average of 6.1 ppt. Monthly high values were usually recorded in July (6.2 ppt) and August (5.8 ppt). Lowest salinity values were recorded in April and May when an average value of 1.2 ppt was measured during both months. The average annual salinity for all areas combined was 2.9 ppt.

Dissolved Oxygen

Dissolved oxygen (DO) concentrations did not vary appreciably between the surface and the bottom. DO values were also about the same for all stations during both years of the study. During the normal discharge year (1972), stations showed an average value of nearly 8 ppm. Lowest values (7 ppm average) were measured in the Intracoastal Waterway; highest average values (8.7 ppm) were taken at Bird Island Bayou and Oyster Lake. During the flood year (1973), the lowest average values of 7.5 ppm were measured at the Vermilion River Cutoff; Dry Reef, also in Vermilion Bay, had the highest average value of 8.6 ppm.

Nitrate

The highest monthly average nitrate value recorded during the period was at East Bay during April 1972 with a value of 26.73 μmg-at/l (microgram atoms per liter). The highest single value was 39.90 μmg-at/l (April 19, 1972) at Dry Reef-Vermilion Bay. The lowest monthly average nitrate value occurred at Oyster Lake during July 1972 with a value of 0.30 μmg-at/l. The lowest single value was 0.00 μmg-at/l taken during September 1973 at Vermilion Bay, Southwest Pass, Bayou Fearman, and on June 8, 1972 at Freshwater Bayou, and July 5, 1972 at Vermilion Bay.

Nitrite

The highest monthly average nitrite value recorded during the study period was 5.37 µmg-at/l during June 1972 at Bird Island Bayou. The highest single value was 8.6 µmg-at/l on October 3, 1972 at Freshwater Bayou. The lowest monthly average was 0.20 µmg-at/l during April 1972 at Southwest Pass. The lowest single value was 0.00 µmg-at/l recorded at several stations throughout the study area at various times of the year.

Inorganic Phosphate

The highest monthly average value recorded during the entire project period was during January 1974 at Point Chevreuil with a value of 17.90 µmg-at/l. Highest single value was 34.2 µmg-at/l during June 1972 at Pelican Point. Lowest single value was 0.00 µmg-at/l recorded on several occasions at several different stations.

Total Phosphorus

During the entire study period an individual high value of 38.00 µmg-at/l was recorded on March 5, 1973 at Freshwater Bayou. Lowest monthly average for total phosphorus during the study period was 1.84 µmg-at/l during April 1972 at Pelican Point. Lowest single value recorded was 0.00 µmg-at/l recorded on several occasions at several different stations.

Other Chemical Parameters

Other chemical parameters recorded included sulfates, which had a high reading of 3000 mg/l (milligrams per liter) at Freshwater Bayou on September 11, 1972, and a low of 0.0 mg/l at several stations at various times. Calcium was recorded in high concentrations at Freshwater Bayou on December 11, 1972, with a reading of 680 mg/l and in low concentrations on February 12, 1974, at Vermilion River Cutoff, Bayou Fearman, and Gulf Intracoastal Waterway at Boston Canal with a reading of 7 mg/l. Alkalinity was measured highest at Freshwater Bayou on October 31, 1972, with a reading of 282 mg/l and lowest at Bird Island Bayou on August 21, 1973, with a reading of 20 mg/l. Turbidity was measured at greater than 395 Jackson units on many occasions. Dissolved solids were also greatest on July 23, 1973, at Freshwater Bayou with a recording of 32 g/l and lowest with a recording of 0 at several stations during March 1972. Suspended solids were highest at the Gulf Intracoastal Waterway at Boston Canal on March 26, 1972, with a reading of 2 g/l and lowest on various occasions.

Primary Producers

There is a paucity of information on the phytoplankton in the Vermilion Bay - West Cote Blanche Bay areas. Thus, to help characterize the phytoplankton in these areas, information is drawn from other studies along the Louisiana Coast. Information on macrophytes for the Vermilion Bay area does exist. The following is taken from Juneau, 1975:

"The coastal marshes of Louisiana have long been characterized by changing habitat due to natural causes, such as hurricanes or sediment discharge from rivers, and artificial causes such as channelization and canal construction by man. These changes in habitat may be gradual or sudden; some are temporary, some permanent. Environmental alterations which are generally irreversible tend to cause the ecological composition to change to what is best suited to the new habitat. For example, a low marsh which has been cut through by a drainage canal may eventually support brackish low ridge species, such as buckbush (Baccharis halimifolia) and later other plants characteristic of a more upland habitat.

"O'Neil (1949) reported that vegetation in the Vermilion Bay complex included mostly leafy three-cornered grass or coco (Scirpus robustus) with other outstanding plants such as black rush (Juncus roemerianus) and brackish three-cornered grass (Scirpus olneyi). ... Norden (1966) reported predominant marsh vegetation surrounding Vermilion Bay as being typical of salt marsh. He reported wiregrass (Spartina patens), hogcane (Spartina cynosuroides), black rush (Juncus roemerianus), and three-cornered grass (Scirpus olneyi) occurring in the study area. Dugas (1970) described the march vegetation surrounding Vermilion Bay as predominately brackish with extensive stands of Spartina patens, Spartina cynosuroides, and Juncus roemerianus. Chabreck (1972) reported virtually no coco (Scirpus robustus in the entire Vermilion Bay complex except near Southwest

Pass at Marsh Island. Over half of the plants reported by Chabreck on Marsh Island and the peripheral edges of Vermilion Bay were wiregrass (Spartina patens). ...

"These sources, therefore, depict somewhat of a change over the last 23 years from a predominately coco or leafy three-cornered grass marsh to a wiregrass brackish marsh."

Table 3.6-9 indicates the species composition found in the natural marshes bordering Vermilion Bay and West Cote Blanche Bay by Chabreck (1972). Note that the greatest acreage (50 percent of total) was in brackish marsh, followed by intermediate marsh (32 percent), fresh marsh (17 percent), and salt marsh (1 percent). Within the brackish and intermediate marsh, the dominant species was Spartina patens, which comprised 57 percent of the macrophytes in brackish marsh and 31 percent in intermediate marsh. The fresh marsh had the greatest diversity of macrophytes while the salt marsh had the lowest diversity.

Phytoplankton are probably the most important primary producers in the offshore coastal waters. The offshore area provides little habitat for larger plants since solid substrate is generally lacking, and in the littoral zone the shallow sandy or mud bottom is subject to scouring due to wave action. Thus the floating phytoplankton, which do not need the solid substrate required by the macrophytes, are the important primary producers in deep water.

Common species of phytoplankton collected from the coastal waters of Louisiana are listed in Table 3.6-10.

There appears to be a definite seasonal trend for the phytoplankton in the Louisiana coastal waters. During the late spring and summer months, the dominant species are the dinoflagellate genera Ceratium, Exuviella, Gonyaulax and Gymnodium; and the diatom genera of Asterionella, Biddulphia, Coscinodiscus, Cyclotella, Lithodesmium, Navicula, Pleurosigma, Surirella, Skeletonema, Stauroneis and Thallasiosira. In the fall months, the dominant genera consisted of Biddulphia, Navicula, Nitzachia and Phizosolenia. During the winter months, the dominant genera were Asterionella, Fragilaria, Guidardia, Porosira, Rhizosolenia, Skeletonema, and Thallasiosira (Louisiana State University, 1975).

Species diversity was greater at the nearshore stations than it was at the offshore stations. Total phytoplankton density in samples ranged from 0 to 305,000 cells per liter. The number of cells from inshore stations was substantially greater than those from the offshore waters.

Simmons and Thomas (1962) described phytoplankton assemblages from the eastern Mississippi Delta associated with two different salinity regimes. A low salinity regime of river water had an assemblage dominated by two species each of the genera Cyclotella, Melosira and Navicula. A high salinity regime in Gulf waters had an assemblage composed of Asterionella japonica, Nitzschia seriata, Skeletonema costatum, Thalassionema nitzochioides, Thalassiothrix frauenfeldii, and three species of Chaetoceros. The Gulf regime (near the freshwater plume) had higher diversity due to mixing of freshwater and marine genera. Seasonal presence and abundance was more variable in the Gulf regime than in the river regime. In both areas, the lowest standing crop (abundance) was found in November.

Dinoflagellates were minor constituents of the phytoplankton observed near the delta. Genera included Ceratium, Glenodinium, Phrocistis, Hypodinium, Gymnodinium, Gloedinium, Peridinium, Hemidinium and Dinophysis.

Sanders and Fryxell (1972) plotted distributions in the Gulf of 14 diatom species. The dominant genera included Chaetoceros, Hemiaulus, Biddulphis, Hemidiscus, Rhizosolonia, Guinardia, Thallassionema, Certaulina and Asterionella. Rhizosolenia alata was the most frequently observed species over the entire Gulf and was found during 11 months of the year. Guinardia flaccida was found in all months. In most months of the year, Chaetoceros compressum, C. peruvianum, Hemiaulus membranaceus and Rhizosolonia stolterfothii can also be found (Balech, 1967).

Species diversity of dinoflagellates (Steidinger, 1973) was found to be higher offshore than nearshore and occasionally exceeded diatom diversity. Dinoflagellate abundance was higher nearshore than offshore.

The open Gulf phytoplankton assemblage includes the diatom genera Gossleriella, Ethmodiscus and Planktoniella, and the dinoflagellate genera Teiposolenia, Heterodinium Amphisolenia, Murrayella, Histioneis, Ptychodiscus, Cladopyxis, Kofoidinium, certain Ceratium spp. and Pyrocystis (Steidinger, 1973). Dinoflagellates are more diverse in the open Gulf but do not necessarily dominate the standing crop.

Steidinger summarized data for phytoplankton of the eastern Gulf and stated that:

1. There appear to be four types of phytoplankton distribution: estuarine, estuarine/coastal, coastal/open Gulf and open Gulf. Diatom and dinoflagellate species are characteristic of each category.
2. Species and composition include primarily year-round resident coastal species that fluctuate in dominance and visitor species. Seasonal peaks vary from year to year and from area to area. Eastern Gulf of Mexico waters are difficult to interpret for succession and seasonality, but maximum production is in spring and summer.
3. Diatom dominate in species diversity and abundance in inshore coastal areas; dinoflagellates often dominate in species diversity in open Gulf waters.
4. Microflagellates may numerically dominate eastern Gulf coastal and estuarine environments. Microflagellates are rarely identified to species.
5. Primary production and chlorphyll a maxima in open Gulf waters occur below the surface.

6. Areas of upwelling or river drainage are the most productive waters. The least productive waters are the open Gulf waters. Eastern Gulf of Mexico estuaries have higher primary productivity and standing crop than many temperate or tropical counterparts. Coastal and open Gulf waters are comparable in nutrient level to rich tropical waters but have lower concentrations than similar temperate areas.

7. The basic ecology of red tides suggest that Gymnodinium breve, the causative organism, blooms annually in selected parts of coastal Gulf waters. Many interrelated parameters must be optimal for the bloom to be developed into a major red tide outbreak.

8. Nutrients, particularly chelated trace metals, have been implicated with the initiation of red tides (in Florida waters) following heavy rainfall and land runoff. Using iron as an index, researchers suggest that monitoring of certain river discharges can be used to predict major red tides.

9. Red tides appear to have their severest effects on local and state economy in the form of reduced tourism and the expense of dead fish removal. Commercial fisheries are reportedly not affected but isolated sports fisheries, i.e., reef fishing, could be affected in a red tide area.

10. Controlling Gymonodinium breve red tides is considered unfeasible at present because of the vast area and volume of saltwater to be treated. Gymnodinium breve blooms are not a surface phenomenon; the organism can be found throughout the euphotic zone.

11. It is difficult to make geographic comparisons without standardized methods. Methods currently available may not be accurate, and the estimates derived should be used with caution, particularly in fisheries harvest projections.

## Zooplankton

Zooplankton samples (taken by a 0.5-meter net towed at the surface) yielded a total of 56 species of fishes, many in the larval form (Table 3.6-11). Only one species, the banded pygmy sunfish (Elassoma sonatum), was not reported by previous investigations. Eight species were not reported for Louisiana by previous studies including the dusky anchovy, channel catfish, bayou killfish, dusky pipefish, banded pygmy sunfish, white mullet, lyre goby, and spotted scorpionfish.

Freshwater Bayou was the most productive station. Total zooplankton biomass for all stations varied considerably by month and year. Peak months included May, June, and October of 1972, and January and December of 1973. A small peak was also observed during April and May. Low amounts of biomass were normally experienced during August and September.

East Bay showed peaks in total zooplankton biomass during May and October. Catches of Acartia spp. made up a large percentage of this biomass. During the second year, biomass was reduced with peaks recorded in May, November, and December (Juneau, 1975).

East Cote Blanche Bay experienced peaks of total biomass during May, July, and October of 1972. Highest values were shown during July. During 1973, catch was very low, but a small increase was present in November. Acartia sptonsa was the most common zooplankter during both years.

Peak zooplankton populations were present at Southwest Pass during May and November of 1972; the total biomass comprised mostly of Acartia spp. During 1972, high peaks were noted during May and December with Acartia spp. again making up most of the total biomass.

Freshwater Bayou was by far the most productive location during both years. This station showed large peaks during May and January of 1972 and two smaller peaks during July and October. During 1973, marked increases were exhibited during April, August, and December. The total biomass was largely comprised of Acartia spp. during both years.

The most abundant zooplankton species collected was Acartia tonsa, which made up most of the copepods recorded as Acartia spp. and was responsible for a very large percentage of the zooplankton biomass. All zooplankton species collected during the 2-year study period are listed in Table 3.6-12.

Other species occurring in abundance in zooplankton tows included nauplii larvae of crustacea, which were most abundant from April through August of 1972 and in June of 1973. Ostracods were present in samples at various times of the year but were in abundance from February through May of 1973. Cladocerans also occurred in conjunction with Ostracods and were again abundant in October, November, and December of 1973.

The copepod Labidocera aestiva was present in quantity during June and July of 1972 and January of 1973. Temora turbinata was also in quantity during these periods while Eurytemora hirundoides occurred at various times of the year but in greatest abundance in May, October, and December of 1972. Gillespie (1971) reported E. hirundoides to be most numerous during the spring with largest numbers occurring during June.

Halicyclops fosteri was reported by Gillespie (1971) as occurring primarily during the fall but during 1972-1974, H. fosteri was collected during all months except June 1972, December 1972, and March 1974. H. fosteri appeared in greatest numbers between February and June of 1973.

Two species of the family sergistidae were also collected: Acetes carolinae and Lucifer faxoni. During the spring and summer of 1972 and 1973, Acetes carolinae appeared in large numbers; Lucifer faxoni occurred only during December of 1973. Gillespie (1971) reported A. carolinae to be most abundant during the spring and stated L. faxoni was present along the Louisiana coast throughout the year except during December.

Another species, although not a true member of the zooplankton, which was present quite often in the estuarine complex, was Aegathoa oculata. This species occurred in samples during every month except August 1973. A. oculata was most abundant during November and December of 1972. This species, which is a parasitic isopod, was also reported to occur frequently along the Louisiana Coast (Gillespie, 1971).

Commercially important invertebrates occurring in zooplankton samples in Vermilion Bay included the brown shrimp, the white shrimp, and the blue crab.

The brown shrimp was taken in the postlarval form during every month of the sampling period except September 1972 and September, October, and November 1973. Periods of greatest concentration occurred during the spring of each year. This species was collected in the postlarval stage at all times of the year by Perret and others (1971) but occurred primarily during the spring of the year. Peak populations of postlarval brown shrimp were reported to vary between late February and early May by St. Amant, Broom, and Ford (1966).

The white shrimp occurred in a post larval form from June through November of 1972, and in July and August of 1973, and January of 1974. Greatest concentrations were in September 1972 and August 1973. Perret and others (1971) reported white shrimp postlarvae from May through March with highest numbers between June and September.

The blue crab was collected in plankton samples during every month except February, June, August, and October of 1973. Highest concentrations were recorded in June and July of 1972 and November of 1973.

Seasonal catches varied only slightly. During 1972, more different species of zooplankton were taken in May, July, and August than any other month. During 1973, surges of zooplankton occurred during March, May, June, October and November.

During 1974, only 3 months were sampled, but during this time, the study area experienced a drastic decline in different types of zooplankton. Only 5 species of zooplankton were taken during March 1974 as compared to 20 taken in March 1973.

Hopkins (1973) summarized zooplankton data for the eastern Gulf:

1. The principal hydrographic factors regulating zooplankton distribution in the eastern Gulf of Mexico are the Loop Current, Mississippi River, and local runoff into Gulf coastal areas.

2. The copepod *Acartia tonsa* is the principal plankton species in terms of biomass in estuaries of the eastern Gulf.

3. Zooplankton diversity in Gulf coast estuaries increases with increasing salinity.

4. Meroplankton constitutes a significant portion of the zooplankton biomass in estuaries, especially during the summer months.

5. Zooplankton diversity in east Gulf Coast estuaries is generally greater in summer than in winter.

6. One of the principal regulators of seasonal patterns of zooplankton in Gulf coast estuaries may be predators such as ctenophores and scyphomedusae, which graze heavily on the plankton population in winter.

7. Zooplankton biomass ranges from 0.08 to 0.80 $ml/m^3$ in an estuary (St. Andrew Bay data x 10 to convert from dry weight to volume), 0.02 to 0.10 $ml/m^3$ in shelf waters, and 0.01 to 0.10 $ml/m^3$ in the east central Gulf. In local areas of the shelf, standing crop can be as high as 3.0 to 8.0 $ml/m^3$.

8. Zooplankton biomass appears to reach a maximum in eastern Gulf estuaries and on the southwest section of the Florida shelf in summer and on the northeastern shelf and central Gulf in winter. No significant seasonal changes in biomass seem to occur within the Loop Current.

9. Upwelling generated by the Loop Current is responsible for the summer biomass maximum on the southwestern Florida shelf while river discharge and cool meteorological conditions are primarily responsible for the winter peak on the northern Gulf shelf.

## Benthos

There is a paucity of information concerning the benthic organisms in the Vermilion-Cote Blanche Bay Complex.

In discussing the benthic fauna the benthic community may be divided into two habitats: an intertidal or marsh edge habitat; and an offshore habitat. The intertidal zone is characterized by an area of wave action and tidal flushing. The offshore (subtidal) habitat is always submerged.

The subtidal zone sediments are mostly composed of a very fine silt. Because of the soft and fine nature of these sediments, there is a scarcity of large sessile forms of benthic mollusks such as clams, scallops or oysters. The density of organisms in the marsh is determined to a large degree by the frequency of tidal action and inundation (Day and others, 1973). The biomass of organisms found in the intertidal marsh area is usually higher than that found in the offshore zone. However, the diversity of animals that live in and on the marsh sediments is usually lower than the diversity found in adjacent submerged areas.

The food web in the benthic marsh system is based largely on the detritus provided by the marsh grasses. Little grass is consumed as "live" grass. Most of the grass is grazed upon after it dies and decays and is broken down by microbial action or physical and chemical factors.

The marsh in Louisiana area is usually covered by water for longer periods of time in September and October and also in late spring or when river runoff is at its peak. During these periods, the benthic organisms move further into the marshland, and the marsh edges become wider or deeper. During the winter months, when runoff from the river systems are low, the marsh may not be covered with water for long periods of time due to these low-flow periods. During these dry months, the water dependent organisms recede with the shrinking fringe areas of the wetland.

An important group of animals that feed on the detrital-bacterial-algal food base is the protozoans and other small benthic organisms (meiobenthos). These organisms include ciliates, foraminifera, nematodes, oligochaetes, polychaetes, and small copepod crustaceans.

Larger organisms of the benthic fauna include the snails Littorina, Melanpus and Neritina, the ribbed mussel Modiolus and the fiddler crab (Sesarama) and blue crab (Callinectes sapidus).

Data collected by Day and others (1973) for Barataria Bay indicate that the average standing crop of polychaetes found in the bay was 0.17 $g/m^2$. The average biomass for fiddler and blue crabs was 3.60 $g/m^2$. Littorina was the most important snail found in the benthos in terms of biomass, ranging from 1.1 to 16.9 $g/m^2$. The average snail biomass

(Neritina, Melampus and Littorina) was 9.80 g/m$^2$. The ribbed mussel (Modiolus demissus) , which lives in groups associated with clumps of Spartina grass, was also an important benthic organism in Barataria Bay.

Fish

Juneau, 1975, sampled the fish population in Vermilion and the Cote Blanche bays during April, 1972 through March, 1974. The results show that 63 species of fish were collected. The Bay anchovy was the most abundant fish collected; it comprised 28 percent of the total catch. The Atlantic croaker was also abundant and accounted for 19 percent of the catch.

The Vermilion - Cote Blanche Bay complex is unique in that it features one of the least saline estuaries along the entire Gulf of Mexico coastline. The average annual salinity for all stations combined was only 3.0 ppt. (Juneau, 1975). According to Juneau's study the estuary complex hosts both marine and freshwater species. Organisms which are primarily marine such as the Atlantic midshipman, gulf toadfish, Atlantic cutlassfish, and Atlantic stingray were collected in the same waters as the white crappie, bluegill, sheepshead minnow, and blue catfish; the latter four species of fish named are indicative of fresh water conditions. A complete species list of fish collected is presented in Table 3.6-13.

Dugas (1975) collected fish samples in Vermilion Bay near Fearman Bayou in 1968 (twice) and 1969 (three times) during a 21-hour period. Out of a total of 22 species collected (Table 3.6-14) 5 species were taken only during the night (Atlantic stingray, menhaden, violet goby, lined sole, and the blackcheek tonguefish), and 1 species was collected only during the day (spotted sea trout).

Gunter (1961) reported a gradual decrease in species numbers from estuarine waters to fresh waters. Greater fish numbers and biomass are found nearshore compared to open waters in spring and summer (Day and others, 1973). In fall or winter, more fish are found in deep bay waters. The largest number of species in the bay occur in late summer or early fall.

Day and others, (1973) also described the food web and interdependence of one trophic level on another for fish as follows:

Herbivores - Fish feeding primarily on vegetable matter, phytoplankton, or organic detritus; only occasionally taking small animal forms.

Omnivores - Fish showing no particular preference for plant or animal material, feeding on either, depending on availability in the particular habitat.

Primary Carnivores - Fish feeding mostly on zooplankton and microbenthic animals but occasionally on plant matter and organic detritus.

Mid Carnivores - Fish feeding on both microbenthic and macrobenthic animals such as mollusks, amphipods, penaeid shrimp, small crabs; small fish of lower trophic levels, and organic detritus. The latter is probably taken incidentally in feeding on animals.

Top Carnivores - Highly predaceous fish feeding mostly on smaller fishes such as the largescale menhaden, bay anchovy, tidewater silverside, and larval Atlantic croakers and the larger invertebrates such as penaeid shrimp and blue crabs. The larval and juvenile stages of these fish may function as mid-carnivores as pointed out by W. E. Odum (1971).

Additional information on commercial fisheries in the Vermilion-Cote Blanche Complex is described in section 3.6.5.4.

Conclusions reached by Day and others (1973) indicate that for Caminada Bay, "organic detritus is the major component (food source) of the herbivorous fish. Fish of the higher trophic levels may utilize detritus somewhat, particularly the bay anchovy, but ingestion may be accidental. The bay anchovy, a primary carnivore, feeds primarily on zooplankton. Little utilization of phytoplankton was observed, lending further evidence that nutrition in this system in based on allochthonous organic detritus such as Spartina and other marginal marsh macrophytes.

"The microbenthic animals are utilized by the majority of these fish. The microbenthos (or meiobenthos according to some authors) includes small animal crustaceans and insects. These organisms are the main diet of the mid-carnivores.

"The top carnivores, represented by sand sea trout and speckled sea trout, feed largely on the fish of lower trophic levels and macrobenthic forms such as blue crabs and penaeid and caridean shrimp".

## Marine Mammals

Numerous marine mammals are known to occur in the Gulf of Mexico, but because of the shallow water in West Cote Blanche Bay, none of these species are known to occur near Cote Blanche Island. Marine mammals include whales, dolphins, porpoises and manatees. Nearly all of the larger or Great whales are now classified as endangered species. Three whale species have been recorded along the Louisiana coast: the Giant Sperm whale (Physeter catadon), the Finback whale (Balaenoptera physalus), and the Sei whale (Balaenoptera borealis). A Sperm whale was found stranded near Sabine Pass in 1910, as was a Finback whale in 1924. Finbacks have been observed at numerous locations along the Louisiana coast. Only one Sei whale has been reported in the northern gulf when a specimen was stranded near the mouth of Fort Bayou (Plaquemine Parish) on Breton Sound (Lowery, 1974). These and several other marine mammals are protected under the Marine Mammal Protection Act.

The West Indian (Florida) manatee is also known to occur along the Louisiana coast. The manatee is only of casual occurrence along the central northern Gulf Coast, and only three instances of its presence in Louisiana are on record. A dead manatee was found in Calcasieu Lake in 1929, and another dead specimen was recovered at Cow Bayou in Sabine Lake in 1937. A live manatee was observed swimming and surfacing in Lake Saint Catherine in 1943. Manatees are somewhat limited in their wandering to northern waters because only a night or two of near freezing temperatures could decimate the population. Therefore, manatees are more commonly found along the warmer south Texas and Florida coasts.

### 3.6.5.4 Important Aquatic Species

The rich and productive estuarine complex of Louisiana supports a wide variety of species that are important for commercial, recreational, and ecological purposes.

## Commercial Fisheries

Louisiana ranks among the top five states in the nation with regard to the total value of its fishery. The shrimp fishery in Louisiana accounts for about 60 percent of the total value. Barataria and Terrebonne basins are the most productive area in the state (U.S. Army Corps of Engineers, 1973b).

Principal finfish species harvested from inshore Louisiana waters are menhaden (130 million pounds), catfish and bullheads (0.9 million pounds), spotted sea trout (0.8 million pounds) and red drum (0.7 million pounds). Vermilion Bay contributed mostly catfish, bullheads, and gar to the inshore harvest. Important commercial fishes in West Cote Blanche Bay are listed in Table 3.6-15.

Table 3.6-16 shows the average annual pounds of harvest of finfish and shellfish from Vermilion-Cote Blanche Bay compared to the average annual catch for all Louisiana inshore and offshore waters during 1968 to 1970. Total finfish harvest for the state equalled over 976.8 million pounds annually. Of this total, more than 842 million pounds came from offshore waters compared to the 134.6 million pounds harvested from inshore waters. For inshore fisheries, Vermilion and Cote Blanche Bays contributed only 0.4 million pounds, or 0.3 percent of the inshore harvest.

Historical landing figures for six of the leading species of commercially exploited estuarine dependent fish are presented in Table 3.6-17. For the last several years, Louisiana has been the number one state in weight of fishery products landed.

The Gulf menhaden (Brevoortia patronus) is by far the most important of all the commercial fish and shellfish in terms of harvested weight and second only to the shrimp industry in value. Menhaden were first fished commercially in 1948 and harvest increased rapidly to 560 million kg in 1971. Other commercial fish include the spotted sea trout, red snapper, king fish, black drum, red drum, flounder, and a number of lesser species. Flounder production has also shown a steady increase.

In the early 1900's, a large number of croakers were harvested. After a decline during the 1950's and 60's, croaker production is again increasing. Mullet production was high in the early 1900's but dropped, probably because of a lack of market. Sea trout has shown erratic production with 2 or 3 good years in a row. Drum production is the most consistent, and it too has shown a slight increase. King whiting was hardly fished before 1945; since then the harvest has increased slightly, but has remained rather stable.

Total fishery landings include not only the species listed but all fish landed in Louisiana. The total has increased regularly, mostly due to the development of the menhaden fishery. The fish value has increased because of increased landings and inflation.

Shrimp - The shrimp fishery is the most valuable fishery in Louisiana as well as in the United States. Management practices are necessary to maintain a suitable supply of commercial shrimp to the fisherman.

Brown shrimp (Penaeus aztecus), pink shrimp (P. duorarum), and white shrimp (P. setiferus) comprise 95 percent of the commercial catch of shrimp in the Gulf of Mexico. Shrimp landings in the Gulf states accounted for 59 percent of the total U.S. landing: 103 million kg out of the total 177 million. This percentage has decreased in recent years as a result of increased development of the Alaska shrimp fishery. Louisiana remained the leading state in 1971 with landings of 42 million kg, or 24 percent of the total U.S. catch (U.S. Dept. of Commerce, 1972).

Shellfish harvest during the 1968 to 1970 period had a total average of more than 110 million pounds (Table 3.6-16). About 62 million pounds came from inshore waters and 47 million pounds came from offshore areas. Vermilion and Cote Blanche Bays had 0.9 million pounds of shellfish harvested from their waters. Most of the shellfish taken from the bay consisted of shrimp (0.5 million pounds) and crabs (0.4 million pounds).

Blue Crab - The blue crab (Callinectes sapidus) is the only species of crab fished commercially in Louisiana. Louisiana crab landings in 1971 amounted to 4,970,000 kg valued at $1,242,521 (Natl. Marine Fish. Service, 1971). The crab fishery in Louisiana ranks third in weight landed after menhaden and shrimp and fourth in dollar value after shrimp, menhaden, and oysters (in order).

The blue crab is also subjected to heavy fishing pressure from the sportsmen of the state. It was estimated (telephone survey conducted by the U.S. Bureau of Sport Fisheries and Wildlife) that the sport catch of crabs may be as much as four times as large as the commercial catch (Lindall and Hall, 1970). Blue crab landing statistics for Louisiana (Table 3.6-18) show that a steady increase in blue crab harvest has occurred between 1908 and 1945. Between 1945 and 1951, the harvest decreased, and then remained at about 8 million pounds for the next 18 years. Recently (1972) blue crab harvest reached 15 million pounds. Total value of this catch was estimated to be $1.7 million.

Oysters - The oyster harvest in Louisiana has deteriorated in the past quarter century, because of overfishing, high salinity encroachment and pollution. For these reasons, there is very little harvesting of "natural" oysters done in estuarine waters of Louisiana today. The increase in water salinity has allowed the oyster drill (*Thais haemostoma*), a major predator of oysters, to devastate many of the old established oyster reefs. Therefore, most of the oysters are now artificially seeded and planted.

Young oysters are allowed to grow for about 15 months on seed grounds where water salinity is between 1 to 15 parts per thousand. The low salinity helps to protect the spot and young oysters from the oyster drill and from susceptability to the fungus (*Dermocystidium marina*).

After the 15-month growth period, the oysters are transferred in the fall to fattening beds (e.g., Barataria Bay) for further development and growth. Salinity at these beds is about 12 to 15 ppt. The oysters remain in the fattening beds for about 6 months, and are harvested from February through May for commercial markets.

Vermilion-Cote Blanche Bay Harvest - The harvest value of the principal species of commercial fish and shellfish in Vermilion-Cote Blanche Bays and in Louisiana is given in Table 3.6-17 for the 5-year period of 1963 to 1967. The average annual harvest value is based on nine major commercial fisheries taken in the state's estuaries for the 1963-67 period: menhaden, shrimp, croaker, oyster, blue crab, catfish and bullhead, spotted sea trout and red drum. The annual harvest of these species averaged 842.4 million pounds worth 43.5 million dollars. Menhaden and shrimp were the two principal species harvested; they totaled more than 93 percent of the catch and 84 percent of the value. The total production of Vermilion and Cote Blanche Bays was 47.5 million pounds, valued at 1.8 million dollars. Compared to other fish and shellfish hydrologic units, the Bay Complex is one of the lowest in terms of total value and value in dollars per acre ($5.7/acre compared to an average of $13.2/acre and a high of $46.3/acre for Hydrologic Unit IV).

Recreationally Important Species

Sport Fishing - Many fish and shellfish sought after for commercial value are also pursued for sport in coastal Louisiana. Freshwater sport species in the marshes and coastal upland streams include largemouth bass, bluegill, redear and other sunfishes, crappie, and blue and channel catfishes. Saltwater-estuarine sport species include spotted sea trout, red drum, red snapper, Florida pompano, and tarpon. A telephone survey by the Bureau of Sport Fisheries and Wildlife shows freshwater fishing in coastal Louisiana totaled 4,927,100 man-days at an estimated value of $31,170,700; finfish activity accounted for 4,263,300 man-days and $29,843,100 of this total. Saltwater fishing equalled 6,669,900 man-days and $35,439,800. Of the saltwater sport fishing, finfishing accounted for 4,045,900 man-days and $28,321,300 (Louisiana State University, 1975).

Estuarine Dependence of Marine Species

The productive coastal wetlands of Louisiana support a wide variety of nekton, ranging from commercially important decapod crustacea, such as penaeid shrimp and blue crabs, to vertebrate species representing a spectrum of trophic levels including herbivores such as mullet and menhaden, primary carnivores such as the bay anchovy, mid-carnivores such as killifish, spot, and croaker and top carnivores such as sea trout.

Many of the nekton species directly provide a broad integrative relationship between the several units of the Louisiana coastal ecosystem through their dependence on different environments at different life stages and their movement of energy offshore and onshore in response to biological needs and seasonal changes.

Estuarine dependence takes two broad forms. One form is that in which a species is indigenous to the coastal zone and spends its entire life within the system, the other is when only a portion of the animal's life history is spent within the system. The latter case includes the use of the estuarine zone as nursery grounds by juveniles of many species.

In the first category are the bay anchovy (Anchoa mitchilli), the tidewater silverside (Menidia veryllina), and killifishes. Seasonal migrants include the Atlantic croaker (Micropogon undulatus), spot (Leiostomus zanthurus), spotted sea trout (Cynoscion nebulosus), Gulf menhaden (Brevoortia patronus) and striped mullet (Mugil cephalus).

The general pattern of fish migration is correlated closely with seasonal changes. As the temperature rises from a winter minimum there is a general inshore movement of fish, building up to a spring maximum. This inshore migration also corresponds to an increased pulse of marsh detritus and primary productivity. As the temperature begins to drop in the fall, maturing subadults leave the estuary, and fish fauna of the area decrease rapidly in number of species.

Species of nektonic invertebrates are relatively few in number, but seasonally population levels can reach peaks of high density. Nearly all of these species are also found in the near offshore waters along the Louisiana beaches. These include primarily shrimp and squid species.

Functional importance of nektonic species in the coastal ecosystem is partially related to such parameters as mean standing stocks (biomass), ingestion rates, and turnover rates. Much more information is currently available for the higher salinity areas than for the fresh marsh and swamp zones, but even where available, the data are sketchy and incomplete. Most effort in this area has been related to the commercial importance of a species, which is not always synonymous with its functional importance.

The penaeid shrimp is an example of a nektonic animal, which has an estuarine dependent cycle. Adults spawn offshore; the larval stages are carried by currents into the estuary where the post larvae grow into juveniles. As they become subadults, the shrimp emigrate again into the deeper waters of the Gulf. The period of most rapid growth occurs in the estuary.

The general migration pattern described for shrimp applies to about 98 percent of the commercially landed fish and shellfish of Louisiana, which spawn in the open Gulf. A portion of their life cycles is absolutely dependent upon estuaries, so much so that the entire estuarine zone is often referred to as a nursery ground.

By definition, nekton are a mobile group of organisms; therefore, they have access to any of the waters of coastal bays and estuaries extending from fresh through brackish to saline waters. Evidence is accumulating that their distribution is limited by salinity as such, but only near the extremes of their range. This is especially true at the low end of the salinity range, but it may also be true in hypersaline waters. Within brackish areas, the predominant types of nekton are of marine origin.

One of the most striking aspects of the nektonic group as a whole is their apparent ability to tolerate wide ranges of salinity. Characteristically, their salinity tolerances change with age. Juvenile shrimp, for instance, appear to be more tolerant of low salinity than adults, and the salinity tolerance of blue crabs varies also with sex.

The migration of freshwater organisms into saline waters is less common than the converse but is often found to occur with certain species. Two freshwater shrimp of the genus Macrobrachium sometimes enter the bays of the Gulf coast where salinities range up to 17 ppt. Species of Palaemonetes are found to be indigenous along the bay shores. Three species of shad are commonly found in the bay and sometimes even in the Gulf. The shad migrate from freshwater areas as does the alligator gar, Lepisosteus spatula. There are also a few species that are seldom found outside of brackish waters.

Within the coastal estuaries of Louisiana the following generalizations (in addition to the previously noted comment that most fish found in brackish water are marine) may be made: 1) the number of species present increases with salinity; 2) the number of individual fish increases with salinity; and 3) the size of individual fish increases with salinity. This last generalization is a consequence of the migratory habits of most estuarine-dependent fish. These fish generally spawn in open marine water, and the young move rapidly into the less saline bays and estuaries. Later as they grow into adults, they gradually work their way back into more saline waters and finally as adults spawn in the offshore area to complete the cycle. Thus, the larger individuals are in the salt marsh areas, the smaller individuals in the brackish areas.

3.6.5.5 Site Threatened or Endangered Species

None of the plant species listed in the botanical survey conducted by Reese and Thieret (1966) for the five salt dome islands (including Cote Blanche) coincide with those species listed in the Federal Register (1976) as threatened or endangered flora.

No rare and endangered mammals are known to occur in the Cote Blanche area. The red wolf is found more to the west in Cameron and Vermilion Parishes.

West Cote Blanche Bay is too shallow for any of the large marine mammals to occur and although the manatee could occur in the Bay, it has never been reported there.

The brown pelican and the southern Bald eagle are federally protected birds and could occur near the site. The brown pelican has been making a gradual comeback along much of its range and has been helped in Louisiana by transplanted colonies from Florida. The shallow Cote Blanche Bay area appears to be excellent feeding grounds for this pelican, which feeds on fish near the surface.

The southern Bald eagle is not reported as utilizing the Cote Blanche area but could occur there. The tall, mature trees on the island are well suited for nesting sites and the close proximity of the bay with abundant fish, which make up this species' diet, appears to offer ample habitat for the eagle.

Table 3.6-8 lists several species of birds that are included in the "Blue List" and considered declining in population. Many of these birds are wading and shore birds and quite likely occur around Cote Blanche. Several of these birds are migratory and are found in this area of Louisiana only during the winter months. The actual importance of Cote Blanche Island to these populations is unknown. However, Avery Island, located a few miles northwest of Cote Blanche, is a sanctuary for approximately a half million wading birds each year (U.S. Army Corps of Engineers, 1973a).

Cote Blanche Island and the surrounding wetlands offer attractive habitat to the American alligator. This species is nationally considered endangered but appears to be doing quite well in coastal Louisiana. The alligator has experienced sufficient population growth to warrant experimental harvesting in the three southwesternmost parishes in Louisiana (Calcasieu, Cameron, and Vermilion) with the result being that the alligator is now a controlled fur-bearing species in these parishes. The population sizes in the Cote Blanche area are not readily available, but the favorable habitat and inaccessibility of the island indicate that populations may be high on the island.

The Atlantic Ridley turtle is one of several sea turtles listed as rare and endangered species. The Atlantic Ridley occurs primarily in the Gulf of Mexico (Conant, 1975). The turtle is occasionally found drowned in offshore shrimpers' nets; otherwise it is rarely seen along the Louisiana coast. The Atlantic Hawksbill and Atlantic Leatherback turtles are also rare and endangered species which may occur along the Louisiana coast, though capture records show that they are very rare in the northern Gulf.

TABLE 3.6-1 Prominent marsh vegetation in Atchafalaya - Vermilion Bay Complex

| Common Name | Scientific Name |
|---|---|
| Leafy three-cornered grass (coco) | *Scirpus robustus* |
| Brackish three-cornered grass | *Scirpus olneyi* |
| Black rush | *Juncus roemerianus* |
| Wiregrass | *Spartina patens* |
| Hogcane | *Spartina cynosuroides* |
| Bulltongue | *Sagittaria* sp. |

TABLE 3.6-2 Insect pests which may occur in the Louisiana Coastal marshes

| Common Name | Scientific Name |
|---|---|
| | Order - Diptera |
| Mosquitoes | Family - Culicidae |
| | *Aedes sollicitans* |
| | *Aedes taeniorhynchus* |
| | *Anopheles* Sp. |
| | *Chaoborus* Sp. |
| Biting Midges | Family - Ceratopogonidae |
| | *Culicoides* Sp. |
| Horse Flies | Family - Tabanidae |
| | *Tebanus* Sp. |

Source: Louisiana State University, 1975.

TABLE 3.6-3 Amphibians and reptiles which may occur on Cote Blanche Island and in adjacent habitats

| Common Name | Scientific Name |
|---|---|
| American Alligator | Alligator mississippiensis |
| Alligator Snapping Turtle | Macrodemys temminchi |
| Common Snapping Turtle | Chelydra serpentina |
| Stinkpot | Sternothaerus odoratus |
| Razor-backed Musk Turtle | Sternothaerus carinatus |
| Mud Turtle | Kinosternon subrubrum |
| Mississippi Map Turtle | Graptemus kohni |
| Diamondback Terrapin | Malaclemys terrapin |
| Southern Painted Turtle | Chrysemys picta |
| Mobile Cooter | Pseudemys concinna mobilensis |
| Missouri Slider | Pseudemys concinna hieroglyphica |
| Atlantic Ridley Turtle | Lepicodhelys kempi |
| Red-eared Turtle | Pseudemys scripta elegans |
| Gulf Coast Box Turtle | Terrapene carolina major |
| Western Chicken Turtle | Deirochelys reticularia |
| Smooth Softshell | Trionyx muticus |
| Gulf Coast Softshell | Trionyx spinifer asper |
| Texas Softshell | Trionyx spinifer emoryi |
| Green Anole | Anolis carolinensis |
| Southern Fence Lizard | Sceloporus undulatus |
| Ground Skink | Lygosoma laterale |
| Fire-lined Skink | Eumeces fasciatus |
| Broad-headed Skink | Eumeces laticeps |
| Six-lined Racerunner | Cnemidophorus sexlineatus |

TABLE 3.6-3 Continued

| Common Name | Scientific Name |
|---|---|
| Western Slender Glass Lizard | Ophisaurus attenuatus |
| Rough Earth Snake | Haldea striatuala |
| Western Earth Snake | Haldea valeriae |
| Northern Red-bellied Snake | Storeria occipitomaculata |
| Texas Brown Snake | Storeria dekayi texana |
| Midland Brown Snake | Storeria dekayi wrightorum |
| Broad-banded Water Snake | Natrix sipedon confluens |
| Yellow-bellied Water Snake | Natrix erythrogaster |
| Gulf Salt Marsh Snake | Natrix sipedon clarki |
| Graham's Water Snake | Natrix grahami |
| Diamond-backed Water Snake | Natrix rhombifera |
| Glossy Water Snake | Natrix rigida |
| Green Water Snake | Natrix cyclopion |
| Eastern Garter Snake | Thomnophis sirtalis |
| Western Ribbon Snake | Thamnophis sauritys |
| Western Mud Snake | Farancia abacura |
| Eastern Hognose Snake | Heterodon platyrhinos |
| Mississippi Ringneck Snake | Diadophis punctatus |
| Eastern Yellow-bellied Racer | Coluber constrictor |
| Eastern Coachwhip | Masticophis flagellum |
| Rough Green Snake | Opheodrys aestivus |
| Texas Rat Snake | Elaphe obsoleta lindheimeri |
| Red Rat Snake | Elaphe guttata |
| Scalet Snake | Cemophora coccinea |
| Louisiana Milk Snake | Lampropeltis doliata |

TABLE 3.6-3 Continued

| Common Name | Scientific Name |
|---|---|
| Speckled King Snake | Lampropeltis getulus holbrooki |
| Texas Coral Snake | Micrurus fluxius |
| Southern Copperhead | Agkistrodon contortrix |
| Western Cottonmouth | Agkistrodon piscivorus |
| Western Pygmy Rattlesnake | Sistrurus miliarius |
| Canebrake Rattlesnake | Crotalus horridus |
| **AMPHIBIANS** | |
| Three-toed Amphiuma | Amphiuma means fridactylum |
| Gulf Coast Waterdog | Necturus beyeri |
| Western Lesser Siren | Siren intermedia |
| Central Newt | Diemictylys viridescens |
| Spotted Salamander | Ambystoma maculatum |
| Small-mouthed Salamander | Ambystoma talpoideum |
| Marbled Salamander | Ambystoma opacum |
| Mole Salamander | Ambystoma talpoideum |
| Central Dusky Salamander | Desmognathus fuscus |
| Dwarf Salamander | Manculus quadridigitatus |
| Eastern Spadefoot | Saphiopus holbrooki |
| Fowler's Toad | Bufo woodhousei fowleri |
| East Texas Toad | Bufo compactilis |
| Gulf Coast Toad | Bufo valliceps |
| Northern Spring Peeper | Hyla crucifer |
| Eastern Gray Treefrog | Hyla versicolor |
| Squirrel Treefrog | Hyla squirella |

TABLE 3.6-3 Continued

| Common Name | Scientific Name |
| --- | --- |
| Green Treefrog | Hyla cinera |
| Eastern Narrow-mouthed Toad | Gastrophryne carolinensis |
| Northern Cricket Frog | Acris crepitans |
| Upland Chorus Frog | Pseudacris triseriata |
| Southern Leopard Frog | Rana pipiens |
| Bronze Frog | Rana Clamitans |
| Bull Frog | Rana catesbeiana |
| Pig Frog | Rana grylio |

Source: Conant, 1958.

TABLE 3.6-4 Waterfowl species wintering in Louisiana

| Common Name | Scientific Name |
|---|---|
| **DUCKS** | |
| Mallard | Anas platyrhynchos |
| Black Duck | A. rubripes |
| Mottled Duck | A. fulvigula* |
| Pintail | A. acuta |
| Gadwall | A. strepera |
| Green-winged Teal | A. carolinensis |
| Blue-winged Teal | A. discors* |
| Cinnamon Teal | A. cyanoptera |
| European Widgeon | Mareca penelope |
| Baldpate | M. americana |
| Shoveller | Spatula clypeata |
| Wood Duck | Aix sponsa* |
| Redhead | Aythya americana |
| Ring-necked Duck | A. collaris |
| Canvasback | A. valisineria |
| Greater Scaup Duck | A. marilla |
| Lesser Scaup Duck | A. affinis |
| American Goldeneye | Bucephala clangula |
| Bufflehead | B. albeola |
| Old Squaw | Clangula hyemalis |
| Harlequin Duck | Histrionicus histrionicus |
| White-winged Scoter | Melamitta deglandi |

*Known to breed in the State

TABLE 3.6-4 Continued

| Common Name | Scientific Name |
|---|---|
| Surf Scoter | M. perspicillata |
| Common Scoter | Oidemia nigra |
| Ruddy Duck | Oxyura jamaicensis |
| Masked Duck | O. dominica |
| Hooded Merganser | Lophodytes cucullatus* |
| Common Merganser | Mergus merganser |
| Red-breasted Merganser | M. serrator |
| Fulvous Tree Duck | Dendrocygna bicolor* |
| **GEESE** | |
| Canada Goose | Branta canadensis |
| Hutchins Goose | B. minima |
| White-fronted Goose | Anser albifrons |
| Snow Goose | Chen hyperborea |
| Blue Goose | C. caerulescens |
| Ross Goose | C. rossii |

* Known to breed in the State

Source: St. Amant, 1959.

TABLE 3.6-5 Mammals which may occur on Cote Blanche Island and in adjacent habitats

| Common Name | Scientific Name |
|---|---|
| Least Shrew | Cryptotis parva |
| Shorttail Shrew | Blarina brevicauda |
| Fuluous Harvest Mouse | Reithrodontomys fulvescens |
| White-footed Mouse | Peromyscus lencopus |
| Cotton Mouse | Peromyscus gossypinus |
| House Mouse | Mus musculus |
| Marsh Rice Rat | Oryzomys palustric |
| Cotton Rat | Sigmodon hispidus |
| Eastern Wood Rat | Nestoma floridana |
| Roof Rat | Rattus ratters |
| Norway Rat | Rattus norvegicus |
| Muskrat | Ondatra zibethicus |
| Nutria | Myocaster coypus |
| Virginia Opossum | Didelphis virginiana |
| Seminole Bat | Lasiurus seminolus |
| Northern Yellow Bat | Lasiurus intermedius |
| Evening Bat | Nycticeius humeralis |
| Rafinesque's Big-eared Bat | Plecotus rafinesquii |
| Armadilla | Dasypus novemcinctus |
| Eastern Cottontail | Sylvilagus floridanus |
| Swamp Rabbit | Sylvilagus aquaticus |
| Gray Squirrel | Sciurus carolinensis |
| Fox Squirrel | Sciurus nigra |
| Atlantic Bottle-nosed Dolpin | Tursiops truncatus |

TABLE 3.6-5 Continued

| Common Name | Scientific Name |
|---|---|
| Red Wolf | *Canis rufus* |
| Gray Fox | *Urocyon cinereoargenteus* |
| Black Bear | *Euarctos americanus* |
| Northern Raccoon | *Procyon lotor* |
| Long-tailed Weasel | *Mustela frenata* |
| North American Mink | *Mustela vison* |
| Nearctic River Otter | *Lutra canadensis* |
| Bobcat | *Lynx rufus* |
| White-tailed Deer | *Odocoiteus virginianus* |

Source: Lowery, 1974.

TABLE 3.6-6 Louisiana plants considered as endangered or threatened species

| Status | Family | Species |
|---|---|---|
| Endangered | Isoetaceae | *Isoetes louisianensis* |
| Threatened | Sarraceniaceae | *Sarracenia psittacina* |
| Endangered | Scrophulariaceae | *Agalinis caddoensis* |
| Endangered | Scrophulariaceae | *Castilleja ludoviciana* |

Source: Federal Register Vol. 41, No. 117, June 16, 1976.

TABLE 3.6-7 **Mammals, birds, and reptiles which occur in coastal Louisiana and its associated waters which are listed on the Federal List of Endangered and Threatened Wildlife**

| Common Name | Scientific Name |
|---|---|
| Red Wolf | Canis rufus |
| Giant Sperm Whale | Physeter catodon |
| Finback Whale | Balaenoptera physalus |
| Sei Whale | Balaenoptera borealis |
| West Indian Manatee | Trichechus manatus |
| Eastern Brown Pelican | Pelecanus occidentalis |
| Southern Bald Eagle | Haliaeetus l. leucocephalus |
| American Peregrin Falcon | Falco peregrinus anatum |
| *Ivory-billed Woodpecker | Campephilus principalis |
| American Alligator | Alligator mississippiensis |
| Atlantic Ridley Turtle | Lepidochelys leempii |
| Atlantic Hawksbill Turtle | Eretmochelys imbricata |
| Atlantic Leatherback Turtle | Dermochelys coriacea |

* Probably extirpated from coastal Louisiana

Source: Federal Register Vol. 40, No. 188, Sept. 26, 1975.

TABLE 3.6-8 Birds which may occur in the Louisiana coastal marsh listed on the "Blue List" as declining in population

| Common Name | Scientific Name |
|---|---|
| White-faced Ibis | *Plegadis chihi* |
| White Ibis | *Eudocimus albus* |
| Black-crowned Night Heron | *Nycticorax nycticorax* |
| Red-shouldered Hawk | *Buteo lineatus* |
| Marsh Hawk | *Circus cyaneus* |
| Osprey | *Pandion haliaetus* |
| White Pelican | *Pelecanus erythrorhynchos* |
| American Oystercatcher | *Haematopus palliatus* |
| Piping Plover | *Charadrius melodus* |
| Snowy Plover | *Charadrius alexandrinus* |
| Least Tern | *Sterna albifrons* |
| Gull-billed Tern | *Gelochelidon nilotica* |

Source: National Audubon Society, 1973. The Blue List for 1974 in American Birds, 27:943-945.

TABLE 3.6-9 Species composition of macrophytes found in vicinity of Vermilion Bay and West Cote Blanche Bay

| | Vegetative Type | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| Natural Marsh Acreage | 3,383 | 134,416 | 85,851 | 47,437 |
| Species | Percent Occurrence Within Each Vegetative Type | | | |
| Alternanthera philoxeroides | - - | - - | - - | 3.44 |
| Aster sp. | - - | - - | 1.30 | - - |
| Batis maritima | 18.18 | - - | - - | - - |
| Borrichia frutescens | 9.10 | - - | - - | - - |
| Cladium jamaicense | - - | - - | - - | 4.01 |
| Colocasia antiquorum | - - | - - | - - | 1.15 |
| Cyperus odoratus | - - | 1.12 | - - | - - |
| Distichlis spicata | - - | 5.16 | - - | - - |
| Echinochloa walteri | - - | - - | 4.05 | 1.15 |
| Eleocharis sp. | - - | - - | 5.19 | 8.60 |
| Hydrocotyle umbellata | - - | - - | - - | 5.16 |
| Hymenocallis occidentalis | - - | - - | - - | 1.43 |
| Ipomoea sagittata | - - | - - | 2.11 | - - |
| Juncus effusus | 27.27 | 14.59 | 1.62 | 10.60 |
| Panicum hemitomon | - - | - - | - - | 2.00 |
| Panicum virgatum | - - | 1.03 | 8.59 | 4.58 |
| Paspalum dissectum | - - | - - | 1.62 | 1.15 |
| Paspalum vaginatum | - - | 1.24 | 1.95 | - - |
| Phragmites communis | - - | - - | 1.46 | - - |
| Pluchea camphorata | - - | - - | 2.11 | - - |
| Sacciolepis striata | - - | - - | - - | 2.29 |
| Sagittaria falcata | - - | - - | 12.64 | 24.06 |
| Scirpus validus | - - | 11.11 | 5.51 | - - |
| Scirpus robustus | 18.18 | 1.12 | - - | - - |

TABLE 3.6-9 (Continued)

| | Vegetative Type | | | |
|---|---|---|---|---|
| | Saline | Brackish | Intermediate | Fresh |
| Natural Marsh Acreage | 3,383 | 134,416 | 85,851 | 47,437 |
| Species | Percent Occurrence Within Each Vegetative Type | | | |
| Spartina alterniflora | 27.27 | - - | - - | - - |
| Spartina cynosuroides | - - | 1.01 | 3.41 | 1.15 |
| Spartina patens | - - | 56.70 | 30.63 | 19.20 |
| Typha spp. | - - | - - | 2.27 | 1.43 |
| Vigna repens | - - | 2.81 | 8.59 | - - |
| Woodwardia virginica | - - | - - | 1.62 | 5.44 |
| Other species* | - - | 4.11 | 5.33 | 3.16 |

*Includes only plants making up less than 1.00 percent of the species composition.

Source: Chabreck, 1972.

TABLE 3.6-10 Phytoplankton identified from the Louisiana coastal waters

| Identification | Identification |
|---|---|
| COCCOID BLUE-GREEN | FILAMENTOUS GREEN |
| *Microcystis* sp. | Unidentified |
| Unidentified | CENTRIC DIATOMS |
| FILAMENTOUS BLUE-GREEN | *Cyclotella* sp. |
| *Anabaena* sp. | *C. striata* |
| *Merismopedia* sp. | *C. meneghiniana* |
| *M. major* | *C. stelligera* |
| *M. elegans* | *Coscinodiscus* sp. |
| *M. punctata* | *C. radiatus* |
| *M. convoluta* | *Melosira* |
| *M. glauca* | PENNATE DIATOMS |
| *Oscillatoria* sp. | *Amphora* sp. |
| *Gleocapsa* sp. | *A. ovalis* |
| *Gomphosphaeria* sp. | *A. angusta* |
| *G. aponina* | *Navicula* sp. |
| *G. wichurae* | *N. hungarica* |
| *Aphanocapsa* sp. | *N. longa* |
| *Meriso* sp. | *N. cuspidata* |
| *Diplococcus* sp. | *Nitzschia* sp. |
| *Polycystis* sp. | *N. closterium* |
| *Chrococcus limnetics* | *N. constricta* |
| COCCOID GREEN | *N. paradoxa* |
| *Chlorella*-like | *N. sigmaformis* |
| *Tetraedron triyonum* | *N. vermicularis* |
| *Protococcus*-like | *N. obtusa* |
| FLAGELLATED GREEN | *N. sigma* |
| *Chlamydomonas*-like | *Cymbella* sp. |
| *Gonium* sp. | *C. ventricosa* |
| Unidentified | |

TABLE 3.6-10 Continued

Identification

*Gyrosigma* sp.
*G. peisonis*
*G. macrum*
*G. fasciola*
*Epithemia* sp.
*E. argus*
*Fragilaria* sp.
*Synedra* sp.
*Mastogolois* sp.
*Cocconeus* sp.
*C. placentula*
*Pinnularia biceps*
*P. viridis*
*Gomphonema* sp.
*Hantzchia* sp.
*Diploneus* sp.
*D. smithii*
*Mastogolois*
*Pleurosigma delicatulum*
*Rhapalodia gibberula*
*Asterionella*

DINOFLAGELLATE

*Procentrium maximum*
*P. minimum*
*P. compressa*
*Peridinium* sp.
*P. limbatum*
*Amphidinium* sp.

Identification

*Ceratium* sp.
*Glenodinium* sp.
*Gymnodinium* sp.
Unidentified

EUGLENOIDS

*Euglena* sp.
*Phacus* sp.
*Trachelmonas* sp.
*T. schauinslandii*
*T. rotunda*
*T. volvocina*

OTHERS

*Scenedesmus* sp.
*S. acuminatus*
*S. armatus*
*S. quadricauda*
*S. abundans*
*Ankistrodesmus* sp.
*Crucigenia* sp.
*C. spiculata*
*C. tetrapedia*
*Closterium kitzingii*
*C. setaceum*
*Calycomonas ovalis*

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Source: Louisiana State University, 1975.

TABLE 3.6-11 Phylogenetic list of fishes collected in zooplankton samples in the study area

Vertebrates

| Common Name | Scientific Name or Grouping |
|---|---|
| Shark | Chondrichthys |
| Gar | Lepisosteus, sp. |
| Ladyfish | Elops saurus |
| Speckled Worm eel | Myrophis punctatus |
| Shrimp eel | Ophichthus gomesi |
| Skipjack herring | Alosa chrysochloris |
| Gulf menhaden | Brevoortia patronus |
| Gizzard shad | Dorosoma cepedianum |
| Threadfin shad | Dorosoma petenense |
| Atlantic threadfin shad | Opisthonema oglinum |
| Striped anchovy | Anchoa lepsetus |
| Dusky anchovy | Anchoa lyolepsis |
| Bay anchovy | Anchoa mitchilli |
| Inshore lizard fish | Synodus foetens |
| Channel catfish | Ictalurus punctatus |
| Skilletfish | Gobiesox strumosus |
| Halfbeak | Hyporhamphus unifasciatus |
| Atlantic needlefish | Strongylura marina |
| Gulf killifish | Fundulus grandis |
| Bayou killifish | Fundulus pulverous |
| Killifish | Fundulus, sp. |
| Rainwater killifish | Lucania parva |
| Mosquitofish | Gambusia affinis |

TABLE 3.6-11 Continued

| Common Name | Scientific Name or Grouping |
|---|---|
| Rough silverside | Membras martinica |
| Tidewater silverside | Menidia beryllina |
| Dusky pipefish | Syngnathus floridae |
| Chain pipefish | Syngnathus louisianae |
| Pipefish (unidentified) | Syngnathus, sp. |
| Sand perch | Diplectrum, sp. |
| Branded pygmy sunfish | Elassoma zonatum |
| Crevalle jack | Caranx hippos |
| Atlantic bumper | Chloroscombrus chrysurus |
| Leatherjacket | Oligoplites saurus |
| Florida pompano | Trachinotus carolinus |
| Tripletail | Lobotes surinamensis |
| Freshwater drum | Aplodinotus grunniens |
| Silver perch | Bairdiella chrysurus |
| Spotted seatrout | Cynoscion nebulosus |
| Atlantic croaker | Micropogon undulatus |
| Striped mullet | Mugil cephalus |
| White mullet | Mugil curema |
| Mullet (unidentified) | Mugil, sp. |
| Great barracuda | Sphyraena barracuda |
| Atlantic threadfin | Polydoctylus octonemus |
| Freckled blenny | Hypsoblennius ionthas |
| Lyre goby | Evorthodus lyricus |
| Sharptail goby | Gobionellus hastatus |
| Freshwater goby | Gobionellus shufeldti |
| Naked goby | Gobiosoma bosci |
| Spotted scorpionfish | Scorpaena plumieri |

TABLE 3.6-11 Continued

| Common Name | Scientific Name or Grouping |
|---|---|
| Bighead scarobin | Prionotus tribulus |
| Bay whiff | Citharichythys spilopterus |
| Fringed flounder | Etropus crossotus |
| Southern flounder | Paralichthys lethostigma |
| Blackcheek tonguefish | Symphurus plagiusa |
| Southern puffer | Sphderoides mephelus |
| puffer (unidentified) | Sphoeroides, sp. |

Source: Juneau, 1975.

TABLE 3.6-12 Phylogenetic list of organisms collected in all plankton samples in the study area

## Invertebrates

Phylum COELENTERATA
Class Hydrozoa

Phylum ASCHELMINTHES
Class Nematoda

Phylum ANNELIDA
Class Polychaeta

Phylum ECTOPROCTA
Bryzoa

Phylum MOLLUSCA
Class Gastropoda
snails

Class Pelecypoda
clams
oyster larvae

Class Cephalopoda
squids

Phylum ARTHROPODA,
Class Crustacea
Penilia avirostrus
Daphnia longispinna

Order Calanoida
Acartia tonsa
Acartia spp.
Temora turbinata
Labidocera aestiva
Centropages furcatus
Centropages sp.
Paracalanus sp.
Eucalanus spp.
Eurytemora hirundoides
Halicyclops fosteri
caligus sp.
squilla sp.
Penaeus aztecus
Penaeus sp.
P. setiferus
Acetus carolinae
Lucifer faxoni
Palaemonetes pugio
P. vulgaris
Leander tenuicornis
Argulus sp.
Cerapus tubularis
Cerapus sp.
Carinogammarus mucronatus
Atylus sp.
Sphaeroma quadridentatum
Aegathoa oculata
Ancinus depressus
Synidotea sp.
Edotea montosa
Leptocuma minor
Mysidopsis almyra
Callinectes sapidus

Phylum CHAETOGNATHA
Sagitta sp.
S. hispida

Source: Juneau, 1975.

TABLE 3.6-13 Checklist of Fishes Taken in Vermilion Cote Blanche Areas During 1972-74 (Juneau, 1975)

Atlantic stingray (Dasyatis sabina)
Alligator gar (Lepisosteus spatula)
Ladyfish (Elops saurus)
Shrimp eel (Ophichthus gomesi)
Skipjack herring (Alosa chrysochloris)
Gulf menhaden (Brevoortia patronus)
Gizzard shad (Dorosoma cepedianum)
Threadfin shad (Dorosoma petense)
Striped anchovy (Anchoa hepsetus)
Bay anchovy (Anchoa mitchilli)
Blue catfish (Ictalurus furcatus)
Gafftopsail catfish (Bagre marinus)
Sea catfish (Arius felis)
Gulf toadfish (Opsanus beta)
Atlantic midshipman (Porichthys porosissimus)
Skilletfish (Gobiesox strumosus)
Atlantic needlefish (Strongylura marina)
Sheepshead minnow (Cyprindon variegatus)
Gulf killfish (Fundulus grandis)
Southern hake (Urophycis floridanus)
Crested cusk-eel (Ophidion welshi)
Gulf pipefish (Syngnathus scovelli)
Bluegill (Lepomis macrochirus)
White crappie (Pomoxis annularis)
Crevalle jack (Caranx hippos)
Atlantic bumper (Chloroscombrus chrysurus)
Leatherjacket (Oligoplites saurus)
Lookdown (Selene voner)
Atlantic moonfish (Vomer setapinnis)
Sheepshead (Archosargus probatocephalus)
Pinfish (Lagodon rhomboides)
Silver perch (Bairdiella chrysra)
Sand seatrout (Cynoscion arenarius)
Spotted seatrout (Cynoscion nebulosus)

TABLE 3.6-13 (Continued)

Banded drum (Larimus fasciatus)
Spot (Leiostomus xanthurus)
Southern kingfish (Menticirrhus americanus)
Atlantic croaker (Micropogon undulatus)
Black drum (Pogonias cromis)
Red drum (Sciaenops ocellata)
Star drum (Stellifer lanceolatus)
Atlantic spadefish (Chaetodipterus faber)
Atlantic cutlassfish (Trichiurus lepturus)
King mackeral (Scomberomorus cavalla)
Spanish mackeral (Scomberomorus maculatus)
Striped mullet (Mugil cephalus)
Fat sleeper (Dormitator maculatus)
Atlantic threadfin (Polydactylus octonemus)

Freckled blenny (Hypsoblennius ionthas)
Violet goby (Gobioides broussonneti)
Naked goby (Gobioides bosci)
Harvestfish (Peprilus alepidotus)
Butterfish (Peprilus triacanthus)
Bighead searobin (Prionotus tribulus)
Rough silverside (Membras martinica)
Tidewater silverside (Menidia beryllina)
Bay whiff (Citharichthys spilopterus)
Fringed flounder (Etropus crossotus)
Southern flounder (Paralichthys lethostigma)
Lined sole (Achirus lineatus)
Hogchoker (Trinectes maculatus)
Blackcheek tonguefish (Symphurus plagiusa)
Southern puffer (Sphoeroides nephelus)

TABLE 3.4-14 The combined catch with regards to time taken during the day-night study in Vermilion Bay, Louisiana

| Species | TIME | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | 1500 | 1800 | 2100 | 2400 | 0300 | 0600 | 0900 | 1200 |
| Atlantic stringray *Dasyatis sabina* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| Menhaden *Brevoortia patronus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |
| Gizzard shad *Dorosoma cepedianun* | 1 | 0 | 0 | 1 | 0 | 1 | 0 | 1 |
| Anchovy *Anchoa mitchilli* | 0 | 1 | 0 | 0 | 1 | 0 | 1 | 2 |
| Sea catfish *Arius felis* | 3 | 3 | 2 | 9 | 2 | 0 | 2 | 0 |
| Blue catfish *Ictalurus furcatus* | 0 | 0 | 4 | 7 | 6 | 7 | 1 | 4 |
| Spotted seatrout *Cynoscion nebulosus* | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Sand seatrout *Cynoscion arenarius* | 0 | 1 | 10 | 5 | 6 | 6 | 3 | 7 |
| Spot *Leistomus xanthurus* | 4 | 2 | 3 | 7 | 2 | 0 | 3 | 1 |
| Croaker *Micropogon undulatus* | 20 | 47 | 40 | 74 | 32 | 32 | 26 | 5 |
| Black drum *Pogonias cromis* | 0 | 1 | 1 | 0 | 0 | 3 | 0 | 0 |
| Sheepshead *Archosargus probatocephalus* | 2 | 0 | 4 | 2 | 1 | 0 | 1 | 0 |
| Pinfish *Lagodon rhomboides* | 0 | 1 | 1 | 1 | 2 | 1 | 0 | 1 |
| Violet goby *Gobioides broussoneti* | 0 | 0 | 0 | k | 0 | 0 | 0 | 0 |
| Bighead searobin *Prionotus tribulus* | 0 | 1 | 0 | 0 | 1 | 2 | 1 | 0 |
| Bay whiff *Citharichthys spilopterus* | 0 | 1 | 3 | 8 | 0 | 3 | 1 | 0 |
| Southern flounder *Paralichthys lethostigma* | 0 | 0 | 3 | 2 | 2 | 1 | 1 | 0 |
| Lined sole *Achirus lineatus* | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 |

TABLE 3.6-14 Continued

| Species | TIME 1500 | 1800 | 2100 | 2400 | 0300 | 0600 | 0900 | 1200 |
|---|---|---|---|---|---|---|---|---|
| Hogchoker *Trinectes maculatus* | 17 | 13 | 32 | 30 | 37 | 46 | 20 | 9 |
| Tonguefish *Symphurus plagiusa* | 0 | 0 | 0 | 2 | 0 | 0 | 0 | 0 |
| White shrimp *Penaeus setiferus* | 33 | 37 | 37 | 41 | 18 | 26 | 56 | 46 |
| Brown shrimp *Penaeus aztecus* | 3 | 16 | 21 | 199 | 36 | 36 | 3 | 2 |
| Blue crab *Callinectes sapidus* | 38 | 42 | 58 | 60 | 64 | 47 | 67 | 38 |

Source: Dugas, 1975.

TABLE 3.6-15 Commercially important vertebrate species found in West Cote Blanche Bay

| Common Name | Scientific Name |
| --- | --- |
| Alligator Gar | Lepisosteus spatula |
| Ladyfish | Elops saurus |
| Gulf menhaden | Brevoortia patronus |
| Gizzard Shad | Dorosoma cepedianum |
| Blue catfish | Ictalurus furcatus |
| Sea catfish | Arius felis |
| Gafftopsail catfish | Bagre marinus |
| Crevalle jack | Caranx hippos |
| Sheepshead | Archosargus probatocephalus |
| Pinfish | Lagodon rhomboides |
| Silver perch | Bairdiella chrysura |
| Sand Seatrout | Cynoscion arenarius |
| Spotted Seatrout | Cynoscion nebulosus |
| Spot | Leiostomus xanthurus |
| Southern kingfish | Menticirrhus americanus |
| Atlantic croaker | Micropogon undulatus |
| Black Drum | Pogonias cromis |
| Red Drum | Sciaenops ocellata |
| Atlantic spadefish | Chaetodipterus faber |
| Atlantic cutlassfish | Trichiurus lepturus |
| King mackerel | Scomberomorus cavalla |
| Bighead Searobin | Prionotus tribulus |
| Striped mullet | Mugil cephalus |
| Tidewater silverside | Menidia beryllina |
| Bay Whiff | Citharichthys spilopterus |
| Fringed flounder | Etropus crossotus |
| Southern flounder | Paralichthys lethostigma |
| Hogchoker | Trinectes maculatus |

Source: Juneau, 1975.

TABLE 3.6-16 Average annual fisheries harvest of Vermilion and Cote Blanche Bays compared to total inshore and offshore harvest

| Species | Vermilion and Cote Blanche Bays (lbs) | Offshore - Inshore Harvest: Inshore Waters (lbs) | Offshore Waters (lbs) | Offshore-Inshore Totals (lbs) |
|---|---|---|---|---|
| Amberjack | | | 14,466 | 14,466 |
| Bluefish | | 2,867 | 8,033 | 10,900 |
| Bluerunner | | 100 | | 100 |
| Buffalo | 47,167 | 51,600 | | 51,600 |
| Cobia | | | 8,167 | 8,169 |
| Carp | 566 | 2,533 | | 2,533 |
| Catfish & Bullheads | 244,100 | 959,601 | | 959,601 |
| Croaker | | 110,400 | 1,716,767 | 1,827,167 |
| Drum, Black | 1,133 | 405,732 | 75,100 | 480,832 |
| Drum, Red | 5,567 | 726,566 | 136,167 | 862,733 |
| Flounders | 2,200 | 84,832 | 433,233 | 518,065 |
| Gar | 79,633 | 362,662 | | 362,662 |
| Groupers | | | 263,133 | 263,133 |
| Jewfish | | | 5,666 | 5,666 |
| King Whiting (Kingfish) | 500 | 93,432 | 554,800 | 648,232 |
| Menhaden | | 130,540,533 | 797,457,067 | 927,997,600 |
| Mullet | | 116,766 | 10,567 | 127,333 |
| Pompano | | 200 | 32,900 | 33,100 |
| Sawfish | | 800 | 1,467 | 2,267 |
| Scup | | | 16,201 | 16,201 |
| Sea Catfish | | 36,401 | 100,933 | 137,334 |
| Seatrout, Spotted | | 793,735 | 122,166 | 915,901 |
| Seatrout, Sand | | 90,632 | 271,166 | 361,798 |
| Sharks | | 433 | 3,801 | 4,234 |
| Sheepshead, Freshwater | 20,967 | 21,833 | | 21,833 |
| Sheepshead | | 240,064 | 74,366 | 314,430 |

TABLE 3.6-16 Continued

| Species | Vermilion and Cote Blanche Bays (lbs) | Offshore - Inshore Harvest: Inshore Waters (lbs) | Offshore Waters (lbs) | Offshore-Inshore Totals (lbs) |
|---|---|---|---|---|
| Snapper, Mangrove | | | 3,200 | 3,200 |
| Snapper, Red | | 533 | 2,914,933 | 2,915,466 |
| Snapper, Vermilion | | | 36,566 | 36,566 |
| Snapper, Yellowtail | | | 67 | 67 |
| Spanish Mackerel | | 3,733 | 54,866 | 58,599 |
| Spot | | 4,233 | 23,566 | 27,799 |
| Swordfish | | | 6,067 | 6,067 |
| Triggerfish | | | 6,599 | 6,599 |
| Tripletail | | 433 | 5,400 | 5,833 |
| Warsaw | | | 35,734 | 35,734 |
| Unclassified Food Fish | | | 8,366 | 8,366 |
| Unclassified Industrial Fish | | | 37,742,433 | 37,742,433 |
| Total Finfish | 401,833 | 134,650,654 | 842,143,965 | 976,794,619 |
| Crabs | 411,800 | 9,802,930 | 360,231 | 10,163,161 |
| Crawfish | | | 66,666 | 66,666 |
| Shrimp | 524,600 | 41,359,330 | 46,732,765 | 88,092,095 |
| Oysters | 6,366 | 10,856,462 | | 10,856,462 |
| Total Shellfish | 942,766 | 62,018,722 | 47,159,662 | 109,178,384 |
| Squid | | | 1,998 | 1,998 |
| Terrapin | | 800 | 33 | 833 |
| Turtles, Baby | | 133 | | 133 |
| Turtles, Green | | | 1,465 | 1,465 |
| Turtles, Snapper | | 767 | | 767 |
| Total Non-finfish | 942,766 | 62,020,422 | 47,163,158 | 109,183,580 |
| Total Harvest | 1,344,599 | 196,671,076 | 889,307,123 | 1,085,978,199 |

Source: U. S. Army Corps of Engineers, 1973b.

TABLE 3.6-17 Average annual harvest and value of major commercial fishes and shellfish for Vermilion and Cote Blanche Bays and all of Louisiana during period 1963-67

| Species | Vermilion - Cote Blanche Bays (Hydrologic Unit VII) | Total |
|---|---|---|
| Menhaden | | |
| Production[2] | 41.10 | 713.06 |
| Value[3] | 0.58 | 10.12 |
| Shrimp | | |
| Production | 3.20 | 73.51 |
| Value | 1.17 | 26.68 |
| Croaker | | |
| Production | 2.11 | 23.71 |
| Value | 0.04 | 0.42 |
| Oyster | | |
| Production | 0.01 | 9.97 |
| Value | 0.005 | 4.39 |
| Blue Crab | | |
| Production | 0.06 | 8.27 |
| Value | 0.005 | 0.73 |
| Spot | | |
| Production | 0.53 | 4.62 |
| Value | 0.01 | 0.08 |
| Catfish and Bullheads | | |
| Production | 0.07 | 4.59 |
| Value | 0.01 | 0.78 |
| Seatrout | | |
| Production | 0.42 | 4.11 |
| Value | 0.02 | 0.19 |
| Red Drum | | |
| Production | 0.00 | 0.53 |
| Value | 0.00 | 0.09 |
| TOTAL | | |
| Production[a] | 47.50 | 842.37 |
| Value[b] | 1.84 | 43.48 |
| Estuarine water[c] | 323 | 3,283 |
| Production, pounds/acre | 147.1 | 256.6 |
| Value dollars/acre | 5.7 | 13.2 |

[a] millions of pounds [b] millions of dollars [c] thousands of acres

Source: U.S. Army Corps of Engineers, 1973b.

TABLE 3.6-18 Historical fishery statistics - Bureau of Commercial Fisheries Louisiana crab landings, 1880-1972 thousands of pounds and thousands of dollars

| | Hard Shell | | Soft Shell | |
|---|---|---|---|---|
| Year | Quantity | Value | Quantity | Value |
| 1880 | 288 | 7 | -- | -- |
| 1887 | 837 | 13 | 133 | 7 |
| 1888 | 851 | 13 | 143 | 7 |
| 1889 | 842 | 14 | 147 | 8 |
| 1890 | 851 | 13 | 130 | 7 |
| 1897 | 1,459 | 13 | -- | -- |
| 1902 | 1,312 | 16 | -- | -- |
| 1908 | 244 | 8 | 78 | 21 |
| 1918 | 282 | 10 | -- | -- |
| 1923 | 312 | 8 | 3 | 1 |
| 1927 | 1,091 | 51 | 137 | 48 |
| 1928 | 2,320 | 78 | 183 | 52 |
| 1929 | 2,675 | 78 | 81 | 25 |
| 1930 | 4,186 | 63 | 146 | 58 |
| 1931 | 4,985 | 53 | 121 | 45 |
| 1932 | 5,878 | 57 | 99 | 25 |
| 1934 | 11,676 | 164 | 651 | 86 |
| 1936 | 12,576 | 168 | 365 | 53 |
| 1937 | 14,717 | 195 | 329 | 51 |
| 1938 | 10,533 | 106 | 248 | 37 |
| 1939 | 11,228 | 129 | 215 | 33 |
| 1940 | 14,062 | 172 | 252 | 40 |
| 1945 | 31,280 | 1,418 | 2,370 | 1,706 |
| 1948 | 21,110 | 608 | 881 | 440 |
| 1949 | 17,874 | 555 | 455 | 192 |
| 1950 | 13,106 | 599 | 364 | 165 |
| 1951 | 8,710 | 461 | 350 | 188 |
| 1952 | 7,334 | 314 | 448 | 215 |
| 1953 | 8,131 | 333 | 488 | 203 |
| 1954 | 7,085 | 294 | 455 | 215 |
| 1955 | 10,811 | 449 | 581 | 290 |
| 1956 | 9,402 | 433 | 600 | 250 |
| 1957 | 8,559 | 419 | 551 | 192 |
| 1958 | 9,336 | 402 | 577 | 298 |
| 1959 | 9,570 | 461 | 605 | 302 |
| 1960 | 10,050 | 497 | 514 | 256 |
| 1961 | 11,910 | 514 | 620 | 310 |
| 1962 | 9,523 | 463 | 344 | 172 |
| 1963 | 7,982 | 447 | 329 | 164 |
| 1964 | 5,692 | 379 | 200 | 127 |
| 1965 | 9,284 | 635 | 204 | 141 |
| 1966 | 7,986 | 537 | 128 | 85 |
| 1967 | 7,559 | 520 | 145 | 121 |
| 1968 | 9,551 | 807 | 284 | 206 |
| 1969 | 11,602 | 1,072 | 197 | 161 |
| 1970 | 10,254 | 928 | 90 | 79 |
| 1971 | 12,186 | 1,256 | 127 | 126 |
| 1972 | 15,083 | 1,777 | 102 | 109 |

Source: Louisiana State University, 1975.

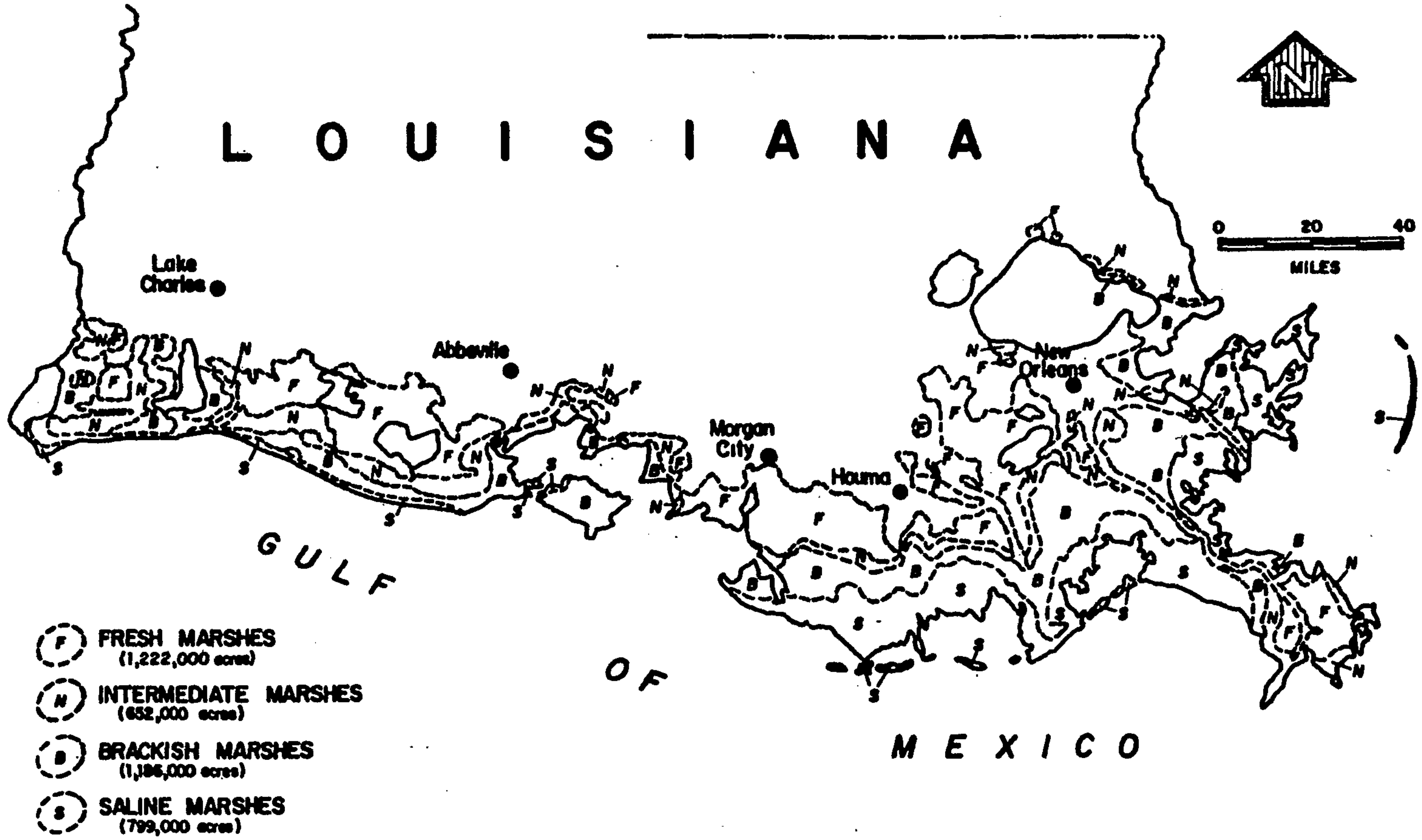
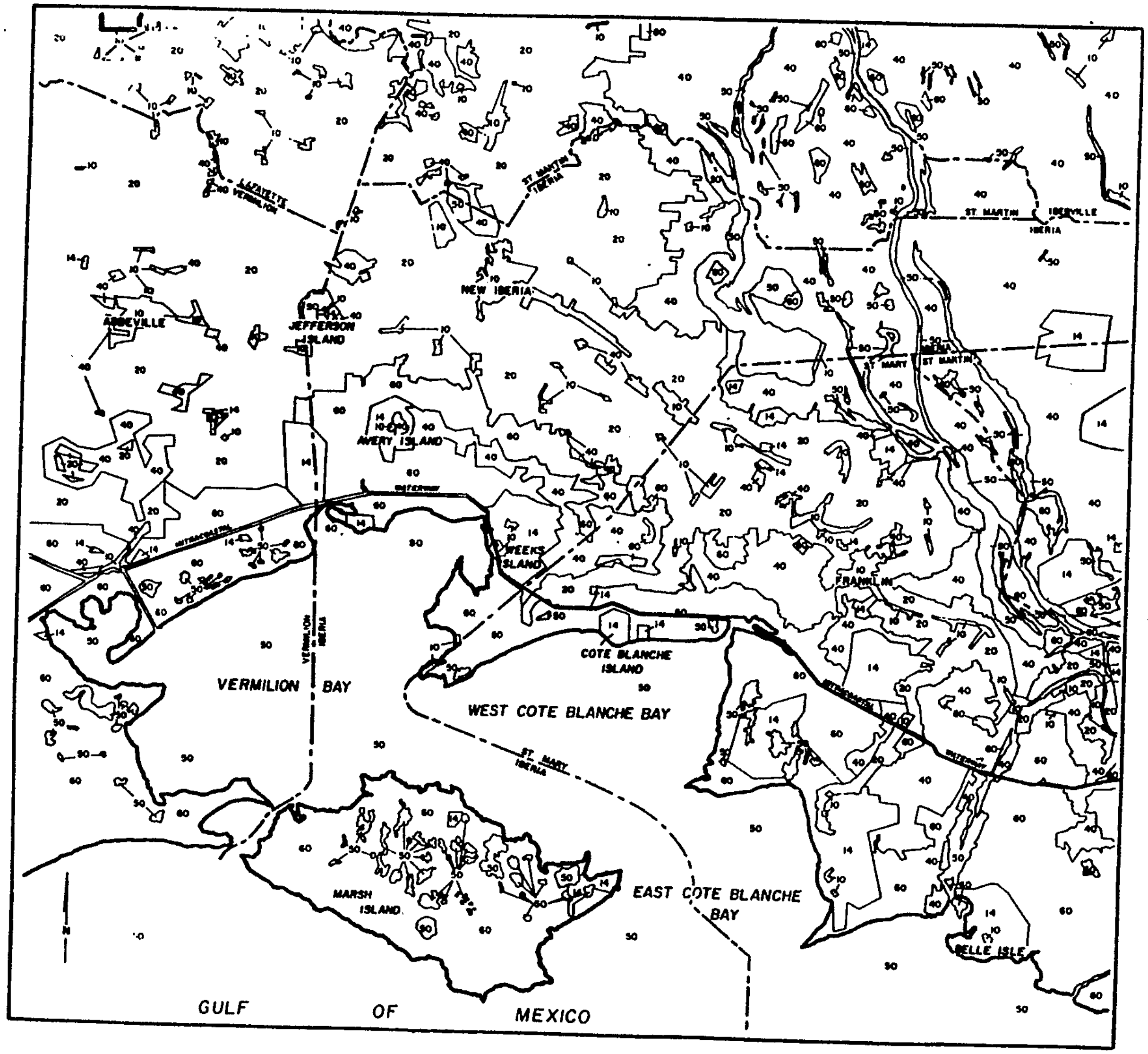



FIGURE 3.6-1. Vegetative type map of the Louisiana coastal marshes.




SOURCE: LOUISIANA STATE PLANNING OFFICE, LAND USE AND DATA ANALYSIS (LUDA) PROGRAM, U.S. GEOLOGICAL SURVEY, 1972.
LAND USE MAPS: NEW ORLEANS
PORT ARTHUR
LAKE CHARLES
BATON ROUGE

LEGEND

10 URBAN AND BUILT-UP LAND
14 EXTRACTIVE LAND
20 AGRICULTURAL LAND
30 RANGELAND (NOT APPLICABLE)
40 FORESTLAND
50 WATER
60 MARSH (WETLAND)
70 BARREN LAND (NOT APPLICABLE)

SCALE:


FIGURE 3.6-2. Regional land use in the vicinity of Cote Blanche Island.

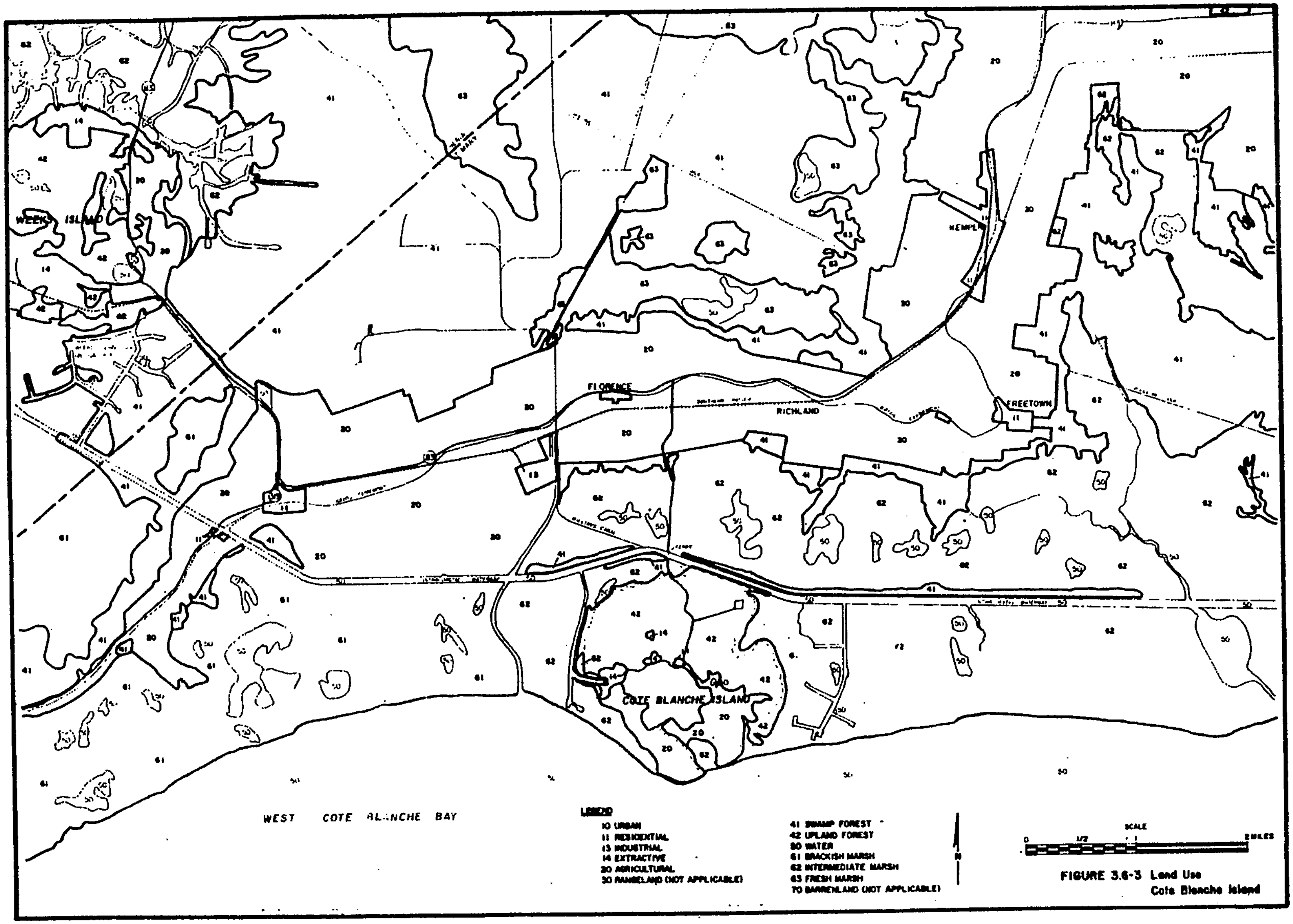



FIGURE 3.6-3 Land Use
Cote Blanche Island

## 3.7 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

### 3.7.1 Regional Sites of Importance

Within the five parish region around Cote Blanche Island, many sites have been identified as sites of historical, archaeological, architectural, or cultural importance.

The U.S. Army Corps of Engineers environmental inventory (1973b) lists the following number of archaeological sites: 57 in Iberia Parish; 3 in Lafayette Parish; 47 in St. Mary Parish; 36 in St. Martin Parish and 34 in Vermilion Parish.

Federal historical sites listed in the National Register (Red Book) through December 1975 include two sites in New Iberia and one site at Jefferson Island, Iberia Parish; three sites in St. Martinville, St. Martin Parish; and one site in Franklin, St Mary Parish. No historical sites were listed for Lafayette or Vermilion Parishes.

Historical sites of state or local interest listed in the U.S. Army Corps of Engineers environmental inventory (1973b) include 22 sites in Iberia Parish (including Weeks Island), 19 sites in Lafayette Parish, 28 sites in St. Martin Parish, 42 sites in St. Mary Parish (none within 5 miles of Cote Blanche Island), and 10 sites in Vermilion Parish. The state listing for these parishes is to be updated by the Acadiana Planning and Development District in the near future.

### 3.7.2 Site Vicinity

The State Art, Historical, and Cultural Preservation Agency in Lafayette, Louisiana, and the Louisiana Archaeological Survey and Antiquities Commission in Baton Rouge were contacted concerning the possible location of important historical or archaeological sites within 5 miles of Cote Blanche Island and, particularly, any sites that might be affected by the proposed project. Copies of responses from these agencies are included in Appendix D.

No known properties are presently included in the National Register of Historic Places. However, four known archaeological sites are in the vicinity of Cote Blanche and are identified as follows:

1. SMY 100 Burk Hill - A multicomponent village location with an extensive concentration of surface debris.

2. SMY 101 Alligator Hole - A shell midden.

3. IB 3 Morton Shell Mound (also known as Weeks Island site) - a very important site with over 25 feet of well-preserved cultural deposits.

4. IB 102 North Hill - A camp site with scattered lithic materials.

The Morton Shell Mound site is of exceptional importance and is in the process of being nominated to the National Register of Historic Places. The locations of these sites are shown in Appendix D. Sites SMY 100 and 101 are located north of the Cote Blanche Mine site on the northwest edge of the island. The other two sites are on Weeks Island several miles to the northwest. None of the sites are threatened by the proposed project.

Because of the elevated character of Cote Blanche Island, it is highly probable that other unknown archaeological and/or historic sites may exist, although these sites are less likely to have remained in an undisturbed condition if they are close to existing surface development. No comprehensive archaeological surveys have been conducted in the area.

Appendix D contains the results of a cultural resource survey conducted on, and in the near vicinity of, the proposed Cote Blanche project site. No evidence was found to indicate that cultural resources would be endangered by the proposed project. Also included in Appendix D is the State Historic Officer concurrence with results of this survey.

During construction at the site, a qualified archaeologist will be present to examine excavated material taken from the barge slip and from the upper 20 to 50 feet of the shafts and to inspect and record any materials of interest that are unearthed.

## 3.8 SCENIC, CULTURAL AND NATURAL RESOURCES

### 3.8.1 Scenic Resources

Along the coastline of Louisiana is the vast region of marshlands and prairie terraces described in section 3.6. The continuity of these marshlands is altered in the Cote Blanche area by the presence of the Five Islands, which attain heights of 150 feet or more above sea level. These isolated topographic features are of scenic interest because of the contrast they provide to the prevailing lowlands. At Cote Blanche Island, this contrast is striking when one compares the high forested hillside with the surrounding low brackish marsh. In addition, despite the fact that the island has been occupied and exploited by man for a considerable number of years, it still supports a significant amount of native vegetation. The unique range of habitats on the island supports vegetation that is strikingly different from that of the Louisiana coast in general, ranging from marsh around the edge of the island to freshwater lakes, pasture land, and mature forests high up in the hills. Parts of the forest have a distinct tropical aspect, being composed of tall trees supporting many lianas of various types. On Cote Blanche, a planted grove of several large palmetto trees and the remnants of a street of live oaks almost engulfed by forest are all that remain of a bathing resort that occupied part of the island more than 45 years ago.

The remote, inaccessible nature of the coastal estuaries creates an environment that in some places is almost wilderness in nature. Though there are many drill rigs and production platforms in several bays and marshes, most of the area is visited only by an occasional fisherman, duck hunter, or trapper. Regionally, there is little obvious variation in the elevation or vegetation so that the aesthetic experience is much different from most popular scenic areas that draw large numbers of tourists. Nevertheless, to one who understands and appreciates the character of the marshland, south Louisiana can be a source of great scenic beauty.

### 3.8.2 Cultural Resources

Cultural features of importance in the wetlands of south Louisiana are generally limited to archaeological sites, mostly shell middens and

Indian mounds. These have been considered in section 3.7. There are many examples of grand old southern plantation homes and other buildings associated with the history of Louisiana along the natural levees, particularly Bayou Teche in this area to the north.

The parishes in this portion of the state are the center of the Cajun culture, unique to southern Louisiana. Lafayette, 35 miles to the northwest of Cote Blanche, is considered to be in the heart of Cajun country.

3.8.3 Natural Resources

3.8.3.1 National Wildlife Refuges

The U.S. Fish and Wildlife Service of the U.S. Department of the Interior has the responsibility to provide sanctuaries for wildlife and fish by preserving breeding grounds and habitat that may be scarce in other areas due to encroachment on natural habitats by agricultural, industrial, and urban development. These refuges also provide important opportunities for scientific study and for outdoor recreation (primarily nature study) and natural scenic appreciation.

The Louisiana coastal zone contains five national wildlife refuges. The nearest national refuge to Cote Blanche is the Shell Keys National Wildlife Refuge located 25 miles to the southwest (Figure 2.2-1). This refuge was established in 1907 and is an 8-acre colonial bird nesting area offshore in the Gulf of Mexico. Shell Keys is under the administration of the Lacassine National Wildlife Refuge located 65 miles due west of Cote Blanche.

3.8.3.2 State Wildlife Refuges and Management Areas

The State of Louisiana Wildlife and Fisheries Commission maintains three wildlife management areas within the Gulf coastal zone. These areas serve primarily to maintain habitat and breeding grounds for wildlife and to provide wildlife-oriented recreation under closely supervised conditions.

In the coastal area, The Louisiana Wildlife and Fisheries Commission administers: the Russell Sage or Marsh Island Refuge (79,000 acres) at the mouth of Vermilion Bay, the nearby Louisiana State Refuge and Game Preserve (15,000 acres), and the Rockefeller Refuge (82,000 acres). In addition there are 12 state wildlife management areas or preserves (Table 3.8-1).

### 3.8.3.3 Private Wildlife Refuges

The National Audubon Society manages the 26,161-acre Paul J. Rainey Wildlife Refuge on the Louisiana coast in southwest Vermilion Bay. This refuge is located next to the Louisiana State Wildlife Refuge and Game Preserve and serves to extend the sanctuary provided by this refuge (Figure 2.2-1).

### 3.8.3.4 Summary of Cote Blanche Island Environs

Cote Blanche is one of the Five Islands, which extend well above the surrounding wetlands in south central Louisiana. Reaching a height of approximately 100 feet, the island provides a uniquely different type of environment, including an unusually good vantage point for viewing the surrounding bays and marshlands. For the same reason, the island provides excellent wildlife habitat of a type uncommon to south Louisiana.

Cote Blanche is a privately owned island, however, and has been for many years. Except for the Domtar employees and the owner of cattle and sheep that graze there, the island is closed to public use. No hunting, fishing, sightseeing or other activities are allowed. The island is more than a mile south of Highway 83 and is separated from the mainland by the Intracoastal Waterway. The only vantage point from which the island is particularly visible is the north end of West Cote Blanche Bay. Therefore, although of great potential scenic and recreational character, Cote Blanche Island is not presently, or expected to be in the future, a tangible resource to the people of Louisiana.

The island does not contain any known historical or cultural site of great importance. As indicated in section 3.7.2, two known archaeological sites are located on the northwest edge of the island. The elevated character of the island gives promise that many other archaeologically important sites may exist, however.

Cote Blanche Island is set in the midst of a vast estuarine complex and wildlife area extending the breadth of Louisiana along the Gulf of

Mexico. The value of this wetland system to biological organisms, particularly estuarine dependent fish, benthos, avifauna and mammals, is well recognized though difficult to quantify. Much of the commercial fishing industry, sport fishing, hunting and other outdoor recreational activities owe their existence to the coastal marshlands and bays. The several wildlife refuges and game management areas established preserve large blocks of this productive habitat for ecological purposes and human enjoyment.

TABLE 3.8-1 Louisiana State wildlife management areas and preserves

| Name of Area | Parish Location | Acreage |
|---|---|---|
| Pearl River | St. Tammany | 26,716 |
| St. Tammany | St. Tammany | 1,300 |
| Biloxi | St. Bernard | 39,583 |
| Bohemia | Plaquemine | 33,000 |
| Pass a Loutre | Plaquemine | 66,000 |
| Wisner | Lafourche | 21,621 |
| Salvador | St. Charles | 27,499 |
| Pointe au Chien | Lafourche | 28,244 |
| Bonnet Carre' | St. Charles | 3,789 |
| Thistlethwaite | St. Landry | 11,100 |
| West Bay | Allen | 55,185 |
| Sabine | Calcasieu | 10,500 |

## 3.9 SOCIOECONOMIC ENVIRONMENT

This section describes the social and economic setting of the proposed project. Consideration is given both to the local area and to the region within which the Cote Blanche site is located. Because most socioeconomic data are compiled by political jurisdictions or subdivisions of the state, the local area is defined as St. Mary Parish and the region selected is Acadiana, one of Louisiana's eight planning districts, consisting of eight parishes in southcentral Louisiana. The land-use section considers the five southernmost parishes in Acadiana for regional land use, and a distance of up to 5 miles from Cote Blanche Island for local land use.

### 3.9.1 Regional Setting

Acadiana's eight parishes are Acadia, Evangeline, Iberia, Lafayette, St. Landry, St. Martin, St. Mary, and Vermilion (Figure 3.9-1). The region extends from the central Gulf Coast north almost to the geographic center of the state. The total area is about 6,000 square miles. The city of Lafayette in Lafayette Parish is the economic hub of the region.

#### 3.9.1.1 History

Before European settlement, most of coastal Louisiana was inhabited by Chitimacha Indians of Gulf linguistic stocks. The first recorded discovery of Louisiana was by Hernando de Soto. The first colony was established in 1699 by d'Iberville and Bienville. From this period until the purchase of Louisiana by the United States, the area was ruled alternately by Spain, England, and France. A notable immigration into the coast area by Acadians began in 1756. Driven from Canada by the British, the Acadians were accepted by the Spanish rulers in Louisiana. They brought with them a pastoral lifestyle and cultural influences that are still felt today. Settlement of the area came dearly, with yellow fever and malaria taking their toll. Piracy flourished in some coastal areas.

After the Louisiana Purchase and the gradual influx of American settlers from the southern states, the economy of the area began to change. Large plantations developed, based on cotton and sugar cane cash crops. Seeing her economic base threatened by Union intervention Louisiana seceded and became a lone republic but soon joined with the Confederacy. New Orleans was captured early in the war and most of coastal Louisiana came under federal military rule. However, Confederate guerrilla action continued in the area with counter operations carried out by Federal troops.

After the war, the large plantations were dissolved. The previous economic system was shattered and little capital was available for re-instituting a new one. The tenant-sharecropping system filled the void but economic recovery was slow.

The discovery of oil in 1901 signaled the beginning of a new era for Louisiana. The activity of oil and gas exploration and mining provided employment opportunities other than agriculture, fishing, and trade, and stimulated the economy. The severance tax levied on minerals extracted from state lands also furnished the state with money for needed public services.

The flood of 1927 affected much of coastal Louisiana and provided the needed impetus for the construction of many flood control projects. Coastal Louisiana probably weathered the Great Depression as well as any area of the United States, and with the coming of World War II, oil and gas activity was expanded. Today the area economy is based upon natural resources, especially agriculture, fishing, and mineral extraction.

3.9.1.2 <u>Land-Use Patterns and Planning</u>

<u>Land Use</u>

The topography of the region is varied and characterized by the major rivers of the area and the proximity of the Gulf Coast. Much of the southern portions of Vermilion, Iberia, and St. Mary Parishes are coastal marshlands, bisected by natural levees created by long-term flooding of the major bayous (Figure 3.2-1). Prairies cover northern Vermilion Parish, with blufflands found in Lafayette, western St. Martin and western Iberia Parishes. Much of eastern St. Martin, Iberia, and northern St. Mary Parishes are characterized by Mississippi River flood plain topographic features (Acadiana Planning and Development District, 1974a).

Topography in the region has influenced settlement patterns significantly. Early settlement in the coastal area was limited to natural levees along waterways. These were the only areas suitable for development in the low wetland, and they provided easy access to the waterways, the main means of transportation. As the process of inheritance and sale subdivided the land into blocks, these gradually became narrower, since frontage on the bayou had to be maintained to preserve land values. Eventually the French long lot system (deep, narrow parcels of land fronting on the bayou) became the predominant pattern of land ownership along the bayous in southern Louisiana. Urban settlement has clustered at the ends of the lots along the bayous. This strip settlement is similar to that which occurs along highways in other sections of the country. In areas of sparse development the pattern is less pronounced (Richardson, 1972).

Agricultural land in the coastal region is also generally confined to the natural levees along the bayous. Most of the land is used for sugar cane production or cattle grazing. The marshlands provide excellent hunting, fishing, and trapping. In some areas, oil and gas wells are extensive. Numerous canals and pipelines crisscross the marshes in the areas of oil and gas activity.

Data compiled in the 1967 Soil and Water Conservation Needs Inventory for Louisiana by the Soil Conservation Service for the years 1958 and 1967 was considered for land-use trend analysis. However, due to remeasurements of parish boundaries between 1958 and 1967 and alteration of water bodies and land areas since 1940, much of the data was unsuitable for comparison purposes. Although no specific figures could be developed from the data for Iberia and St. Mary Parishes, some conclusions are possible. Rangeland and pasture acreage decreased substantially in Iberia Parish, with cropland and forest uses increasing. In St. Mary Parish, there was a definite strong urbanization trend.

Present land use within 20 miles of Cote Blanche Island is depicted on Figure 3.6-2. The data depicted is derived from the Land Use Development Analysis Program (LUDA) sponsored in Louisiana by the Louisiana State Planning Office in conjunction with the U.S. Geological Survey.

The land-use maps generated by the program are keyed to U.S. Geological Survey 1:250,000 scale topographic maps. Source photography for the maps was obtained in 1972. The land-use classification categories and minimum parcel sizes for each classification are shown in Table 3.9-1. Level One land uses, as depicted on the maps in this report, conform to the LUDA classification scheme except in two instances. Extractive land uses are subcategorized to provide differentiation from other urban land uses, and the wetland forest category was combined with forested land to provide a separate classification for wetland marsh.

The use of the bayou levee for urban and agricultural land is clearly depicted on the map, as are the extensive oil and gas activities in the marshes. At this level of detail, both Weeks Island and Cote Blanche Island are classified as being used for extractive purposes, although in reality neither is heavily developed for this purpose.

Table 3.9-2 indicates the acreage and percentage of area of each land use in the five parishes, according to LUDA tabulations. St. Mary Parish has the largest total land area devoted to urban uses, 19,019 acres, followed by Lafayette with 18,031. St. Mary Parish has 54,340 acres devoted to extractive uses with St. Martin recording 31,863 acres. Of the five parishes considered, Iberia, Vermilion, St. Martin and Lafayette have the largest amounts of agricultural land, totalling over 823,000 acres. Almost 84 percent of Lafayette Parish is in agricultural uses. Forest land is prevalent in St. Martin Parish due to its location within the Atchafalaya Basin; substantial forest acreage occurs in St. Mary and Iberia Parishes as well. In Iberia, Vermilion and St. Mary Parishes, over half of the total parish area is water. Approximately 20 percent of Vermilion Parish (268,242 acres) is marshland.

Recreational and Environmental Management Areas

Review of the Regional Recreation System Plan developed by the Acadiana Planning and Development District indicates that although the supply of facilities in the area is increasing, it is still deficient and is not keeping pace with the area's needs. Specific areas of recommended attention include the development of picnic facilities, boat ramps, golf courses, beaches and trails, and the restriction of industrial uses along river banks so that they may be used for recreational purposes. The study indicated that to implement the plans and programs, a source of money must be obtained (Acadiana Planning and Development District, 1975).

A list of exceptional existing and potential recreational sites is provided in Table 3.9-3; their locations are shown on Figure 3.9-2. To provide a better understanding of recreational opportunities in the area, an inventory of facilities in the parishes of Vermilion, Lafayette, St. Martin, Iberia and St. Mary is provided in Appendix E.

Areas of particular environmental sensitivity within 25 miles of the Cote Blanche Island include three nonfederal game management refuge areas and one National Wildlife Refuge (Figure 2.2-1). These areas are located southwest of Cote Blanche Island across Vermilion and West Cote Blanche Bays. The Paul J. Rainey Refuge is owned by the Audubon Society and consists of 27,000 acres. The Louisiana State Wildlife Refuge and Game Preserve and the Russell Sage (Marsh Island) Wildlife Refuge and Game Preserve total about 97,000 acres. The Shell Keys National Wildlife Refuge south of Marsh Island covers 8 acres (U.S. Army Corps of Engineers, 1973b).

Land and Water Interface Management

The entire coast of Louisiana has been inventoried by the U.S. Corps of Engineers for the National Shoreline Study (1971). For purposes of the study the shoreline was divided into zones. Zone II, in which Cote Blanche Island is located, extends from Southwest Pass at Vermilion Bay eastward to Point au Fer. This zone contains Vermilion Bay, West and East Cote Blanche Bays, Atchafalaya Bay and Marsh Island. In general, this shoreline may be divided into two broad categories: those which face the Gulf of Mexico (Gulf shoreline), and a bay-sound shoreline located in bays and protected inlets. The Gulf shoreline extends about 21 miles along the southern shore of Marsh Island and the Southwest Pass area of Vermilion Bay. This shoreline has 16 miles of sand and shell beaches and 5 miles of mud/silt shoreline. The bay/sound shoreline of the zone contains 104 miles of sand and shell beaches and 146 miles of mud/silt shorelines. Most of the shoreline is in noncritical stages of erosion.

Approximately 70 percent of the Zone II shoreline is in private ownership with the remaining 30 percent in public nonfederal ownership. Most of the public owned shoreline is along Marsh Island. Two areas of the shoreline, both in the vicinity of Cypremort Point in St. Mary Parish are developed for recreational uses. Cypremort Point Beach is a public beach about 0.6 mile in length and covers approximately 185 acres. The area is intended for inclusion in the state park system and is potentially an excellent swimming and water sport facility for the region. Camp Development is a privately owned campground and recreation area covering 1.2 miles of shoreline, with 300 camp and trailer sites. On East Cote Blanche Bay, near Point Chevreuil, is the Burns Point Picnic area, a 10-acre developed beach with 20 camping spaces. This area is owned and operated by St. Mary Parish, (U.S. Army Corps of Engineers, 1971).

Land-Use Planning

The Acadiana Planning and Development District was contacted to determine the extent of future land-use plans for the area. There are no existing land use or zoning regulations and no future plans for regulations of land use in the planning district, either at county or local levels (personal communication, 1976). Initial work under the Coastal Zone Management Program has begun, however, with a portion of the work contracted to the Acadiana Planning and Development District by the Louisiana Office of State Planning. The Coastal Zone Management Program is a federally funded program implemented by the Department of Commerce, National Oceanic and Atmospheric Administration. The program consists of project grants to aid states in development and implementation of a management program for land and water resources of their coastal area.

3.9.1.3 Transportation Systems

Acadiana probably has the most diversified system of transportation facilities in the southern United States (Evangeline Economic Development District, no date), including an extensive network of inland waterways with many linkages to major ports.

## Highway System

The region's thoroughfare circulation system is the most heavily used component of the total transportation system (Acadiana Planning and Development District, 1974b). The primary highways include: 1) Interstate 10, an east-west route that bisects the area and provides the major link with New Orleans to the east and with Houston to the west; 2) U.S. 167, an important north-south route in Acadiana; 3) U.S. 90, an important link between Acadiana and New Orleans through the bayou country; and 4) U.S. 190, an east-west route in the northern part of the region (Figure 3.9-3). Generally, the highway system is less well developed in the southern portion of the region where much of the land is swamp forest or marshland. In St. Mary Parish in the extreme southeast, U.S. 90 is almost the only available surface route and through much of this area it is only a two-lane road; however, work is underway to upgrade this important southern link between Acadiana and New Orleans.

## Railroad System

Acadiana is serviced by the Southern Pacific, Missouri Pacific, Kansas City Southern, Texas Pacific, Chicago Rock Island, and AMTRAK rail systems. Altogether, there are 4075 miles of main line Class II trackage in Louisiana (Evangeline Economic Development District, undated).

Southern Pacific has its Louisiana headquarters based in Lafayette in addition to the division offices and the repair center. The Lafayette terminal handles approximately 50,000 rail cars per month. Besides the Lafayette terminal, depots are located in New Iberia, Franklin, Morgan City, Baldwin, Jeanerette, Broussard, and Opelousas.

The only railroad offering passenger service within the district is AMTRAK, which operates between New Orleans and Los Angeles. The route includes tri-weekly stops in Lafayette and New Iberia (Acadiana Planning and Development District, 1974b).

## Water Transportation

Waterways provide a major form of transportation in Acadiana. The Intracoastal Waterway, which crosses the southernmost parishes and stretches from the Gulf to the Atlantic Coast, is a vital artery through which flows the bulk of east-west commercial water shipment in the southern United States. Several easily navigable north-south channels connect the cities of Acadiana to the Intracoastal Waterway. Other components of the main water transport system include the Atchafalaya River and Bay, the Vermilion River, Bayou Teche, East Cote Blanche Bay, West Cote Blanche Bay, Six Mile Lake, Grand Lake, and Wax Lake Outlet (Figure 2.2-1).

Locks are located at Berwick, at Bayou Beouf, above New Iberia (Keystone Locks), and west of Intracoastal City on the Intracoastal Waterway (Vermilion Locks). Floodgates are located at East Calumet, West Calumet, Charenton, Schooner Bayou, and Freshwater Bayou.

The total number of vessels and the total tonnage that passed on these waterbodies in 1970 are summarized below (Acadiana Planning and Development District, 1974b):

| Water Body | Total Number of Vessels | Total Tonnage |
|---|---|---|
| Atchafalaya River Morgan City-Gulf of Mexico | 21,470 | 4,536,695 |
| Atchafalaya River Old River Locks at Mississippi River-Morgan City | 5,925 | 5,369,106 |
| Intracoastal Waterway | 13,963 | 19,173,890 |
| Freshwater Bayou | 723 | 404,850 |
| Bayou Teche | 2,487 | 660,119 |
| Vermilion River | 5,729 | 1,517,133 |
| Franklin Canal | 311 | 10,333 |

The region's major port is Morgan City in St. Mary Parish; it is the nation's largest shrimp port and a center for offshore drilling activities. Other important ports outside Acadiana are accessible via Interstate 10: New Orleans, the nation's second largest port, is 150 miles east; Baton Rouge, the seventh largest port in the United States, is 60 miles north; and Lake Charles, the nation's largest rice port, is 60 miles west.

Air Transportation

While there are several airports located throughout the district, only the Lafayette Municipal Airport offers scheduled passenger and freight services. The city of Lafayette is centered in the heart of Acadiana, and the Lafayette Municipal Airport is no more than an hour's drive from any Acadiana community. The airport moves more passengers through its terminals than any other single-airline airport in the nation (over 130,000 per year), and its cargo carriers transport more than 2,392,080 pounds of cargo each year.

Including the Lafayette Airport there are 10 public airports, 51 private airports, 26 heliports or helipads, and 5 seaplane ports in the district.

Pipeline Transportation Systems

In Louisiana the oil and gas pipeline transport system is second only to the thoroughfare system in total mileage. The extent of the oil transport system is presented on Figure 3.9-4 and of the gas pipeline network on Figure 3.9-5. Acadiana is crisscrossed with pipelines, the system within the region linking it with major pipelines in other parts of the state and the nation.

3.9.1.4 Population and Housing Characteristics

Population Trends

Between 1960 and 1970 Acadiana grew at a much faster rate than the state as a whole (36.4 percent versus 11.8 percent). This difference is expected to diminish in the 1970's and in the 1980's; the 1973 estimate indicates that the growth rate in Acadiana has already dropped to just 0.6 percent above the statewide rate. Data supporting these conclusions are presented in Table 3.9-4.

Population Density and Distribution

Acadiana has a higher population density than the state as a whole (104.9 persons per square mile versus 81.0; see Table 3.9-5). Within Acadiana the highest population density occurs in Lafayette Parish, the economic, urban, and geographic center of the region. The lowest densities occur in Vermilion, St. Martin, and Evangeline Parishes.

Differences in urban/rural distribution support the population density data. It should be noted here that urban population includes persons living in incorporated or unincorporated places of 2500 inhabitants or more together with the population of the city of Lafayette, and the densely settled areas immediately surrounding Lafayette. It is important to note that rural population includes, in addition to farm population, the inhabitants of very small communities (under 2,500). Table 3.9-6 gives 1960 and 1970 populations of the largest towns in Vermilion, Iberia and St. Mary Parishes.

## Population Characteristics

Demographically (with reference to age and racial characteristics), Acadiana in 1970 was not greatly different from the state as a whole (see Table 3.9-7). There was a somewhat lower percentage of blacks and other nonwhite residents and the median age was slightly younger.

The more significant differences are seen in characteristics that reflect socioeconomic conditions. Here, Acadiana's inhabitants are seen to have had significantly less education and lower incomes. A slightly higher percentage of families were on public assistance, but a considerably larger proportion of households (families plus single persons) were below the poverty income level. There was a somewhat lower proportion of professionals and white-collar employees, a slightly higher proportion of blue-collar workers, and a significantly higher proportion of farm owners and workers.

## Housing Characteristics

Selected housing characteristics are summarized in Table 3.9-8. Compared with the state, in 1970 the region was characterized by a slightly higher proportion of owner occupied housing units and units that were crowded and/or lacked complete plumbing facilities. Home value and rent were lower than the statewide averages. The difference in vacancy rate was negligible. The region's vacancy rate of 7 percent indicates that the housing market was not too tight to permit some population expansion, but this potential flexibility is significantly reduced by the fact that 17 percent of the housing was crowded (1.01 or more persons per room), 15 percent had plumbing deficiencies, and 4 percent was both overcrowded and lacking some or all plumbing. It is not possible to determine whether the vacancies occur more in the sound housing or in the inadequate housing.

#### 3.9.1.5 Economy

According to a recent study (Acadiana Planning and Development District, 1974c), the economic base of the Acadiana region is in a transitional state. Between 1950 and 1970, there has been a considerable expansion of the nonbasic sector (which consists of industries that tend more to serve the local area rather than to export goods and services outside the area). This is reflected by the change in ratio of basic to nonbasic employment (described in the study cited above):

| | |
|---|---|
| 1950 | 1:1.75 |
| 1960 | 1:2.06 |
| 1970 | 1:2.29 |

This changing ratio indicates that over the period one job in the basic (export) sector supported an increasing number of jobs in the nonbasic (secondary) sector and indicates a growing strength in the economic base as well as greater economic diversity. This condition reflects the increasing urbanization and industrialization of the region. Typically, the service sector tends to expand with increased industrialization; a rural population tends to be more self-sufficient, requiring (and affording) fewer services.

Between 1950 and 1970, agriculture and employment decreased from over one-third of the region's employment to less than 10 percent, while mining approximately doubled (5.3 to 10.1 percent). The service sector grew rapidly from a small base in 1950. Manufacturing employment increased slowly but steadily, a considerable portion of this being related to the growth of mining. As a result of these changes, the region's economy has achieved a fairly diverse economic base.

Table 3.9-9, which presents data developed by the Acadiana Planning and Development District for their economic study published in June 1974, presents employment trends by industrial sector for the period

1968 to 1972 with a projection for 1977. It was felt that insufficient historical data were available to support a projection farther into the future. The data are presented here because the projection is the only one available for the region, although it should be noted that the figures for 1970 civilian work force, total employment, and unemployment do not correspond to those presented by the U.S. Census. These figures indicate a continued expansion of the secondary sector; a slower growth of manufacturing and mining, and a significant decline in agricultural employment.

Data on earnings by industrial sector for 1950, 1959, and 1970 (Table 3.9-10) further reinforces earlier observations: nonfarm earnings increased 197 percent in the 20-year period while farm earnings decreased 15 percent. The greatest relative increases were in contract construction, mining, finance, insurance, and real estate. Other growth sectors (in terms of number of jobs) did not experience as great an increase in earnings.

In Table 3.9-11, employment has been related to earnings for selected employment sectors for 1970. This comparison gives a rough indication of the relative economic contribution of various sectors. The average earnings for all sectors is $5,100. All of the selected sectors, with the notable exception of agriculture, produce higher average earnings, and per capita earnings in mining are nearly double the average.

### 3.9.1.6 Government

Acadiana consists of the following eight parishes (administrative subdivisions of the state of Louisiana):

| Parish | County Seat |
|---|---|
| Acadia | Crowley |
| Evangeline | Ville Platte |
| Iberia | New Iberia |
| Lafayette | Lafayette |
| St. Landry | Opelousas |
| St. Martin | St. Martinville |
| St. Mary | Franklin |
| Vermilion | Abbeville |

Public Revenues

Table 3.9-12 presents data on property tax, a major source of local revenue, and in Louisiana a state source as well. The average assessed valuation for parishes in Acadiana in 1970 was $81,132,000, lower than the average of $99,348,000 for all Louisiana parishes. The variation around the Acadiana average was quite large, from a low of $38,120,000 in Evangeline Parish to a high of $155,842,000 in St. Mary Parish.

In terms of the tax revenue produced by property tax, the average for the Acadiana parishes is $3,907,000, of which $3,456,000 or 88.5 percent goes to local jurisdictions, schools, roads, and so forth. Evangeline Parish produces the lowest total revenue ($1,531,000) and Lafayette the greatest ($6,366,000). The Acadiana parishes also show variation in the percentage of property tax revenue, which stays at the local level, ranging from 84.3 percent in St. Mary Parish to 93.7 percent in St. Martin.

Acadiana, which constitutes 10.5 percent of the area of the state, contributes 9.6 percent of the total property tax revenue (both state and local); of this total revenue, it contributes a higher percentage to the state than the average of all the state's parishes.

Severance taxes (collected on the production of natural resources) are a more important source of revenue in the Acadiana region than is property tax. As may be seen in Table 3.9-13, the region produces 31 percent of the state's revenue from this source, including 20 percent of the oil tax, 38 percent of the gas tax, and 100 percent of the salt tax (all from Iberia and St. Mary Parishes). Most of the severance tax revenue goes to the state, but some is returned to the contributing parishes (State of Louisiana, 1975).

The salt tax revenue is derived from a tax of $0.06/ton; in 1972-73, production amounted to just over 6 million tons.

Sales tax revenue from Acadiana amounts to only 8.6 percent of the total state revenue, attesting again to the fact that the area's economy is based less on commerce and retail sales and more upon the basic, or exporting, sectors. The parish average sales tax revenue is $3,479,000, compared with an average of $5,029,000 for all Louisiana parishes (see Table 3.9-14). Acadiana's average is strongly affected by metropolitan Lafayette Parish, but it should be noted that the statewide average is also affected by the other large metropolitan areas: New Orleans, Baton Route, Shreveport, and Lake Charles.

### 3.9.2 Local Setting

St. Mary Parish is located in the extreme southeast portion of the Acadiana region. It contains 11 percent of the total area and 13 percent of the total population of Acadiana.

#### 3.9.2.1 History

The history of the area of Weeks and Cote Blanche Islands was largely shaped by adventurers and refugees. New Iberia was supposedly settled in the 1700's by Canary Islanders under the leadership of Bernardo de Galvez. Nicknamed "the Queen City of the Teche", it became an early important shipping center since, at the time, the Teche Bayou was only navigable to that point.

St. Martinville was founded by refugees from the French Revolution and at one time was known as "Le Petit Paris", or Little Paris. Architecture in these cities was heavily influenced by the Spanish and French. Acadians, driven from Canada by the British in 1756, have left a lasting cultural impression. This is particularly evidenced by place names honoring Longfellow and his poem of their ordeals, Evangeline. Franklin, founded in 1800 by Guinea Lewis, a former Pennsylvanian, was named for Benjamin Franklin.

The Teche Bayou, on which New Iberia is situated, received its name from the word Deutsch, derived from an Indian name for snake. Legend has it that the Bayou was formed by the trail of a great snake. Before the Civil War, numerous wealthy planters settled along the Bayou. New Iberia was captured during the Red River Campaign in 1863 by Federal forces commanded by General Banks, but suffered little damage in the war.

Weeks Island was formerly known as Grand Cote, but was renamed in 1930 in honor of David Weeks, a wealthy planter and owner of The Shadows

Plantation near New Iberia. His father received the island along with thousands of acres of other land by Spanish land grant in 1792. Before the Civil War, several large plantations were located there also. A guidebook published by the Works Project Administration in 1941 advised that excellent hunting and fishing was available there for 5 dollars a day. Cote Blanche was also noted as being a favorite area for hunting and fishing and is reputed to have been the site of several large plantations (Federal Work Agency, 1941).

3.9.2.2 Land-Use Patterns and Planning

Cote Blanche Island is isolated from much of the urban development in the area. Jeanerette is 12 miles to the north, Baldwin and Franklin are 11 miles to the northeast, and New Iberia is 16 miles north of the island. All of these communities are located along Bayou Teche and U.S. Highway 90. Weeks Island is located about 6 miles northwest of Cote Blanche Island, and Cypremort Point is about 10 miles west of Cote Blanche, at the furthest seaward point of Bayou Cypremort.

Cote Blanche Island is a distinctive topographic feature in the area, rising more than 90 feet above the marshlands and sea that surround it. To the north the Intracoastal Waterway passes between the island and the natural levees of Bayou Cypremort; to the south is West Cote Blanche Bay. East, west and north of the island lie marshlands. Local land use is depicted on Figure 3.6-3.

The major cultural features within 5 miles of the dome are located along Bayou Cypremort. Although the bayou is only intermittently navigable, Highway 83 and the Southern Pacific Rail Line follow the levee. Most of the communities in the area are small, consisting of 10 to 15 residential structures, and are located along Highway 83. Approximately 2 miles northwest of the dome is a chemical plant and a supply center for offshore oil platforms. Together these two facilities occupy approximately 60 acres. Most of the land along the bayou is in sugar cane production. Drainage canals are evident over much of the cleared land.

Cote Blanche Island covers approximately 1700 acres. Of this, 1200 acres is forested with 350 acres being devoted to pasture uses. Most of the remaining acreage consists of cleared land associated with extractive activities. The areas in pasture were once cropped for sugar cane.

At present the island is under private ownership, with areas leased for farming and extractive activities. There are no legal constraints upon the area concerning zoning or future land-use plans; however, completion of the Coastal Zone Management Program may include land-use constraints in the nearby area.

Information on community water and sewer systems was obtained from an inventory of the systems conducted by the Acadiana Planning and Development District in 1974. Characteristics of the systems for Vermilion, Iberia, St. Mary and St. Martin Parishes are contained in Tables 3.9-15 through 3.9-18. No information was available for Lafayette Parish.

Most of the urban areas in the four counties are served by water distribution systems. The adequacy of the systems varies greatly, with expansion of many of the systems planned or under consideration. Most communities utilize surface water supplies, especially in the coastal areas. In general, water distribution facilities outnumber water treatment and sewage collection facilities. Sewage treatment facilities are lacking in many communities (Acadiana Planning and Development District, 1974).

### 3.9.2.3 Transportation Systems

As for Acadiana as a whole, St. Mary Parish is heavily dependent on coastal bays and inland waterways for transportation. The extensive wetland areas limit overland transportation routes.

#### Highway System

The surface road network in St. Mary Parish is much less developed than in the region as a whole because of the low-lying, wetland nature of much of the area. U.S. 90, one of the region's major highways and the southern link to New Orleans, crosses the parish parallel to Bayou Teche. Most of the urban and other development is located along this route. The highway is not presently adequate for the amount of traffic it carries, and improvements are underway.

Railroad System

The Southern Pacific Railroad parallels U.S. 90 across the parish. There are no passenger stops, but there are freight terminals in Baldwin, Franklin, and Morgan City.

Water Transportation

The waterways play an even greater role in this parish than in the region as a whole. They include the Intracoastal Waterway, which passes just to the north of Cote Blanche Island, the Atchafalaya River, and Bayou Teche, as well as the coastal bays and connecting canals. Data on waterway usage may be found in section 3.9.1.3. Morgan City, an important Gulf Coast harbor, is located in eastern St. Mary Parish.

Air Transportation

There are three small airports in the parish: Harry P. Williams Memorial, 2 miles west of Patterson; Jeanerette, 1 mile south of Jeanerette; and Amelia, about 3 miles east of Morgan City. The latter does not have a hard surface runway. (U.S. Army Corps of Engineers, 1973b).

Oil and Gas Pipeline System

The location of pipelines in St. Mary Parish may be seen on Figures 3.9-4 and 3.9-5 in section 3.9.1.3. The closest oil pipeline to the Cote Blanche site is a 12-inch offshore line belonging to the Texas Pipe Line Company. Onshore the closest is a 22-inch Texas Pipe Line Company line that passes about 7 miles to the north (U.S. Army Corps of Engineers, 1973b).

3.9.2.4 Population and Housing

Population Trends

Between 1960 and 1970 the population of St. Mary Parish grew at a rate twice as high as that of the state (see Table 3.9-4), but not as high as the Acadiana region as a whole. Between 1970 and 1973 the parish growth slowed to a lower rate than both Acadiana and the state. However, projections to 1980 and 1990 anticipate that in the future, St. Mary will grow much more rapidly than other parts of Acadiana and the state of Louisiana.

Population Density and Distribution

St. Mary's population density is slightly lower than that of Acadiana as a whole. As may be seen in Table 3.9-5 in section 3.9.1.4, Acadiana's population is heavily concentrated in the metropolitan area of Lafayette. St. Mary has the second highest proportion of urban population in Acadiana, roughly the same as that for the state as a whole. The rural population in St. Mary is heavily nonfarm, i.e., people living in communities too small to be defined by the Census as urban (2500 inhabitants or more). Farm population is less than 3 percent of the total. Most of these people live along the roads and highways that cross the higher ground, notably along U.S. 90, which follows Bayou Teche, and Highways 83 and 319, which pass near Cote Blanche Island. Many of the miners at Cote Blanche live in these small rural communities.

Population Characteristics

Differences between St. Mary Parish and the Acadiana region are presented in Table 3.9-19. Racial composition in St. Mary Parish in 1970 was little different than that of the region and the state. Median age was slightly younger than both region and state. Education (measured by median years of school completed by person 25 years of age and over) was higher than the Acadiana region but lower than the statewide median. Unemployment was only slightly lower than in the region and state. There was a somewhat lower proportion of families on public assistance and a significantly lower proportion of households under the poverty level. In addition, median family income was substantially higher.

In terms of occupation, it is clear that employment in St. Mary Parish was less dependent on agriculture and more on blue collar jobs; there was also a slightly lower proportion of persons in the sales, clerical and service occupations in St. Mary Parish than in Acadiana.

Housing

Selected housing characteristics for the parish and for the principal communities are presented in Table 3.9-20. The greatest difference between the parish and the region was in the cost of housing; both median value and rent were considerably higher in St. Mary Parish than in Acadiana as a whole. The parish had a somewhat higher proportion of renter-occupied units; vacancy was comparable; housing conditions, as indicated by inadequacies in plumbing, were somewhat better than at the parish level. A recent study (Acadiana Planning and Development District, 1975) indicates that most of the inadequate housing (both overcrowded and lacking complete plumbing facilities) was occupied by blacks; the percentage was 90 in St. Mary Parish and even higher in the towns of Baldwin, Franklin, and Patterson.

There was considerable variation in the housing quality from town to town. Baldwin had a higher proportion of substandard housing than the other communities and the parish as a whole. All of the units that were crowded and lacking some or all plumbing were occupied by blacks.

3.9.2.5 Economy

Employment trends and projections for the years 1968 through 1977 are presented for St. Mary Parish in Table 3.9-21. The civilian work force grew at the same rate from 1968 to 1972 in St. Mary Parish as in the region (6.8 percent over the 4-year period), but the parish increase in unemployment was 4 times greater: 108 percent in St. Mary Parish versus 25 percent in Acadiana (Acadiana Planning and Development District, 1974c). Other differences are summarized below:

| Employment by Industry | Percent of Total Employment, 1972 | | Percent Change 1968-1972 | |
|---|---|---|---|---|
| | St. Mary | Acadiana | St. Mary | Acadiana |
| Manufacturing | 13.1 | 8.9 | + 9.0 | +16.6 |
| Mining | 13.9 | 9.3 | - 9.6 | + 5.3 |
| Construction | 5.9 | 4.8 | -22.1 | -11.9 |
| Transportation, etc. | 10.6 | 6.5 | + 8.1 | +16.7 |
| Trades | 16.1 | 8.4 | +27.3 | +17.3 |
| Finance, etc. | 1.7 | 2.4 | +21.4 | +11.6 |
| Service and Misc. | 10.7 | 11.1 | +18.7 | +24.9 |
| Government | 7.3 | 12.5 | + 5.7 | + 2.7 |
| Agriculture | 5.3 | 10.2 | - 8.5 | -19.6 |
| All Other Nonagriculture | 15.3 | 15.9 | - | + 3.2 |

The parish experienced a greater drop during the period in mining and construction employment and a greater increase in trades and finance/insurance/real estate employment.

Comparing the local area with the region regarding current (1972) employment differences, it may be seen that St. Mary Parish has a larger proportion of employed persons in the basic industries of manufacturing and mining, but only half as large a percentage in agriculture. In the nonbasic sectors, the other major differences are seen in construction, transportation, and trades, which are more important employers locally than regionally, and in government, which is less important locally.

The above-cited Acadiana economic base study provides another means of comparing the economy of the parish with that of the region over a period of 2 decades (1950 to 1970). This is a comparison of the basic/nonbasic employment ratio, summarized below:

| | 1950 | 1960 | 1970 |
|---|---|---|---|
| Acadiana | 1:1.75 | 1:2.06 | 1:2.29 |
| St. Mary Parish | 1:1.40 | 1:1.62 | 1 1.67 |

These ratios represent the relative number of jobs in the basic (exporting) sector (first number) versus the number of jobs in the secondary sector (second number). Thus, there has been an increase in secondary employment both locally and regionally. However, St. Mary Parish not only started with a lower proportion in 1950, but also increased at a lower rate over the 20-year period. This is largely due to the fact that the region's population and economic hub, the Lafayette metropolitan area, is attracting a much larger share of the commercial establishments and service activities, which account for much of the secondary employment. St. Mary's cities are small in population and more limited in economic diversity.

In most industrial sectors, local real income increased from 1950 to 1970 more rapidly than for the region as a whole, the notable exceptions being farm and construction earnings. The greatest local increase was in mining, which grew by 1239 percent in the decade of the 1950's, and then more than doubled during the 1960's (see Table 3.9-22).

Table 3.9-23 indicates the relative economic importance of mining in St. Mary Parish which, in 1950, accounted for 20 percent of the parish's real earnings, compared with 12 percent of the employment. Average earnings per worker were $9,500, over one-fourth higher than the next highest sector and nearly two-thirds higher than the average of all sectors.

The Cote Blanche salt mine employs about 98 miners and other laborers who are paid about $10,000 per year. In addition, there is a staff of 19 earning an average of about $12,000 per year. The 117 employees at this mine, thus, account for 3.8 percent of the total parish mining employment and about 4.2 percent of the parish earnings from the mining sector (using 1970 base data).

3.9.2.6 Government

St. Mary Parish is one of 64 parishes that are governmental subdivisions of the state of Louisiana. The Parish Seat is the city of Franklin.

Table 3.9-24 summarizes the distribution of 1972 state and local property tax revenue levied in the parish.

Three of the major sources of revenue to state and local government are the property tax, severance tax, and sales tax. Table 3.9-25 summarizes data on revenue from these three sources for St. Mary Parish, the Acadiana region, and the state of Louisiana in order to permit an evaluation of the relative importance of this parish as a source of public revenue.

The parish's contribution from property taxes and severance taxes (including salt tax) to the state is higher than average but somewhat lower than the state average in revenues from sales tax. This reinforces earlier observations about the nature of the economy of the parish.

3.9.2.7 Visual Aesthetic Qualities

The aesthetic value placed on an area depends to a large extent on a complex of factors characteristic of each individual, including their life style and value orientation. Contributing to the aesthetic value of any locale is its visual accessibility, its natural physical characteristics, and the nature of the man-made development that has taken place.

Emphasis here will be placed on a description of the physical characteristics (natural and man-made) and the accessibility of Cote Blanche Island.

Cote Blanche Island rises 100 feet out of the salt marsh on the coast of St. Mary Parish. It is the most prominent physical feature for several miles around, but is visible only from West Cote Blanche Bay and the adjacent marsh. The island lies between the Intracoastal Waterway to the north and West Cote Blanche Bay to the south. It is accessible only by ferry or by water. Because the island is privately owned, public access is restricted. Dominant uses are mining of salt and cattle grazing. Much of the eastern portion of the island has been cleared (originally for sugar cane fields, now for grazing). The remainder of the island is heavily wooded, and this vegetation provides a visual screen from all directions except the immediate south and east for surface activities.

Little of the area around the island remains in a completely natural state unaffected by present or past human activity. Many canals have been constructed across the low-lying marsh and swampland. Other major portions of marshland have been drained and planted in sugar cane. Higher land, principally natural levees formed by the bayous, is developed with farms, hamlets, and larger communities; where recent human development is absent, the levees are heavily covered with native vegetation.

The nearest communities are hamlets along Highway 83, about 2-1/2 miles north of the center of the island; these are separated from the island by the Southern Pacific Railroad, Intracoastal Waterway, and more than 1/2 mile of brackish marsh.

The largest number of potential viewers of the activities on the island are persons who work there, persons passing it on barges traveling in the adjacent canal, and fishermen crossing West Cote Blanche Bay near shore immediately to the southeast.

In summary, Cote Blanche Mine is in an area now used for industrial purposes. The number of potential viewers is restricted almost totally to persons using the industrial environment. The screen of natural vegetation limits the view to restricted locations immediately east and southeast of the mine site.

TABLE 3.9-1 Areal resolution capability for land use delineation, LUDA Program

| | Map No. | Category | Acres* | Feet |
|---|---|---|---|---|
| Urban | 11 | Residential | 10 | |
| | 12 | Commercial and Services | 10 | |
| | 13 | Industrial | 10 | |
| | 14 | Extractive (oil and gas) | 10 | |
| | 15 | Transportation, Communications and Utilities | | 660 |
| | 16 | Institutional | 10 | |
| | 17 | Strip and Clustered Settlement | 10 | |
| | 18 | Mixed | 10 | |
| | 19 | Open and Other | 10 | |
| Agricultural | 21 | Cropland and Pasture | 40 | |
| | 22 | Orchards, Groves, Bush Fruits, Vineyards, and Horticultural Areas | 40 | |
| | 23 | Feeding Operations | 10 | |
| | 24 | Other | 10 | |
| Rangeland | 31 | Grass | 40 | |
| | 32 | Savannas (Palmetto Prairies) | 40 | |
| | 33 | Chaparral | 40 | |
| | 34 | Desert Shrub | 40 | |
| Forest | 41 | Deciduous | 40 | |
| | 42 | Evergreen (Coniferous and Other) | 40 | |
| | 43 | Mixed (2/3 +) | 40 | |
| Water | 51 | Streams and Waterways | | 660 |
| | 52 | Lakes | 40 | |
| | 53 | Reservoirs | 40 | |
| | 54 | Bays and Estuaries | 40 | |
| | 55 | Other (Gulf of Mexico) | 40 | |

TABLE 3.9-1 Continued

| | Map No. | Category | Acres* | Feet |
|---|---|---|---|---|
| Wetland | 61 | Forested (Swamp) | 40 | |
| | 62 | Non-forested (Marsh) | 40 | |
| Barren Land | 71 | Salt Flats | 40 | |
| | 72 | Beaches | 40 | |
| | 73 | Sands other than Beaches | 40 | |
| | 74 | Bare Exposed Rock | 40 | |
| | 75 | Other | 40 | |

Source: Louisiana State Planning Office
Land Use and Data Analysis (LUDA) Program
U.S. Geological Survey, 1972.

* Minimum parcel size for photographic resolution of land use

TABLE 3.9-2 Existing land use, 1972

| | Urban and Built-Up Land | Extractive Land | Agricul-tural Land | Forest Land | Water | Wetland (Marsh) | Barren Land | Total Acreage |
|---|---|---|---|---|---|---|---|---|
| Parish IBERIA | | | | | | | | |
| Acreage | 9,633 | 19,266 | 122,512 | 82,251 | 642,694 | 122,759 | 10,621 | 1,009,736 |
| % of Total Acreage | 1.0 | 1.9 | 12.1 | 8.2 | 63.6 | 12.2 | 1.0 | |
| Parish LAFAYETTE | | | | | | | | |
| Acreage | 18,031 | 494 | 136,838 | 7,163 | 247 | 247 | 0 | 163,020 |
| % of Total Acreage | 11.0 | 0.3 | 83.9 | 4.4 | 0.2 | 0.2 | 0 | |
| Parish ST. MARTIN | | | | | | | | |
| Acreage | 8,892 | 31,863 | 135,109 | 298,129 | 21,736 | 21,983 | 0 | 517,712 |
| % of Total Acreage | 1.7 | 6.1 | 26.0 | 57.6 | 4.2 | 4.2 | 0 | |
| Parish ST. MARY | | | | | | | | |
| Acreage | 19,019 | 54,340 | 85,709 | 103,987 | 578,227 | 132,145 | 12,350 | 985,777 |
| % of Total acreage | 1.9 | 5.5 | 8.7 | 10.5 | 58.7 | 13.4 | 1.3 | |
| Parish VERMILION | | | | | | | | |
| Acreage | 6,916 | 5,187 | 429,039 | 35,815 | 632,814 | 268,242 | 247 | 1,378,260 |
| % of Total Acreage | 0.5 | 0.4 | 31.1 | 2.6 | 45.9 | 19.5 | 0 | |
| Total Acreage | 62,491 | 111,150 | 909,207 | 527,345 | 1,875,718 | 545,376 | 23,218 | 4,054,505 |
| % of Total Acreage | 1.5 | 2.7 | 22.4 | 13.0 | 46.3 | 13.5 | 0.6 | |

Source: Louisiana State Planning Office
Land Use and Data Analysis (LUDA)
U.S. Geological Survey, 1972

TABLE 3.9-3 Existing and potential recreational sites

| Site No. | Site | Parish | Comments |
|---|---|---|---|
| 4-1 | Lac Acadia | St. Martin | Natural swamp and lakes near Lafayette |
| 4-2 | Beau Sejour Oaks | Lafayette | Area of 100 year-old oaks |
| 4-3 | Lake Fausse Pointe | Iberia | Natural swamp and water area |
| 4-4 | Cypremore Point | St. Mary | Vermilion Bay peninsula |
| 4-5 | Palmetto Island | Vermilion | Wetlands and woodlands along Vermilion River |
| 4-6 | Cheniere Au Tigre | Vermilion | State-owned accredited land along Gulf |
| 4-7 | Millers Lake | Evangeline | Present use-irrigation, fishing, hunting, camping |
| 4-8 | Bayou Teche | St. Landry | Scenic bayou, natural levee and backswamp |
| 4-9 | Lake Arthur | Vermilion | Accessible water body connecting with Grand Lake, White Lake |
| 4-10 | Atchafalaya | St. Martin | Extensive natural area |
| 4-11 | Bayou Des Cannes | Acadia | Scenic bayou |
| 4-12 | Burns Point | St. Mary | Accredited site on Cote Blanche Bay |
| 4-13 | Bayou Cocodrie | Evangeline | Swamp surrounded by forests and hills |
| 4-14 | Belle Chaney Springs | Evangeline | Spring water flowing through hills and forests |
| 4-15 | Bayou Toureau | Evangeline | Natural stream, wood-lands, swamp |
| 4-16 | Chicot State Park | Evangeline | 6,479 acres of land and water areas draped with Cypress trees |
| 4-17 | Spanish Lake | Iberia | Bass fishing mecca |
| 4-18 | Grand-Lake-Six-Mile Lake Area (Atchafalaya Basin) | | Future water recreation area with abundant wildlife |
| 4-19 | Berwick Island | St. Mary | 7 acres of wooded island potentially acceptable for recreation |

TABLE 3.9-3 Continued

| Site No. | Site | Parish | Comments |
|---|---|---|---|
| 4-20 | Crooked Creek | Evangeline | Excellent fishing, boating and modern camper-trailer facilities |
| 4-21 | Avery Island | Iberia | 200-acre wooded island with bird sanctuary |
| 4-22 | Burns Point | St. Mary | Shady camping and picnic areas with access to Gulf |
| 4-23 | Lake Palourde | St. Mary | Recreational lake by Morgan City |

Source: Outdoor Recreation in Louisiana 1975-1980, State Parks Recreation Commission, June 1974 and Acadiana Planning and Development District Survey, June 1975

TABLE 3.9-4 Population trends, State of Louisiana, Acadiana Region and St. Mary Parish 1960 - 1990

| | 1960 | 1970 | | 1973(est) | | Projections 1980 | | Projections 1990 | |
|---|---|---|---|---|---|---|---|---|---|
| | Number[a] | Number[a] | % Change 1960-70 | Number[b] | % Change 1970-73 | Number[c] | % Change 1970-80 | Number[c] | % Change 1980-90 |
| State of Louisiana | 3,257,022 | 3,643,180 | 11.8 | 3,764,000 | 3.4 | 4,054,406 | 11.3 | 4,504,807 | 11.1 |
| Acadiana Region | 342,783 | 467,794 | 36.4 | 486,400 | 4.0 | 526,067 | 12.5 | 593,443 | 12.8 |
| St. Mary Parish | 48,833 | 60,752 | 24.4 | 61,800 | 1.7 | 73,898 | 21.6 | 90,717 | 22.8 |

Source:

[a]Bureau of the Census, Characteristics of Population, Vol. 20, Table 9, 1970.

[b]Bureau of the Census, Population Estimates, P 26, No.54, February 1974.

[c]Cristou, Georgios C., and Segal, Harris S., Population Projections to 1980 and 1990, Louisiana and its Parishes, no date.

TABLE 3.9-5 Population density and distribution, State of Louisiana, Acadiana Region and eight regional parishes, 1970

| | Total Population | Percent of State/Region | Population Density (per sq mi) | Urban/Rural Population Distribution: Urban Population: Number | Urban Population: Percent | Urban Population: % Change from 1960 | Rural Population: Number | Rural Population: Percent | Rural Population: % Change from 1960 |
|---|---|---|---|---|---|---|---|---|---|
| State of Louisiana | 3,643,180 | | 81.0 | 2,406,150 | 66.0 | 16.8 | 1,235,156 | 34.0 | 3.2 |
| Acadiana Region | 467,794 | 13 | 104.9 | 257,210 | 55.0 | NA | 210,584 | 45.0 | NA |
| Acadia Parish | 52,109 | 11 | 78.6 | 29,591 | 56.7 | 6.2 | 22,518 | 43.2 | 2.0 |
| Evangeline Parish | 31,932 | 7 | 47.7 | 12,967 | 40.6 | 24.2 | 18,965 | 59.4 | 10.5 |
| Iberia Parish | 57,397 | 12 | 97.4 | 36,469 | 63.5 | 5.3 | 20,928 | 36.5 | 22.9 |
| Lafayette Parish | 109,716 | 23 | 387.7 | 78,544 | 71.6 | 66.8 | 31,172 | 28.4 | -17.0 |
| St. Landry Parish | 80,364 | 17 | 86.2 | 31,399 | 39.1 | 9.2 | 48,965 | 60.9 | - 7.2 |
| St. Martin Parish | 32,453 | 7 | 44.1 | 12,095 | 37.3 | 23.8 | 20,358 | 62.7 | 5.5 |
| St. Mary Parish | 60,752 | 13 | 97.4 | 39,609 | 65.2 | 36.5 | 21,143 | 34.8 | 6.7 |
| Vermilion Parish | 43,071 | 9 | 35.7 | 16,356 | 38.5 | 5.5 | 26,535 | 61.7 | 14.5 |

Source: U.S. Bureau of the Census, Characteristics of the Population, Vol. 20, Table 9

Table 3.9-6 Population figures for towns (over 1,000) in the parishes of Vermilion-Atchafalaya Complex

| All Incorporated Places<br>Unincorporated Places | Parish | 1970 | 1960 | Percent Change |
|---|---|---|---|---|
| Abbeville Town | Vermilion | 10,986 | 10,414 | 5.6 |
| Amelia (U) | St. Mary | 2,292 | - - | - - |
| Baldwin Town | St. Mary | 2,117 | 1,548 | 36.8 |
| Bayou Vista (U) | St. Mary | 5,121 | - - | - - |
| Berwick Town | St. Mary | 4,168 | 3,880 | 7.4 |
| Delcambre Town | Iberia | 1,975 | 1,857 | 6.4 |
| Erath Town | Vermilion | 2,024 | 2,019 | 0.2 |
| Franklin Town | St. Mary | 9,325 | 8,673 | 7.5 |
| Jeanerette Town | Iberia | 6,322 | 5,568 | 13.5 |
| Kaplan Town | Vermilion | 5,340 | 5,267 | 5.2 |
| Loreauville Village | Iberia | 728 | 655 | 11.1 |
| Maurice Village | Vermilion | 476 | 411 | 15.8 |
| Morgan City | St. Mary | 16,586 | 13,540 | 22.5 |
| New Iberia City | Iberia | 30,147 | 29,002 | 3.7 |
| Patterson Town | St. Mary | 4,409 | 2,923 | 50.8 |

Source: U.S. Bureau of the Census.

TABLE 3.9-7 Population characteristics, State of Louisiana and Acadiana Region, 1970

| | Acadiana Region | | State of Louisiana | |
|---|---|---|---|---|
| | Number | Percent or Median | Number | Percent or Median |
| Total Population | 467,794 | - | 3,643,180 | - |
| Black | 126,186 | 27.0% | 1,086,832 | 29.8% |
| White | 340,698 | 72.8% | 2,541,498 | 69.8% |
| Other | 910 | 0.2% | 12,976 | 0.4% |
| Median Age[a] (years) | | 23.8 | | 24.8 |
| Education (median years of school completed - persons 25 years of age and over) | | 7.8 | | 10.8 |
| Total Employed | 138,829 | | 1,166,668 | |
| Occupation[b] | | | | |
| Professional and Managerial | 30,234 | 21.7% | 253,294 | 23.5% |
| Sales and Clerical | 25,454 | 18.3% | 243,114 | 22.5% |
| Craftsmen, Operatives and Kindred Workers | 51,531 | 37.1% | 387,778 | 35.9% |
| Farm Owners and Workers | 9,894 | 7.1% | 34,426 | 3.1% |
| Service Workers | 21,716 | 15.6% | 162,282 | 15.0% |
| Unemployed | 4,732 | 5.0% | 67,442 | 5.0% |
| Median Family Income | -- | $5,535 | -- | $7,530 |
| Families on Public Assistance | 12,707 | 11.0% | 872,772 | 10.6% |
| Households with Incomes Under Poverty Level | 33,985 | 33.4% | 233,247 | 26.0% |

[a] Weighted average of eight parishes

[b] Adjusted for State to account for occupations not reported

Source: Bureau of the Census, General Social and Economic Characteristics, 1970.

TABLE 3.9-8 Housing characteristics, Acadiana Region and State of Louisiana, 1970

| | Acadiana Region | | State of Louisiana | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| Total Housing Units | 140,015 | -- | 1,150,669 | -- |
| Owner Occupied | 87,349 | 62 | 663,927 | 58 |
| Renter Occupied | 41,898 | 30 | 388,111 | 34 |
| Vacant | 10,768 | 7 | 98,631 | 8 |
| Units lacking some or all plumbing | 21,263 | 15 | 132,191 | 13 |
| Crowded Housing Units | 23,514 | 17 | 166,847 | 16 |
| Crowded and lacking some or all plumbing | 5,761 | 4 | 33,321 | 3 |
| Median Home Value | $11,800 | -- | $14,600 | -- |
| Median Rent | $ 47 | -- | $ 62 | -- |

Source: U.S. Bureau of the Census, Detailed Housing Characteristics, Vol. 20, 1970.

TABLE 3.9-9 Employment trends and projections, Acadiana Region*
(Annual averages) 1968 to 1977

| | 1968 | | 1970 | | 1972 | | 1977 Projection | |
|---|---|---|---|---|---|---|---|---|
| | Number | % of Total Employment | Number | % of Total Employment | Number | % of Total Employment | Number | % of Total Employment |
| Total Civilian Work Force | 149,900 | | 156,975 | | 160,150 | | | |
| Unemployment | 7,700 | | 10,250 | | 9,625 | | | |
| Total Employment | 142,200 | | 146,725 | | 150,525 | | 164,170 | |
| Nonagricultural Wage and Salaried Employment | 99,900 | 70.2 | 104,400 | 71.2 | 111,200 | 73.9 | 125,888 | 76.7 |
| Manufacturing | 11,450 | 8.1 | 11,175 | 7.6 | 13,350 | 8.9 | 14,880 | 9.1 |
| Durable Goods | 3,850 | 2.7 | 3,875 | 2.6 | 4,900 | 3.3 | 6,061 | 3.7 |
| Nondurable Goods | 7,600 | 5.3 | 7,300 | 5.0 | 8,450 | 5.6 | 8,819 | 5.4 |
| Nonmanufacturing | 88,450 | 67.2 | 93,225 | 63.5 | 97,850 | 65.0 | 111,008 | 67.6 |
| Mining | 13,325 | 9.4 | 12,775 | 8.7 | 14,025 | 9.3 | 16,067 | 9.8 |
| Construction | 8,250 | 5.8 | 7,725 | 5.3 | 7,275 | 4.8 | 7,253 | 4.4 |
| Transportation, Communication, etc. | 8,375 | 5.9 | 9,225 | 6.3 | 9,775 | 6.5 | 11,660 | 7.1 |
| Trades (Total) | 23,575 | 16.6 | 25,700 | 17.5 | 27,650 | 8.4 | 32,217 | 19.6 |
| Finance, Insurance, and Real Estate | 3,225 | 2.3 | 3,200 | 2.2 | 3,600 | 2.4 | 3,928 | 2.4 |
| Service and Misc. | 13,375 | 9.4 | 15,225 | 10.4 | 16,700 | 11.1 | 20,161 | 12.3 |
| Government | 18,325 | 12.9 | 19,375 | 13.2 | 18,825 | 12.5 | 19,722 | 12.0 |
| All Other Nonagricultural | 23,250 | 16.4 | 23,700 | 16.2 | 24,000 | 15.9 | 25,644 | 15.6 |
| Agricultural | 19,050 | 13.4 | 18,625 | 12.7 | 15,325 | 10.2 | 12,638 | 7.7 |

* Figures adjusted to be additive

Source: Acadiana Planning and Development District, June 1975 (from statistics of the Louisiana State Employment Security Department).

TABLE 3.9-10 Real income and earnings by broad industrial sector Acadiana Region, 1950 - 1970 (in $ thousands)

| Deflators (% of 1967)* | 1950<br>72.1 | 1959<br>87.3 | 1970<br>116.3 | % Change 1950-59 | % Change 1959-70 |
|---|---|---|---|---|---|
| Total Personal Income | 394,995 | 584,011 | 995,402 | 48 | 70 |
| Total Earnings | 311,533 | 461,856 | 746,032 | 48 | 62 |
| Farm Earnings | 84,643 | 60,165 | 71,578 | - 29 | 19 |
| Nonfarm Earnings | 226,890 | 401,691 | 674,454 | 77 | 68 |
| Government | 31,087 | 60,228 | 105,949 | 94 | 76 |
| Private Nonfarm | 195,803 | 341,463 | 568,505 | 74 | 66 |
| Manufacturing | 30,835 | 35,695 | 66,595 | 16 | 87 |
| Mining | 28,753 | 74,344 | 117,521 | 159 | 58 |
| Contract Construction | 12,387 | 31,467 | 54,161 | 154 | 72 |
| Transportation, Communication, and Public Utilities | 17,767 | 33,794 | 61,955 | 90 | 83 |
| Wholesale and Retail Trade | 60,699 | 92,922 | 142,107 | 53 | 53 |
| Finance, Insurance, and Real Estate | 5,950 | 14,400 | 20,846 | 142 | 45 |
| Services | 34,248 | 54,672 | 100,737 | 60 | 84 |
| Other | 5,164 | 4,168 | 4,583 | - 19 | 109 |

* Deflated in terms of 1967 dollars (1967 - 100 percent)

Source: Acadiana Planning and Development District, June 1974 (from Department of Commerce, Bureau of Economic Analysis).

TABLE 3.9-11 Real earnings compared to employment for selected industrial sectors Acadiana Region 1970

| | Employment | | Earnings | | |
|---|---|---|---|---|---|
| | Number | Percent of Total | Thousands of Dollars | Percent of Total Earnings | Average per Worker |
| TOTAL | 146,725 | 100.0 | 746,032 | 100.0 | $5,100 |
| Manufacturing | 11,175 | 7.6 | 66,595 | 8.9 | 6,000 |
| Mining | 12,775 | 8.7 | 117,521 | 15.8 | 9,200 |
| Construction | 7,725 | 5.3 | 54,161 | 7.3 | 7,000 |
| Transportation, Communication, etc. | 9,225 | 6.3 | 61,955 | 8.3 | 6,700 |
| Government | 19,375 | 13.2 | 105,949 | 14.2 | 5,500 |
| Agriculture | 18,625 | 12.7 | 71,578 | 9.6 | 3,800 |

Source: Tables 3.9-9 and 3.9-10.

TABLE 3.9-12 Assessed evaluation and distribution of property tax revenue, 1973

| | Assessed Valuation (in $ thousands) | | | | | | | Distribution of Revenue (in $ thousands) | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | Real Estate | | Personal Property | | Public Service Corporations* | | Total Assessed Value | State Revenue | Local Revenue | Total Revenue | Local % of Total Revenue |
| | Number | Percent | Number | Percent | Number | Percent | | | | | |
| Acadia | 26,850 | 34.3 | 25,336 | 32.4 | 26,002 | 33.3 | 78,188 | 439 | 2,498 | 2,937 | 85.06 |
| Evangeline | 11,858 | 31.1 | 7,704 | 20.2 | 18,558 | 48.7 | 38,120 | 217 | 1,319 | 1,531 | 86.13 |
| Iberia | 34,491 | 43.8 | 30,059 | 38.2 | 14,211 | 18.0 | 78,761 | 435 | 3,987 | 4,422 | 90.15 |
| Lafayette | 50,239 | 49.4 | 29,595 | 29.1 | 21,909 | 21.5 | 101,743 | 549 | 5,817 | 6,366 | 91.37 |
| St. Landry | 59,361 | 57.6 | 19,704 | 19.1 | 23,993 | 23.3 | 103,058 | 569 | 3,645 | 4,214 | 86.49 |
| St. Martin | 6,655 | 23.6 | 12,265 | 43.6 | 9,212 | 32.7 | 28,132 | 162 | 2,395 | 2,557 | 93.66 |
| St. Mary | 52,813 | 33.9 | 72,861 | 46.8 | 30,168 | 19.4 | 155,842 | 887 | 4,764 | 5,651 | 84.30 |
| Vermilion | 16,815 | 25.6 | 26,674 | 40.6 | 21,728 | 33.1 | 65,217 | 354 | 3,221 | 3,575 | 90.10 |
| Acadiana Total | 259,082 | 39.9 | 224,198 | 34.5 | 165,781 | 25.5 | 649,061 | 3,607 | 27,647 | 31,235 | 88.5 |
| Acadiana Average | 32,385 | | 28,024 | | 20,722 | | 81,132 | 451 | 3,456 | 3,907 | 88.5 |
| State Total | 3,039,179 | 47.8 | 1,988,404 | 31.3 | 1,330,681 | 20.9 | 6,358,264 | 27,508 | 297,468 | 324,976 | 91.53 |

* Assessed by the State

TABLE 3.9-13 Severance tax collections by product
Acadiana and State of Louisiana, 1972-1973

($ in thousands)

| | Total Tax Collected | Oil Tax | Gas Tax | Salt Tax | Other Taxes* |
|---|---|---|---|---|---|
| Acadia | $ 8,276 | $ 1,086 | $ 6,336 | -- | $ 854 |
| Evangeline | 777 | 214 | 390 | -- | 173 |
| Iberia | 15,902 | 5,027 | 9,960 | 227 | 688 |
| Lafayette | 1,923 | 145 | 1,531 | -- | 247 |
| St. Landry | 3,187 | 431 | 2,309 | -- | 447 |
| St. Martin | 6,627 | 2,888 | 3,142 | -- | 597 |
| St. Mary | 27,138 | 7,733 | 17,728 | 145 | 1,532 |
| Vermilion | 18,326 | 2,031 | 14,748 | -- | 1,547 |
| Acadiana Total | 82,156 | 19,555 | 56,144 | 372 | 6,085 |
| Percent of State Total | 31 | 20 | 22 | 100 | 28 |
| State Total | 265,399 | 96,205 | 147,394 | 372 | 21,429 |

* Includes timber, pulpwood, distillate, gravel, sand, sulphur, salt brine, shell, stone, and reforestation

Source: State of Louisiana, 1974, Table X-8.

TABLE 3.9-14 Revenue derived from state sales tax, Acadiana and State of Louisiana, 1974-75

($ in thousands)

| | |
|---|---|
| Acadia | $ 2,267 |
| Evangeline | 750 |
| Iberia | 3,581 |
| Lafayette | 13,314 |
| St. Landry | 2,636 |
| St. Martin | 626 |
| St. Mary | 3,229 |
| Vermilion | 1,425 |
| Acadiana Total | $ 27,828 |
| State Total | $ 321,864 |

Source: State of Louisiana, 1975.

TABLE 3.9-15 Water and sewer systems inventory, Vermilion Parish

| City | 1970 Population | Water Distribution System | Water Treatment Facilities | Sewerage Collection System | Sewerage Treatment Facilities |
|---|---|---|---|---|---|
| Abbeville | 10,996 | yes | yes | yes | yes |
| Delcambre | 1,975 | yes | yes | yes | yes |
| Erath | 2,024 | yes | no | no | no |
| Gueydan | 1,984 | yes | no | yes | yes |
| Kaplan | 5,540 | yes | yes | yes | yes |
| Maurice | 476 | no | no | no | no |

Source: Water and Sewer Systems Inventory, 1974, Acadiana Planning and Development District.

TABLE 3.9-16 Water and sewer systems inventory, Iberia Parish

| City | 1970 Population | Water Distribution System | Water Treatment Facilities | Sewerage Collection System | Sewerage Treatment Facilities |
|---|---|---|---|---|---|
| Jeanerette | 6,322 | yes | | yes | yes |
| Loreauville | 728 | not available | | no | no |
| New Iberia | 30,147 | yes | | yes | yes |

Source: Water and Sewer Systems Inventory, 1974, Acadiana Planning and Development District.

TABLE 3.9-17 Water and sewer systems inventory, St. Mary Parish

| City | 1970 Population | Water Distribution System | Water Treatment Facilities | Sewerage Collection System | Sewerage Treatment Facilities |
|---|---|---|---|---|---|
| Baldwin | 2,117 | yes | yes | yes | yes |
| Berwick | 4,168 | yes | yes | yes | no |
| Franklin | 9,325 | yes | yes | yes | yes |
| Morgan City | 16,586 | yes | yes | yes | no |
| Patterson | 4,409 | yes | yes | yes | yes |
| Bayou Vista Area | 5,078 | yes | no | yes | no |
| Amelia Area | | yes | yes | yes | yes |
| Charenton Area (Waterworks District No. 6) | | yes | yes | no | no |
| Centerville Area (Waterworks District No. 5) | | yes | yes | no | no |

Source: Water and Sewer Systems Inventory, 1974, Acadiana Planning and Development District.

TABLE 3.9-18 Water and sewer systems inventory, St. Martin Parish

| City | 1970 Population | Water Distribution System | Water Treatment Facilities | Sewerage Collection System | Sewerage Treatment Facilities |
|---|---|---|---|---|---|
| Breaux Bridge | 4,942 | yes | | yes | not available |
| Henderson | 270 | yes | yes | no | not available |
| Parks | 491 | yes | yes | no | not available |
| St. Martinville | 7,153 | yes | yes | yes | yes |
| Cecilia | - | yes | yes | no | no |
| Catahoula | - | yes | yes | no | no |
| Stephensville | - | yes | yes | no | no |
| Belle River | - | yes | yes | no | no |

- Under 1,000 population according to 1970 Census

Source: Water and Sewer Inventory, 1974, Acadiana Planning and Development District.

TABLE 3.9-19 Population characteristics, St. Mary Parish and Acadiana Region*

| | St. Mary Parish | | Acadiana Region | |
|---|---|---|---|---|
| | Number | Percent or Median | Number | Percent or Median |
| Total Population | 60,752 | -- | 467,794 | -- |
| Black | 17,056 | 28.0% | 126,186 | 27.0% |
| White | 43,387 | 71.0% | 340,698 | 72.8% |
| Other | 309 | 0.5% | 910 | 0.2% |
| Median Age | -- | 22.1 | -- | 23.8 |
| Education (Median years of school completed - persons 25 years of age and over | | 9.9 | | 7.8 |
| Total Employed | 19,130 | -- | 138,829 | -- |
| Occupation | | | | |
| Professional and Managerial | 4,423 | 23.1% | 30,234 | 21.7% |
| Sales and Clerical | 3,395 | 17.7% | 25,454 | 18.3% |
| Craftsmen, Operatives and Kindred Workers | 8,016 | 41.9% | 51,531 | 37.1% |
| Farm Owners and Workers | 725 | 3.8% | 9,894 | 7.1% |
| Service Workers | 2,571 | 13.4% | 21,716 | 15.6% |
| Unemployed | 964 | 4.8% | 4,732 | 5.0% |
| Median Family Income | -- | $ 8,146 | -- | $ 5,535 |
| Families on Public Assistance | 1,191 | 8.5% | 12,707 | 11.0% |
| Households with Income Under Poverty Level | 3,311 | 24.2% | 33,985 | 33.4% |

* Bureau of the Census, General Social and Economic Characteristics, 1970.

TABLE 3.9-20 Housing characteristics, Acadiana, St. Mary Parish, and local communities, 1970

| | Acadiana Region | | St. Mary Parish | | Local Communities: Baldwin | | Berwick | | Franklin | | Morgan City | | Patterson | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| Total Housing Units | 140,015 | -- | 17,279 | -- | 550 | -- | 1,306 | -- | 2,722 | -- | 4,974 | -- | 1,209 | -- |
| Owner Occupied | 87,349 | 62 | 9,974 | 57 | 393 | 71 | 727 | 55 | 1,602 | 58 | 2,707 | 54 | 686 | 56 |
| Renter Occupied | 41,898 | 30 | 6,116 | 35 | 130 | 23 | 463 | 35 | 992 | 36 | 1,960 | 39 | 446 | 37 |
| Vacant | 10,768 | 7 | 1,189 | 7 | 27 | 4 | 116 | 9 | 128 | 5 | 307 | 6 | 77 | 6 |
| Units Lacking Some or All Plumbing | 21,263 | 15 | 2,335 | 13 | 116 | 21 | 52 | 3 | 239 | 8 | 299 | 6 | 163 | 13 |
| Crowded Housing Units | 23,514 | 17 | 3,172 | 18 | 123 | 22 | 206 | 15 | 441 | 16 | 742 | 14 | 246 | 20 |
| Crowded and Lacking Some or All Plumbing | 5,761 | 4 | 678 | 3.9 | 41 | 7 | 11 | 0.08 | 71 | 2 | 63 | 1 | 33 | 2 |
| Percent Occupied by Blacks | | NA | | 90 | | 100 | | NA | | 99 | | 78 | | 97 |
| Median Home Value | $11,800 | -- | $14,900 | -- | NA | -- | NA | -- | NA | -- | NA | -- | NA | -- |
| Median Rent | $ 47 | -- | $ 64 | -- | NA | -- | NA | -- | NA | -- | NA | -- | NA | -- |

Source: Bureau of the Census, Detailed Housing Characteristics, Vol. 20, 1970.
Acadiana Planning and Development District, June 1975.

TABLE 3.9-21 Employment trends and projections, St. Mary Parish*
(Annual averages)

| | 1968 | | 1970 | | 1972 | | 1977 Projection | |
|---|---|---|---|---|---|---|---|---|
| | Number | % of Total Employment | Number | % of Total Employment | Number | % of Total Employment | Number | % of Total Employment |
| Total Civilian Work Force | 24,900 | | 25,925 | | 26,600 | | -- | |
| Unemployment | 625 | | 775 | | 1,300 | | -- | |
| Total Employment | 24,275 | | 25,150 | | 25,300 | | 27,010 | |
| Nonagriculture Wage and Salaried Employment | 18,925 | 77.8 | 19,775 | 78.6 | 20,075 | 79.3 | 21,810 | 80.7 |
| Manufacturing | 3,050 | 12.6 | 2,950 | 11.7 | 3,325 | 13.1 | 3,552 | 13.2 |
| Durable Goods | 1,625 | 6.7 | 1,575 | 6.3 | 1,925 | 7.6 | 2,210 | 8.2 |
| Nondurable Goods | 1,425 | 5.9 | 1,375 | 5.5 | 1,400 | 5.5 | 1,342 | 5.0 |
| Nonmanufacturing | 15,875 | 65.4 | 16,825 | 66.9 | 16,750 | 66.2 | 18,258 | 67.6 |
| Mining | 3,900 | 16.1 | 3,100 | 12.3 | 3,525 | 13.9 | 3,700 | 13.7 |
| Construction | 1,925 | 7.9 | 2,350 | 9.3 | 1,500 | 5.9 | 1,225 | 4.5 |
| Transportation, Communication, etc. | 2,475 | 10.2 | 2,550 | 10.1 | 2,675 | 10.6 | 2,883 | 10.7 |
| Trades (Total) | 3,200 | 13.2 | 3,775 | 15.0 | 4,075 | 16.1 | 5,020 | 18.6 |
| Finance, Insurance, and Real Estate | 350 | 1.4 | 400 | 1.6 | 425 | 1.7 | 500 | 1.9 |
| Service and Misc. | 2,275 | 9.4 | 2,825 | 11.2 | 2,700 | 10.7 | 2,940 | 10.9 |
| Government | 1,750 | 7.2 | 1,825 | 7.3 | 1,850 | 7.3 | 1,990 | 7.4 |
| All Other Nonagricultural | 3,875 | 16.0 | 3,900 | 15.5 | 3,875 | 15.3 | 3,925 | 14.5 |
| Agricultural | 1,475 | 6.1 | 1,475 | 5.9 | 1,350 | 5.3 | 1,275 | 4.7 |

* Figures adjusted to be additive

Source: Acadiana Planning and Development District, June 1974 (from Louisiana State Employment Security Department data).

TABLE 3.9-22 Real income and earnings by broad industrial sector, St. Mary Parish 1950-1970 (in $ thousands)

| Deflators (% of 1967)* | 1950<br>72.1 | 1959<br>87.3 | 1970<br>116.3 | % Change<br>1950-59 | % Change<br>1959-70 |
|---|---|---|---|---|---|
| Total Personal Income | 41,419 | 83,356 | 182,265 | 108 | 111 |
| Total Earnings | 31,313 | 69,518 | 145,334 | 122 | 109 |
| Farm Earnings | 5,277 | 5,841 | 3,135 | 11 | - 46 |
| Nonfarm Earnings | 26,036 | 63,677 | 142,199 | 145 | 123 |
| Government | .2,811 | 6,451 | 11,420 | 129 | 77 |
| Private Nonfarm | 23,225 | 57,226 | 130,779 | 146 | 129 |
| Manufacturing | 5,025 | 8,002 | 22,268 | 60 | 178 |
| Mining | 885 | 11,849 | 29,451 | 1,239 | 149 |
| Construction | 1,942 | 10,200 | 16,917 | 425 | 66 |
| Transportation, Communication, and Public Utilities | 1,669 | 7,362 | 17,782 | 341 | 142 |
| Wholesale and Retail Trade | 7,978 | 11,809 | 24,690 | 48 | 109 |
| Finance, Insurance and Real Estate | 429 | 1,076 | 2,415 | 151 | 124 |
| Services | 3,315 | 5,992 | 16,174 | 81 | 170 |
| Other | 1,982 | 936 | 1,082 | - 53 | 16 |

* Deflated in terms of 1967 dollars (1967 - 100 percent)

Source: Acadiana Planning and Development District from Department of Commerce, Bureau of Economic Analysis.

TABLE 3.9-23 Real earnings compared to employment for selected industrial sectors St. Mary Parish, 1970

| | Employment | | Earnings | | |
|---|---|---|---|---|---|
| | Number | Percent of Total | Thousands of Dollars | Percent of Total Earnings | Average per Worker |
| TOTAL - All Sectors | 25,150 | 100.0 | 145,334 | 100.0 | $ 5,800 |
| Manufacturing | 2,950 | 11.7 | 22,268 | 15.3 | 7,500 |
| Mining | 3,100 | 12.3 | 29,451 | 20.3 | 9,500 |
| Construction | 2,350 | 9.3 | 16,917 | 11.6 | 7,200 |
| Transportation, Communication, etc. | 2,550 | 10.1 | 17,782 | 12.2 | 7,000 |
| Government | 1,825 | 7.3 | 11,420 | 7.9 | 6.300 |
| Agriculture | 1,475 | 5.9 | 3,135 | 2.2 | 2,100 |

Source: Tables 3.9-21 and 3.9-22.

TABLE 3.9-24 Tax revenue sources for St. Mary Parish, Acadiana Region, and State of Louisiana

Total Assessed Value ........................................ $154,278,135.00

**State Taxes**

| | | | | |
|---|---|---|---|---|
| State Tax | @ | 2 | mills.....$ | 308,558.14 |
| Confederate Veteran Tax | @ | ¾ | mill ..... | 115,709.30 |
| State School Tax | @ | 2½ | mills..... | 385,697.68 |
| State University Tax | @ | ½ | mill ..... | 77,139.53 |
| **Total State Tax** | @ | 5¾ | mills.....$ | 887,104.65 |

**Local Taxes**

| | | | | |
|---|---|---|---|---|
| Parish Tax | @ | 4 | mills.....$ | 431,129.93 |
| School Taxes: | | | | |
| Constitutional School Tax | @ | 5 | mills..... | 771,395.34 |
| School Maintenance Tax | @ | 3 | mills..... | 462,837.18 |
| Consolidated School District #1 | @ | 8 | mills..... | 367,667.92 |
| Consolidated School District #2 | @ | 1½ | mills..... | 50,428.02 |
| Consolidated School District #3 | @ | 1½ | mills..... | 103,325.36 |
| Fourth Ward School Tax | @ | 3 | mills..... | 68,775.24 |
| Fifth Ward School Tax | @ | 6 | mills..... | 110,712.95 |
| Sixth Ward School Tax | @ | 11 | mills..... | 564,341.30 |
| Eighth Ward School Tax | @ | 10 | mills..... | 151,665.35 |
| Levee Taxes: | | | | |
| Atchafalaya District Levee Tax | @ | 2½ | mills..... | 16,524.16 |
| Drainage Taxes: | | | | |
| Bayou Cypremont Gravity Drainage District | @ | $.50 | per acre.. | 805.90 |
| Consolidated Gravity Drainage District #1 | @ | 2 | mills..... | 137,767.10 |
| Sub-Drainage District #1 of Wax Lake East | @ | 5 | mills..... | 21,446.50 |
| Wax Lake East Drainage District | @ | 1 | mill ..... | 20,312.45 |
| Gravity Drainage District #3 | @ | 2⅝ | mills..... | 54,585.10 |
| Miscellaneous Taxes: | | | | |
| Criminal Tax | @ | 2 | mills..... | 92,993.15 |
| Waterworks District #2 | @ | 2½ | mills..... | 16,524.40 |
| Waterworks District #3 | @ | 7 | mills..... | 101,687.06 |
| Waterworks District #5 | @ | 7½ | mills..... | 219,710.43 |
| Waterworks District #6 | @ | 5 | mills..... | 71,365.71 |
| Hospital Service District #1 | @ | 3½ | mills..... | 241,092.47 |
| Hospital Service District #2 | @ | 1 | mill ..... | 51,303.76 |
| Hospital Service District #3 | @ | 6 | mills..... | 201,710.70 |
| Library Tax | @ | 2 | mills..... | 257,408.71 |
| Sewer District #1 | @ | 2¼ | mills..... | 24,020.08 |
| Sewer District #2 | @ | 5½ | mills..... | 24,906.72 |
| Sewer District #4 | @ | 7 | mills..... | 57,381.67 |
| Morgan City Harbor and Terminal Court | @ | 1 | mill ..... | 70,609.31 |

**Total Parish and Local Taxes** ........................................ $ 4,764,433.97
**Total Taxes for all Purposes** ........................................ $ 5,651,538.62

TABLE 3.9-25 Major sources of tax revenue, St. Mary Parish, Acadiana, and State of Louisiana, 1973 (in $ thousands)

| | St. Mary | Acadiana | State of Louisiana |
|---|---|---|---|
| All Property Tax | | | |
| Local Revenue | | | |
| Total | $ 4,764 | $22,647 | $297,468 |
| Parish Average | 4,764 | 3,456 | 4,648 |
| State Revenue | | | |
| Total | 887 | 3,067 | 27,508 |
| Parish Average | 887 | 451 | 430 |
| All Severance Tax | | | |
| Total | 27,138 | 82,156 | 265,399 |
| Parish Average | 27,138 | 10,269 | 397 |
| Salt Severance Tax | | | |
| Total | 145 | 372 | 372 |
| Parish Average | 145 | 47 | 6 |
| All Sales Tax | | | |
| Total | 3,229 | 27,828 | 321,864 |
| Parish Average | 3,229 | 3,479 | 5,029 |

Source: Tables 3.9-12, 3.9-13, and 3.9-14.

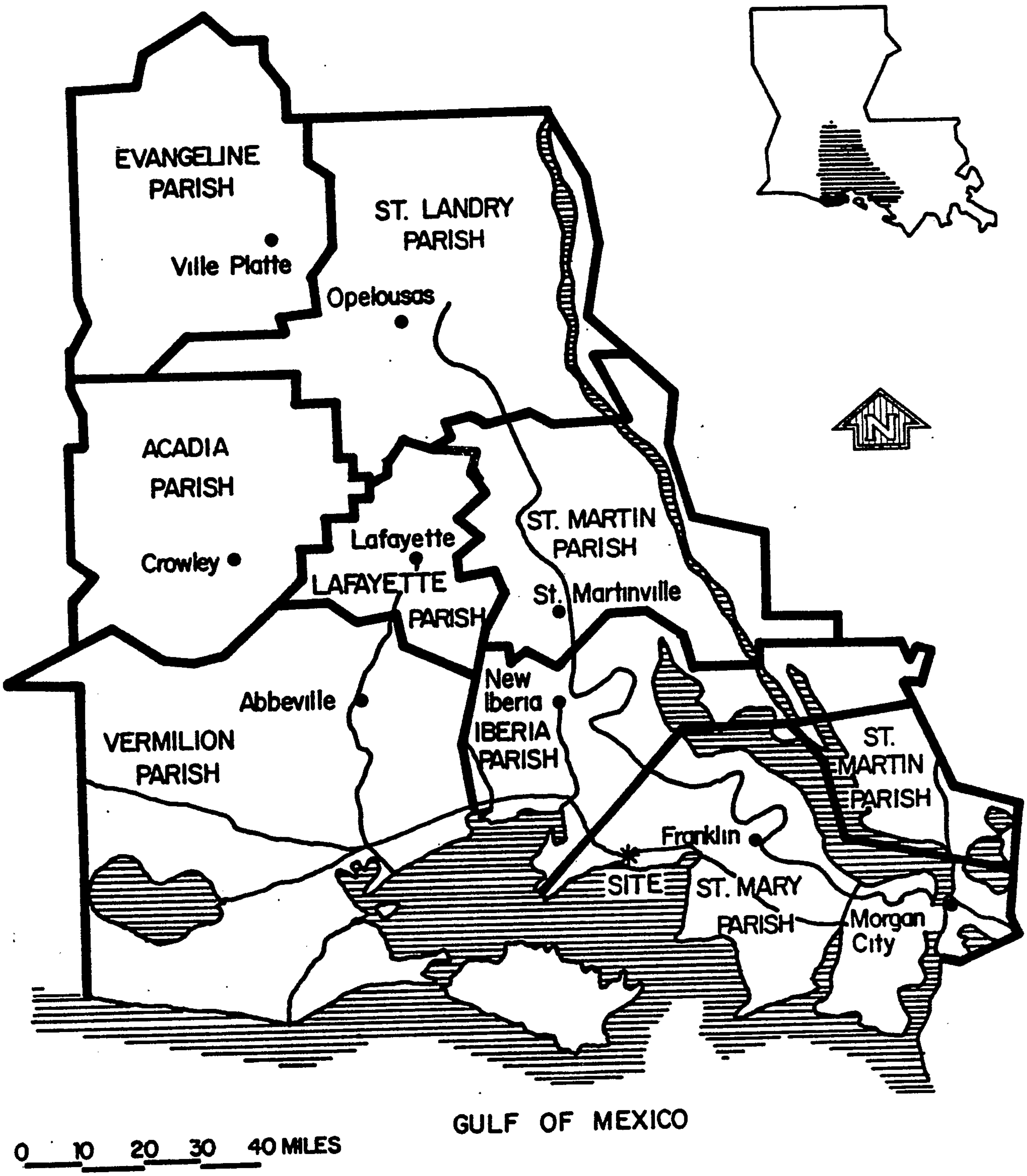



FIGURE 3.9-1. Acadiana region.

ACADIANA PLANNING AND DEVELOPMENT DISTRICT

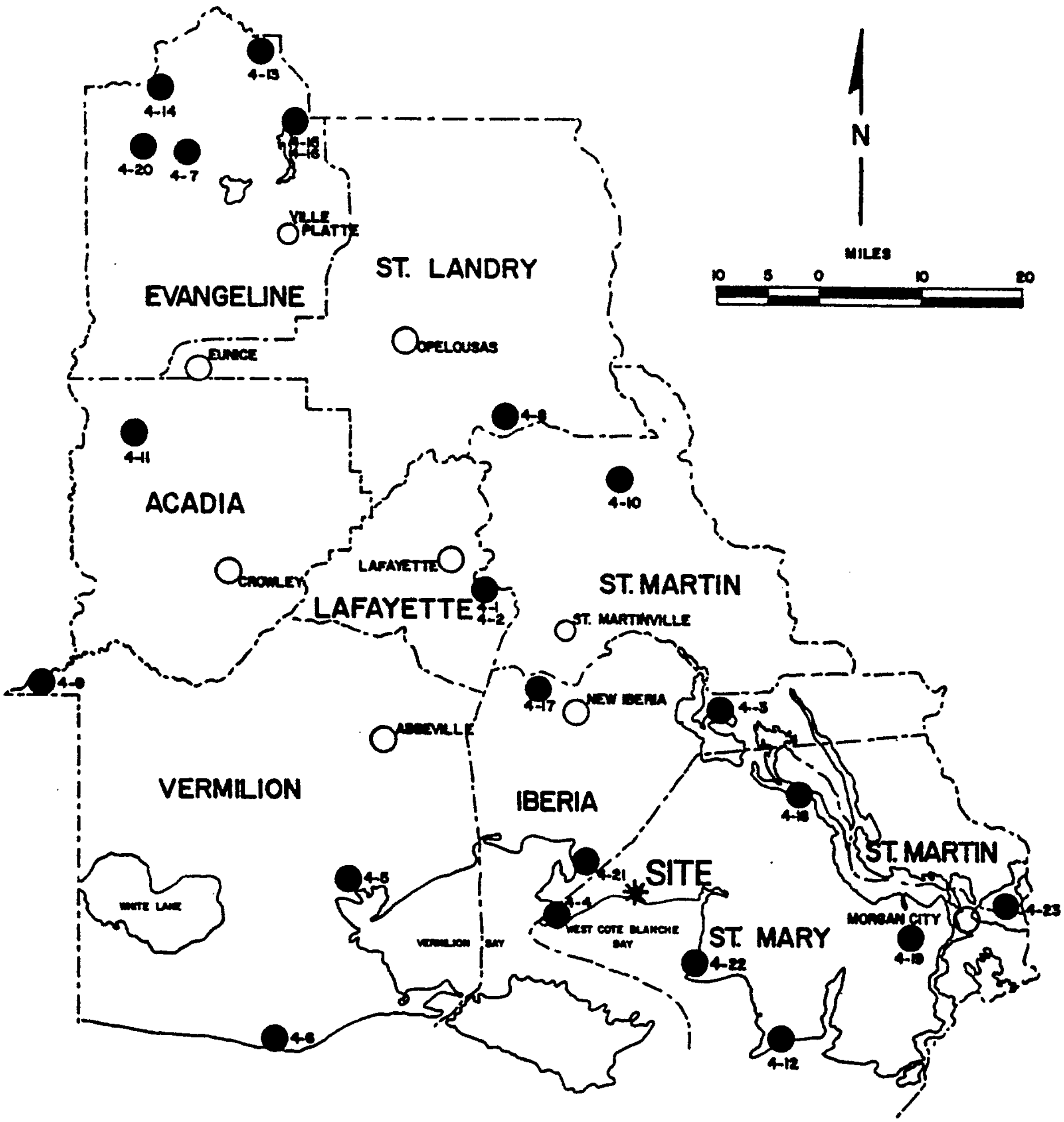



FIGURE 3.9-2. Potential regional recreation areas.

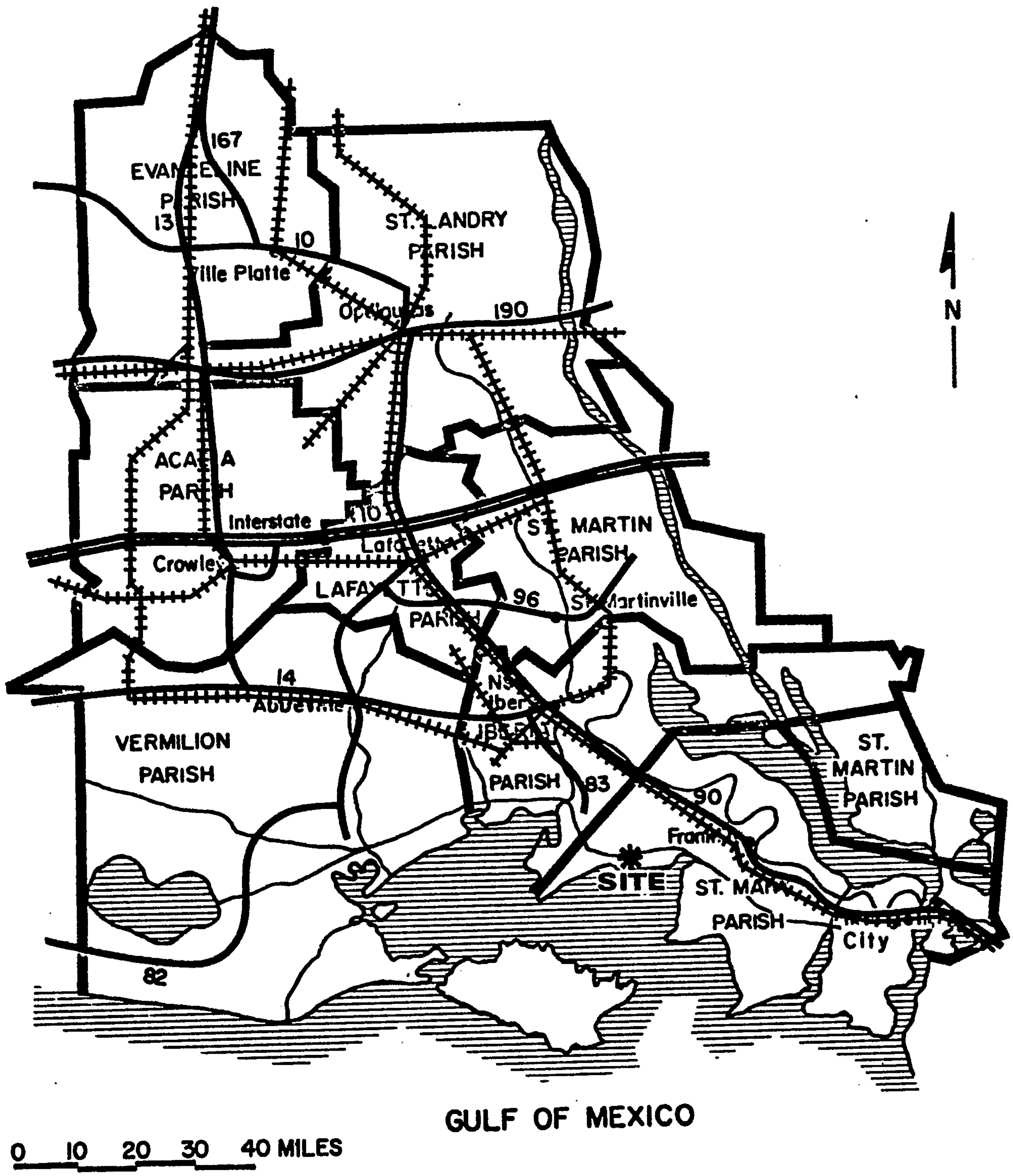
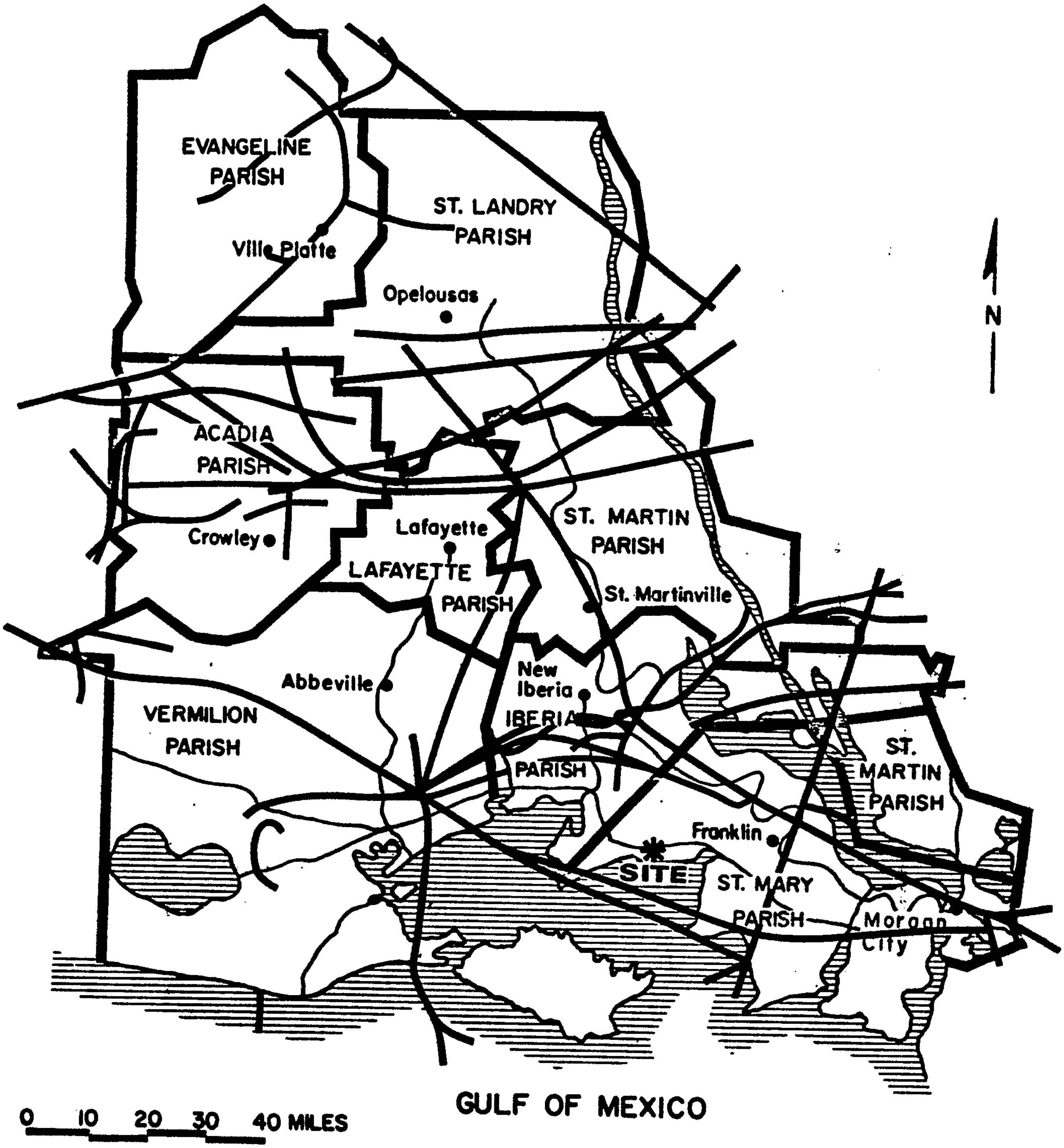



FIGURE 3.9-3. Highway railroad network Acadiana region, 1974.




**Source: Acadiana Planning and Development District, May 1974**

FIGURE 3.9-4. Oil pipeline network Acadiana region, 1974.


**Source: Acadiana Planning and Development District, May 1974**

FIGURE 3.9-5. Gas pipeline network Acadiana region, 1974.

SECTION 4.0

# ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTIONS

## 4.1 INTRODUCTION AND SUMMARY

The actions that may cause environmental or social impacts are construction and operation of the proposed oil storage facility and preparation of a new mine on Cote Blanche Island. Expected and potential impacts (both positive and negative) are described in some detail in the remainder of section 4.0. The most significant adverse effects that may occur are related to the potential for oil spills, the release of large quantities of hydrocarbon vapors during oil transfer operations, the temporary influx of large numbers of construction workers to the region, and the possible dislocation of a substantial number of Domtar employees if the decision is made to temporarily close the mine.

Oil spill damage potential is described in detail in section 4.3.8. The expected annual average volume of oil spills does not pose a threat to coastal ecosystems, to any unique or otherwise important component of the ecosystems, to human safety, or to normal use of land and water resources. The maximum credible spill of 60,000 barrels could severely pollute a local natural area (several hundred acres). The frequency of occurrence of such a spill, based on historical data, is extremely low.

Hydrocarbon emissions which could result from transfer of oil between tankers, barges and the storage cavern are described in section 4.3.3.2. Atmospheric loading of hydrocarbons in southern Louisiana resulting from oil evaporation and venting may be as high as 126 BPD, or 2800 tons per year, during withdrawal operations. Such emission rates will produce concentrations of hydrocarbons exceeding 160 $\mu gm/m^3$ for several miles downwind of the transfer sites. During periods of high volume oil movement, there may be increased photochemical reactivity and ozone concentrations in portions of the coastal Louisiana atmosphere.

The influx of new construction workers to the region may be as high as 140 at any given time. Housing shortages may be severe enough at these times to require extensive commuting distances or, alternatively, to require temporary housing at the construction site. Since the duration of peak construction employment is low, few families will move into the area so local services should not be strained.

Should the decision be made to develop the oil storage facility without closing the mine temporarily, there will be no significant adverse effects on the mine owner or workers because of the project. If, however, a decision is made to expedite the oil storage, the Cote Blanche Mine may be closed down for an estimated 74 weeks. Perhaps half (60) of the Domtar employees could be expected to find employment in the construction phase of the project. The remainder would be without work, or possibly underemployed, until salt production begins at the new mine.

Concurrent development of a similar storage facility at Weeks Island will reinforce these (and some other) impacts. Depending on peak barge traffic levels in the Intracoastal Waterway during an oil supply interruption (which in turn depends on the use of other Louisiana sites in the Strategic Petroleum Reserve Plan), oil spill exposure may be significantly greater than for the Cote Blanche facility alone. These high traffic levels would occur only for a short duration (5 to 9 months) for each emergency withdrawal.

If peak construction employment levels for Weeks Island coincide with those at Cote Blanche, housing shortages could become severe. Under these circumstances, some special arrangements might be made by the contractors to provide temporary quarters (see section 5.0). If mine shutdown occurs, many additional construction workers would likely come from the local area, thus reducing the need for temporary housing.

Should the Morton Mine at Weeks Island be shut down at the same time as the Domtar Mine, impacts on the local communities could be serious. Local unemployment would increase by more than 200 persons (direct layoffs) in Iberia and St. Mary Parishes. There may also be a significant temporary effect on the regional supply of salt. (See section 4.5 for a description of Weeks Island and Cote Blanche project interactions.)

Since there will be no waste or waste products to be removed from the mine or to be disposed of in the Gulf of Mexico, there will be no direct adverse international impact. Transportation of foreign oil through international waters poses some risk of oil spill. Since assessment of these risks involves the entire SPR program, treatment of oil spills in international waters is provided in the programmatic EIS (DES-76-2, 1976).

## 4.2 SITE PREPARATION AND CONSTRUCTION

Preparation of an oil storage facility at Cote Blanche Island involves modification of existing mine facilities to receive oil and development of a new salt mine. Modification of the existing mine includes sinking a pump shaft (for the option that avoids temporary salt mine shutdown); sealing the service and production shafts; removing certain aboveground facilities such as the headframe and hoisting equipment; construction of an electrical power substation, piping, manifolds, and four barge platforms; enlargement of the barge slip; and regrading of the mine caverns to promote oil drainage.

Development of a new mine involves excavating new service and production shafts; constructing headframe and hoisting equipment and a new salt conveyor system; preparation of sufficient working faces in the mine; and installation of new crushing and screening equipment. Further information on site preparation and construction can be obtained from section 2.0 and from the Phase 3 Feasibility Study (FEA, 1976a).

The following sections describe the expected and potential effects of the proposed project. For clarity, effects are treated within major areas of concern, i.e., geology, hydrology, air quality, and so forth.

### 4.2.1 Geology

Surface construction activities will not adversely affect the geology or topography of Cote Blanche Island. A minimal amount of regrading and excavation is required; this is expected to be of no significant consequence to soil erosion rates. An estimated 250,000 cubic yards of soil will be excavated in enlarging the barge slip. This will alter the terrain on 6 acres of land from marsh and spoil banks to open water. Material excavated from the slip will be disposed of in a site approved by the Corps of Engineers.

Shaft drilling and sinking are common practice on salt domes. Numerous oil, gas, and water wells exist on Cote Blanche. There are two large diameter shafts at the existing mine. Either two or three new shafts will be excavated to depths of over 1000 feet. However, these will be located a sufficient distance from the others to eliminate any interference effects. The ground freezing and drilling techniques proposed are standard engineering practices intended to prevent shaft collapse and ground water migration.

Modification of the existing mine involves no further large-scale excavation or solution mining. The new mine will be designed according to conventional salt mine engineering principles with regard to room size, roof support, and ventilation. A minimum of 300 feet of salt will be left between the existing workings and the new mine to eliminate any possibility of structural weakness. Since the existing mine is completely dry, fault free, and has no floor heaves or roof collapse, there should be no problem with the structural integrity or utility of either the new mine or the oil storage facility.

The waste salt removed from the dome in preparing the necessary access shafts will be placed in the existing mine and stabilized. No salts or any other potentially toxic material will be disposed of at the surface of the island. Sand, gravels, and clays excavated from the shafts at depths above the salt will be disposed of in a small landfill at the site. The total disposal volume is less than 15,000 cubic yards, comparable to a 2-acre landfill less than 5 feet high.

None of these activities are considered to be significantly adverse, even locally, on the island.

### 4.2.2 Hydrology

#### 4.2.2.1 Surface Water

The construction phase of the project will have impacts to the surface waters mainly because of construction in the following locations:

1. Pipeline between barge slip and pump shaft.
2. Port barging facility.

In general, these impacts will be due to runoff and will cause:

1. An increase in sedimentation.
2. An increase in infiltration.
3. A decrease in water quality.

The excavation and refilling of the pipeline trench would disturb the natural soil along the 0.5-mile pipeline corridor. This disturbance would subject several thousand cubic feet of soil to the runoff-erosion process. This eroded material would be deposited mainly into the existing access canal at the new barging facility and partly off the west coast of Cote Blanche Island into the marshland and bayous. Also, the disturbed soil will be less compact than the undisturbed material, causing a higher infiltration rate. However, this impact is very insignificant to both the local and regional environment because of the small volume of eroded material involved.

Site excavation and grading during the construction of the barge platforms will cause the following changes in water quality that will be limited to the area of the barge slip and, possibly, the southern end of the access canal:

1. An increase in the amount of biological oxygen demand (BOD).
2. A decrease in the quantity of dissolved oxygen (DO).
3. A reduction in pH.
4. An increase in the nutrients in the water column.
5. Possibly an increase in the heavy metal concentrations released from the sediments.

Some minor surface water quality effects will occur in the local area from the proposed project construction activities. Site grading, excavation, and construction will increase the runoff coefficient within the southwest watershed on the island. Together with grading and bank stabilization at the barge slip, there will be a slight increase in runoff, and suspended solids within the slip. Bank stabilization will ultimately improve water quality by minimizing bank erosion and sedimentation.

Impacts due to the construction of the four new barge platforms and expanded barge slip at the Cote Blanche facility will result in the loss of as much as 15 acres of land along the northern bank of the existing barge slip. Most of this land (about 60 percent) consists of marshland; the remainder is in either upland forest or is used in the transport of salt from the mine to the access canal. As a result of this excavation, about 250,000 cubic yards of material will have to be disposed of in either landfill areas on Cote Blanche Island or in authorized disposal areas inland or offshore.

The dominant flora of the marsh area (see section 3.6) is Spartina, which may comprise about 95 percent of the biomass of the higher plants growing in the marsh. Evidence indicates that, in the shallow estuaries (less than 10 feet deep) such as at Cote Blanche, large plants (macrophytes) are the most important primary producers. Estimates of annual net production of marsh grasses are scarce, and many of these estimates are extrapolated from infrequently collected data. These production estimates range from 500 to 2800 grams of dry organic matter per square meter per year ($g/m^2/yr$). High production rates for a given species have been shown to be associated with small fluctuations in salinity, while low rates are associated with large fluctuations in salinity concentrations (Good, 1972).

Annual net production of Spartina in Louisiana marsh has been shown by Kirby (1971) to amount to about 2000 g dry $wt/m^2/yr$. This rate indicates that $50 \times 10^6$ grams dry weight of marsh grass would be removed from annual production due to the development of the barge slip.

The 250,000 cubic yards of excavated material will have to be disposed of in the landfill area located on Cote Blanche Island or in authorized disposal areas in southern Louisiana or offshore in the Gulf of Mexico. Landfill disposal of the material would have minimal impact if this material were used to enhance the dump area on the island, since the material will be of high organic content and could be used for nourishment of new plantings to restore the dump site to a more natural environment. Disposal of the excavated material in wetland or offshore areas will increase the turbidity and the nutrient concentrations at the disposal site and reduce the transparency of the water column. These changes, together with other biochemical changes at the site such as alterations in pH or oxygen concentration, could have a significant impact on the ecological characteristics at the disposal site.

The diversity of animals living in the marsh can be expected to be lower than that of the adjacent open waters of West Cote Blanche Bay; however, their biomass is higher.

Other than the small benthic organisms (microbenthos), which include nematodes, ostracodes, small polychaetes, amphipods and some copepods, the marsh community is composed of large organisms such as polychaetes, snails, fiddler and blue crabs. The total average biomass of macrofauna collected at Airport Lake, Louisiana (Day and others, 1973), to the 50-meter line into the marsh amounted to 16.76 grams of organisms per square meter. This total suggests that about 6 x $10^5$ grams of organisms would be directly affected by barge slip excavation.

Large mammals such as raccoon and muskrat would indirectly be affected since habitat and food for these animals that use the Cote Blanche marsh would be reduced.

It is not possible to quantify all of the water quality impacts from data collected from limited site studies; therefore, estimates of the magnitude of these impacts are discussed below.

There will be no increase or decrease in the water temperature of the access canal or ICW due to project construction.

A small increase in the BOD will occur due to the organic compounds present in the marsh material that may be released into the access canal. The effects of adding these materials to water are a function of the amount of water available for the dilution. For this reason, it is not expected that the BOD values would increase by more than 20 milligrams per litre (mg/l) since the access canal, Vermilion Bay, and ICW are relatively low in present BOD values (about 2.0 mg/l); considering the large amount of water available for dilution, the effect will be minimal.

For a similar reason, a small decrease in the DO concentration in the access canal will occur, but since the DO values in the ICW are generally high (greater than 7.0 ppm), this impact will be minimal.

A small reduction in the normal pH (about 7.8) of the canal water may occur because of the deposit of organic matter from the disturbed marsh. Because of the presence in solution of carbonate and bicarbonate ions, the pH of most productive natural waters (fresh to saline) is between 6.5 and 8.5. This natural buffer system makes it possible for small amounts of acid or base to dissolve in the waters without causing appreciable changes in the pH. (The pH in Vermilion Bay and the ICW is about 7.5.)

A slight increase in the concentrations of nutrients (i.e., nitrite, nitrate, phosphate and silicate) will occur in the slip area from the drainage of disturbed dredge spoil and the existence of peat and muck soils in the marsh that may drain into the slip. Both nitrogen and phosphorous are present in small amounts in the natural waters around Cote Blanche Island, but their concentrations could be temporarily increased by dredging of the barge slip.

Many heavy metals are toxic to aquatic life in low concentrations. Studies have related these toxicities to specific organisms and to specific dilution volumes. The toxicity of a particular substance is dependent to a large extent on other water quality characteristics associated with the toxicant, such as temperature, pH, alkalinity, and so forth. In most cases it is necessary to determine through bioassay the toxicity to aquatic organisms of the disturbed sediments or the effect on water quality.

Existing water quality and bottom conditions are adversely affected by present industrial usage of the area. Barges transport salt from the Domtar Mine, stirring the bottom and occasionally spilling salt into the barge slip. The access canal and slip are dredged approximately once every 2 years. Because of these conditions, incremental effects of the project construction activities on water quality, water use, and biological resources in this area will be insignificant.

Presently, Domtar uses a septic tank system to dispose of sanitary wastes. Construction crews will number up to 350 at a time (working in two or three shifts each day), which is more than twice the present mine employment level. Sanitary wastes will have to be handled either by another, larger capacity, septic tank system or by chemical toilet facilities. The short duration of construction probably would not justify installation of a package treatment plant.

Cattle may utilize the several small lakes on the island, but these are not in the vicinity of the construction site. No surface water is expected to be required for the project.

Considering the small size of the proposed facility, no significant impact on regional or local surface water supply, water quality or hydrological regime is expected to result from the proposed action.

4.2.2.2 Ground Water

Construction of Pipeline and Other Surface Facilities

As outlined in section 2.3, the proposed project requires four pipelines extending from the new pump shaft near the center of the surface facilities to the barge slip, a distance of less than 1/2 mile across a hummocky, low sloping hillside. The pipelines will be placed entirely in permeable sands, silts and clays. Because of the high soil permeability, the height of the local water table approximates sea level such that the pipelines as well as other surface facilities will be well above the water table. Therefore, the construction of the pipeline and other surface facilities will not affect the ground water in the area.

To protect the pipelines from corrosion, it is industry practice to use an external protective coating. Possibilities include a coal tar enamel with felt wrapper, a pressure sensitive plastic wrap, and a thermal setting thin film plastic coating. It is also likely that sacrificial anodes of zinc would be used as further protection.

The materials used to protect the pipeline may be leached or otherwise deposited into the soil. Zinc is the only material which is particularly toxic to aquatic life, however, and therefore is a potential ground water pollutant. Zinc readily forms insoluble oxide and hydroxide precipitates in a neutral pH environment. Unless there is a considerable amount of excavation and surface exposure of soils near the anodes after installation, it is highly unlikely that sufficient quantities of zinc would be leached into nearby waters to have any adverse impact to life forms.

New Shaft Construction

As previously described, site preparation will include construction of either two or three shafts (depending on the mine production option selected). The pump shaft (optional) and new mine production shaft will be conventionally excavated after first freezing the unconsolidated sediments above the impermeable salt. In addition to providing stability to the materials, freezing will render them impermeable to water inflow (or outflow) until they are allowed to thaw after permanent shaft lining is in place. Therefore, the ground water regimen will be entirely isolated from any disturbances resulting from the sinking of these two shafts.

The new mine service shaft will be excavated by conventional large diameter drilling techniques. Instead of freezing, the walls of the hole will be maintained by drilling mud. The mud will have a density that is just sufficient to offset the local hydrostatic head, hence preventing ground water inflow. Conventionally, the mud remains in the drilled shaft until the unstable portions are continuously cased with permanent lining. Therefore, the drilling of this shaft will not affect the ground water except for the insignificant effects associated with minor amounts of drilling mud that may locally migrate short distances into permeable horizons. The drilling muds will be chemically inert, nontoxic, and formulated to reduce migration, as is conventional for drilling of water wells.

Ground water is presently extracted from a well at a depth of 250 feet for use at the Cote Blanche Mine. Pumping rates are minimal. Existing water quality is suitable for drinking with filtration. A source of fresh water will be required during construction and modification of the site. An estimated 35 gpm (maximum) will be required for about 1 year for drilling mud, concrete, washing and general human consumption. This water may be taken from the existing well, but more likely a new well will be drilled into the same aquifer. In any case, the withdrawal is not large enough to affect the supply of fresh water available in the aquifer (see section 3.3.3.6).

Barge Slip Excavation and Spoil Disposal

Significant amounts of material will be excavated from the barge slip area (250,000 cubic yards) and from shaft excavation (15,000 cubic yards). As previously described, soil and rock materials excavated from the shafts and suitable for landfill (nontoxic) will be disposed of in a small landfill near the mine, placed in a manner designed to minimize possible impacts from runoff and erosion. Those materials unsuitable for surface disposal will be placed underground in the present mine workings, along with that portion of the excavated salt undesirable for normal salt processing.

Material excavated from the barge slip will be taken to a suitable disposal site in accordance with a permit issued by the Corps of Engineers. There will be no effect on ground water conditions as a result of either excavation or spoil disposal.

### 4.2.3 Air Quality

The quality of the air near the site will be slightly affected during site preparation and construction. The two largest potential effects on air quality associated with construction of the proposed oil storage facility are particulate matter (dust) and diesel exhaust ($SO_2$, $NO_x$, CO, hydrocarbons) emissions resulting from the construction equipment. Most of the construction activity at the mine site (installation of bulkheads, channelization of mine floor) will be underground. Therefore, the surface pipeline system and barge facility construction will be the major cause of pollutant emissions.

#### 4.2.3.1 Sources of Emissions

The quality of the air during the construction of the site will be affected by the following pollution sources:

1. General construction vehicles
2. Light duty general use vehicles
3. Fugitive dust from excavation, vehicular traffic

General Construction Vehicles

During the site preparation phase there will be excavation activity, drilling, and underground blasting and construction. A number of machines will be used. The diesel and gasoline engines will emit hydrocarbons (HC), $SO_2$, CO, $NO_x$, and particulates. The underground construction activity will not significantly affect the existing air quality. However, the construction of the pipeline system will result in some deterioration of the air quality.

Accurate prediction of quantities of pollutants emitted during construction is difficult in that it depends upon the following factors: number, type, and model year of vehicles, speed, duty cycle, cold operation cycle, and local meteorological conditions. The emission factors for the construction equipment that will be utilized in the construction activity were taken from the U.S. E.P.A. Compilation of Air Pollutant Emission factors (December, 1975). The total emissions were calculated using the emission factors and estimates of the amount and projected use of construction equipment. Section 4.2.4 describes the construction equipment required for the construction activity. The construction equipment was assumed to have a 20 working hours/day and 2,000 working hours/year duty load. In addition, it was assumed that equipment will be used at 2/3 of the maximum power output during construction.

Light Duty General-Use Traffic

The air quality will also be affected by vehicular traffic other than that directly related to the construction activity. It was assumed that an additional 10 vehicles are to be in use during construction, each running at 100 miles per day at various speeds.

Table 4.2-1 presents the calculated emissions by pollutant resulting from the total amount of construction equipment. The emissions include all miscellaneous devices including welding equipment, refrigeration equipment, ventilation equipment, and generators. These are assumed maximum one hour emission rates. The largest portion (greater than 50 percent) of the emissions given in the table will result from the equipment used in the drilling and pile driving operations.

Fugitive Dust

In addition to the particulate concentrations resulting from the operation of equipment, dust emissions will result from construction activities at the site. The dust will be associated with land clearing, blasting, excavation, cut and fill operations, and other activities. The amount of dust will vary from day to day, depending on activity and the weather. A large portion of the dust will be due to equipment traffic over temporary roads.

Field measurements at apartment and shopping center construction sites yield an estimate of 1.2 tons (1,089 kg) of dust per acre of construction per month of activity. This estimate is high for the Cote Blanche site because it was determined for a semiarid climate. Dust emission is inversely proportional to the square of ground moisture, and ground moisture is twice the semiarid level in Louisiana. Therefore, the dust emission during construction at Cote Blanche is estimated to be 0.3 tons (272 kg) of dust per acre of construction per month of activity. This is approximately 15 percent of the emission rate given in Table 4.2-1.

4.2.3.2 Impacts on Air Quality

The impact of the computed emissions is dependent on the ambient air quality and the dispersal characteristics of the atmosphere, both of which have been discussed in section 3.4. The atmospheric calculations were made using methods recommended by the Environmental Protection Agency (Turner, 1969) and averaged over appropriate time intervals.

The pollutant concentrations resulting from the construction equipment is given by Table 4.2-2. The concentrations were calculated using the construction emission rates (Table 4.2-1) and assuming an area source model with a construction area having dimensions of 250 meters on a side. The downwind concentration was computed at a point 500 meters downwind under F stability and a wind speed of 2.0 meters per second. Because all pollutants released during the construction are essentially ground releases, all concentrations given by Table 4.2-2 will be lower with increasing distance. Therefore, the concentrations .5 km from the site are the maximum levels expected to be obtained offsite.

All primary standards are easily met for the given assumptions. The concentration levels shown in Table 4.2-2 do not include ambient levels due to sources outside the project. The closest ambient measurements are given in section 3.4.

The EPA Regional Administrator has recently disapproved the existing control strategy of the State Implementation Plan for particulate matter for the attainment and maintenance of national secondary and primary ambient air quality standards. Because of recent air quality data which indicated frequent violations of the secondary air standards, a detailed analysis is currently being conducted to determine the extent of the problem. However, no deadline has been set for the state to submit a new plan, as yet.

The State of Louisiana is currently challenging the position of the EPA on the basis that at least a portion of the data used for the original determination of violations was erroneous. No resolution of the dispute between the State of Louisiana and the EPA with regard to particulate levels has been achieved as yet.

The island is not inhabited and is not used for recreation purposes. Effects on biota will be limited to accumulations of dust on foliage in the immediate vicinity of construction activities. These short-term, local effects on air quality will have little or no adverse impact.

There are no odors expected to be caused by the proposed facility construction.

### 4.2.4 Noise Level

The following sections describe the analysis of possible acoustical impacts at locations and residences near the Cote Blanche construction site. Section 4.2.4.1 specifies the noise levels associated with the major construction equipment. Using hemispherical sound radiation assumptions, the noise levels are extrapolated to nearby locations off the site to determine the effect on ambient noise levels (sections 4.2.4.2 and 4.2.4.3).

#### 4.2.4.1 Construction Noise Sources

The existing salt mine will be converted to a storage facility suitable for the storage of oil. During the conversion period there will be many construction activities on the site. The major construction activities that have been identified are:

1. Construction of new mine.
2. Conversion of present mine to a storage facility.
3. Construction of pipeline systems and transportation support facility.

Construction of New Mine

Part of the site development program includes construction of new mine facilities. The major construction efforts will be excavation of the new production shaft and a new service shaft. It is estimated that the new production shaft will be about 1120 feet deep with an inner diameter of 14 feet. The upper half of the shaft will pass through a layer of totally unconsolidated to semiconsolidated gravel, sand, silt and clay, which is above the salt. In order to control the extraordinarily difficult construction conditions presented by these materials, this layer will be thoroughly frozen to an outer radius sufficient to withstand anticipated pressure prior to excavation. The freezing process requires the installation of a refrigeration system consisting of a refrigeration plant and underground pipes.

The holes for installation of refrigeration pipes will be drilled using large drilling equipment. It is estimated that two drills may be operating simultaneously on the site. The sound level data of this equipment are presented in Table 4.2-3. The equivalent sound level, $L_{eq}$, contribution of this activity is estimated to be 67 decibels (dB) at 500 feet. Assuming that drilling activity is continuous throughout a 24-hour day, the daytime and nighttime equivalent sound level, $L_d$ and $L_n$, contributions are both estimated to be 67 dB at 500 feet.

A refrigeration plant typically consists of a 100- to 150-HP reciprocating compressor, a 24-inch diameter condenser, and a suction trap. These units will be enclosed in a building. Equipment manufacturers estimate operating sound levels inside the refrigeration building of 89 to 102 dB, resulting in an equivalent sound level, $L_{eq}$, contribution of 37 dB at 500 feet. The refrigeration process will be continuous throughout a 24-hour day and will operate for a period of about 11 months. The daytime and nighttime equivalent sound level, $L_d$ and $L_n$, contributions are both estimated to be 37 dB at 500 feet.

The production shaft will be excavated by conventional drilling and blasting techniques. This is a cyclic process composed of:

1. Drilling holes into the floor for placing explosives and possibly into the side walls for installing rock bolt supports.
2. Emplacement and detonation of explosives.
3. Removal of fragmented material.
4. Installation of steel supports.

Typical noise-producing surface equipment associated with the above construction may include 1 ventilation blower, 3 air compressors, 2 trucks, a crane, 1 or 2 concrete trucks, and probably a batch plant (Table 4.2-4). The equivalent sound level, $L_{eq}$, contribution for these phases of construction is estimated to be 70 dB at 500 feet. Construction activity will be continuous throughout the 24-hour day. The daytime and nighttime equivalent sound level, $L_d$ and $L_n$, contributions are estimated to be 70 dB at 500 feet.

Underground noise generators from the production shaft construction include drills, explosives, and excavation equipment. The audible sound level above the existing ambient sound level due to underground construction activity is considered to be negligible.

It is estimated that there will be two to six detonations of 50 to 300 pounds of dynamite each day. Since the overpressure created from detonation depends on both the amount used and the depth at which it occurs, it is difficult to estimate the sound pressure level created from this activity. While the overpressures are high, they are of a short duration and will contribute to the instantaneous sound level energy but not significantly alter the equivalent steady sound level.

Because of its smaller diameter, the service shaft will be drilled rather than mined. Large diameter drill rigs employed for such work are typically powered by two or three 400- to 600-HP electric motors. In relation to the other construction noises that will be occurring simultaneously with the service shaft, the drilling of the service shaft will contribute negligible sound levels.

Conversion of Present Mine to a Storage Facility

Most of the construction activity such as conversion of the existing production shaft to a pump shaft, installation of bulkheads, and channelization along the mine floor to improve drainage will be conducted underground. The audible sound level above the existing ambient sound level due to underground construction activity is estimated to be negligible.

If salt mining production is not to be interrupted, the construction of a 12-foot diameter pump shaft at the present mining site may be required. The construction methodology, equipment use, and noise levels are similar to those presented in the previous section.

Construction of Pipelines and Transportation Support Facility

Four pipeline systems will be constructed from the storage facility to the barge loading docks. Basically, there are four phases of construction:

1. Excavation
2. Laying of pipes
3. Welding
4. Finishing

It is estimated that pipeline construction at Cote Blanche Island would require the use of 2 trucks, 1 backhoe, 1 concrete mixer, 1 welding machine, 1 scraper and 3 wheel-mounted cranes. Sound level data associated with this equipment are presented in Table 4.2-5. Construction activity is generally scheduled for 10 hours a day during daytime. The equivalent sound level, $L_{eq}$, contribution is estimated to be 68 dB at 500 feet;

thus, the daytime equivalent sound level, $L_d$, contribution is 66 dB at 500 feet.

At the barge loading area, it is anticipated that four barge docks will be constructed. The major noise producing equipment used for this construction is expected to be one or two pile drivers and trucks. This equipment and its sound level data are presented in Table 4.2-6. For construction activity conducted 10 hours a day in the daytime, the equivalent sound level, $L_{eq}$, and daytime equivalent sound level, $L_d$, contributions are estimated to be 71 dB and 69 dB at 500 feet, respectively.

Summary of Construction Noise

Sound levels from construction activities presented above are summarized in Table 4.2-7.

4.2.4.2 Ambient Sound Levels During Construction

Major construction activities will occur near the present mine site, new mine site, along the pipeline route, and at the barge loading docks.

In order to estimate the ambient sound levels during construction, the sound level contributions discussed in the previous section (see Table 4.2-7) are extrapolated, using hemispherical sound radiation, and are combined with the background ambient sound levels (section 3.5). The assumption of hemispherical radiation does not include attenuation due to foliage, air, or ground absorption, and is therefore conservative. The construction at the mine site is assumed to occur concurrently with the construction of the pipeline and barge loading docks. The results of this computation are presented in Table 4.2-8.

The results indicate that, except at the mine site, the increase in ambient daytime equivalent sound level is negligible. Since the background ambient nighttime sound levels are very low, the increase in nighttime equivalent sound levels at undeveloped areas, approximately 2 miles from the site, is estimated to be about 6 dB. The increase in ambient nighttime equivalent sound levels at noise sensitive land uses, such as the town of Kemper, is estimated to be about 1 dB (see Figure 3.5-1).

#### 4.2.4.3 Acoustical Impact During Construction

The impact on nearby residents during construction of the proposed facility is evaluated using baseline sound level data and estimated construction ambient sound levels for the situation where the construction of the new mine, conversion of the mine facility, construction of pipeline and barge loading docks, and excavation of the barge slip take place concurrently. The impact assessment presented in this section is based on Federal guidelines and state regulations.

The Federal Environmental Protection Agency has promulgated guidelines that suggest that annual day/night average ambient sound levels below an $L_{dn}$ of about 55 dB do not degrade the public health and welfare (Appendix B). A review of data presented in the previous section (Table 4.2-8) indicates that at nearby residences (noise-sensitive land uses, Table 3.5-1), such as at the town of Kemper, construction activity will have no effect on the annual day/night ($L_{dn}$) ambient sound levels. Also, the negligible increase in sound level experienced in inhabited areas indicates that even if construction took place on a Weeks Island storage facility concurrently, there will be no noticeable cumulative impact.

The state of Louisiana has no noise regulation limiting the sound levels from the proposed activity.

### 4.2.5 Impact on Ecological Environment

As indicated in the following paragraphs, site preparation and construction is expected to have no significant effect on biological resources or the ecological structure on the island.

#### 4.2.5.1 Terrestrial Ecology

Approximately 40 acres will be impacted by construction on Cote Blanche Island. Of this area, approximately 7 acres are woodland habitat, 13 acres are cleared land, and 20 acres are previously developed lands (or immediately adjacent to developed lands). Some adjacent lands may be made temporarily unsuitable for certain wildlife species or activities because of the noise and activity associated with construction. The loss of this habitat is not significant when compared to the total acreage of similar habitat on the island (approximately 1700 acres total, most of which is more suitable for wildlife habitat).

There are no known breeding or nesting sites in the area to be impacted and no threatened, endangered, or otherwise unique or important species known to occur there (section 3.6). Mobile populations of mammals and birds will experience temporary difficulty in locating suitable replacement habitats, but the potential for relocation is good on the island.

Some positive effects may occur from the establishment of the new mine site. It has long been known that a very useful habitat to a great many species is that which occurs where two habitat types meet, commonly called the "edge" or "ecotone" (Barick, 1945). Such an edge could be created along the perimeter of the new mine site with a probable result of increased diversity in the immediate area. Certain species of birds (kinglets, thrushes, quail, and others), as well as rabbits and small rodents, would be expected to utilize the increased "edge" on Cote Blanche. Also, construction of the oil storage facility on the island may preclude other potential development from this land during the life of the project for security reasons. Should this be the case, development of this area helps safeguard natural habitat on the remainder of the island from the encroachment of future development.

4.2.5.2 <u>Aquatic Ecology</u>

The impact on aquatic ecology due to site construction will be small since the dredging required for the construction of the new barge slip will be limited to a small restricted area in the existing barge canal. There should be no direct influence of site preparation on the aquatic resources adjacent to Cote Blanche Island.

Vegetative and benthic aquatic communities would be primarily affected by the dredging operations because of direct elimination or modification of their habitat. Members of the nekton could move out of the affected area but could be indirectly affected in the new habitat because of competition for available space and food.

Dredging will require the excavation of about 250,000 cubic yards of spoil at the new barge facilities. Most of this spoil will be taken from the marsh, the existing docking facilities, and from the barge slip to deepen the channel to about 11 feet. The total area involved in the excavation amounts to 15 acres, of which 10 acres are marsh and shrub habitat, 3 acres are used for salt shipment, and 2 acres are in the existing barge slip channel.

No quantitative information is available for the ecology of the area to be excavated. However, the land is adjacent to existing barge docks and spoil disposal areas. Natural circulation has been disrupted. For these reasons, the productivity and habitat value should be relatively low. As an estimate of worst case impacts, data is taken from a study of salt and brackish marshes adjacent to Barataria Bay.

During dredging activities, phytoplankton productivity in the barge canal would be reduced because of the increased turbidity and subsequent reduction in the transparency of the water to solar radiation. Assuming a complete loss of net annual phytoplankton production, 418 g dry wt/m$^2$ would be removed from the ecosystem budget. Similarly, 488 g dry weight of benthic plant production would be removed from the system for every square meter excavated along the barge canal.

Because of the soft peaty and muddy materials in the barge slip, there is a scarcity of large sessile benthic forms. The greatest amount of biomass of the benthic community is represented by the small animal forms consisting of nematodes, amphipods, and some copepods, ostracodes, and polychaetes. The total average animal biomass of these organisms that would be removed per square meter would be about 1.47 g dry weight. Depending upon the season of the year during which the dredging would be conducted, a large variation in the amount of crabs depleted may be estimated. For example, Day and others (1973) showed the biomass for crabs in Barataria Bay to range from 0.23 g dry wt/m$^2$ in summer to about 0.02 g dry wt/m$^2$ in winter.

It is not expected that the excavation activities would directly affect the nekton or swimming organisms in the barge canal, since these animals have a means of locomotion to avoid the disturbed area. However, these organisms could show some sensitivity to the suspended sediments and the displacement or modification of their habitat. Both of these impacts would occur primarily in the vicinity (less than 100 yards) of, and only during, the dredging operation. In some cases, the nekton may be attracted to the dredge site because of the elevated levels of organic matter in the water column on which they could feed.

Because of the restricted area within the existing barge canal, it is not expected that the dredging activities pose a potential for mortality to commercially or recreationally important estuarine organisms due to either direct habitat displacement or to impacts associated with elevated concentrations of suspended sediments. In addition, because of the restricted canal area, direct or indirect stress on the adjoining ICW or other aquatic habitats will also be minimal.

4.2.6 Historic and Archaeological Resources

As part of the analysis of environmental impacts and in accordance with federal law (PL93-291), a cultural resources survey was conducted within the proposed site construction boundaries and in the near vicinity of the site. As a thorough archaeological survey of the area had not been conducted previously, this effort improves the existing state of knowledge on Cote Blanche Island. Results of the survey are contained in Appendix D. The State Historic Office has approved the findings of the survey and issued clearance for commencement of construction with the stipulation that a professional archaeologist must be present to examine excavated materials and to notify the state if potentially significant cultural resources are uncovered.

Cote Blanche Island has great potential for containing unknown archaeological resources due to its unique topography; two known sites were described in section 3.7. Neither these nor any other known sites will be affected by the project. No additional sites of significance were found at the surface in the area of proposed construction during the survey. In accordance with the recommendations of the State Historic Office, material excavated from the upper 20 to 50 feet of the shafts and from the barge slip will be investigated for the presence of fossil or archaeological remains before disposal to further assure that no important sites are destroyed by construction.

4.2.7 Impacts on Socioeconomic Environment

The impacts outlined in this section are based in part on the construction schedules provided on Figures 2.3-1 and 2.3-2. Key elements are listed below. Where these differ for the two development options, those that apply for the case of no mine shutdown are listed under "a" and those that apply for the case of temporary mine shutdown are given under "b".

1.a. The new replacement mine will become operational as soon as the old mine closes (Figure 2.3-1). Consequently, the workers in the existing mine will not be adversely affected by the proposed oil storage program. This requires that the construction work be performed by a new labor force (in addition to the existing Domtar miners).

1.b. The new replacement mine will be developed as soon as possible; however, to expedite getting oil into storage, the existing mine production shaft will be converted to a pump shaft, thus halting mine production for an estimated 74 weeks (Figure 2.3-2). As no salt stockpile has been developed, it will not be possible to continue processing and shipping of bulk salt. It is estimated that 50 percent (60) of the Domtar workers will find employment on the project construction crew. Most of the remainder will either find other jobs in the area at lower pay or will remain unemployed until the new mine reopens.

2.a. Construction work on conversion of the old mine and preparation of the new mine will require about 25,000 man-weeks over a 103-week period.

2.b. Construction work on conversion of the old mine and preparation of the new mine will require about 20,000 manweeks over an 83-week period.

3.a The number of workers will not be constant over the 103-week period. After minor onsite efforts associated with surveying and geotechnical studies, the main influx of workers begins about week 47 with the initiation of work for all three shafts. An estimated 250 to 350 workers may be required virtually immediately at that time; they will be involved mostly in drilling the new service shaft and installing the refrigeration systems for the two larger shafts. The latter task will be completed around week 70. However, in order to stabilize the work force and reduce future employment peaks, the overall employment level can be maintained by early initiation of mine grading and cleaning, opening of the new mine, and installation of surface facilities. About week 70 the total work force is anticipated to expand by about 50 workers. This employment level is anticipated to last until about week 110, and will involve mostly the excavation of two of the shafts, installing associated surface and underground appurtenances, and completing development of the new mine openings from the base of the newly completed service shaft. After completion of these tasks, near week 110, the work force is expected to decrease abruptly to about 100 to 150 workers. This level will then gradually decrease to about 50 workers over the last few months until work is completed around week 150. The bulk of the efforts of this final phase will include completion of mine grading and cleaning, installation of shaft seals and pumps, and barge area conversion (see Figure 2.3-1).

3.b. The number of workers will be nearly constant over the 83-week period. After minor onsite efforts associated with surveying and geotechnical studies, the main influx of workers begins about week 47 with the initiation of work on the two shafts. An estimated 250 workers may be required virtually immediately at that time; they will be involved mostly in drilling the new service shaft, installing the refrigeration system for the production shaft, and removing equipment in the existing production shaft. In order to stabilize the work force and reduce future employment peaks, the overall employment level can be maintained by early initiation of mine grading and cleaning. Around week 70, work will begin on opening the new mine, installation of surface facilities, construction of barge facilities, and excavation of the production shaft. After completion of these tasks, near week 110, the work force is expected to decrease to about 200 workers who will complete installation of service facilities and development of new mine openings from the base of the newly completed service shaft (see Figure 2.3-2).

4.a. Each of the major construction phases will require importation (from beyond commuting distance) of seasoned specialists, which at any one time may compose 20 to 30 percent of the total work force. Just under half of the remainder of the work force will consist of skilled and semiskilled workers (including carpenters, electricians, steel workers, and so forth), and slightly over half will be nonskilled laborers. It is estimated that 60 percent of the skilled and semiskilled workers will come from the local area and 40 percent will be imported; all of the nonskilled labor will come from the local labor force.

4.b. For the temporary mine shutdown option, the only difference in work force will be that an estimated 80 percent of the skilled and semiskilled workers will come from the local area, instead of 60 percent for the no mine shutdown case. The additional local workers would be drawn from among the present Domtar employees.

5. Annual salary estimates for the three categories of workers are:

| | |
|---|---|
| Specialists | $15,000 - $25,000 |
| Skilled/semiskilled | 15,000 - 20,000 |
| Nonskilled laborers | 10,000 - 15,000 |

6. Most of the major construction tasks, including the underground development of the new mine and construction of the three shafts, would be worked by at least two shifts, but more likely three shifts per day. Thus, the maximum number of workers actually working at one time would probably not exceed 150 or so (and will be somewhat lower for the mine shutdown option).

7. The new salt mine to be constructed at Cote Blanche will have the same production and employment characteristics as the existing operation; thus, there will be no long-range dislocation of employment, or changes in revenue to the state and parish.

8. Oil will be transported to and from Cote Blanche by barge. Approximately 15 workers (3 skilled and 12 unskilled) will be required during transfer. Only the skilled workers will come from outside the local area. During standby operation, three men will be required to operate the facility.

9. Socioeconomic impacts expected to occur as a result of developing the Cote Blanche Mine for crude oil storage are similar to those

expected at nearby Weeks Island and will occur within the same local and regional areas. If both sites are developed, the impacts will be additive including, to the extent that development follows the same schedule (as planned), peak employment, layoffs, and traffic.

4.2.7.1 Land Use

Site Changes

Land-use changes on Cote Blanche Island will result from the salt mining activity being relocated to provide for the proposed oil storage. The facilities associated with the oil storage will occupy a portion of the space now used by Domtar Chemicals Inc. Appproximately 20 acres of land are expected to be disturbed by the development of the new salt mining facilities. Most of this land is in forest or semicleared pasture and is presently used for cattle grazing. The removal of these 20 acres from grazing activity is not considered a serious economic impact. Another 20 acres will be used for aboveground oil storage equipment and the enlarged barge slip. This land is either presently cleared or is disrupted marshland adjacent to the existing barge facilities.

No legally designated areas of open space or recreation would be affected by the project.

Peripheral Changes

Changes in land use outside the immediate construction area on Cote Blanche Island will be minor and possibly nonexistent. Elsewhere on the dome, the only use being made of the land is for cattle and sheep grazing; this can continue unaffected. Beyond the dome, other than the possibility of some new or temporary housing in Lafayette or Morgan City, there will be no direct land-use changes associated with the project. No new industrial development will be stimulated by the project.

4.2.7.2 Transportation Impacts

Impact of construction on local traffic will depend on the amount of material that must be transported to the site by surface routes and upon the scheduling of construction of the oil storage facility and the replacement mine. Most heavy equipment and materials will probably be transported by barge rather than by rail or highway.

For the option of no mine shutdown, the construction work force will average about 240 workers (25,000 man-weeks/103 weeks), although the total will be 300 or more for 63 weeks and 350 or more for 40 weeks. Because of multiple shifts (at least 2 and more likely 3 shifts per day) there should not be more than 150 to 175 workers entering and leaving Cote Blanche at any one time.

For the option of temporary mine shutdown, the work force will also average about 240 workers (20,000 man-weeks/83 weeks), although the total will be 200 or more for the entire 83-week period. Because of multiple shifts (at least 2 and more likely 3 shifts per day), there should not be more than 125 workers entering or leaving Cote Blanche at any one time.

The road system in the area is primarily two-lane highways; the island is accessible only by ferry. The expected increase in traffic may be as much as 75 to 100 vehicles for each shift. This increase would not significantly affect local traffic conditions, except at the ferry where passage would become extremely slow. This effect may be mitigated by providing bus transportation for construction workers from one or more towns along U.S. 90, and from the ferry to the project site. Alternatively, staggered shifts and/or car pooling could reduce peak commuting congestion (see section 5.2). Should the mine be closed down temporarily, 60 fewer workers will be commuting to the site, thus reducing potential transportation problems.

Some increase in barge traffic may be expected from material and equipment transport, but this will be insignificant compared with the existing traffic on the Intracoastal Waterway.

4.2.7.3 Population and Housing Changes

Population

Tables 2.3-1 and 2.3-2 summarize estimates regarding the number of workers required during the course of project construction and estimates of the number that will be imported from outside the local area for the two cases of no mine shutdown and temporary mine shutdown, respectively. As many as 140 workers will be brought into the area at any one time for the no mine shutdown case. For the temporary mine shutdown option, only 80 workers would be required from outside the local area (Table 2.3-2).

Since the construction period will be completed in 2 years or less, it is anticipated that few, if any, of the imported workers are likely to move into the area on a permanent basis with their families. Thus no significant population changes are expected.

Housing

There is a general housing shortage in St. Mary Parish where some of the imported workers may seek temporary housing. This shortage to a great extent is related to the poor conditions of the housing (Joseph Bourg, 1975). In addition, there is little transient housing in the parish. Presumably the greatest portion of the imported work force will want temporary housing in apartments, motels, rooming houses, and trailer parks. Because little is available in St. Mary Parish, it is likely that they will have to go as far as Lafayette, about 45 miles northwest on U.S. 90, or to Morgan City, roughly the same distance to the east. The commuting distance to Baton Rouge, Thibodaux, or Houma is probably too great, even though construction workers typically are used to long distance commuting.

If additional motel units or trailer parks were constructed to meet the short-term need of the construction workers, there could be an adverse economic impact following project completion if the housing demand drops below the supply. The problem of inadequate housing supply could be mitigated if space were provided at the site for trailers and campers and/or if temporary housing were provided (see section 5.2).

Housing shortages created by the temporary residence of Cote Blanche construction workers in the local area will be further stressed by the need for housing that may be created by parallel development of an oil storage facility at Weeks Island, 5 miles to the northwest. If selected, both projects would be constructed at approximately the same time; as a result, shortages will be more critical. It may be necessary for the contractor to provide temporary housing in trailers or other portable quarters at the construction site.

### 4.2.7.4 Economic Impacts

Tables 2.3-1 and 2.3-2 present a summary of the estimated average wage of the workers, the total expected earnings and earnings broken down by place of permanent residence of the workers, for the cases of no mine shutdown and temporary mine shutdown, respectively.

Local workers (those who reside permanently within commuting distance) may be expected to spend more of their disposable income in the local area while imported workers who move into temporary quarters for the duration of their employment are more apt to send part of their checks home to their families and/or to save larger parts of their salary.

It is not expected that all of the local workers will be residents of St. Mary Parish. Perhaps as many as half will come from other parishes, especially Iberia and Lafayette Parishes.

The total estimated earnings from project construction are estimated at about $8,000,000 (see Table 2.3-1), or about $4,000,000 a year for the case of no mine shutdown. The disposable income of the construction workers (that portion available for spending after payment of taxes, and Social Security payments) is estimated as 75 percent of total earnings, or an average of $3,000,000 per year. This amounts to 0.4 percent of the three-parish estimated effective buying income of $774,569,000 (Louisiana State University, 1974).

For the case of temporary mine shutdown, an estimated 60 mine workers will be without employment (or underemployed) for approximately 74 weeks. This may reduce the total local earnings by as much as $850,000 ($640,000 in disposable income). Unemployment benefits will partially offset this effect for part of the 74-week period. Even though the remainder of the mine workers will find employment in project construction, there will be an opportunity loss of 60 jobs, representing an additional $850,000 in total earnings to the local economy. Thus, the net economic effect of the project is the difference between the construction earnings ($6.3 million, from Table 2.3-2) and the lost mine employee and opportunity earnings ($1.7 million), or a net increase of $4.6 million in wages (compared to $8.0 million for the no mine shutdown option).

There is also the possibility that the mine owner would have difficulty regaining profitable contracts for salt delivery after such a long absence from the market.

Secondary effects on the local economy will occur as a result of the project. From section 3.9, approximately 1.7 nonbasic (service) jobs are created for each basic job in St. Mary Parish. Since some of the workers are likely to spend a significant portion of their income outside the local area, somewhat less effect is expected due to the temporary nature of project employment. There is still a potential for several hundred induced jobs in the area, however. Should the mine be shut down temporarily, the opportunity for secondary jobs will be reduced by roughly 40 percent (120/300).

All of these economic impacts would be in addition to those caused by the Weeks Island project. Construction employment in the area would be increased as a result of both projects. Should both salt mines temporarily close down, however, approximately 200 jobs would be lost, totaling approximately $2.6 million in earnings during the 1-1/2-year shutdown period. This would significantly reduce the net beneficial economic effect to the local area (see section 4.6).

4.2.7.5 Government Revenue

Under one of the project development options, operation of the existing mine will continue during the construction period. Consequently, existing revenue to local and state government from property and severance taxes would not be affected by the construction phase. Some increase in revenue from sales taxes may be expected as a result of local purchases of supplies and materials and also from purchases by employees. In addition, income taxes levied on construction wages could increase. The magnitude will depend upon the number of employees who will come into the area from out of state and upon the amount by which project employment will increase the incomes of workers now residing in Louisiana.

Under the other development option, salt mining will be terminated for a period of 74 weeks. This would reduce state severance taxes (at $0.06 per ton) by an estimated $110,000 over the 1-1/2-year period.

State and federal income taxes would be lower than for the no mine shutdown option in proportion to the income lost by the mine workers ($1.7 million). Property tax loss during time needed to construct the new mine would total an estimated $26,000 per year (assuming no primary tax payment on the old mine facilities due to federal ownership).

Secondary effects on government revenue for the mine shutdown option would result from concurrent reductions in local purchases of goods and materials. Should similar action be taken with the Weeks Island Mine, government revenues would be significantly lower than with the no mine shutdown option. In both cases, however, there would be a net positive effect from project construction.

#### 4.2.7.6 Aesthetic and Sociocultural Impacts

No significant impact is anticipated on the aesthetic or sociocultural environment from the proposed activity, if no mine shutdown occurs. The existing mine and all of Cote Blanche Island is privately owned and is inaccessible to the general public. It is surrounded by marshland, West Cote Blanche Bay, and the ICW, and is not closely approached by any public thoroughfare. In addition, dense vegetation that covers a large part of the island provides a visual screen for surface activities on the island. Much of the activity will be below the surface, but any surface construction activities would be most visible from the access canal and barge slip or from West Cote Blanche Bay directly to the southwest near shore (Figure 2.1-2). Since industrial activities are predominant in these areas, the area would not be impacted negatively from an aesthetic standpoint.

There are no cultural facilities or activities near Cote Blanche Island, hence no adverse impact. As stated in section 3.8, cultural resource surveys have been conducted and indicate that no adverse impacts will occur to any known archaeological or historical sites.

Should the Domtar Mine be closed temporarily to expedite oil storage, the loss of jobs for local residents would adversely affect the social welfare of their families. Most mine workers are long-time residents of the area and many have worked in salt mining most of their adult lives. Alternative employment would not be readily available in the area and, because of the likely resistance to moving, the workers would probably remain in the area until the mine reopened. Life-styles would obviously be adversely affected during the intervening 1-1/2-year period, though unemployment compensation would partially mitigate both the economic and social effects.

TABLE 4.2-1 Total emissions from site construction (in grams/hour) from the storage facility and pipeline construction

| Pollutant | Emission |
|---|---|
| Particulates | 3,000 gm/hr |
| CO | 34,000 " |
| Hydrocarbons | 4,500 " |
| $SO_2$ | 4,200 " |
| $NO_x$ | 56,000 " |

TABLE 4.2-2 Pollutant concentration 0.5 km downwind from site construction (source area: .25 km x .25 km)

| Pollutant | Federal and State Standards | ($\mu gm/m^3$) | Calculated Downwind Concentration ($\mu gm/m^3$) |
|---|---|---|---|
| Particulate | Annual Mean | 75 | 1.6 |
| | 24-hr max | 260 | 48 |
| CO | 8-hr max | 10,000 | 637 |
| | 1-hr max | 40,000 | 907 |
| HC | 3-hr max | 160 | 99 |
| $NO_2$ | Annual Mean | 100 | 3 |
| $SO_2$ | Annual Mean | 80 | 2.2 |
| | 24-hr max | 305 | 66 |

Note: Downwind concentration of durations greater than one hour was estimated by methods recommended by Turner (1970).

TABLE 4.2-3 Noise created by refrigeration system installation and operation equipment

| Equipment | Number | A-Weighted[1] (per unit) at 50 feet | Sound Level at 500 feet | Usage Factor[b] [1] |
|---|---|---|---|---|
| Installation | | | | |
| Drill | 2 | 98 | 78 | 0.04 |
| Operation | | | | |
| Reciprocating Compressor | 1 | a | a | 1.0 |
| Condenser | 1 | a | a | 1.0 |
| Suction Trap | 1 | a | a | 1.0 |

[a] Total indoor A-weighted sound level 89-102 dB
Assumed attenuation of building -25 dB

[b] Fraction of time equipment is operating in its noisiest mode

(1) "Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-4 Noise created by shaft excavation equipment

| Equipment | Number | A-Weighted[1] (each unit) at 50 feet | Sound Level at 500 feet | Usage Factor[a] [1] |
|---|---|---|---|---|
| Ventilator blower | 1 | 71[b] | 51 | 1.0[c] |
| Air Compressor | 3 | 81 | 61 | 1.0 |
| Truck | 2 | 88 | 68 | 0.16 |
| Mobile Crane | 1 | 83 | 63 | 0.16 |
| Concrete Trucks | 2 | 85 | 65 | 0.4 |
| Concrete Batch Plant | 1 | 83[b] | 63 | 1.0[c] |

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[a] Fraction of time equipment is in its noisiest mode of operation

[b] Dames & Moore files

[c] Estimated

(1) "Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-5 Noise created by pipeline construction equipment

| Equipment | Number | A-Weighted[1] (per unit) at 50 feet | Sound Level at 500 feet | Usage Factor[a] [1] |
|---|---|---|---|---|
| Truck | 2 | 88 | 68 | 0.16 |
| Backhoe | 1 | 85 | 65 | 0.4 |
| Concrete Mixer | 1 | 85 | 65 | 0.16 |
| Welding Machine | 1 | 83[b] | 63 | 0.5[b] |
| Scraper | 1 | 88 | 68 | 0.08 |
| Crane | [illegible] | 83 | 63 | 0.16 |

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a Fraction of time equipment is operating in its noisiest mode

b Estimated

(1) "Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-6 Noise created by barge loading dock construction equipment

| Equipment | Number | A-Weighted[(1)] (each unit) at 50 feet | Sound Level at 500 feet | Usage Factor*[(1)] |
|---|---|---|---|---|
| Pile Driver | 2 | 101 | 81 | 0.04 |
| Trucks | 2 | 88 | 68 | 0.16 |

---

* Fraction of time equipment is in its noisiest mode of operation

(1) "Background Document for Proposed Portable Air Compressor Noise Emission Regulations," U.S. Environmental Protection Agency, EPA-550/90/9-74-016 (October 1974).

TABLE 4.2-7 Summary of sound level contribution from construction activities - estimated at 500 feet from center of activity (dB)

| | $L_{eq}$ | $L_d$ | $L_n$ |
|---|---|---|---|
| Installation of Refrigeration Pipes | 67 | 67 | 67 |
| Operation of Refrigeration System | 37 | 37 | 37 |
| Shaft Excavation | 70 | 70 | 70 |
| Pipeline Construction | 68 | 66 | -- |
| Barge Loading Dock Construction | 71 | 69 | -- |

TABLE 4.2-8 Ambient sound levels during construction (dB)

| | Background Ambient | | | Construction Ambient | | |
|---|---|---|---|---|---|---|
| | $L_d$ | $L_n$ | $L_{dn}$ | $L_d$ | $L_n$ | $L_{dn}$ |
| Center of Site | 66 | 68 | 74 | 73 | 72 | 79 |
| Along Intracoastal Waterway[a] | 59 | 54 | 61 | 60 | 55 | 63 |
| Undeveloped Areas[b] | 55 | 39 | 53 | 56 | 45 | 56 |
| Nearby Noise Sensitive Land Uses[c] | 58 | 39 | 56 | 58 | 40 | 56 |

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[a] Estimated at Ferry Crossing

[b] Estimated at two miles from center of site

[c] Estimated at Village of Kemper

## 4.3 ENVIRONMENTAL IMPACTS OF OPERATION AND OIL STORAGE

### 4.3.1 Impacts on Geology and Mineral Resources

At present the Cote Blanche Salt Mine is owned and operated by Domtar Chemicals, Inc. Salt mine operations will continue in a new location adjacent to the existing facilities at the same level of production and with the same basic methods of operation (section 2.4).

The storage of oil in existing caverns is a well-established technology as evidenced by the historical safe operation of cavern storage of gaseous and liquid petroleum in Europe, Scandinavia, and the United States. The present mine does not have any known faults or leakage into the cavern and, due to the impermeable nature of the salt and the pressures of ground water surrounding the dome, no oil will seep out of the storage cavern. Some minor loss of the mineral salt resource will occur due to the absorption of the oil onto the walls, roof and floor of the caverns (see section 7.5). Likewise, some loss of recoverable oil will occur for similar reasons. In a mixed state, these resources will not be useful for the present market. However, if and when the market values of the salt and/or oil reach levels making recovery of these resources attractive, techniques such as solution mining and distillation processes could be used to separate the oil from the salt and make both of these resources available for use.

As described in section 3.2.6, economically significant mineral deposits on Cote Blanche Island are restricted to hydrocarbons and salt. Deposits of sulfur that characterize the caprocks of some salt domes are absent at Cote Blanche. Also, gravels are of poor quality and are too deep for economic extraction.

Neither the hydrocarbon nor salt resources appear to be threatened, either temporarily or permanently, by the oil storage program. As described in section 4.3.2.2, the existing oil and gas wells are sufficiently distant from the mine workings to eliminate any present or foreseeable interaction between them. Also, traps in the immediate area of the workings appear to have been thoroughly developed, including those beneath the salt plug overhang. Therefore, any further local development associated with the Cote Blanche dome will apparently be around its flanks, well beyond the oil storage area. If further development of the immediate vicinity is deemed appropriate, additional wells can be directionally drilled to safely avoid the workings.

As described in sections 2.0 and 4.2, present salt mining will either be continued without interruption or will be temporarily halted for a period of approximately 74 weeks. Based on current production rates, the mineable resources of the new workings are ample for many more years of production and could include two or more levels above the existing caverns. Because of possible regulatory restrictions, mining may not be possible at levels beneath the storage space until it is no longer used for oil storage. However, after that time, the use of the caverns for oil storage would not deter deeper mining. Therefore, although the vast reserves existent below the present workings will be temporarily unavailable, no permanent impact or other irreversible effect on salt resources is anticipated.

In summary, operation of the oil storage program offers no significant impacts on local mineral resources.

### 4.3.2 Hydrological Impacts

#### 4.3.2.1 Impacts on Surface Water

Water requirements of the existing mine facilities are minimal, limited primarily to sanitary purposes, drinking, and fire prevention. These waters are presently supplied from a single local well, drawn from a deep ground water aquifer. Water requirements for the new mine will be similarly supplied, without impact on surface waters.

#### Cavern Storage

During operation of the oil storage program, which will include both initial filling of the cavern with oil and future withdrawal of the oil during a national emergency (estimated to occur once every 5 years), impacts to the surface water and on water use will be minimal. Domestic water required will be taken from the existing well or from a new well drilled at the mine site.

Since no water will be introduced into the cavern, either purposely or accidentally, any impacts will be limited to the possible effects of accidental oil spills at the surface, described in detail in section 4.3.8.

Surface Facilities (and Pipelines)

During operation the increased barge traffic in the Intracoastal Waterway and access canal may produce some additional erosion of the banks from waves generated by the tugs and barges moving along the Waterway. This erosion could produce higher turbidities and lower water quality in the adjacent surface waters. As present turbidities are already fairly high for similar reasons (Juneau, 1975), biota occurring there are adapted to such conditions and the effect should not be significant.

There is expected to be no discharge of wastes to surface waters on the island. The major potential impact to the surface water is from the possibility of small or large spills of oil at the surface. However, the risk of a large spill is small (section 4.3.8). An oil spill would affect the surface water quality, but, as there are no other human uses of this water, the impact is important primarily to biological resources in the spill zone. This aspect is discussed in detail in section 4.3.8. Frequent small spills, if occurring with greater than expected frequency at both Weeks Island and Cote Blanche, could have a cumulative effect on the water quality in the area.

Flooding

As indicated in section 3.3, the 100-year return flood level at Cote Blanche is predicted to be +11.6 feet MSL, with maximum wave runup of +20 feet MSL. The major surface facilities are located at elevation +37 feet MSL and will be unaffected by any conceivable storm water level. (The shallow waters of the bay prevent the propagation of major tidal waves along the coast.) The barge platforms and lower portion of the pipelines (buried) will be subject to flooding. Also, barge traffic will be required to vacate the area well in advance of an approaching tropical storm. Under storm conditions, the oil transfer pipeline will be flushed of oil to prevent any possibility of oil release if the line is ruptured.

4.3.2.2 Impacts on Ground Water

New Salt Mine

Impacts of the new mine on the ground water at Cote Blanche Island will be negligible. Present ground water use at the existing mine is small and will not be altered at the newly constructed mine.

Cavern Storage

Despite a hydrostatic head of several hundred feet, the mine workings are dry, illustrating the virtual impermeability of the salt. The mine and its shafts presently compose a hydrologically closed system, unconnected to the local or regional ground water regimen. Therefore, any future effects of oil storage on ground water will require an alteration of existing conditions.

The following paragraphs evaluate the various plausible changes. In summary, the only realistic situation recognized that might possibly impact ground water would involve shaft collapse and associated rupture of intake and discharge pipes. However, this hazard would be small and can be mitigated by filling the sump to the level of the pipes with water, thereby creating a water seal (see section 5.2).

As described in section 4.2, none of the modifications to the mine interrelate with the ground water system. Furthermore, the absence of water inflow makes disposal of untreated oil-polluted water that indirectly could affect ground water unnecessary. No situations are perceived which involve purposeful pumpage of waste oil or untreated polluted water from the workings to the ground water system during storage. Therefore, any potential impact would involve a loss of the integrity of the mine and/or its appurtenant structures resulting in an accidental outward migration of oil. Such migration requires both a driving force and a passageway. Potential driving forces consist of either buoyant uplift by insurgent ground water or pressures induced by decreased available volume. Decreased volume could possibly result from temporary overpressures from barometric fluctuations, tidal gravimetric changes, earthquake-generated seismic pulses, long-term plastic mine closure, or intrusion by water or gas. The small volume changes due to barometric, tidal, and seismic causes as well as those associated with plastic mine closure will be accounted for in establishing the size of the unfilled space in the workings, in accordance with standard engineering design practice. Therefore, the remaining possible significant driving forces are water and gas inflows.

Mining and other past explorations at Cote Blanche indicate that significant amounts of water and gas do not occur within the salt plug. Therefore, the only passageways that appear pertinent to water and gas influx are those that extend beyond the boundaries of the salt. Potential man-made avenues include shafts, other intake and discharge pipes, and oil and gas wells. Other potential passageways that have been considered are fractures created by accidental explosion, faults reactivated by earthquakes, and a possible upward growth of a rubble chimney that could result from mine collapse.

As shown on Figure 2.2-2, all wells within the confines of the storage area are bounded by a 150-foot buffer zone of impervious salt. The figure also shows that all other wells in the vicinity as well as the new mine workings, are separated from the oil storage space by much greater distances.

The cavern geometry, past mine experience, and the apparent present stability of the mine indicate that massive collapse that could cause a rubble chimney is virtually impossible. The ratio of working heights to pillar spacings indicates that any substantial collapse would arch a short distance above the present roof. This distance would be approximately that of the working widths, or about 50 to 70 feet. Such a collapse height is of little significance compared to the hundreds of feet of impermeable salt that exist above any possible collapse. Consequently, any conceivable roof collapse could not result in a passageway for oil to migrate from the dome to the surface or to ground water aquifers.

There is no likelihood of significant explosion-induced fracturing. As mentioned in section 4.3.8, the possibility of an underground explosion is very remote. That section further shows that should an explosion occur, its maximum overpressure would be no higher than 150 psi, or less than 20 percent of the lithostatic pressure on the storage space. Because of the very low flame velocities associated with oil explosions, the high relative confining pressures of the rock column are sufficient to preclude cavern expansion and associated fracturing. Inflow from reactivated faults is also not a consideration at Cote Blanche, simply because of the absence of such faults in any of the workings.

Therefore, the only passageways recognized as potentially pertinent to water or gas inflows are intake, discharge and vent lines in the shafts and the shafts themselves. Since no evidence for the presence of significant amounts of gas is known in the sediments above the salt in the vicinity of the shaft, then potential impacts are reduced to those involving water inflows, occurring within the shaft and its appurtenant structures.

Potential sources for water inflows through the shaft are twofold: either from the surface, in the form of flood water, or from prolific ground water. The first possibility is prevented by the presence of the collar seal and shaft plug, shown as a construction modification on Figure 2.3-3, and by the elevation of the shaft opening and lack of surface flooding potential. The sole remaining potential impact, then, involves shaft collapse or leakage in the soft saturated strata above the salt, where the amounts of water inflow could likely be quite voluminous, probably enough to entirely fill the shaft in a few hours. If, in turn, the pipes through the shaft plug are broken at or above the plug, then water in the shaft would be free to mingle with any oil in the ruptured pipes, and sink into the mine, allowing upward migration of oil into the flooded shaft. However, once enough water enters the cavern to fill the sump up to the bottom of the pipes, no more oil can escape from storage. Therefore, the total amount of oil escaping the caverns would be that displaced by the few tens of barrels of water required to partly fill the sump.

Once in the shaft, the oil lacks a driving force to migrate any further. As described before, none of the aquifers above the salt are artesian. The water level in the shaft would rise to the natural water table, about 40 feet below the shaft collar, and thus cannot impose a surface oil spill hazard. The worst result would be minor local oil intrusion into aquifers that may be bared by shaft lining failures. Once the shaft water reaches the water table, the hydrostatic heads of both the aquifer and the shaft will be equal and the water flow from such an aquifer will cease to drive the oil/water mix upward in the shaft. For the same reason, the oil will not significantly penetrate the aquifer. Even this remote and volumetrically minor threat can be eliminated by adding a closure mechanism to the pipes below where they pass through the shaft plugs. So designed, no plausible means have been recognized to suggest that oil storage will significantly affect the ground water regimen.

Pipeline and Surface Facility Operation

As described in section 4.3.8, the possibilities of a large surface spill are remote. Furthermore, adverse effects of such spills on ground water are considered to be even more remote; if they were to occur, the effects would be restricted to the locale of the spill. Because of its density, oil of any spill at the surface could percolate no deeper than the water table or to some higher impervious layer. Although lateral migration could then occur, leading possibly to eventual seepage into the marshes around the island, the ground water regimen would remain unaffected.

Waste Water Discharge

There will be no significant discharge of waste to the ground water. Sanitary wastes from the operating personnel will be routed to a septic tank system or to a portable chemical treatment facility.

### 4.3.3 Impacts on Air Quality

The largest potential effects on air quality associated with the proposed oil storage operation at Cote Blanche are hydrocarbon and $SO_2$ emissions resulting from leakage, venting and flaring of vapors during transportation of oil.

#### 4.3.3.1 Leakage from System Piping and Flaring of Gases Displaced from the Storage Cavern

Some small leakage may occur from the system of pipes, manifolds, and valves at the site during filling and withdrawal of the oil. Leakage of this kind will be tightly controlled in accordance with standard practice and thus be of small consequence. Odors from these small spills will not be noticeable except in the immediate vicinity of the leaked gases or oil.

As described in section 2.3.3, flaring will be conducted at the surface outlet of vent pipes, which will be sunk to the cavern chamber. Flaring will occur only during the filling process. The main purpose of this flaring will be to prevent the volatile oil fractions from collecting in the upper atmosphere of the chamber and in the vicinity of the above-ground facilities, thus reducing the explosive hazard potential. In addition to reducing the explosive potential, flaring will reduce odors emanating from the caverns by converting the hydrogen sulfide gases into odorless sulfur dioxide (see Appendix F) and will also reduce hydrocarbon emissions by converting the vapors into $CO_2$ and water vapor.

Estimates of leakage and flaring rates from the mine have been made and are presented in Appendix F. Hydrocarbons in the amount of 150 pounds per day (lbs/day) (0.80 grams per second) and hydrogen sulfide in the amount of 0.15 lbs/day (0.0008 gm/sec) are expected to be lost from leakage during pumping. Fifty-one lbs/day (0.27 gm/sec) of $H_2S$ would be emitted from an unflared cavern, and 100 lbs/day (0.53 gm/sec) of $SO_2$ will result from flaring the displaced hydrogen sulfide vapors.

Concentration estimates were made of resulting downwind vapors under the assumption that flaring of vapors will be emitted at a height of 20 meters and pump leakage will be released at ground level. The concentration estimates were made using methods recommended by the U.S. Environmental Protection Agency. These estimates are very conservative in that they assume a ground level concentration under "F" stability (unstable) conditions and a wind speed of 2.0 meters per second. In addition, no allowance was made for wind variability. Figures 4.3-1 through 4.3-3 show the estimated downwind concentrations. The concentrations of $SO_2$ on Figure 4.3-1 are based on 0.53 gm/sec of emissions from flaring. The concentrations of hydrocarbons (Figure 4.3-2) result from pipe system leakage; therefore, a ground release mode was assumed. The $H_2S$ concentration on Figure 4.3-3 would result from the filling of the mine without flaring of displaced vapor.

The highest ground-level concentration of $SO_2$ (Figure 4.3-1) is 8.3 $\mu g/m^3$, which is well below the maximum 3-hour (365 $\mu g/m^3$) and the annual (80 $\mu g/m^3$) concentrations allowed by the state air quality regulations. The concentration of hydrocarbons at ground level is 387 $\mu g/m^3$ at a distance of 300 meters downwind of the site. The hydrocarbon concentration exceeds 160 $\mu g/m^3$ (the 3-hour primary standard) as far as 500 meters downwind, then drops to negligible levels further from the site (Figure 4.3-2). The state of Louisiana air quality regulations do not permit any emission of hydrogen sulfide from storage facilities. The $H_2S$ concentrations indicated on Figure 4.3-2 would occur only if gases vented from the storage cavern were not flared.

It should be emphasized that the concentration estimates represent the worst case under the most conservative meteorological conditions. The concentration profiles with distance downwind indicate that no significant interaction is likely with similar releases from an oil storage facility at Weeks Island 5 miles to the northwest.

4.3.3.2 Hydrocarbon Vapors Emitted During Oil Transport

Another source of air pollutants associated with the proposed oil storage facility will be hydrocarbon vapors emitted during transportation of the oil to and from the storage cavern. Based on the transport mode described in section 4.3.8, hydrocarbons would be primarily released during the following activities: a) transfer of oil between VLCC and tanker in the Gulf of Mexico just south of the mouth of Southwest Pass, Mississippi River (estimated at 0.03 percent of oil lost for each transfer direction); b) transfer of oil between tanker and inland waterway barges in the Mississippi River near Venice (estimated at 0.032 percent lost for tanker-to-barge, and 0.016 percent for barge-to-tanker transfer); c) transfer of oil from storage cavern to barge at Cote Blanche docks (estimated at 0.018 percent lost; insignificant hydrocarbon vapors are emitted during transfer from barge to cavern, due to flaring); and d) "breathing" losses in transit by barge and tanker (estimated at 0.006 percent lost for two days transit between VLCC and storage site). These rates are calculated for a crude oil having the properties listed in section 2.3.2 (i.e., Reid vapor pressure of 3 psi and density of 0.893 at 60°F). Evaporation losses are proportional to true vapor pressure and density of the crude oil (EPA, 1976). Vapor condensation or blowback systems at the transfer points could reduce these losses substantially (section 5.0). It is unlikely that VLCCs would be used to transport oil to refinery centers. However, VLCCs estimates are included for the purpose of worst case analysis.

In terms of equivalent barrels of crude oil, the hydrocarbon emissions from uncontrolled evaporation of oil during the lifetime of the program (5 fills and 5 withdrawals) are estimated to be: a) 81,100 barrels for transfers in the Gulf of Mexico; b) 64,800 barrels for transfers in the Mississippi River at Venice; c) 24,300 barrels for transfers at the Cote Blanche barge docks; and d) 16,220 barrels for emissions in transit between the Gulf and the storage site. Approximately 51 percent of the emissions would occur during the five withdrawal periods which extend over a total of 750 days; the remainder would occur during the five cavern fill periods which extend over a total of 1590 days. Thus, emission rates are approximately twice as high during withdrawal as during fill because of the higher oil transfer rates during withdrawal.

Downwind ground level hydrocarbon concentration estimates were calculated for worst case emissions due to oil transfer at the site (Figure 4.3-4) and in the Mississippi River at Venice (Figure 4.3-5). These estimates were made for atmospheric conditions corresponding to worst case ("F" stability and wind speed of 2 meters/second) and average conditions ("D", or neutral stability, and wind speed of 3.8 meters/second). A description of the model used to estimate ground level concentrations is provided in Appendix F. Background hydrocarbon concentrations were assumed zero. For purposes of comparison, the primary standard for non-methane hydrocarbons in Louisiana (160 $\mu gm/m^3$, not to be exceeded during any three-hour period more than once a year) is also indicated on the graphs. The Louisiana Air Pollution Control Regulations presently exempt emissions from crude oil sources from regulation.

At the storage site, the ground level concentration of hydrocarbons will exceed 160 $\mu gm/m^3$ as far as 6500 meters (4 miles) downwind under worst case atmospheric conditions (Figure 4.3-4). Under more normal conditions, these concentrations will exceed 160 $\mu gm/m^3$ as far as 2500 meters (1.5 miles) downwind. At the Mississippi River transfer point, concentrations will exceed 160 $\mu gm/m^3$ as far as 11,000 meters (6.8 miles) downwind under worst case conditions (Figure 4.3-5) and as far as 3800 meters (2.4 miles) downwind under normal conditions. Peak concentrations near the transfer sites will be extremely high.

The contribution to atmospheric loading of hydrocarbons due to project operation may be compared to existing emissions in southern Louisiana (EPA, 1976). Currently, hydrocarbon emissions are: in St. Mary Parish, 9676 tons/year; in Plaquemines Parish, 9995 tons/year; in Jefferson Parish (portions of New Orleans), 39,792 tons/year; and in East Baton Rouge Parish, 162,619 tons/year. During maximum periods of project emissions, annual loading rates of hydrocarbons would be: 731 tons/year at Cote Blanche (St. Mary Parish) during cavern withdrawal; 1300 tons/year at Venice (Plaquemines Parish) during cavern fill; 1220 tons/year in the Gulf just south of Plaquemines Parish during fill and withdrawal (if VLCCs are used); and 244 tons/year dispersed during transport of the oil along the Mississippi River and the ICW across southeastern Louisiana during fill and withdrawal. The maximum annual hydrocarbon loading to the region due to the project is, therefore, approximately 2800 tons/year during each fill and withdrawal.

At present, non-methane hydrocarbons and ozone concentrations are quite high in southeastern Louisiana, but the levels of CO, $NO_x$, and particulates (as measured by coefficient of haze) are low. Emission rates of $NO_x$ are greater than those of hydrocarbons throughout most of southern Louisiana (EPA, 1976). Thus, the proposed storage facility has potential for increasing photochemical reactions and levels of ozone in the region during periods of rapid oil withdrawal or filling at the Cote Blanche site.

The Louisiana State Implementation Plan (SIP), revised in 1972 had exempted from regulation the hydrocarbon emission from crude oil storage and handling. At that time the SIP had not been developed to detail projected levels of air quality by region but predicted that all primary standards would be met by 1976. However, because of the high 1 hour photochemical oxidant levels which have been tabulated from 1975 data, the EPA has disapproved the control strategy for attainment and maintenance of the national primary and secondary air quality standards for photochemical oxidants in the Southern Louisiana - Southeast Texas AQCR.

The State has been ordered to prepare and submit by July 1, 1977, a revision containing:

a. All achievable emission limitations that are needed to provide for the attainment of the national standard for photochemical oxidants, and
b. A demonstration of the effect on air quality concentrations of such measures.

If additional control measures such as land use and transportation measures are needed for attainment of the national standard, the State will submit by July 1, 1978:

a. Such measures for attainment of the standard for photochemical oxidants, and
b. A demonstration that the control strategy will attain the standard for photochemical oxidants.

The foregoing revision requirements are currently under review by the Louisiana Air Control Commission; a hearing will be held in March of 1977 to provide its response to the new requirements.

As a result of the current status of the Louisiana SIP, neither vapor emissions from crude oil storage nor those from crude oil transfer operations are regulated at this time. Although it is impossible to predict with certainty if any control measures will be required when the final EPA-approved SIP is promulgated, it is possible to gain an insight into the probable approach which may be taken toward crude oil storage and transfer operations by examining the recently proposed EPA revision to the Texas SIP for the Houston-Galveston AQCR.*

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*"Proposed EPA Revision to the Texas State Implementation Plan," Environmental Reporter, Current Developments, Volume 7, Number 29, November 19, 1976, 1065-1083.

Like Louisiana, the Texas SIP is currently in a state of disapproval because of the inability to meet the primary standard for photochemical oxidents. Furthermore, parts of the Houston-Galveston AQCR have experienced much more severe violations of the one hour standard (both with regard to level and duration) than have been experienced generally in the Southern Louisiana-Southeast Texas AQCR. The new proposal would require controls for previously exempt emissions from crude oil storage tanks. Floating roof tanks are considered by EPA to be the best available control technology. However, regulation of emissions resulting from vessel loading and unloading of crude oil was not specified in the proposed SIP revision.

Another requirement for SIPs to meet the National Ambient Air Quality Standards (NAAQS) is new source review. The most recent ruling from EPA regarding new source review has established the trade-off system.* Under the proposed provision, new sources would be required to show that emissions proposed from the new sources plus SIP-required reductions from existing sources equal a net decrease in emissions. That is, the new source should not delay progress toward achieving the NAAQS in non-attainment AQCRs. The effects, if any, of this ruling on the SPR program remain uncertain at this time.

4.3.3.3 Emissions from Barge and Tanker Pumping Operations

Other sources of emissions to the atmosphere are the barge and tanker engines. Engine exhaust produced during transport of oil along the ICW and Mississippi River have been disregarded because these pollutants are dispersed over a 250-mile long waterway. Emissions produced during transloading at the Cote Blanche barge docks and at Venice have been estimated since these emissions are essentially continuous point sources during fill and withdrawal.

At Cote Blanche, the maximum rate of barge emissions will occur during cavern fill. Assuming an average of 3.4 barges offloading in 7 hours each per day, calculated emissions are: 4.4 lb/day particulates,

*"EPA Draft Preamble to Interpretive Ruling on New Source Review Requirements," Environmental Reporter, Current Developments, Volume 7, Number 29, November 19, 1976, pp. 1091-1094.

8.8 lb/day $SO_x$, 49.0 lb/day CO, 34.7 lb/day HC, 70.0 lb/day $NO_x$ (based on data in EPA, 1976). Emissions in the Mississippi River at Venice due to offloading from tanker to barges are calculated to be: 14 lb/day particulate, 163 lb/day $SO_x$, 2.4 lb/day CO, 0.5 lb/day HC, and 38 lb/day $NO_x$, occurring once every 4 days in batching operations. These emission loads are relatively minor in comparison to existing sources and should have negligible effects on air quality in the area.

### 4.3.4 Impacts on Acoustical Levels

#### 4.3.4.1 Operation Sound Sources

The major sound sources during the operation of the oil storage facility will be material handling equipment such as pumps for filling and emptying the storage facility and for controlling mine water levels. These pumps will be mounted on the surface and driven by electric motors.

Operation sound levels from the facilities described above are estimated from measurements at a similar facility in New York State. This facility is a liquefied propane gas storage plant with similar material handling and processing equipment, the major differences being the use of dehydrators and trucks for transportation. From these measurements, it is estimated that the equivalent sound level contribution from the operation of the proposed facility at Cote Blanche Island to the ambient sound level is 55 dB at 500 feet.

The oil from the storage caverns will be transported by barges along the Intracoastal Waterway to various destinations. Currently, the barge traffic on the ICW within the Acadiana region is approximately 38 per day (see section 3.9), or 1.6 per hour. (Other sections of the ICW may have up to 6 pass-bys per hour during the day.) During the period of filling the storage facility, it is estimated that the barge traffic will increase to an average of 1.8 pass-bys per hour. The proposed facility has a 5-month emptying criterion. In order to fulfill this criterion, it is estimated that 7.2 loads of 25,000-barrel capacity barges per day are required. During this period, barge traffic along the Intracoastal Waterways will be increased to an average of 1.9 pass-bys per hour. The sound level time history of a typical barge pass-by was measured at Cote Blanche Island ferry crossing and is presented on

Figure 4.3-6. The equivalent sound level contribution of a one-barge pass-by is estimated to be 53 dB at 150 feet for 6 minutes.

4.3.4.2 Ambient Sound Levels During Operation

Major activities during the operation of the proposed project will be during the filling and emptying of the storage facility. Continuous filling and emptying will occur for periods of 10 and 5 months, respectively, and is assumed to be required once every 5 years due to oil shortages caused by foreign oil supply interruption. Thus, in 5-year cycles, noise will be generated due to the handling of crude oil and increased barge traffic along the Intracoastal Waterway.

The sound level contribution from equipment operating on the site is estimated to be 55 dB at 500 feet from the center of activity. This contribution is at least 11 dB lower than the existing background ambient sound level on the site. Thus, noise from operation of equipment at the storage facility will not increase the ambient sound levels.

With an emptying criterion of 5 months, the increase in barge traffic is estimated to be 19 percent. However, it is likely that normal traffic levels will be somewhat lower during an embargo. Therefore, the increase in ambient sound level due to the increase in barge traffic should be negligible.

4.3.4.3 Acoustical Impact During Operation

As discussed in the previous section, the proposed facility operation will not increase the existing ambient sound levels. Thus, it is anticipated that there will not be any noise impact because of the proposed activity.

Should traffic levels be further increased by operation of oil storage facilities at Weeks Island or other nearby locations, the frequency of barge noise on the Intracoastal Waterway will increase. However, the duration for maximum traffic levels is only 5 months, and the potential noise impact is not considered to be significant.

4.3.5 Ecological Impacts of Operation

Impacts of normal operations are described in this section; impacts of oil spills are treated in section 4.3.8.

#### 4.3.5.1 Terrestrial Impacts

The major terrestrial impacts of the storage site will begin during site preparation and construction when approximately 40 acres will be required for the oil storage structures and new salt mine, eliminating some wildlife breeding, nesting and forage habitats. The details of this assessment are discussed in section 4.2. Terrestrial impacts during normal operations, other than accidental oil spills (section 4.3.8), and during standby operations will be very small.

Wildlife will return to the outer fringes of the surface facilities after construction is completed. Daily activities of storage operating personnel will be minimal. Public access to the island is restricted by the remote location of the island, the Intracoastal Waterway, and the fact that the island is private property. Road use will be less than that during construction; therefore, road kills of small mammals and birds will be minimal. The peak time for road kills during operation would be when traffic density is highest and young fauna are emerging from their nests. Normally this peak would be during the summer months.

Other impacts on wildlife could be due to poor revegetation or seeding of the construction site and subsequent poor vegetation and wildlife management practices. In areas completely cleared for construction, irregularly shaped areas could be developed and planted with natural herbaceous vegetation or trees (see section 5.2).

The projected noise levels from operation of the site (section 4.3.4) fall within acceptable ranges and should have no effect on the wildlife on Cote Blanche Island.

Some positive effects may occur from the establishment of the new mine site. It has long been known that a very useful habitat to a great many species is that which occurs where two habitat types meet, commonly called the "edge" (Barick, 1945). Such an edge could be created along the perimeter of the new mine site with a possible result of increased diversity in the immediate area. Many species of birds (kinglets, thrushes, quail, and others) as well as rabbits and small rodents would be expected to utilize the increased "edge" on Cote Blanche.

#### 4.3.5.2 Aquatic Ecological Impacts

Operational impact of the storage area on aquatic ecology of the site will be very minimal since there will be little direct influence of the operation on the aquatic resources.

The major aquatic impacts will be from oil spills (section 4.3.8) and from erosional effects caused by barge traffic during operation. Existing background levels of total solids in the water column in the ICW (Wax Lake Outlet) average 520 mg/l. High values of 32,298 mg/l were recorded at Freshwater Bayou (Juneau, 1975). Aquatic biota in the canals are adapted to these higher turbidities. The incremental increase in turbidity and suspended solids in the canal due to additional barge traffic (as much as 19 percent total increase during withdrawal) should not be significant to these organisms.

### 4.3.6 Historical/Archaeological Resources

There will be no impact on historical or archaeological resources as a result of project operations.

### 4.3.7 Impacts on Socioeconomic Environment

The operational phase of the facility will include filling and withdrawal of crude oil, as necessary, and maintenance of operational readiness during storage. During most of the operational life of the project, the oil storage facility will be relatively inactive. Only two or three permanent employees will be needed to monitor equipment and provide general security at the site. Mining operations will continue unaffected.

At approximate 5-year intervals, the oil in the caverns is assumed to be withdrawn under emergency oil supply interruption conditions. As soon thereafter as feasible, the cavern will be refilled with oil. Withdrawal will take approximately 5 months and a total work force of 15. Refill operations will take approximately 10 months and also employ 15 people. Most of the transfer personnel can be drawn from the local work force. Perhaps three supervisory level personnel will be required from outside the local area.

#### 4.3.7.1 Impacts on Land Use

Operation of the oil storage project will not affect land use on Cote Blanche Island or in the surrounding parishes.

#### 4.3.7.2 Impacts on Transportation

Operation of the project will result in an increase of barge traffic on the Intracoastal Waterway (ICW). During 1970, the ICW handled approximately 14,000 vessels in the vicinity of Cote Blanche (average of 38 each day). During normal cavern filling, approximately 3.4 barges will visit the barge slip each day for a 45-week period. Considering each round trip as two vessel passages, and assuming that two barges are transported in tandem by a single tug, there will be a 9 percent increase in average daily vessel pass-bys and an 8 percent increase in annual number of pass-bys.

Under emergency withdrawal rates, there will be 7.2 barges calling at the facility each day. This will increase the daily average traffic level in the ICW over a 5-month period by 19 percent (other traffic may be reduced under these circumstances, however).

The increased traffic will accelerate bank erosion and siltation and will increase noise levels along the ICW (see sections 4.3.4 and 4.3.5). Effect on accident rates is described in section 4.3.8.

The barge traffic described above will be in addition to that caused by the Weeks Island storage facility (see section 4.5) and by any other oil storage sites in coastal Louisiana.

No significant long-term increase in commuting traffic on area highways is expected since the operating staff of the new mine will be approximately the same size as that of the present mine, and the oil storage facility staff will be small.

#### 4.3.7.3 Impacts on Population and Housing

During standby storage operations, the oil storage facility will require only two or three employees. Workers in the existing mine will be employed in the replacement mine at Cote Blanche. Consequently, no significant change in population or housing demand is anticipated. Changes in occupation and income will not be significant either in the regional or local context.

During oil transfer (fill or withdrawal), there will be a temporary employment of 15 workers at Cote Blanche Island. Nearly all of these will come from the local area. Consequently, there will be no significant increase in population, employment, or housing demands either locally or regionally (even with the additional demand caused by the Weeks Island storage facility).

4.3.7.4 Economic Changes

The project with mine relocation at Cote Blanche would have minimal economic effects on the area. Three full-time employees will be required at the storage facility during standby operations. Approximately 15 employees (including 12 unskilled laborers from the local area) will be required for transfer operations expected to be underway perhaps 25 percent of the time (15 months out of each 5 years). A recent study estimates that, in St. Mary Parish, one job in the basic (exporting) sector supports 1.67 jobs in the secondary service sector (Acadiana Planning and Development District, 1974c). Thus, it may be expected that a very small amount of new local secondary employment will result from employment at the oil storage facility. This new employment is a beneficial, but not significant, impact to the local area and is in addition to the employment that would occur as a result of the Weeks Island storage site.

4.3.7.5 Government Revenue

The existing mine will be replaced by a new mine having the same production and employment characteristics. Thus, after the new mine is in full production, the tax revenue generated will be the same as is now produced by the existing mine. It is anticipated that it will take about 1 year to get into full production after the new mine opens; during this year, the salt severance tax may be reduced by one-half the existing amount. This is a significant change but, since revenue from salt severance tax is a relatively unimportant source of revenue to St. Mary Parish and the state, the impact will not be significant. Additional revenues generated by the minimal employment required by operation of the oil storage facility also will not be significant.

The oil storage project will generate an estimated $84,000 in property taxes annually if leased, rather than purchased, by the federal government for operation. Property taxes on the new mine facilities should be unchanged from present values.

4.3.7.6 Aesthetic and Cultural Impacts

An oil spill during the operation of the proposed storage facility would have a negative aesthetic impact along the coastline. However, there is almost no public access to the shores of Vermilion Bay, East and West Cote Blanche Bays, or Atchafalaya Bay. The exceptions would be a recreation area (bathing and fishing, Camp Development) and a small, boating-oriented resort community at the tip of Cypremort Point southwest of Cote Blanche Island on Highway 319. The aesthetic impact of an oil spill in these areas would be significantly negative. However, as indicated in section 4.3.8, there is little chance of a spill reaching these areas. Recurrence intervals of a major spill are calculated to be hundreds of years. The total expected average spill during a complete fill and withdrawal cycle is approximately 545 barrels, 89 of which would occur at the barge dock or storage site and 456 anywhere in the ICW, Mississippi River, or Gulf of Mexico between Cote Blanche Island and the VLCC transfer location. Even if a large oil spill did reach West Cote Blanche Bay from the site, the developed beaches are on the opposite side of Cypremort Point. Normal surface currents would carry the oil toward Southwest Pass, rather than into Vermilion Bay.

Other than possible effects of an oil spill, no significant negative aesthetic impacts are anticipated from the operation of the proposed project. The island is isolated and is situated at a site already significantly altered by man and presently in industrial use.

4.3.8 Impacts Due to Oil Spills and Related Risks

The risks considered from storing oil in the Cote Blanche salt dome are mainly those of accidentally discharging oil into the surrounding marsh-estuarine ecosystem. This risk is considered to begin with transport of the oil to or from the site from some representative distribuof 428 barrels was taken from the same report for tank vessel spills in harbors. If a spill does occur, the chances of different size spill ranges are approximately:

| Barrels | Percent |
|---|---|
| 0-200 | 45.8 |
| 200-500 | 35.0 |
| 500-1000 | 13.1 |
| 1000-2000 | 4.3 |
| 2000-5000 | 1.3 |
| 5000-10,000 | 0.4 |
| 10,000-20,000 | 0.1 |

This distribution is based upon a log normal estimation for the probability distribution of spill sizes. It implies that the chance of having a spill between 2,000 and 20,000 barrels during the life of the project would be about 2.2 percent (1.23 incidents total expected from Table 4.3-1). Most U.S. spills involve less than 200 barrels of oil released.

The location of a possible barge spill could be anywhere between the transloading station (e.g., Venice, Louisiana) and the Cote Blanche barge slip. The two end ports are more likely locations of frequent, small spill accidents; the Intracoastal Waterway or Mississippi River is more likely for high speed, large spills.

4.3.8.2 Oil Spill Risk from Site Operations

Oil spills at loading, unloading, and transfer terminals are generally characterized as small spills, although occurring more frequently than transport casualties. Loading spills are considered to be more frequent and to lose more oil than unloading spills because of the inherently more difficult task of pouring from a large reservoir to a small one (i.e., many separate fill cycles). At Cote Blanche, the comparison is between the cavern filling rate of 85,000 bbl/d, and emptying at 180,000 bbl/d.

The most suitable exposure variables for handling spills have not been well determined from the historical data, although data sets are available from many terminals. Two hypotheses seem reasonable:

1. The frequency of handling spills is correlated to the number of operations undertaken (connects, disconnects or port calls).

2. The size of spills is correlated to how much oil can escape in a representative period of time required to recognize a failure and to shut down the flow.

Unfortunately, many other conditions, such as weather, mix of vessels being accommodated, age and type of equipment, and regulations for reporting spills play a strong role in the spill history of a given terminal. Handling spills are generally classified by:

frequency - spills per loading operation
spill size - average number of barrels
volume fraction lost - barrels spilled per million barrels passing through the terminal.

However, parameters taken from various sets of U.S. data are not necessarily consistent. Characteristic volume loss rates range from 0.5 to 9 x $10^{-6}$ units lost per unit transferred, with the lower range being most applicable to conditions at Cote Blanche, and the upper range representative of open ocean Single Point Mooring buoy (SPM) operation in rough waters. U.S. ports are characterized by the lower values of spill rates. If we consider the following as appropriate for Cote Blanche (conservatively, because of the sheltered conditions):

| | |
|---|---|
| barge unloading | 1 x $10^{-6}$ (cavern filling) |
| barge loading | 2 x $10^{-6}$ (cavern emptying) |

the average volume spilled per cycle would be 81 barrels, or 405 barrels over the 5 cycles estimated for project duration.

Approximately 1080 barge calls are required to fill or empty the cavern (at 25,000 bbl/barge). About 11,000 calls are required over the project duration. If 5 barrels were taken as an average representative spill size for the site, then 16 spills per cycle, or 81 small spills throughout the project would be projected (405 barrels total). This is a frequency of one spill per 135 barge calls. This frequency is low compared to U.S. historical records, which indicate present (1969-72) terminal spills ranging between 1 per 18 and 1 per 60 port calls. It is more likely that the average spill size is smaller, 3 to 4 barrels, and that spill frequency would range between 1 per 60 and 1 per 120 barge calls.

The average spill size and total spillage must be understood as expectations -- averages based upon larger samples than Cote Blanche alone. Therefore, given that a spill has occurred during transfer operations at Cote Blanche, there is a probability distribution for the size. As an approximate estimation:

| | | | |
|---|---|---|---|
| less than 2 bbl | -- 61.6 percent | 20 - 50 bbl | -- 1.0 percent |
| 2 - 5 bbl | -- 22.5 percent | 50 - 100 bbl | -- 0.27 percent |
| 5 - 10 bbl | -- 10.0 percent | 100 - 200 bbl | -- 0.05 percent |
| 10 - 20 bbl | -- 4.5 percent | 200 - 500 bbl | -- 0.011 percent |

Thus the maximum credible spill size from transfer operation at the barge docks is estimated to be 500 barrels. This also means that there is a very small chance that a single spill could exceed the total expectation (for this accident mode) for the life of the project (405 barrels). Historically, a few large spills (5,000 to 10,000 barrels) have occurred during transfer at terminals through negligence. Petroleum was pumped into an open tank and simply ran out into the environment, while no one bothered to look. A routine of rigorous close inspection can avoid spills of this type, which needlessly inflate the average spillage size.

In addition, there is a chance of spillage from the meter farm, the fill lines, and pump housing, considered independently from the docks. Estimation of the chances of a spill from this source requires some correlation of the throughput to that in the entire United States. In the data base, the chance of a terminal spill is about $1.5 \times 10^{-8}$ for a barrel of oil moving into the country through many terminals, refineries, and eventually to market and consumption. For a barrel of oil moving through a filling-emptying cycle at Cote Blanche, a rate of $5 \times 10^{-10}$ per barrel is estimated to be appropriate. This means a probability of 0.0135, or 1 in 74 that a spill would occur during a given fill or withdrawal cycle.

Spills from the terminal after transfer is completed have an historical average size on the order of 1100 barrels, but 300 barrels seems more appropriate for the expected oil storage system size and pumping rates, compared with U.S. averages. An estimated 300 barrels is also the approximate amount remaining in the piping between the cavern and each barge dock during standby.

The total expectation of oil spillage at the site over the duration of the project is:

| | |
|---|---|
| at the barge slip | - 405 barrels, from 120 spills |
| in the pumping/meter facility | - 41 barrels, 1 chance in 7 of spill occurring. |

For each single filling or emptying cycle, expectation of spillage would be 1/10 of the above (five cycles during the project lifetime).

A summary of oil spill accident potential for barge transport, terminal operation, and transfer handling is provided in Table 4.3-1. Also, should a spill occur, the probability of a particular oil volume size range is given in Table 4.3-2. It is evident that very large spills are statistically improbable from the proposed transport system.

Fume and Vent Control

There is a slight risk of toxic gas ($H_2S$) venting during cavern filling. The residual of hydrogen sulfide gas remaining after shipment of a sour crude from Middle East sources, transshipment, and barge loading, should be negligible. However, it must be considered that a batch of fresh sour crude might unaccountably arrive for storage, in which case some hazard could be present. Combustion of the vented gas out of the cavern through a piloted flare, as planned, eliminates even this extremely remote hazard risk.

Diking

Petroleum facilities frequently use a containing berm around facilities to contain small spills. The high rainfall in the area would likely cause the enclosed section to pond full, eliminating its effectiveness. The risk of a meter farm spill at the facility is so low, compared with the expectation in the barge docking slip, that it is more effective to make the slip the primary enclosure to prevent spreading of spilled oil into the surrounding marsh. Diversion dikes would likely be used in preference to enclosure dikes, thereby limiting or channeling the downhill spread of fluids from pipe ruptures (see mitigating measures, section 5.2).

Fire Losses

The incremental increase in risk of fire from storage at the Cote Blanche site lies almost wholly in the two barge and tanker transport periods -- between arrival in a VLCC and filling a cavern, and the return segment of the trip to the Gulf off Southwest Pass. While the oil is in storage, it is virtually insulated from major loss by fire. At the site, fire resulting from a pump failure would not be expected to consume more than the 300 barrels of oil exposed at any one time in the piping system. In a barge casualty, the maximum amount of oil which might be consumed by fire (100,000 bbl or the contents of two barge tows) is greater than the maximum credible spill. In a collision of barges, all the cargo might be burned, but only a portion of it is likely to be spilled. Fire occurs only in a small fraction of spills and casualties. The total expectation of spillage from inland waterway barge casualties was estimated at 526 barrels over the life of the program, and the expectation of loss from fires is a small fraction of that. Thus, fire constitutes a negligible source of hazard for the program.

Storage of crude oil at Cote Blanche increases the necessary oil handling steps for the oil involved before it is eventually consumed. To that extent, there will be minor incremental risk of injury to barge operators and loading facility personnel, and an even smaller exposure gain for storage facility personnel. The likelihood that the exposure would have an expectation of a single severe or fatal injury over the life of the project is slight. Quantification of an estimate is complicated because most of the exposures to personnel working in the petroleum industry are unrelated to the specific situations to be encountered in the program.

### 4.3.8.3 Oil Spill Risk From Gulf of Mexico and Mississippi River Transport Operations

Movement of oil to and from the barge transfer station at Venice, Louisiana, might occur by several possible modes. The source and destination of crude oil to be stored at Cote Blanche is not known with certainty at this time. The transportation mode assumed for this analysis consists of offloading from VLCCs (very large crude carriers) to small tankers or sea barges in the Gulf, and a second transfer to inland waterway barges at Venice. During an oil supply interruption, oil would be withdrawn by the same method. Oil spill risks calculated are summarized in Tables 4.3-1 and 4.3-2.

#### VLCC Transfer in Gulf

Sea barges (17,000- to 25,000-barrel capacity) might be used to move oil between the VLCCs in the Gulf (at depths of approximately 90 feet) and the vicinity of Venice on the Mississippi River. Spills during transfer operations are estimated at $3 \times 10^{-6}$ units per unit transferred, or 81 barrels for each cavern fill or withdrawal (810 barrels for 5 complete fill/withdrawal cycles). Based on data for similar operations, spills will occur an average of once in every 18 transfers, which is 60 spills averaging 1.35 barrels each if 25,000-barrel sea barges are used.

Because of the relative scarcity of available sea barges in the Gulf, a more likely mode of transport would be to use small tankers (e.q., 45 MDWT). This mode would require only 89 trips per fill or withdrawal (compared to 1080 for the barges). Spill volume during VLCC transfer is estimated to be the same as for barges (rate of $3 \times 10^{-6}$, or

81 barrels); fewer spills are expected to occur, however, and the average size would be about 16 barrels (because of greater pumping rates and line sizes).

Given the occurrence of a spill, the chance of a particular size range for tanker transfers is given in Table 4.3-2. Large spills (more than 200 barrels) have less than a 10 percent chance of occurring from this mode during the life of the project.

The maximum credible spill size associated with this accident mode is estimated to be 1000 barrels. This is twice the size considered for transfer operations inshore because pumping rates are greater and sea-state conditions are more hazardous.

Transport Between VLCC and Venice

Transport of oil between Venice and the VLCC involves approximately 28 miles of travel in the Mississippi River (via Southwest Pass), and 4 miles in the Gulf of Mexico. For sea barge transport, a spill rate of $1.4 \times 10^{-10}$ incidents per ton-mile (the same as for inland waterway barges) yields an estimated 0.0184 spills per fill or withdrawal (1 chance in 5.4 over the life of the project). For an average spill size of 428 barrels (again, the same as for inland waterway barges), the total expected spillage is 79 barrels for 5 fill/withdrawal cycles. The maximum credible spill is considered to be 20,000 barrels, the same as that of inland waterway barges.

For transport by 45,000-DWT tanker, accident rate data are based on different parameters for the two legs of the trip. In Gulf of Mexico waters, the accident rate is considered to be 0.078 per vessel/year. Approximately 89 trips would be required to transport 27 million barrels of oil; the total vessel transport time is estimated at 303 hours (0.035 yr.). Average spill size is taken to be 1111 barrels (J. J. Henry, 1973). During the life of the project, the total number of expected spills is therefore 0.027 (1 chance in 37), and total expected spillage is 30 barrels. In the Mississippi River, tanker spill incidents occur at a frequency of $268 \times 10^{-6}$ per trip; average spill size is only 428 barrels (from the same data set as used for barges) because of the lower speed conditions. During the life of the project, therefore, the total number of tanker spills in the Mississippi River is 0.239 (1 chance in 4), and total expected spillage is 102 barrels. The maximum credible tanker spill is considered to be 60,000 barrels (see Table 4.3-1).

Given the occurrence of a spill, the chance of a particular size range is given in Table 4.3-2. Large spills (more than 2000 barrels) have less than a 3 percent chance of occurring with tankers, and even less of a chance with sea barges.

Transfer in the Mississippi River

Transfer to and from 25,000-barrel inland waterway barges is expected to take place while these vessels are anchored in the Mississippi River near Venice. Total spillage is estimated at $3 \times 10^{-6}$ units per unit transferred ($2 \times 10^{-6}$ for onloading plus $1 \times 10^{-6}$ for offloading), or 81 barrels per fill or withdrawal (810 bbl over the life of the project). Spill frequency is estimated at once in 72 onloadings, and once in 120 offloading (i.e., once in 45 transfers). Using sea barges, this yields an estimated 24 accidents averaging 3.4 barrels each per fill or withdrawal; using tankers, the estimate is 13 accidents averaging 6 barrels each (see Table 4.3-1).

Given the occurrence of a spill, the chance of a specific size range is given in Table 4.3-2 for barge-to-tanker transfers. Spills greater than 200 barrels have less than a 10 percent chance of occurring.

Maximum credible spill size for oil transfer operations in the Mississippi River is considered to be 500 barrels, the same as for transfer at the Cote Blanche Terminal.

4.3.8.4 Summary of Oil Spill Risk From Oil Transport Operations

From Table 4.3-1, it may be seen that the maximum credible spill size and the largest expected average spill are associated with tanker (60,000 barrels maximum; 1111 barrels average) and barge (20,000 barrels maximum; 428 barrels average) transport. The largest expected total spill volume and most frequent spill incidents are associated with the transfer of oil between vessels in the Gulf and in the Mississippi River at Venice (1620 barrels total; 180 spills). The total oil spillage expected during five complete fill/withdrawal cycles is 2724 barrels.

As indicated in Table 4.3-2, very large spills are extremely unlikely. The percent chance of a spill over 2000 barrels during the life of the project may be calculated by multiplying the expected number of spill incidents during the life of the project from Table 4.3-1 and the percent probability of spills greater than 2000 barrels, given a spill occurs, from Table 4.3-2. These percent chances with barge transport, tanker transport, and at the terminal are 2.8 percent, 2.8 percent, and 0.1 percent. There is no significant chance of such a spill occurring during transfer operations.

4.3.8.5 Oil Spill Risk From Cavern Storage

Oil storage in an ordinary petroleum tank depends upon the walls, roof, and floor of the tank to form an impermeable barrier to migration of the oil. Should the barrier be broken, gravity or pressure forces would provide a mechanism for migration of the oil onto or into the surrounding soil. In cone roof tanks, the roof forms an imperfect barrier, and evaporation provides a mechanism for migration into the environment.

The risk of loss of oil to the environment from underground storage involves the same two factors, both of which must be present: loss of impermeability in the confining walls, and a mechanism for oil migration. In salt dome storage, the massive salt structure is generally impermeable, except for the entry shaft which has been cut for access. Gravity forces in the oil itself, as a mechanism for migration, are replaced by another concern: upward displacement of the oil by a heavier fluid, such as ground or surface water.

Review of Features of the Cote Blanche Mine Affecting Oil Spill Risk

The Cote Blanche salt deposit is a piercement dome rising from deep evaporific salt beds. The top of the dome is at approximately -400 feet MSL. The salt mine has been excavated at a single level between -1290 and -1370 feet MSL by the room and pillar method. Horizontal extent of the mine is about 3000 by 4500 feet. Width of the salt dome at the mine level is about 6000 to 7000 feet. Oil and gas deposits have been extracted from the deep flanks of the dome, and some of the wells pass through the mine working, separated from the mine void in salt pillars of at least 150-foot radius.

The mine is stable and impermeable, with minimal closure due to plastic creep of the salt. Debris (mine equipment and unusable salt fines) has been left in the mine and will have to be secured before oil can be placed in storage. The present shafts will be replaced by a 12-foot diameter pump shaft (unless temporary mine shutdown is selected). Elevations of the present and planned shaft openings are +37 feet MSL or more, which places them above any projected hurricane storm surge and/or wave runup.

The mine is free from inflows of water or gas, consistent with its impermeability, though some moisture condensation from the ventilating air may be found around the service shaft. Consequently, no disposal of effluent from the mine during storage periods is planned. The mine walls have a temperature of 90° to 100°F, compared to surface storage vessel temperatures in the Gulf Coast area of 100° to 110°F.

Cote Blanche Island is nearly surrounded by brackish and intermediate marsh, which has been disturbed by numerous canals dredged during oil and gas well drilling operations (Figure 2.1-2). The Intracoastal Waterway (ICW) passes by the north side of the island, and the waters of West Cote Blanche Bay reach the south side of the island, creating a small bluff at one point. Barge access from the ICW utilizes a connector canal bordering the west side of the island. The connector canal opens onto bay waters but provides no dredged draught for barges. A dock slip has been cut from the connector up to the island close to the mine buildings, permitting salt loading on to barges of 1000 to 2000 DWT (dead weight ton) by a short conveyor (about 300 to 350 feet). Vehicle access to the island is by ferry across the ICW.

Risk of Catastrophic Spills from Storage Cavern

The level of storage is below both surface and ground water. To escape the reservoir, oil must be displaced to the surface or to ground water levels, thence along a pressure gradient to produce lateral migration. If oil reaches the surface, it can migrate running downhill and/or floating on water. If it reaches ground water levels, it may not have a significant pressure gradient for lateral migration, other than local diffusion into aquifer sands.

The primary defenses of the reservoir against water entry are the shaft seal constructed at about 1200 feet below MSL within the salt dome and the room and pillar geometry of the caverns.

Surface Water - The present mine shafts are in Catchment V (outlined in the hydrological description of the island, section 3.3), having an area of about 0.55 square miles and an annual runoff of 1700 acre-feet. This annual runoff is nearly one-half the volume of the mine, and the shaft openings are to be situated near the runoff zone for the catchment. The catchment has negligible surface water accumulation. The average grade is about 1 percent (50 feet in 4000), so there is no chance to develop deep or high velocity runoff. Nevertheless, with such heavy rainfall, sheet runoff from a small area has the potential of placing substantial amounts of water down the mine if no simple precautions are taken. A diversion ditch or a raised berm around the shaft openings is standard practice in such situations to prevent runoff inflow. If the diversion should fail, the shaft could fill with water; the shaft seal will then prevent entry of the water into the reservoir and any displacement of oil. A water column extending to the surface represents a design load criterion of about 400 to 500 psi on the shaft plug. A cover over the shafts will be used to prevent such accumulations of rainwater from collecting over the seal.

The coastal regions of the Atchafalaya Basin are subject to inundation from both freshwater runoff and saltwater hurricane surges. The shaft openings, both present and planned, are at 37 feet MSL or higher elevations. The projected maximum level of inundation, including wave runup, is around +20 feet MSL, well below the shaft entrances (section 3.3). Storm and flood inundation of the shaft can therefore be discounted as a hazard. However, the barge docks and piping below 20 feet MSL are subject to such flooding and also wind-driven waves. The risk of oil spill from the piping as a result of a storm is included in the risk analysis summarized in the preceding section.

A final question on hurricane hazard is whether the storm could catastrophically erode the portion of the island on which the mine and pumping facilities are located. The island is subjected to hurricanes about every 4 years, and has undergone minimal erosion over the past 200 years. The chance of catastrophic erosion over the next 20 years seems remote. However, even if such damage were postulated, it would not present an oil spill risk to facilities other than the surface piping system because there would be no hazard to the cavern seals or cavern structure.

Ground Water Inflow - The impermeability of the salt mass precludes any entry of ground water into the reservoirs except through failure of the shaft seal (i.e., penetration of ground water via a shaft).

Shaft Failure - As described in section 4.3.2.2, the chance of shaft failure, along with possible rupture of the pipes above the shaft seal, has to be considered a potential risk for salt dome oil storage. However, there is little chance of any oil migration from the site following such a failure, so long as the shaft seal over the cavern remains intact. Water could enter the cavern through a broken pipe above the shaft seal. The water will flow down the pipe into the sump, displacing an equal volume of oil up the pipe. When the sump has filled with water to the bottom of the pipe, no more oil can enter it -- a water seal is created. The total amount of oil that could be displaced from the cavern is around 50 to 100 barrels, and this would be contained in the shaft. The water seal is an important passive safety factor.

If the shaft plug should fail along with a shaft collapse, substantial amounts of oil could escape into the shaft. Because of the hydrostatic head of the ground water, the oil could then migrate into the overlaying sediment and to the surface. However, this possibility appears very remote. As shown by Figure 2.3-3, the plug will be situated in the massive competent salt deep within the dome, secure from the solutionary and potentially unstable materials that threaten higher portions of the shaft. Given the shaft plug emplacement environment, coupled with its vital importance, final design of the plug will incorporate necessary assurances against failure. The level of dependability that is achievable by standard engineering practice is best illustrated by the numerous successes of such plugs to contain shaft- and tunnel-emplaced nuclear detonations.

Lateral Cavern Failure - The cavern level is penetrated by several oil wells. Although no connection between the wells and the cavern space exists, the hazard potential of such wells can be examined by hypothesizing such a connection. There is no mechanism to lift stored petroleum up to the surface after leaking into an oil well cavity. If the oil well is inactive, it has been sealed above. Oil might migrate deeper down the well, and be lost, but this would present no evident environmental hazards. If pressurized oil from an overfilled cavern should break into an inactive oil well, the volume escape downhole will act as a relief to the cavern.

The inverse problem, a high pressure well breaking into the cavern, could conceivably pressurize the fluid and tend to force it up the fill and vent lines. If the pressure could blow out the valves, oil would rise from storage, driven by the gas pressure. If the pressure blows out a shaft seal, the gas, but not the oil, would escape up the mine shaft.

This situation is not considered possible with the existing wells, since highest gas pressures will always be encountered at the beginning of recovery from wells. If new deep drilling, or redrilling of existing wells is contemplated while oil is stored in the caverns, then the location of the new wells and the adequacy of the containing walls (inner steel casing and 150-foot radius in the surrounding salt pillar) would have to be examined carefully.

The possibility of any other lateral penetration into the cavern would not be expected to present any escape route for oil to the environment. There are no brine wells on the dome.

Explosions - The explosive range of the air-vapor mixture over crude oil is narrow, but it must be considered reasonable that an explosive mixture could exist in the cavern at some point during a filling and/or emptying cycle. There are no flame ignition sources in the mine, but possible sources can be hypothesized: static electricity (salt being a dielectric), sparks induced by the electromagnetic field of lightning strokes, metallic sparks, spontaneous ignition by temperature or dieseling, some chemical reaction with an unknown piece of debris left in the mine, and so forth. None of these seem possible for the Cote Blanche Mine, although they cannot be ruled out as impossible. The alternatives for safety are either to inert the atmosphere before filling, or to design the mine to harmlessly withstand the effects of a gas explosion.

A gas explosion is characterized by passage of a flame front through the gas volume. As an explosion, the action is very slow, in contrast to the decomposition of an explosive device located at some particular point. The pressure rise through the gas occurs more uniformly, without generation of high energy shock waves. Consequently, the explosion overpressures tend to be low. The devastating effects of other gas explosions arise from the enormous total forces generated over large areas, in contrast to an explosive device that creates a high overpressure suddenly over a localized area.

It has been estimated that maximum overpressure from petroleum vapor explosions may be as high as 150 psi (personal communication, Lindblom). European practice is to design shaft plugs and seals to withstand 10 atmospheres. Rock structures in the cavern would be virtually unaffected by a pressure surge of 10 atmospheres because of the slow rise of the pulse (i.e., fractions of a second, as opposed to microseconds in a dynamite type of explosion).

Transport and Storage of Mining Explosives - There is potential for some risk to aboveground workers and facilities at the Cote Blanche storage terminal as a result of the transport of explosives used in mining salt. Up to 60 tons of ammonium nitrate explosives (amphoprill) are consumed monthly. The explosives are delivered to the site in 20-ton lots by truck across the ferry at the ICW. The amphoprill is stored within the mine under regulations established by MESA. Similar storage would be provided at the new mine. The 300-foot separation between the new mine and the oil storage caverns would eliminate any risk to the oil facilities in the event of an explosion while in storage.

Ammonium nitrate has an explosive power rated at 60 percent of TNT. The peek overpressure one-half mile from the point of detonation of 20 tons of amphoprill would be about 1/2 psi; the maximum velocity of primary fragments generated by the blast would be about 0.3 feet per second

(U. S. Department of the Army, 1969). Personnel and equipment located at the surface within one-half mile of the detonation of the transport truck can be assumed to be subject to damage or injury.

Based on historical data, the accident rate for truck shipments of hazardous cargo is about 1.7 incidents per million vehicle miles (Brobst, 1972). Because of low traffic levels on Cote Blanche Island, the applicable accident rate is estimated at 10 percent of the historical average. Furthermore, ammonium nitrate is difficult to detonate accidentally; at most, no more than 2 percent of the transport accidents at Cote Blanche are projected to result in a detonation (1.5 percent of all accidents in the data base resulted in cargo fire damage). Thus, assuming that each delivery involves one-half mile of travel exposure to the site and that there are 36 deliveries per year, the probability of a detonation of the truck within damage range can be estimated at $6 \times 10^{-8}$ per year, or a recurrence frequency of once every 16 million years (i.e., 1 chance in 770,000 during the life of the project).

The incremental risk to personnel and facilities (above that calculated elsewhere in section 4.3.8) is negligibly small. A detonation at the terminal could destroy the surface facilities, but presents no hazard to the oil in the storage caverns. Furthermore, it is unlikely that a detonation could ignite a barge cargo of oil at the docks.

Personnel exposure to explosives-related risk (other than the present risk to mine personnel) is limited to the few workers present during project operations (15 during pumping, 2 or 3 during standby) and the construction work force (as many as 350) during project construction. Should the decision be made to shut down the mine for a 74-week period during project construction, the personnel hazard would be reduced significantly. Another option would be to clear the area of construction personnel during delivery of the explosives.

#### 4.3.8.6 Noncatastrophic Loss of Oil from Storage

The previous description of catastrophic or sudden oil losses applies as well to small or gradual leaks from storage. For the salt dome, the mechanisms are equivalent, differing only in time frame. However, oil in storage can, under adverse conditions, deteriorate.

A common problem with stored petroleum is growth of bacteria, which is most likely where the oil is in contact with water. Crude oil contains a small fraction of water, most of which is bound in emulsion. In time, some of this water, typically of order 0.1 percent, but under some conditions up to 0.5 percent, may pool at the bottom of the oil. The water tends to be briny, but may solution some salt until saturation is reached. The volume of solutioning would be very slight because so little water is involved.

In salt storage, the saturated brine does not favor bacterial growth, and very little would be anticipated. A small amount of sludge may build up at the salt-saturated brine-oil interface. This sludge will tend to be drawn into the sump during oil withdrawal. A low lip is constructed at the sump to reduce sludge intake. Loss of stored oil due to salt-sludge buildup can be considered a very minor hazard to the stored oil.

The shelf life of the stored oil, even with sludge buildup, can thus be considered to be beyond the expected lifetime of the project.

#### 4.3.8.7 Movement and Dispersion of Spilled Oil

##### Spills at the Site

Land spills at the site could result from rupture of the piping system between the barge slip and pump shaft, in the metering units, or from the booster pumps. The main lifting pumps will be submerged in the cavern, and any major failure in their casing would be confined. The piping system is composed of 10-inch diameter lines. Maximum content held in the system above ground would be no more than 100 barrels per line, or about 150 barrels total for each barge dock, since the pump shaft is close (600 to 1000 feet) to the barge slips. During oil transfer by barge, the site would be manned.

The maximum credible spill size for manned barge dock transfer operations has been indicated to be 500 barrels (section 4.3.8.2). Mechanisms for loss and migration of the stored oil have been shown to be absent. Thus, there is no opportunity for a large area or large volume land spill to occur. A 500-barrel spill can be considered representative for oil movement. The sandy soil, if dry, could be expected to absorb an average of 1/8 to 1/4 inch of oil moving over it (i.e., retain 130 to 260 barrels per acre). However, oil could run over wet sand with much less retention. Once oil has permeated the sand surface layers at the site, there is little reason to remove it, unless later seepage into marsh waters or the barge slip during rainy periods should occur.

The slope at the site is about 3 to 4 percent, which will tend to direct a spill downhill, predominantly westerly toward the barge slip. Although drainage paths to the south are possible, the road system and/or the salt mine operation will probably block that drainage route, which could carry oil into the marsh buffer between the island and bay. If oil should enter the marsh zone, removal would be very difficult. Because of the small amount of oil that could enter the marsh, affecting perhaps at most 5 acres of the 40 to 50 acres in the vicinity, it is likely that the oil would be allowed to weather and degrade naturally.

A number of factors dictate against the necessity and cost of a protective dike and containment reservoir around the surface piping. The slope of the site, the high annual rainfall, and the requirement of siting the reservoir at the bottom of the slope next to the barge slip mean that a relatively large and costly dike and water runoff handling capability would be needed to protect a rather small exposure. Furthermore, spills into the water from the barges and docks (much greater expected spill volume, section 4.3.8.2) would not be mitigated by such a berm. In fact, diverting southerly runoff from the piping area into the barge slip by ditches along the site access roads may be a practical method of limiting the areal exposure of land and marsh at the site (section 5.2).

Maximum credible spills into the water at the barge slip, whether by runoff from the land, or from barge loading operation, can also be represented by spills of the 500-barrel size class. A small spill on the water tends to spread, mainly by surface tension, out to a density of 6 to 12 barrels per acre of water surface. Therefore, an uncontained spill of 500 barrels could produce a slick of about 75 acres. However, the configuration of the barge slip is very good for containment. The access barge canal off the Intracoastal Waterway has a shallow water connection with West Cote Blanche Bay waters at the south end, although there is no passage for barges. The barge docks are in a small slip off of this passageway (Figure 2.1-2). Either the dock slip or connector slip can be boomed for containment of oil spills. Traffic on these slips would be exclusively for Cote Blanche Island, either salt or oil storage operations, and could be temporarily halted for cleanup. The spoil banks around the dredged slip provide some barrier to the spread of oil into the marsh zone, although there may be some shoreline sections through which migration of oil standing behind a boom could occur.

Spills of Oil in Transit

The average oil spill resulting from a barge casualty is estimated to be between 400 and 500 barrels. There may be little opportunity to contain a spill along the Intracoastal Waterway (ICW) or Mississippi River before considerable spreading occurs. The surface area of the ICW is about 15 acres per mile, so an oil slick from 500 barrels, at 6 barrels per acre, has a theoretical potential of affecting about 5-1/2 miles or more of waterway. Most of the ICW and Mississippi River has a pronounced spoil bank, which would contain the spilled oil until a natural drainage path is intersected. Such drainage paths are numerous, and the movement of water along them is generally toward the Gulf. Examples are the lower Atchafalaya River, Wax Lake Outlet, Bayou Sale, and the Clarenton Canal in the vicinity of Cote Blanche Island. Many smaller outlets to the Gulf exist along the full length of the ICW in Louisiana. However, most are subject to tidal influence, particularly in the Cote Blanche, Weeks, and Vermilion Bay reaches. The spreading of a small spill may be such that ultimate recovery is rather low, but the areas affected would also be limited and would generally not be ecologically sensitive. The entire ICW, as has been noted, is subject to oil spills; in 1970 the petroleum cargo transported was 70 million tons. The total tonnage of Cote Blanche storage is about 4 million tons. The total tonnage contemplated at Weeks Island, also a potential site for the program and located not far away on the ICW, is about 13 million tons. The added traffic due to the storage siting is not insignificant, but Louisiana oil production is decreasing and normal oil-related traffic should also decrease from present levels.

The movement of a major spill must also be considered. The barge size for Cote Blanche is about 3750 DWT, or 25,000-barrel capacity. Barge tows (actually they are nearly all pushed instead of towed) generally consist of two barges. Total loss from a barge casualty is very unlikely, especially in Intracoastal Waters, because of cargo compartmentalization. To create a large barge loss, rather energetic casualty conditions (strong currents, storms, rocks, or collision speeds greater than those used on the ICW) are generally required. A spill of about 20,000 barrels may be considered as a maximum credible event for a tow accident involving two barge tows (total of 100,000 barrels in the tows). A barge loss of this magnitude has never occurred in U.S. inland waters, nor in international waters, according to the casualty listings through 1972 (MIT, 1974).

The movement of oil from such a spill will vary with the location of occurrence. On the Mississippi River, a slick up to about 10 miles in length would be formed. This could expand further, but rapid cleanup would tend to reduce the size after the first 12 hours. In the Gulf section of the ICW, the spill would be contained in the channel, spreading along the waterway and into the cross passages. Some of it could reach the Gulf through connecting waterways. If it spread into wet marsh, up to 600 acres could be contaminated. This estimate is based upon a typical deposition of 25 barrels per acre for 75 percent of the oil spilled (the condition of near maximum damage for wet marsh).

A spill near the oil storage site along the ICW could reach Cote Blanche, Weeks, and Vermilion Bays. There appears to exist a counterclockwise net flow of water in the Vermilion/West Cote Blanche Bay system, based upon the net ebb tidal flux measured at Southwest Pass, and the net flood tide at other stations to the east. East Cote Blanche and Atchafalaya Bays contribute water flow to the system from the east.

Wind drift is a predominating influence offshore along the Gulf Coast. The drift factor is 3 percent, which means that a wind of 15 knots would move surface waters at 0.45 knots, comparable to many surface water current speeds. Surface currents tend to move with the wind in the Gulf unless shallow water zones are involved. In the event of southerly (onshore) breezes, an oil slick in West Cote Blanche, Weeks, and Vermilion Bays, is likely to be drawn slowly into the gyre towards Southwest Pass and adjacent shorelines. In the event of northerly (offshore) winds, a slick would be pushed there rapidly. In the first case, a shoreline contact in the Marsh Island and Vermilion Parish Wildlife Refuges might occur in about 10 hours. For a northerly wind condition, contact could occur 3 to 4 hours after entry into the Vermilion/West Cote Blanche Bay system. If the entry point is Weeks Bay, contact time would be delayed because surface currents are probably less persistent.

Large spills near Morgan City on the ICW might work into the Atchafalaya River drainage system and thence into Atchafalaya Bay. With onshore winds, a slick could be drawn into the Southwest Pass discharge; with northerly winds, the slick might be dispersed into the Gulf. The time lapse for entry into Atchafalaya Bay would permit considerable cleanup effort and reduction of the slick size before the Vermilion/Iberia Parish Wildlife Refuges could be contacted.

If oil delivery to the site should originate in Western Louisiana or Texas Gulf receiving ports, the primary passageways to the Gulf coast waters would be the major ones -- Galveston Bay, Sabine Pass, Calcasieu Pass, Mermentau River -- and a few smaller bayous. The lock systems would assist in confining the spread of spill on the ICW.

The remaining areas that might be impacted by oil transport spills are the ICW-Gulf Branch (Morgan City to New Orleans), ICW-Port Allen Branch (Morgan City to Baton Rouge) and the Mississippi River (Baton Rouge to Southwest Pass). For the two branches of the ICW, there is a diffuse flow of water towards the Gulf, but it is possible that most spills would be confined to local waterways, lakes, and adjoining marshland.

There is a possibility that a spill of up to 60,000 barrels might occur as a result of a tanker accident in the lower Mississippi River (below Venice) or in the Gulf of Mexico. Oil spilled in this area would be rather quickly carried into the Gulf through one of the passes.

From there, currents could carry the oil in almost any direction, though little of it would be expected to be transported directly to shore.

The triangle area (Baton Rouge, New Orleans, Morgan City) is affected by flood runoff from the Mississippi and Atchafalaya Rivers, but barge transport of oil during damaging flood crests is unlikely. During high water periods (i.e., controlled flood), operation as usual can be expected. Movement of oil spilled then might reach the Gulf Coast, but high water spills are biologically less damaging because of the dilution effect of the flood, increased dispersion from turbulence, and faster moving water (decreased exposure).

The movement of oil spills during a hurricane is most likely to be inland. Transit or barge spills during a hurricane are unlikely, as movements would cease. At the site, the barge docks and lower levels of the piping system could be inundated. If the piping were torn loose, the 600-barrel volume in it could be dispersed into the salt marsh north of the island, but would be very unlikely to get across the Cypremort levee to agricultural land. The dispersion could also be sufficient to dilute the oil exposure below biologically significant levels. Oil will be purged from the pipeline system at the terminal in case of a hurricane to prevent such an incident (section 5.2).

4.3.8.8 Oil Spill Containment and Recovery Plan

Oil Spill Contingency Plans

A Spill Prevention Control and Countermeasure Plan (SPCC) must be prepared by an operator of a nontransportation related oil facility that might be capable of discharging by accident, equipment failure, or operator error enough oil into navigable waters of the United States to create a visible sheen discoloration, subsurface sludge or emulsion, pursuant to the provisions of the Federal Water Pollution Control Act, P.L. 92-500. The Cote Blanche facility, therefore, would be subject to the provisions of these regulations. Departments, agencies, and instrumentalities of the Federal government are subject to the regulations to the same extent as private operators. The purpose of the SPCC is to outline the method of operations, measures and equipment used to prevent spills and to describe available equipment to be used, and the planned program of response, in the event of a spill.

The loading facility (barge docks) must also meet Coast Guard regulations (33 CFR 154) promulgated under Public Law 92-500, for design of hose connections, necessary equipment, sumps, and so forth, emerging shutoff switches, and trained personnel.

Transfer operations must meet Coast Guard rules (33 CFR 156) that define personnel requirements, lighting, communication, use of the equipment, and adherence to procedures.

Barges used for oil transport must meet Coast Guard regulations for spill prevention equipment (33 CFR 155). The construction of barges and their operation come under a large body of regulations, one of which is the Port and Waterway Safety Act (Public Law 92-340). This Act increases Coast Guard authority to: direct vessel movement, prescribe safety equipment requirements, safety zones, investigate accidents affecting environmental quality of navigable waters, and regulate vessels carrying hazardous cargo in bulk.

Inland Rules of the Road apply to the ICW; Western River Rules of the Road apply to the Mississippi River. The Coast Guard has the primary regulatory authority for vessel licensing, inspection, and enforcement of regulations.

In the event of a spill, the Coast Guard must be notified (18 CFR 610). Under the National Oil and Hazardous Materials Pollution Contingency Plan, a Regional Response Team headed by an On-Scene Coordinator (OSC) will take steps to assure that the best and most appropriate cleanup measures are taken. The operator of the facility involved in the spill is primarily responsible for cleanup efforts. The OSC may authorize the use of various cleanup agents, sorbents, or other chemicals, if they can assist in cleanup efforts without increasing ecological stress or damage. If the parties responsible for the spill do not or cannot undertake adequate cleanup (or if the spill should be large enough to warrant widespread concern), an emergency strike force may be organized to commit available manpower and equipment resources to the containment and cleanup effort.

If wastewater or treated wastewater should be discharged from the Cote Blanche storage facility in the future as a result of an alternative mode of pipeline operation (replacing the barging operation), then the Procedures for the National Pollutant Discharge Elimination System (NPDES) might apply to the facility (40 CFR 125, as amended), under Public Law 92-500, Sec. 402 and 405. Specifically, if flushing of the meter lines and cavern fill lines during standby is instituted, then it will be necessary to either discharge the flushing water, or to store it in the cavern. In view of the volume of the necessary flush water supply (about 150 barrels per line) and rust inhibiting chemicals used to protect the pipes, storage of this waste in the cavern would be feasible.

The Complete Spill Prevention Countermeasure and Cleanup Plan does not have to be prepared until the facility begins operations. For purposes of the Environmental Impact Statement, it is sufficient only to outline the elements of such a plan and the efficacy of cleanup technology pertinent to the spill risk associated with Cote Blanche storage. This outline is provided below:

Facility Spills

SPCC guidelines provide that where experience indicates reasonable potential for equipment failure, appropriate containment and/or diversionary structures or equipment to prevent discharged oil from reaching a navigable water course should be used, including:

1. Dikes, berms, and impervious retaining walls.
2. Curbing.
3. Culverting, gutters, or other drainage systems.
4. Weirs, booms, or other barriers.
5. Spill diversion ponds.
6. Retention ponds.
7. Sorbent materials.

In the following discussion, and elsewhere in this assessment, the barge slip has been viewed as the primary point of oil spill defense. Because of the downslope of the terrain on Cote Blanche, and the extremely heavy rainfall at times, berms, dikes, and ponds are deemed subject to frequent overflow, rendering them useless in retaining oil in an unmanned facility. However, if all runoff (including spilled oil) from the facility is diverted into a permanently boomed section of the barge slip (or a connecting enlargement of it), the oil could be retained. The critical element here is to substitute underflow (under the boom) for overflow to allow escape of runoff water. The retaining area should have sufficient boom height and depth to contain the maximum anticipated spills.

In the event of a spill, the soil (unless saturated with water) would tend to absorb some of the crude. The primary concern here would be secondary contamination of water runoff or ground water. If the area runoff is diverted into a boomed containment area, secondary surface contamination from absorbed oil would also be diverted to the containment area.

Cavern filling and emptying operations should not require installation of an oily water treatment system at the site since no water seeps into the salt cavern. Oily wastewater from barge operations and cleanup of spilled oil could be stored in a sump tank (not an open pond), and subsequently be transported from the site by barge to an existing onshore separation facility. The presence of the large petrochemical industry throughout southern Louisiana means that certified receivers are available at the large oil barge terminals. If the capacity of the sump tank is exceeded, barges can also be pressed into service to remove the recovered oil and water.

Loading and Unloading Spills

The SPCC plan for barge dock operations would involve a two-fold approach: 1) operation of the facility by a "Dock Operations Manual", which specifies the physical equipment, oil transfer procedures, emergency procedures, and inspection routine to detect faulty equipment, poor connections, errors, and leaks; 2) response to a detected spill according to an "Oil Spill Contingency Manual", dealing with stopping the outflow, containment, cleanup, and guidelines for communication with local, state, and Federal response teams.

The elements of the preventive plan include:

1. Containment of Leakage - During cargo transfer, containment of leakage will be accomplished by using fiberglass spill prevention decks

placed under loading manifolds, sump tanks of adequate capacity, portable drip-pans for any hose connections not over the spill prevention deck, and motor driven block valves, closed when not in use.

2. Emergency Shutdown Capability - This procedure shuts off all pumps and closes all valves. Activation switches are located at accessible locations on the dock, and a portable switch is placed on board the barge. The system must be capable of instantly stopping the barge pumps, and must also have a locked manual override to close the system during a power failure.

3. Personnel and Training - Adequate numbers of personnel must be on hand during operations to ensure safe operation, and to assist in emergency containment routines. Operators designated "persons in charge" should have at least 48 hours' experience in transfer operations and pass oral qualification examinations. Any language barriers between boat and dock supervisors must be resolved. The use of the Cajun language on the barge and/or docks should be no problem, since all persons speaking Cajun are usually also fluent in English.

4. Cargo Transfer Procedures - These specify the placement, linking, and handling of hoses and/or loading arms to avoid excessive wear, pulling strain, ruptures, kinking, and so forth. Use of quick-connect devices and latches is generally limited or prescribed. Important aspects include the conduct of a transfer conference between the dock operator and the barge operator, and use of a checklist to ensure procedure compliance. From the standpoint of spill avoidance, and especially, large spills, inspection routines of the area on a regular, frequent basis are significant. Other regulations establish lighting standards, equipment specifications, record-keeping, and so forth.

5. Equipment Maintenance Program - Equipment service and life is documented; regular pressure and stress tests are conducted; bolt and coupling flanges, coupling seals, and gaskets, are examined for wear, abrasion, and so forth.

Staffing or having available competent, trained personnel for positions that are not permanent - i.e., which last only for a filling or emptying cycle - may be difficult. Training of personnel hired would have to be emphasized. During emptying cycles for strategic drawdown, it could be assumed that personnel would be available from the petroleum industry. Much of the regional labor pool in the area has some familiarity with petroleum-type equipment as a result of earlier drilling and oil field activities.

The elements of the cleanup plan would include:

1. Inspection for Leaks - The area must be lighted, and frequent, regular inspections of the water must be made. If reliable automatic detection devices become available, provision would be made for their use.

2. Containment of Spilled Oil - The most effective spill containment device is the rapid deployment boom. One boom should be located at each end of the dock to isolate both barges; a boom or rubber air dam should be available to close off the entire slip. A skimming device, which can operate in the slip, should also be available at the site. For very small spills contained around a single barge, sorbent material could be used, although a skimming device would be preferable. The skimmer should be able to deliver collected materials to a sump tank, either by direct hose from the barge slip or from a holding tank.

3. Response Mobilization - Nearly all loading and unloading mishaps would be contained in the barge slip, since no strong currents occur in the canal. If oil should escape the slip closure because of unusual size or wind conditions, guidelines for notifying and mobilizing additional response teams would be followed. Cleanup cooperatives and contractors are discussed in the following section, since these teams are part of the regional response team for oil spills from barge casualties.

Transportation Spills

Spills of oil from barges may occur as a result of barge casualties, i.e., collision, grounding, structural or tankage failure, fire, explosion, ramming (collision with fixed objects), and so forth. Spills could also occur as a result of erroneous discharge - bilge, open valving, testing of discharge engines with improper valve setting, and so forth.

In the event of such mishaps or casualties, the barge operator would notify the regional response team center, and the organization of the National Oil and Hazardous Materials Pollution Contingency Plan would be activated. If the barge operator is unable to obtain sufficient assistance to clean up spilled oil, the On-Scene Coordinator may initiate action directly to implement spill cleanup. All barge operators must have proof of ability to assume financial liability for cleanup costs in order to obtain an operating certificate. Most operators have prior mutual aid arrangements, either directly or through insurors, for cleanup of spills.

Clean Gulf Associates is a cooperative of 30 to 40 companies involved in oil production or transportation in the Gulf coastal area, and specifically the ICW. Clean Gulf maintains booms and shallow draft skimmers for use in bays and the ICW. Member companies have access to the equipment, but must supply the operating labor, beyond the supervisory skeleton crew that provides operational expertise. The equipment can be leased to nonmembers as well, but manpower must be obtained elsewhere. Clean Gulf is located at Venice (eastern Louisiana), Intracoastal City (near the site), and Cameron (western Louisiana). Large equipment suitable for cleanup in Vermilion or Cote Blanche Bays is located at Grand Isle, Louisiana.

On the Mississippi River, a cooperative called Clean River Associates has a capability similar to that of Clean Gulf.

One contractor, Oil Mop, Inc., operates in the Cote Blanche area and can provide both equipment and manpower for cleanup. Other contractural services available in the area include wastewater processing, and disposal of oil contaminated materials. Some of these processors may act as salvors as well to reclaim oil. The Coast Guard has oil recovery equipment on the Gulf of Mexico primarily for ocean-going vessel salvage and spill containment. The Coast Guard could supply a submersible pump to facilitate emptying of a foundering oil barge.

#### 4.3.8.9 Effects of Oil Spills on Water Quality

##### Behavior of Oil in the Water Column

An average crude oil has 30 percent paraffin hydrocarbons (alkanes), 50 percent napthene hydrocarbons (cycloalkanes), 15 percent aromatic hydrocarbons, and 5 percent nitrogen, sulfur, and oxygen-containing compounds. As soon as oil is released to the water environment, weathering begins. The major weathering processes are evaporation, dissolution, emulsification, sedimentation, biological degradation, and chemical oxidation.

Low molecular-weight hydrocarbons and aromatics are the most immediately toxic components of crude oil. Evaporation results in selective loss of low molecular-weight hydrocarbons and aromatics, thus tending to reduce concentrations of the most toxic portions of the crude oil. Also, evaporation causes a surface residue, which has a higher concentration of sulfur and organics and may develop a specific gravity greater than water, especially if silt, clay, or organic particles are suspended in the water and available for attachment. As a result, this portion of crude oil will sink and may physically and chemically affect bottom organisms.

Dissolution in the water column is selective for low molecular-weight hydrocarbons and aromatics as well as some of the nonhydrocarbon components that are more polar. Most of the soluble materials go into solution in a relatively short time, but additional soluble material is produced later from biological and chemical oxidation. The solubility of the normal alkanes ranges from 40 ppm for $C_6$ molecules to 0.01 ppm for $C_{12}$ molecules. For aromatics, solubility ranges from 1800 ppm for $C_6$ (benzene) to 0.075 ppm for $C_{14}$ (amtracene). The proportion of crude oil likely to go into solution in sea water and conversion factors for selected concentrations of barrels per acre are presented in Tables 4.3-3 and 4.3-4, respectively.

Emulsifications, which are crude oil globules in water columns, are dispersed easily by currents and, it is believed, eventually dissolve or sink to the sediments after contact with suspended solids.

Sedimentation of oil is encouraged by evaporation and dissolution of the lighter weight fractions and by contact with suspended sediments and organic material. Close to shore, contact with suspended solids is likely during periods of high runoff or stormy weather, which disturbs bottom sediments. Sedimentation also can occur as a result of bacterial masses in the oil slick.

Bacterial degradation can occur to almost all crude oil fractions. But normal alkanes are attacked preferentially, and aromatics are least preferred. A supply of nitrogen, phosphorus, and oxygen is needed. In areas where oxygen concentrations are low, biodegradation is a slow, long-term process.

Expected Effects of Oil Spills at Cote Blanche

Crude oil spills (major or minor) are the only significant potential impact to the surface water quality of the environment during the operation of the oil storage facility. Crude oil spills may occur in different locations: at the shaft area, along the pipeline, at the barge slip, and during barge transportation along the Intracoastal Waterway.

A spill from the pump station or along the pipeline will behave as follows, depending on the amount of the spill: move as overland flow generally toward the west side of Cote Blanche Island and into the marshlands, bayous, and barge slip waters around the port area; infiltrate into the top soil; evaporate, and remain on the ground as a sheet cover. The portion of the crude oil spill remaining as a sheet cover on the ground will likely be removed. Minor volumes of crude oil that infiltrate into the ground are unlikely to affect ground water because of the depth to water table.

The impact of a crude oil spill on surface waters of Cote Blanche Island will be negligible. There are no perennial streams and no surface water usage. Also, there is no water body that will be affected by an oil spill in this part of the Island (see section 3.3.3.1, Watershed V).

Oil spills at the port area during normal meteorological conditions will be localized in the barge slip, access canal, or Intracoastal Waterway, due to low flow velocities in the water. Most of it will evaporate or be recovered. Some part of the crude oil will sink directly to the bottom. There is only limited potential for lateral spreading. Depending on the bottom currents, lateral movements of 30 to 3000 feet have been observed several months after spills in open waters.

Oil spilled on the water's surface will initially spread under gravitational, viscosity, and surface-tension forces. The rate of spreading because of these forces will be a function of the initial chemical characteristics of the oil and the physical characteristics of the slick, e.g., viscosity, specific gravity, slick thickness, and so forth. The rate will also vary with time as weathering or degradative processes act on the spilled oil. In addition, surface currents and surface winds will transport the slick away from its point of origin.

Because surface currents within the area of interest are relatively weak and surface winds in excess of 30 to 40 feet/second (15 to 20 knots) are not uncommon, wind drift may often be the dominant factor in oil spill transport. Surface currents can be expected to be strong only in restricted waters (narrow channels), such as Southwest Pass; in other areas, water current speeds will probably be slower than 2.0 feet/second (1 knot). Nevertheless, the weak tidal currents in combination with the net fresh water inflow into the bay system will gradually draw the surface slick towards Southwest Pass (Figure 2.2-1).

The wind effect alone will cause a surface slick to move roughly downwind with a speed equal to about 3 percent of the surface wind speed. Slick movement with, for example, a 35-foot/second wind will be about 1.0 foot/second (0.6 knot). Oil released under those conditions into the relatively open waters of either Vermilion Bay or West Cote Blanche Bay may therefore contact the shoreline to the south in a period of time on the order of 10 hours. Tidal currents will increase or decrease that time period depending on tidal phase and spill location within the area of interest.

A spill occurring near shore may find its way into local circulation patterns, contact the shoreline in a short period of time and be carried over large areas of marshland on a rising tide; containment and cleanup would be difficult under such conditions.

The various combinations of spill sites, wind and wave conditions, and upland discharge conditions create a wide and complex range of oil spill effects, many of which may be mitigable by oil spill response efforts.

Any oil spill occurring in the inland waterways (e.g., Atchafalaya River, Mississippi River) will affect domestic or industrial water users, if any, for a period of time depending on the size of spill and the average flow velocities in the stream. Any water body affected by oil spill cannot be used for drinking purposes, without extensive filtration and oxidation. Most of the oil handling operations on the Mississippi River occur below New Orleans and do not pose a threat to water supplies.

4.3.8.10 Ecological Impacts of Oil Spills

Relative Vulnerability of Organisms

An oil spill in the West Cote Blanche Bay or Intracoastal Waterway will affect aquatic and terrestrial resources by changes in water quality and by direct oiling of vegetation, substrate and individual organisms. Aquatic life may be considered in two general categories with regard to the effects of oil pollution: 1) organisms of the water column, including fish, plankton, and invertebrates; and 2) organisms primarily utilizing the bottom, including benthic invertebrates and fish. Terrestrial impacts are most likely to occur to vegetation, to birds and to mammals. Each of these categories will be discussed below in separate sections.

Plankton - Plankton are comprised of those organisms that have limited mobility and hence are subjected to the movements of the water column. These organisms include temporary members of the zooplankton (eggs and larvae of benthic organisms and fish) and organisms that are planktonic during their entire life cycle (permanent plankton).

Phytoplankton and zooplankton make up the vast majority of primary producers and consumers in open Gulf waters. They are also important to the food web in coastal bays.

Plankton cannot easily escape adverse conditions because of their limited motility; however, they do have some capability of vertical motion, which may allow them to avoid potentially toxic substances.

Populations of phyto- and zooplankton that are part of the permanent plankton have short reproductive and life cycles; thus, unless extensive areas are denuded of populations or toxic materials persist in the environment, the effects are likely to be of short duration.

Zooplankton that are temporary residents of the plankton community often have much longer life cycles. These forms are the progeny of mature benthic organisms and larger invertebrates of the water column and, in time, will develop into new generations of adult forms of these organisms. Generally larval and juvenile forms are more sensitive to toxic substances than are adult forms. Extensive mortality of these organisms can affect the adult populations for several years. Species of particular commercial importance are shrimp and blue crabs (section 3.6.5.3).

Research reports show that plankton are affected primarily by soluble portions of oil, although they are known to ingest very small globules of emulsified oil. These reports are based on laboratory studies; most field studies have shown little to no effect of major spills on plankton.

Benthic Populations - Populations of benthic organisms generally have low motility and are highly dependent on the substrate for attachment or cover. Many feed on detritus, although the full range of trophic levels is represented. Clams and oysters are commercially important benthic organisms occurring in the vicinity of the site. In the event of an oil spill, these benthic organisms will be susceptible primarily to loss resulting from oil sinking and accumulating on the bottom substrate. The effects are incurred by direct smothering and by rendering the substrate unsuitable for many of the bottom organisms.

Effects on subtidal life from sinking oil can be expected. But specific conditions that influence the amount of oil sunk and its distribution over the bottom will be prime elements in determining the magnitude of effects; effects will be a function of the size of bottom area covered, the thickness of the covering, and the duration of cover until a normal substrate returns.

Fish and Other Nekton - In considering the effects of an oil spill on adult life stages of fish and other nekton, two categories are appropriate: 1) those species of the upper water column; and 2) those living on or near the bottom. Many species of fish in the upper water column are fast swimmers such as sea trout, bluefish and members of the tuna family. Little is known about this group since most work has been done with bottom trawls, which do not yield comprehensive data on species of the upper water column. Commercially important bottom species include flounder, catfish and drum (Table 3.6-16).

Oil may affect fish life by: 1) release of toxic portions of oil dissolved into the water column; 2) physically coating gills (or blowholes of marine mammals) with oily residue; 3) reducing oxygen levels; 4) ingestion through the food web of prey animals that were oil contaminated; or 5) loss of habitat or food supply.

Because fish of the upper waters are highly mobile and range widely, direct oil effects by toxicity or coating of gills is not considered to result in significant loss. Bottom fish are not as mobile and may be dependent on local benthos populations for food supply. Direct toxicity or oil coating effects are unlikely with these species as well.

In the open bay area, restriction of oxygen diffusion is not significant because the oil slick is moving and will not suppress oxygen diffusion for long time periods in one area.

Sinking oil could add to the BOD of bottom waters and lower oxygen levels in these areas. Fish and larger nekton would depart areas of low oxygen and thus the net effect would be to temporarily reduce bottom habitat and food supply for these forms.

Some research indicates that tainting of the flesh in fish occurs when they are subjected to oil-polluted waters. This has occurred directly and through concentration of hydrocarbons in the food web (Louisiana State University, 1975).

The conclusion reached from previous field studies is that fish kills generally occur only in enclosed water bodies. Any effects of significance to a population are likely to be from secondary effects, i.e., through mortality of larval and juvenile life stages in the plankton or reduction in food supply.

Vegetation - The main vegetative community that is likely to be impacted by an oil spill is the marsh, due to its proximity to the barge traffic in the ICW. Marsh plants are susceptible to oil damage with the actual impact depending on several factors. The factors include:

1) species and age of plants; 2) time of year and whether the plant is in a dormant or active-growth stage; 3) amount and type of oil; and 4) degree of weathering of the oil. Vegetation is damaged primarily by direct toxic effects of dissolved oil fractions entering the plant and by physical coating of the plant. Certain oil fractions can enter the plant at point of contact and others can penetrate through stomata, which are pores utilized during gaseous exchange. Once within the plant, oil travels within intercellular spaces and reduces transpiration and translocation by blocking the intercellular spaces as well as stomata. Heavy oiling can effectively block gaseous exchange through stomata from the outside and thereby disrupt the plant's metabolic mechanism.

In general, marsh plants are more vulnerable to damage from oil when they are in the active growing stage. This is understandable, since during periods of new growth and reproduction, the plants have accelerated metabolisms that demand increased amounts of nutrients, sunlight, and other necessary elements; when metabolism is disrupted or the plant deprived of essential elements, the plant is affected almost immediately. The growing season for southern Louisiana is quite long; averaging 317 days (Kniffen, 1968). While the most active period of growth probably occurs during the spring and summer months, it appears that marsh plants are vulnerable to some degree during a large portion of the year.

Submerged aquatic plants in the shallow waters of the nearshore bays could also be coated with oil. This is not likely because an oil slick would normally not be stationary long enough for significant amounts of oil to sink through the water column.

Avifauna - Bird mortalities from oil spills are well documented in the literature and are among the more visible biological effects of large oil spills. The primary factors influencing the impacts on bird life are: 1) the particular species involved and their habits; 2) the time of year; 3) the reproductive capacity of the species involved; and 4) the location, size, and duration of the oil slick. Direct causes of mortality include oil destroying the waterproofing and insulating properties of feathers and ingestion of toxic fractions, either on food or while preening. Once a bird is fouled with oil, its chances of survival are usually 20 percent or less (Boesch and others, 1974). Indirect impacts on birds can occur when food or roosting or nesting sites are contaminated with oil, thus making an area uninhabitable.

The area around Cote Blanche is characterized as nearshore rather than offshore; a larger number of birds are potentially susceptible to oil damage in the nearshore area. Gulls, terns, and many species of diving ducks frequent the inshore area of West Cote Blanche Bay. Estimates of population densities are not available. Site specific effects are estimated in succeeding sections on Effects of Chronic Oil Pollution and Effects of a Maximum Credible Spill. These species frequently congregate in large numbers to form floating "rafts" where they rest and feed on fish and bottom fauna and flora. In such a large gathering, these birds are quite vulnerable to fouling from an oil spill, especially if one should occur during the night when the spill is not as obvious and the birds are resting. Wading birds (ibises, herons and egrets), shore birds (plovers, sandpipers, rails, and killdeer), and fishing birds (terns, black skimmers, and the brown pelican) may easily become fouled should they encounter a slick while feeding.

Obviously those birds most vulnerable to oil damage are those whose habits bring them into contact with the water medium.

Mammals - Mammals most likely to be affected by an oil spill are marine mammals. Very little is known of oil effects on these mammals, but oil ingested by a mammal while feeding or cleaning would be potentially harmful.

Furbearing mammals such as muskrat, mink, and otter would experience loss of insulation upon being fouled with oil. These mammals depend more on fatty deposits than fur for insulation and the resultant loss of insulation would not be quite as serious as with birds. As with birds, any loss of food or habitat due to oil effects would be detrimental to those mammals that depend on the marsh and inshore areas for food and shelter.

## Relative Toxicity of Oil and Petroleum Products

It is difficult to assess the total impact of oil on the marine resources in West Cote Blanche Bay since the different types of crude oil have basic dissimilarities of chemical composition and hence have differing effects on marine organisms. When released into the marine environment, actions of wind, waves, air and water affect these oil components and thus affect their interaction with aquatic and terrestrial life.

Crude oil is composed of four basic components, each having fairly distinctive properties affecting living organisms and each being present in different proportions. Paraffin alkanes may affect metabolism and chemical communications in some invertebrates. Cycloalkane hydrocarbons generally affect metabolic processes in animals. Aromatics are the most immediately toxic components of crude oil. Nitrogen, sulfur, and oxygen-containing compounds are similar to hydrocarbons, but little is known about their effects on life processes.

In the event oil is released to the marine environment, a "weathering" process begins. The major processes that react on the oil slick due to atmospheric conditions cause the oil to break up thereby increasing degradation by biological and chemical oxidation. For a discussion of weathering processes, see section 4.3.8.7 and Appendix G.

In summary, oil is harmful to living organisms because it can 1) physically interfere with movement or respiration or habitat availability; 2) release substances chemically toxic to plants and animals; 3) reduce or eliminate food sources; and 4) change behavior patterns through physical or chemical means.

The effects of oil spills in the West Cote Blanche Bay waters are a function of the probability and size of spills, the size of area affected, the value of the affected area in terms of productivity, the duration of effect, or effect on particular species at various stages of their life cycle.

## Biological Recovery

Vegetation - Several studies have been conducted on biological recovery of living organisms following an oil spill. A majority of these studies have dealt with the salt marsh ecosystem as this is normally the first terrestrial community encountered once an oil spill makes landfall. The coastal salt marsh has generally proven to be resistant to many types of environmental stresses. In the case of oil pollution, the marsh has been found to suffer only minimal damage and actually helped alleviate the pollution problem by trapping and holding oil (Boesch and others, 1974). Most studies show that marsh plants survive light to moderate oiling in a single dose with immediate effects being mortality of heavily oiled shoots followed by regrowth from living roots. Multiple dosing, however, can do considerable damage to marsh plants.

Cowell and Baker (1969) report a Welsh marsh, badly oiled after a tanker accident, was virtually completely recovered 2 years later. Studies by Louisiana State University (1975) found Spartina alterniflora to be unaffected when sprayed with unweathered crude oil at the rate of 6.5 barrels per acre. Clipped Spartina was significantly affected by the same application, however. A study by Baker (1969) revealed that weathered crude actually stimulated growth of salt marsh grasses. This was probably due to the release of nutrients from the oil and oil-killed vegetation.

The rate of recovery for the marsh area will depend upon local conditions, season of year when impacted, amount and type of oil, and type of grass. From the literature, it appears that about 2 years will be required for the marsh to recover in northern climates and probably less in the warmer Gulf areas. In the marsh areas, the presence of abundant organic material, nutrients, and microbial organisms will provide conditions favorable to degradation, whereas on sandy beaches the time required for degradation will be considerably longer.

Avifauna and Mammals - Recovery of avifauna and mammals depends on the degree and type of initial impact. Direct oiling effects are usually recoverable if not immediately destructive. Secondary effects on food supply are cumulative and potentially more serious to whole populations if frequent spills occur. Recovery of populations of birds and mammals heavily impacted by an oil spill usually depends on migration of individuals from adjacent areas. Reproductive times are on the order of years.

Plankton - Most field studies have shown little to no effect of major spills on plankton; however, effects have been shown by laboratory studies. Boesch and others (1974), determined that no major effects were discovered on the zooplankton, but some effects were noted on the phytoplankton after the Torrey Canyon spill. No effects were noted in studies of plankton in Louisiana waters following an extensive leak from a crude oil drilling site (Louisiana State University, 1975).

The rate of recovery for plankton populations is very rapid, usually a few weeks since they have short life cycles and high reproductive rates. Recovery in affected areas is also aided by transport of plankton populations by surface current patterns.

Benthic Populations - Benthic organisms are not very mobile and thus would be susceptible to loss resulting from oil sinking and accumulating in the bottom substrate. The effects are incurred by direct smothering and rendering the substrate unsuitable for many organisms.

Louisiana State University (1975), reported that a release of 50,000 and 100,000 barrels of oil over a 4-month period affected benthic populations by reducing the species number and diversity.

In the event of a spill, up to 25 percent of the oil will evaporate, dissolve or sink to the bottom, covering it and making it unsuitable for organisms. The rate of recovery would vary with the actual conditions including bottom type and amount of oil spilled, but it is estimated that the time for complete recovery for benthos would take 4 years in the immediate affected area.

Fish and Other Nekton - An oil spill will not cause a significant loss to fish and other nekton since these organisms are mobile and may avoid the affected area. However, a spill may render the habitat unsuitable for fish and other nekton; especially, fishes that remain at or near the bottom may be temporarily subjected to losses of food supply and habitat, proportional to benthic losses as described in the previous section. Recovery for these species is dependent on repopulation of the benthos or finding suitable food supplies elsewhere.

Seasonal Factors Influencing Oil Spill Damage

As has already been stated, coastal Louisiana has a very mild climate and a long growing season. Plants that are actively undergoing the reproductive growth stage are especially susceptible to any outside influence that will disrupt the plant at this stage. Therefore, an oil spill would normally have more permanent effect on marsh vegetation if it occurred during the spring or early summer than if it occurred during late fall or winter. However, if the oiling is heavy enough to smother the root system, effects might be more severe in late winter when less aboveground growth is present to absorb the oil.

The fall and winter months are the seasons when migratory waterfowl utilize the coast of Louisiana. Since water fowl are especially affected by oil spills, these seasons would be the period when a large number of birds could be killed by oil.

Mammals would experience greater direct mortality from oil contamination during the colder months due to the greater likelihood of dying from exposure should they lose insulation from being covered with oil.

An oil spill during the spring and summer would not be without consequence to mammals. Marsh animals would be actively raising young during this time and would depend on certain habitats for denning sites and food for themselves and their young. Any loss of such habitat would be detrimental to the population growth in that area and may actually have a more far-reaching impact than if the spill had occurred during the colder months and directly affected more individuals.

Similarly, if an important waterfowl feeding area is affected during the growing season to the extent that it cannot recover for 1 or more years, waterfowl that could be supported by this area must compete for food elsewhere, thereby overpopulating adjacent areas and lowering the carrying capacity of the region.

An oil spill that occurred during the reproductive season for fish and other nekton would have a more permanent effect than in a non-reproductive time. As already stated, fish and other nekton utilize the inshore marsh areas for reproductive purposes, and this may be directly related to effects of an oil spill in the marsh area. Also, planktonic stages of nekton are extremely susceptible to oil toxicity. Thus, an oil spill would have more permanent effect on nekton if it occurred during the spring of the year than other times.

Ford and St. Amant (1971) stated that peak movement of shrimp into the Louisiana bays and marshes occurs between January and April for some species and June for others; thus, an oil spill of magnitude during these critical times could be locally very significant to the commercially important shrimp populations.

Effects of Chronic Oil Pollution

Certain small amounts of oil can be expected to spill or leak during the loading and unloading operations at the barge slip area. These could occur from minor accidents while maneuvering the barges and from leaks in the pipelines used for transporting the oil.

Terrestrial Organisms - Chronic oil pollution in the barge area and along the pipeline will probably have a negligible effect on terrestrial life. Vegetation around the barge slip is presently minimal due to frequent disruptive activity. Vegetation along the pipeline from the barge slip to the pump shaft is presently in a somewhat disrupted state having been cleared during salt mining acitivties and allowed to revegetate naturally. The result is very sparse growth of salt tolerant species such as myrtle. Assuming frequent chronic oil spills of a barrel or less in size, we can assume from past studies that the vegetation found on the pipeline route would experience loss of productivity of up to 25 or 30 percent (Mackin, 1950). The average total volume of oil expected to be spilled during transfer operations for one complete emptying of the dome is 54 barrels. If half this volume were spread along the pipeline right-of-way, the effect would be a loss of productivity along the pipeline of up to 100 percent. The total productivity loss might be less than an acre of sparse vegetation for a 2-year period. As stated previously, however, this vegetation does not provide high quality wildlife habitat or food supply.

It is likely that some birds may occur at the slip and along the pipeline. It is doubtful that many birds would be present during the actual loading or unloading stages due to activity in the area. The area of chronic spillage would be so small that birds could feasibly avoid the oil and would therefore not be impacted. Some deaths may occur from the oil, but these are expected to be very few and certainly nothing significantly above normal attrition rates experienced in unimpacted areas.

No effect is expected on mammals in the area. Whatever rabbits occur in the area may lose the use of the sparse pipeline vegetation due to chronic spills, but this loss is negligible when compared to that available in surrounding habitat.

Aquatic Organisms- Certain amounts of oil can be expected to spill or leak during loading or unloading operations (estimated to total approximately 80 barrels during a complete fill/withdrawal cycle. Because of the nominal size of the spills (3 to 4 barrels each) and projected cleanup potential and dilution, little to no effect attributable to small spills is expected on fish, plankton or benthos except possibly in the immediate area of the spill. The effects on fish and plankton resources would be so small as not to be measurable, though localized death of a few individual fish might occur. Effects on the benthos in the immediate barge slip area would be detrimental, depending on frequency of occurrence, but these would be of no regional, or even local, significance. Benthic organisms are not abundant in the barge slip, access canal, and ICW because of frequent dredging and boat traffic.

Bach and others (1974) concluded that no large-scale effect on aquatic life in the Gulf has resulted from the oil industry, and GURC (1974) indicated that no negative effects on aquatic life have been observed in the Gulf due to oil released from drilling activities.

Effects of a Maximum Credible Spill

Barge Accidents - A maximum credible spill resulting from the sinking or heavy damage to a barge tow while in transit to or from Cote Blanche is expected to be 20,000 barrels. For estimation of impacts, it is assumed that 10 percent or 2000 barrels would evaporate and another 10 percent would dissolve in the water column or become heavier than fresh water and sink. A minimum of 50 percent of the remaining 16,000 barrels could be assumed to be recovered under normal weather conditions. This is a very conservative estimate, considering the rapid identification of such a spill and the ease of getting men and equipment to the area. The result would be that a maximum of 8000 barrels could eventually enter the surrounding marsh or wetland environment. Once again, this is a conservative estimate due to the small potential for oil in the waterway to reach vulnerable wetlands due to the presence of elevated spoil banks along most of the ICW.

A review of the literature reveals that no study presently predicts 100 percent damage to the terrestrial environment at concentrations of less than 25 barrels per acre. Much higher concentrations are normally needed to cause 100 percent loss of productivity. In order to be conservative, however, we can assume that 25 barrels per acre of fresh crude oil will result in total loss of vegetation within the affected area for at least 2 years. With this assumption, therefore, it would appear that the 8000 barrels could effectively eliminate productivity on 320 acres of marsh for that period.

Bird and mammal mortality from a spill within the Intracoastal Waterway would be very small. The traffic in the waterway is so frequent that it is doubtful that many animals use the area. If the oil were to reach the marsh, however, some animals would be impacted. Marsh birds such as herons, egrets, and snipe would be the group of birds most likely affected. No numerical values can be estimated due to the lack of data on present populations in the area. The secondary effect from loss of 320 acres of habitat would be more significant to the bird populations of the area. Viewing the region as a whole, however, it is doubtful that the loss of 320 acres would be especially important for the 2 years involved for regeneration. This is particularly true since the predicted occurrence interval of a 10,000 to 20,000-barrel spill is on the order of 15,000 years and the potential impact area could be anywhere within a 220-mile long section of the ICW and the Mississippi River.

The loss of habitat would also be the greatest impact to mammals. Estimates of carrying capacities of different habitats for game and fur bearing mammals can be used to estimate the maximum number of animals displaced by a maximum credible spill. A maximum of four deer could be expected to utilize 320 acres in coastal Louisiana (St. Amant, 1959). As many as 60 rabbits could be found in 320 acres of prime habitat (St. Amant, 1959) and 640 muskrats could possibly occur in this area of marsh (O'Neil, 1949).

The seasonal factors will determine whether eggs and larvae of fish and larger invertebrates are present and determine what loss will be related to the aquatic biota. The potential for loss of biota in the 320 acres of marshland is insignificant when one considers the overall amount of productive area present and the very slight chance of such a spill occurring.

In the Intracoastal Waterway itself, little is known about the aquatic biota present and the extent that this area is used for the colonization and movement of organisms. It is expected that it is relatively unimportant since boat and barge traffic is fairly heavy; thus the area would not be considered prime habitat for organisms.

The canal servicing Cote Blanche Island has a shallow water outlet to West Cote Blanche Bay at present. Should an accident occur near Cote Blanche or elsewhere on the Intracoastal Waterway near an outlet to the bay, there is a possibility that some oil could reach the bay despite emplacement of booms. The same damage assumptions would apply in this case as along the ICW, i.e., as much as 320 acres of marshland could be removed from production along the northern border of West Cote Blanche Bay.

An area of particular importance when considering an oil spill in West Cote Blanche Bay is the state wildlife refuges at Marsh Island and across Southwest Pass to the west. Normal tides and wind currents indicate that a spill eminating from Cote Blanche would take less than 24 hours to reach Marsh Island. During this time, recovery efforts could most certainly be implemented to recover or disperse much of the oil. Oil spill containment and recovery equipment are available from Clean Gulf Associates at nearby Intracoastal City and from the many oil production platforms in West Cote Blanche Bay (see section 4.3.8.6). Any oil that might reach Marsh Island would have lost much of its toxicity due to the weathering of aromatics and other components.

Storm seas might hamper oil containment and recovery efforts. If a major spill should occur at a point in the ICW (or at the barge slip) from which the oil could move directly to the Bay before cleanup during a tropical storm (an extremely unlikely set of circumstances), a considerable amount of oil, perhaps 18,000 barrels, might get into the bay. Once in West Cote Blanche Bay (or any similar bay), oil movement would be controlled primarily by winds and storm surge, most likely being pushed into the marshes along the north rim of the bay. Some weathering, evaporation, and sinking would occur. Under conditions of no possible recovery, a conservative damage estimate would be 12,000 barrels reaching the north bay marshes, 4000 barrels reaching Marsh Island or another wildlife refuge to the south, and 2000 barrels sinking or evaporating. Using the same damage threshold level of 25 barrels per acre, this situation would result in 480 acres of north bay marsh and 160 acres of wildlife refuge being lost for a period of approximately 2 years. This would be an unfortunate event, but probably not of disastrous consequence to the ecosystem or any particular wildlife population. Repeated occurrences of such spills would be a serious threat to the estuary, but statistics indicate that there is less than a 0.2 percent chance that even one such incident would occur during the project lifetime. Repetition of such an event, especially at the same location, is extremely unlikely.

In addition to the impact on marsh acreage, the portion of the oil penetrating the water column or sinking to the bottom will affect benthos population. Even if organisms within a 750-acre area were totally destroyed, this would be less than 1 percent of the acreage of West Cote Blanche Bay.

Waterfowl are more likely to be affected by an oil spill in coastal bays than in the Intracoastal Waterway, since large numbers of birds could occur in the bay during the fall and winter. Accurate population data on birds using West Cote Blanche Bay (as an example) are unavailable; under worst case conditions, it may be assumed that a significant portion of bird populations in the bay (perhaps 25 percent) could be lost if several thousand barrels of oil reach the marshes or open water.

Tanker Accidents - A maximum credible spill resulting from the sinking or heavy damage to a 45,000-DWT tanker while in transit between Venice and the Gulf of Mexico is expected to be 60,000 barrels. Because of the generally strong currents in this area, most of this oil could reach the passes and Gulf of Mexico before effective spill control equipment could be developed (Figure 4.3-7). Assuming that 20 percent evaporates and 10 percent dissolves or sinks, a potential 42,000 barrels of oil might remain at the surface within the delta or open Gulf waters. Because of the potential for wide dispersal of oil in this area, it will be assumed that a maximum of 50 percent of this oil could be recovered; under storm conditions, no oil might be recovered. Thus, at a density of 25 barrels per acre for complete vegetation mortality, from 840 to 1680 acres of marsh could potentially be lost.

The fresh marshes of the lower delta are prime water fowl habitat, especially to the east in Delta National Wildlife Refuge and the Pass a Loutre Management Area. Also exposed to an oil spill in this vicinity is the Breton National Wildlife Refuge on the Chandeleur Islands to the north (Figure 4.3-7).

An oil spill that reaches Southwest Pass would be carried strongly offshore to the southwest. From there, it should take several days before landfall might occur, and the chances are that the oil would follow the westward-trending current offshore. This is the most likely fate of a tanker spill.

If a spill should occur above the Head of Passes, oil could reach Main Pass, Pass a Loutre, South Pass, or any of several smaller distributaries of the Mississippi River. From these passes, the currents are not very strong, and the chance of immediate landfall in the valuable wildlife refuges and management areas is high. The 1680 acres of marsh that could be lost represent 1.5 percent of the area of the Delta and Pass a Loutre reserves.

Oil Transfer Accidents - The maximum credible spill that could occur at the Cote Blanche site while filling or emptying the storage cavity is 5000 barrels (Table 4.3-1). Assuming that this total amount would be deposited on the land from a pipeline failure, and assuming no catch basins or ditches are utilized, the topography dictates that most of the spill would reach the barge slip, but most would be contained within the spoil banks and would have little impact on terrestrial life. The loss of productivity to the land between the line break and the ship would be of very little consequence to the area.

Assuming a case in which the whole spill reaches the slip itself, it can be assumed that 20 percent of the oil would be lost to evaporation and another 10 percent would dissolve or sink to the bottom of the slip. The remainder would be contained and could be totally recovered from the barge slip area. If not, the 3500 barrels could potentially destroy up to 140 acres of marsh, and spread through the water column and substrate of the barge access canal.

Spills of up to 500 barrels could occur during oil transfer operations at Venice, and up to 1000 barrels in the open waters in the Gulf of Mexico. If the oil should reach the marshes of the Delta, as much as 40 acres of vegetation could be destroyed. These fresh marshes are prime habitat for waterfowl, especially the Delta National Wildlife Refuge and the Pass a Loutre State Waterfowl Management Area on the east side of the delta. The water column and substrate offshore are not highly productive areas because of heavy sediment loads and fluctuating river flow conditions; impacts of oil spilled during transfer operations should not be significant in these locations.

TABLE 4.3-1 Summary of oil spill accident potential for various accident modes, Cote Blanche storage facility

| Accident Mode | Expected Number of Spill Incidents per Single Fill or Withdrawal Cycle | Expected Number of Spill Incidents During Lifetime of Project | Average Spill Volume per Incident (barrels) | Volume of oil Release Expected During Project Lifetime (barrels) | Maximum Credible Spill Volume (barrels) |
|---|---|---|---|---|---|
| VLCC Transfer | | | | | |
| 25,000 bbl Sea Barges | 60 | 600 | 1.35 | 810 | 1000 |
| or | | | | | |
| 45 MDWT Tankers | 5 | 50 | 16.2 | 810 | 1000 |
| Venice/VLCC Transport | | | | | |
| 25,000 bbl Sea Barges | 0.01848 | 0.1848 | 428 | 79 | 20,000 |
| or | | | | | |
| 45 MDWT Tankers | 0.0266 | 0.266 | 428[a] / 1111[b] | 132[c] | 60,000 |
| Transfer at Venice | | | | | |
| 25,000 bbl Sea Barges | 24 | 240 | 3.4 | 810 | 500 |
| or | | | | | |
| 45 MDWT Tankers | 13 | 130 | 6.2 | 810 | 500 |
| 25,000 bbl Barge Transport, Venice/Cote Blanche | 1.23 | 1.23 | 428 | 526 | 20,000 |
| Barge Transfer at Cote Blanche[d] | 12 | 120 | 3.4 | 405 | 500 |
| Terminal Facilities at Cote Blanche | 0.0135 | 0.135 | 300 | 41 | 5000 |
| Total Expected[e] | 30 | 302 | 9.0 | 2724 | -- |

[a] Average spill size in Mississippi River portion of route.

[b] Average spill size in Gulf of Mexico portion of route.

[c] 102 barrels in Mississippi River; 30 barrels in Gulf of Mexico.

[d] Assumes average between fill spill rate ($1 \times 10^{-6}$) and withdrawal spill rate ($2 \times 10^{-6}$).

[e] Totals include 45 MDWT tankers and not sea barges.

TABLE 4.3-2 Probable spill size distribution for various accident modes, given the occurrence of an oil release

**VLCC/45 MDWT Tanker Transfer in Gulf**

(Average Size = 16.2 bbl)

| Size Range (bbl) | % Probability |
|---|---|
| 0 - 20 | 83.9 |
| 20 - 50 | 12.0 |
| 50 - 100 | 3.16 |
| 100 - 200 | 0.75 |
| 200 - 500 | 0.16 |
| 500 - 1,000 | 0.03 |

**45 MDWT Tanker Transport Leg**

(Average Size = 1111 bbl)

| Size Range (bbl) | % Probability |
|---|---|
| 0 - 200 | 23.0 |
| 200 - 500 | 23.7 |
| 500 - 1,000 | 24.0 |
| 1,000 - 2,000 | 19.0 |
| 2,000 - 5,000 | 7.0 |
| 5,000 - 10,000 | 2.6 |
| 10,000 - 20,000 | 0.6 |
| 20,000 - 50,000 | 0.14 |
| 50,000 - 60,000 | 0.006 |

**Barge/45 MDWT Tanker Transfer at Venice**

(Average Size = 6.2 bbl)*

| Size Range (bbl) | % Probability (3 to 3.6 bbl size) | % Probability (45 bbl size) |
|---|---|---|
| 0 - 2 | 61.7 | |
| 2 - 5 | 22.5 | 44.9 |
| 5 - 10 | 10.0 | |
| 10 - 20 | 4.5 | |
| 20 - 50 | 1.0 | 30.5 |
| 50 - 100 | 0.27 | 17.4 |
| 100 - 200 | 0.05 | 5.8 |
| 200 - 500 | 0.011 | 1.4 |

**25,000 bbl Barge Transport**

(Average Size = 428 bbl)

| Size Range (bbl) | % Probability |
|---|---|
| 0 - 200 | 45.8 |
| 200 - 500 | 35.0 |
| 500 - 1,000 | 13.1 |
| 1,000 - 2,000 | 4.3 |
| 2,000 - 5,000 | 1.3 |
| 5,000 - 10,000 | 0.4 |
| 10,000 - 20,000 | 0.1 |

* Spill modes have expected average sizes ranging from 3 bbl to 45 bbl. Weighted average is approximately 6 bbl. Spill size distributions for the lowest and highest average spill size modes are provided.

TABLE 4.3-2 Continued

**Barge Transfer at Cote Blanche**

(Average Size = 3.4 bbl)

| Size Range (bbl) | % Probability |
|---|---|
| 0 - 2 | 61.7 |
| 2 - 5 | 22.5 |
| 5 - 10 | 10.0 |
| 10 - 20 | 4.5 |
| 20 - 50 | 1.0 |
| 50 - 100 | 0.27 |
| 100 - 200 | 0.05 |
| 200 - 500 | 0.011 |

**Terminal Facilities at Cote Blanche**

(Average Size = 300 bbl)

| Size Range (bbl) | % Probability |
|---|---|
| 0 - 200 | 49 |
| 200 - 500 | 40 |
| 500 - 1,000 | 7.8 |
| 1,000 - 2,000 | 2.4 |
| 2,000 - 5,000 | 0.8 |

TABLE 4.3-3 Proportion of crude oil likely to go into solution in sea water*

| Fraction of Oil | Range of % in Crude | Avg % | Proportion of fraction likely to go into solution | % in Solution |
|---|---|---|---|---|
| a) Lower b.p. paraffins $C_6 - C_{12}$ | 1-10 | (5.5) | 1/60 | 0.09 |
| b) Higher b.p. paraffins $C_{13} - C_{25}$ | 1-7 | | 0 | |
| c) Lower b.p. cycloparaffins $C_6 - C_{12}$ | 5-15 | (10) | 1/12 | 0.83 |
| d) High b.p. cycloparaffins $C_{13} - C_{23}$ | 5-20 | | 0 | |
| e) Mono- and di-cyclic aromatics $C_6 - C_{12}$ | 1-5 | (3.5) | 1/6 | 0.58 |
| f) Poly-cyclic aromatics $C_{12} - C_{18}$ | 3-6 | (4.5) | 1/20 | 0.22 |
| g) Naptheno-aromatics $C_9 - C_{25}$ | 10-20 | (15) | 1/20 | 0.75 |
| h) Residual | 25-65 | | | |
| | | | Total | 2.47 |

* Based on Moore, Dwyer, and Katz, 1973.

TABLE 4.3-4 Conversion factors for selected concentrations of barrels per acre

| BBL/Acre* | Depth of Oil on Surface | ppm Oil/Acre One Foot Deep (ppt) | $ml/ft^2$ of oil | $ml/cm^2$ of oil |
|---|---|---|---|---|
| 1 | 0.041 mm | 130 (0.13) | 3.8 ml | 0.0039 ml |
| 10 | 0.41 mm | 1300 (1.3) | 7.6 ml | 0.0078 ml |
| 25 | 4.1 mm (0.16 in.) | 3250 (3.2) | 19.0 ml | 0.019 ml |
| 50 | 8.2 mm (0.32 in.) | 6500 (6.5) | 38.0 ml | 0.039 ml |

* 1 bbl = 42 gallons.

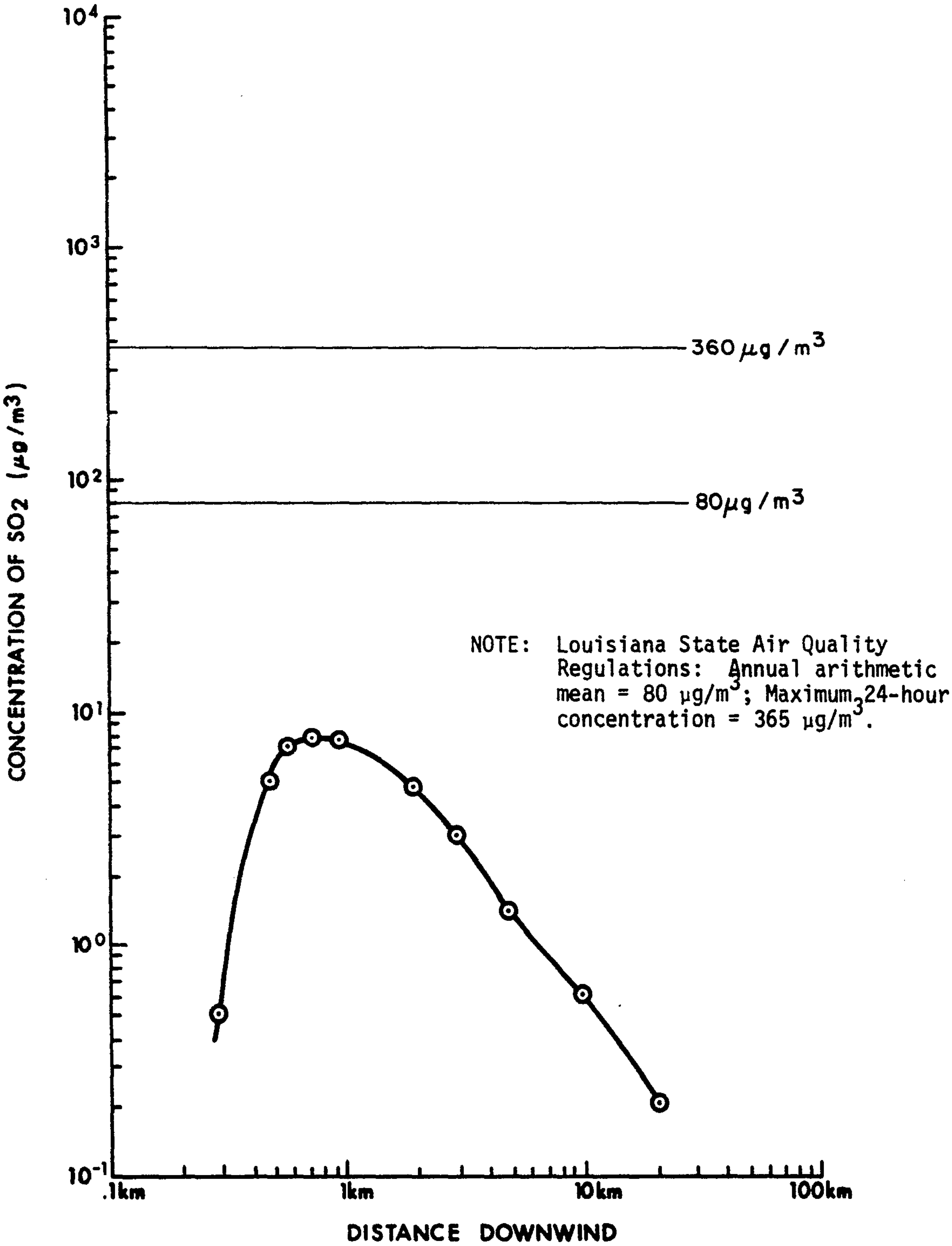


FIGURE 4.3-1. Downwind concentration of $SO_2$ ($\mu g/m^3$) resulting from flaring (assuming 0.53 gm/sec. release $SO_2$, and 100,000 bbl/day pumping).

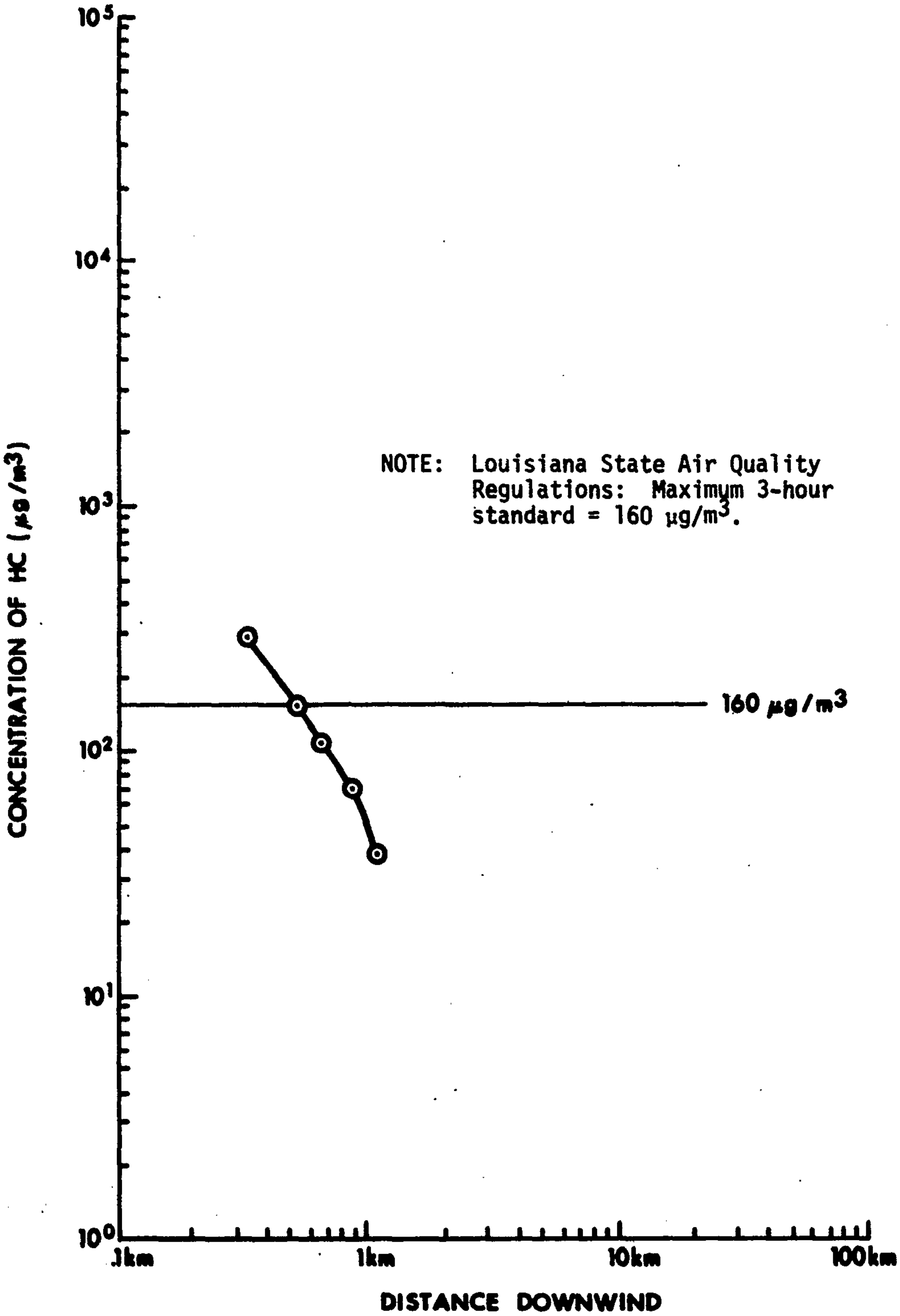


FIGURE 4.3-2 Downwind concentration of HC from leakage (ground release) assuming .80 gm/sec. venting from 100,000 bbl/day pumping.

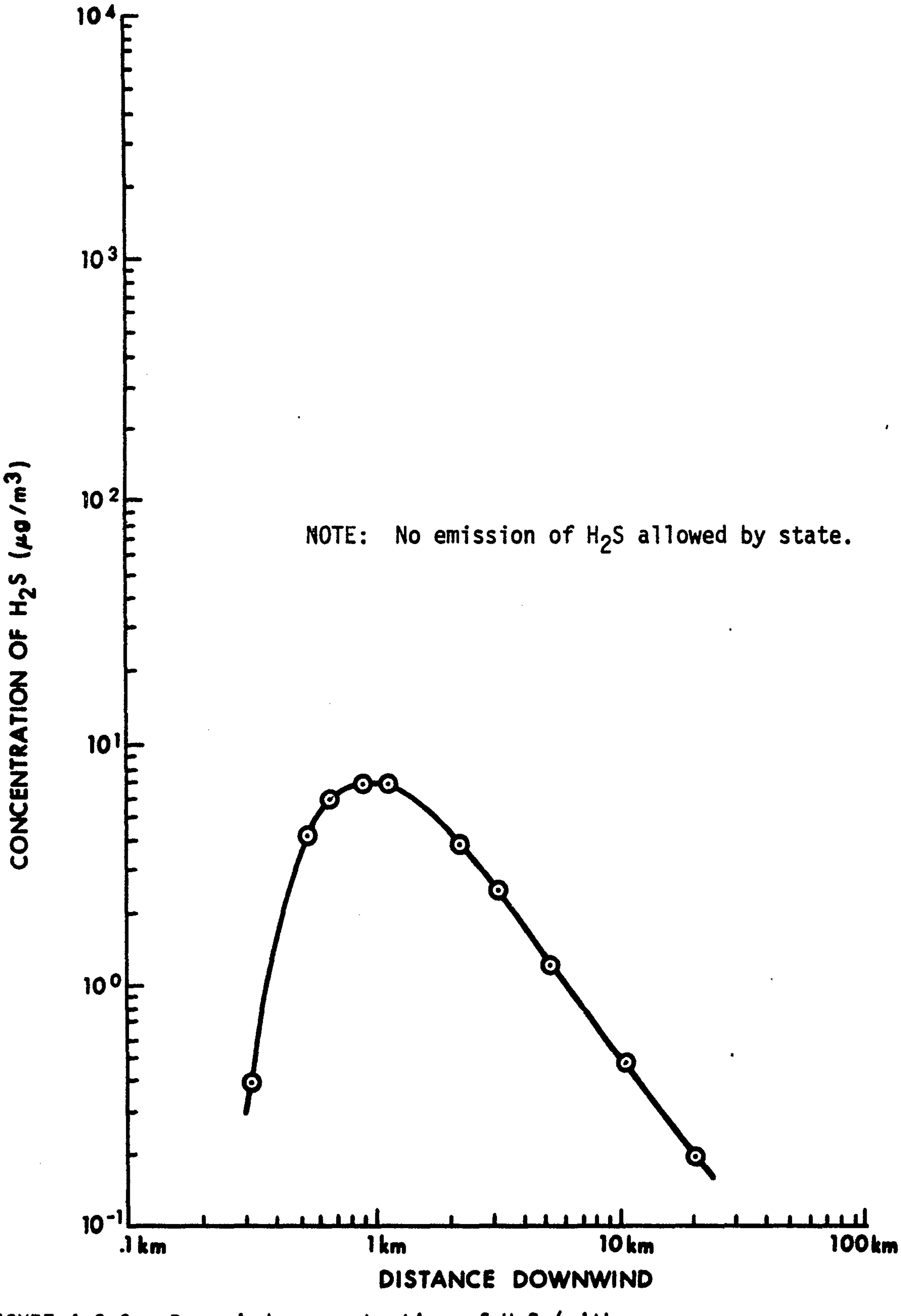


FIGURE 4.3-3. Downwind concentration of $H_2S$ (with no burn off) assuming 100,000 bbl/day pumping rate and .27 gm/sec release of $H_2S$.

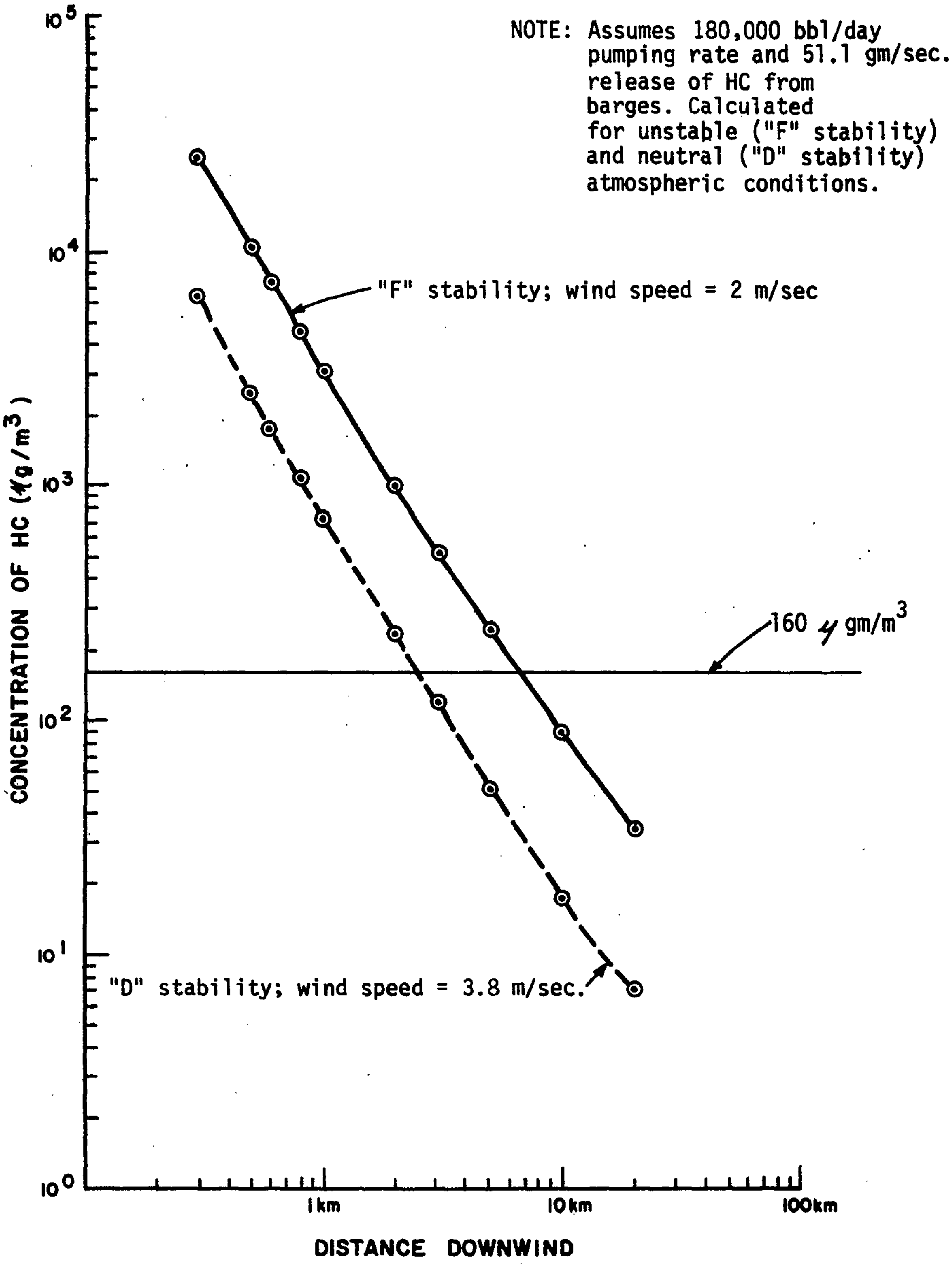


FIGURE 4.3-4. Downwind ground level concentration of HC (with no vapor control system) released at Cote Blanche barge docks during oil withdrawal.

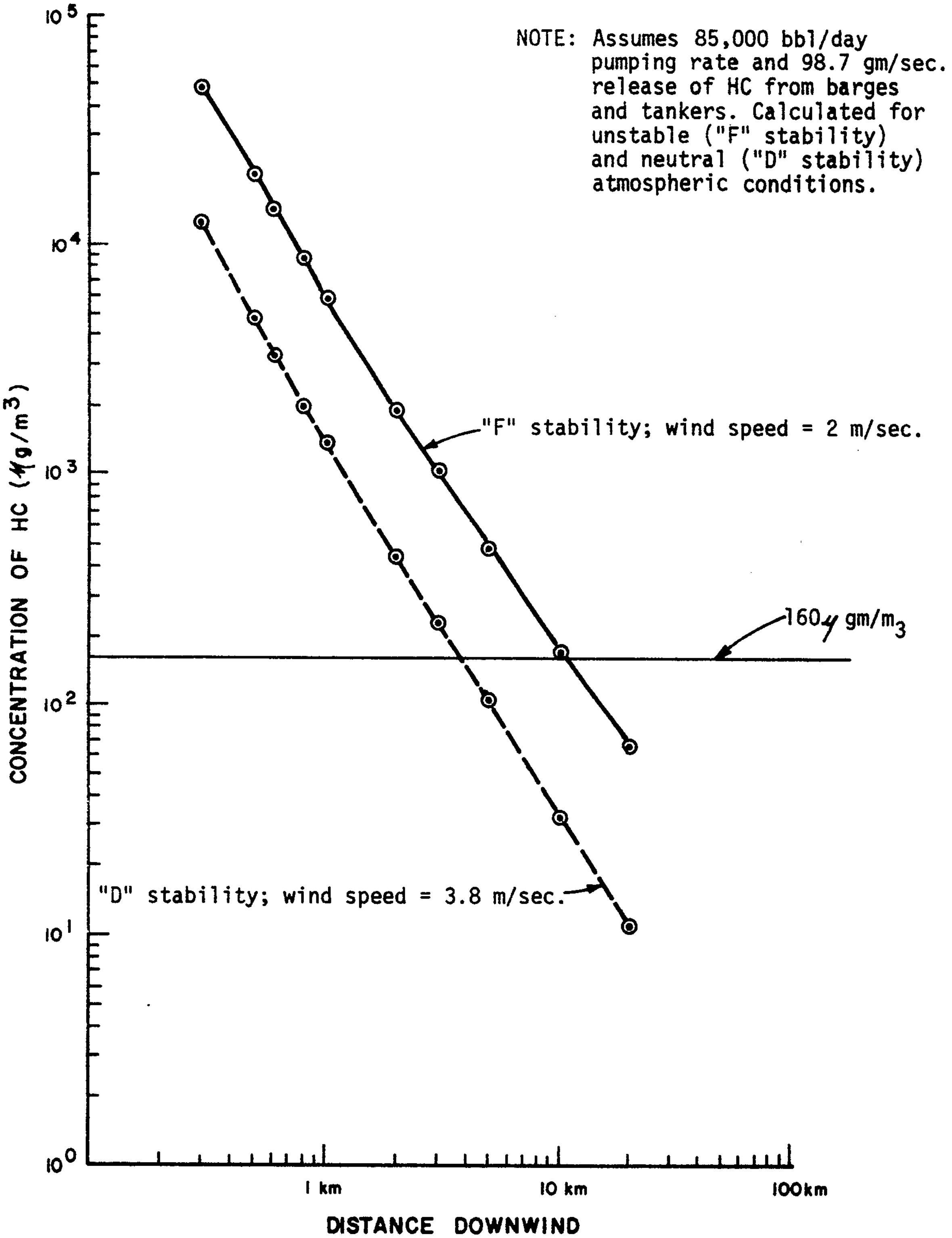


FIGURE 4.3-5. Downwind ground level concentration of HC( with no vapor control system) released at Venice transfer terminal during oil fill for Cote Blanche.

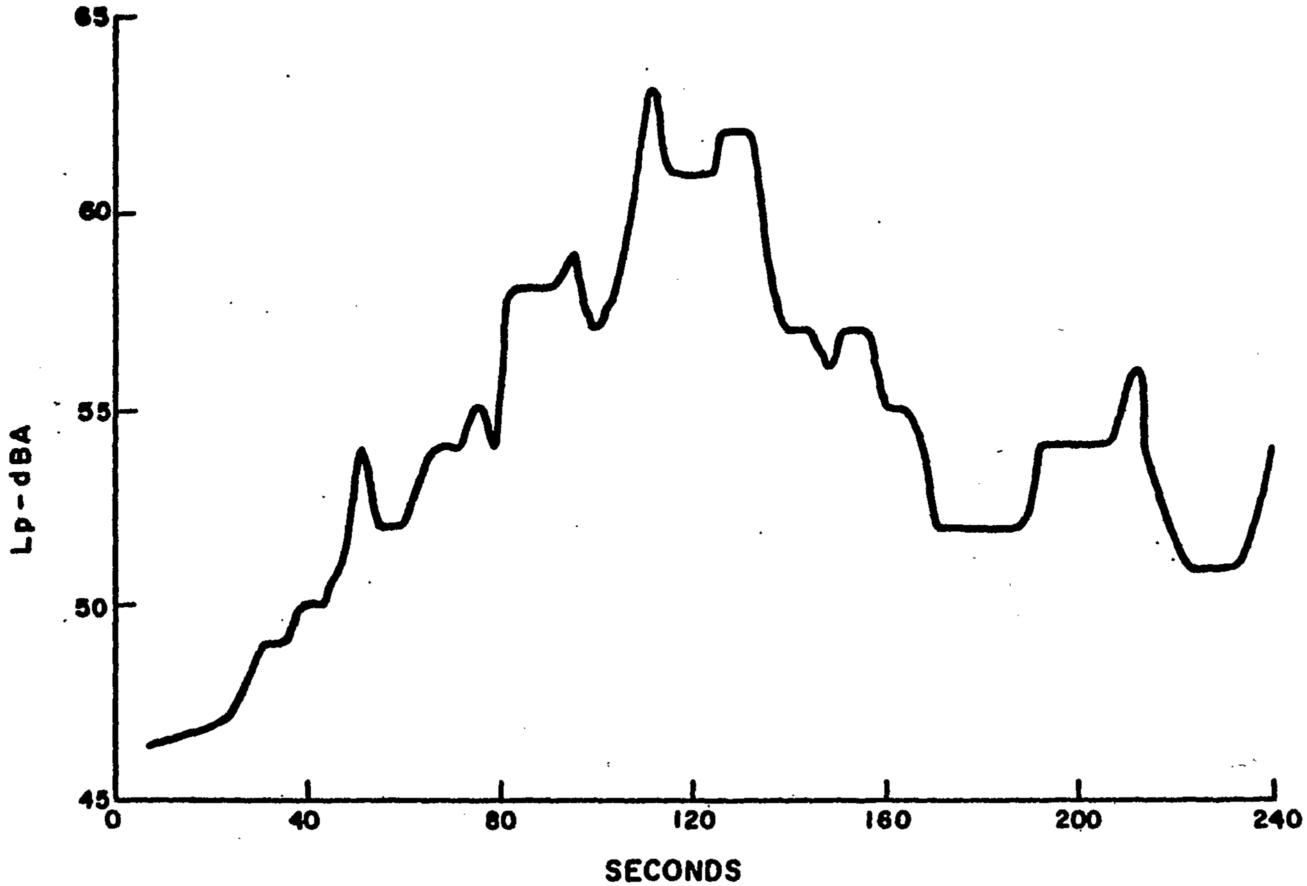


FIGURE 4.3-6. Sound level history of barge passby as measured at 150 feet from microphone.

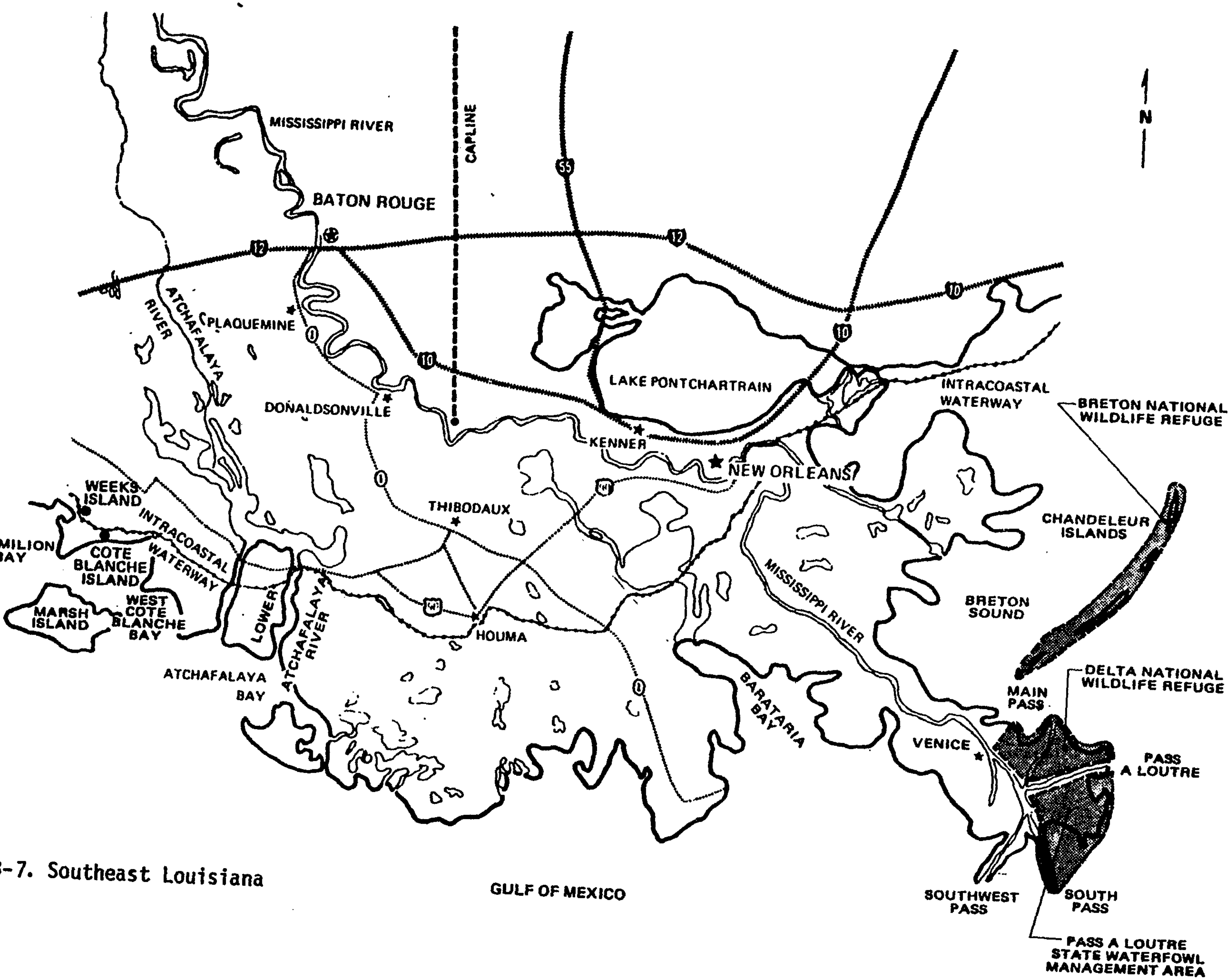


FIGURE 4.3-7. Southeast Louisiana

## 4.4 TERMINATION AND ABANDONMENT

No specific plan for termination and abandonment of the Cote Blanche oil storage site has been established. However, the FEA will be required to develop such a plan near the termination of the action. To date, no specific experience with the abandonment of an oil storage cavern facility has been developed in the United States. However, various feasible plans are available. Those that appear most conservative in terms of environmental hazards must account for surface subsidence and release of residual oils squeezed from the workings by possible longterm plastic closure.

At present, it is intended to put the facility to some beneficial use, rather than abandon it. Beneficial uses might include disposal of wastes, such as dredge spoil, slurried fly ash, or other polluted or toxic materials. Another possibility is to develop a compressed air storage facility for peak power use. The final selection of an abandonment plan will likely depend on the economic and environmental trade-offs and regulations that are in effect at the time of termination.

Use of the facility in the manner described above would assure continued surveillance of the cavern. The inherent integrity of the cavern would prevent any leakage of material into the environment. Certain activities associated with the specific use, such as waste transport, would impose some potential for environmental damage resulting from traffic, spillage, and noise.

Should no beneficial use be found for the facility, the shafts could be sealed and the caverns left empty, as is normal practice with abandoned mines. No adverse environmental effects are likely to result from such action.

## 4.5 THE RELATIONSHIP OF THE PROPOSED ACTION TO LAND-USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREAS

There are presently no official plans, policies, or controls established by Federal, state, or local government agencies in St. Mary Parish. Furthermore, lands under consideration for use in developing the Strategic Petroleum Reserve facility at Cote Blanche Island are presently devoted to industrial uses. This includes the 20 to 25 acres required for facilities on the island and the barge slip, access canal, and ICW to be used for barge transport of the oil.

Although a Coastal Zone Management Plan is in preparation in Louisiana, there is no apparent project conflict with the basic concepts established by the Louisiana Advisory Commission on Coastal and Marine Resources (1973), which are expected to be an important part of the ultimate plan. Thus, development is to occur at a previously established industrial site, oil transportation follows established corridors, and little or no water resources or undisturbed marshlands are required for the project.

An oil storage facility, very similar to the Cote Blanche project, is under consideration for the Morton Salt Mine on Weeks Island in Iberia Parish, approximately 5 miles northwest of Cote Blanche Island. (Figure 2.2-1). Should both storage facilities be developed, there is potential for interaction of effects within the local and regional area. These interactions are described in appropriate portions of section 4.0 in the EIS and are summarized in the remainder of this section (see also section 8.2.2.4).

The Weeks Island facility would be located in an existing underground salt mine owned and operated by Morton Salt Company. Aboveground facilities include an extensive processing plant. Adjacent to the mine and processing plant is a chemical plant that utilizes bulk salt from the mine. Employment in the mine and processing plant is approximately 260, of which 60 are underground miners similar to those at Cote Blanche. Most of the salt is transported to the market by barge through the ICW, though some moves by rail and truck.

The proposed storage facility would require conversion of the existing mine cavern and development of a new mine in a manner similar to Cote Blanche. Potential storage volume at Weeks is 89 million barrels of crude, significantly greater than at Cote Blanche. Oil is planned to be barged to and from the site through the ICW. Alternate transportation systems are an overland pipeline to St. James or an offshore line to a deepwater monobuoy (the same pipeline could serve both Weeks Island and Cote Blanche). Development schedules for the two facilities are essentially identical, though Weeks would require more time to fill. Both facilities could be developed either with or without temporary salt mine shutdown, depending upon the program option selected.

Because of the proximity of the two sites and the similarities between the development plans, the potential impacts of both sites must be considered in a decision to develop either one. Due to the greater storage volume available at Weeks Island for essentially the same cost and environmental impact, it is unlikely that only the Cote Blanche facility would be developed. If storage capacity requirements dictate that Weeks Island be developed alone, the interaction described here will not occur. If both sites are developed concurrently, there is a greater likelihood that a common pipeline would be used to transport oil to and from the sites (see section 8.2). This would take advantage of the cost effectiveness associated with a single large-diameter pipeline serving both sites and would remove the potential problems associated with high-density barge traffic on the ICW, in the Mississippi River, and at the terminals. Since there would be essentially no adverse interaction between transportation facilities if pipeline transport were selected, the following description of significant cumulative effects is based on the assumption of concurrent project development and use of barge transportation for both sites.

The first major source of interaction between the projects occurs during construction. Peak construction employment for the two sites together totals over 600 workers. Between 170 (mine shutdown cases) and 250 (no mine shutdown) of these can be expected to be composed of residents from beyond commuting distance and would, therefore, require some form of temporary housing for periods of half a year or longer. The necessary housing is not likely to be available in the nearby towns of Franklin, Jeanerette or Baldwin; many employees will likely have to commute from as far as Morgan City and Lafayette. Few of these construction workers are expected to bring families for such short periods. Therefore, local schools and other public services should not be significantly affected.

Traffic levels on U.S. Highway 90 and State Highway 83 would increase by perhaps as many as 300 vehicles per shift as a result of construction workers commuting to the site. For the mine shutdown option, there would be a net reduction of approximately 260 employees at the mines. Though some of these would perhaps be on the highways for other reasons, the traffic congestion would certainly be lower than if both mines were in full operation. Despite this traffic increase, there is not expected to be substantial inconvenience for commuters in the area, except perhaps at certain intersections in local towns. These localized problems should be easily mitigated by staggered shifts and minor adjustments in traffic control. Provision of temporary housing facilities at the construction sites would also minimize any possible housing and traffic problems (section 5.2).

Construction of the new mine sites and conversion of the existing mines into oil storage facilities would bring significant amounts of new income to the region. For the option of no mine shutdown at both Weeks and Cote Blanche, the construction earnings over a 103-week period are estimated at approximately $13.9 million. Of this amount, an estimated $7.2 million would be earned by workers within commuting distance and $6.7 million by workers originating from beyond commuting distance. For the option of temporary mine shutdown, construction earnings would total $11.7 million over an 83-week period; $6.9 million of this would accrue to local residents and $4.8 million to outside residents. In both cases, some of the money earned by nonresidents would be spent locally; also, some purchases of construction materials and equipment would be made locally. As the total effective buying income of Iberia, St. Mary, and Lafayette Parishes is $774 million, these additional wages are significant.

For the option of temporary mine shutdown, there would be a loss of employment at the existing mines that would reduce the effect of new construction earnings. An estimated 200 to 210 workers at Weeks Island and 120 workers at Cote Blanche would be temporarily laid off for a period of approximately 64 to 74 weeks. Although an estimated 60 from each workforce might find employment at the construction sites, the effective loss in employment would be 330 jobs, with total earnings of $3.7 million for the 74 weeks. Thus, the net increase in local earnings for this option would be $3.2 million rather than $6.9 million.

Displaced workers who do not find employment at the construction sites (estimated at 200 to 210 workers) would likely remain unemployed or underemployed for the 64- to 74-week shutdown period. Few are expected to move from the area, and high-paying alternate jobs are not readily available. Many would draw unemployment during part of this period. Social effects in families and local communities might be significantly adverse.

Shutdown of salt production at both mines would reduce the bulk salt output in St. Mary and Iberia Parishes by an estimated 3.5 million tons. At $0.06 per ton, the loss in severance tax income to the state would be $210,000. If property taxes cannot be collected on the converted salt mine facilities, over $150,000 loss in revenue may occur to St. Mary and Iberia Parishes until the new mines are in operation. This would be a significant loss.

If there is no mine shutdown, government revenues would only be beneficially affected by the increased earnings and expenditures in the state and region.

Development of both the Weeks Island and Cote Blanche sites would require use of approximately 80 acres of land on the two islands. The land to be developed is neither of high value as habitat nor is of scenic or recreational value. The cumulative environmental effect of the required construction of both sites is not significant.

If both the Weeks Island and Cote Blanche storage sites use barges for oil transport, there would be a significant cumulative effect on barge availability in south Louisiana. Industry experts indicate that in the event of an oil supply interruption, there would be a minimum of 80 25,000-barrel (or equivalent volume) inland waterway barges available for lease to transport oil from storage. For purposes of analysis, it is assumed that 70 could be used to transport oil from the Cote Blanche and Weeks Island facilities.

Barge travel time from the storage sites along the Gulf Branch of the ICW to Algiers locks, New Orleans, down the Mississippi River to Venice, offloading to 30,000- to 50,000-DWT (dead weight ton) tankers, and return is estimated at 123 hours (including 15 percent downtime). Thus, with 70 25,000-barrel barges in service, an average withdrawal rate of 341,000 BPD could be achieved. Total withdrawal of the 116 million barrels of oil stored at the two sites would take approximately 340 days.

Therefore, a major impact of developing both storage sites and using inland barges for oil transport would be a reduction in the achievable withdrawal rate during an oil supply interruption from a goal of 770,000 BPD (150 days) to 341,000 BPD. As indicated elsewhere, development of both sites is more likely to result in construction of a pipeline to St. James that could handle the desired withdrawal rate. Alternatively, oil could be barged to other, closer transfer locations. Sea-going barges could withdraw an additional 71,000 BPD. All of these alternatives are considered in section 8.0. They are not exclusive; some combination might be required to deliver oil to points of need in a national emergency.

Total Cote Blanche and Weeks Island design fill rates are less than 200,000 BPD. Only 41 25,000-barrel barges are required to meet this demand. This capacity should be available, especially since contracts can be let well in advance of the need for filling.

Simultaneous operation of the Weeks Island and Cote Blanche oil storage facilities would have potentially significant impacts primarily as a result of barge traffic, oil spills, and hydrocarbon emissions. Traffic levels on the ICW would increase by 14 percent over those with Cote Blanche alone during oil withdrawal if other traffic remains the same. The heavy traffic would continue for 340 days. Noise levels and erosion would also increase. It is likely, however, that reduced industrial activity in the case of an oil supply interruption would result in less background traffic at these times.

The oil spill analyses for the two storage facilities indicate that approximately 9150 barrels of oil may be spilled during five fill/withdrawal cycles at Weeks Island, in addition to the 2720 barrels expected for Cote Blanche. The three basic accident modes will have the following total spill expectation: barge and tanker transport -- 2890 barrels; oil storage facilities -- 2000 barrels; and vessel-to-vessel transfer -- 6960 barrels. Barge and tanker transport and vessel-to-vessel transfer spills have a potential for cumulative or interactive effects. However, the location of such spills could be anywhere along the 250-mile waterway system between the storage facilities and the Gulf of Mexico off the Southwest Pass of the Mississippi River. Over a 20-year period, 11,870 barrels of oil are not considered to represent a significant incremental threat to regional water quality or to the functioning of coastal ecosystems. However, there may be definite adverse effects in the vicinity of the Venice transfer point during operations where a total of 3500 barrels are estimated to spill.

The chance of a major spill (more than 2000 barrels) occurring in south Louisiana as a result of both facilities operating simultaneously for five fill/withdrawal cycles is estimated at 1 in 4.5 (22.5 percent chance).

Analyses of hydrocarbon vapor emissions expected to occur during transportation of oil and oil transfer between tankers, barges and oil storage caverns indicate that an estimated 92,350 tons (0.02 percent of oil storage capacity) of hydrocarbon vapors may be released during five fill/withdrawal cycles at Weeks Island, in addition to the 28,030 tons (0.02 percent) expected from Cote Blanche facility operations. The three primary locations for hydrocarbon releases will have the following total expectation during the lifetime of the two projects (Figure 4.3-7): Gulf of Mexico, just south of Southwest Pass (assuming VLCCs are used to transport all oil to and from the sites -- very likely) -- 52,350 tons; Mississippi River near Venice, Louisiana -- 41,870 tons; Cote Blanche and Weeks Island barge docks -- 15,700 tons. Another 10,460 tons would be released in transit between the lower Mississippi River and the storage sites. During periods of peak release there would be a definite potential for air quality degradation in coastal Louisiana, particularly within 10 to 15 miles of the oil transfer terminals where hydrocarbon concentrations will frequently exceed 160 $\mu g/m^3$.

## 4.6 SUMMARY OF ADVERSE AND BENEFICIAL PROJECT IMPACTS

### 4.6.1 Summary Tabulation of Adverse and Beneficial Impacts

Table 4.6-1 summarizes the findings of the various discipline analyses of project impacts. The data are in both qualitative and quantitative form as appropriate, and represent the best professional judgment of potential impacts that could be made. A general appraisal of overall environmental impacts of the Cote Blanche Mine Project is presented in section 4.6.2.

A benefit that must be added to those tabulated is, of course, the intended goal of providing a substantial crude oil reserve for the country in case of a national emergency (see section 4.7). The 27 million barrels to be stored at Cote Blanche represent about 5 percent of the total planned Strategic Petroleum Reserve and 18 percent of the Early Storage Reserve.

### 4.6.2 Overall Project Appraisal

Conversion of the Cote Blanche salt mine to an oil storage facility and development of a new mine elsewhere in the dome are not likely to generate significant environmental impacts, except for possible short-term employment due to temporary mine shutdown, the remote possibility of a major oil spill, and the uncontrolled release of hydrocarbon vapors during oil transportation. The fact that the island has long been used for industrial purposes and that the area to be directly affected is not a unique resource or habitat for significant flora and fauna minimizes the scope of changes resulting from construction activities. Also, the area affected by construction is very small. For the option of no mine shutdown, socioeconomic impacts of construction are not likely to be large or long-lasting since much of the work force is expected to reside in the area. Simultaneous undertaking of the Weeks Island Mine conversion could, however, lead to scarcity in local manpower, and potentially generate a locally signficant transient worker population. In such a case, housing availability and costs could become a problem; public service expenses should not be adversely affected, however, since population increases will be very small.

Should the option of temporarily shutting down the existing mine be selected, there is likely to be significant, short-term adverse social and economic impacts to segments of the local population. Simultaneous shutdown of the Weeks Island mine would greatly magnify these impacts.

Operation of the Cote Blanche facility would have negligible socio-economic impacts since its employment requirements (in addition to the salt mining operation at the relocated mine) are very small. Continuation of salt mining activities is of considerable importance to the local economy, and the assessment that operation of the oil storage facility would be of negligible local socioeconomic significance is contingent upon the continuation of salt production after a new mine has been developed.

Environmental impacts of operation relate primarily to transportation of the oil by barge, particularly the release of hydrocarbon vapors during vessel transfer operations and possible accidents involving oil spills. Regarding environmental impacts of oil spills, the effects could be very large, although probably of only local significance, in case of a catastrophic accident; the probability of such a spill is very low, however. Property damage would not likely be great, although costs of recovering a large spill could be significant.

The significant quantities of hydrocarbon vapors released during uncontrolled vessel transfer operations are a potential source of air quality degradation and a loss of valuable petroleum resources. Calculations of hydrocarbon concentrations downwind from the primary vapor release points indicate that ground level hydrocarbon concentrations will exceed 160 $\mu g/m^3$ for several miles. The effect on regional air quality is difficult to determine, though the potential for increased photochemical reactivity and ozone formation exists. A significant reduction in quantity of vapors released to the atmosphere can be achieved by developing effective vapor control systems (section 5.0).

TABLE 4.6-1 Summary tabulations of adverse and beneficial project impacts

| Subject Areas and Environmental Impact | Summary Characterization of Impact: Adverse | Beneficial |
|---|---|---|
| **Geology** | | |
| 1. Land subsidence | No impact | None |
| 2. Seismic stability | No impact | None |
| 3. Engineering stability | No impact | None |
| 4. Salt flow mechanics | No impact | None |
| 5. Disposal of brine and/or mine water | No change from present operation | None |
| 6. Loss of mineral resource | Negligible oil absorption; slight loss of recoverable salt | Expanded accessibility to salt deposits (due to relocation of present mine) |
| **Hydrology** | | |
| 1. Surface water pollution | From mine: negligible. From oil spill: small risk of large spill; temporary adverse impact. From barge slip excavation: small decrease in water quality but limited to immediate area of excavation. From barge traffic: slight increase in bank erosion during operating periods. | None |
| 2. Ground water pollution | Highly unlikely due to impermeability of salt and absence of faulting; none of the engineering modifications of the mine interrelate with the groundwater system. | None |

| Subject Areas and Environmental Impact | Summary Characterization of Impact: Adverse | Beneficial |
|---|---|---|
| 3. Water supply | No impact | None |
| **Air Quality** | | |
| 1. Increase of hydrocarbons, $NO_x$, $SO_2$, particulates, and dust | Temporary localized increase in fugitive dust during construction operations; minor amounts of $NO_x$ and $SO_2$ from construction equipment and tugboats and from flaring of volatile oil fractions vented during filling of cavern; negligible odor generation during filling and withdrawing operations; significant quantities of hydrocarbon vapors released during transport of oil by tanker and barge and especially during transfer between vessels. | None |
| **Noise** | | |
| 1. Construction equipment | Increase in nighttime ambient sound levels at nearby undeveloped areas will be less than 6 dB; increase at nearby towns will be 1 dB | None |
| 2. Pumping and barge operations during filling and withdrawal | 55 dB at 500 feet (at least 11 dB lower than existing background ambient sound level on the site). 55 dB at 500 feet for one barge passby; frequency of occurrence to increase by less than one additional barge passby per hour over present rates | None |

TABLE 4.6-1 Continued

| Subject Areas and Environmental Impact | Summary Characterization of Impact: Adverse | Beneficial |
|---|---|---|
| **Terrestrial Ecology** | | |
| 1. Wildlife habitat | Removal of approximately 40 acres for site preparation and additional structures | Creation of new "edge" at perimeter of site might lead to increased diversity of wildlife in immediate area |
| | Reduction in terrestrial habitat due to barge slip excavation | Increase in aquatic habitat in newly excavated slip |
| 2. Road kills of small animals and birds | Some increase during construction but no long term increase afterwards over current levels | None |
| 3. Oil spill effects | Some risk to avifauna and wildlife inhabiting coastal marshes | None |
| **Aquatic Ecology** | | |
| 1. Wildlife habitat | Minor amounts of bank erosion and turbidity resulting from increased barge traffic (during filling and withdrawal period only), and from site excavation and grading. An oil spill could significantly affect habitat and populations, but risk of major spill judged to be minimal. Enlargement of barge slip would temporarily displace local aquatic life | Increase in aquatic habitat area |

TABLE 4.6-1 Continued

| Subject Areas and Environmental Impact | Summary Characterizarion of Impact Adverse | Beneficial |
|---|---|---|
| Historical and Archaeological Assets | | |
| 1. Historic places | None (no known properties on island) | None |
| 2. Archaeological sites | No known site will be affected by construction or operation; a survey of potential sites within the proposed development area indicates no cultural resources will be affected | Survey adds to archaeological knowledge of area |
| Socioeconomic Characteristics | | |
| 1. Land Use | | |
| a) Construction phase | Removal of approximately 40 acres of land for marsh and forest for mine relocation and oil handling equipment | Increased economic utilization of natural resource (land) and expansion of local property tax base (if privately developed) |
| b) Operation phase | No impact on existing land uses in area, except in case (remote) of major oil spill; sparse recreational development in area, however, probability of large oil spill occurring and reaching developed water recreation area judged very small | None |

TABLE 4.6-1 Continued

| Subject Areas and Environmental Impact | Summary Characterization of Impact Adverse | Beneficial |
|---|---|---|
| 2. Transportation | | |
| a) Construction phase | Negligible impact on waterborne traffic (primarily ferry between mainland and Cote Blanche Island); temporary increase in vehicular traffic between island and mainland points (effect is lower if mine is temporarily shut down) | Temporary increase in transportation employment judged to be of minor significance |
| b) Operation phase | Significant impact on demand for barges, tugboats and crews during emergency; may require establishment of priorities for equipment use and curtailment of lower priority barge movements. Routine filling operations probably can be accommodated by timing operations to coincide with periods of reduced transport demand. | Increased demand for barges, tugboats and crews, and resulting expanded employment and income in region |
| 3. Population and Housing | | |
| a) Construction phase | Temporary increase in transient population for approximately 2 years; maximum 140 non-local construction workers (80 with mine shutdown) plus some dependents. Due to housing shortage in St. Mary Parish, transient workers probably will be distributed over relatively large commuting area. Possibly some raising of rental rates. Impacts would be exacerbated by simultaneous work at Weeks Island | Potential stimulus for upgrading of transient housing facilities in local area (judged not to be strong enough to stimulate overbuilding) |

TABLE 4.6-1 Continued

| Subject Areas and Environmental Impact | Summary Characterization of Impact Adverse | Beneficial |
|---|---|---|
| b) Operation phase | Negligible (non-local personnel for storage facility estimated at fewer than 5) | Slight net increase in income accruing to local residents. |
| 4. Economic Changes | | |
| a) Construction phase | Possible temporary slight local scarcity of construction workers during period of peak employment for mine conversion and relocation (no scarcity expected if mine is closed). Effect on salt production dependent on decision to close mine. Maximum of 74 weeks of output loss. Availability of local construction manpower would be constrained if Weeks Island project proceeds simultaneously, necessitating additional non-local workers. (Again, not a problem if Weeks mine is closed.) | Estimated $8 million of regional construction labor income during mine conversion and further relocation activities (net of only $4.6 million if mine is shut down temporarily). Increase in area income would result from Weeks Island project proceeding. Increased demand for local supplies of construction services (materials, fuels, labor). Combined effect of construction payroll spending and procurements could stimulate some increase in secondary employment and income. |
| b) Operation phase | No significant adverse impact | Slight long-term increase in area income and employment. |
| 5. Government Sector | | |
| a) Construction phase | Possible increase in public safety costs due to influx of transient construction workers; judged not to be significant due to dispersal of residences. Construction traffic near Cote Blanche | None |

TABLE 4.6-1 Continued

| Subject Area and Environmental Impact | Summary Characterization of Impact Adverse | Beneficial |
|---|---|---|
| (Government Sector, Construction phase, continued) | Island may necessitate controls. No increase in education and public welfare costs anticipated. Temporary decline in severance tax revenues on salt production if new mine output does not exactly offset decline in present mine production or if mine is shut down temporarily. | (None) |
| b) Operation phase | Costs of restoring public facilities in case of oil spill; possibly significant, but not highly probable | Expanded parish tax base and increased *ad valorem* tax revenues if owned and operated by a private company (estimated to exceed current mine property taxes by approximately $84,000 per year). |
| 6. Aesthetic and Sociocultural Assets | Significant adverse social effect on dislocated miners and families if mine shutdown occurs. No significant aesthetic or cultural effects. Island not used for cultural purposes and is not pristine. An oil spill could significantly degrade aesthetic qualities relating to recreational uses of water, and costs of restoration could be significant; the probability of a large spill is very low, however. | No direct impacts. Increased parish tax revenues could possibly lead to improvements in public cultural facilities. |

## 4.7 CONSIDERATIONS OFFSETTING ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIVITY

The United States possesses abundant natural resources and yet is dependent upon the importation of large quantities of fuels. It has become increasingly dependent upon petroleum imports, which now constitute approximately 35 to 45 percent of the nation's oil consumption and account for 20 percent of the total domestic energy usage. In 1974 the annual cost of these imports was over $25 billion.

In the past twenty-five years, the United States has experienced four sudden denials of oil imports for various reasons by oil-exporting countries. Not, however, until the oil embargo of 1973-74 did the nation find itself without the capacity and resources to offset the interruption of oil imports. This embargo reduced the quantities of petroleum exported to the United States by approximately 2 million barrels per day for 19 weeks and caused world prices for crude oil to escalate.

Although the economic impacts of these events on the United States economy are still under study and debate, most of the macroeconomic study estimates of the repercussions of supply denial and simultaneous price increases tend to indicate a Gross National Product (GNP) loss of approximately $35-45 billion.[1,2] Although not all of this GNP loss can be ascribed to the embargo, the interruption contributed significantly to increases in the consumer and wholesale price indices. In addition, the GNP loss was reflected in higher unemployment and stagnation in several sectors, including automobile sales and housing starts, which exacerbated the economic downturn believed to have started in late 1973. During this period, the embargo prevented real growth that probably would have stabilized unemployment and provided a stronger base for eventual economic recovery.

The United States is now more vulnerable to a petroleum supply interruption than it was in the fall of 1973. In responding to that interruption, many relatively easy steps to conserve energy were taken, and significant improvements in energy efficiency have been achieved. Higher energy prices, natural gas shortfalls, and continued uncertainty about the availability and prices of alternative forms of energy have induced many energy users to restrict their energy consumption and emphasize more effective energy management practices. However, additional improvements will require substantial investment, longer lead times, and even more intensive energy management. Moreover, the program to convert oil- and gas-fired utilities and industrial plants to coal will have converted many plants to coal, which will largely preclude further conversion to coal during a future supply interruption. Some estimates have shown that a future supply interruption of the magnitude of the one in 1973-74 could cause a reduction in GNP that, in terms of employment impact, would be equivalent to the loss of jobs for 2 million workers. Economic effects would not be limited to some geographical areas or industries but would affect the entire nation.

Standby supplies of petroleum have been proposed repeatedly as a way to buffer the impact of future supply interruptions. The National Petroleum Council (NPC),[3] Ford Foundation,[4] and the Energy Laboratory at the Massachusetts Institute of Technology (MIT)[5] have allrecommended this action. In addition, the International Energy Program (IEP) agreement, which the United States has entered into with 17 other energy-importing countries, provides for the establishment of this type of reserve. Although the western European countries and Japan have developed stockpiles, the only appreciable stocks in the United States are working inventories.

The concern voiced by these organizations as well as the public, in addition to the nation's formal commitments to the IEP, provided strong impetus for passage of the Energy Policy and Conservation Act of 1975 (P.L. 94-163), which provides for the creation of the Strategic Petroleum Reserve. The Cote Blanche ESR storage facility provides 27 million barrels of the SPR requirement.

## 4.8 REFERENCES


1. The Economic Impact of an Interruption in United States Petroleum Imports 1975-2000; CRC 245; Center for Naval Analysis, Naval Warfare Analysis Group; by Randall G. Holcombe, Nov. 1974.

2. Emergency Preparedness for Interruption of Petroleum Imports into the United States; National Petroleum Council Committee on Emergency Preparedness, by Carrol M. Bennet, et. al.; Sept. 1974.

3. Petroleum Storage for National Security; National Petroleum Council; Aug. 1975.

4. Time To Choose America's Energy Future; Ford Foundation; 1974.

5. Energy Self-Sufficiency: An Economic Evaluation; Massachusetts Institute of Technology, Energy Laboratory Study Group; 1974.

## SECTION 5.0

## MITIGATIVE MEASURES AND UNAVOIDABLE ADVERSE IMPACTS

### 5.1 INTRODUCTION AND SUMMARY

In section 5.2, several mitigative measures are recommended that could moderate adverse impacts on both the natural and man-made environment. Adverse impacts that cannot be avoided, despite these mitigative measures, should the Cote Blanche site be included in the Strategic Petroleum Reserve Plan are summarized in sections 5.3, 5.4 and 5.5. Specific impacts have been previously discussed in section 4.0.

## 5.2 MITIGATIVE MEASURES AND CONTROLS AVAILABLE TO LIMIT ADVERSE EFFECTS DURING CONSTRUCTION AND OPERATION

The following measures are available to minimize the extent and significance of potential adverse project impacts. Measures that are intended to be an integral part of the project design or are required by law are included in section 4.0, rather than as mitigative measures.

### 5.2.1 Site Preparation, Construction and Design

#### 5.2.1.1 Erosion Control

1. Soil erosion during grading and excavation may be controlled by diverting surface runoff away from the construction and spoils areas to the barge slip and marsh.

2. After grading, measures taken to control soil erosion may include temporary vegetative cover, muching, gravel cover, and riprapping.

3. During all construction activities, movement of vehicles can be controlled to protect natural vegetation, seeded areas, and erosion control structures. Vehicles should cross drainageways only where culverts are provided.

4. In order to check the effectiveness of the erosion control measures, water quality may be monitored at appropriate locations as part of the construction program.

#### 5.2.1.2 Air Quality

1. Burning of waste timber, brush, and other waste materials can be carried out in compliance with all applicable regulations. Whenever practicable, other methods of disposal (shredding or mulching) can be used rather than burning of vegetation.

2. Internal combustion engines can be maintained in good mechanical condition to reduce gaseous emissions.

3. Dust emissions from the batch concrete plant can be controlled by techniques reflecting the best available engineering practices.

4. Areas used by heavy equipment may be gravel surfaced and sprinkled when necessary to control dust. Main roadways should be paved and maintained.

#### 5.2.1.3 Water Quality

1. A temporary cofferdam can be installed in the barge slip to control siltation during dredging and deepening.

2. The bank of the canal adjacent to the barge docks can be protected against erosion by additional riprap.

5.2.1.4 Habitat Quality

1. In clearing the transportation and pipeline rights-of-way, only small trees and shrubs should be removed. No growth retardants, chemicals or herbicides should be used during construction.

2. Buffer strips of natural vegetation can be preserved along the forests and canal banks wherever possible to provide wildlife habitat and minimize erosion.

3. Original topsoil removed can be separated and later replaced and reseeded with native grasses when appropriate.

4. After completion of construction, all areas disturbed by construction and not required for permanent facilities can be landscaped and seeded to be compatible with the original terrain and to provide wildlife habitat.

5. Dredge spoil removed from creation of new barge slips may be used to create new marshland islands in West Cote Blanche or Vermilion Bay or used to refurbish areas with high rates of erosion.

5.2.1.5 Oil Spill Containment and Prevention

1. A portion of the barge slip can be dedicated to receipt of spilled oil. A permanent boom can be placed to contain oily water at the surface for skimming and storage in a waste oil sump.

2. Diversion dikes or channels can be constructed to divert any oil spillage to a boomed containment area in the barge slip.

3. Dredge spoil may be placed at the southern end of the barge access canal to improve the containment potential of the canal in case of a large oil spill.

4. Water level in the mine sump can be maintained above the level of the oil pipes to provide a water seal in case of a shaft collapse.

5.2.1.6 Pump Shaft Integrity

1. A berm or other raised barrier can be placed around the entrance of the shaft and a cover placed over the pump shaft to prevent flooding.

5.2.1.7 Socioeconomic Conditions

1. Transportation can be provided from nearby communities to minimize the local traffic generated during peak construction periods.

2. Transporation can be provided from the ferry to the construction site to minimize delay in crossing the ICW.

3. Construction work shifts can be scheduled to avoid or minimize adverse effects on local highway traffic.

4. Consideration may be given to providing temporary housing on the island during the peak construction period if local housing is unsuitable or not available.

5, If temporary mine shutdown is required, contractors may be encouraged to hire displaced mine workers.

5.2.2 Operations

5.2.2.1 Water Quality

1. During operation and storage of the oil, observation wells may be monitored regularly to detect changes in water table elevation or contamination of the aquifer.

5.2.2.2 Habitat Quality

1. Permanent fencing can be limited to that necessary to maintain security of plant structures.

2. No firearms or hunting should be allowed on project lands.

5.2.2.3 Oil Spill Control

1. Oil lines can be purged at the storage site in case of a hurricane.

2. Vapor control systems can be installed to minimize the release of hydrocarbons to the atmosphere during transport of oil (see section 5.2.3).

5.2.3 Vapor Control Systems

The release of hydrocarbon vapors to the atmosphere, either by flaring or venting, affects project impacts in two ways. First, the hydrocarbon vapor represents an irretrievable loss of petroleum resources from the SPR system. The loss is estimated to be 0.3 percent of the potential cavern storage capacity from an uncontrolled system -- a total of 381,000 barrels (equivalent) for five fill/withdrawal cycles (section 7.5.2). Second, vapors which are not flared contribute a significant amount of hydrocarbons to the atmosphere in southern Louisiana, where hydrocarbon concentrations are already high. The quantities of unflared hydrocarbon emissions contributed to the atmosphere from an uncontrolled system are estimated to be: 1) a maximum rate of 126 BPD; 2) a maximum annual emission of 18,910 barrels; and 3) a total release of 186,420 barrels of oil during the project lifetime (section 4.3.3.2).

Technology exists to significantly reduce the amount of vapors lost from the storage and transportation system. For example, a vapor blowback system involves simply a return line for gas flow between two petroleum reservoirs exchanging fluid. The gas expelled from the receiving reservoir is returned to the originating reservoir so that, in theory, the entire system is closed. Allowing for system leaks, 95 percent recovery should be achievable. This system would be most easily implemented at the Cote Blanche barge docks and could be used for filling and withdrawal. A method of clamping the return lines onto the barge vents would be required. The system would be relatively inexpensive to construct.

Another system of vapor recovery is a vapor condensation unit. A condensation unit compresses the gases to 3 or 4 atmospheres, liquefying most of the petroleum vapors which are then recovered and reinjected into the cavern under pressure. The compressed air must eventually be returned to the atmosphere, and some petroleum is flashed off. The system's efficiency may range from 60 to 85 percent petroleum recovery. This systemwould be most easily implemented at the Mississippi River transfer terminal near Venice, especially if the oil transfer were accomplished at a shore dock facility. It is also possible that a condensation system would be utilized in place of venting through a flare during cavern fill at the storage site to eliminate loss of vapors and to provide a means of continuous control of cavern storage pressures. A vapor condensation system requires a considerable capital investment, depending on the size of the unit required.

A third possibility is to flare the vapors before release, at a safe distance from the oil. Flaring essentially eliminates air quality effects but does not allow hydrocarbon recovery. A fourth possibility is permanent ballasting of tankers. This would reduce hydrocarbon emissions associated with transfer activities at Venice and would also eliminate ballast discharge at the lightering site in the Gulf. All of these technologies for vapor control and recovery described above are state-of-the-art.

At present, most crude oil facilities do not handle sufficient quantities of oil to justify extensive vapor control systems. Also, existing state air quality regulations in Louisiana and Texas (locations of major crude oil facilities) specifically exclude crude oil facilities from control. Adaptation of existing technology would be feasible for the Cote Blanche oil storage system and may be economically advantageous.

As estimate of the mitigative effects of vapor recovery may be made by assuming the following: 1) at the Cote Blanche storage site, install a reversible vapor blowback system with 95 percent efficiency (except initial volume of cavern saturated with light hydrocarbons, assumed lost); 2) at the Mississippi River transfer terminal, install a vapor condensation unit with 60 percent efficiency; 3) losses during transfer between VLCCs and tanker in Gulf of Mexico and in transit on tankers and barges assumed unrecoverable and unsafe to flare.

The mitigative effects of such a system may be expressed in terms of the reduction in hydrocarbon release to the atmosphere and a reduction in total loss of hydrocarbons from the Cote Blanche system. The reduction in estimated hydrocarbon release to the atmosphere may be summarized as follows: 1) maximum system daily emission rate reduced by 38 percent to 78 BPD; 2) maximum annual release to the atmosphere reduced by 30 percent to 13,200 barrels of oil (equivalent); and 3) total release of hydrocarbons to the atmosphere during the project lifetime reduced by 33 percent to 125,000 barrels of oil. The reduction in total hydrocarbon loss from the Cote Blanche storage system would be approximately 62 percent to 144,400 barrels over the life of the project.

## 5.3 UNAVOIDABLE ADVERSE IMPACTS ON PHYSICAL AND SOCIOECONOMIC ENVIRONMENTS

### 5.3.1 Land Impacts

The area in the immediate vicinity of the existing Cote Blanche salt mine will be withdrawn from use for salt production for the life of the Strategic Reserve Plan. Access to the site will be controlled by the FEA for reasons of safety and security of the stored oil. About 40 acres of the island will be occupied by aboveground structures and barge facilities for the new storage and new salt mine facilities. These structures include new mine buildings and parking lots, a new conveyor belt system, the storage pumphouse, electric substation, enlarged barge slips and barge loading docks with associated fill-withdrawal pipelines.

During construction, another 2 acres will be disturbed temporarily by mine modification activities for equipment set-up facilities and a temporary landfill site.

### 5.3.2 Water Impacts

During construction, some siltation of the barge slip and access canal will occur despite efforts to prevent erosion. Minor reduction in water quality will temporarily occur in the slip due to increased turbidity and suspended solids during site excavation and grading. No toxic materials or heavy metals are expected to be resuspended into the water column during upgrading of the barge slip.

Consumptive use of water by the oil storage facility during operation will be small. Mine modification and new mine development should require less than 35 gallons per minute. This water will be required for mixing cement, sanitary and other miscellaneous uses. During operation, little or no water use at the storage facility will be required. Consumptive use of water at the new salt mine will be the same as that currently being used for mine personnel and sanitary facilities.

### 5.3.3 Air and Noise

Dust and noise typical of mining construction activities will be created, particularly during the site preparation activities and when explosive blasting and refrigeration compressor operations will be necessary. Small amounts of emissions will be produced from open burning, engine exhaust and the new salt mine facilities. The applicant is commited to minimize such effects and to comply with local and state regulations and standards.

During facility operation, atmospheric emissions will occur as a result of transportation of oil and transfer between vessels and the storage cavern. Even with the use of appropriate vapor control systems, significant quantities of hydrocarbon vapors will be released to the atmosphere (section 5.2.3). Measurable increases in hydrocarbon concentrations will occur for a distance of 10 to 15 miles downstream of the transfer terminals, and there will be a potential for increased photochemical reactivity and ozone formation in coastal Louisiana.

No significant increases in ambient noise levels due to construction or operation of the project will be experienced on public thoroughfares or in residential areas. There will be some increase in noise level at the construction site, however.

### 5.3.4 Other Effects

Trucking and other vehicular traffic will increase during construction of the project. The level of traffic will depend on provisions made to bus employees to the site or to provide temporary quarters on the island. Local traffic levels are light enough to allow some increase in traffic without significant impact.

During operation of the storage site, barge and tug traffic between the oil terminal points and Cote Blanche will increase. The ICW is capable of handling these traffic levels without significantly increasing the accident rate (Appendix G). The demand for barges and barge crews, especially during emergency withdrawal of oil, will create shortages along the Gulf Coast. These shortages will be more acute should the Weeks Island storage facility be in operation simultaneously.

A system of priorities may have to be established to meet the temporarily high demand for barge capacity.

Other adverse effects on the community will be related primarily to the temporarily increased demand for housing. Due to the general shortage of vacancies in the area, construction workers from outside the region may have to commute relatively long distances to the site.

Because of the low profile of the existing and new facilities required on Cote Blanche, these structures will be concealed by the tree-covered terrain of the island. Landscaping could further improve the visual aspect of the facility. In some areas (especially from the southwest) the facilities may be visible from boats in the access canal or bay. Flaring may also constitute a visual impact in the immediate area, especially when the gases are burned at night, but will not be visible from inhabited areas.

Should a decision be made to temporarily close down the existing mine operations, an estimated 60 employees would not be able to find suitable work in the area. Despite efforts to hire as many of these as possible for project construction, many will not be suited to the jobs available. Resulting social and economic impacts for these individuals and their families will likely be severe, though of relatively short duration.

## 5.4 BIOTIC EFFECTS

### 5.4.1 Terrestrial

Small animals such as rabbits and rodents will be displaced from the immediate site area affected by construction activities. Most of these animals should return to the area during facility operation.

About 40 acres of terrestrial habitats (vegetation) will be lost on Cote Blanche, which is a small fraction of existing habitats on the island. Habitat quality of the affected acreage is generally poor relative to the remainder of the island.

### 5.4.2 Aquatic

The aquatic biota in the existing barge slip will be affected to some degree during excavation and grading of the barge slip, docks, and terminal facilities. No information is available on the numbers of benthic invertebrates that currently inhabit the barge slip and access canal, but it is not expected that the present population will be significantly affected beyond the immediate area of the present slip. Currently the slip is dredged every 2 years to maintain channel depth.

Increased barge traffic during fill and withdrawal will increase bank erosion and further stress water column and substrate populations due to increases in turbidity. Because present conditions are not suitable for productive commercial or sport fishery species, the increased traffic should not have a substantial impact on fish populations.

## 5.5 OIL SPILL IMPACTS

The risk of oil spill incidents is described in some detail in section 4.3.8. Normal operations are not expected to have regionally significant adverse impacts on the environment because of the relatively small volume of oil release expected, the improbability of large spills (greater than 2000 barrels) and the expected effectiveness of oil spill contingency plans. Oil storage in underground salt caverns, as at Cote Blanche, is probably the safest storage technique available.

There is a very slight chance that a major spill (5,000 to 60,000 barrels) may occur during barge transport of the oil. The oil spill contingency plan is designed to minimize impacts of such an occurrence.

## SECTION 6.0

## RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

### 6.1 INTRODUCTION AND SCOPE

This section describes the relatively short-term uses of the local environment that are implicit in the construction and operation of the proposed oil storage facility at Cote Blanche Island and the expected effects on maintenance and enhancement of long-term productivity. Based on the analysis in the previous sections of this statement it is concluded that the proposed uses of the site and its environs would not significantly affect the long-term productivity of the environment.

The principal short-term use of the Cote Blanche Mine will be the underground storage of petroleum for use during a period of national emergency. This oil storage will contribute to the short-term availability of petroleum resources should the nation's foreign supplies be reduced, thus providing an element of stability and security to our economy and to our national well-being. The use of Cote Blanche for underground oil storage will add a potential reserve of 27 million barrels of oil for immediate use in the future. This amount will account for approximately 5 percent of the storage requirements as detailed in the Energy Policy and Conservation Act of 1975.

There is no current experience in the United States to indicate any stress to the environment that would occur due to underground oil storage. Long-term studies and experience in European countries indicate that no harmful effects can be expected using current technology. The increased storage potential may enhance both the short- and long-term economic productivity of the nation by reducing the threat of an oil supply interruption, promoting international stability of oil supply and freeing national resources for the development of alternative energy supplies. With adequate safety and monitoring measures for fire prevention and to prevent the leakage of oil into the ground water system or to the surface, no localized harmful effects are expected.

On the other hand, it is recognized that chronic or high-level pollution from possible accidental oil spills could have adverse impacts in certain areas. It is difficult to quantify these impacts or to estimate the short- or long-term effects of major oil spill, since these effects would depend upon the location and fate of the spill. Data provided on expected average spill rates and on maximum credible spill impact indicate that significant environmental damage should be localized and not affect regional resource values (section 4.3.8).

If the Cote Blanche Mine is developed for storage, approximately 5 surface acres and all salt within 150 feet of the existing mine caverns would be eliminated from future salt mining (at least until the caverns are no longer used for oil storage, see section 7.5). This removal will result in a reduction in the long-term mineral resources available to the local miners and the mine owners. However, the salt mine will be relocated to an area above the oil storage cavern and available salt resources, both on the island and in the United States, are sufficient to allow continued mining during the foreseeable future.

Disturbance of 40 acres of island terrain for construction of new barging and surface facilities will decrease the productivity of these areas for at least the life of the project. The habitats to be affected are already disturbed by industrial and shipping activities, however, and do not represent a unique or especially valuable resource.

## 6.2 EFFECT ON NATIONAL ECONOMIC PRODUCTIVITY

The Cote Blanche oil storage facility will provide a potential reserve supply of about 27 million barrels of petroleum during the 20- to 25-year operating life of the facility. This oil will provide some measure of certainty in meeting the projected national energy needs of government, industrial, commercial, residential and other users.

Construction and operation of the storage site will thus increase available standby energy; the beneficial effect on economic productivity will be large compared to the loss of mineral salt resources, agricultural, forestry, recreational or other potential uses of the site. Substantially increased payrolls and, possibly, increased property taxes will have a beneficial economic impact on the surrounding parishes in Louisiana.

Should temporary closing of the Domtar Mine be selected as the development option, there will be a significant short-term loss of economic productivity for those workers not able to find suitable alternate employment.

## 6.3 ADVERSE IMPACTS ON PRODUCTIVITY

### 6.3.1 Impacts on Land Use

Construction and operation of the storage area will remove about 40 acres of land and a relatively small volume of salt from other uses for the life of the storage site. Salt is the primary resource of Cote Blanche Island. Surface productivity of the island is utilized as pasturage for cattle; this use will be unaffected by the proposed action. Most of the land area affected can be restored to its present use when the project is terminated or abandoned. No unique, threatened, or endangered species of plants or animals should be affected by the project.

### 6.3.2 Impacts on Water Use

Construction and operation of the project is not expected to be detrimental to commercial and recreational uses of the Intracoastal Waterway or the Vermilion-Cote Blanche Bay Complex, except in a minor way during construction and modification of the barge slip and loading platforms or in the case of a major oil spill.

### 6.3.3 Impacts on Air Resource Uses

Operation of the project with uncontrolled release of hydrocarbon vapors from barges and tankers during oil transfer and transportation will produce a significant increase in atmospheric hydrocarbon loading, at least in the vicinity of the primary transfer terminals. This increase could affect the selection of future industrial sites in areas which experience noticeably increased hydrocarbon or ozone concentrations as a result of the project. This impact should be of greatest significance within 5 to 10 miles of the transfer terminals.

## SECTION 7.0

## IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

### 7.1 INTRODUCTION

Irreversible commitments of resources generally concern changes caused by the proposed action that cannot be altered at some later time to restore the original value of these resources. Such irretrievable commitments consume resources that are not recoverable for subsequent use.

## 7.2 COMMITMENTS CONSIDERED

The types of resources affected by the underground storage of oil can be described as: 1) material resources, for example, renewable and nonrenewable resource materials consumed in construction and operation, and 2) natural resources, including any recognized beneficial uses of the environment. Resources that may be irreversibly committed are: 1) plants and animals destroyed on and around the site; 2) construction materials and energy that cannot be recovered or recycled; 3) materials consumed or reduced to waste products; and 4) land areas removed from present uses.

## 7.3 LAND RESOURCES

Land areas that will be removed from present use for oil storage total about 40 acres. Except for areas occupied by the pumphouse, pipelines, and other small structures, which will be situated on about 5 acres of the site, and the enlarged barge slip (6 acres), this land could readily be converted to other uses when the aboveground facilities are no longer needed.

## 7.4 WATER AND AIR RESOURCES

The expected release of hydrocarbon vapors as a result of uncontrolled venting during transfer and transport of oil to and from the storage cavern is described in section 4.3.3.2. Other releases to the atmosphere are of relatively minor significance.

During plant operation, air resources must be used to receive these discharges. As planned, no liquid or solid wastes will be discharged to the waterways surrounding Cote Blanche during oil storage, filling, or withdrawal. Oil spill releases are expected to be relatively minor, of local importance, and of temporary impact. No irreversible commitments of air or water resources in the region are necessary for the proposed project.

## 7.5 MATERIAL AND ENERGY RESOURCES

The primary resource irretrievably committed in storing petroleum in the Cote Blanche Mine is the energy required to create the reservoir and to store and recover the oil. This includes the energy content of the materials used and the energy required to restore salt production at the present production level.

Some material resources, such as metals used structurally or in piping, concrete, salt that is no longer minable, and petroleum lost or abandoned, may also be irretrievably committed. However, unlike energy which cannot be recycled, materials may be physically retrievable, though often not economically retrievable. Both oil-contaminated salt, and salt-oil sludges can be refined to recover the physical materials in a useful form. Metals can be recycled. However, to be conservative, it will be assumed that the mine will never be reentered. After abandonment, all materials beyond the shaft seal will be considered as economically irretrievable. Estimates are provided only for the option of no mine shutdown, which requires a new pump shaft and therefore the greatest commitment of material and energy resources

### 7.5.1 Material Resources

If the minimum safe distance between adjacent mines is considered to be 150 feet, then a 150-foot layer of salt around the mine is excluded from future recovery. This barrier distance can be used to estimate salt deposit resources lost. Alternative thicknesses, from 100 to 300 feet, may eventually be adopted as a safety standard. The 150-foot measure has been selected since this is the approximate barrier radius around oil well shafts penetrating the salt mines. A complicating factor is that the Cote Blanche salt dome is not wide enough to accommodate another mine at the same level. Consequently, the resource effectively excluded from dry mining consists of the entire content of the dome between depths of 1140 and 1520 feet. This is about 9 billion cubic feet, of which about 2 percent has been excavated. Thus about 560 million tons of salt may be considered lost to future production (solution mining is still possible). In comparison, the amount of salt contained in the dome to a depth of 3500 feet is roughly 5600 million tons, or 10 times the excluded deposit.

The surface area of the mine includes about 2 million square feet of floor surface, an equal area of ceiling surface, and up to about 6 million square feet of wall surface. If an average of 0.1 inch oil residue is left on the walls and 0.25 inch on the floor after withdrawal, about 16,000 barrels, or 0.06 percent of the storage capacity would be unrecoverable. In actuality, because of sludge buildup, about three times this amount may become unrecoverable (0.2 percent).

Estimates of construction material irretrievably committed total about 800 tons of steel and 15,000 tons of concrete, including two shafts for a new salt mine

### 7.5.2 Energy Resources

The energy consumed directly in construction is estimated at 9.0 million horsepowerhours; in addition, energy is required to supply the 800 tons of steel and 15,000 tons of concrete that will be irretrievably lost. Barge power required in filling and emptying the cavern is measured at slow (energy efficient) water transportation rates of 350 BTU/ton mile for inland barges, assuming 5 full fill/withdrawal cycles over the life of the project. Tanker transport is estimated to require 750 BTU/ton mile for the short hauls expected. Tabulated gross energy values include:

| | Millions of BTU (includes energy lost in conversion) |
|---|---|
| Direct Construction | |
| Storage cavern shaft | 125,000 |
| New mine shafts and barge slip | 161,000 |
| Steel (800 tons structure) | 32,000 |
| Concrete (15,000 tons) | 90,000 |
| | 408,000 |
| Indirect Construction | |
| Labor support | 62,000 |
| Steel (manufactured, recoverable, 200 tons) | 8,000 |
| | 70,000 |
| Barge and tanker transport ($10 \times 10^9$ ton miles) | 4,190,000 |
| Loading, unloading | 823,000 |
| | 5,013,000 |

The tabulations indicate that about 500,000 MMBTU (million BTU) are consumed in converting the cavern and relocating the salt mine, and $5.0 \times 10^6$ MMBTU are expended in handling the oil (5 storage cycles). In terms of crude oil equivalence content (5.5 MMBTU/barrel), the potential oil resource use is:

| | |
|---|---|
| Construction -- 0.067% of potential cavern storage capacity | (91,000 bbl) |
| Handling (five cycles) -- 0.67% of potential cavern storage capacity | (911,000 bbl) |
| Oil not recovered from cavern -- 0.04% of potential cavern storage capacity | (56,000 bbl) |
| Oil released in evaporation during transportation of oil by barge and tanker -- 0.138% of potential cavern storage capacity | (186,420 bbl) |
| Oil released by flaring during cavern fill -- 0.144% of potential cavern storage capacity | (194,400 bbl) |
| Spill expectation during project lifetime -- 0.002% of potential cavern storage capacity | (2720 bbl) |
| Maximum credible spill -- 0.04% of potential cavern storage capacity (assumed to occur for analysis of worst case conditions) | (60,000 bbl) |
| Total -- 1.11% of potential storage capacity, where total potential storage capacity is 135 million barrels | (1,501,540 bbl) |

The energy used is irretrievable. It represents an investment of less than 1.2 percent of the storage capacity to help prevent future drastic reductions in energy availability as a result of arbitrary decisions made by foreign suppliers.

## 7.6 BIOTIC RESOURCES

Construction of the oil storage facility and its associated barge slip, docks, and pipelines will result in habitat alterations that will cause some displacement and/or loss of the plants and animals from approximately 40 acres for the Cote Blanche Island activities. A temporary disruption of the benthic organisms in the existing barge slip will occur during dredging and if erosion from construction areas is extensive. These impacts will be limited to the existing access slip. None of these losses will be significant compared to the total extent of these resources in the Cote Blanche-Vermilion Bay Complex. It is not expected that there will be any effect on cattle or sheep grazing on the island during the normal operating life of the oil storage program. No endangered, threatened, or unique wildlife or vegetation will be affected.

## SECTION 8.0

## ALTERNATIVES TO THE PROPOSED ACTION

### 8.1 INTRODUCTION

The purpose of this section is to consider the environmental impacts associated with alternatives available to the proposed storage facilities at Cote Blanche Island. Alternatives to the proposed program available to the FEA can be characterized under two main categories: 1) nonstructural alternatives; and 2) structural alternatives. Nonstructural alternatives refer to those other federal programs that can be considered as alternatives to the Strategic Petroleum Reserve. These have been treated at length in the FEA Environmental Impact Statement on the programmatic aspects of the Strategic Petroleum Reserve Program (DES-76-2, 1976). These alternatives include programs such as: 1) accelerated development of presently unavailable domestic energy resources; 2) energy conservation; 3) substitution of available domestic energy sources for imported oil; and 4) no action. These are not actually alternatives to the Cote Blanche Mine; they address the larger question of optimum program policy.

## 8.2 STRUCTURAL ALTERNATIVES

Structural alternatives available to the FEA can be discussed both in terms of alternatives to the program (alternate storage methods and alternate mine sites other than Cote Blanche Island) and alternative methods for developing the Cote Blanche facility (design changes in the oil distribution system).

### 8.2.1 Alternative Storage Methods

The programmatic Strategic Petroleum Reserve EIS (DES-76-2, 1976) includes consideration of all feasible oil storage methods and their impacts, including relatively small volume product storage in above-ground tanks and high-volume crude storage in underground caverns. Alternative storage methods include use of 1) existing and new solution-mined caverns in salt domes; 2) existing and new conventional mines; 3) existing and new conventional storage tanks; and 4) surplus oil tankers.

### 8.2.2 Alternative Storage Sites

During any future oil import interruption, SPR crude oil will have to be distributed to refineries in each of three major markets: East Coast and Caribbean via tanker ship; inland via the Seaway, Texoma and Capline pipelines; and the Gulf Coast refinery complexes (Freeport, Port Neches and St. James). The Cote Blanche salt dome storage site is one of a group of five sites within the eight candidate ESR sites which can service all three markets, including each of the three pipelines (see Figure 8.2-1). Of the eight sites there are only five candidate sites which can supply both the Gulf Coast, and the Caribbean and East Coast markets. Based on current demand, these two markets combined would, in the event of a supply interruption, require approximately 75 percent of the 150 million barrels in the ESR, or about 110 million barrels. Together the five sites have an existing capacity of approximately 330 million barrels--well above the 110 million barrels needed for the two markets.

Site selection, therefore, will involve a two-step decision-making process. The first decision in the site selection process will be to choose two or three of the five sites for the purpose of satisfying the ESR needs of the Gulf Coast, the East Coast and the Caribbean. These five candidate sites are thus alternatives for accomplishing this purpose. Site specific EISs have been prepared for all five alternative candidate sites. The impacts which would result from development of each of the other four candidate sites are described briefly in Sections 8.2.2.1-8.2.2.4. The individual statements should be consulted for a detailed assessment of these impacts.

The second step of the site selection process will involve choosing sites to satisfy the ESR requirement for the inland refineries. The remaining three of the eight candidate ESR sites are unique in that oil from them could be distributed only to the inland market area because they are "downstream" on major crude oil transmission pipelines. One would connect with the Seaway pipeline market area, while the other two would service the same part of the inland market area served by the Capline pipeline. Because of their ability to supply this inland market, those of the five candidate sites which are considered in the first step of site selection, but are not selected in that process, would be considered again as alternatives to the three inland market sites during the second step in the site selection process. EISs are now in preparation for the additional three inland sites which will be considered.

The future site selection for the longer-range portion of the SPR program will be very similar to the process described above for the ESR. Candidate sites will be grouped geographically according to market and distribution requirements. Each group will comprise a set of alternative sites, and EISs will be prepared which compare the impacts of developing each site. Those among the first eight which are not selected for the ESR will be considered as alternative storage sites for the longer-term phase of the SPR if they were rejected as ESR sites for reasons other than unsuitability for oil storage; e.g., if they were found to be unavailable for the ESR within the required time frame.

8.2.2.1 West Hackberry

Converting existing solution-mined cavities in the West Hackberry salt dome to a 60-million barrel oil storage facility would require drilling three new wells for oil injection and 11 brine disposal wells, and constructing a temporary barge dock on Alkali Ditch as well as a new tanker terminal on the Calcasieu River with connecting oil pipelines to the site. Displacement water for oil withdrawal would be pumped from Black Lake Bayou. The construction and operation of these facilities would cause several unavoidable disturbances, but no long term environmental effects. The most significant of these are displayed in Table 8.2-1 and discussed below for storage site construction, brine disposal, dock facilities and pipelines, displacement, marine operations, and facility operations.

Storage Site Construction

The storage site itself would require three new wells, two 10,000 barrel brine surge tanks, pump and office buildings, and access roadways. Since the land is now used for industrial purposes, no major land use changes are anticipated. However, the construction activity would temporarily disrupt soils around the storage site and cause an increase in erosion and runoff which would diminish local water quality. Over the course of construction, the level of suspended solids are expected to increase just over 2 percent.

Construction equipment would temporarily reduce on-site air quality with increased concentrations of carbon monoxide (CO), sulfur dioxide ($SO_2$), nitrogen oxides ($NO_x$), hydrocarbons (HC), and 0.3 tons of particulates per month. Only the HC might exceed primary air quality and standards.

Since the land is classified as already highly disturbed, the water, air, and noise impacts are not expected to affect vegetation, wildlife, or aquatic biota significantly.

Construction of the storage site facilities and brine disposal wells together would generate 700 man-months of labor in the Lake Charles area, which would result in approximately $1.2 million in wages. Although local traffic would increase somewhat during the construction period, no significant adverse impacts on community facilities or local housing are anticipated.

## Brine Disposal

To dispose of the brine now in the West Hackberry dome cavities would require drilling 11 brine disposal wells and installing two 10,000-barrel surge tanks as well as a 10,000-foot pipeline between the storage site and disposal area. The brine disposal area would include 25 acres of pasture and 10 acres of marsh; filling the marsh would reduce fish and shellfish production by as much as 1,650 pounds annually.

Brine injection would increase salinity in the disposal aquifer by one part per thousand (ppt). Fracture of the overlying rock is not likely at standard brine injection rates, but brine could seep into the Chicot Sands fresh water storage area if old wells around the disposal area were not adequately plugged.

An alternative to injection wells for brine disposal would involve a brine pipeline running 20 miles to the Gulf of Mexico and would protect the geology and water quality near the site but would increase salinity in the Gulf to a maximum of 3.5 ppt 16 feet downstream of the diffuser and 0.1 ppt over a 250-acre area. Construction would temporarily disturb soils and lower water quality along the pipeline route, crossing the Sabine National Wildlife Refuge.

## Dock Facilities and Pipelines

The proposal for storage at West Hackberry calls for the construction of a temporary barge dock on Alkali Ditch and construction of a new tanker terminal on the Calcasieu River, connected to the storage site by a four-mile pipeline. The temporary facilities at Alkali Ditch would include two 1,000-barrel surge tanks (one for oil and one for brine), while the facilities at the tanker terminal would include a total of six tanks - two 100,000-barrel oil surge tanks, two 100,000-barrel ballast holding tanks, and two 15,000-barrel tanks for emulsion treatment. Construction would require dredging 35,000 yards of material from Alkali Ditch and 1 million yards from the Calcasieu River Channel. This could increase levels of turbidity, toxic sulfides, heavy metals and arsenic, as well as pesticides and other toxic hydrocarbons in bottom material. Disposal of the dredge spoil would destroy 90 acres of marshland. Maintenance dredging would also be required at both sites.

Construction of the proposed dock and pipeline facilities would require about 700 man-months of labor over approximately one year. The payroll for this aspect of the project would be about $1.2 million.

Paint solvent emissions from the preparation of the facilities would exceed standards at 2 kilometers from the site.

As an alternative, the existing Lone Star Terminal could be expanded with a 12-mile pipeline to the storage site as an alternative to construction of a new tanker terminal on the Calcasieu River. Less dredging would be required, 660,000 cubic yards. The dredge spoil could be disposed of in a less sensitive area, an already disturbed abandoned industrial property. However, the longer pipeline would disrupt 180 acres of marsh and farm land, as opposed to 55 acres of farm land, would slightly decrease water quality in the marsh, and would eliminate an additional 312 tons of productive marsh materials.

Two additional alternatives that involve existing pipelines may be possible with minimal new construction. Connection to these pipelines would disrupt 70 acres of brackish marsh and 50 to 80 acres of rice farming, at an income loss of nearly $33,000 in the latter. A third alternative, a new pipeline to the Texoma terminal, would disturb more marsh and dry land than any other alternative. Associated dredging in the Sabine-Neches Waterway would temporarily eliminate bottom organisms and lower water quality in the vicinity.

Oil Displacement

Water to displace the stored oil would be taken from Black Lake Bayou at the rate of 10,650 gallons per minute for 150 days, which would increase salinity slightly and temporarily lower the surface of the lake. Intake structures would trap some small organisms, but water quality and ecology in the lake would be restored shortly after displacement was completed.

An alternative environmentally less desirable and more expensive than the use of Black Lake would involve groundwater from drilled wells. Drilling the wells would eliminate the use of coastal plain grasslands for one year, and pumping would depress the local water table and possibly contaminate groundwater temporarily with salt water.

## Marine Operations

Over the life of the project, the risk of oil spillage from accidents is the same for the proposed facility at West Hackberry as for the alternative of expanding the Lone Star Terminal, estimated at approximately 273 barrels for the tankship option and 3,087 barrels with the temporary barge system. Oil spills would destroy non-mobile species in their path, and leave a residual oily taste in fish caught in the vicinity. Vegetation contaminated by an oil spill would die but the contaminated area would revegetate itself within a couple of years.

Tanker and barge unloading during fill and tanker loading during withdrawal would result in the release of substantial amounts of hydrocarbons. During fill, barges and tankers would release 781 pounds per day and 8,286 pounds per day, respectively. During withdrawal, tankers would release 20,953 pounds per day. This would cause the Federal standard of 160 $\mu gm/m^3$ to be exceeded as far as 6 miles downwind for the barge operations, and for the tankers 30 miles during fill and 45 miles during withdrawal. Emissions from crude oil transfers are not regulated in the State of Louisiana.

## Facility Operations

The major impacts associated with facility operation would occur during fill and withdrawal. During these operations the oil storage tank at the barge dock and those at the tanker terminal would release hydrocarbons at rates of 588 and 500 pounds per day, respectively. This would cause the Federal standards of 160 $\mu gm/m^3$ to be exceeded as far as 3 kilometers downwind for the barge dock, and greater than 2 kilometers downwind for the tanker terminal. The storage phase of the program would cause no additional significant impacts.

Only ten people would be needed to operate the facility during the storage phase. During oil recovery operations, 20 to 30 people would be required.

### 8.2.2.2 Bayou Choctaw

Converting existing solution-mined cavities in the Bayou Choctaw salt dome into a 94-million barrel oil storage facility would require drilling 28 brine disposal wells, constructing related brine handling facilities, expanding an existing dock and storage tank facility on Bull Bay, constructing a new tanker terminal at Addis on the Mississippi River, and constructing an oil pipeline between the dock at Addis and the storage site. Water for displacement of oil during withdrawal operations would come from a small on-site lake. Although the oil storage reserve at the Bayou Choctaw salt dome would not likely cause long term adverse environmental impacts, it would alter the local environment in significant ways. These effects are displayed in Table 8.2-2 and discussed below for storage site construction, brine disposal, dock facilities and pipelines, oil displacement, marine operations, and facility operation.

#### Storage Site Construction

Construction of dikes, roadways, well-heads, and buildings at the storage site would require about 15 months and would disturb farm and swamp land and induce soil erosion, which will, in turn, increase turbidity and suspended solids in nearby waters. Resident wildlife will be forced to emigrate to a more tranquil setting until the construction activities cease.

Construction equipment would temporarily degrade on-site air quality with CO, $SO_2$, $NO_2$, HC, and particulates. However, resulting levels of these pollutants, with the possible exception of the hydrocarbon concentrations from drilling rigs within a downwind distance of 0.5 kilometers, would meet Federal and state primary standards. Point solvent emissions would be high, but do not exceed Federal three-hour standards and are not regulated in Louisiana.

#### Brine Disposal

The brine disposal system would consist of 28 disposal wells evenly spaced in a rectangular field of 1,150 acres. Brine would be collected in a 500,000-barrel holding pond for temporary storage and settling, and then piped 6,500 feet to the disposal area. Since the brine disposal area is located in a backwater swamp forest, 128 acres of which would be converted to industrial use, construction would result in a loss of wildlife habitat.

The major environmental risk in brine disposal is the danger of acquifer fracture, which could cause contamination of fresh water or interference with oil and gas production. During the filling process at the Bayou Choctaw site, 267 ppt brine would be injected at a maximum rate of 19,450 gallons per minute at depths of -5,000 to -7,000 feet. After 150 days of brine injection under average conditions, the bottom hole pressure would increase but remain well below the fracture pressure. Pressure throughout the well would tend to equalize when injection is stopped and thus cause the bottom hole pressure to decrease. After several fill and withdrawal cycles, the bottom hole pressure would steadily increase again but still remain below the fracturing point. However, in thin (50-foot) sand layers, where the average pressure build-up is greater, the bottom hole pressure would probably exceed the fracturing point during the fifth cycle. The likelihood of actual fracture varies with the potential for well clogging, which in turn depends on the chemical and biological compatibility of the injected brine and the saline water in the aquifer.

Some risk of fresh ground water contamination also exists where abandoned oil and gas wells provide passageways between a fresh water aquifer and the saline acquifer used for brine disposal. Two such wells, the conditions of which are unknown, lie within the brine disposal area. In the worst case, 15 million barrels of saline water could leak to the Plaquemine aquifer (a nearby fresh water supply) over 20 years. Relative to the capacity of the Plaquemine aquifer, such leakage is small, and careful inspection and replugging of the 2 abandoned on-site wells can avoid any negative impact.

As an alternative to deep-well injection, a 116-mile pipeline would carry the brine 20 miles into the Gulf of Mexico. Since it would follow an existing right-of-way, this pipeline would avoid many impacts associated with pipelines in general. Nevertheless, the pipeline would eliminate 182 acres of sugar cane (one harvest valued at $62,500) and a total of 350 acres of wetlands, an amount considerably more than that affected by the deep well injection of brine. Disposal of brine in the Gulf would increase salinity 0.1 parts per thousand over a 250 acre area and 2.5 ppt over one acre. Although bottom organisms would be destroyed in the diffuser area, they would repopulate shortly after disposal stopped.

## Dock Facilities and Pipelines

Barges serving the Bayou Choctaw site would use an existing barge dock on Bull Bay for the initial fill of the first storage cavern. The existing dock facility would be expanded by a new barge mooring ship and a new dock. In addition, a new tanker facility with mooring for two tankers would be constructed on the Mississippi River, southeast of Addis and 5 miles east of Bayou Choctaw. Six surge tanks and two ballast tanks would also be constructed at the tanker terminal.

Exapansion of the Bull Bay dock would have little impact; however, construction of the new tanker dock would require a 250-acre tract of already disturbed land and 30 acres of property planted in sugar cane. Dredging 86,000 cubic uards of bottom material in the Mississippi would moderately increase turbidity, toxic sulfides, heavy metals, hydrocarbons, ammonia, TKN, and COD at both the dredging and disposal sites. The dredging operations would destroy bottom organisms, and sediment settling would suffocate local mollusks and shellfish.

Oil for storage or distribution would be carried by a 5-mile pipeline between the docks and the storage site. The pipeline would temporarily disturb 30 acres of sugar cane and 25 acres of backwater swamp and thus cause temporary increases in turbidity. Ecological impacts would also be temporary since the pipelines would be buried and vegetation expected to return. Although a pipeline accident is very unlikely, an expected spill would release 16 barrels of oil, which would destroy local soil organisms.

An alternative to constructing a new tanker dock at Addis is to install a pipeline to an existing tank farm at St. James and expand the tanker terminal there. Most effects would be the same, but because it would require less dredging, this alternative would have less impact on water quality and aquatic ecology. In addition, since the river sediment is less polluted at St. James, the effects of dredge disposal would be further reduced. The pipeline itself, along an existing right-of-way, would have little impact on the environment. However, this alternative could prevent 127 acres of sugar cane production, valued at $43,000 (one harvest, requiring three years' growth).

Oil Displacement

Water to displace the stored oil would be taken from a 12-acre on-site lake, connected by canal to the Choctaw Bayou and the Int  oastal Waterway, that could accommodate displacement (115 million barrel  cycle) because of connection with these two waterways. No adverse eff  to water quality are expected in any of the waters. However, some aquatic species would become trapped during the pumping process, and more mobile species would emigrate from the area. Both types of species would return after displacement is completed.

An alternative to the lake as a water supply source is the Mississippi River. The ecological impacts of using this water source would be the same, and no adverse effects on river flow would occur.

A third alternative, to use ground water pumped from drilled wells, would have the greatest adverse impact. The water table would be lowered approximately 10 feet within a half mile of this well area, accompanied by loss of swamp productivity.

Marine Operations

The major potential impacts from the operations of tankers and barges is the risk of oil spillage from accidents and the hydrocarbons emissions from the various oil transfer operations. Marine operations include both the temporary arrangement of transporting the oil along the Mississippi River by tankship to Port Allen and by barge to Bull Bay, and the permanent use of only tankship docking at Addis.

Vessels loading and unloading would produce estimated total hydrocarbon emissions of about 2,000 tons occurring over about 2.8 years of initial fill operations or about 2,000 tons for each 150 day withdrawal operation. Although hydrocarbon emissions from vessel loading and unloading are not regulated in Louisiana, the downwind associated with these emissions would greatly exceed the three-hour Federal standard of 160 $\mu gm/m^3$ for considerable distance downwind (5-10 km) during worst case atmospheric conditions.

Statistical analysis of accidents and spillage indicates that expected spills from tankers alone would total 536 barrels, and the temporary combination of tankers and barges, 7,857 barrels in a single fill and withdrawal cycle.

The large difference between the two systems arises solely from the need for barges at the temporary Bull Bay dock; the risk from the tankship phase of the operation is the same for both the temporary and permanent phases.

Oil spilled from vessels in transit would temporarily contaminate sediment and might affect the taste of fish in the area. Vegetation contaminated by oil would die, but the area would revegetate within a couple of years.

The potential impact of oil spills would be essentially the same for permanent docks located at Addis or St. James. The shorter travel distance up the Mississippi to St. James is offset by the greater congestion at that terminal.

Facility Operations

Operations of the Bayou Choctaw storage site would have no significant impacts other than those associated with oil fill and withdrawal and related employment. Vapor losses from the oil storage tanks at the tanker and barge docks would exceed Federal three-hour standards up to 10 km downwind from the tanks. The Bayou Choctaw storage facility would employ 20 to 30 skilled workers during oil recovery operations (150 days) and 10 full-time employees for maintenance and site security during the storage phase.

### 8.2.2.3 Bryan Mound

Converting existing solution-mined cavities in the Bryan Mound salt dome into a 58-million barrel oil storage facility would require on-site construction; construction of pipelines between the site and the Seaway dock, the Seaway tank farm (both under construction), and the displacement water source (Brazoria and Harris Reservoirs). Although the oil storage facility at the Bryan Mound salt dome would not likely cause long term adverse impacts, it would alter the local environment in several significant ways. The most significant effects are discussed below and displayed in Table 8.2-3 for storage site construction, brine disposal, storage tanks, dock facilities, pipelines, displacement, marine operations, and facility operations.

#### Storage Site Construction

Construction of dikes, roadways, well-heads, and buildings at the storage site would affect some already disturbed land within the existing site. Turbidity and suspended solids would be increased, but since little resident wildlife is on the site, impact would be minimal.

Construction equipment would temporarily degrade on-site air quality with hydrocarbons, $SO_2$, CO and $NO_2$; approximately 0.5 tons per acre of dust per month would be generated from construction activity. Since the area surrounding Bryan Mound is industrially developed, air quality is often degraded and pollutant levels may exceed Primary Air Quality Standards by factors of 3-15.

#### Brine Disposal

The Dow Chemical Company would process the brine displaced during fill through two close-by chemical plants. If Dow could not take the brine, a 4-mile pipeline would carry it to the Gulf for disposal. The two miles of pipeline along a 100-ft. wide corridor would affect 24 acres of coastal prairie, beach, marsh and developed land. The installation of two miles of pipeline in the Gulf would destroy 24 acres of benthic habitat temporarily. Although the increased salinity from brine disposal in the Gulf would destroy bottom organisms in the diffusion area, they would repopulate shortly after disposal stopped.

A second alternative brine disposal method, deep well injection, would require ten wells spaced at 1000-foot intervals one mile outside the perimeter of the site and would require 20 acres of additional land. The adverse effects of this alternative include drilling noise for a 12-month period, a one percent chance of brine spill from pipeline or well-head failure, and the possibility that overpressurization would contaminate the freshwater aquifers.

Dock Facilities, Storage Tanks, and Pipelines

Oil supply and distribution would involve on-site storage tanks, a pipeline system, and dock facilities (including a 20,000 barrel surge tank). Thirty acres of land would be cleared. During construction, runoff would carry some petroleum, herebicides, pesticides, and sediment into adjacent waters. The painting of the four 400,000-barrel floating-roof storage tanks would cause a vapor plume one kilometer long and 200 meters wide on several days during a 90-day period, depending on winds.

The proposed method of crude oil supply and distribution is designed to utilize, under a common carrier contract, the Seaway dock facilities now being constructed east of Bryan Mound, and the Seaway tank farm facilities west of Bryan Mound. Initially, the facility would consist of three tanker docks, to moor tankers from 35,000 to 85,000 dead weight tons (DWT), and a 15,000,000-barrel tank farm, located 7 miles west-northwest of the harbor. Ultimately, the dock facility could be expanded to four docks and the tank farm to a 27,000,000-barrel capacity with pipelines for inland distribution to northwestern and mid-western United States markets. Constructing the 100,000-barrel ballast treatment facility at the dock would require the clearing of three acres of already disturbed land. The painting of the tanks would release solvent emissions downwind. Treated ballast water released to Freeport harbor would contain 7 ppm of oil (maximum monthly average). Oil recovered from the ballast treatment process would be injected into the cavities at Bryan Mound.

Construction of new barge docks in the ICW approximately one mile southeast of the storage site is an alternative to the proposed facilities. The most significant impacts would be those associated with dredging. Dredged materials would be deposited in a 184-acre disposal area 3 miles east of the dredging site.

Oil distribution would require two 30-inch pipelines, both along 100-foot rights-of-way. A 3.7-mile pipeline connecting the site with the Seaway dock at Freeport would be routed along the protected side of an existing levee and would cause minimal damage to the already disturbed land involved. A 4.5-mile pipeline would link the site to the Seaway Storage Tank Facility to the west. This pipeline would affect 18 acres of marsh and 26 acres of coastal prairie as well as 9 acres of disturbed land. In addition, the pipeline would cross the Brazos River and the necessary dredging would increase turbidity up to one mile downstream and increase levels of toxic heavy metals, hydrocarbons and pesticides. One-half acre of Benthic habitat would be eliminated, but repopulation would occur after one to two months following completion of construction.

The pipeline spill expectation for the entire project is 106 barrels. Spills associated with pipelines would be discovered quickly as a result of constant monitoring. On land areas contamination of soil would occur to a 10-centimeter depth and cover 0.4 acres for a 1,000-barrel spill. If rupture occurred at the Brazos River crossing, that section of the pipeline could be quickly isolated by valves on both sides.

Oil Displacement

Water to displace the stored oil would be taken from Brazoria and Harris Reservoirs via Dow Plant B at a maximum rate of 14,000 gallons per minute. No significant impact on the reservoirs or the Brazos River replenishment sources is expected since the reservoir volume is ten times the projected volume of displacement water required for one cycle.

A 24-inch concrete pipeline, requiring 15 acres for a 25 foot right-of-way, would be constructed for carrying water to the site from the Dow Chemical plant located five miles away. Construction would have little effect on the use of nine acres of previously developed land. Six acres of coastal prairie, although destroyed temporarily, should return to its previous condition during the next growing season.

Water from an alternative source of supply for displacement, the Gulf of Mexico, would be transported by a two-mile pipeline. Construction of a pumping station would affect one to two acres permanently and would temporarily affect up to 14 acres of coastal prairie and marsh. Unattached organisms of low mobility would be entrained at the intake during the five-month withdrawal phase, although intake velocities are relatively low.

A second alternative source for displacement water is the Brazos River, adjacent to the site. Less than one mile of disturbed industrial land would be involved, and dredging for the intake would destroy a small area of benthic habitat. Entraining and entrapping organisms of low mobility at the intake would be a minor problem.

Marine Operations

One of the most significant impacts from the operation of tankers and barges is the risk of accidental spillage in and approaching Freeport Harbor. Tanker traffic would reach a maximum during an emergency withdrawal of stored oil, with a worst case condition of 1.5 tankers per day (32,000 DWT) unloading 58 million barrels in 150 days. The total spillage expected during the lifetime of the program is 1,655 barrels, including terminal spills and vessel accidents. Should a maximum credible vessel accident occur in a given cycle, a median spill size of 5,300 barrels is estimated, which could involve about 3,850 acres of water surface in 48 hours if the spill is uncontained by the harbor and entrance channel.

If the alternative of constructing barge docks on the ICW is implemented, a total spillage of 14,500 barrels (versus 1,655 for tankers) could be expected for the fill or withdrawal project cycles because the number of barge trips is higher than that for tankers.

During the life of the project, offshore spills, more than spills in the harbor, would affect a diverse and productive habitat, causing destruction of immobile species and residual oily taste in fish.

Vessel loading and unloading at the Seaway dock would result in significant hydrocarbon emissions. It is estimated that vapor losses would occur at rates of 46,100 pounds per day during unloading and 70,500 pounds per day during loading at the respective proposed fill and withdrawal rates of 254,000 and 385,000 barrels per day. Under worst case atmospheric conditions, these operations would cause hydrocarbon concentrations to greatly exceed the 3-hour Federal standard of 160 $\mu gm/m^3$ for a considerable distance (greater than 10 kilometers) downwind. The maximum concentration at .5 kilometers is estimated at 57,700 $\mu gm/m^3$ (total hydrocarbons). The State of Louisiana currently exempts from regulation emissions from crude oil transfers.

## Facility Operations

During fill and withdrawal, hydrocarbon vapors would be emitted from the surge tank and the four storage tanks at rates of 12.2 and 986 pounds per day, respectively. Under worst case atmospheric conditions, the vapors from the storage tanks would cause concentration to slightly exceed the 3-hour Federal standard of 160 $\mu gm/m^3$ for approximately .5 kilometer downwind.

The weight of the filled tanks may cause some minor subsidence due to compaction of aquifers, unconsolidated material, and caprock.

The crew of ten, present at the site during the storage phase primarily for security and monitoring purposes, would expand to 46 during the loading and withdrawal phases.

### 8.2.2.4 Weeks Island

Conversion of an existing salt mine to an 89-million barrel oil storage facility at Weeks Island would involve the construction of a new replacement salt mine, enlargement of an existing barge slip, and construction of abutment barge docks and six and one-half-mile pipelines between the barge slip and storage facility. Although the oil storage reserve at Weeks Island is not likely to cause long term adverse impacts, construction and operation of this facility would alter the local environment in several significant ways. These effects are discussed below and in Table 8.2-4 for the construction of the storage site as well as for a new replacement mine, dock facilities, pipelines, marine operations, and facility operations.

Storage Site Construction and Acquisition

Conversion of an existing salt mine to an 89 million-barrel oil storage site would entail only temporary, local increases in the levels of hydrocarbons, $NO_x$ and $SO_2$, as well as dust, which results from the grading needed for the above-ground pump station and small electric substation.

Construction of a new salt mine to replace that converted for oil storage would involve about 20 acres of land used currently as a landfill site. The socioeconomic impact of such construction would depend on whether (1) salt production was interrupted and (2) Cote Blanche followed a construction schedule similar to Weeks Island.

Development of the new mine at Weeks Island with no interruption in salt production would require 18,500 man-weeks of labor over 93 weeks and provide an estimated $6 million in salaries. If mining operations continue uninterrupted at Weeks Island as well as at Cote Blanche, production at both sites would yield a total of $13.9 million.

With a 64-week cessation in salt production at Weeks Island, designed to expedite the completion of the storage facility, 16,800 man-weeks over 73 weeks could be required, and the resulting loss in salt production would decrease state revenue, through severance taxes, by $92,000 and local revenues by $50,000. If construction interrupted salt production at both Weeks Island and Cote Blanche, only $11.7 million in salaries would be released, with $7 million to the local area. The resulting 3.5 million-ton decrease in salt production would proportionately reduce state revenues, through severance tax, by $210,000 and local revenues by $150,000.

A construction schedule for Weeks Island that does not require an interruption in salt mining would cause a shortage of laborers for the time that both mine relocation and storage conversion peak. One possible solution to this problem would entail a different coordination of activities between the two sites. If the Cote Blanche mine were closed during conversion at Weeks Island, the unoccupied work force could assist in mining operations at Weeks Island to expedite construction without drawing heavily from the outside labor market.

Dock Facilities and Pipelines

The proposed method of crude oil supply and distribution is designed for barge transport coordinated with a pipeline system. Six abutment docks would be constructed to accommodate 25,000-barrel barges, and the southern portion of an existing barge slip would be enlarged by 80 percent. An estimated 250,000 cubic yards, involving about 9 acres of marsh and spoil banks, would be excavated for the slip and transported to an approved Corps of Engineers site. Ancillary equipment (manifold, pumps, meters) would require ten acres adjacent to the slip. The excavation would temporarily displace local aquatic life, including benthic organisms like blue crabs. Increased runoff from the grading of the adjacent ten acres would cause temporary turbidity, BOD, DO and nutrient problems.

Barge transport would require the construction of six 0.5-mile pipelines between the barge slip and the storage facility. Although excavation and backfilling would, in displacing several thousand cubic yards of soil, temporarily cause sediment to run off into the barge slips and Waterway, overall impact would be small.

Despite the probability that a pipeline rupture would cause oil spill is low, a maximum spill of 500 barrels would most likely affect only three acres.

With both Weeks Island and Cote Blanche as storage facilities, the proximity of the two sites increases the possibility that a large diameter pipeline could replace the barge system as the means of supply and distribution for the sites. Two alternative pipeline routes to St. James are available, one running 80 miles along Bayou Teche and the other 60 miles along Atchafalaya. The first would more adversely affect virgin wetland forest. The pipeline would involve a lower operating expense and probability of oil spill than those of barge transport.

Marine Operations

Barge operations would involve a total distance of 225 miles. Oil would be offloaded from very large crude carriers to 45,000 DWT tankers in the Gulf of Mexico, transported up the Mississippi River to Venice, Louisiana, and transferred to 25,000-barrel barges for further transport up the Mississippi through Algiers Lock to the ICW and ultimately Weeks Island barge slip.

Daily barge traffic should increase 11 percent for the 28-month fill period and 36 percent for the shorter 9-month withdrawal period.

The maximum credible oil spill for the Gulf, possibly 60,000 barrels, could render 840 to 1,680 acres of marsh (1.5 percent of total marsh in the area) nonproductive for two years. Of the expected average spill of 1,827 barrels, 312 barrels may occur at the barge slip and 1,515 barrels anywhere in the ICW, Mississippi River, or the Gulf. The maximum credible spill from barges into the ICW, estimated at 20,000 barrels, could affect 10 miles of the channel. Transporting the oil from the dock at the storage site would result in significant hydrocarbon emissions, both during transit and at the transfer points in the Mississippi River and in the Gulf of Mexico. "Breathing" losses from tankers and barges would occur at a maximum annual atmospheric loading rate of 800 tons/year during fill and withdrawal. These emissions would be dispersed along the Mississippi River-Intracoastal Waterway route from the Gulf to the storage site. VLCC-tanker transfers in the Gulf and tanker-barge transfers in the Mississippi River would cause emissions at maximum annual rates of 4015 tons/year and 2140 tons/year, respectively. Under worst case atmospheric conditions, transfers at the Mississippi River transfer point would cause hydrocarbon concentrations in excess of the three-hour Federal standard of 160 $\mu gm/m^3$ as far as 7.5 miles downwind. The State of Louisiana currently exempts from regulation emissions from crude oil transfers.

As an alternative to small barges, large, seagoing barges might be used to transport part of the oil directly between the tankers in the Gulf and the site. This system would require larger dock facilities and a pipeline across the island creating a greater impact on the ecology of the island. However, their use could result in a 42 percent reduction in spilled oil and a 46 percent reduction in hydrocarbon emissions.

Facility Operations

Transferring the oil from the storage cavern to the barges at the dock would result in significant hydrocarbon emissions as the barge tanks are filled with oil and the vapors contained therein are vented to the atmosphere. These venting losses would occur at a maximum annual atmospheric loading rate of 2,410 tons/year. Under worst case atmospheric conditions, this operation would cause hydrocarbon concentrations in excess of the 3-hour Federal standard of 160 $\mu gm/m^3$ as far as 5.7 miles downwind. Because of unavoidable system leaks, minor amounts of hydrocarbons and hydrogen sulfide would be emitted during pumping. Minor amounts of sulphur dioxide would be emitted during filling of the storage cavern as a result of flaring of the vapors that would be vented during that operation.

Fifteen workers would be required for transfer operations during fill or withdrawal periods. A crew of five or less would be required during the storage phase of the program, primarily for security purposes.

### 8.2.3 Permanent Shutdown of Domtar Mine

As indicated in section 2.4 and elsewhere in this report, the FEA intends to provide for development of a new salt mine at Cote Blanche Island, which is equivalent in every way to the existing mine. The Cote Blanche salt dome is capable of supporting such a mine above the level of the existing cavern. The only effect on salt production or mine employment would be a possible temporary shutdown lasting approximately 74 weeks if this development option is taken (Figure 2.3-2).

The method by which mine relocation is accomplished, however, is for the FEA to pay the actual reasonable expenses associated with the move, in accordance with the Uniform Relocation Assistance and Real Property Acquisition Policies Act of 1970 (42 U.S.C. 4601 et seq.). The FEA has no authority to require Domtar Chemicals to develop another mine at Cote Blanche, or at any other location. If market conditions are unfavorable to mine development at Cote Blanche, Domtar could decide to invest the relocation payment elsewhere. Such a decision would be strictly up to the mine owner.

It is estimated that approximately one-half of the total construction manpower requirements estimated for the project (including mine relocation) would be associated with development of the replacement mine. Thus, out of a total peak construction labor force of over 300 workers (Table 2.3-1), around 150 would be used for the new mine development. Of these, an estimated 90 to 100 would be local area residents (per place of residence relationships in Table 2.3-1). Less than 60 of the Domtar miners and aboveground production workers might be able to find substitute employment on mine conversion; for the rest, differences in occupational skills and other factors would limit their job flexibility. Residents of the area, other than miners, would obtain much of the local-hire unskilled jobs.

At an average annual wage of $10,000 per Domtar employee, shutting down the existing mine permanently would remove $1.2 million in annual gross wages from the local economy. After-tax disposable income in the area (if not offset by unemployment compensation or alternative employment) would drop by an estimated $800,000 to $900,000 per year. Though some workers would find temporary employment in mine conversion, there would still be an opportunity loss of 120 jobs locally.

If the project were limited only to conversion of the old mine to oil storage, construction earnings flowing into the local economy would temporarily more than offset the lost wages of the Domtar salt miners ($4 million construction earnings versus $1.7 million lost wages). After conversion was completed and the construction workers left the area, however, total area wage income would decline. The loss of 120 mining jobs would, if uncompensated, also lead to an induced decline of another 200 or more service jobs in the area, assuming employment multiplier relationships remained constant for St. Mary Parish and the Acadiana area (section 3.9.2.5). If the Weeks Island salt mine were to be similarly affected, a further permanent loss of 260 basic jobs and several hundred nonbasic jobs would result; the regional economy would be noticeably affected. The impact on the small towns nearest the sites could be very severe. Social disruption of life-styles would be equally great. There are few opportunites for equivalent jobs in the area and the residents are not typically very mobile.

Environmental effects of the project without development of a new salt mine would be only slightly reduced. The 20 to 25 surface acres required for the new mine (Figure 2.2-3) would be left unaltered. Wildlife habitat would be left undisturbed. Site excavation and grading would be reduced by approximately 50 percent, with consequent reduction in erosion and siltation potential in the barge slip. Noise levels, dust, and engine exhaust would be somewhat reduced. During oil fill and withdrawal, there would be no competition between oil and salt transport for barge facilities.

### 8.2.4 Alternative Oil Transportation Systems

Oil transportation system alternatives could have important effects on the environmental impact and economic efficiency of the program. Oil must be readily available to fill the storage facilities and, more importantly, there must be a ready capability for withdrawing, refining and delivering necessary petroleum supplies during a national emergency.

The following sections briefly summarize advantages and disadvantages of the available options for the oil transportation system.

8.2.4.1 Barge Transport

Transport of oil to and from the Cote Blanche Mine by barge is the primary design mode of operation considered in sections 2.0 through 7.0 of this EIS. Small tankers (30,000 to 50,000 DWT) would receive oil from VLCCs in the Gulf of Mexico (or from some other source) and take it up the Mississippi River to the vicinity of Venice (approximately 30 miles). There the oil would be transferred to 25,000-barrel capacity barges. The barges would take the oil 80 miles up river to New Orleans, through the Algiers locks, and down the Gulf Branch of the ICW to Cote Blanche Island (total distance of 218 miles). Withdrawal would simply reverse the direction of oil movement. This system does not require extensive construction of new pipelines and can utilize existing navigable waterways in the vicinity of the site (principally the ICW). Expected oil spills from this mode of transportation total approximately 2720 barrels for 5 complete fill/withdrawal cycles (see section 4.3.8). Hydrocarbon emissions resulting from oil transfer and transportation would total 186,460 barrels over the life of the project (section 4.3.3).

A possible disadvantage to this method of transport occurs if one or more additional storage sites along the Gulf coast are also developed with the intention of using barges for oil transportation. Under these conditions, there may not be enough barges (or barge operators) available to handle the total volume of oil within the desired timeframe (see section 4.5 for the case of Weeks Island and Cote Blanche developed together). This lack of barge capacity would be a serious flaw to the program under conditions of an oil supply interruption.

There are several other possible modes of transporting oil by barge to and from storage at Cote Blanche Island. One or more of these may be needed during an oil supply interruption, especially if the Weeks Island facility is also developed. Brief descriptions of these systems and the expected impacts of their use are provided below.

Sea-going Barges

A limited amount of oil might be transported between Cote Blanche and tankers in the Gulf of Mexico via sea-going barges. Industry experts indicate that only 10 to 20 of these specially equipped barges might be available for use. Because the typical draft of these barges is 11.5 feet, they would have to use the main channel of the Lower Atchafalaya River to reach the Gulf (see Figure 4.3-7). A special barge slip, approximately 1600 feet long, 120 feet wide and 11.5 feet deep, would have to be excavated along the south edge of the ICW north of Cote Blanche Island to handle these barges. Oil would be pumped to and from the barge platforms through a 22-inch diameter pipeline crossing the eastern edge of the island and the adjoining marsh.

Total transport distance to a point of possible transfer to oil tankers in the Gulf is approximately 100 miles; half of this distance is in the open Gulf. Cycle time (including 30 percent down-time) is estimated to be 74 hours. If ten 25,000-barrel barges were available, a maximum of 80,000 barrels per day could be withdrawn by this method.

Oil spillage estimated to occur as a result of withdrawing all the Cote Blanche oil by this alternative is given in Table 8.2-2. Comparison with Table 4.3-1 shows 42 percent less expected oil spillage than the Venice alternative because of the shorter transport route and fewer vessel to vessel transfers. Maximum credible spill exposure is 30,000 barrels in the open Gulf and 20,000 barrels in the inland waterways. Vulnerability of the environment to oil spills is lower in offshore Gulf waters if landfall can be averted. However, if oil reaches the coastal bays and salt marshes, damage is likely to be much greater than along the banks of the ICW.

The use of seagoing barges would eliminate the barge-tanker transfer operation required for the proposed transport mode. The route is also approximately 150 miles shorter from VLCC to storage site. As a result, total hydrocarbon emissions to the atmosphere would be reduced by approximately 69,000 barrels (37 percent) over the life of the project. Energy requirements would also be smaller.

Sea-going barges are not an attractive alternative to inland barge transport because of the requirement for significantly expanded barge facilities at Cote Blanche Island and because the potential transport capacity is likely to be quite low. This is an attractive supplementary transport method if oil can be loaded by some means other than constructing a pipeline across the island.

Small Inland Waterway Barge Transport

The Cote Blanche Mine could be developed for oil storage without expanding the existing barge slip. If two barge docks are constructed, a maximum withdrawal rate of 105,000 BPD might be achieved (15 percent down time). At this rate, it would take approximately 257 days to withdraw the entire 27 million barrels of oil from storage. More frequent barge visitation would require enlargement of the barge slip and might require more 10,000-barrel barges than are available (105,000 BPD transported to Venice would require approximately 53 barges).

Construction impacts would be minimal with this alternative. Traffic in the ICW would be higher (17.7 pass-bys per day) than using the 25,000-barrel barges and 150-day withdrawal (7.2 pass-bys per day).

Oil spillage estimated to occur as a result of a complete drawdown transported to two possible transfer stations - Venice and St. James - is given in Table 8.2-6. Expected oil spill volume is proportional to the transport distance and is affected by the transfer methods required. Thus, the Venice route would produce the greatest oil spillage because of the 218-mile barge route and the comparatively risky oil transfer with tankers anchored in the Mississippi River. Maximum credible spill size in inland waters is 10,000 barrels for both transport routes; offshore, spills of 60,000 barrels are considered feasible.

Hydrocarbon emissions to the atmosphere for the Venice transfer station would be approximately the same as for the selected transportation mode (25,000-barrel barges), totaling approximately 186,000 barrels over the life of the project. If oil is transported by barge up the Mississippi River, or delivered to the St. James Pipeline from St. James, that option would release only 97,000 barrels of oil as hydrocarbon vapors, a reduction of 48 percent.

The use of 10,000-barrel barges as the sole means of moving oil out of storage is not a practical alternative because of high traffic levels and less than adequate withdrawal capacity.

### 8.2.4.2 Pipeline Transport

Pipelines are a common and generally accepted mode of transport for oil and gas throughout the United States. Many existing pipelines have been laid successfully along the Gulf coast and throughout the nation to connect production or import centers with refinery and market centers.

Two possible alternatives exist for transporting oil to and from Cote Blanche Island by pipeline: 1) use of existing lines; and 2) construction of a new line to a major distribution system.

#### Existing Pipelines

One environmentally acceptable method of transporting the oil would be to use existing pipeline capacity. This would minimize construction costs and environmental disruption. However, it may be impossible to dedicate sufficient pipeline capacity for future use. During fill periods, most lines will be delivering oil to normal market areas. During a supply interruption, domestic production will be expanded to maximum possible capacity.

It may also be possible to convert some natural gas pipelines for oil transport, since the production of natural gas is decreasing throughout the Gulf coast. Virtually all segments of pipeline alignments indicated in Figure 8.2-2 parallel existing gas lines, many having diameters of from 20 to 30 inches. Investigations are in progress to determine the possible availability of these lines, but it is possible that substantial existing capacity cannot be reserved for the program in the near future.

#### New Pipelines

A pipeline route connecting the oil storage area with the existing U.S. oil pipeline system is a reasonable alternative to the filling and withdrawal of oil by barges. This is particularly true should the Weeks Island facility also be developed for oil storage (see section 4.5).

If a new pipeline is required to transport oil to and from Cote Blanche, the route and size of the pipeline should be selected on the basis of 1) the location of all intended storage sites in coastal Louisiana; 2) the environmental sensitivity of the route; and 3) the costs of constructing and operating the pipeline system. As the state of Louisiana requires all permanent pipelines to be placed below ground level, above ground pipelines are not considered in the following analysis.

Two alternative routes between Cote Blanche Island and St. James, Louisiana, were selected for analysis (Figure 8.2-2). One follows existing oil pipeline corridors (Texas Pipeline Company's 22-inch line) along Bayou Teche to the vicinity of Lake Cocodrie, west of Morgan City, and then north along another corridor (Shell's 20-inch line) to St. James a total distance of approximately 80 miles (Bayou Teche Route, ABDE). The second route (Atchafalaya Route, ABCE) crosses the Atchafalaya Basin from Cote Blanche directly northeast to St. James (a distance of about 60 miles) using some existing pipeline corridors along the way (including the United Gas Pipe Line Company's 30-inch line across the Atchafalaya Basin). Both lines would connect with the Capline system at St. James. Oil could be transported to St. James during SPR fill either by tanker or barge up the Mississippi River or by pipeline through the proposed LOOP deepwater port facilities. As this alternative is intended to illustrate the effect of using pipelines rather than vessels for inland oil transport, the oil spill analyses will assume use of the LOOP facilities. (LOOP would not be available for the first fill, prior to 1980, however.) Distribution of oil from St. James during withdrawal from Cote Blanche depends on allocation decisions which have not been made. Therefore, the oil spill analysis for withdrawal terminates at St. James.

Existing Environment

Physical Setting - The pipeline routes selected for analysis are shown on Figure 8.2-2. Except for an additional 7-mile segment between Weeks Island and Cote Blanche Island, the same pipeline can transport oil between both sites and the terminal at St. James, Louisiana.

Except for natural river levees, much of the land along the pipeline routes is either permanently [illegible] under water; salinities here are generally [illegible] routes do not cross any recognized de[illegible] or federal management [illegible]. However, they [illegible] generally [illegible] cross [illegible] regional north-south drainage patterns in the Marsh Island-Bayou Teche, Atchafalaya, [illegible] Verret, and Barataria-Salvador-[illegible]ands drainage systems.

Perhaps the most distinctive physical features in the area are the Bayou Teche levee and the Atchafalaya flood plain. Bayou Teche follows a former course of the Mississippi River; the levee forms the southwest boundary of the Atchafalaya Basin. The relatively high and dry land of the levee provides the major highway transportation corridor through southcentral Louisiana and is the locus of most urban development and agriculture in the area. The Atchafalaya Basin was formed when the Lower Mississippi Alluvial Valley became surrounded by ridges built up by various Mississippi River courses. The Atchafalaya is presently the major distributary of the Mississippi and contains a vast, almost impenetrable expanse of bayous, swamp forests, and lakes. The basin formerly extended more than 20 miles across between the levees of Bayou Lafourche and Bayou Teche but is now confined by man-made levees in the vicinity of Morgan City.

Ecological Characteristics - The major ecological system encountered along the pipeline routes is the bottomland deciduous swamp forest. Dominant trees are the bald cypress and the water tupelo. Most of this forest has been previously logged. Slightly elevated ground also contains sweetgum, and various species of oak. The understory is usually well developed with various species of vines, holly, palmetto and blackberry.

The swamp forest is a highly productive ecosystem, containing an exceptionally large diversity of microhabitats for plants and animals. Common fauna include deer, swamp rabbit, squirrels, wood duck, migrant waterfowl, raccoon, otter, mink, catfish, crawfish, bass, and gar. Also occurring are bobcat, black bear, fox, alligator, and southern bald eagle; the latter two species are classified as endangered. Although of less importance as habitat for waterfowl than the coastal marshes, the swamp forest is important to other species of birds, particularly raptors. A large portion of the Atchafalaya Basin north of Morgan City, is considered a potential preservation or natural recreation area (Corps of Engineers, 1973a).

Marsh traversed by the pipeline route (generally south of Bayou Teche) is either fresh or intermediate. Fresh marsh is dominated by maiden cane, water pennywort, water hyacinth, pickerel weed, alligator weed, and bull-tongue. Intermediate marsh is dominated by wire grass, three-cornered grass, coco, and widgeon grass. Both marsh types have high vegetative productivity. Plant diversity is somewhat greater in the fresh marsh compared to intermediate marshland. Both types are extremely important to waterfowl and to fur animals as habitat, and also as nursery grounds for many aquatic estuarine species. Other inhabitants include deer, mink, otter, various birds, and alligator (Corps of Engineers, 1973a).

A third major ecosystem crossed by the pipeline is levee land, usually cleared and drained for agricultural purposes or urban development. Most agricultural land in southcentral Louisiana is planted in sugar cane or in pasture grass. There are also some field crops and many discontinuous areas of deciduous and pine forest on the levees. Diversity of both plants and animals is normally lower on agricultural land. However, deer, turkey, dove, cottontail rabbit, song birds, quail, and various species of mice and rats are common inhabitants in and around the levees.

Land and Water Uses - Throughout the swamp, the major use of the land is for oil and gas production. Some portions of the swamp adjoining natural levees have been drained and developed, but the interior has been left in forest. Most of the swamp forest was logged in the past; thus, most trees now are in secondary reforestation. Little logging is carried out in the area at present.

Marsh is also left predominantly undeveloped, except along natural levees where drainage is commonly practiced. Fishing and hunting are popular recreational activities in the marsh. Many parts of the marsh have been diked and ditched for navigation or for oil and gas production.

Levee lands are practically the only areas suitable for urban development in coastal Louisiana. Nearly all roads, agricultural land, industrial and urban development occur along the levees of bayous such as Teche, Lafourche, Black, and Terrebonne.

The Mississippi River (above New Orleans), Bayou Lafourche (upper section), Intracoastal Waterway, and Atchafalaya River are used for domestic and industrial water supply after treatment. These waterways and other bayous are also major transportation routes. Ground water is generally not suitable for domestic usage.

Socioeconomic Characteristics - Most of the population in south-central Louisiana resides along either Bayou Teche, Bayou Lafourche, or Bayou Terrebonne. Major cities on Bayou Teche include Lafayette (population 69,000), New Iberia (30,000) and Morgan City (17,000). Along Bayou Lafourche is Thibodaux (15,000), and on Bayou Terrebonne is Houma (31,000). (All population data for 1970.) All other towns in the area have populations less than 10,000. St. Mary and Terrebonne Parishes have more than 50 percent of their populations classified as urban. St. James Parish has about 30 percent classified as urban, and Assumption Parish is classified as 100 percent rural (Corps of Engineers, 1973a).

Important industries include seafood processing and packaging, petroleum and gas production and product distribution, commercial fishing, ship and offshore platform construction, and salt and sugar processing.

Many of the native Louisianans in the region are of Cajun heritage.

## Description of Pipeline System

A maximum withdrawal flow rate of 180,000 BPD for Cote Blanche would require a 22-inch diameter pipeline. However, should a pipeline also be desired to transport oil from storage at Weeks Island (593,000 BPD together), a 40-inch diameter line would be needed. Therefore, for the present analysis, a 40-inch line, serving both Cote Blanche and Weeks Island, is assumed. Construction of the smaller line would utilize the same type of equipment and methods, and impact roughly the same amount of land. However, a 30 percent smaller construction crew would be needed.

Construction Methods - Three basic techniques of construction would be used during construction of the pipeline: 1) flotation canal method;

2) push-ditch method; and 3) conventional dry land method.

The flotation canal method of construction may be used in the marsh portion of the pipeline route. The ground in this area may not support heavy construction equipment. Therefore, the work must be done on barges operating in the canal. The push-ditch method of construction may be used in parts of the marsh and in the freshwater swamp portion of the pipeline route where the ground can support marsh buggy-mounted excavating and backfilling equipment, but cannot support conventional dry land pipeline construction equipment. Conventional construction methods would be used through the dry portion of the pipeline route where heavy construction equipment can be supported.

A. Flotation Canals - In the flotation canal method, a canal is dug along the surveyed pipeline route to accommodate construction barges. The canal is dredged to provide a water depth of approximately 7 feet. The canal may be 40 to 50 feet wide at the bottom, and up to 75 feet wide at the top. The equipment needed for construction are a dredge, a pipe lay barge, materials barges, personnel boats, and special equipment barges required for tie-ins and work at pipeline crossings. The required right-of-way will range from 125 to 150 feet.

A pipe ditch is dug in each flotation canal to accommodate the proposed pipeline. The spoil removed in dredging the flotation canal and pipe ditch is placed along both sides of the flotation canal until after the pipeline has been installed. The pipe lay barge travels along the flotation canal while the joints of pipe are being welded together. The completed pipeline is lowered off the stern of the barge into the pipe ditch. After hydrostatic testing, a barge-mounted dipper dredge travels along the flotation canal backfilling the canal behind it. However, due to subsidence and oxidation, there is usually insufficient material to entirely fill the canal and a shallow water area, devoid of marsh grass remains.

B. Push Ditch - In the push-ditch method of construction, a right-of-way width of approximately 125 feet is cleared. The push ditch is then excavated down the right-of-way. Several push sites are selected at convenient locations along the right-of-way. These sites are used to assemble the pipe joints into a completed pipeline and to push it to its final location.

The fabrication and assembly of the pipeline consists of welding together joints of pipe (each pipe is about 40 feet long) on the push site. When operations on each joint at the push site are complete, the assembled pipeline is pushed forward into the push ditch by the length of another joint of pipe, and the assembly procedure is repeated. A marsh buggy, or similar equipment, travels along the right-of-way with the front end of the pipeline to guide the pipeline down the push ditch and to aid in starting and stopping the pipeline as the assembly continues.

After the pipeline is assembled and in its desired location, it is filled with water, causing the line to sink to its final position. Draglines, mounted on marsh buggies, then travel along the right-of-way, filling the ditch with the spoil that was stored along the right-of-way.

C. Conventional Pipeline Laying - With the conventional dry land method, a right-of-way width of approximately 100 to 125 feet is cleared. Excavation equipment then travels along the right-of-way, digging the pipe ditch to a depth of approximately 6 feet so that the pipeline will have a minimum cover of 3 feet. The pipe joints are then strung along the pipe ditch, welded together, the required corrosion protection applied, and the pipe is lowered into the ditch.

Pipeline backfill equipment then travels along the right-of-way, backfilling the open ditch with the spoil removed in excavation. Restoration of the right-of-way is made to permit continued agricultural use of the land.

D. Conventional Measures Designed to Minimize Environmental Effects - Several measures are normally taken to minimize the environmental effects of laying pipeline through coastal wetlands. All lines are hydrostatically tested to 150 percent of the maximum working pressure, buried, and marked for protection. A wire-mesh reinforced concrete coating is placed on the lines for mechanical and corrosion protection. Sacrificial anodes are used in salt and brackish environments to further prevent corrosion. Culverts, or breaks in temporary spoil banks, are provided to facilitate normal surface water flows. Bulkheads are constructed across the pipeline canal on either side of major drainage crossings to prevent flow diversion and saltwater intrusion. All canals are backfilled as soon as possible to restore the terrain to near previous conditions. Finally, remote-controlled shut-offs or block valves are installed on either side of major waterways and in key locations along the route to isolate pipeline segments in case of a possible line rupture.

Operation - The pipeline from Cote Blanche to St. James would ideally be used for both filling and withdrawal of the storage cavern. Actual construction of the pipeline should take less than 9 months. However, surveying the route, obtaining property rights, letting contracts, and obtaining materials might require another year or longer. If necessary, oil could be initially barged to the site. When the pipeline is completed, however, fill rates would probably be limited only by oil supply, since the pipeline capacity would be sufficient to fill the storage cavern in 5 months.

A pumping station would be required to boost line pressures and achieve full flowrate capacities. This station might require two 1- or 2-acre sites midway along the selected pipeline route.

During pumping, which would occur for approximately 15 months every 5 years for a complete fill/withdrawal cycle, line pressures and flowmeters would be closely monitored. An operations center, located either at the Cote Blanche site or at St. James, could serve as the control center. A computer-directed supervisory control and data acquisition system would be installed to obtain continuous information on critical flow variables and to detect and direct instant responses to abnormal line conditions such as high pressures or leaks. Accurate leak detection systems would be designed into the system.

All piping and other equipment would be equipped with pressure relief valves, isolation valves, and oil pumps. Although the pump station would probably be unmanned, weekly inspections of the entire route would be made by air to check for surface problems or evidence of leaks. During standby conditions, the pipeline would not contain oil, but would be filled with corrosion-inhibited water. Periodic 24-hour pressure checks would assure system integrity and readiness in case of immediate need.

Oil Spill Analysis - It is assumed that the pipeline system would be used for five complete fill/withdrawal cycles during the life of the project. Cavern filling would take approximately 10.5 months at 85,000 BPD; withdrawal would take 150 days at 180,000 BPD. During standby storage, the pipeline would be left full of oil in accordance with standard engineering practice.

Pipeline spill risks are expressed in terms of miles of line length and years of operation at design conditions. A rate of $128 \times 10^{-5}$ spill incidents per mile per year has been indicated from the 1968-73 data record of the Office of Pipeline Safety (U.S. Dept. of Transportation, 1974). However, for newly constructed lines utilizing new design techniques, materials, and protective systems, a rate of $50 \times 10^{-5}$/mile/year is considered more appropriate. During the life of the project (5 storage cycles), the statistical chances of the pipeline rupturing while pumping oil are:

| 80-Mile Line | | 60-Mile Line | |
|---|---|---|---|
| Number of Transport Spills | Probability (Percent) | Number of Transport Spills | Probability (Percent) |
| None | 40.7 | None | 51.2 |
| 1 | 37.3 | 1 | 34.8 |
| 2 | 16.3 | 2 | 11.0 |
| 3 or more | 5.7 | 3 or more | 3.0 |

The expected number of pipeline spills during the project lifetime is 0.88, or one chance in 1.1 of a spill occurring for the 80-mile pipeline; for the 60-mile pipeline the expected number is 0.66, or one chance in 1.5 (Table 8.2-7). (For a more detailed presentation of spill risk analysis methodology, see Appendix G.)

More important than the frequency of spill occurrence is the expected size distribution of the spills. Historical pipeline spill data show that the average incident spill size is 1083 barrels. The maximum credible spill in the flat terrain of coastal Louisiana with a sophisticated leak detection and shutdown system is 10,000 barrels. The percent chance of a given spill in each of six size ranges is given in Table 8.2-8. Thus, there is a 57 percent chance of any spill that does occur being less than 1000 barrels.

The total oil spill risk for the Cote Blanche facility using pipeline transportation is dependent on the pipeline and the terminal risks. It can be seen from Table 8.2-7 that pipeline spills are more likely to occur, and to be of larger size, than the terminal spills. The total expected number of spills is 1.02 during the life of the project for an 80-mile pipeline system, and 0.795, or 1 chance in 1.3 for a 60-mile pipeline system. The total amount of oil spilled would be 994 barrels for an 80-mile line and 756 for a 60-mile line. The chance of a spill greater than 2000 barrels would be approximately 0.0627, or 1 chance in 16 for an 80-mile pipeline system and 0.0473, or 1 chance in 21, for a 60-mile pipeline system.

Oil spill risks would also occur as a result of utilizing the LOOP facilities for unloading VLCCs and pumping oil approximately 100 miles to St. James. Assuming an average throughput capacity of approximately 1 million barrels per day, offloading oil for Cote Blanche storage would require 27 days of LOOP operations. During each fill operation, approximately 0.23 spills are estimated to occur at the SPMs 18 miles from shore, totalling 42 barrels of oil. Pipeline risks are estimated to be 0.004 spills, totalling 4 barrels. Thus, for five fill cycles, the total number of spills from the LOOP facilities is estimated at 1.17 incidents, with a total oil release of 230 barrels. The maximum credible spill from the LOOP pipeline is estimated to be 10,000 barrels; average spill size would be 1083 barrels. The maximum credible spill size at the SPMs is estimated at 2000 barrels; average spill size would be 185 barrels.

Appendix G contains a more detailed treatment of oil spill risks from both barge and pipeline transportation systems.

Impacts of Pipeline Transportation System

In order to compare the effects of construction and operation of a pipeline transportation system to those of a barge system, the two routes shown on Figure 8.2-2 must be considered in some detail. One route, the Bayou Teche Route, follows the natural levee flanks of Bayous Cypremort and Teche eastward to approximately the town of Gibson, then northward to St. James Terminal. The second route, the Atchafalaya Route, coincides with the first route eastward to approximately Centerville, then diverges northeastward across the Atchafalaya Basin to Napoleonville, after which it joins the first route again some 10 miles south of St. James Terminal. (Construction impacts associated with the LOOP facilities are not considered here as these are not a result of the SPR program.)

For the purpose of route analysis of impact sensitivity within the areas traversed, the potential routes are divided into segments A through E, as shown on Figure 8.2-2 (segment A applies only to the Weeks Island pipeline). Utilizing the most recently available aerial imagery and area experience, each segment is divided into numbered subsegments coincident with the following specific physical terrain features: upland, natural levee, swamp, marsh, and major water bodies. Subsegments were then analyzed systematically according to the following aspects:

| | |
|---|---|
| Upland | mixed hardwood<br>cleared |
| Natural levee | mixed hardwood<br>swamp/mixed hardwood<br>agricultural development<br>rural residential |
| Swamp | cypress-tupelo<br>willow-cottonwood<br>extent of hydrographic modification<br>renewable resource value<br>(habitat, aesthetic quality) |
| Marsh | fresh water (0 - 3 ppt salinity)<br>intermediate (3 - 5 ppt salinity)<br>degree of hydrologic modification<br>extent of deterioration<br>renewable resource value<br>(habitat, aesthetic quality) |
| Major water bodies | lake<br>stream<br>turbidity<br>flow conditions<br>use |
| Minor water bodies | streams<br>drainage canals<br>oil and gas industry canals |
| Highway, levee, railroad | crossings |

Table 8.2-9 provides a summary of important characterisitcs for each subsegment route.

Following is a short description of the environmental setting of the Bayou Teche (ABDE) and Atchafalaya (ABCE) route segments. Segment and subsegment numbers correspond to those indicated on Figure 8.2-2. Only specific problems are indicated. General problems such as effects on water level where wetlands are crossed are implicit.

1. Segment A (Weeks Island pipeline only) - No specific problems in alignment are encountered. The route parallels existing linear elements such as a navigation canal, highway, and natural levee so that interference with water movement in traversed areas is insignificant because of these existing conditions. A minimum of wetland environment is traversed.

2. Segment B (Bayou Teche and Atchafalaya Routes) - This segment traverses an impact-sensitive area of tidal marsh and swamp which is relatively undisturbed ($B_4$). The area represents a wetland basin contained between the natural levee ridge of Bayou Cypremort to the north and the Gulf Intracoastal Water (ICW) to the south. Tide-regulated water movement is generally north-south from Jaws Bay, while route alignment is east-west. The resulting pipeline canal would greatly interfere with natural circulation, causing ponding of water, which is known to lead to marsh deterioration. Expansion of the existing pipeline canal would tend to create an undesirable pipeline corridor.

3. Segment C (Atchafalaya Route) - High impact sensitivity is encountered in the wetlands of the Atchafalaya Basin Floodway ($C_3$ through $C_9$), the Verret Basin between the East Floodway levee and the Bayou Lafourche natural levee ($C_{10}$ through $C_{12}$), and between the Lafourche levee and Mississippi levee in the Salvador Basin ($C_{14}$).

Although the potential route in the eastern part of the Floodway transects or fringes existing oil field developments where modification of hydrology is already high, the swamp traversed between the Atchafalaya Main Channel and the oil fields ($C_5$ through $C_8$) is relatively unmodified and represents one of the biologically most productive areas of the floodway. The potential route crosses a large number of natural streams at right angles in this area, thus interfering with natural drainage.

This type [illegible] cypress-tupelo sw[illegible] [illegible] highly se[illegible] [illegible] modificatic[illegible] [illegible]

In the [illegible] subsegment $C_{12}$ [illegible] relatively un[illegible] [illegible] water circulation is not significant[illegible] [illegible] this [illegible] is generally parallel to the pipeline), scenic quality and recreational use make this swamp basin highly sensitive to impact. This is true in particular at the lake-swamp interface.

Hydrologic impact sensitivity and aesthetic value are the main aspects in the Salvador Basin subsegment ($C_{14}$). The swamp basin receives runoff from adjacent natural levees, and water movement is generally perpendicular to the potential pipeline route. Despite the presence of pipeline canals, the cypress-tupelo swamp is still relatively unmodified; the potential cumulative impact of pipelines should therefore be considered.

4. Segment D (Bayou Teche Route) - From Centerville to Bayou Chene, segment D ($D_1$ through $D_{13}$) generally remains within an existing pipeline corridor (characterized by several parallel pipeline canals) adjacent to the Bayou Teche - Bayou Boeuff natural levee ridge trend and to other linear elements such as a railroad embankment; impact sensitivity is low. However, a highly sensitive area is encountered in the wetlands south of Gibson. Subsegment $D_{15}$ traverses a nearby unmodified cypress-tupelo swamp surrounding Bay Wallace. The area has an extremely high aesthetic and recreational value and alignment of the potential pipeline canal produces maximum interference with hydrologic conditions.

From Gibson to Bayou Lafourche ($D_{17}$), wetlands are less impact-sensitive due to existing linear elements such as highways, existing mineral industry development, and drainage canals.

In the Salvador Basin, north of Bayou Lafourche ($D_{19}$), the same comments apply as given for segment $C_{14}$; however, the length of segment $D_{19}$ within the Salvador Basin is greater than that of $C_{14}$.

5. Segment E - No specific environmental problems are encountered with regard to alignment of segment E.

Based on an initial 120-foot wide impact right-of-way required to lay the pipeline and a permanent impact width of 50 feet associated with the remaining pipeline canal where wetlands are traversed, the acreages impacted along each of the proposed routes can be calculated for each environment and subsegment. Acreages of environments to be potentially impacted are given by subsegment in Table 8.2-10, together with the numbers of highway, levee and minor water body crossings. Impacted acreages are calculated for a 50-foot and 120-foot width, respectively, where wetland environments are involved. Data are summarized in Table 8.2-8 for both the Atchafalaya and the Bayou Teche Routes. Comparison of the data shows the most significant differences between the routes occur in the extent of unmodified swamp, which must be considered impact-sensitive. Approximately 350 more acres of relatively unmodified, high quality habitat swamp are affected by the Bayou Teche Route than by the Atchafalaya Route.

Physical Impacts

A. Construction - The primary physical impact of the proposed pipeline system is caused by excavation along the pipeline route. Acreages of each land use/habitat type affected by an assumed 120-foot wide construction right-of-way are shown in Table 8.2-11. Assuming that dry land excavation will be used through upland and agricultural land, that the flotation canal method will be used through marsh and open water, and that the push-ditch method will be used through swamp forest, an estimate of total sediment volumes excavated can be made. For dry land excavation (estimated at 10,000 cubic yards per mile), the total volume is 225,000 cubic yards for the Bayou Teche Route and 182,000 cubic yards for the Atchafalaya Route. For marsh and shallow water areas (assuming 90,000 cubic yards per mile), the total volumes are 680,000 cubic yards and 980,000 cubic yards, respectively. For swamp forest (assuming 30,000 cubic yards per mile), the total volumes to be removed are 1.44 million cubic yards and 923,000 cubic yards, respectively.

This excavated material must be placed in temporary spoil banks along the pipeline route until the line is installed and pressure-checked. During this period of time, a significant amount of interstitial water will be released to surrounding areas, possibly lowering pH and dissolved oxygen and raising nutrient concentrations and BOD in surrounding waters. If 50 percent of the excavated material is water, 1.2 million cubic yards (26,[illegible] acre-feet) of interstitial water would be released gradually to surface waters along the Bayou Teche pipeline route, and 1.0 million cubic yards for the Atchafalaya Route. Leaching and erosion are also likely to occur from runoff and normal surface water flow during the 6- to 9-month period of pipeline construction.

To prevent low water quality and stagnation in bayous adjacent to the pipeline route, spoil banks should be carefully placed to avoid disruption or blockage of normal surface water flow patterns. This will allow for dilution of spoil leachate and the movement of aquatic organisms in the bayous. If several construction crews work simultaneously, completed segments of the pipeline can be pressure-checked and backfilled immediately without waiting for completion of the entire line. Bulkheads can be constructed immediately after pipe installation at various locations to reduce the impact on major streams.

Backfilling will not restore areas to natural conditions in all cases. For example, in the marsh, erosion and compaction inevitably lead to a loss of some material. After backfilling, a shallow water canal will remain along the pipeline route. Assuming a 50-foot wide canal, this will represent a permanent loss of approximately 0.1 square miles of coastal marsh for both routes. This canal will also affect the local surface water flow patterns to some degree. Areas that may be especially sensitive to such changes in flow patterns are indicated in Table 8.2-6.

Without backfilling and bulkheading, surface and ground water flow patterns could be disrupted along the entire pipeline route. Salinity intrusion, flow stagnation, and many other possible effects could alter habitat over a wide area through both marsh and swamp forest. Current practice is to minimize this disruption by proper restoration measures such as described above.

Backfilling in dry land and swamp forest is usually successful. In dry land area, prior terrain can be duplicated. In swamp forests, there is a small loss of material, but often not enough to significantly affect the final elevation or regrowth of vegetation. To be conservative, however, it is assumed for the present analysis that a 50-foot corridor through the swamp is permanently lost as wooded swamp habitat (Table 8.2-11).

Ground water systems should not be affected by pipeline construction since all excavations are too shallow to disturb the local aquifers.

B. Operation - Normal operation of the pipeline system should have no effect on physical conditions along the corridor. The entire route can be allowed to reseed and revegetate naturally or, in certain aesthetically or ecologically sensitive areas, vegetation can be intentionally transplanted. Permanent right of access must be retained for system repairs and maintenance.

Comparing pipeline transportation (Tables 8.2-7 and 8.2-8 and text of oil spill analysis) with barge transportation at Cote Blanche (section 4.3.8 and Tables 4.3-1 and 4.3-2), the following comparisons may be made (including spill risks to the LOOP facilities): 1) the frequency of spills for the pipeline system is much smaller (2 spills compared to 302); 2) the average size of pipeline system spills is much larger (550 barrels compared to 9); 3) the total spill volume for the pipeline system is 60 percent lower (1100 barrels versus 2724); and 4) the chance of a major spill greater than 2000 barrels is much larger for the barge system (1 chance in 5.7 versus 1 in 14).

An oil spill is the major potential source of physical and ecological impact during pipeline operation. A scenario for a maximum credible spill of 10,000 barrels is as follows: Despite warning signs indicating pipeline crossing and burial of 5 feet or more, a large boat anchor is dragged across the pipeline in the Intracoastal Waterway, rupturing the line. Lack of wind and waves results in only 10 percent evaporation of the volatile oil fractions and 10 percent sinking of heavy fractions. Only 50 percent of the remainder is recovered, leaving 4000 barrels to spread along the canal banks and possibly reach the marsh or swamp forest. Because of the high toxicity of recently spilled unweathered oil, total plant loss could be assumed to occur at an average coverage of only 15 barrels per acre, compared to 25 barrels per acre for weathered oil. Thus, a worst case loss of 260 acres would occur. Since the expected total pipeline spill volume during the life of the project is only 990 barrels, the expected loss of acreage due to pipeline spills is much smaller than that estimated for the maximum credible spill.

Spills that occur in marsh or swamp land and on dry land will probably not spread as far as in a major waterway. Destruction of vegetation and wildlife would be great, and residual oil in the soil will affect recovery. Nearly all fractions of crude oil are attacked by bacteria and eventually decomposed; thus, a single heavy oil spill does not represent a permanent stress on the environment.

Transportation of oil by pipeline minimizes the problem of hydrocarbon vapor emissions which occurs with barge transportation, particularly since the pipeline would be left full of oil during standby storage. The only appreciable release of hydrocarbon vapors would occur during ballast uptake by VLCCs 18 miles off the coast. Maximum release would be 216 tons per fill. Filling of the cavern would also displace vapors from the system. These would either be flared, as presently proposed, or passed through a vapor condensation system. In either case, no appreciable amount of hydrocarbons would be released. With a vapor condensation system, a minimal amount of oil would be lost from the storage system.

C. Comparison of Physical Effects Caused by Pipeline and Barge Transportation Systems - Construction impacts of the pipeline system are much greater than for the barge system. The only construction associated with barge transportation is modification of the barge slip (approximately 15 acres) and less than 0.5 mile of pipeline to the pump shaft (assuming that new barge construction would not be required). Some increase in maintenance dredging of the ICW may be presumed to occur as a result of increased barge traffic. This may be compared to disruption of from 920 to 1200 acres during pipeline installation. There is also some potential for permanently altering water flow patterns, erosion rates, and subsidence rates along the pipeline route.

Operation of the pipeline system would have much less effect on the environment than the barge system. Pipeline oil spills are projected to be 60 percent lower (difference of 1600 barrels) than barge spills; maximum credible spill size is 83 percent lower (difference of 50,000 barrels). Hydrocarbon emissions would be 7,200 barrels of oil with pipeline transportation, occurring 18 miles from the coast; with barges, emissions would total the equivalent of 186,000 barrels of oil during 5 fill/withdrawal cycles. Also, the pipeline system avoids the large increases in barge demand, barge traffic, and the frequent small spills associated with barge oil transfer activities.

Biological Impacts

A. Construction - Pipeline construction through coastal Louisiana can have several possible effects on biota. Excavation can directly destroy vegetation and sessile organisms. Reduction in habitat can displace animal life and put stress on neighboring animal populations. Spoil banks can disrupt normal migration patterns for aquatic life. Spoil runoff can lower water quality, smother benthos, and stress populations in adjoining areas. Noise and the physical presence of construction crews can disturb wildlife. Greatly altered physical conditions can prevent regeneration of productive habitats after construction is complete. The extent and significance of these impacts depend to a large degree on the success of restoration measures in mitigating potentially lasting construction effects.

As an indication of potential direct displacement effects on wildlife, data on carrying capacities of typical habitats in Louisiana can be used. Using the estimated acreage impacts shown in Tables 8.2-10 and 8.2-11, and estimates of faunal carrying capacity given in the Corps of Engineers Environmental Inventory (1973a), an estimate of the number of certain species displaced from the pipeline right-of-way can be made.

Tables 8.2-12 and 8.2-13 summarize the potential initial and long-term impact on selected species due to direct habitat disruption. A worst case effect would occur if adjacent habitats were already at full carrying capacity and no further population increase could be absorbed. This would result in the death of individuals least able to compete for food and shelter in numbers equal to those displaced. This may be true for certain of the species listed, but probably not for the less common species (e.g., black bear, fox), which may be limited by factors other than habitat acreage. For the present analysis, dry land and marsh are assumed to recover fully in 2 years (except where a canal displaces the marsh). Swamp forest is assumed to recover full productivity in 10 years (though regrowth may take 30 years or longer).

The greatest impact to numbers of individuals and species occurs in the swamp forest as a result of the large acreage affected and the high quality of wildlife habitat. The Bayou Teche Route is particularly damaging in this habitat.

The data on faunal carrying capacity used in computing wildlife impacts (Tables 8.2-12 and 8.2-13 ) do not distinguish between modified and relatively unmodified sections of the wetlands in terms of habitat quality. From Table 8.2-11, however, it is evident that virtually the entire acreage of swampland crossed by the Bayou Teche Route is relatively unmodified, while 20 percent of the Atchafalaya swamp acreage is significantly modified (primarily by oil field development in Sections $C_8$ and $C_9$). The Atchafalaya Route crosses roughly the same number of minor water bodies, highways, levees and railroads, significantly more acreage of large water bodies, and less agricultural land and marsh.

Areas of particular impact sensitivity are indicated in Table 8.2-9 and summarized below (see Figure 8.2-2 ):

1. Bayou Teche Route -
   a. Bay Wallace area ($D_{15}$), a relatively unmodified cypress-tupelo swamp and lake having high scenic quality and natural water circulation.
   b. Salvador Basin ($D_{19}$), another relatively unmodified cypress-tupelo swamp with high scenic and habitat value with natural drainage.
2. Atchafalaya Route -
   a. Atchafalaya Floodway ($C_6$ and $C_8$), relatively unmodified cypress-tupelo swamp with high scenic quality and having exceptionally high biological productivity.
   b. Verret Basin ($C_{10}$ and $C_{12}$), relatively unmodified cypress-tupelo swamp with high scenic quality.
   c. Salvador Basin ($C_{14}$), relatively unmodified cypress-tupelo swamp with high scenic quality and resource value.

Common to both routes:

Jaws Bay area ($B_4$), relatively unmodified tidal basin with alternating intermediate marsh and cypress-tupelo swamp.

The total loss of vegetation and wildlife along the pipeline routes is not a significant portion of the vast resources of similar kind still existent in Louisiana. Offsite effects caused by spoil disposal and surface water disruption may double the temporary effects for a period of a week to several months, but should not increase the permanent effects if construction is carried out properly.

A significant advantage to the pipeline routes in terms of biological impact is the fact that they parallel existing pipeline rights-of-way for almost the entire length. Thus, the habitat directly impacted should be of generally lower wildlife value and productivity than other areas. However, a pipeline does add to the incremental construction impacts occurring throughout the Louisiana wetlands. By following an existing right-of-way, no previously undisturbed areas are directly affected. However, some sections of the routes have only one shallow canal that does not greatly affect natural surface drainage. Widening these canals or laying a parallel canal increases the risk of flow disruption and creates a pipeline corridor likely to be used again in the future.

B. Operation - Operation of the pipeline affects biota only in the case of an oil spill. Because of the many interconnecting rivers and bayous in the Louisiana coastal wetlands, oil spills from buried pipelines can have significant impacts on large areas of vegetation and wildlife unless they occur in the vicinity of a small enclosed water body or in heavy vegetation where the effects are usually localized.

Existing pipeline technology, however, provides excellent supervisory control systems for monitoring oil transport. For example, a pipeline leak can be detected by meters; flow can be automatically shut down and block valves closed to isolate line segments. Oil spill recovery teams and cleanup equipment can then be quickly transported to the spill scene to rapidly clean up the oil.

For the maximum credible spill treated in the previous section on physical impacts, a 260-acre area of marsh vegetation would be destroyed. Birds, mammals, and fish are the most likely fauna to be affected. The impact would be especially great on waterfowl if the spill occurred in the winter when many species are nesting in the area. On land, however, oil spreading would be limited. Habitat recovery in all but the most heavily oiled areas would be expected to be complete in 2 to 3 years.

Expected oil spill impacts would be much lower than those from a maximum credible spill. A total of 1200 barrels might destroy 50 acres over the life of the project. This is a small fraction of the available marsh, swamp, and agricultural land in the region.

C. Mitigative Measures - In addition to the standard construction measures, such as backfilling and bulkheading, biological impacts may be mitigated directly by selecting less sensitive route alignments. Several potential alignments are identified on Figure 8.2-3

C-1. Alignment $B_7$ - This alignment follows the ICW and Franklin drainage canal across the Jaws tidal basin area. There is much less potential for altering natural drainage patterns and disrupting the wetland ecosystem. Pipeline length is only 0.8 miles longer than segments $B_2$ through $B_6$, so costs should be relatively unaffected.

C-2. Alignment $C_{15}$ - This alignment avoids the highly productive cypress-tupelo swamp in the Atchafalaya Basin by crossing an area of active sedimentation and willow swamps north of Six Mile Lake. As this ecosystem is adapting to changing drainage patterns, impact sensitivity is low and recovery should be rapid. The alignment further follows the ICW and east bank of the Atchafalaya Floodway to the north, avoiding high quality wetlands as much as possible. Alignment $C_{15}$ is approximately 7.6 miles longer than the basic route C, however, and consequently would be significantly more costly to build.

C-3. Alignment $C_{16}$ - This alignment uses the existing, much modified pipeline corridor south of Bayou Teche to the vicinity of Morgan City ($D_1$ through $D_8$). From there, the route passes east of Morgan City and up the ICW and east bank of the Atchafalaya Floodway. As with alignment $C_{15}$, impact sensitive swamps in the Atchafalaya Basin are avoided. Alignment $C_{16}$ is 10.4 miles longer than the basic route C, however, and consequently significantly more costly to build.

C-4. Alignment $C_{17}$ - This alignment follows the Baker Canal and cleared natural levee, avoiding the Salvador Basin swamp. Since the alignment is approximately the same length as corresponding segments of routes C and E, its cost to construct should be approximately the same.

C-5. Alignment $D_{20}$ - This alignment follows existing highway, railroad, and utility corridors close to the natural levee, avoiding the sensitive Bay Wallace swamp ($D_{15}$). The alignment is 5.6 miles shorter than the basic route D and, consequently, should be significantly less expensive to construct.

Utilizing the above route alternatives, it is evident that the Atchafalaya Route (perhaps including segments $D_1$ through $D_8$) can be constructed to cross fewer high quality wetland areas than does the Bayou Teche route. The Atchafalaya Route is also significantly shorter and, therefore, less costly to build. The selection of alignment to use in crossing the Atchafalaya involves a tradeoff between environmental impacts and project costs. Of the Atchafalaya alignments, the lowest environmental impact and the highest economic cost are associated with routes $B_7$ $D_{1-8}$ $C_{16}$ $C_{12-13}$ $C_{17}$ (Figure 8.2-3).

D. Comparison of Biological Effects Caused by Pipeline and Barge Transportation Systems - Except for a possible increase in maintenance dredging frequency and the loss of 15 acres of land for the new barge facility at Cote Blanche Island, there are no significant impacts on biota due to construction of necessary facilities for barge transport. Impacts due to construction of the pipeline are locally significant (920 to 1200 acres), though mostly temporary (2 to 10 years) in duration.

Operation effects will be much greater with barge transportation because of greater expected average and maximum credible oil spill volumes, and because of increased barge traffic in the waterways.

Land and Water Use Impacts - Construction and operation of a pipeline to St. James will impact water traffic only for short periods during construction at navigable waterway crossings. Domestic water supplies will not be affected. Land-use restrictions will be required for a 50-foot wide right-of-way, but these may alter current or potential usage only on levee lands. Possible conflicts with a future Coastal Zone Management Plan would be avoided as long as existing development corridors were used.

The barge system will not affect land use except to a minor degree on Cote Blanche Island, where about 15 acres of land would be needed. Traffic on the ICW and in the vicinity of the terminals may increase to a point that causes some delay and inconvenience to local ship traffic. However, this increase will probably not be significant since it may be assumed that, during a period of critical supply interruption, recreational and some commercial vessel traffic will be curtailed.

Socioeconomic Impacts - Socioeconomic impacts of construction and operation of a pipeline to serve the Cote Blanche Island storage facility primarily relate to employment, income, and property tax revenues. Assuming an 80-mile Bayou Teche to St. James route was to be selected, construction would require the expenditure of an estimated $80 million in capital costs.

Construction might require up to 1 year, and would employ an average of 150 workers full time. Energy costs in constructing the pipeline and pumping 27 million barrels of oil to and from storage five times over the life of the project are estimated at $4.8 \times 10^6$ MMBTU (compared to $5.0 \times 10^6$ MMBTU for barge transportation). This means that approximately 36,000 more barrels of oil would be required for barge transportation than for pipeline transportation during the life of the project. Operation costs for pipeline transport will be from $800,000 (for fill) to $1.6 million (for withdrawal) per month less than with barge transport because barge and tug lease fees would not be required.

For a 60-mile pipeline route, economic effects and energy requirements would be approximately 75 percent of those for the 80-mile route. Thus, capital costs might be $60 million. Energy use would be approximately 100,000 barrels of oil less than with barge transport.

Most pipeline construction workers are specialists who move from job to job. There is little requirement for common day laborers, so the pipeline installation is not likely to generate significant local employment along the route. Most of the pipeline crew will take temporary lodgings in communities near the right-of-way and relocate as work progresses. Few workers will bring dependents or spend significant amounts of their wages locally.

After completion, it is assumed that property taxes would be levied on the pipeline by the parishes through which it passes. Alternatively, an in-lieu tax might be paid on the facility if it remained in public ownership. The incremental impact of such revenues on parish or state finances would not be very significant in view of the large number of oil and gas pipelines already crisscrossing the region (see Figures 3.9-4 and 3.9-5).

Operation of the pipeline requires only a few personnel. Numbers increase during filling and withdrawal operations because of the need to tend valves and pumps. During standby, however, only maintenance and security personnel are required. Accordingly, operations will place no significant demand on the area labor force; for the same reasons, the pipeline will generate little local wage income.

8.2.4.3 Offshore Terminal

An offshore terminal could be constructed to utilize tankers to transport oil to and from Cote Blanche Island. This terminal would require construction of a submarine pipeline across Vermilion or West Cote Blanche Bay and out to water depths (approximately 60 feet) suitable for tankers. Water depths are shallow in the Gulf south of Marsh Island. The 60-foot contour is approximately 64 miles from Cote Blanche Island.

Costs for installing a 40-inch submarine pipeline in coastal Gulf waters are approximately $1 million per mile for this range of water depths. This is roughly the same as for an onshore pipeline constructed through marsh or swampland. A single point mooring buoy (SPM) may cost an additional $5 million. Thus, an offshore pipeline system can cost upwards of $70 million, very similar to the cost of an onshore pipeline system.

Environmental impacts of an offshore pipeline are primarily associated with installation of the pipeline. Offshore pipelines are buried in the sea floor in water depths less than 200 feet to protect against damage from storm-induced wave action and dragging ship anchors. Installation is accomplished by jetting a trench in the ocean floor and laying the assembled pipeline in the trench. Ocean-bottom currents refill the trench within a few days. Three feet of bottom cover is normally used beyond the surf zone and 7 to 10 feet near shore to avoid the possibility of induced erosion.

Jetting the pipe trench directly disturbs a 10- to 20-foot wide corridor of substrate and benthic habitat; heavy siltation can be expected to occur within 100 feet on either side of the trench. Thus, approximately 1550 acres of sea floor would be physically affected by a 64-mile pipeline. Recovery of benthic animals is likely to occur within 2 years.

Jetting affects the water column over a greater area than it does the substrate. Typical effects are increased BOD and nutrient concentrations, and a reduction in dissolved oxygen and pH. It is also possible that heavy metal or pesticide residues in the substrate will be resuspended in the water column.

Water column effects may be measurable a mile or more from the jetting sled, depending on current conditions. Continual water movement will disperse the affected waters quickly, however.

Aquatic life most likely to be affected by offshore pipeline construction is the benthos. These organisms are more numerous in shallow, near-shore waters. Oyster reefs and clam beds are particularly vulnerable to excessive siltation. Some reduction in plankton productivity is likely to occur in shallow surface waters due to turbidity increases. Offshore spawning areas of the white shrimp could be affected to a minor degree. Though most nekton can avoid unsuitable waters, the loss of benthos and plankton will have some effect through the food web.

Oil transfer through a submarine pipeline would be subject to the same safety precautions as onshore. Estimated spillage of oil during a single fill/withdrawal cycle is 45 barrels from pipeline spills and 162 barrels from transfer through an SPM to a VLCC (Table 8.2-14). Maximum credible spill is 10,000 barrels.

Because of the dispersion of any possible oil spill over a wide area, no major environmental effects should occur. The relatively small oil spill volumes expected should not pose a threat to the shoreline unless the spill occurs in Vermilion Bay or close to Marsh Island. Some offshore birds may be affected. Time is usually available for recovery of the oil before landfall. Also, the oil will lose most toxic fractions due to weathering after 1 or 2 days.

Hydrocarbons would be emitted during filling of tankers from the pipeline 60 miles south of Cote Blanche. An estimated 20,000 barrels of oil would be released to the atmosphere during five fill/withdrawal cycles, only 11 percent of the amount released with the barge transport mode. Maximum rate of release would be 27 BPD. As these emissions would be released more than 60 miles south of Cote Blanche, there should be no measurable effect on air quality in coastal Louisiana.

In general, if particularly sensitive areas such as oyster reefs, clam beds, or known important spawning grounds can be avoided, the environmental effects of an offshore pipeline are smaller and of shorter duration than those of a similar length pipeline through coastal wetlands. The economic costs of installing such a system to serve the Cote Blanche Mine site are approximately the same as an onshore pipeline system since a storage site developed at Weeks Island could also be served by the same pipeline. However, filling the caverns with oil through an offshore pipeline would require construction of an offshore pumping platform. Such a platform would have only minor, temporary effects on water quality and marine life but might increase the total system cost by 50 percent.

8.2.5 Increased Cavern Fill Rate

The cavern fill rate used as a basis for evaluation of project impacts in section 4.3 and elsewhere is 85,000 BPD. Sufficient barge capacity should easily be available to transport this amount of oil to Cote Blanche (3.4 barges per day or approximately 17 required full time). However, at this rate it would take more than 10 months to fill the cavern with 27 million barrels of oil. For the option of no salt mine production shutdown, the projected construction schedule (Figure 2.3-1) would result in only 10 million barrels of oil in storage by January 1979. Should any delays be experienced in this schedule, even less oil would be in storage by that date and the mine would contribute very little to the 150 million barrel ESR goal.

To increase the amount of oil in ESR storage, it may be necessary to increase the cavern fill rate. For the purpose of impact analysis, the maximum rate of oil transfer which can be handled by the barge facility design (180,000 BPD) will be taken as the maximum possible fill rate. This would also be the maximum fill rate for subsequent cavern fill operations and would depend, among other factors, on oil availability.

A fill rate of 180,000 BPD requires 7.2 barges/day at the site and a total of 37 barges used exclusively for Cote Blanche over a 150-day period. At this rate, approximately 21 million barrels of oil could be placed in storage under the no mine shutdown option by January 1979, an increase of 11 million barrels during the ESR period.

The major adverse impact associated with this fill rate could be the utilization of many barges which might be needed for other purposes (depending on market conditions). Traffic levels on the ICW would be approximately 10 percent higher than with the 85,000 BPD fill rate. This is not enough of an increase to affect oil spill risk potential. The rate of oil spills, hydrocarbon emissions, bank erosion and barge pass-bys would increase by a factor of two, but as the fill operation would take only half as long, the ultimate effect should be substantially the same.

The number of personnel required to operate the facility may be somewhat higher with the larger fill rate, but the use of personnel may be more efficient. Thus, somewhat lower total wages might be earned locally, but the difference would not be significant.

In summary, the impacts associated with a 180,000 BPD fill rate are essentially the same, though occurring over a shorter time period, as those of an 85,000 BPD fill rate. An additional 11 million barrels of oil could be in storage for the ESR if the no mine shutdown option is selected; there would be no change in the oil stored (a full 27 million barrels) for the temporary mine shutdown option. Important factors to be considered are the availability of oil and the importance of alternative uses of the additional 20 barges needed.

Should both Weeks Island and Cote Blanche Island be selected for concurrent development as oil storage sites, maximum rate of fill for both sites together is estimated to be 342,000 BPD (assuming 70 barges would be available to the SPR). At this rate, both facilities could then be filled in 340 days. Approximately 14 barges/day would offload at the two sites, which is a 36 percent increase in present traffic levels on the ICW. As in the case with Cote Blanche alone, however, the magnitude and type of impacts would not be changed significantly. Availability of oil and barges would be an important factor to consider, however.

**West Hackberry**

# E N V I R O N M E N T A L   I M P A C T   S U M M A R Y

## Table 8.2-1

| ACTIVITY | IMPACTS DUE TO ACTIVITIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| Drilling of 3 new wells; construction of pump and office buildings and additional roadways | Temporary erosion and sedimentation; change in drainage patterns. | Enclosure of 240 acres now in industrial use; disposal of construction waste in existing land fill. | Increase of 2.354 in suspended solids from 5,028 cu yds of sediment; increase in turbidity. | Temporary degradation from construction equipment emissions; increase in fugitive dust of 0.3 tons per month; possible violation of 3-hr HC standards. | Noise impact zone (>55 dBA) up to 2,000 feet; nearest residence at 2,000 feet. | No significant impact; vegetation and wildlife at storage site already highly disturbed. | $1.2 million of construction labor from Lake Charles area; slightly increased local traffic. |
| **BRINE DISPOSAL** | | | | | | | |
| 11 brine wells<br>2 10,000 bbl surge tanks<br>30,000-ft pipeline to disposal area (P) | 10 acres of marsh filled around wellhead. | Conversion of 25 acres from pasture to brine disposal. | Salinity increase in disposal aquifer of 1 ppt; increase in salinity of Chicot Sands possible if old wells in area are unplugged. | Slight impact during drilling operations. | Noise impact zone up to 1,000 feet. | Reduction in fish and shellfish production by 1,650 lb/yr due to loss of 10 acres of marsh. | Same as site construction. |
| 20-mi pipeline to Gulf (A) | Temporary surface disruption. | Some alteration to Sabine-Neches dredging area. | Salinity increase of 1.5 ppt 16 foot downcurrent; increase of 0.1 ppt. over 250 acres; increased turbidity along pipeline routes. | Temporary localized degradation from construction equipment emissions. | Noise impact zone up to 500 feet. | Temporary elimination of low mobility organisms near diffuser. | Greater impact than proposal. |
| **DOCK FACILITY CONSTRUCTION** | | | | | | | |
| Temporary barge dock on Alkali Ditch; new tanker terminal at Calcasieu River, required pumps and tanks (P) | 36,000 cu yds of dredging in Alkali Ditch and 1 million cu yds in Calcasieu River Channel; maintenance dredging at both sites; suspended sediment at both sites. | Alteration of 90 acres of marsh by dredging disposal. | Localized degradation from increased turbidity, toxic sulfides, heavy metals or arsenic, pesticides, and other toxic hydrocarbons in Alkali Ditch and Calcasieu dredging and spoil disposal. | Paint solvent emissions exceeding standards at 2 km. | Noise impact zone up to 2,000 feet; nearest residence beyond 2,000 feet. | Temporary elimination of bottom species and reduction of plankton productivity from dredging; temporary disruption of wildlife and vegetation from dredge disposal. | $1.2 million of construction labor from Lake Charles area. |
| Expansion of Lone Star Terminal (A) | Dredging of 440,000 cu yds. | Use of 30 acres of abandoned industrial property already disturbed; conversion of 100 acres of marsh to dry land with dredge disposal. | Turbidity downstream to lake; less impact than proposal due to less dredging and preferable disposal area. | Impact same as proposal. | Impact same as proposal. | Impact same as proposal. | Impact same as proposal. |
| **PIPELINES** | | | | | | | |
| 4-mi pipeline between site and terminal at Calcasieu (P) | Temporary surface disruption. | 1-year disruption of 55 acres of agricultural land. | No impact. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary disruption of wildlife. | Same as dock facility construction. |
| 13-mi pipeline between site and Lone Star Terminal (A) | Temporary surface disruption. | Disruption of 180 acres of marsh and agricultural land. | Slight increase in turbidity in marsh during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Loss of a small amount (312 tons) of marsh productivity during construction. | Greater impact than proposal due to longer pipeline. |
| Connect to existing pipelines (A) | Temporary surface disruption. | Disruption of 76 acres of brackish marsh and 50 to 80 acres of rice farming. | Slight increase in turbidity in marsh during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary wildlife disruption. | Loss of $32,[illegible] in rice farming income. |
| New pipeline to Texoma Terminal (A) | Temporary soil disruption. | 180 acres of brackish marsh, 106 acres of intermediate marsh, 48 acres of fresh marsh, 24 acres of dry land. | Slight increase in turbidity in marshes during construction. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet. | Temporary disruption of wildlife; disruption of benthic community in waterways where dredging required. | Greatest impact due to length of pipeline. |
| Pipeline accidents | Soil fouled in vicinity of pipelines. | Land unsuitable for farming until oil dispersed through soil. | Local degradation of water quality. | Slight hydrocarbon emissions. | Noise from cleanup operations. | Temporary destruction of local soil organisms and vegetation (on land) and non-mobile organisms in water. | Temporary loss of farm production over small area. |
| **OIL DISPLACEMENT WATER SOURCE** | | | | | | | |
| Black Lake Bayou (P) | No impact. | No impact. | Slight increase in salinity and temporary drop in surface level associated with withdrawal of 10,650 gpm for 150 days. | Slight hydrocarbon emissions. | Noise from pumps. | Entrapment of some organisms in intake structures; no effect on productivity; temporary loss of wildlife during construction. | Same as site construction. |
| Groundwater wells (A) | Surface disruption from drilling. | 1-year loss of small area of coastal prairie grassland. | 10,650 gpm for 150 days will result in local cone of depression and some temporary salt water intrusion. | Slight hydrocarbon emissions. | Noise impact zone up to 1,800 feet. | Temporary disruption of wildlife during drilling. | Greater impact than proposal. |
| **MARINE OPERATIONS** | Small amount of erosion on channel bottom. | No impact. | Expected oil spill of 273 bbls with tankers, 3,087 bbls with barges. | Barge hydrocarbon emissions of 781 lb/day during unloading; tanker emissions of 8,286 lb/day during unloading and 20,953 during loading; concentrations in excess of 160 $\mu gm/m^3$ would extend downwind for 6 miles and 30-45 miles during the barge and tanker operations respectively. | Very slight impact. | Destruction of non-mobile species and residual oily taste in fish from oil spills. | Reduced marketability of fish fouled by oil. |
| **FACILITY OPERATION** | No additional impact. | No additional impact. | Small quantities of sanitary waste; slight impact. | Evaporative hydrocarbon losses of 588 lb/day and 500 lb/day from the storage tanks at the barge dock and the tanker terminal respectively; concentrations would be 160 $\mu gm/m^3$ at 3 km (barge dock) and at >3km (tanker terminal). | Very slight impact; less than 70 dBA at 50 feet; no nearby residences. | No additional impact. | 10 people employed during operations; 20-30 employed during oil recovery; payroll during operation of $18,000 per month; payroll during recovery of $43,050 per month. |

(P) Proposed system design
(A) Alternative to the proposed system design

## Bayou Choctaw

# ENVIRONMENTAL IMPACT SUMMARY

## Table 8.2-2

| ACTIVITY | IMPACTS DUE TO ACTIVITIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
| STORAGE SITE CONSTRUCTION | Short-term erosion from dikes, swale, and other earthmoving; 701 cubic yards of sediment. | 104 acres enclosed; industrial use unchanged; 3,000 to 10,000 cubic yards of construction waste in 1 of 9 landfill sites. | Small increase in turbidity from grease and oil; 7% increase in suspended solids in local waters. | Temporary degradation from construction equipment and paint solvents not in excess of standards; increase of 19.1 tons/yr of suspended particulates; 7% increase for parish overall. | Noise impact zone (greater than 55 dBA) within 2,000 feet; no residences within 1 mile. | Minor disturbance to wildlife; alteration of vegetation. | 386 man-months of construction employment on site; $675,500 in payroll; slightly increased traffic and resulting maintenance costs for public facilities. |
| BRINE DISPOSAL | | | | | | | |
| 28 Injection Wells 500,000-Barrel Holding Pond 6,500-Foot Pipeline (P) | No rock fracture under average pressure; possible rock fracture in 50-foot sand layers during fifth cycle. | 128 acres of swamp forest changed to industrial use. | Increase in salinity in saline aquifers; possible contamination of fresh aquifers if old wells unplugged. | Slight impact from drilling operations. | 95-100 dBA at 50 feet; noise impact zone at 1,800 feet; no residences within 1 mile. | Loss of wildlife habitat and production; <1% probability of brine spill that could destroy some marshland over 120 acres. | Included in storage site construction. |
| 116-Mile Pipeline to Gulf (A) | Temporary surface disruption. | 182 acres of sugar cane and 350 acres of wetlands lost. | 0.1-ppt salinity increase in Gulf waters over 450 acres; increase of 2.5 ppt over 1 acre; no increase more than 3.5 ppt. | Slight impact. | Noise impact zone within 500 feet; no residences within one quarter mile. | Temporary loss of benthic organisms and fish; <1% probability of brine spill that could destroy marsh. | Loss of $62,500 in sugar cane (one harvest; requires 3 yrs growth). |
| DOCK FACILITY CONSTRUCTION | | | | | | | |
| Expansion of Bull Bay; Tanker Dock at Addis; Storage and Ballast Tanks (P) | Suspension of sediment. | 250-acre tract, including 30 agricultural acres, disturbed. | Local increases in turbidity, toxic sulfides, heavy metals, hydrocarbons, ammonia, TKN, COD from dredging, and dredge disposal of 86,000 cubic yards and 1.5 million cubic yards for permanent dock. | Same as site construction. | 70 dBA at dock during construction. | No impact at Bull Bay; loss of aquatic species at new dock site. | 500 man-months of construction labor at dock sites; $875,500 in payroll. |
| Expansion of St. James Terminal Pipeline to St. James (A) | Suspension of sediment. | 30 acres disturbed; 127 acres of sugar cane production possibly precluded. | Same as proposal, but larger turbidity plumes that will dissipate more rapidly; river sediment less polluted; less dredging impact. | Same impact as proposal. | Same impact as proposal. | Less impact than proposal. | Possible loss of $43,000 in sugar cane (one harvest). |
| PIPELINE | | | | | | | |
| Oil Line 5 Miles from Addis to Site (P) | Temporary surface disruption. | 55 acres disturbed (30 in sugar cane, 25 in backwater swamps). | Temporarily increased turbidity in swamp. | Slight hydrocarbon emissions. | Noise impact zone at 500 feet; few residences within one quarter mile. | Minimal impact during construction only; vegetation will return. | 450 man-months of construction employment; loss of $7,500 in sugar cane production (one harvest). |
| Pipeline Accidents | Soil fouled in vicinity of pipeline. | Land unsuitable for farming until oil dispersion through soil complete. | Local degradation of water quality. | Slight hydrocarbon emissions. | Slight impact during cleanup operations. | 16 barrels spilled oil would destroy local soil organisms (if underground) and vegetation (if above ground). | Temporary loss of farm and swamp production over small area. |
| OIL DISPLACEMENT WATER SOURCE | | | | | | | |
| 12-Acre On-Site Lake (P) | No impact. | No impact. | No significant impact on lake or replenishing water sources; 1 ppt decrease in lake salinity. | Slight hydrocarbon emissions. | Slight impact; pumps and motors. | Temporary migration during displacement; entrapment of plankton, larval fishes, vertically migrating benthics, small aquatic plants. | No impact. |
| Mississippi River (A) | No impact. | No impact. | 32,000 gpm, representing 0.035% of river flow; no adverse impact. | Slight hydrocarbon emissions. | Slight impact; pumps and motors. | Impact same as on-site lake. | No impact. |
| Ground Wells (A) | Surface disruption due to drilling. | 5.7 acre-well area. | 10-foot reduction in water table level at 0.5 miles from pumping station. | Slight hydrocarbon emissions. | Slight impact; pumps and drilling rigs. | 4.2-ton loss of biological swamp production for 1 year plus impacts of on-site lake. | No impact. |
| MARINE OPERATIONS | Small amount of erosion on channel bottom. | No impact. | Expected spill of 536 barrels from tankers or 7,857 from barges per fill/withdrawal cycle. Disposal of 47,500 barrels of ballast water per tanker in brine well; no adverse impact to aquifer. | Worst case hydrocarbon emissions from storage tanks could exceed 160 $\mu gm/m^3$ as far as 10 km downwind; maximum concentrations of 7500 $\mu gm/m^3$ at 0.5 km. | Noise impact zone at 200 feet; no residences within ½ mile. | Destruction of non-mobile species and residual oily taste in fish if oil spills occur. | Reduced marketability of fish fouled if oil spills occur. |
| FACILITY OPERATION | No impact. | No additional impact. | Small quantities of solid and sanitary waste; no adverse impact. | Vessel loading and unloading could produce 2,000 tons hydrocarbon emissions for each fill or withdrawal; worst case emissions could exceed 160 $\mu gm/m^3$ for considerable distance downwind (5-10 km); maximum concentration at 0.5 km of 6,125 $\mu gm/m^3$. | Noise impact zone at 200 feet; no residences within ½ mile. | No additional impact. | 10 full-time personnel: 6 skilled, 3 laborers, 1 clerical; 20-30 skilled workers for oil recovery. |

(P) Proposed system design

(A) Alternative to the proposed system design

## Bryan Mound

## Table 8.2-3

### ENVIRONMENTAL IMPACT SUMMARY

| ACTIVITY | IMPACTS DUE TO ACTIVITIES: GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC* |
|---|---|---|---|---|---|---|---|
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| 50 million-barrel capacity involving 216 acres (P) | Short-term erosion from dikes, roads, and pipelines; 64,500 cubic yards of material involved. | 216 acres previously used for production of sulphur; 20 acres involved in new construction; one new 65x100-foot building. 3,000 to 12,000 cubic feet of surplus lumber, paper waste, concrete and formation water for entire project to landfill sites. | Small increase in turbidity and levels of petroleum products, herbicides and pesticides, metals, salt additives, and construction chemicals. | Temporary degradation by construction vehicles and drill rig equipment, resulting in hydrocarbons, $SO_x$, $NO_x$; about 0.5 tons/acre of dust given off per month of activity. | Noise impact zone (greater than 55 dBA) at 2,500 feet; no nearby residences. | Minor additional disruption of wildlife habitat. | 1,750 man-months of total construction employment on site; $250,000 per month payroll; 90 men involved in general site construction and drilling; slightly increased traffic and resulting maintenance costs for public facilities. |
| **BRINE DISPOSAL** | | | | | | | |
| Disposal of brine to chemical plants via existing pipeline (P). | No impact. | Brine disposed of in existing ponds at rate of 9,333 gallons per minute. | No impact. | No impact. | No additional impact. | No impact. | No impact. |
| Disposal of brine to Gulf via 4-mile pipeline (A) | Temporary surface disruption. | 24 acres (100-foot right-of-way through 8 acres of coastal prairie, 2 acres of beach, 4 acres of marsh, and 10 acres of cleared land). | Crossing of Gulf Intracoastal Waterway (ICWW) near Brazos River; destruction of nonproductive benthic habitat. | Slight hydrocarbon and dust emissions during construction. | Temporary annoyance to beach visitors from construction equipment. | 24 acres of benthic habitat destroyed temporarily along 100-foot corridor for 2 miles into Gulf; entrainment of low mobility unattached organisms near the intake. | No impact. |
| Deep well injection using 10 wells spaced at 1,000 feet on the perimeter of the site (A) | Temporary surface disruption. | 20 additional acres required outside site boundaries. | Less than 1% chance of brine spill due to pipeline or wellhead failure; possibility that overpressurization would fracture aquiclude to cause freshwater contamination. | Slight hydrocarbon emissions during drilling. | Drilling noise for 12 months. | Minor additional disruption of wildlife habitat. | No impact. |
| **STORAGE TANK CONSTRUCTION** | | | | | | | |
| Four 400,000-barrel above-ground floating roof storage tanks on site (P) | Permanent surface disruption. | 30 acres of cleared land to be modified for tanks. | During construction, some petroleum products, herbicides, pesticides, and sediment. | Vapors from solvents during spray painting of tanks 1 km downwind for several of 90 days, depending on wind. | Noise impact zone up to 2,500 feet; no nearby residences. | Minor additional disruption of wildlife habitat. | 25 welders and pipefitters for all pipeline and tank construction. |
| **DOCK FACILITY CONSTRUCTION** | | | | | | | |
| Use of Seaway, Inc. dock facilities under construction; 100,000 barrel ballast treatment system and pump building (P) | Suspension of some sediment from channel. | 3 acres of cleared and already disturbed land for Ballast Treatment System. | Same as storage tanks. | Paint solvent emissions from spraying 1.18 gram per second during initial painting. | 70 dBA at dock facilities. | 3 acres of land for ballast treatment tanks; no critical wildlife habitat; no impact. | No impact. |
| New barge docks in ICWW (A) | Temporary surface disruption. | Precise location not determined but approximately 1 mile southeast of storage site. | Dredged materials to be placed on 184-acre disposal area 3 miles east; oil spills from associated barge traffic to be contained in the ICWW. | Slight hydrocarbon emissions. | Slight impact from construction. | Marshland, the waterway, a sand dune (disposal site) affected by dredged material; stagnant ICWW water; increased barge traffic. | Construction payroll less than that for storage site construction. |
| **PIPELINES** | | | | | | | |
| 30-inch pipeline from site to dock at Freeport, 3.7 miles east (P) | Temporary surface disruptions. | 45 acres, 100-foot right-of-way (ROW) through disturbed land. | Local and temporary increase in turbidity and levels of toxic heavy metals and hydrocarbons, and pesticides from dredging and dredge disposal for Brazos River crossing. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; no nearby residences. | Little effect except temporary displacement of transient species like waterfowl and small mammals. | 50-man labor force for all pipeline construction. |
| 30-inch pipeline from site to Seaway storage tank facility, 4.5 miles west (P) | Temporary surface disruptions. | 53 acres, 100-foot ROW through 18 acres of marsh, 9 acres of developed land, and 26 acres of coastal prairie. | | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; no nearby residences. | Temporary disturbance of marsh and coastal prairie to displace wildlife until vegetation reestablished; dredging on Brazos River crossing to eliminate 0.5 acres of benthic habitat, but with repopulation after 1 to 2 months. | |
| Pipeline accidents | Soil fouled to 10 cm depth in buried pipeline for 1,000 barrel spill, covering 0.4 acres. | Local land unsuitable for current use until oil dispersion through soil complete. | Only local and minor degradation of water quality. | Slight hydrocarbon emissions. | Slight impact during cleanup. | 4.3 barrels, annual spill expected with mean spill size approximately 1,000 barrels; would destroy local soil organisms (if underground) and vegetation (if aboveground). | Small area involved not commercially productive; no impact. |
| **OIL DISPLACEMENT WATER SOURCE** | | | | | | | |
| Water supply from Brazoria and Harris reservoirs via Dow plant and 5-mile pipeline (P) | Temporary surface disruption. | 15 acres, 50-foot ROW through 6 acres of coastal prairie, 4 acres of developed land. | Displacement at maximum rate of 14,000 gallons per minute; no significant impact on reservoirs or Brazos River replenishment source; reservoir volume 10 times projected displacement water requirement during one cycle. | Slight hydrocarbon emissions. | Noise impact zone up to 500 feet; slight temporary impact on residences and businesses. Slight impact from pumps during operations. | Plankton affected primarily during withdrawal phase due to impingement and entrainment in intake structure. | 50-man labor force for all pipeline construction. |
| Gulf of Mexico water transported by 3-mile pipeline (A) | Temporary surface disruption. | 1 to 2 acres onshore for pumping station; 14 acres of coastal prairie and marsh. | Crossing of ICWW; disturbance of land areas with possible turbidity due to runoff during construction. | Slight hydrocarbon emissions. | Temporary annoyance to beach visitors due to construction. | Benthic habitat along corridor temporarily destroyed; entrainment of low mobility unattached organisms at the intake. | 50-man labor force as above for all pipeline construction. |
| Water from Brazos diversion channel adjacent to site (A) | Temporary surface disruption. | Less than 1 acre of disturbed industrial land involved. | Temporary increase in turbidity in diversion channel. | Slight hydrocarbon emissions. | Slight impact from construction and pumps. | Entrainment of low mobility, unattached organisms near intake; dredging for the intake would destroy small area of benthic habitat. | 50-man labor force for all pipeline construction. |
| **MARINE OPERATIONS** | Small amount of erosion on harbor bottom. | No impact. | Increased turbidity due to tanker traffic; possibility that median oil spill of 5,500 barrels could affect 3,850 acres of surface water if spill not contained to harbor and entrance channel; 331 barrels total expected spillage during complete withdrawal cycle for tankers; for barges, 2,900 barrels total expected spillage during one fill/withdrawal cycle (higher than tankers because of number of trips required). | Tanker hydrocarbon emissions of 70,500 lb/day during loading and 46,100 lb/day during unloading; concentrations in excess of 160 $\mu gm/m^3$ for considerable distances (>10 km) downwind; maximum concentration of 57,000 $\mu gm/m^3$ at 0.5 km. | Slight impact. | Destruction of non-mobile species and residual oily taste in fish from spill. | Reduced marketability of fish fouled by oil. |
| **FACILITY OPERATIONS** | Possible compaction of aquifers and unconsolidated material in immediate vicinity of tanks. | No impact. | 7 ppm oil from ballast water treatment to Freeport Harbor at onshore facility; small quantities of sanitary waste. | Evaporative hydrocarbon losses of ~1,000 lb/day for surge and storage tanks combined; storage tank emissions exceed 160 $\mu gm/m^3$ for ~0.5 km downwind; small quantities of emissions from pumps. | Slight impact. | No additional impact. | Crew of 10 during storage phase; 46 during loading and withdrawal phases. |

(P) Proposed system design

(A) Alternative to the proposed system design

## Weeks Island

## E N V I R O N M E N T A L   I M P A C T   S U M M A R Y

### Table 8.2-4

| ACTIVITY | IMPACTS DUE TO ACTIVITIES | | | | | | |
|---|---|---|---|---|---|---|---|
| | GEOLOGY AND SOILS | LAND USE | WATER QUALITY AND SUPPLY | AIR QUALITY | NOISE | ECOLOGY | SOCIOECONOMIC |
| **STORAGE SITE CONSTRUCTION** | | | | | | | |
| Conversion of existing salt mine to 90 million barrels oil storage facility (P) | Minimal regrading of soil. | Only temporary increase in vehicular traffic likely. | Impermeability of salt offsets potential impacts on groundwater system; no impacts. | Temporary local increase in hydrocarbons, $NO_x$, $SO_x$, particulates, and dust from construction (not measurable beyond several hundred yards from site). | Less than 6 dB increase in nighttime ambient sound levels in nearby undeveloped areas during construction; no increase in nearby towns. | Removal of total 45 acres for entire site of low-quality habitat but creation of new "edge" along site perimeter for possible increase in wildlife diversity. | Slight loss of recoverable salt due to minor oil absorption; minor temporary increase in construction-related transportation employment. |
| CONSTRUCTION OF REPLACEMENT MINE (P) | Expanded access to salt deposits; increased gradings and soil erosion. | Approximately 20 acres of land affected on site currently used for landfill. Waste overburden disposed of in 1 acre landfill on site. | No impacts to ground or surface water systems; no flooding risk because of high surface elevation of facilities. | Impacts as above. | 57 to 70 dB at 500 feet for ground refrigeration equipment and service shaft construction, explosives; no impact on nearby towns, however. | No impact; new mine on site of landfill. | Increased accessibility to salt deposits due to relocation of operation to new mine; 18,500 man-weeks labor, involving 110 non-local workers, over 93 weeks to generate $6 million ($13.9 million combined with Cote Blanche); with interruption in mining, 16,000 man-weeks labor, involving 80 non-local workers, over 73 weeks to generate $2.9 million ($11.7 million combined with Cote Blanche); loss from interruption of 64 weeks' salt output, $92,000 in severance tax, $210,000 combined sites), $50,000 to local ($150,000 combined sites). |
| **DOCK FACILITIES** | | | | | | | |
| Enlargement of existing slip to 800 x 650 feet and construction of 6 abutment-type barge docks (P) | Estimated 500,000 cubic yards excavated to enlarge southerly portion of existing slip. | Total of 20 acres affected; 9 acres of marsh and spoil deposit to be altered to open water; 10 acres of land adjacent to slip to be used for ancillary equipment (manifold, pumps, motors); excavated material to be disposed of in an approved site. | Temporary impact to water quality before bank stabilization complete from increased runoff; small increases in turbidity, nutrient, BOD, DO, decreased pH, possible increase in heavy metals; major impact on Spartina. | Impacts as above. | 71 dB 10 hours each day at 500 feet from pile drivers for barge dock construction; no impact to nearby towns due to distance. | Temporary displacement of local aquatic life by enlargement of slip; approximate loss of 50 x $10^6$ grams dry weight marsh grass due to barge slip development and 8 x $10^6$ grams of benthic organisms (9 x $10^3$ of which would be blue crabs). | Included above. |
| **PIPELINES** | | | | | | | |
| 6 0.5-mile pipelines between barge slip and storage facility (P) | Several thousand cubic feet of soil disturbed by excavation and refilling of pipeline trenches. | About 3 acres affected by representative 500-bbl spill; seepage and movement to barge slip where it would be contained. | Sediment runoff to Waterway, barge slip and marsh to west of site. | Slight hydrocarbon emissions. | 68 dB at 500 feet. | Spills reaching marsh beyond barge slip probably would affect less than 5 acres and would be allowed to weather and degrade naturally. | Included above. |
| 1 80-mile pipeline to St. James via Bayou Teche (A) | Temporary disruption of soils along right-of-way resulting in runoff and sedimentation. | Alteration of 1,301 acres, of which 60% are undisturbed wetlands. | Possible lowering of pH and DO increase in nutrient concentrations and BOD from deposition of excavated soils; no impact on groundwater; oil spill impacts less than with barge system. | Slight hydrocarbon emissions. | As above. | More adverse impact on ecology of unmodified wetland forest than Atchafalaya route or dock construction. | Less operating expense than for barge transport; construction employment 150 persons for 1 year. |
| 1 60-mile pipeline to St. James via Atchafalaya (A) | Temporary disruption of soils along right-of-way resulting in runoff and sedimentation. | Disturbance of 923 acres, of which 43% are undisturbed wetlands. | Same as first alternative. | Slight hydrocarbon emissions. | As above. | Less impact than Bayou Teche route. | Less operating expense than for barge transport; construction employment 130 persons for 1 year. |
| **MARINE OPERATIONS** | | | | | | | |
| Barges (P) | Some erosion of banks generated by tugs and barges moving along waterway. | Very small possibility of large oil spill reaching developed water recreation areas; increases in barge traffic 11% daily during filling period; increases in traffic 36% over shorter 5-month withdrawal period; all in addition to Cote Blanche. | Slight increase in bank erosion during 30-month fill, 5- to 9-month emptying periods from increased barge traffic; minimal impact from spilled oil in ICW (1827 barrels maximum) or Gulf (60,000 barrels maximum). | Hydrocarbon emissions during transit at an annual rate of 800 tons/yr, and during vessel-to-vessel transfers at an annual rate of 3140-4015 tons/yr. Tanker-barge transfers would cause hydrocarbon concentrations in excess of 160μgm/m³ as far as 7.5 mi downwind. | 55 dB at 500 feet for one barge passby; frequency of occurrence to increase by less than one additional passby per hour over present rate for 30-month fill, 5-month withdrawal period; noise levels occurring over 12 months if Cote Blanche also developed and barges used for transfer; if both Weeks and Cote Blanche, probable use of pipelines. | Oil spilled in Gulf would significantly affect habitat and populations; from 840 to 1680 acres of marsh could be lost from productivity for 2 years (1.5% of total marsh in area) if tanker spill occurred inland from Gulf; maximum credible spill in ICW could contaminate up to 320 acres for 2 years if it reached wet marsh. | Significant increased demand for barges, tug boats, crews with resultant expanded employment and income in region; need for priorities in equipment use during emergency; possible impact to recreational use of water nearby from oil spill; significant clean-up costs. |
| Seagoing Barges (A) | Greater disruption of soils due to need for larger barge facilities and pipeline across island. | More land required for dock facilities. | Fewer water impacts due to expected spillage of 42% less oil. | Hydrocarbon emissions 46% lower than from smaller barges. | Same as dock facilities. | Less impact due to lower expected volume of spilled oil. | Slightly greater than dock operation. |
| **FACILITIES OPERATIONS** | | | | | | | |
| Filling (30 months); storage (unknown period); withdrawal (5 months) | No impact. | No impact. | No impact. | Hydrocarbon emissions during barge loading at an annual rate of 3410 tons/yr, causing concentrations in excess of 160μgm/m³ as far as 5.7 mi downwind. Minor hydrocarbon and hydrogen sulfide leakage during pumping and minor sulfur dioxide emissions from flaring of vapors during fill. | Loading and unloading barges result in 55 dB at 500 feet (at least 22 dB lower than existing background). | No additional impact. | Negligible impact; non-local personnel estimated at less than 5 for storage periods; 15 workers (3 skilled, 12 unskilled) during transfer operations. |

(P) Proposed system design

(A) Alternative to the proposed system design

TABLE 8.2-5 Summary of oil spill risk from sea-going barge transport of oil to Cote Blanche Island

| Accident Mode | Expected Number of Spill Incidents per Single Fill or Withdrawal Cycle | Expected Number of Spill Incidents During Lifetime of Project | Average Spill Volume per Incident (barrels) | Volume of oil Release Expected During Project Lifetime (barrels) | Maximum Credible Spill Volume (barrels) |
|---|---|---|---|---|---|
| Tanker Transfer in Gulf | 60 | 600 | 1.4 | 810 | 1,000 |
| Barge Transport, Gulf/ Cote Blanche | 0.0756 (1 chance in 13) | 0.756 (1 chance in 1.3) | 428 | 324 | 30,000 (Gulf) 20,000 (ICW) |
| Transfer at Barge Deck* | 12 | 120 | 3.4 | 405 | 500 |
| Pipeline to Cote Blanche* | $3.2 \times 10^{-4}$ (1 chance in 3125) | $3.2 \times 10^{-3}$ (1 chance in 313) | 1083 | 3.5 | 4,000 |
| Terminal Facilities at Cote Blanche | 0.0135 (1 chance in 74) | 0.135 (1 chance in 7) | 300 | 41 | 5,000 |
| Total Expected | 72 | 721 | 2.2 | 1584 | -- |

* Assumes average spill rate for fill and withdrawal operations.

TABLE 8.2-6 Summary of oil spill risk from 10,000-barrel barge transport of oil to Venice or St. James

| Accident Mode | Expected Number of Spill Incidents per Single Fill or Withdrawal Cycle | Expected Number of Spill Incidents During Lifetime of Project | Average Spill Volume per Incident (barrels) | Volume of Oil Release Expected During Project Lifetime (barrels) | Maximum Credible Spill Volume (barrels) |
|---|---|---|---|---|---|
| ***Cote Blanche - Venice*** | | | | | |
| VLCC Transfer | 5 | 50 | 16.2 | 810 | 1,000 |
| 45 MDWT Tanker, Gulf/Venice | 0.0266 (1 chance in 38) | 0.266 (1 chance in 3.8) | 428[a] / 1111[b] | 132[c] | 60,000 |
| Transfer at Venice | 38 | 380 | 2.1 | 810 | 500 |
| 10,000 bbl Barge Transport, Venice/ Cote Blanche | 0.122 (1 chance in 8.2) | 1.22 | 206 | 251 | 10,000 |
| Barge Transfer at Cote Blanche[d] | 30 | 300 | 1.4 | 405 | 500 |
| Terminal Facilities at Cote Blanche | 0.0135 (1 chance in 74) | 0.135 (1 chance in 7.4) | 300 | 41 | 5,000 |
| Total Expected | 73 | 731 | 3.4 | 2449 | -- |
| **Cote Blanche - St. James** | | | | | |
| Barge Transfer at St. James[d] | 30 | 300 | 1.4 | 405 | 500 |
| 10,000 bbl Barge Transport, St. James/ Cote Blanche | 0.0986 (1 chance in 10) | 0.986 | 206 | 203 | 10,000 |
| Barge Transfer at Cote Blanche[d] | 30 | 300 | 1.4 | 405 | 500 |
| Terminal Facilities at Cote Blanche | 0.0135 (1 chance in 74) | 0.135 (1 chance in 7.4) | 300 | 41 | 5,000 |
| Total Expected | 60 | 601 | 1.8 | 1054 | -- |

[a] Average spill size in Mississippi River portion of route.

[b] Average spill size in Gulf of Mexico portion of route.

[c] 102 barrels in Mississippi River; 30 barrels in Gulf of Mexico.

[d] Assumes average spill rate for fill and withdrawal.

TABLE 8.2-7 Summary of oil spill accident potential for various accident modes using pipeline transportation, Cote Blanche storage facility

| Accident Mode | Expected Number of Spill Incidents Per Single Fill and Withdrawal Cycle | Expected Number of Spill Incidents During Lifetime of Project[a] | Average Spill Volume per Incident (barrels) | Volume of Oil Release Expected During Project Lifetime (barrels) | Maximum Credible Spill Volume (barrels) |
|---|---|---|---|---|---|
| Pipeline Transportation[b] | | | | | |
| 80-mile system | 0.176 (1 chance in 5.7) | 0.88 (1 chance in 1.1) | 1083 | 953 | 10,000 |
| 60-mile system | 0.132 (1 chance in 7.6) | 0.66 (1 chance in 1.5) | 1083 | 715 | 10,000 |
| Terminal Facilities | 0.027 (1 chance in 37) | 0.135 (1 chance in 7.4) | 300 | 41 | 5,000 |
| Total Expected | | | | | |
| 80-mile system | 0.203 (1 chance in 4.9) | 1.02 | 974 | 994 | --- |
| 60-mile system | 0.159 (1 chance in 6.3) | 0.795 (1 chance in 1.3) | 951 | 756 | --- |

[a] Lifetime of project is taken as 5 fill and 5 withdrawal cycles or total movement of 270 million barrels of oil.

[b] Assumes pipeline full during standby.

TABLE 8.2-8 Probable spill size range for accident modes with pipeline transportation, given the occurrence of an oil release

| Pipeline Transport (Average Size = 1083 bbl) | | Terminal Facilities (Average Size = 300 bbl) | |
|---|---|---|---|
| Size Range (bbl) | % Probability | Size Range (bbl) | % Probability |
| 0 - 200 | 10 | 0 - 200 | 49 |
| 200 - 500 | 20 | 200 - 500 | 40 |
| 500 - 1000 | 27 | 500 - 1000 | 7.8 |
| 1000 - 2000 | 36 | 1000 - 2000 | 2.4 |
| 2000 - 5000 | 5.7 | 2000 - 5000 | 0.8 |
| 5000 - 10,000 | 1.3 | | |

TABLE 8.2-9 Description of existing pipeline route conditions by subsegment (Refer to Figure 8.2-1)

| | |
|---|---|
| $A_1$ | Uplifted Pleistocene surface, mixed hardwoods |
| $A_2$ | Cypress-tupelo swamp, parallels railroad embankment and La. Hwy. 83 |
| $A_3$ | Cleared natural levee, agricultural development<br>Crosses Bayou Cypremort and La. Hwy. 83 |
| $A_4$ | Intermediate marsh impounded by spoil<br>Parallels ICW |
| $B_1$ | Uplifted Pleistocene surface, mixed hardwoods<br>Crosses ICW |
| $B_2$ | Intermediate marsh in deteriorating condition<br>Partially impounded by ICW spoil |
| $B_3$ | Cleared natural levee flank, Bayou Cypremort<br>Agricultural development |
| $B_4$ | Alternate intermediate marsh and tupelo-cypress swamp<br>Relatively unmodified natural state<br>Drained by numerous tidal channels connecting with Jaws Bay<br>Alignment perpendicular to drainage network<br>Already two pipeline canals present which partially modify natural circulation<br>Crosses Charenton Drainage and Navigation Canal |
| $B_5$ | Cypress-tupelo swamp<br>Drainage highly modified as a result of oil field canals |
| $B_6$ | Cleared natural levee, Bayou Sale, agricultural development<br>Crosses Bayou Sale and La. Hwy. 60 |
| $C_1$ | Cleared natural levee, Bayou Sale and Bayou Teche<br>Agricultural development, rural housing<br>Crosses La. Hwy. 896 twice, crosses U.S. Hwy. 90<br>Crosses Bayou Teche, crosses W. Atchafalaya Floodway Protection Levee and borrow pit |
| $C_2$ | Cypress-tupelo swamp<br>Relatively unmodified |
| $C_3$ | Six Mile Lake, major stream channel, depth of 10 feet, width of 3700 feet<br>Medium velocity flows, turbid waters |
| $C_4$ | Riverine environment of bars and shoots<br>Bars vegetated with willows and cottonwood<br>Shallow, turbid water bodies |

TABLE 8.2-9 Continued

| | |
|---|---|
| $C_5$ | Cypress-tupelo swamp, relatively unmodified and major stream channel (Cypress Pass)<br>Main channel Atchafalaya Basin Floodway<br>High velocity flows, depth of 40 feet, width of 2500 feet<br>Turbid water |
| $C_6$ | Cypress-tupelo swamp<br>Relatively unmodified |
| $C_7$ | Shallow lake, turbid water during most of year<br>Receives flow from Atchafalaya River |
| $C_8$ | Cypress-tupelo swamp, relatively unmodified<br>Biologically highly productive swamp, high scenic quality<br>Crosses many natural swamp drainage channels at right angles<br>Alignment interferes with natural water circulation |
| $C_9$ | Cypress-tupelo swamp, highly modified as a result of oil field development and access canals<br>Crosses Alternate Route Intracoastal Waterway |
| $C_{10}$ | Crosses E. Atchafalaya Floodway Protection Levee<br>Crosses La. Hwy. 70<br>Crosses Belle River, local swamp drainage<br>Cypress-tupelo swamp, relatively unmodified<br>High scenic quality |
| $C_{11}$ | Shallow lake<br>Turbid during strong wind conditions |
| $C_{12}$ | Cypress-tupelo swamp, relatively unmodified<br>High scenic quality |
| $C_{13}$ | Cleared natural levee, Bayou Lafourche, agricultural development<br>Scattered rural residential<br>Crosses La. Hwy. 1<br>Crosses Bayou Lafourche<br>Crosses La. Hwy. 308 |
| $C_{14}$ | Cypress-tupelo swamp, relatively unmodified<br>High scenic quality and resource value<br>Alignment perpendicular to natural drainage<br>Interferes with natural circulation |
| $D_1$ | Cleared natural levee, Bayou Sale<br>Agricultural development |
| $D_2$ | Cypress-tupelo swamp<br>Existing pipeline corridor |

TABLE 8.2- 9 Continued

| | |
|---|---|
| $D_3$ | Cleared natural levee, Bayou Teche<br>Agricultural development |
| $D_4$ | Cypress-tupelo swamp and major channel, depth of 50 feet, width 7000 feet<br>Atchafalaya Basin Floodway outlet<br>Turbid water, high velocity flows<br>Crosses two floodway outlet guide levees |
| $D_5$ | Drained back-levee swamp, cleared<br>Agricultural development |
| $D_6$ | Cypress-tupelo swamp, highly modified drainage as a result of pipeline canals<br>Existing pipeline corridor |
| $D_7$ | Cleared natural levee, Bayou Teche<br>Agricultural development |
| $D_8$ | Cypress-tupelo and mixed hardwood swamp<br>Fresh marsh - deteriorated condition due to impoundment<br>Natural circulation highly modified as a result of pipeline and access canals |
| $D_9$ | Lower Atchafalaya River, main outlet<br>Atchafalaya Basin Floodway<br>Navigation and flood control<br>High velocity flows, turbid waters<br>Channel depth of 60 feet, width of 1000 feet<br>Crosses flood protection levee |
| $D_{10}$ | Cypress-tupelo swamp<br>Highly modified by pipeline canals<br>Existing pipeline corridor |
| $D_{11}$ | Bayou Shaefer<br>Secondary outlet for Atchafalaya Basin waters, high turbidity<br>Moderate flows |
| $D_{12}$ | Natural levee flank, mixed hardwood and cypress-tupelo swamp<br>Highly modified, existing pipeline corridor |
| $D_{13}$ | Cleared natural levee, Bayou Boeuff<br>Agricultural development |
| $D_{14}$ | Cypress-tupelo swamp, moderate modification of hydrology due to pipeline canals and U.S. Hwy. 90<br>Alignment perpendicular to natural drainage and resulting interference<br>Crosses Bayou Chene (ICW navigation)<br>Crosses Bayou Black (local drainage) |

TABLE 8.2-9 Continued

| | |
|---|---|
| $D_{15}$ | Cypress-tupelo swamp and lake, relatively unmodified<br>High scenic quality with natural circulation<br>Construction represents major disturbance |
| $D_{16}$ | Cleared natural levee, Bayou Black<br>Agricultural development<br>Crosses U.S. Hwy. 90<br>Crosses Bayou Black (local drainage)<br>Crosses planned realigned U.S. Hwy. 90 |
| $D_{17}$ | Cypress-tupelo swamp<br>Local drainage modified because of extensive pipeline and access canals<br>Crosses La. Hwy. 20<br>Crosses Chacahoula Bayou (local drainage)<br>Alignment interferes with natural drainage of swamp basin |
| $D_{18}$ | Cleared natural levee, Bayou Lafourche<br>Agricultural development, scattered rural residential<br>Crosses Bayou Lafourche<br>Crosses La. Hwy. 1<br>Crosses La. Hwy. 308 |
| $D_{19}$ | Cypress-tupelo swamp<br>Relatively modified<br>High scenic and resource value<br>Alignment interferes with natural drainage |
| $E_1$ | Cypress-tupelo swamp<br>Relatively unmodified, high scenic and resource value |
| $E_2$ | Cleared natural levee, Mississippi River<br>Agricultural development, scattered rural residential |

TABLE 8.2-10 Acreages potentially affected by proposed pipeline alignments

SEGMENT A (Weeks Island pipeline only)

Acres Affected for 50- and 120-foot Widths

| Subsegment | | Upland | Agric. Develop. | Swamp | | | | Marsh | | | | Major Water Bodies | Crossings | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Modified | | Relatively Unmodified | | Fresh | | Intermediate | | | Minor Water Bodies | Railroad (RR) Hwy (H) Levee (L) |
| No. | Length (ft) | 120ft | 120ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | Number | Number |
| 1 | 7,200 | 21 | | | | | | | | | | | | |
| 2 | 7,400 | | | | | 21 | 9 | | | | | | 1 | 1 (RR) |
| 3 | 16,000 | | 46 | | | | | | | | | | 1 | 1 (H) |
| 4 | 6,300 | | | | | | | | | 18 | 7 | | 2 | |
| Total | 36,900 | 21 | 46 | 0 | 0 | 21 | 9 | 0 | 0 | 18 | 7 | 0 | 4 | 1 (H)<br>1 (RR) |

TABLE 8.2-10 Continued

SEGMENT B (Subsegment 1 applies to Cote Blanche only)

Acres Affected for 50- and 120-foot Widths

| Subsegment | | Upland | Agric. Develop. | Swamp | | | | Marsh | | | | Major Water Bodies | Crossings | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Modified | | Relatively Unmodified | | Fresh | | Intermediate | | | Minor Water Bodies | Railroad (RR) Hwy (H) Levee (L) |
| No. | Length (ft) | 120ft | 120ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | Number | Number |
| 1 | 8,400 | 24 | | | | | | | | | | | | |
| 2 | 12,400 | | | | | | | | | 35 | 14 | | 1 | |
| 3 | 8,600 | | 25 | | | | | | | | | | | |
| 4 | 38,900 | | | | | 61 | 25 | | | 55 | 22 | | 17 | |
| 5 | 24,700 | | | | | 71 | 28 | | | | | | 5 | |
| 6 | 8,900 | | 25 | | | | | | | | | | 1 | 1 (H), 1 (RR) |
| Total | 101,900 | 24 | 50 | 0 | 0 | 132 | 53 | 0 | 0 | 90 | 36 | 0 | 24 | 1 (H), 1 (RR) |

TABLE 8.2-10 Continued

SEGMENT C

Acres Affected for 50- and 120-foot Widths

| Subsegment No. | Subsegment Length (ft) | Upland 120ft | Agric. Develop. 120ft | Swamp: Modified 120ft | Swamp: Modified 50ft | Swamp: Relatively Unmodified 120ft | Swamp: Relatively Unmodified 50ft | Marsh: Fresh 120ft | Marsh: Fresh 50ft | Marsh: Intermediate 120ft | Marsh: Intermediate 50ft | Major Water Bodies 120ft | Crossings: Minor Water Bodies Number | Crossings: Railroad (RR) Hwy (H) Levee (L) Number |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 15,200 | | 43 | | | | | | | | | | 3 | 2 (H), 1 (RR) |
| 2 | 3,700 | | | | | 11 | 4 | | | | | | | 1 (L) |
| 3 | 2,700 | | | | | | | | | | | 8 | | |
| 4 | 3,500 | | | | | 5 | 2 | | | | | 5 | | |
| 5 | 6,500 | | | | | 15 | 6 | | | | | 3 | | |
| 6 | 16,800 | | | | | 48 | 19 | | | | | | 1 | |
| 7 | 4,000 | | | | | | | | | | | 11 | | |
| 8 | 19,500 | | | 37 | 15 | 19 | 7 | | | | | | 9 | |
| 9 | 16,000 | | | 46 | 18 | | | | | | | 1 | 2 | |
| 10 | 6,200 | | | | | 14 | 6 | | | | | 2 | | 1 (H), 1 (L) |
| 11 | 16,500 | | | | | | | | | | | 47 | | |
| 12 | 7,500 | | | | | 21 | 9 | | | | | | 2 | |
| 13 | 41,800 | | 119 | | | | | | | | | | | 3 (H), 2 (RR) |
| 14 | 30,000 | | | | | 86 | 34 | | | | | | 5 | |
| Total | 189,000 | 0 | 162 | 83 | 33 | 219 | 87 | 0 | 0 | 0 | 0 | 77 | 22 | 6 (H), 2 (L), 3 (RR) |

TABLE 8.2-10 Continued

SEGMENT D

Acres Affected for 50- and 120-foot Widths

| Subsegment | | Upland | Agric. Develop. | Swamp: Modified | | Swamp: Relatively Unmodified | | Marsh: Fresh | | Marsh: Intermediate | | Major Water Bodies | Crossings: Minor Water Bodies | Crossings: Railroad (RR) Hwy (H) Levee (L) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| No. | Length (ft) | 120ft | 120ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | Number | Number |
| 1 | 5,300 | | 15 | | | | | | | | | | | |
| 2 | 10,500 | | | | | 30 | 12 | | | | | | 1 | |
| 3 | 5,400 | | 15 | | | | | | | | | | | |
| 4 | 1,800 | | | 3 | 1 | | | | | | | 2 | | 2 (L) |
| 5 | 1,900 | | 5 | | | | | | | | | | | |
| 6 | 13,000 | | | | | 37 | 15 | | | | | | 4 | |
| 7 | 14,200 | | 41 | | | | | | | | | | | |
| 8 | 15,400 | | | | | 27 | 11 | 17 | 7 | | | | 3 | |
| 9 | 1,300 | | | | | | | | | | | 4 | | 1 (L) |
| 10 | 5,500 | | | | | 16 | 6 | | | | | | | |
| 11 | 800 | | | | | | | | | | | 2 | | 1 (L) |
| 12 | 19,100 | | | | | 55 | 22 | | | | | | | |
| 13 | 16,600 | | 45 | | | | | | | | | | | |
| 14 | 21,300 | | | | | 59 | 24 | | | | | 1 | 4 | |
| 15 | 27,300 | | | | | 78 | 31 | | | | | | | |
| 16 | 3,800 | | 11 | | | | | | | | | | | 1 (H) |
| 17 | 32,100 | | | | | 92 | 37 | | | | | | 5 | 2 (H), 1 (RR) |
| 18 | 33,500 | | 96 | | | | | | | | | | 1 | 2 (H), 2 (RR) |
| 19 | 52,300 | | | | | 149 | 60 | | | | | | 7 | |
| Total | 280,100 | 0 | 228 | 3 | 1 | 543 | 218 | 17 | 7 | 0 | 0 | 9 | 25 | 4 (L) 5 (H) 3 (RR) |

TABLE 8.2-10 Continued

SEGMENT E

Acres Affected for 50- and 120-foot Widths

| Subsegment | | Upland | Agric. Develop. | Swamp | | | | Marsh | | | | Major Water Bodies | Crossings | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Modified | | Relatively Unmodified | | Fresh | | Intermediate | | | Minor Water Bodies | Railroad (RR) Hwy (H) Levee (L) |
| No. | Length (ft) | 120ft | 120ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | 50ft | 120ft | Number | Number |
| 1 | 14,000 | | | | | 40 | 16 | | | | | | 1 | |
| 2 | 15,500 | | 44 | | | | | | | | | | | 1 (RR) |
| Total | 29,500 | 0 | 44 | 0 | 0 | 40 | 16 | 0 | 0 | 0 | 0 | 0 | 1 | 1 (RR) |

TABLE 8.2-11 Summary of proposed pipeline route acreages affected, Cote Blanche to St. James, Louisiana

| Environment | Atchafalaya Route Acres(ft) 120 | 50 | Bayou Teche Route Acres(ft) 120 | 50 |
|---|---|---|---|---|
| Upland | 24 | - | 24 | - |
| Agricultural Development | 257 | - | 322 | - |
| Swamp (Modified) | 83 | 33 | 3 | 1 |
| Swamp (Unmodified) | 391 | 156 | 715 | 287 |
| Marsh | 91 | 36 | 107 | 43 |
| Major Water Bodies | 77 | - | 9 | - |
| Total Acreage Affected | 923 | 225 | 1201 | 340 |
| Number of Minor Water Bodies | 48 | | 50 | |
| Number of Highway (H), Railroad (RR), and Levee (L) Crossings | 7 (H)<br>5 (RR)<br>2 (L) | | 6 (H)<br>5 (RR)<br>4 (L) | |

TABLE 8.2-12 Potential displacement of animal life by habitat for proposed pipeline routes

| ENVIRON-MENT | Species | ATCHAFALAYA ROUTE (BCE) Initial | ATCHAFALAYA ROUTE (BCE) Long-Term | TECHE ROUTE (BDE) Initial | TECHE ROUTE (BDE) Long-Term |
|---|---|---|---|---|---|
| UPLAND | Deer | 1 | - | 1 | - |
| | Turkey | - | - | - | - |
| | Squirrel | 3 | - | 3 | - |
| | Quail | 1 | - | 1 | - |
| | Rabbit | 3 | - | 3 | - |
| | Raccoon | - | - | - | - |
| | Fox | - | - | - | - |
| | Woodcock | 2 | - | 2 | - |
| SWAMP | Deer | 9 | 4 | 13 | 5 |
| | Swamp Rabbit | 247 | 100 | 370 | 149 |
| | Squirrel | 641 | 258 | 961 | 387 |
| | Wood Duck | 5 | 2 | 7 | 3 |
| | Bobcat | 2 | 1 | 3 | 1 |
| | Turkey | 7 | 3 | 10 | 4 |
| | Migrant Waterfowl | 49 | 20 | 74 | 30 |
| | Raccoon | 33 | 13 | 49 | 20 |
| | Fox | 7 | 3 | 10 | 4 |
| | Fish (lbs.) | 250,000 | 100,000 | 369,000 | 149,000 |
| | Mink | 49 | 20 | 74 | 30 |
| | Alligator | 12 | 5 | 18 | 7 |
| | Otter | 14 | 6 | 21 | 9 |
| MARSH | Deer | - | - | - | - |
| | Rail | 18 | 7 | 21 | 8 |
| | Snipe | 22 | 9 | 25 | 10 |
| | Coot | 22 | 9 | 25 | 10 |
| | Migrant Waterfowl | 43 | 17 | 50 | 20 |
| | Wood Duck | - | - | - | - |
| | Mink | 1 | - | 2 | 1 |
| | Muskrat | 145 | 58 | 167 | 67 |
| | Nutria | 54 | 22 | 63 | 25 |
| | Otter | 3 | 1 | 4 | 1 |
| | Alligator | 5 | 2 | 6 | 3 |
| CLEARED LAND (AGRICULT. DEVELOP.) | Migrant Waterfowl | 252 | - | 307 | - |
| | Resident Waterfowl | 2 | - | 2 | - |
| | Woodcock | 20 | - | 25 | - |
| | Dove | 38 | - | 46 | - |
| | Quail | 50 | - | 61 | - |
| | Rabbit | 43 | - | 53 | - |
| | Squirrel | 6 | - | 7 | - |
| | Songbirds | many | - | many | - |
| | Fox | 1 | - | 1 | - |

TABLE 8.2-13 Summary of potential carrying capacity loss

| Species | TECHE ROUTE Initial | TECHE ROUTE Long-Term | ATCHAFALAYA ROUTE Initial | ATCHAFALAYA ROUTE Long-Term |
|---|---|---|---|---|
| Deer | 14 | 5 | 10 | 4 |
| Turkey | 10 | 4 | 7 | 3 |
| Squirrel | 977 | 387 | 650 | 258 |
| Quail | 62 | - | 51 | - |
| Rabbit | 56 | - | 46 | - |
| Swamp Rabbit | 370 | 149 | 247 | 100 |
| Raccoon | 49 | 20 | 33 | 13 |
| Fox | 11 | 4 | 8 | 3 |
| Woodcock | 27 | - | 22 | - |
| Wood Duck | 7 | 3 | 5 | 2 |
| Mink | 76 | 31 | 50 | 20 |
| Bobcat | 3 | 1 | 2 | 1 |
| Migrant Waterfowl | 381 | 30 | 301 | 20 |
| Resident Waterfowl | 2 | - | 2 | - |
| Alligator | 24 | 10 | 17 | 7 |
| Otter | 25 | 10 | 17 | 7 |
| Fish (lbs.) | 369,000 | 149,000 | 250,000 | 100,000 |
| Rail | 21 | 8 | 18 | 7 |
| Snipe | 25 | 10 | 22 | 9 |
| Coot | 25 | 10 | 22 | 9 |
| Dove | 46 | - | 38 | - |
| Songbirds | many | - | many | - |

TABLE 8.2-14 Summary of oil spill risk from an offshore pipeline connecting Cote Blanche with an SPM in Gulf of Mexico

| Accident Mode | Expected Number of Spill Incidents per Single Fill and Withdrawal Cycle | Expected Number of Spill Incidents During Lifetime of Project[a] | Average Spill Volume per Incident (barrels) | Volume of oil Release Expected During Project Lifetime (barrels) | Maximum Credible Spill Volume (barrels) |
|---|---|---|---|---|---|
| Tanker Transfer at SPM | 5 | 25 | 32 | 810 | 10,000 |
| 64-mile Pipeline | 0.0411 (1 chance in 24.3) | 0.2055 (1 chance in 4.9) | 1083 | 223 | 10,000 |
| Terminal Facilities at Cote Blanche | 0.0270 (1 chance in 37) | 0.135 (1 chance in 7.4) | 300 | 41 | 5,000 |
| Total Expected | 5.1 | 25.3 | 42.5 | 1074 | -- |

[a] Lifetime of project is taken as 5 fill and 5 withdrawal (150 days) cycles or total movement of 270 million barrels of oil. Filling Cote Blanche would not be possible without a pumping platform offshore, however.

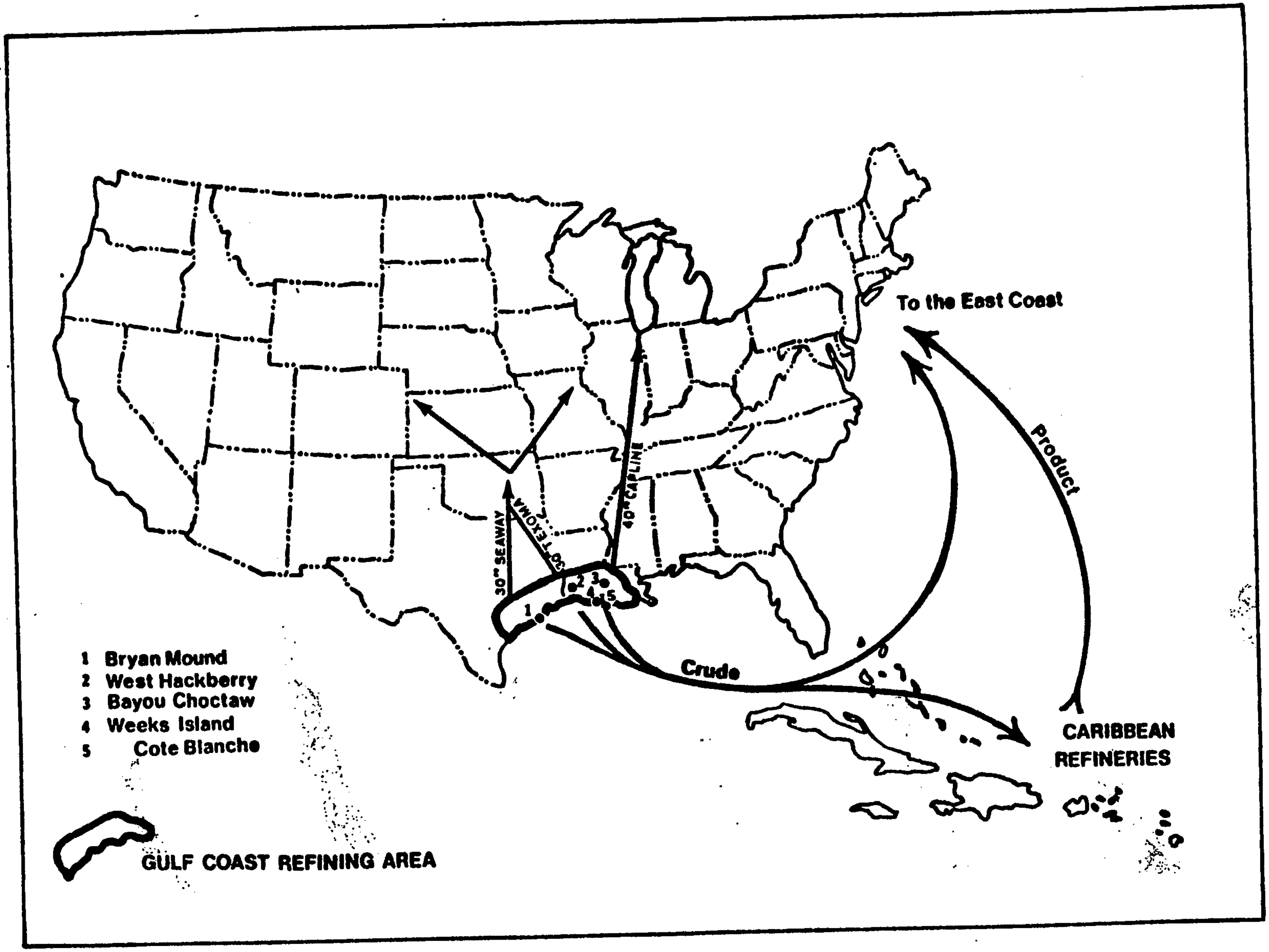


Figure 8.2-1 SPR Distribution Network

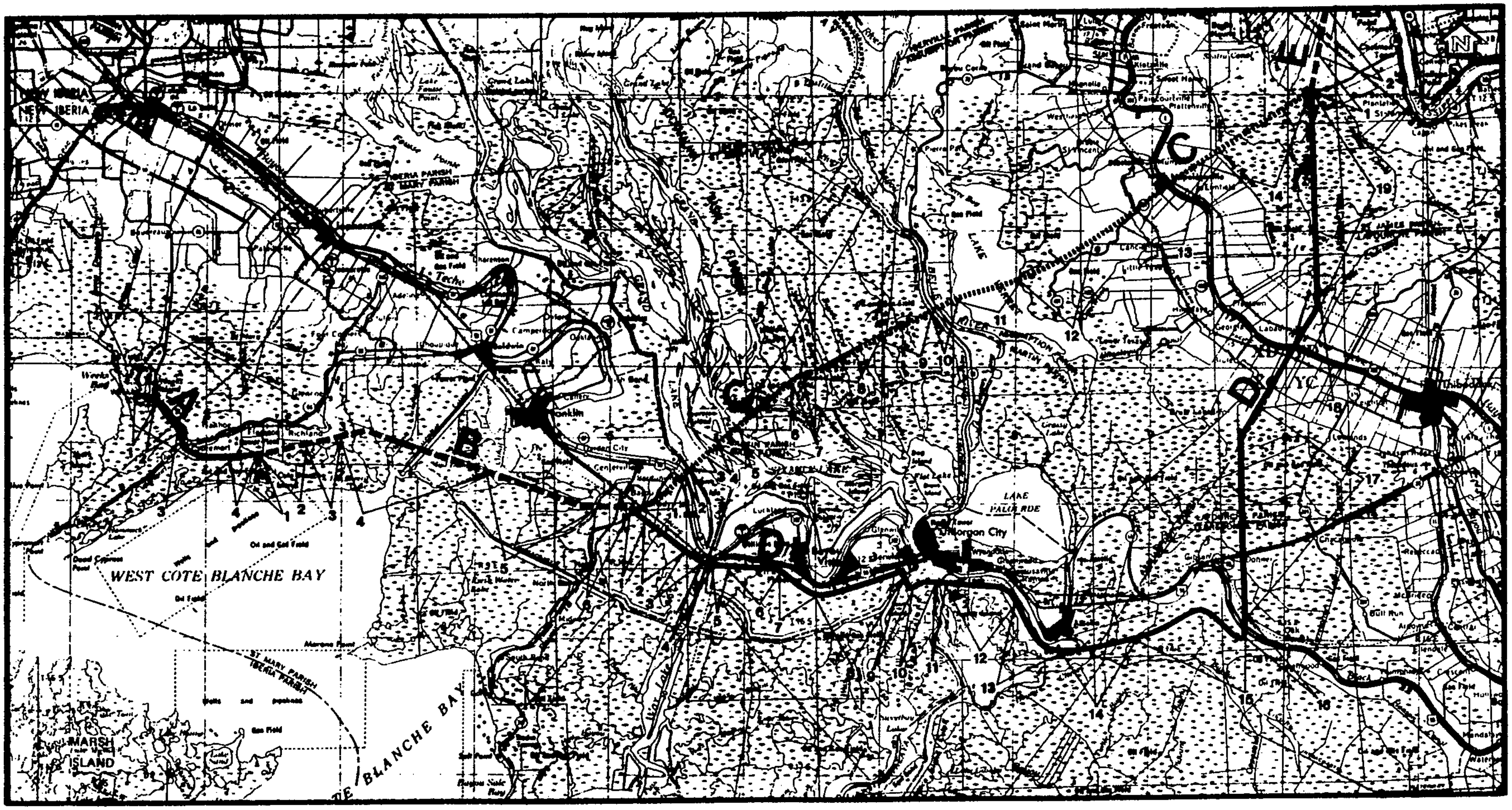


Figure 8.2-2 Alternative pipeline routes between oil storage sites and St. James, Louisiana

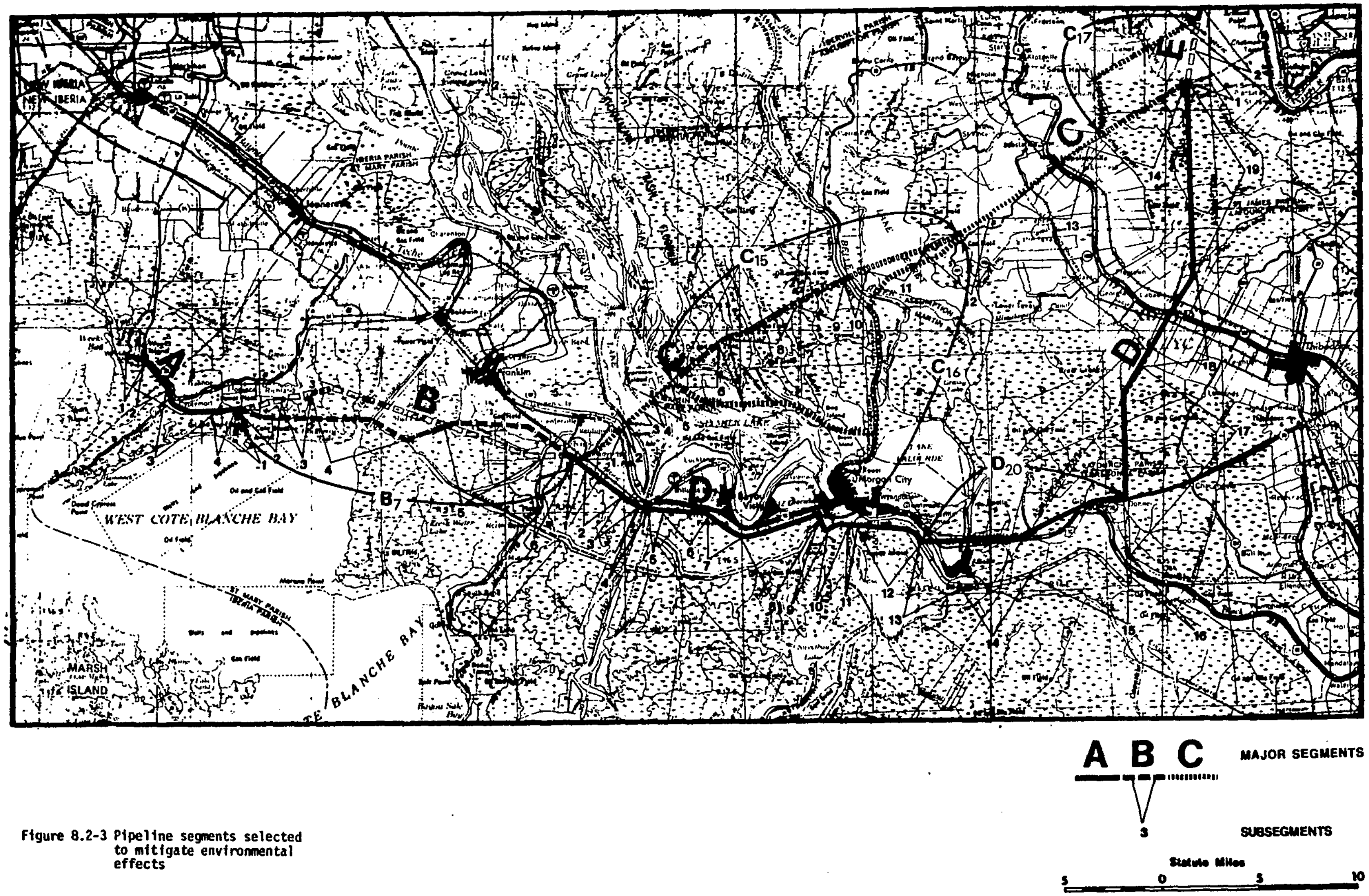


Figure 8.2-3 Pipeline segments selected to mitigate environmental effects

## 8.3 NO ACTION

A description of the no action alternative and its impacts, as it applies to the entire program, is provided in the programmatic EIS DES-76-2). Within the program, a decision not to develop the Cote Blanche Mine facility would result in the development of one of the other candidate sites to take its place. In that case, the impacts described in section 4.0 would not occur and the existing environment of Cote Blanche Island (as described in section 3.0) would be maintained. However, the decision to develop another facility in lieu of Cote Blanche would result in the impacts associated with this alternate facility. Since many of the candidate sites are also located in the Gulf coast region, it is likely that many of the impacts resulting from development of the replacement site would be substantially the same as those for Cote Blanche. However, the detailed impacts of any particular facility are very site specific and would be discussed in the EIS for that site.

SECTION 9.0

## CONSULTATION AND COORDINATION WITH OTHERS

### 9.1 COORDINATION AND CONTACTS WITH OTHERS

In the course of developing this EIS, information and guidance was obtained from many different sources. The following tabulation lists those agencies or companies that were contacted.

| AGENCY - FEDERAL | LOCATION |
|---|---|
| Department of the Army; U.S. Army Corps of Engineers | Washington, D.C. |
| Department of the Army; U.S. Army Corps of Engineers, Costal Engineering Division | New Orleans, Louisiana |
| Department of the Army; U.S. Army Corps of Engineers, Kansas City District | Kansas City, Missouri |
| Department of the Army; U.S. Corps of Engineers, New Orleans District | New Orleans, Louisiana |
| Department of the Interior; Bureau of Land Management | Washington, D.C. |
| Environmental Data Services, Deep Water Ports, NOAA | Washington, D.C. |
| Environmental Protection Agency | Washington, D.C. |
| Environmental Protection Agency, Region VI | Dallas, Texas |
| Federal Energy Administration | Washington, D.C. |
| Federal Energy Administration, Region VI | Dallas, Texas |
| National Climatic Center | Asheville, North Carolina |
| United States Department of Transportation, Coast Guard Division (Deep Water Ports) | Washington, D.C. |

| | |
|---|---|
| United States Geological Survey | Baton Rouge, Louisiana |
| United States Geological Survey | Reston, Virginia |

| AGENCY - STATE | LOCATION |
|---|---|
| Louisiana Air Pollution Control Commission | Baton Rouge, Louisiana |
| Louisiana Archeological Survey and Antiquities Commission | Baton Rouge, Louisiana |
| Louisiana Department of Agriculture, Soil Conservation Service | New Iberia, Louisiana |
| Louisiana Department of Agriculture, Soil Conservation Service | New Orleans, Louisiana |
| Louisiana Department of Conservation | Baton Rouge, Louisiana |
| Louisiana Department of Conservation | New Orleans, Louisiana |
| Louisiana Department of Health | New Orleans, Louisiana |
| Louisiana Department of Natural Resources | New Iberia, Louisiana |
| Louisiana Department of Public Works | Baton Rouge, Louisiana |
| Louisiana Department of Revenue | Baton Rouge, Louisiana |
| Louisiana State Planning Board | Baton Rouge, Louisiana |
| Louisiana State Tax Commission | Baton Rouge, Louisiana |
| Louisiana State University, Center for Wetlands Research | Baton Rouge, Louisiana |
| Louisiana State University, College of Forestry, Cooperative Fishing Unit | Baton Rouge, Louisiana |
| Louisiana State University, Institute of Environmental Studies | Lafayette, Louisiana |
| Louisiana State University, the Library | Baton Rouge, Louisiana |
| Louisiana Stream Control Commission | Baton Rouge, Louisiana |

| AGENCY - STATE | LOCATION |
|---|---|
| Louisiana Wildlife and Fisheries Commission | New Orleans, Louisiana |
| Louisiana Wildlife and Fisheries Commission; Oyster, Seafood & Water Bottom Commission | Baton Rouge, Louisiana |
| New Orleans, University of; College Business Administration | New Orleans, Louisiana |
| State Art, Historical & Cultural Preservation Agency | Baton Rouge, Louisiana |

| AGENCY OR COMPANY - LOCAL | LOCATION |
|---|---|
| Acadiana Planning & Development District | Lafayette, Louisiana |
| Acres America, Inc., Consulting Engineers | Buffalo, New York |
| American Petroleum Institute, Division of Transportation | Washington, D.C. |
| Association of Oil Pipelines | Washington, D.C. |
| Burk & Associates, Inc., Environmental Section | New Orleans, Louisiana |
| Domtar Chemicals, Inc. | Cote Blanche Island, Louisiana |
| Domtar Chemicals LTD, Goderich Mine | Ontario, Canada |
| Fenix & Scisson Inc. | Tulsa, Oklahoma |
| Morton Salt Co. | Weeks Island, Louisiana |
| Oil & Gas Journal | Tulsa, Oklahoma |
| Oil Mop Co. | Belle Chasse, Louisiana |

## 9.2 ENVIRONMENTALLY ORIENTED PERMITS AND LICENSES

Federal laws which have potential applicability to the Strategic Petroleum Reserve project include the Clean Air Act as amended in 1970, the Federal Water Pollution Control Act and amendments of 1972, the Endangered Species Act of 1973, the Marine Protection, Research and Sanctuaries Act of 1972, the Ports and Waterways Safety Act of 1899, the National Environmental Policy Act of 1969, the Fish and Wildlife Coordination Act, and the Coastal Zone Management Act of 1972. These laws and the regulations adopted pursuant to them have been reviewed to determine the types of permits, licenses, certifications, and approvals needed for the various construction and operational phases of the project. Environmentally oriented permits and licenses are listed in Table 9.2-1. No final determination has been made as to what State and local regulations or permits are specifically applicable to the project; regulations not applicable may be complied with by the FEA voluntarily.

Local building permits are required from the St. Mary Parish Police Jury for all new construction of buildings, all additions to buildings, all remodeling of buildings, and all moving and relocation of buildings.

The State of Louisiana Department of Conservation requires a permit to be issued to drill, or renew drilling, for minerals.

TABLE 9.2-1 Environmentally oriented permits and licenses

| AGENCY | PERMIT TYPE | REFERENCES | REMARKS |
|---|---|---|---|
| 1. U.S. Corps of Engineers, District Engineer (New Orleans) | (a) Discharge of dredged material into navigable waters.<br>(b) Structures or activities affecting the navigability of navigable waters; includes structures under a navigable waterway.<br>(c) Any transport of dredged material into coastal waters.<br>(d) Work causing canals to become connected to navigable waters.<br>(e) Fixed structures on the outer continental shelf.<br>(f) Piers or bulkheads at the coastline. | 33 CFR 209.120 (b) (3), (b) (7) (e) (i), (g) (5) (ii), (g) (17) (iii);<br>33 CFR 209.130<br>33 CFR 209.131 | |
| 2. U.S. Coast Guard, District Commander of 8th Coast Guard District (New Orleans) | Letter of Intent to operate an oil transfer facility. | 33 CFR 154.110 | Letters of Intent must be submitted and approved 60 days prior to date intended operation is to begin. |
| 3. U.S. Coast Guard, Commandant (Washington, D.C.) | Certification is required for marine sanitation devices on new vessels equipped with installed toilet facilities, where "new" vessels refer to those constructed after January 30, 1977. | 33 CFR 159 | If desired, operators of vessels constructed prior to January 30, 1977 may apply for certification of marine sanitation devices installed on these watercraft. |
| 4. U.S. Environmental Protection Agency, Region VI | NPDES (National Pollutant Discharge Elimination System) permit required for any industrial discharges into navigable waters including the "contiguous zone" (ocean waters). Such a permit would probably be necessary for discharge of effluents from the offshore and onshore terminal waste treatment facilities. In | 40 CFR 125; Water Pollution Control Act, Section 401 | The State of Louisiana does not yet have an approved program for issuing NPDES permits. However, the State has to certify that it has seen and approved the permit application before EPA will act on it. |

TABLE 9.2-1 Continued

| AGENCY | PERMIT TYPE | REFERENCES | REMARKS |
|---|---|---|---|
| (4. U.S. Environmental Protection Agency, Region VI, Continued) | addition, certification is still requiref from the EPA administrator (or from appropriate designated State or Interstate agencies) whenever a Federal license or permit is being sought for activities which may result in discharge into the navigable waters. | | |
| 5. U.S. Environmental Protection Agency, Region VI | Permit for Ocean Dumping required for brine disposal. | 40 CFR 220 | |
| 6. Louisiana Stream Control Commission (enforcement agency is the Louisiana Division of Water Pollution Control) (Baton Rouge) | (a) Certificate of Approval required for permission to discharge wastes into the public waters.<br>(b) State must approve applications for NPDES permits before submission to U.S. Environmental Protection Agency. | Louisiana Regulation Requiring Submission of Reports for the Discharge of Industrial Waste . . ., Section IIIA; 40 CFR 123 | Certificate of Approval required at least 30 days prior to beginning of discharges. |
| 7. Louisiana Air Control Commission (enforcement agency is the Louisiana Division of Air Control and Occupational Health) (Baton Rouge) | Certificate of Approval for construction of sources of air pollution emissions. Applies primarily to onshore turbines, but might apply to some petroleum handling equipment as well. | Louisiana Air Control | (a) Application for certificate must be submitted prior to preliminary site preparation.<br>(b) State of Louisiana has not previously extended permitting authority to offshore structures. |
| 8. Louisiana Air Control Commission - Division of Air Control and Occupational Health (Baton Rouge) | Approval for open burning of land clearing debris is not specifically required at present so long as the guidelines stipulated in the air control regulations are met. However, it is advisable to notify the Division prior to such burning to determine | Louisiana Air Control Commission Regulations, Section 11.0 | |

TABLE 9.2-1 Continued

| AGENCY | PERMIT TYPE | REFERENCES | REMARKS |
|---|---|---|---|
| (8. Louisiana Air Control Commission, continued) | that predicted ambient air quality and atmospheric conditions at the time of burning will be suitable and to alert the Division that burning is planned and will be properly conducted. | | |
| 9. Louisiana Air Control Commission - Division of Air Control and Occupational Health (Baton Rouge) | Regulations are not being considered for the establishment of ambient noise level standards. In final form, such regulations may require permits for the operation of specified industrial noise sources. | None | |
| 10. Not Established | Compliance with Coastal Zone Management Plan, when adopted. | None | The State of Louisiana is in the process of developing a Coastal Zone Management Plan, but a final program has not yet been adopted. None of the adjacent coastal states have management programs which are as yet federally approved. Florida and Texas have drawn up CZM Plans, the contents of which do not appear to require state approval of construction and operation activities. |
| 11. Louisiana Offshore Terminal Authority | Authorization for construction and operation of deepwater port facilities within the Authority's jurisdiction. Such authorization will include State environmental review and approval of the deepwater port under the Authority's Environmental Protection Plan. | Louisiana Revised Statutes 34: 3101-3116; Superport Environmental Protection Plan | |
| 12. Louisiana State Division of Health Bureau of Environmental Services | Permit for installation of sewage treatment facilities and for disposal of solid and oily water wastes. | Chapter X, Sanitary Codes, Sections 10.50 10.56.4 State of Louisiana | |

## 9.3 REQUEST FOR COMMENTS

Comments on the Draft EIS for Cote Blanche Mine were requested from the following agencies, companies, and organizations. Copies of the document were also made available to the Council on Environmental Quality and to the public in September, 1976.

Federal:

Advisory Council on Historic Preservation
Department of Agriculture
Appalachian Regional Commission
Department of Commerce
Council on Environmental Quality
Department of Defense
Energy Research and Development Administration
Environmental Protection Agency
Federal Power Commission
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of Interior
Interstate Commerce Commission
Department of Labor
National Science Foundation
Nuclear Regulatory Commission
Department of State
Tennessee Valley Authority
Department of Transportation
Department of Treasury
U. S. Army Corps of Engineers
Water Resources Council

States:

Louisiana
Texas

Local:

South Central Planning and Development Commission
South Louisiana Environmental Council
St. Mary Parish

Others:

American Fisheries Society
American Littoral Society
American Petroleum Institute
Center for Law and Social Policy
Ecology Center of Louisiana, Inc.

Electric Power Research Institute
Environmental Defense Fund
Environmental Policy Center
Florida Audubon Center
Friends of the Earth
Funds for Animals, Inc.
Gulf States Marine Fisheries Commission
Institute of Gas Technology
Interstate Natural Gas Association
Izaak Walton League of America
LOOP, Inc.
Louisiana Wildlife Federation
Morton Salt Company
National Association of Counties
National Aubudon Society
National League of Cities
National Parks and Conservation Association
National Wildlife Federation
Natural Resources Defense Council
Orleans Audubon Society
Seadock, Inc.
Sierra Club - Gulf Coast Regional Conservation Committee
Sierra Club - National Headquarters
Sierra Club - Southern Plains Regional Conservation Committee
U. S. Conference of Mayors

## 9.4 DISCUSSION OF COMMENTS RECEIVED ON THE DRAFT ENVIRONMENTAL IMPACT STATEMENT

The list of agencies and groups included with the Summary in the front of this statement indicates those who furnished written comments on the Draft Environmental Impact Statement to the Federal Energy Administration within the allotted comment period. Copies of the letters of comments are included in Appendix H.

All of the review comments received by FEA have been considered in the preparation of this Final Environmental Impact Statement. The EIS has been expanded and modified where appropriate as a result of comments received. In other cases, either no substantive issues were raised or no change to the EIS was considered appropriate. The following listing presents a summary of the disposition of substantive issues raised in the comments.

### 9.4.1 Comments Received from Federal Agencies

A. Advisory Council on Historic Preservation, October 1, 1976

Comment: During construction activities, which will be monitored by a professional archaeologist, should previously unknown cultural resources be encountered which are subsequently determined to be eligible for inclusion in the National Register, it is required that the Council be afforded an opportunity to comment in accordance with "Procedures for the Protection of Historic and Cultural Properties" (36 CFR, Part 800) prior to taking any action with respect to the cultural resource.

Response: FEA acknowledges the responsibility and authority of the Council with regard to cultural resources of national significance.

B. Environmental Protection Agency, November 1, 1976

Comment 1: Existing levels of photochemical oxidants in the project area and the national standard for photochemical oxidant concentrations should be included in section 3.4. Also, a discussion should be included summarizing the status of EPA's requested revision to the Louisiana State Implementation Plan (SIP) to achieve emission limitations needed for attainment of the national standard for photochemical oxidants by July 1977.

Response: The information requested on photochemical oxidant ambient concentrations and national standards has been included in section 3.4. Also, a summary of the status of requested revisions to the Louisiana SIP has been included in section 4.2.3 for particulates and in section 4.3.3 for photochemical oxidants.

Comment 2: Selection of a specific vapor control system should be made a part of the project design and discussed within the final EIS.

Response: The EIS is a document which is prepared prior to detailed engineering design specifications. Project systems and components used in determining probable environmental effects are those established in preliminary engineering feasibility studies. In addition, reasonable alternatives and mitigating measures are considered for their effect on project impacts. Flaring of vapors at the storage cavern during fill is the principal vapor control system incorporated in the present design. The effect of utilizing other vapor control systems as possible mitigative measures is described in section 5.2.3. Should detailed engineering studies result in selection of a vapor control system having a significantly different or more adverse impact on hydrocarbon emissions, the Final EIS will be amended accordingly.

Comment 3: The discussion on page 2.1-3 should specify the degree of treatment for oil-contaminated brine to be released into the Intracoastal Waterway (ICW). Also, if oil is to be displaced to the surface by water, full discussion of the impacts of treatment and disposal of the oil-contaminated brine, including evaporative hydrocarbon emissions, should be provided.

Response: Reference to disposal of oil-contaminated brine into the ICW has been deleted as no such disposal requirement is expected.

As indicated in sections 2.3.1 and 2.3.2, Figures 2.3-4 and 2.3-6, and elsewhere, oil will be pumped to and from the storage cavern through pipelines connected with the barge docks. No water will be introduced into the caverns and, consequently, no oil-contaminated brine will require treatment or disposal.

Comment 4: The discussion of pipeline construction should specify the manner of pipeline coating and the possibility of such material leaching into the soil. Also, the method of testing pipelines should be discussed before oil transfer is initiated.

Response: A description of possible protective pipeline coatings and the potential for leaching material into the soil has been added to section 4.2.2.2.

Hydrostatic tests will be performed on all piping systems prior to filling with oil. Statements to this effect have been added to sections 2.3.2 and 8.2.4.2.

Comment 5: The possibility of using the LOOP Deepwater Port Facility and St. James pipeline to provide for SPR filling after 1980 should be considered in the discussion of alternatives.

Response: The analysis of pipeline transport impacts in section 8.2.4.2 assumes use of the LOOP facilities to deliver oil to St. James. The text has been modified to specifically state this assumption and to include oil spills from the LOOP facilities in the comparison of impacts.

C. Department of the Treasury, November 1, 1976

Comment: Conventional cost-benefit analysis deals with a national rather than a regional perspective and assumes a full employment economy. Under such assumptions employment effects caused by facility construction are considered neither costs nor benefits since one more job in any region implies one less job elsewhere. Similarly, the "cost" of laying-off salt mine workers is not a cost if alternative employment opportunities exist. Social costs of lay-offs, such as unemployment compensation, are miniscule compared to the normal job turnover costs for the region.

Response: Analysis of economic and social effects conducted in an EIS for a specific project is not a formal or conventional cost-benefit analysis. Consideration of local and regional effects must be considered along with those of national significance. Otherwise, decisions regarding project desirability and alternatives would be made without full consideration of expected consequences.

For these reasons, it is considered necessary to consider the local effects of increased construction employment and the adverse effects accompanying the possibility that a large number of mine employees may temporarily be displaced from their jobs. The beneficial effects of construction at Cote Blanche are measurable and locally significant; the adverse effects of removing workers from the labor force at several dispersed, unidentified locations are not as readily measured and have little local, regional, or national significance. Also, the displaced mine workers are not ideally mobile. The availability of alternative employment opportunities is considered to be less than adequate to provide comparable income for most during the mine shut-down period.

D. U. S. Army Corps of Engineers

Comment C (1) (b): Inclusion of data from onsite sampling of flora and fauna would substantially improve the statements.

Response: A reconnaissance survey of Cote Blanche Island was made on January 27, 1976 by a terrestrial biologist; observations of island flora and fauna are combined with information gathered from the literature in section 3.6.5.1. A detailed listing of flora found in the Five Islands (Jefferson, Avery, Weeks, Cote Blanche and Belle), as reported in the literature, is reproduced in entirety as Appendix C. Personal contacts were made with several knowledgeable state and university biologists to determine whether any unusual, unique, commercially significant, rare, or endangered species or assemblages of flora or fauna exist on Cote Blanche Island. All of this information was included in the evaluation of project impacts.

It was determined that the relatively small extent of construction impact associated with the project (nearly all occurs on previously developed land, Figure 2.1-2) and the apparent absence of unique or otherwise important species on the affected land precluded the need for a detailed terrestrial sampling effort.

Comment C (1) (c): Additional water quality data are required to more readily quantify the impacts of the project.

Response: Juneau (1975) sampled the water quality at 17 stations in the vicinity of Vermilion and West Cote Blanche bays, including two stations in the Intracoastal Waterway, during the period April 1972 through March 1974 (Figure 3.3-3). The parameters measured included temperature, salinity, nitrates, nitrites, inorganic phosphates, total phosphorous, sulfates, calcium, pH, specific conductivity, alkalinity, turbidity, total solids, dissolved solids, and suspended solids. These and other data are summarized in sections 3.3.3.5 and 3.6.5, and Tables 3.3-8 through 3.3-13, and were used in evaluation of construction impacts (section 4.2.2.1). The four small lakes on Cote Blanche Island will not be affected by the project.

The highly turbid water in the ICW is of generally poor quality as productive habitat for aquatic life. Conditions are highly variable, however, depending on barge traffic, location, tide and weather conditions, among other factors. As no significant alteration in type or degree of present sources of pollution is anticipated, there was little to be gained from additional sampling efforts.

Comment C (2) (a): Page 3.1-1, paragraph 3, sentence 3 should be revised to state that the Atchafalaya-Vermilion Bay complex is rimmed by brackish, intermediate and fresh marsh to the north and by predominantly brackish marsh to the south.

Response: The text has been revised as requested.

Comment C (2) (b): Only Marsh Island provides significant protection to the bay complex from the Gulf of Mexico.

Response: The text has been clarified to specify Marsh Island on page 3.1-1.

Comment C (2) (c) and (d): Data presented in Tables 3.4-1 through 3.4-12 were obtained from locations too distant from the site to be of direct utility.

Response: The data presented in Tables 3.4-1 through 3.4-12 and Table 3.4-15 represent meteorological and air quality data from the nearest first order stations operated by the National Weather Service (NWS). A first order weather station reports all meteorological surface phenomena. There is one second order reporting station (Morgan City) which is 30 miles west of the site. Second order stations report and record only temperature and rainfall data. A comparison of ten years of temperature and rainfall data for Morgan City, Baton Rouge, New Orleans, and Lake Charles shows that the rainfall near the southern coast is about 10 inches higher than for the more inland first order station (Lake Charles), and that the temperature averages 1 to 2°F warmer at the coast. There is very little variation of other weather elements such as wind, relative humidity, and severe weather events with location in southern Louisiana. As stated on page 3.4-12, air quality varies more with the degree of urban development than with geographical location in southern Louisiana.

Comment C (2) (e and g): The blue goose is the dark color phase of the lesser snow goose.

Response: References to the blue goose in section 3.6.5.1 have been changed to the snow goose. However, as this reclassification is very recent an explanatory statement has been added to avoid possible confusion to the reader.

Comment C (2) (f): The reddish egret is uncommon to rare in the project area.

Response: The status of the reddish egret has been corrected in the text (section 3.6.5.1).

Comment C (2) (h): The discussion of the American alligator should be removed from the Game Species section and added to the Threatened and Endangered Species section.

Response: Discussion of the American alligator has been moved from the Game Species section to the Fur-bearers section (which includes hide-bearers). This species is now classified as threatened or endangered in southern Louisiana and is discussed in that section as well.

Comment C (2) (i): Pure populations of the red wolf occur in Cameron and Calcasieu parishes, not in Cameron and Vermilion parishes.

Response: The U. S. Fish and Wildlife Service states that a red wolf management area has been established in Cameron and Vermilion parishes. (Threatened Wildlife of the United States, 1973). Also, Corps of Engineers Inventory of Basic Environmental Data, South Louisiana (1973) lists Vermilion Parish as containing a pure strain of the red wolf. As FEA is not aware of documented evidence of a pure strain occurring in Calcasieu and since Vermilion Parish is much closer to project activities, no change has been made in the text.

Comment C (2) (j): Two additional rare and endangered species of reptiles which occur in the coastal region of Louisiana are the hawksbill and leatherback turtles.

Response: The Atlantic Hawksbill and Atlantic Leatherback turtles were not included in the Draft EIS as occurring in Louisiana since capture records in the 1900's show they are very rarely seen in the northern Gulf. However, they have been added to the Threatened and Endangered Species section of the Final EIS on the chance that they may occur in the project area.

Comment C (2) (k): As prevailing environmental conditions in Barataria Bay and the Gulf of Mexico are near marine, the choice of studies conducted in these areas to help characterize the primary producers in the vicinity of Cote Blanche Island is inappropriate.

Response: There is little information on the phytoplankton community of the Vermilion Bay - West Cote Blanche Bay areas. Information taken from Barataria Bay and nearshore Gulf waters is the best available, although these waters are of higher salinity than the project area. Additional information on macrophytes in the Vermilion Bay area has been added to section 3.6.5.3 of the Final EIS.

Comment C (2) (l): Salt warts, the black mangrove and sea lettuce do not occur in the project area.

Response: This paragraph has been revised as indicated in the response to comment C (2) (k) above.

Comment C (2) (m): The Gulf menhaden is a separate species from the Atlantic menhaden and is the most important fish in terms of harvested weight.

Response: A correction has been made in the text (section 3.6.5.4).

Comment C (2) (n): The value of estuarine waters in terms of dollars of commercial harvest per acre are incorrect in section 3.6.5.4.

Response: The data is taken in part from Table 3.6-17. Quoted values should be dollars per acre rather than million dollars per acre as originally presented.

Comment C (2) (o): The American alligator is not a controlled game species.

Response: The reference in section 3.6.5.5 has been changed to the alligator being a harvested fur-bearing (hide-bearing) species in these parishes.

Comment C (2) (p): Table 3.6-6 should be revised to agree with Federal Register, Volume 41, No. 117, 16 June 1976, "Endangered and Threatened Species, Plants."

Response: The revision has been made.

Comment C (2) (q): The hawksbill and leatherback turtle should be added to Table 3.6-7.

Response: The revision has been made.

Comment C (2) (r) and (s): Data presented in Tables 3.6-9 and 3.6-14 are of no value in predicting the primary producers and fish life of the project area because the Barataria Bay area has much higher salinity waters.

Response: Table 3.6-9 has been replaced with data on macrophytes taken from Chabreck (1972) for Hydrologic Unit VII. The general listing of phytoplankton in Table 3.6-10 is retained since more site-specific data is not available.

Table 3.6-14 has been revised with a list of fishes taken in the Vermilion - Cote Blanche Bay area, from Juneau (1975).

Comment C (2) (t): The statement on page 4.2-18 that the area to be excavated for enlargement of the barge slip is similar to marshes in Barataria Bay is incorrect since salinities in Barataria Bay are much higher than in the vicinity of Cote Blanche Island.

Response: The marshes around Cote Blanche Island are subject to generally lower salinities than in Barataria Bay and therefore have many different species of flora and fauna. The text has been clarified to indicate these differences.

There are no published studies of plant and animal productivity in the marshes around Cote Blanche Island. However, researchers at LSU (1975) have indicated that the average annual primary productivity for all wetlands in Louisiana (salt, brackish, intermediate and fresh marsh and swamp forest) is approximately the same. Differences are more a function of local variations in conditions, particularly flushing action, than salinity.

Since the marsh acreage to be affected by enlargement of the barge slip at Cote Blanche is only a few acres and is generally not highly productive, a conservative (worst case) estimate of productivity loss is obtained by using data from Barataria Bay.

Comment C (2) (u): As high ambient turbidity restricts growth of submerged aquatic plants in the project area, the paragraph on page 4.3-54 should be deleted.

Response: Though this is true along much of the Louisiana coast, oil is transported across so many different environments that an oil spill could very possibly affect submerged plants. Therefore, the paragraph has been retained.

Comment C (2) (v): The loblolly pine is generally absent from the Mississippi River flood plain and should be deleted from page 8.2-28.

Response: Though occurring occasionally on upland areas, the loblolly pine does not occur frequently enough to list as a dominant species. The revision has been made.

Comment C (2) (w): The turkey is not common in the wooded swamp traversed by the pipeline routes.

Response: The revision has been made.

Comment C (2) (x): The push-ditch method is often the most environmentally sound construction technique in marsh areas.

Response: The push-ditch method was included as one of the recommended construction methods. Where access is limited by very soft substrate and high waters, this method cannot be used.

Comment C (2) (y): Subsidence and oxidation usually limit the quantity of backfill, resulting in permanent loss of marsh habitat.

Response: The text has been altered to indicate that a shallow canal will usually result from the flotation canal method of pipeline installation.

Comment e (1): Application for permits should be made as soon as practicable, well in advance of the need to perform the proposed work.

Response: FEA will make the necessary permit applications as soon as possible.

Comment e (2): Encroachment of water courses that provide natural circulation of surface waters and creation of vector problems are two factors critical to continuing use of disposal areas.

Response: FEA will work with the Corps of Engineers and the Fish and Wildlife Service to select environmentally acceptable spoil disposal sites and methods.

Comment e (3): Adverse effects of surface preparation for painting during construction and operation should be considered.

Response: The aboveground structures necessary for the SPR facility at Weeks Island are minimal. Impacts of painting will be negligible.

Comment e (4): Reference to certain important legislation regarding disposal of dredged spoil material has been omitted.

Response: These references are made in section 9.2 along with a listing of required permits and licenses.

### 9.4.2 Comments Received from State Agencies

No substantive comments were received from state agencies.

### 9.4.3 Comments Received from Local Agencies

No substantive comments were received from local agencies.

### 9.4.4 Comments Received from Companies, Groups and the Public

No substantive comments were received from companies, groups or the public.

SECTION 10.0

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## APPENDIX A

## LOUISIANA WATER QUALITY CRITERIA

In April 1973 the Louisiana Stream Control Commission issued revised Water Quality Criteria for the state in order to comply with the provisions of Public Law 92-500 (Federal Water Pollution Control Act Amendments of 1972). Below are reproduced pertinent sections of the publication setting forth the criteria along with specific stream criteria.

GENERAL CRITERIA:

The following general criteria are applicable to the surface waters of the State of Louisiana and specifically apply with respect to substances attributed to waste discharges or the activities of man as opposed to natural phenomena.

Natural waters may, on occasion, have characteristics outside the limits established by these criteria; in which case these criteria do not apply. The criteria adopted herein relate to the condition of water as affected by waste discharges of man's activities.

These general criteria do not supersede specific exceptions to any one or more of the following if the exception is specifically stated in a specific water quality standard. All waters of the state shall be capable of supporting desirable diversified aquatic life.

(1) Aesthetics - The present and future use of all streams and water bodies are considered in these criteria. The waters of the state shall be maintained in an aesthetically attractive condition and shall meet the generally accepted aesthetic qualifications.

(2) Color - True color shall not be increased to the extent that it will interfere with present usage and projected future use of the streams and water bodies.

(3) Floating, Suspended and Steeleable Solids - Free from substances that will produce distinctly visible turbidity, solids or scum, nor shall there be any formation of slimes, bottom deposits or sludge banks attributable to waste discharges from municipal, industrial, or other sources including agricultural practices.

(4) Taste and Odor - Taste- and odor-producing substances shall be limited to concentrations in the waters of the state that will not interfere with the production of potable water by reasonable water treatment methods, or impart unpalatable flavor to food fish, including shellfish, or result in offensive odors arising from the waters, or otherwise interfere with the reasonable use of the waters.

(5) Toxic Substances - None present in quantities that alone or in combination will be toxic to animal or plant life. In all cases the level shall not exceed the $TLM_{96/10}$. Bioassay techniques will be used in evaluating toxicity, utilizing methods and species of test organisms suitable to the purpose at hand. In cases where the stream is used as a public water supply the level of toxic substances shall not exceed the levels established by the United States Public Health Service drinking water standards latest edition.

(6) Oils and Greases - There shall be no free or floating oil or grease present in sufficient quantities to interfere with the designated uses, nor shall emulsified oils be present in sufficient quantities to interfere with the designated uses.

(7) Foaming or Frothing Materials - None of a persistent nature.

(8) Nutrients - The naturally occurring nitrogen-phosphorus ratio shall be maintained. On completion of detailed studies on the naturally occurring levels of the various macro and micro nutrients the state will establish numerical limits on nutrients where possible.

(9) Turbidity - There shall be no substantial increase in turbidity from ambient conditions due to waste discharges.

(10) Other Materials - Limits on other substances not specified in these revised water quality standards shall be in accordance with recommendations set by the Louisiana Stream Control Commission and/or the Louisiana Health and Social and Rehabilitation Services Administration for municipal raw water sources.

CLASSIFICATION OF SURFACE WATERS:

The surface waters of the state will be divided into the following categories for ease of classification. Where the geographical coverage of a particular identified water or segment is subject to interpretation, e.g., East Cote Blanche Bay, the segment limits shall be defined by the maps included in the standards.

(1) River Basin Waters - those surface inland waters comprising the lakes, reservoirs, major rivers and their tributaries and including the tidal portion of the river to the extent that it is confined in a channel. (This definition specifically does not apply to impoundments constructed solely for waste treatment purposes.)

(2) Coastal Basin Waters - those surface inland waters exclusive of number one (River Basin Waters) discharging or flowing or otherwise communicating with bays or the gulf including the tidal portion of streams to the extent that they are confined in channels.

(3) Bay Waters - all tidal waters exclusive of those included in river basin waters, coastal basin waters, and gulf waters.

(4) Gulf Waters - those waters which are not included in or form a part of any bay or estuary but which are a part of the open waters of the Gulf of Mexico to the limit of Louisiana's jurisdiction.

WATER USE CLASSIFICATION:

Policy:

It is the policy of the State of Louisiana that all state waters should be protected for recreational uses in and/or on the water and for the preservation and propogation of desirable species of aquatic biota as part of the Louisiana Water Quality Management program. Use and value of water for public water supplies, agricultural, industrial, and other purposes as well as navigation, shall also be considered in setting standards, but in no case, except as provided below, shall the criteria supporting these uses be permitted to interfere with recreational uses and the preservation of desirable species of aquatic biota.

Recreational uses will be specified as either "primary contact" or "secondary contact." Desirable species of aquatic biota will be specified as "fresh warm water", or "marine waters." All future designations of stream uses and their associated criteria must, at a minimum, adhere to these classifications except as provided below.

Exceptions:

Some waters, because of naturally occurring poor quality, man-made pollution or technological limitations may qualify for an excepted classification. This determination, however, will be made on a case-by-case basis following the analyses of each such area. In all cases where exceptions are proposed the concurrence of the Regional Administrator of the United States Environmental Protection Agency will first be obtained. In any case where the exception is based on technological limitations, the exception will be temporary, i.e., the exception will be reviewed at least every three years as required by Section 303(c) of Public Law 95-500.

In applying this policy, the terms "recreational uses" and "desirable species of aquatic biota" will be given common sense application. The existence of man-made pollution will be reviewed as a problem to be solved, not as an impediment against assigning this use classification.

"Desirable species of aquatic biota" refers to the range of aquatic biota indigenous to an area, and not to species that could and/or do not live in the area in question due to man's activities.

The most stringent criteria specified for each parameter shall be applicable where waters are classified for multiple uses.

CLASS A: Water Contact Recreation and Other Uses (Primary Contact)

A surface raw water source intended for uses where the human body may come in direct contact with the raw water to the point of complete body submergence. The raw water may be ingested accidentally and certain sensitive body organs such as eyes, ears, nose, etc., may be exposed to the water. Although the water may be ingested accidentally it is not intended to be used as a potable supply unless acceptable treatment is applied. Water may be used for swimming, water skiing, skin diving, other similar activities, or as a raw water source for public water supply, support and propogation of aquatic fish and wildlife, agricultural, industrial and navigational uses.

CLASS B: Fish, Wildlife and Other Aquatic and Semi-Aquatic Life, Secondary Contact Recreation and Other Uses

A surface raw water source, suitable for the growth and propagation of fish, other aquatic and semi-aquatic life both marine and fresh water; waterfowl, fur bearers; and wildlife. This water may be used for warm water fish habitat, wildlife habitat, and other similar uses. This water is also suitable for secondary water contact recreation such as fishing, wading, boating, or activities where ingestion of the water is not probable or as a raw water source public water supply, agricultural, industrial and navigational uses.

Criteria for Class A and B are equal to or more stringent than those applicable for public water supply use as stated in the report of the National Technical Advisory Committee to the Secretary of the Interior on the Water Quality Criteria. However, when a water body is used as a public water supply it shall be identified as such in the standards for the stream and/or segment where the use occurs.

NUMERICAL CRITERIA

These numerical criteria apply to the specific waters of Louisiana identified in the tables, their navigable tributaries, distributaries and ancillary streams and waterbodies (unless such tributaries, distributaries and ancillary streams or waterbodies are specifically identified and have numerical standards listed in this book) and specifically apply with respect to substances or conditions attributed to waste discharges or activities of man as opposed to natural phenomena.

pH

The pH range represents minimum and maximum conditions throughout the segment with reasonable gradients applying towards segment boundaries. In all cases the pH shall fall within the range of 6.0 to 9.0 unless otherwise specified in the tables. No discharge of wastes shall cause the pH of the water body to vary by more than one (1) pH unit within the specified pH range for that segment where the discharge occurs. (This does not apply in the Mixing Zone.)

CHLORIDES, SULFATES & DISSOLVED SOLIDS

Values for these parameters apply to the approximate midpoint of the segment with reasonable gradients applying towards segment boundaries. Values listed in the standards in general represent the arithmetic mean of existing data plus one standard deviation.

DISSOLVED OXYGEN

The following Dissolved Oxygen values represent minimum for the types of water specified. These values shall apply at all times except in naturally dystrophic waters or where natural conditions cause the Dissolved Oxygen to be depressed. For short periods of time, diurnal variations below the standard specified may occur. However, no waste discharge or activity of man shall lower the Dissolved Oxygen concentration to the point where the diurnal variation falls below the specified minimum.

FRESH WATER - For a diversified warm water biota including game fish, the daily D.O. concentration shall be above 5 mg/l assuming normal seasonal and daily variations are above this concentration. However, they may range between 5 and 4 mg/l for short periods of time during a 24-hour period, provided the water quality is favorable in all other respects.

ESTUARINE WATER - Dissolved oxygen concentrations in estuaries and tidal tributaries shall not be less than 4 mg/l at any time or place except in naturally dystrophic waters, or where natural conditions cause D.O. to be depressed.

COASTAL WATER - Dissolved oxygen concentration in surface coastal waters shall be greater than 5 mg/l except when the upwellings and other natural phenomena may cause this value to be depressed.

TEMPERATURE

The temperature standards enumerated in the tables, in most cases, represent maximum values obtained from existing data. However, in a few cases a limited number of unusually high temperatures in the range of $35^{o}$ - $36^{o}C$ have been deleted as it is felt that these values were recorded during conditions of unseasonably high temperatures and/or unusually low flows or water levels and, therefore, do not represent normal maximum temperatures.

In order to protect a diversified water biota including game fish, the following temperature criteria shall apply (except when natural conditions cause the temperature to be raised above these limits).

The standard shall consist of two parts, a temperature differential and a maximum temperature. The temperature differential represents the maximum permissable rise above ambient conditions. There shall be no addition of artificial heat once the ambient temperature reaches the maximum temperature specified in the standards.

FRESH WATER - Temperature differential

(1) Maximum of $5^{o}F$ ($2.8^{o}C$) rise above ambient for streams and rivers.

(2) Maximum of $3^{o}F$ ($1.7^{o}C$) rise above ambient for lakes and reservoirs.

MAXIMUM TEMPERATURE - $90^{o}F$ ($32.2^{o}C$) except where otherwise listed in tables or due to natural conditions.

ESTUARINE AND COASTAL WATERS - Temperature differential

(1) Maximum of $4^{o}F$ ($2.2^{o}C$) rise above ambient during the period October through May.

(2) Maximum $1.5^{o}F$ ($0.83^{o}C$) during the period June through September.

MAXIMUM TEMPERATURE - $95^{o}F$ ($35^{o}C$) except when natural conditions elevate temperature above this level.

These temperature criteria shall not apply to privately owned reservoirs, or reservoirs constructed solely for industrial cooling purposes.

BACTERIAL STANDARDS:

Standard #1. Based on a minimum of not less than 5 samples taken over not more than a 30-day period, the fecal coliform content shall not exceed a log mean of 200/100 nor shall more than 10 percent of the total samples during any 30-day period exceed 400/100 ml.

Standard #2. Based on a minimum of not less than 5 samples taken over not more than a 30-day period, the fecal coliform content shall not exceed a log mean of 1,000/100 ml, nor shall more than 10 percent of the total samples during any 30-day period equal or exceed 2,000/100 ml.

Standard #3. The monthly arithmetic average of total coliform MPN (most probable number) shall not exceed 10,000/100 ml, nor shall the monthly arithmetic average of fecal coliforms exceed 20,000/100 ml.

Standard #4. The monthly total coliform median MPN (most probable number) shall not exceed 70 per 100 ml, and no more than 10 percent of the samples ordinarily exceed an MPN of 230/100 ml.

APPLICATION OF STANDARDS:

Flow Conditions:

Except where indicated below the water quality standards specified herein shall apply during all flow conditions.

Chemical Parameters:

The chemical parameters (except Dissolved Oxygen) represent maximum values for the segment specified in the tables. These standards shall apply at all times except when natural conditions cause them to be exceeded.

Dissolved Oxygen:

The Dissolved Oxygen values represent minimum values for the type of water specified. These values shall apply at all times except in naturally dystrophic waters or where natural conditions cause the Dissolved Oxygen to be depressed; for short periods of time diurnal variations below the standard specified may occur. However, no waste discharge or activity of man shall lower the Dissolved Oxygen concentration to the point where diurnal variation falls below the specified minimum.

Temperature:

The temperature standards represent maximum values and shall apply in all cases when unusual natural conditions of extremely low flow and unseasonably high temperatures may cause the established temperature standard to be exceeded. There shall be no addition of artificial heat once the ambient temperature reaches the maximum specified in the standards.

General Criteria and Other Parameters:

The general criteria and other criteria not specifically discussed above shall apply at all times except when natural conditions may cause the standard to be exceeded.

Mixing Zones:

The total area and/or volume of a stream assigned to mixing zones will be limited to that which will: (1) not interfere with biological communities or populations of important species to a degree which is damaging to the ecosystem; (2) not diminish other beneficial uses disproportionately.

Zones of Passage:

In river streams, reservoirs, lakes, estuaries and coastal waters, zones of passage are continuous water routes of the volume, area and quality necessary to allow passage of free-swimming and drifting organisms with no significant effects produced on their populations. These zones must be provided wherever mixing zones are allowed.

Because of varying local physical and chemical conditions and biological phenomena no single value can be given on the percentage of river (or stream) width necessary to allow passage of critical free-swimming and drifting organisms so that negligible or no effects are produced on their populations. As a guideline and except when otherwise specified by the Louisiana Stream Control Commission in a valid waste discharge permit the Mixing Zone will be limited to no more than 1/4 of the cross sectional area and/or volume of flow of stream or estuary, leaving at least 3/4 free as a zone of passage.

EXCEPTIONS:

The water quality standards will not apply to:

(1) Effluents

(2) With the exception of the several criteria the water quality criteria will not apply to water in mixing zones as defined above or in a valid waste discharge permit from the Louisiana Stream Control Commission and/or a National Pollution Discharge Elimination System Permit.

SPECIFIC WATER QUALITY CRITERIA:

The water quality criteria for the region is presented in Table 3.3-6.

APPENDIX B

# FIELD SURVEY TO ESTIMATE BACKGROUND AMBIENT SOUND LEVELS

## B.1 INTRODUCTION

A background ambient sound level survey was conducted at and near the proposed mine site on February 4 and 5, 1976. Five locations were selected for the survey, as shown in Figure B-1. Locations were selected to reflect the present sound climate on the site, at nearby areas, and at noise sensitive land uses. Measurements were made at:

Location 1 - Center of mining activity, Cote Blanche Island

Location 2 - Ferry crossing to Cote Blanche Island, north of intracoastal waterway

Location 3 - Village of Kemper

Location 4 - Village of Boudreaux

Location 5 - Along Route 83, 4 miles north of Weeks Island

The ambient sound survey was conducted at the above locations on typical weekdays during daytime (0700-2200) and nighttime (2200-0700) periods. These time periods are in accordance with the daytime and nighttime periods as defined by the U.S. Environmental Protection Agency.*

The range of sound pressures that can be heard by humans is very large. This range varies from two ten-thousand-millionths ($2 \times 10^{-10}$) of an atmosphere for sounds barely audible to humans to two thousandths ($2 \times 10^{-3}$) of an atmosphere for sounds which are so loud as to be painful. The decibel notation is used to present sound levels over this wide physical range. Essentially, the decibel unit compresses this range to a workable range using logarithms. It is defined as:

$$\text{Sound pressure level (dB)} - 20 \log_{10} \left(\frac{P}{P_o}\right)$$

where $P_o$ is a reference sound pressure required for a minimum sensation of hearing.

* "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," USEPA, 550/9-74-004, March 1974.

[illegible] 140 [illegible] ou [illegible] which is [illegible] million is expressed on a scale [illegible]

The [illegible] at low frequencies in the same manner as those at higher frequencies. Sounds of equal intensity at low frequency do not seem as loud as those at higher frequencies. The A-weighted network is provided in sound analysis systems to simulate the human ear. A-weighted sound levels are expressed in units of dBA. These levels in dBA are used by the engineer to evaluate hearing damage risk (OSHA) or community annoyance impact and are also used in federal, state, and local noise guidelines and ordinances.

Sound is not constant in time. Statistical analysis is used to describe the temporal distribution of sound and to compute single number descriptors for the time-varying sound. This report contains the statistical A-weighted sound levels:

$L_{90}$ - This is the sound level exceeded 90 percent of the time during the measurement period and is often used to represent the "residual" sound level.

$L_{50}$ - This is the sound level exceeded 50 percent of the time during the measurement period and is used to represent the "median" sound level.

$L_{10}$ - This is the sound level exceeded 10 percent of the time during the measurement period and is often used to represent the "intrusive" sound level.

$L_{eq}$ - This is the equivalent steady sound level which provides an equal amount of acoustic energy as the time-varying sound.

$L_d$ - Equivalent sound level, $L_{eq}$, for the daytime period (0700-2200) only.

$L_n$ - Equivalent sound level, $L_{eq}$, for the nighttime period (2200-0700) only.

$L_{dn}$ - Equivalent day/night sound level, defined as:

$$L_{dn} = 10 \log_{10} ([15 \times 10^{L_d/10} + 9 \times 10^{(L_n+10)/10})]/24)$$

Note: A 10 dB correction factor is added to the nighttime equivalent sound level when computing $L_{dn}$.

The data acquisition system used in this baseline survey consisted of a General Radio omni-directional one-inch electret condenser microphone with windscreen, a General Radio Type 1933 Sound Level Meter and Octave Bank Analyzer, and a Nagra 4.2L single track magnetic tape recorder. The General Radio Type 1933 Sound Level Meter and Octave Bank Analyzer was used as a linear amplifier and step attenuator. Ambient sound was recorded on Scotch 177 magnetic tape. The data acquisition system is shown schematically in Figure B-2.

The above system was calibrated before each recording by means of a reference signal at 1000 Hertz of 114 dB generated by a General Radio Type 1562A Sound Level Calibrator.

The microphone was mounted on a tripod four feet above the ground surface and at least ten feet from any sizable sound reflecting surfaces in order to avoid major interference with sound propagation. Most recordings of the background ambient sound were 15 minutes in length. However, if a large number of intrusions, such as aircraft overflights or wind induced system overloads, occurred, the measurement period was extended. Meteorological parameters such as wet bulb and dry bulb temperature, barometric pressure, and wind speed and direction were noted during each recording period. If high relative humidity (over 90%) or excessive wind speed (over 10 knots) occurred during the measurement period, the recording session was terminated.

The tape recorded data were returned to the acoustic laboratory at Dames & Moore for analysis, using a General Radio Real-Time Analyzer and a Digital Equipment Corporation mini-computer shown schematically in Figure B-3.

During the recording sessions, any unusual intrusions, such as wind pop over the microphone or clipping due to overloads, were noted by the engineer monitoring the signal input to the tape. Such intrusions are not characteristic of the acoustic environment, and are deleted during the analysis phase.

## B.2 BACKGROUND AMBIENT SOUND LEVELS

A summary of the background ambient sound survey results is presented in Table B-1. This table contains the statistical A-weighted sound level, $L_{90}$, L ), $L_{10}$, and $L_{eq}$ for each measurement location. These data represent the background ambient sound levels of the existing environment at and near the project area. They were made during periods when there were no uncharacteristic activities on the site and thus do not contain any intrusive sounds. Nighttime measurements at Locations 2, 4 and 5 were omitted due to adverse weather conditions during the ambient survey. Ambient nighttime sound levels at these locations were estimated from other data.

Background ambient sound level data for each measurement period are presented in Figures B-4 to B-10. Each figure contains an A-weighted sound level histogram (indicating the number of times a particular sound level occurred during the measurement period) and the cumulative distribution of the A-weighted sound levels (indicating the percentage of time a sound level is exceeded). Also included on each figure is the cumulative distribution of the sound pressure levels at the octave band center frequencies. The meteorological data which existed during the time these measurements were taken are presented in Table B-2.

Measurements at Location 1 are representative of existing sound climate on the site for an operating mine. Sound levels are mainly from the mining activities and facility operation.

At Location 2, the ferry crossing to Cote Blanche Island, the background ambient sound level data consist of the noise due to a barge passby, but does not include any sound from the ferry. Sound levels at this location are mainly contributed by barge traffic and wind, thus representing the ambient sound levels along the intracoastal waterways.

Locations 3 and 4 are noise sensitive land uses; sound levels are mainly from vehicular traffic, wind, and community activities. Train passbys also contributed to the sound levels at Location 3.

Sound levels at undeveloped areas along country roads are represented by measurements made at Location 5, a location along Route 83, where major sound sources are road traffic and wind rustling through the trees.

## B.3 FEDERAL GUIDELINES AND STATE NOISE REGULATION

The federal Environmental Protection Agency has established guidelines for limits of $L_{dn}$ requisite for the protection of public health and welfare.*

According to EPA guidelines, outdoor ambient sound levels, $L_{dn}$, below 55 dB will not degrade public health and welfare.

SUMMARY OF NOISE LEVELS IDENTIFIED AS REQUISITE TO PROTECT PUBLIC HEALTH AND WELFARE WITH AN ADEQUATE MARGIN OF SAFETY

| Effect | Level | Area |
|---|---|---|
| Hearing Loss | $L_{eq(24)} \leq 70$ dB | All areas |
| Outdoor activity interference and annoyance | $L_{dn} \leq 55$ dB | Outdoors in residential areas and farms and other outdoor areas where people spend widely varying amounts of time and other places in which quiet is a basis for use. |
| | $L_{eq(24)} \leq 55$ dB | Outdoor areas where people spend limited amounts of time, such as school yards, playgrounds, etc. |
| Indoor activity interference and annoyance | $L_{dn} \leq 45$ dB | Indoor residential areas |
| | $L_{eq(24)} \leq 45$ dB | Other indoor areas with human activities such as schools, etc. |

$L_{eq(24)}$ represents the sound energy averaged over a 24-hour period.

$L_{dn}$ represents the $L_{eq}$ with a 10 dB nighttime weighting.

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* "Information on Levels of Environmental Noise Requisite to Protect Public Health and Welfare with an Adequate Margin of Safety," USEPA, 550/9-74-004, March 1974.

The State of Louisiana has no noise regulation pertaining to the construction or operation of the proposed project.

TABLE B-1 Summary of ambient sound levels

| Statistical Sound Levels | Daytime (0700-2200) | Nighttime (2200-0700) | Day/Night Sound Levels |
|---|---|---|---|
| Location 1 | | | |
| $L_{90}$ | 62 | 64 | - |
| $L_{50}$ | 64 | 68 | - |
| $L_{10}$ | 68 | 70 | - |
| $L_{eq}$ | 65.5 | 67.9 | - |
| $L_{d}$ | - | - | 65.5 |
| $L_{n}$ | - | - | 67.9 |
| $L_{dn}$ | - | - | 74.0 |
| Location 2 | | | |
| $L_{90}$ | 44 | - | - |
| $L_{50}$ | 50 | - | - |
| $L_{10}$ | 59 | - | - |
| $L_{eq}$ | 58.5 | 54 (estimated) | - |
| $L_{d}$ | - | - | 58.5 |
| $L_{n}$ | - | - | 54 (estimated) |
| $L_{dn}$ | - | - | 61.4 (estimated) |
| Location 3 | | | |
| $L_{90}$ | 42 | 33 | - |
| $L_{50}$ | 47 | 35 | - |
| $L_{10}$ | 58 | 44 | - |
| $L_{eq}$ | 59.6 | 38.7 | - |
| $L_{d}$ | - | - | 59.6 |
| $L_{n}$ | - | - | 38.7 |
| $L_{dn}$ | - | - | 57.8 |
| Location 4 | | | |
| $L_{90}$ | 41 | - | - |
| $L_{50}$ | 47 | - | - |
| $L_{10}$ | 55 | - | - |
| $L_{eq}$ | 55.1 | 39 (estimated) | - |
| $L_{d}$ | - | - | 55.1 |
| $L_{n}$ | - | - | 39 (estimated) |
| $L_{dn}$ | - | - | 53.7 (estimated) |

TABLE B-1 Continuea

| Statistical Sound Levels | Daytime (0700-2200) | Nighttime (2200-0700) | Day/Night Sound Levels |
|---|---|---|---|
| Location 5 | | | |
| $L_{90}$ | 40 | - | - |
| $L_{50}$ | 41 | - | - |
| $L_{10}$ | 51 | - | - |
| $L_{eq}$ | 54.6 | 39 (estimated) | - |
| $L_d$ | - | - | 54.6 |
| $L_n$ | - | - | 39 (estimated) |
| $L_{dn}$ | - | - | 53.2 (estimated) |

TABLE B-2 Meteorological conditions during ambient survey

| Location | Date | Time | Temperature (°F) | Humidity (%) | Wind | Direction |
|---|---|---|---|---|---|---|
| | | | (Daytime) | | | |
| 1 | 2/5/76 | 1225 | 67 | 90 | 9-11 | SE |
| 2 | 2/4/76 | 2125 | 66 | 90 | 8-10 | SE |
| 3 | 2/5/76 | 1325 | 71 | 86 | 5-6 | SE |
| 4 | 2/4/76 | 1940 | 66 | 90 | 5-6 | SE |
| 5 | 2/4/76 | 2030 | 66 | 95 | 8-9 | SE |
| | | | (Nighttime) | | | |
| 1 | 2/4/76 | 2305 | 63 | 95 | 8-10* | SE |
| 2 | | | | | | |
| 3 | 2/5/76 | 0030 | 66 | 90 | 5-6 | SE |
| 4 | | | | | | |
| 5 | | | | | | |

* Gusting to 13 knots

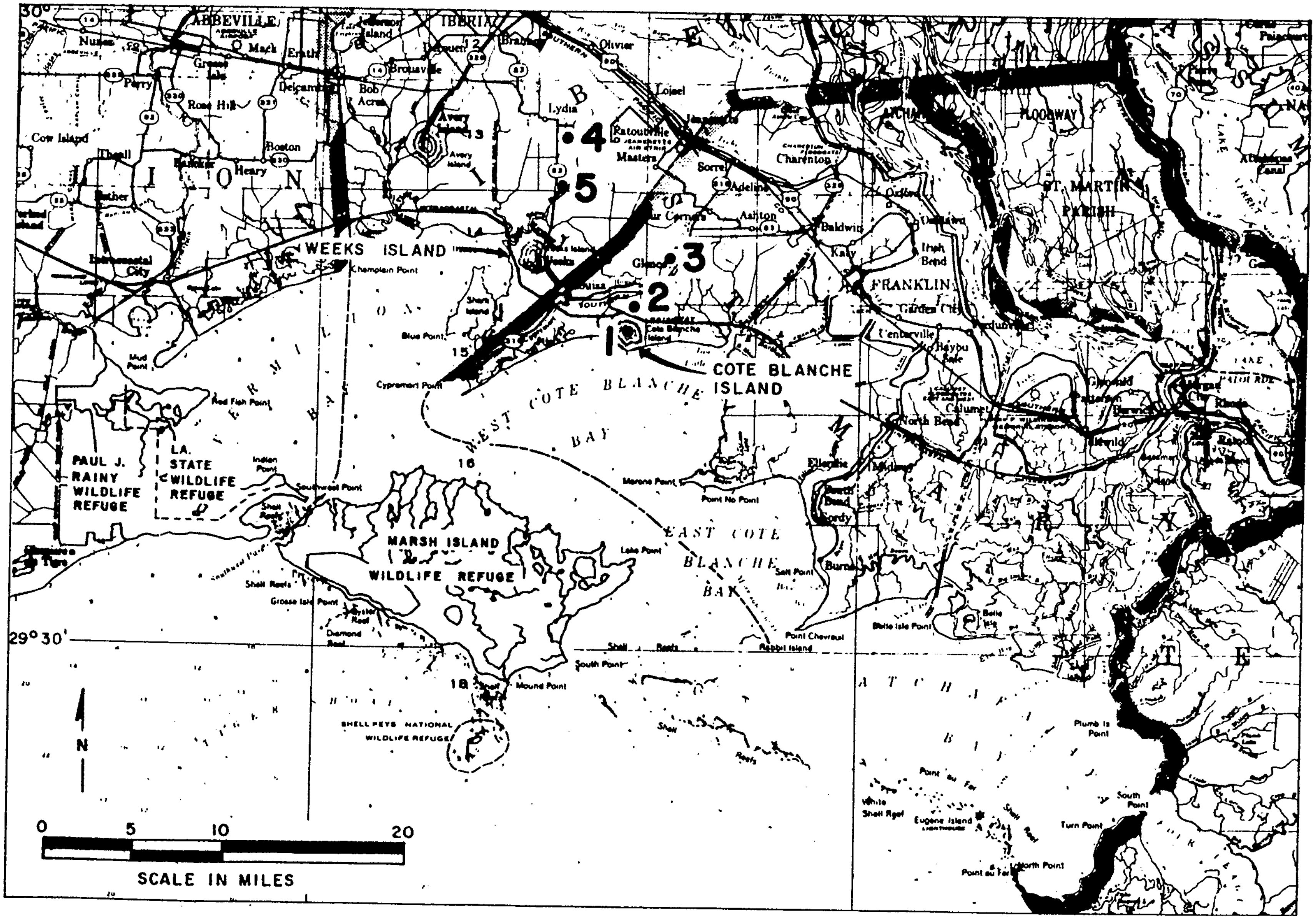


FIGURE B-1 Background ambient sound level survey locations.

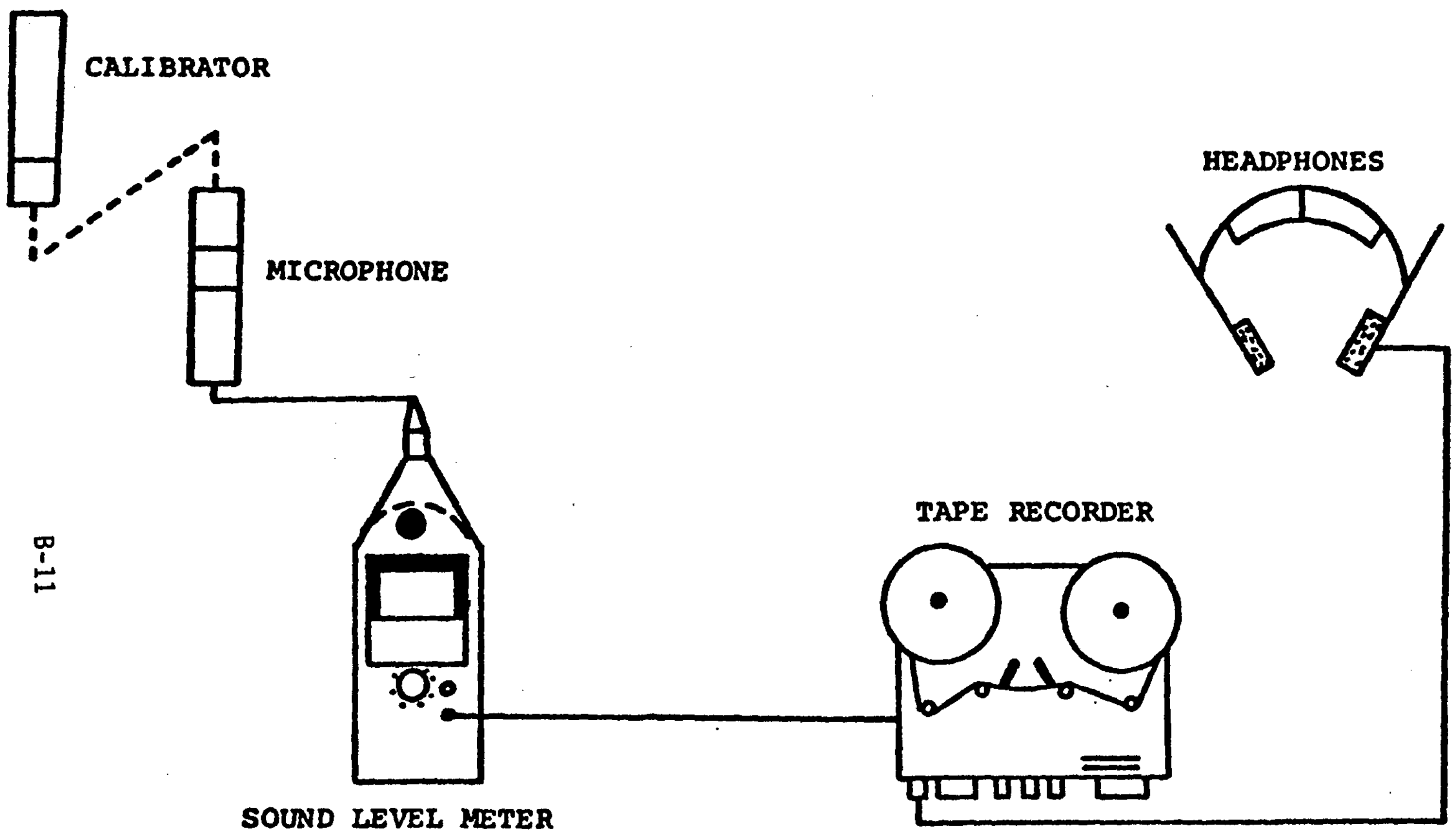


FIGURE B-2. Data acquisition system.

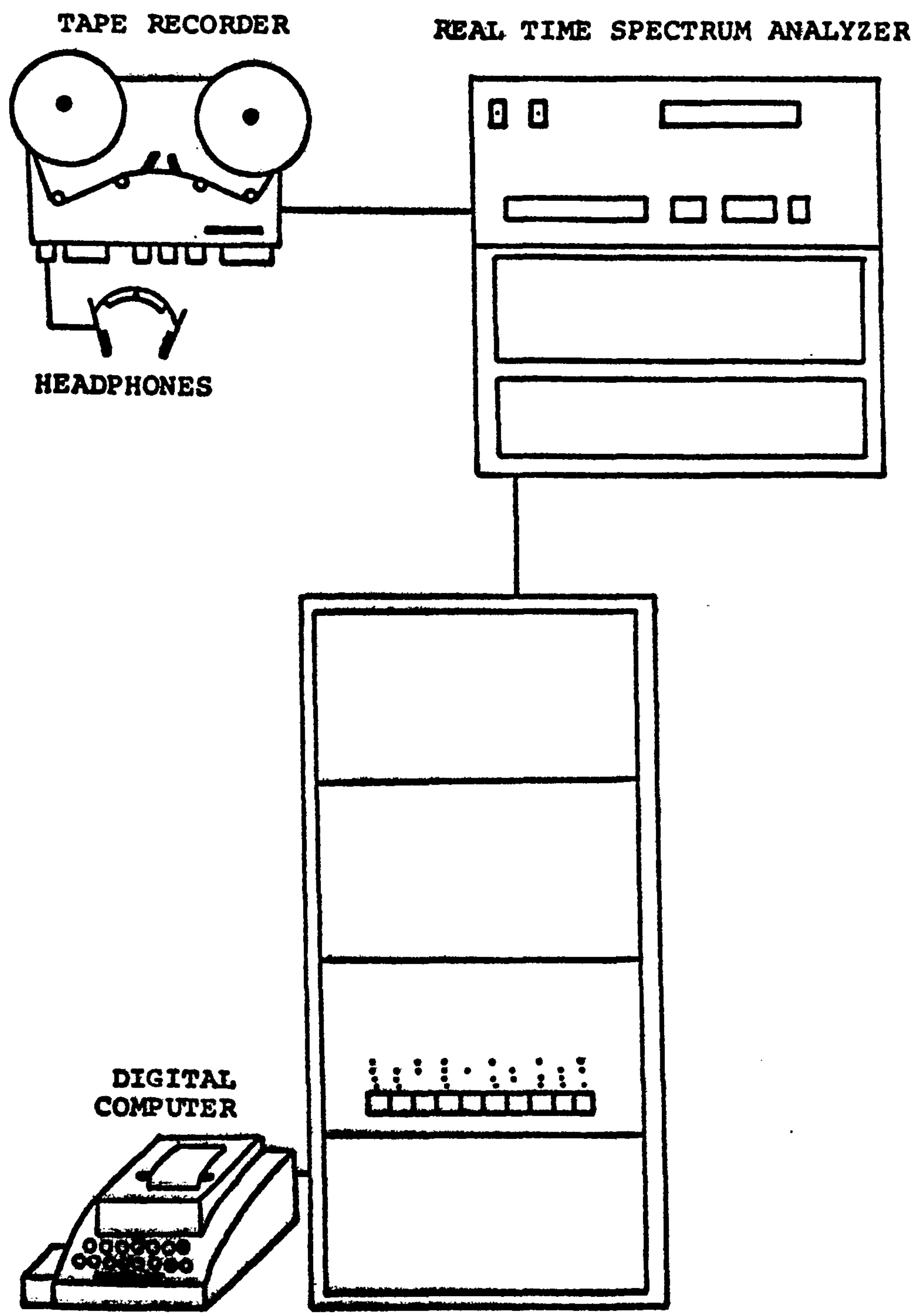


FIGURE B-3. Data analysis system

FIGURE B-4 Background ambient sound level data
Location: 1
Date: February 5, 1976
Time: 1225

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 78.6 | 82 | 76 | 72 |
| 63 | 69.3 | 71 | 68 | 67 |
| 125 | 69.6 | 71 | 69 | 68 |
| 250 | 65.4 | 67 | 65 | 64 |
| 500 | 65.0 | 69 | 60 | 58 |
| 1000 | 56.4 | 58 | 56 | 54 |
| 2000 | 53.8 | 56 | 53 | 51 |
| 4000 | 49.2 | 51 | 49 | 47 |
| 8000 | 46.4 | 49 | 45 | 44 |
| A-Wt. | 65.5 | 68 | 64 | 62 |

Sound Level (A-Weighting) in dB re 20 $\mu N/m^2$

```
60  *  2
61  **  8
62  ********************  116
63  ************************************************  285
64  *********************************  195
65  ****************  95
66  **********  55
67  *******  37
68  *****  29
69  ****  22
70  *** 17
71  **** 19
72  *  4
73  **  7
74  *  5
75  *  1
76  *  2
77  *  1
```

Equivalent Sound Level = 65.5 dB

FIGURE B-4 Continued

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level - dB |
|---|---|
| 95 | 62 |
| 90 | 62 |
| 85 | 63 |
| 80 | 63 |
| 75 | 63 |
| 70 | 63 |
| 65 | 63 |
| 60 | 63 |
| 55 | 63 |
| 50 | 64 |
| 45 | 64 |
| 40 | 64 |
| 35 | 64 |
| 30 | 65 |
| 25 | 65 |
| 20 | 66 |
| 15 | 67 |
| 10 | 68 |
| 5 | 70 |

FIGURE B-5 Background ambient sound level data
Location: 2
Date: February 4, 1976
Time: 2125

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 71.9 | 76 | 66 | 62 |
| 63 | 61.6 | 64 | 58 | 55 |
| 125 | 60.2 | 61 | 53 | 49 |
| 250 | 58.8 | 62 | 51 | 45 |
| 500 | 54.6 | 58 | 46 | 44 |
| 1000 | 51.0 | 51 | 44 | 44 |
| 2000 | 48.6 | 49 | 44 | 44 |
| 4000 | 46.5 | 44 | 44 | 44 |
| 8000 | 53.1 | 44 | 44 | 44 |
| A-WT. | 58.5 | 59 | 50 | 44 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 43 |
| 90 | 44 |
| 85 | 44 |
| 80 | 45 |
| 75 | 45 |
| 70 | 47 |
| 65 | 48 |
| 60 | 48 |
| 55 | 49 |
| 50 | 50 |
| 45 | 51 |
| 40 | 52 |
| 35 | 53 |
| 30 | 54 |
| 25 | 55 |
| 20 | 56 |
| 15 | 57 |
| 10 | 59 |
| 5 | 63 |

FIGURE B-5 Continued

Sound Level (A-Weighting) in dB re 20 μN/m$^2$

```
41 * 1
42 **** 8
43 ********************** 44
44 ********************************************** 92
45 ***************************************** 82
46 ******************** 40
47 *********************** 45
48 ************************** 51
49 ********************************** 67
50 ************************** 51
51 ************************ 48
52 ************************ 48
53 ********************* 41
54 *************************** 53
55 *************** 29
56 ********************* 42
57 ******************* 37
58 ********** 20
59 ******* 14
60 ****** 11
61 ********* 17
62 ******* 13
63 ****** 11
64 **** 7
65 * 1
66 ** 3
67 * 1
68 ** 4
69 *** 6
70
71 *** 5
72 * 2
73 * 2
74
75 * 1
76 * 2
77
78
79 * 1
```

Equivalent sound level = 58.5 dB.

FIGURE B-6 Background ambient sound level data
Location: 3
Date: February 5, 1976
Time: 1325

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 71.8 | 76 | 66 | 56 |
| 63 | 61.3 | 63 | 53 | 47 |
| 125 | 62.0 | 61 | 50 | 46 |
| 250 | 58.1 | 56 | 45 | 40 |
| 500 | 56.6 | 53 | 42 | 38 |
| 1000 | 53.8 | 52 | 39 | 35 |
| 2000 | 49.7 | 48 | 36 | 35 |
| 4000 | 44.1 | 43 | 34 | 34 |
| 8000 | 40.8 | 36 | 35 | 34 |
| A-WT. | 59.6 | 58 | 47 | 42 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 42 |
| 90 | 42 |
| 85 | 43 |
| 80 | 43 |
| 75 | 44 |
| 70 | 44 |
| 65 | 45 |
| 60 | 46 |
| 55 | 46 |
| 50 | 47 |
| 45 | 48 |
| 40 | 48 |
| 35 | 49 |
| 30 | 50 |
| 25 | 51 |
| 20 | 52 |
| 15 | 54 |
| 10 | 58 |
| 5 | 64 |

FIGURE B-6 Continued

```
                  Sound Level (A-Weighting) in dB re 20 µN/m²

40  *  2
41  ************  31
42  *************************  71
43  ***************************************  113
44  **************************  75
45  *********************  60
46  **************************  73
47  **********************  62
48  *********************  59
49  *********************  58
50  ****************  45
51  ***************  40
52  **************  37
53  **********  26
54  ******  16
55  *****  14
56  ****  11
57  *****  13
58  **  6
59  **  5
60  ****  10
61  ****  12
62  **  6
63  **  6
64  **  5
65  **  6
66  ***  7
67  *  3
68  **  4
69  **  4
70  *  3
71  *  2
72  **  4
73  **  4
74  *  1
75  *  2
76
77  *  2
78
79  *  1
80  *  1
```

Equivalent Sound Level = 59.6 dB

FIGURE B-7 Background ambient sound level data
Location: 4
Date: February 4, 1976
Time: 1940

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 68.0 | 72 | 63 | 57 |
| 63 | 56.8 | 59 | 51 | 47 |
| 125 | 63.0 | 61 | 54 | 46 |
| 250 | 56.7 | 55 | 51 | 41 |
| 500 | 50.0 | 49 | 43 | 37 |
| 1000 | 47.7 | 47 | 35 | 34 |
| 2000 | 44.2 | 44 | 34 | 34 |
| 4000 | 41.1 | 39 | 34 | 34 |
| 8000 | 36.9 | 34 | 34 | 34 |
| A-WT. | 55.1 | 55 | 47 | 41 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 38 |
| 90 | 41 |
| 85 | 46 |
| 80 | 46 |
| 75 | 47 |
| 70 | 47 |
| 65 | 47 |
| 60 | 47 |
| 55 | 47 |
| 50 | 47 |
| 45 | 48 |
| 40 | 48 |
| 35 | 48 |
| 30 | 49 |
| 25 | 49 |
| 20 | 50 |
| 15 | 52 |
| 10 | 55 |
| 5 | 59 |

FIGURE B-7 Continued

Sound Level (A-Weighting) in dB re 20 μN/m²

```
37  ***  17
38  ******  34
39  ***  17
40  ***  14
41  **  12
42  **  9
43  **  9
44  *  5
45  *  5
46  *************  73
47  **********************************************  271
48  ***************************  161
49  ************  70
50  *****  27
51  ****  21
52  *****  25
53  ***  16
54  ****  19
55  ***  17
56  ***  14
57  **  8
58  **  10
59  **  7
60  *  3
61  **  8
62  *  1
63  *  6
64  *  5
65  *  1
66  *  2
67  *  3
68  *  3
69  *  2
70  *  1
71
72  *  1
73
74  *  1
75  *  2
```

Equivalent sound level = 55.1 dB

FIGURE B-8 Background ambient sound level data
Location: 5
Date: February 4, 1976
Time: 2030

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 72.7 | 75 | 71 | 69 |
| 63 | 57.2 | 60 | 55 | 52 |
| 125 | 57.3 | 55 | 47 | 44 |
| 250 | 52.0 | 47 | 40 | 38 |
| 500 | 49.5 | 45 | 36 | 35 |
| 1000 | 49.3 | 45 | 34 | 34 |
| 2000 | 46.4 | 42 | 34 | 34 |
| 4000 | 41.3 | 35 | 34 | 34 |
| 8000 | 36.5 | 34 | 34 | 34 |
| A-WT. | 54.6 | 51 | 41 | 40 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 39 |
| 90 | 40 |
| 85 | 40 |
| 80 | 40 |
| 75 | 40 |
| 70 | 40 |
| 65 | 41 |
| 60 | 41 |
| 55 | 41 |
| 50 | 41 |
| 45 | 42 |
| 40 | 42 |
| 35 | 43 |
| 30 | 43 |
| 25 | 44 |
| 20 | 45 |
| 15 | 48 |
| 10 | 51 |
| 5 | 58 |

FIGURE B-8 Continued

Sound Level (A-Weighting) in dB re 20 $N/m^2$

```
38  *  2
39  **************  54
40  ********************************************  173
41  *********************************************  180
42  *******************  74
43  ***************  57
44  *********  33
45  ********  29
46  *****  18
47  ****  16
48  *****  20
49  **  5
50  **  5
51  ***  12
52  **  7
53  ***  9
54  **  5
55  *  3
56  *  3
57  *  4
58  *  4
59  **  5
60  *  3
61  **  5
62  **  5
63  *  3
64  **  5
65  *  3
66  *  1
67
68
69  *  2
70  *  1
71  *  1
72
73  *  1
74
75  *  1
76
77  *  1
```

Equivalent sound level = 54.6 dB

FIGURE B-9 Background ambient sound level data
Location: 1
Date: February 4, 1976
Time: 2305

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 74.9 | 78 | 73 | 70 |
| 63 | 71.9 | 73 | 71 | 70 |
| 125 | 72.4 | 74 | 73 | 68 |
| 250 | 69.0 | 71 | 69 | 65 |
| 500 | 66.6 | 70 | 65 | 61 |
| 1000 | 57.4 | 59 | 57 | 55 |
| 2000 | 58.4 | 60 | 58 | 55 |
| 4000 | 52.2 | 54 | 52 | 49 |
| 8000 | 46.1 | 47 | 46 | 45 |
| A-WT. | 67.9 | 70 | 68 | 64 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 63 |
| 90 | 64 |
| 85 | 64 |
| 80 | 64 |
| 75 | 65 |
| 70 | 66 |
| 65 | 67 |
| 60 | 67 |
| 55 | 67 |
| 50 | 68 |
| 45 | 68 |
| 40 | 68 |
| 35 | 68 |
| 30 | 68 |
| 25 | 68 |
| 20 | 69 |
| 15 | 69 |
| 10 | 70 |
| 5 | 71 |

FIGURE B-9 Continued

Sound Level (A-Weighting) in dB re 20 μN/m²

```
62  ***  16
63  ***********  65
64  *******************  109
65  ***********  64
66  ********  45
67  *********************  126
68  *********************************************  269
69  ******************  106
70  ******  31
71  ******  31
72  ****  19
73  **  10
74  *  3
75  *  2
76  *  2
77  *  1
78
79  *  1
```

FIGURE B-10 Background ambient sound level data
Location: 3
Date: February 5, 1976
Time: 0030

| Octave Band Hz. | $L_{eq}$ dB | $L_{10}$ | $L_{50}$ | $L_{90}$ |
|---|---|---|---|---|
| 31.5 | 54.1 | 59 | 50 | 46 |
| 63 | 48 | 53 | 40 | 37 |
| 125 | 45.5 | 50 | 39 | 35 |
| 250 | 35.8 | 41 | 31 | 28 |
| 500 | 35.4 | 41 | 29 | 26 |
| 1000 | 31.4 | 37 | 25 | 24 |
| 2000 | 27.1 | 31 | 24 | 24 |
| 4000 | 30 | 31 | 30 | 29 |
| 8000 | 24 | 24 | 24 | 24 |
| A-WT. | 38.7 | 44 | 35 | 33 |

Cumulative Distribution

| (%) Exceeded | Sound Pressure Level-dB |
|---|---|
| 95 | 32 |
| 90 | 33 |
| 85 | 33 |
| 80 | 33 |
| 75 | 33 |
| 70 | 34 |
| 65 | 34 |
| 60 | 34 |
| 55 | 34 |
| 50 | 35 |
| 45 | 35 |
| 40 | 35 |
| 35 | 36 |
| 30 | 36 |
| 25 | 37 |
| 20 | 40 |
| 15 | 43 |
| 10 | 44 |
| 5 | 45 |

FIGURE B-10 Continued

Sound Level (A-Weighting) in dB re 20 μN/m²

```
31  *  1
32  **********  47
33  *****************************************  202
34  ****************************************  196
35  ************************  116
36  ****************  79
37  ********  37
38  ****  19
39  ***  13
40  ****  18
41  ***  11
42  ****  20
43  *******  33
44  ************  60
45  ******  28
46  **  10
47  **  8
48  *  2
```

Equivalent sound level = 38.7 dB

## APPENDIX C

## VEGETATION OCCURRING ON THE FIVE ISLANDS IN COASTAL LOUISIANA*

*Source: Reese and Thieret, 1966.

# APPENDIX C

## VEGETATION OCCURRING ON THE FIVE ISLANDS IN COASTAL LOUISIANA

The following list includes 92 species of bryophytes, 14 species of pteridophytes, 2 species of gymnosperms, 110 species of monocotyledons, and 280 species of dicotyledons.

Among the monocotyledons, the families with most species present on the islands are Gramineae (56) and Cyperaceae (24); among the dicotyledons the largest families are the Compositae (45) and Leguminosae (26). Genera with the largest number of species are *Fissidens* (12), *Cyperus* (10), *Panicum* (8), and *Carex* (8).

Collections were made only on the islands - not in the encircling marshlands. No effort was made to include those plants persisting in abandoned plantings (e.g., *Thuja orientalis* and *Pittosporum tobira*), but "naturalized" cultivated species are listed.

1. MUSCI

Fissidentaceae

- *Fissidens bryoides* Hedw.
- *Fissidens cristatus* Wils.
- *Fissidens falcatulus* Ren. & Card.
- *Fissidens garberi* Lesq. & James
- *Fissidens hallii* Aust.
- *Fissidens kegelianus* C. Müll.
- *Fissidens minutulus* Sull.
- *Fissidens pellucidus* Hornsch.
- *Fissidens ravenelii* Sull.
- *Fissidens subbasilaris* Hedw.
- *Fissidens taxifolius* Hedw.
- *Fissidens viridulus* (Web. & Mohr) Wahlenb.

Ditrichaceae

- *Bruchia texana* Aust.
- *Ditrichum pallidum* (Hedw.) Schimp.
- *Trematodon longicollis* Michx.

Dicranaceae

*Dicranella heteromalla* (Hedw.) Schimp.
var. *orthocarpa* (Hedw.) Par.

Leucobryaceae

*Leucobryum albidum* (Brid.) Lindb.

Calymperaceae

*Syrrhopodon incompletus* Schwaegr.
*Syrrhopodon parasiticus* (Sw.) Besch.
*Syrrhopodon texanus* Sull.

Pottiaceae

*Barbula cruegeri* Sond. ex C. Müll.
*Desmatodon plinthobius* Sull. & Lesq.
*Weissia controversa* Hedw.

Grimmiaceae

*Hedwigia ciliata* (Hedw.) P. Beauv.
*Ptychomitrium incurvum* (Mühl.) Sull.

Funariaceae

*Funaria serrata* Brid.
*Physcomitrium pyriforme* (Hedw.) De Not.

Erpodiaceae

*Solmsiella biseriata* (Aust.) Steere

Bartramiaceae

*Philonotis* sp.
*Philonotis glaucescens* (Hornsch.) Par.

Bryaceae

*Bryum* sp.
*Bryum capillare* Hedw.
*Bryum coronatum* Schwaegr.

Mniaceae

*Mnium affine* Bland

Amblystegiaceae

*Amblystegium varium* (Hedw.) Lindb.

Cumpylium chrysophyllum (Brid.) J. Lange
var. brevifolium (Ren. & Card.) Grout

Brachytheciaceae

Brachythecium serrulatum (Hedw.) Robins.
Bryoandersonia illecebra (Hedw.) Robins.
Chamberlainia acuminata (Hedw.) Grout
Eurhynchium hians (Hedw.) Jaeg. & Sauerb.

Climaciaceae

Climacium kindbergii (Ren. & Card.) Grout

Entodontaceae

Entodon cladorrhizans (Hedw.) C. Müll.
Entodon macropus (Hedw.) C. Müll.
Entodon seductrix (Hedw.) C. Müll.

Hypnaceae

Isopterygium micans (Sw.) Broth. var. micans
Isopterygium micans (Sw.) Broth. var. fulvum (Hook. & Wils.) Par.
Platygyrium repens (Brid.) B.S.G.
Taxiphyllum geophilum (Aust.) Fleisch.

Plagiotheciaceae

Plagiothecium sp.

Sematophyllaceae

Sematophyllum adnatum (Michx.) Britt.

Leskeaceae

Anomodon attenuatus (Hedw.) Hub.
Anomodon rostratus (Hedw.) Schimp.
Haplocladium microphyllum (Hedw.) Broth.
Herpetineurum toccoae (Sull. & Lesq.) Card.
Leskea australis Sharp
Thelia hirtella (Hedw.) Sull.
Thuidium allenii Aust.
Thuidium delicatulum (Hedw.) B.S.G.
Thuidium minutulum (Hedw.) B.S.G.

Hookeriaceae

Callicostella pallida (Hornsch.) Angstr.

Cyclodictyon varians (Sull.) Kuntze

Meteoriaceae

Papillaria nigrescens (Hedw.) Jaeg. & Sauerb.

Pterobryaceae

Pireella pohlii (Schwaegr.) Card.

Leucodontaceae

Forsstroemia trichomitria (Hedw.) Lindb.

Leucodon julaceus (Hedw.) Sull.

Cryphaeaceae

Cryphaea glomerata Schimp. ex Sull.

Cryphaea nervosa (Hook. & Wils.) B.S.G.

Fabroniaceae

Anacamptodon splachnoides (Fröhl.) Brid.

Clasmatodon parvulus (Hampe) Hook. & Wils.

Schwetschkeopsis denticulata (Sull.) Broth.

Polytrichaceae

Atrichum angustatum (Brid.) B.S.G.

2. HEPATICAE

Scapaniaceae

Scapania nemorosa (L.) Dum.

Plagiochilaceae

Plagiochila sp.

Lophocoleaceae

Lophocolea heterophylla (Schrad.) Dum.

Odontoschismaceae

Odontoschisma prostratum (Sw.) Trev.

Calypogeiaceae

Calypogeia fissa (L.) Raddi

Radulaceae

*Radula australis* Aust.

Porellaceae

*Porella* sp.

*Porella pinnata* L.

Frullaniaceae

*Frullania* sp.

*Frullania eboracensis* Gott.

Lejeuneaceae

*Euosmolejeunea duriuscula* (Nees) Evans

*Leptocolea cardiocarpa* (Mont.) Evans

*Leucolejeunea unciloba* (Lindb.) Evans

*Microlejeunea laetevirens* (Nees & Mont.) Evans

Pallaviciniaceae

*Pallavicinia lyellii* (Hook.) Gray

Sphaerocarpaceae

*Sphaerocarpus texanus* Aust.

Marchantiaceae

*Dumortiera hirsuta* (Sw.) Nees

Ricciaceae

*Riccia* sp.

*Riccia fluitans* L.

*Ricciocarpus natans* (L.) Corda

3. ANTHOCEROTAE

Anthocerotaceae

*Anthoceros punctatus* L.

4. PTERIDOPHYTA

Ophioglossaceae

*Botrychium dissectum* Spreng.

Osmundaceae

*Osmunda regalis* L.

Schizaeaceae

Lygodium japonicum (Thunb.) Sw.

Polypodiaceae

Asplenium platyneuron (L.) Oakes
Athyrium filix-foemina (L.) Roth var. asplenioides (Michx.) Farw.
Diplazium lonchophyllum Kunze
Diplazium pycnocarpon (Spreng.) Broun
Dryopteris normalis C. Chr.
X Dryopteris versicolor (R. St. John) Broun
Onoclea sensibilis L.
Polypodium polypodioides (L.) Watt
Polystichum acrostichoides (Michx.) Schott
Pteris cretica L.
Woodwardia areolata (L.) Moore

Salviniaceae

Azolla caroliniana Willd.

5. GYMNOSPERMAE

Pinaceae

Juniperus virginiana L.
Taxodium distichum (L.) Rich.

6. MONOCOTYLEDONEAE

Typhaceae

Typha sp.

Alismaceae

Sagittaria platyphylla (Engelm.) J. G. Smith

Gramineae

Agrostis scabra Willd.
Alopecurus carolinianus Walt.
Andropogon elliottii Chapm.
Andropogon saccharoides Sw.
Andropogon scoparius Michx.
Aristida longespica Poir.

Aristida oligantha Michx.
Axonopus affinis Chase
Brachiaria platyphylla (Griseb.) Nash
Cynodon dactylon (L.) Pers.
Digitaria sanguinalis (L.) Scop.
Echinochloa colonum (L.) Link
Eleusine indica (L.) Gaertn.
Elymus virginicus L.
Eragrostis bahiensis Schrad.
Eragrostis capillaris (L.) Nees
Eragrostis lugens Nees
Eremochloa ophiuroides (Munro) Hack.
Erianthus giganteus (Walt.) Mühl.
Festuca octoflora Walt.
Hordeum pusillum Nutt.
Leptochloa fascicularis (Lam.) Gray
Leptochloa filiformis (Lam.) Beauv.
Lolium multiflorum Lam.
Oplismenus setarius (Lam.) Roem. & Schult.
Panicum anceps Michx.
Panicum boscii Poir.
Panicum commutatum Schult.
Panicum fasciculatum Sw.
Panicum gymnocarpon Ell.
Panicum lanuginosum Ell.
Panicum microcarpon Mühl.
Panicum xalapense HBK
Paspalum ciliatifolium Michx.
Paspalum convexum Humb. & Bonpl.
Paspalum dilatatum Poir.
Paspalum distichum L.
Paspalum langei (Fourn.) Nash
Paspalum notatum Flügge
Paspalum plicatulum Michx.
Phalaris caroliniana Walt.
Poa annua L.

Poa sylvestris Gray

Polypogon monspeliensis (L.) Desf.

Sacciolepis striata (L.) Nash

Setaria geniculata (Lam.) Beauv.

Setaria magna Griseb.

Sorghum halepense (L.) Pers.

Sphenopholis obtusata (Michx.) Scribn.

Sporobolus poiretii (Roem. & Schult.) Hitchc.

Tridens flavus (L.) Hitchc.

Tridens strictus (Nutt.) Nash

Tripsacum dactyloides (L.) L.

Trisetum pensylvanicum (L.) Beauv.

Uniola laxa (L.) BSP

Uniola sessiliflora Poir.

Cyperaceae

Bulbostylis warei (Torr.) Clarke

Carex blanda Dewey

Carex cephalophora Mühl.

Carex cherokeensis Schw.

Carex flaccosperma Dewey

Carex frankii Kunth

Carex oxylepis Torr. & Hook.

Carex retroflexa Mühl.

Carex tribuloides Wahl.

Cyperus brevifolius (Rottb.) Hassk.

Cyperus cayennensis (Lam.) Britt.

Cyperus compressus L.

Cyperus globulosus Aubl.

Cyperus iria L.

Cyperus retrorsus Chapm.

Cyperus rotundus L.

Cyperus strigosus L.

Cyperus thyrsiflorus Schlect. & Chapm.

Cyperus virens Michx.

Dichromena colorata (L.) Hitchc.

Eleocharis cellulosa Torr.

*Eleocharis montana* (HBK) Roem. & Schult.
*Finbristylis dichotoma* (L.) Vahl
*Fimbristylis spadicea* (L.) Vahl

Palmaceae
*Sabal minor* (Jacq.) Pers.

Araceae
*Arisaema dracontium* (L.) Schott
*Colocasia esculenta* (L.) Schott

Lemnaceae
*Lemna obscura* (Austin) Daubs
*Spirodela oligorrhiza* (Kurtz) Hegelm.
*Spriodela polyrhiza* (L.) Schleid.
*Wolffia arrhiza* (L.) Wimm.
*Wolffia columbiana* Karst.
*Wolffia papulifera* Thompson
*Wolffiella lingulata* (Hegelm.) Hegelm.

Bromeliaceae
*Tillandsia usneoides* L.

Commelinaceae
*Commelina diffusa* Burm. f.
*Tradescantia subaspera* Ker var. *montana* (Shuttlew.) Anders. & Woods.

Pontederiaceae
*Pontederia cordata* L.

Juncaceae
*Juncus acuminatus* Michx.
*Juncus biflorus* Ell.
*Juncus tenuis* Willd.
*Juncus validus* Cov.

Liliaceae
*Allium canadense* L.
*Nothoscordum bivalve* (L.) Britt.
*Smilax bona-nox* L.
*Smilax glauca* Walt.

Smilax hispida Mühl.
Smilax rotundifolia L.
Smilax smallii Morong

Dioscoreaceae

Dioscorea villosa L.

Iridaceae

Sisyrinchium exile Bick.

Cannaceae

Canna indica L.

7. DICOTYLEDONEAE

Saururaceae

Saururus cernuus L.

Salicaceae

Salix nigra L.

Myricaceae

Myrica cerifera L.

Juglandaceae

Carya cordiformis (Wang.) K. Koch
Carya glabra (Mill.) Sweet
Carya illinoensis (Wang.) K. Koch
X Carya lecontei Little
Juglans nigra L.

Corylaceae

Carpinus caroliniana Walt.

Fagaceae

X Quercus comptonae Sarg.
Quercus falcata Michx. var. pagodaefolia Ell.
Quercus nigra L.
Quercus prinus L.
Quercus virginiana Mill.

Ulmaceae

Celtis laevigata Willd.
Ulmus alata Michx.

Ulmus americana L.
Ulmus rubra Mühl.

Moraceae

Morus rubra L.

Urticaceae

Boehmeria cylindrica (L.) Willd.
Laportea canadensis (L.) Wedd.
Parietaria pensylvanica Mühl.
Pilea pumila (L.) Gray
Urtica chamaedryoides Pursh

Loranthaceae

Phoradendron serotinum (Raf.) M. C. Johnston

Polygonaceae

Brunnichia cirrhosa Gaertn.
Polygonum aviculare L.
Polygonum cristatum Engelm. & Gray
Polygonum densiflorum Meisn.
Polygonum hydropiperoides Michx.
Polygonum punctatum Ell.
Rumex crispus L.
Rumex pulcher L.
Rumex verticillatus L.
Tovara virginiana (L.) Raf.

Chenopodiaceae

Chenopodium ambrosioides L.
Chenopodium berlandieri Moq. var. boscianum (Moq.) Wahl

Amaranthaceae

Alternanthera philoxeroides (Mart.) Standl.
Amaranthus palmeri S. Wats.
Amaranthus viridis L.

Phytolaccaceae

Phytolacca americana L.
Rivina humilis L.

Aizoaceae

*Mollugo verticillata* L.

Portulacaceae

*Portulaca oleracea* L.

Caryophyllaceae

*Cerastium glomeratum* Thuill.

*Sagina decumbens* (Ell.) Torr. & Gray

*Stellaria media* (L.) Cyr.

*Stellaria prostrata* Ell.

Nymphaeaceae

*Nelumbo lutea* (Willd.) Pers.

Ceratophyllaceae

*Ceratophyllum demersum* L.

Ranunculaceae

*Clematis virginiana* L.

*Ranunculus muricatus* L.

*Ranunculus platensis* Spreng.

*Ranunculus pusillus* Poir.

*Ranunculus recurvatus* Poir.

Menispermaceae

*Calycocarpum lyonii* (Pursh) Gray

*Cocculus carolinus* (L.) DC

Magnoliaceae

*Magnolia grandiflora* L.

Annonaceae

*Asimina triloba* (L.) Dunal

Lauraceae

*Cinnamomum camphora* Nees & Eberm.

*Lindera benzoin* (L.) Blume

*Persea borbonia* (L.) Spreng.

*Sassafras albidum* (Nutt.) Nees

Fumariaceae

*Corydalis micrantha* (Engelm.) Gray ssp. *australis* (Chapm.) G.B. Ownbey

Cruciferae

Coronopus didymus (L.) Sm.
Lepidium virginicum L.
Rorippa islandica (Oeder) Borbas

Saxifragaceae

Penthorum sedoides L.

Hamamelidaceae

Liquidambar styraciflua L.

Rosaceae

Crataegus viridis L.
Duchesnea indica (Andrz.) Focke
Geum canadense Jacq.
Prunus caroliniana (Mill.) Ait.
Prunus serotina Ehrh.
Prunus umbellata Ell.
Rubus louisianus Berger
Rubus trivialis Michx.
Rosa bracteata Wendl.

Leguminosae

Alysicarpus vaginalis (L.) DC
Apios americana Medic.
Cassia fasciculata Michx.
Cassia nictitans L.
Cassia occidentalis L.
Cassia tora L.
Centrosema virginianum (L.) Benth.
Crotalaria spectabilis Roth
Desmanthus illinoensis (Michx.) MacM.
Desmodium ciliare (Mühl.) DC
Desmodium sessilifolium (Torr.) Torr. & Gray
Dolicholus minimus (L.) Medic.
Erythrina herbacea L.
Galactia volubilis (L.) Britt.
Gleditsia triacanthos L.
Lespedeza cuneata (Dumont) G. Don

*Lespedeza striata* (Thunb.) Hook. & Arn.
*Medicago arabica* (L.) Huds.
*Melilotus albus* Desr.
*Melilotus indicus* L.
*Neptunia pubescens* Benth.
*Pueraria lobata* (Willd.) Ohwi
*Sesbania macrocarpa* Mühl.
*Sesbania vesicaria* (Jacq.) Ell.
*Trifolium repens* L.
*Vicia ludoviciana* Nutt.

Oxalidacene

*Oxalis dillenii* Jacq. var. *radicans* Shinners

Geraniaceae

*Geranium carolinianum* L.

Rutaceae

*Poncirus trifoliata* (L.) Raf.
*Ptelea trifoliata* L.
*Xanthoxylum clava-herculis* L.

Meliaceae

*Melia azedarach* L.

Euphorbiaceae

*Caperonia palustris* (L.) St. Hil.
*Croton capitatus* Michx.
*Croton glandulosus* L.
*Euphorbia heterophylla* L.
*Euphorbia maculata* L.
*Euphorbia supina* Raf.
*Phyllanthus urinaria* L.

Callitrichaceae

*Callitriche deflexa* A. Br.
*Callitriche heterophylla* Pursh

Anacardiaceae

*Rhus copallina* L.
*Rhus radicans* L.

Aquifoliaceae

*Ilex decidua* Walt.
*Ilex opaca* Ait.
*Ilex vomitoria* Ait.

Celastraceae

*Euonymus americanus* L.

Aceraceae

*Acer drummondii* Hook. & Arn.

Hippocastanaceae

*Aesculus pavia* L.

Rhamnaceae

*Berchemia scandens* (Hill) K. Koch
*Rhamnus caroliniana* Walt.

Vitaceae

*Ampelopsis arborea* (L.) Koehne
*Ampelopsis cordata* Michx.
*Cissus incisa* (Nutt.) Des Moulins
*Parthenocissus quinquefolia* (L.) Planch.
*Vitis cinerea* Engelm.
*Vitis rotundifolia* Michx.

Tiliaceae

*Corchorus aestuans* L.
*Tilia americana* L.

Malvaceae

*Abutilon hulseanum* (Torr. & Gray) Torr.
*Malachra capitata* L.
*Modiola caroliniana* (L.) G. Don
*Sida rhombifolia* L.

Sterculiaceae

*Melochia corchorifolia* L.

Guttiferae

*Ascyrum hypericoides* L.

Hypericum drummondii (Grev. & Hook.) Torr. & Gray
Hypericum tubulosum Walt. var. walteri (Gmel.) Lott

Violaceae

Viola langloisii Greene

Passifloraceae

Passiflora incarnata L.
Passiflora lutea L.

Lythraceae

Ammannia coccinea Rottb.
Cuphea carthagenensis (Jacq.) Macbr.

Nyssaceae

Nyssa aquatica L.

Onagraceae

Ludwigia leptocarpa (Nutt.) Hara
Ludwigia palustris (L.) Ell. var. americana (DC) Fern. & Grisc.
Oenothera laciniata Hill

Araliaceae

Aralia spinosa L.

Umbelliferae

Apium leptophyllum (Pers.) F. Muell.
Centella erecta (L.f.) Fern.
Cryptotaenia canadensis (L.) DC
Eryngium prostratum Nutt.
Hydrocotyle bonariensis Lam.
Hydrocotyle ranunculoides L.f.
Hydrocotyle verticillata Thunb.
Ptilimnium capillaceum (Michx.) Raf.
Sanicula canadensis L.
Trepocarpus aethusae Nutt.

Cornaceae

Cornus drummondii C. Mey.
Cornus florida L.

Primulaceae

*Centunculus minimus* L.

*Lysimachia japonica* Thunb.

*Samolus parviflorus* Raf.

Sapotaceae

*Bumelia lanuginosa* (Michx.) Pers.

Ebenaceae

*Diospyros virginiana* L.

Styraceae

*Styrax americana* Lam.

Oleaceae

*Fraxinus pennsylvanica* Marsh.

*Ligustrum villosum* May

Loganiaceae

*Gelsemium sempervirens* (L.) Ait.

*Polypremum procumbens* L.

Gentianaceae

*Sabatia campestris* Nutt.

Apocynaceae

*Amsonia tabernaemontana* Walt.

Asclepiadaceae

*Gonolobus gonocarpus* (Walt.) Perry

Convolvulaceae

*Dichondra repens* Forst.

*Ipomoea pandurata* (L.) G. Mey

*Ipomoea purpurea* (L.) Roth.

*Jacquemontia tamnifolia* (L.) Griseb.

Hydrophyllaceae

*Nemophila microcalyx* (Nutt.) Fisch. & Mey.

*Phacelia hirsuta* Nutt.

Boraginaceae

*Heliotropium indicum* L.

*Myosotis macrosperma* Engelm.

Verbenaceae

<u>Callicarpa</u> <u>americana</u> L.

<u>Lantana</u> <u>camara</u> L.

<u>Lippia</u> <u>lanceolata</u> Michx.

<u>Lippia</u> <u>nodiflora</u> (L.) Michx.

<u>Verbena</u> <u>bonariensis</u> L.

<u>Verbena</u> <u>littoralis</u> HBK

<u>Verbena</u> <u>urticifolia</u> L.

<u>Verbena</u> <u>xutha</u> Lehm.

Labiatae

<u>Clinopodium</u> <u>gracile</u> (Benth.) O. Ktze.

<u>Hedeoma</u> <u>hispida</u> Pursh

<u>Leonurus</u> <u>sibiricus</u> L.

<u>Lycopus</u> <u>rubellus</u> Meonch

<u>Monarda</u> <u>punctata</u> L.

<u>Perilla</u> <u>frutescens</u> (L.) Britt.

<u>Salvia</u> <u>lyrata</u> L.

<u>Scutellaria</u> <u>ovata</u> Hill

<u>Stachys</u> <u>agraria</u> Cham. & Schl.

<u>Stachys</u> <u>tenuifolia</u> Willd.

Solanaceae

<u>Physalis</u> <u>angulata</u> L.

<u>Solanum</u> <u>aculeatissimum</u> Jacq.

<u>Solanum</u> <u>carolinense</u> L.

<u>Solanum</u> <u>pseudo-capsicum</u> L.

Scrophulariaceae

<u>Bacopa</u> <u>monnieri</u> (L.) Penn.

<u>Gratiola</u> <u>neglecta</u> Torr.

<u>Gratiola</u> <u>virginiana</u> L.

<u>Linaria</u> <u>texana</u> Scheele

<u>Micranthemum</u> <u>umbrosum</u> (Walt.) Blake

<u>Scrophularia</u> <u>marilandica</u> L.

<u>Verbascum</u> <u>thapsus</u> L.

<u>Veronica</u> <u>peregrina</u> L.

Bignoniaceae

*Bignonia capreolata* L.
*Campsis radicans* (L.) Seem.

Acanthaceae

*Hygrophila lacustris* (Schl.) Nees
*Dianthera lanceolata* (Chapm.) Small
*Ruellia caroliniensis* (Walt.) Steud.

Phrymaceae

*Phryma leptostachya* L.

Plantaginaceae

*Plantago major* L.
*Plantago virginica* L.

Rubiaceae

*Cephalanthus occidentalis* L.
*Diodia teres* Walt.
*Diodia virginiana* L.
*Galium pilosum* Ait.
*Galium tinctorium* L.
*Hedyotis uniflora* (L.) Lam.

Caprifoliaceae

*Lonicera japonica* Thunb.
*Sambucus canadensis* L.

Cucurbitaceae

*Cucumis melo* L. var. *dudaim* Naud.
*Sicyos angulatus* L.

Compositae

*Actinomeris alternifolia* (L.) DC
*Ambrosia psilostachya* DC
*Ambrosia artemisiifolia* L.
*Anthemis cotula* L.
*Aster cordifolius* L.
*Baccharis angustifolia* Michx.

Bidens bipinnata L.
Calyptocarpus vialis Less.
Cirsium horridulum Michx.
Cirsium muticum Michx.
Crepis japonica (L.) Benth.
Eclipta alba (L.) Hassk.
Erigeron canadensis L.
Erigeron philadelphicus L.
Erigeron strigosus Mühl.
Eupatorium capillifolium (Lam.) Small
Eupatorium coelestinum L.
Eupatorium incarnatum Walt.
Eupatorium rugosum Houtt.
Eupatorium serotinum Michx.
Euthamia leptocephala (Torr. & Gray) Greene
Gnaphalium obtusifolium L.
Gnaphalium peregrinum Fern.
Gymnostyles anthemifolia A. Juss.
Helenium amarum (Raf.) Rock
Hieracium gronovii L.
Krigia oppositifolia Raf.
Melanthera carpenteri Small
Mikania cordifolia (L.) Willd.
Mikania scandens (L.) Willd.
Parthenium hysterophorus L.
Pluchea camphorata (L.) DC
Pluchea rosea Godfrey
Polymnia uvedalia L.
Pyrrhopappus carolinianus (Walt.) DC
Rudbeckia triloba L.
Senecio glabellus Poir.
Solidago altissima L.
Soliva pterosperma (Juss.) Less.
Sonchus asper (L.) Hill

*Sonchus oleraceus* L.
*Verbesina virginica* L.
*Vernonia altissima* Nutt.
*Xanthium chinense* Mill.

# APPENDIX D
# CULTURAL RESOURCE SURVEY
# OF THE MINE WORKS AREA
# OF COTE BLANCHE ISLAND, LOUISIANA

# INTRODUCTION

Archival work and field studies for this survey were accomplished by Dr. Sherwood Gagliano of Baton Rouge, Louisiana under contract to FEA.

As part of the National Strategic Reserve Program, the Federal Energy Administration proposes to convert several existing mine sites in the United States for crude oil storage. The Domtar Mine at Cote Blanche Island, south-central Louisiana, is one of the candidates for this program.

The salt mine is part of the Strategic Petroleum Reserve Program and is expected to be in the process of receiving oil by January of 1979. The existing mine will be converted for storage and a new mine will be developed for Domtar on the salt dome at a shallower depth. Most of the project activity will be underground; however, approximately 20 to 25 surface acres near the existing mines will be needed for such facilities as headframes and hoisting equipment, conveyor belts, barge docks, pipelines and manifolds, electric power substations, etc. No extensive right-of-way will be required for distribution pipelines, utility corridors, access roads or other purposes.

The two main objectives of the archaeological study were: 1) to conduct a total cultural resource survey of the land within the proposed construction areas; and 2) to evaluate the likelihood of finding important sites in the vicinity (within 1/4 mile of the proposed sites). These objectives were accomplished by first conducting an archival review of historic and archaeological materials related to the island and surrounding area, followed by an intensive field survey of the construction site and a reconnaissance survey of parts of the island near the site.

We wish to extend our thanks to Mr. Jack Tufts and Mr. Bill Burke of Domtar, for assistance during the field survey. We are particularly grateful to Mr. Tom Powell, local resident, for providing information regarding archaeological sites and finds on the Island.

## COASTAL LOUISIANA CULTURE SEQUENCE

The sequence of culture recorded in the archaeological record of south Louisiana (Figure D-1 and Table D-1) generally reflects changes that occurred through time in the broad area of eastern North America. Over a period of years, a temporal sequence has gradually been assembled by the piecing together of data from excavated sites, through site surveys, and by the relating of local assemblages and index artifacts to established chronologies in neighboring areas. The sequence reveals a cultural growth from small migratory bands of hunters to agricultural societies of tribes, inhabiting towns and building temples. These changes are generally reflected in the sites of the south-central Louisiana region.

Earliest evidence of man's activity within this region comes from a thick sequence of deposits filling an ancient solution pond on the surface of a salt dome island in south-central Louisiana. Avery Island, where the site occurs, is one of the five salt dome "islands" lying within the coastal marshes of the area. Salt deposits, once exposed on the surface of the dome, attracted large numbers of animals. A rich assemblage, including 11 extinct forms of Pleistocene vertebrates, occurs at the site. Associated with these fossils, stone tools crudely fashioned by a primitive bipolar technique of chipping from chert stream pebbles have been found. Radiocarbon dates indicate that the artifacts are a minimum of 11,500 years old. A bone projectile point, wooden artifacts, cordage and basketry fragments have been found in the brine-saturated deposits. The primitive nature of the stone technology and apparent association with large extinct animals suggest small bands of wandering hunters.

During the time interval of 12,000 to 8,000 years ago, specialized big-game hunting culture became widespread in the New World. Spread of this Paleo-Indian Culture can be traced by very distinctive projectile point forms (Clovis, Folsom, Quad, Dalton, Plainview, Scottsbluff, etc.). These easily identifiable points have a wide distribution throughout North America, and Louisiana is no exception. The pattern is believed to be significant. They have been found associated with relict point bars, natural levees, crevasse channels, and other features related to an oil course of the Mississippi River in south-central Louisiana. These features are best exposed on the Prairie Terrace surface in St. Landry, Lafayette, Iberia, and Vermilion Parishes. The site associations suggest that Paleo-Indian peoples were utilizing the river banks and neighboring environments which have subsequently been abandoned and greatly modified as a result of structural tilting. Bones of large, now-extinct Pleistocene vertebrates (mastodon, mammoth, ground sloth, etc.) also occur in the alluvial and backswamp deposits of the terrace and are believed to have been contemporaries of the Paleo-Indian peoples.

Scattered finds of Paleo-Indian-type fluted points have also been made in the higher and older terracelands. These occur along streams and often in places where stream gravel is abundant. This pattern continues into Early and Middle Archaic times. Through time, the assemblage of chipped artifacts becomes more varied. Numerous stemmed and notched projectile points appear, along with specialized scraping and cutting tools, drills, choppers, and woodworking tools such as gouges and scrapers.

The Late Archaic is characterized by development of highly specialized hunting-gathering cultures. These people probably followed the practice of the annual round, occupying one site for a few months during the season when the local environments gave the greatest food yield and then moving to another site. During this period, we see indications of greater social organization. A circular midden some 550 feet in diameter located just east of the Mississippi Delta on the Pearl River estuary provides one clue of greater organization. A cemetery site on Pecan Island, in the marginal delta plain, provides another. There is also increasing evidence of construction of small conical earth mounds over cremation platforms during this period. Hunting and fishing tools become even more specialized with the appearance of ground and polished atlatl weights (winged, prismatic, and cylindrical forms) and plummets (also bar weights and gorgets). There is increased evidence of trade in the form of rocks and minerals brought into the region from distant sources.

It is during this period that we find the first truly coastal habitation sites. This does not imply that during earlier intervals man was not a resident of the coastal area. It does emphasize, however, that in the low-lying deltaic coast, the early archaeological record has been lost or obscured by the combined effects of the recent rise in sea level and rapid subsidence and sedimentation. In the deltaic plain itself, sites more than about 4,000 years old are either buried or drowned. This realization has been utilized during the past 10 years in efforts to extend the known chronology back in time. The search for early sites has been concentrated on the terracelands and salt dome islands with considerable success.

The Poverty Point Culture can be considered either as an Archaic-Formative transition or as an Archaic climax in the area. One theory (Gibson, 1974) suggests that it was during this time that the first chiefdom was established. The concept of the circular village was continued and is recorded from a site on the Pearl River. Other shell middens, usually buried and exposed by wave erosion or canal construction, are known from the coast. The stone assemblage indicates participation in a widespread and well-organized trading network. Copper from the Great Lakes, quartz crystals, novaculite, hematite, and magnetite from Missouri and Arkansas, gray chert from Ohio, and steatite from Alabama are a few of the distinctive trade items that appear in the sites. Molded clay balls and soapstone pots were used for cooking. The clay "Poverty Point objects" are the hallmark of the period. A large tool assemblage -- virtually an inventory of most of the stone tools manufactured during the Archaic Period -- is also characteristic and includes numerous stemmed and notched projectile points, atlatl weights, celts, gorgets, stone beads, microflints, etc. It was also during this period that the introduction of pottery occurred. This early pottery is usually fiber tempered (see Figure D-2). Tubular pipes suggest the use of tobacco and perhaps the advent of agriculture. Shellfish remains and bones of deer, small animals, waterfowl, and fish are abundant in the sites, and it is likely that specialized hunting-fishing-gathering remained the basis of the economy of these groups.

The Tchefuncte Period is represented by over 50 shell middens in the coastal area and a number of conical mound sites. The shell middens are located in two general areas: in the Pontchartrain Basin and around

Grand Lake. Another major concentration appears to be situated along the middle reaches of the Vermilion River. Habitation of shell middens and a distinctive assemblage of chipped stone, shell, ground stone, bone artifacts, and a few other traits differentiate the coastal sites from Tchefuncte mounds of the alluvial valley. On the coast, burials in the midden become the common way of disposing of the dead. Shell midden habitation and the general artifact assemblage show a continuation of the Archaic pattern in the coastal area. In fact, this pattern continues until historic times in the coastal swamps and marshes. Tchefuncte mound sites are grouped on the west side of the alluvial valley and appear to be related to the Teche course of the Mississippi. The settlement pattern and artifact assemblage of the Late Archaic Period were carried over almost completely into the Tchefuncte Culture. The only difference between late coastal Archaic and Tchefuncte is the introduction of a rather complete ceramic complex in the latter.

By Marskville times, agriculture had certainly become important in the alluvial valley but, in the delta, the fishing-hunting-gathering pattern continued to play a dominant role. However, mounds constructed for burial of the dead on the natural levees during this period are suggestive of a more sedentary way of life. The pottery shows introduction of new motifs, and burial practices are even more formalized. Extended burials in log tombs accompanied by grave offerings and covered by conical earth mounds came into vogue. These new developments are linked with Adena-Hopewell Cultures of the upper Mississippi Valley.

During the Troyville and Coles Creek Periods, the archaeology indicates that a prehistoric population zenith occurred in the delta and alluvial valley. Introduction of new religion is indicated by numerous flat-topped pyramidal temple mounds. These are most often located on the crests of natural levee ridges; they served as the religious nuclei or ceremonial centers for agricultural communities. However, numerous shell middens, often rich in animal bones and water fowl remains, are known from this period. Ceramic designs suggest influences both from the alluvial valley and from the Gulf coastal area to the east. It is curious that there was never a major invasion of the terracelands by ceramic-making peoples, but during this population peak we find some evidence of pottery even in these places.

The Plaquemine Period is identified mainly on the basis of changes in ceramic styles. The basic patterns of settlement, economic organization, and religious practices established during the Troyville and Coles Creek Periods were continued. These patterns, however, were manifest more prominently in a hierarchical socio-political establishment and large ceremonial centers. Maize agriculture became paramount in the economic activities of the Indians, with a scarcity of stone tools and projectile points exemplifying the lithic technology. The Plaquemine Culture can be viewed as an indigenous population creating clay-tempered pottery, but affected by the expanding Mississippian Culture, just beginning to spread south down the Mississippi Valley and westward from the Mobile Bay region, carrying with it the idea of large-scale mound construction and ceremonial centers.

The advent of the Mississippian Period is marked by ceramics decorated with certain "southern cult" or "Death cult" motifs and the introduction of shell-tempered pottery. Distribution of shell-tempered pottery clearly indicates an eastern Gulf coast origin, the maximum percentages occurring around Mobile Bay.

Our knowledge of aboriginal peoples of the area during the Historic Period is based primarily on accounts by the early Spanish and French explorers and missionaries. The Indians of the Louisiana coastal zone were a semi-sedentary people. The tribes along the Mississippi River and the eastern part of the deltaic plain were related culturally to tribes of the Eastern Maize Area of North America, while the people living in the Atchafalaya Basin and southwestern Louisiana were related to the tribes of the Texas coast (Figure D-3). The eastern people lived in relatively permanent villages on the banks of rivers and bayous and practiced slash-burn agriculture. Maize was the most important crop, followed by pumpkins, melons, and beans. These domesticated crops were supplemented by grain of cane and millet, seeds of the palmetto and pond lily, and pecans, acorns, black walnuts, persimmons, wild beans, and fungi. Tobacco was grown for use in rituals and ceremonies.

Hunting was an important activity. Bear and deer were especially sought, but rabbits, squirrels, muskrats, turkeys, ducks, alligators, and all other animals, fowl, and reptiles found in the area were also utilized. The bow was the most important weapon, but cane blowguns were also used for small game. In the coastal area, fishing was a major activity. Coastal shell middens continued to be occupied during historic times. Fish were speared, shot, caught on lines, in traps, and in nets. Fresh and brackish clams were harvested along with crabs and other shellfish. Long, slim dugout canoes fashioned from cypress logs were the principal mode of transportation.

The most common house type was the palmetto hut. Although most were simple pole structures thatched with the broad palmetto leaves, some had mud-plastered "wattle and daub" walls with dome-shaped palmetto roofs.

The practice of mound building continued from prehistoric times. Truncated pyramidal mounds are known from the Tunica Village, the Bayou Goula Village, and other historic sites.

Pots, bowls, and platters were made of clay, utilizing the coiling method. Chipped and ground stone implements were used, but were far less abundant than tools fashioned from wood, bone, and shell. The dressing of skins was important and provided the material for most clothing. Basketry was a highly developed art. The most beautiful baskets were made from split cane. Some of the cane was dyed purple and red and interwoven to create designs. Carrying baskets, "V"-shaped baskets, mats, storage chests, and other specialized forms were made. Utilitarian baskets were also made from split oak.

Linguistically, the coastal Indians fall into two groups: the Tunican and the Muskhogean. The Chitimacha, Atakapa, Opelousa, Chawasha, and Washa made up the Tunican family in the coastal area.

The Chitimacha were a relatively large tribe, occupying the Atchafalaya Basin area, where 15 or more village sites were located. Because the Chitimacha had a long history of association and conflict with the French, much is known of their language and customs. They were outstanding craftsmen and made handsome bracelets, shoulder and breast pieces from copper, and nose ornaments from gold and silver. Their basketry was perhaps the finest in the lower Mississippi Valley. A remnant group of Chitimacha still live near Charenton in St. Mary Parish.

The Atakapa peoples had a reputation for cannibalism among early travelers and explorers. Indeed, the name Atakapa is derived from a Choctaw word meaning "man-eater." Although they may have indulged in some ritualistic form of cannibalism, they were in fact settled agricultural people. The Atakapa settlement remained isolated from European settlers until the end of the eighteenth century. At that time, they were concentrated in three main areas: along the Vermilion River and Bay, along the Mermentau River and its tributaries, and along Calcasieu River and Lake.

Little is known of the Opelousa, Washa, and Chawasha. They were apparently small tribes who migrated frequently. They were probably displaced by encroachment of European settlers and lost their identity through amalgamation with other tribes.

The Muskhogean tribes of the Louisiana coastal zone and vicinity included the Choctaw, Acolapissa, Taensa, Tangipahoa, Avoyel, Okelusa, Bayogoula, Quinipissa, and Houma.

The Acolapissa were living along the Pearl River about 10 to 12 miles from its mouth when the French arrived in Louisiana. In 1702 or 1705, they moved to the north shore of Lake Pontchartrain, where they were joined by the Natchitoche, assigned to the place by the Frenchman St. Denis. For some unknown reason, the Acolapissa massacred many of the Natchitoche. In 1718, the Acolapissa joined other tribes in a new settlement on the banks of the Mississippi, 13 leagues above New Orleans.

When discovered by the French, the Taensa were living on the shore of Lake Joseph in northeastern Louisiana. In 1706, they were forced to move south. They resettled near either Edgard or Manchac. Before 1744, they moved again to the Tensas River, to which they gave their name. They continued to move about periodically. Their last village was located on Bayou Boeuf, where they either died out or became absorbed by other groups.

The Houma were an important tribe noted for their bravery. Tonti states that the Houma Indians were the "bravest savages on the river." Iberville ended his explorations up the Mississippi River at one of their villages in 1699. In 1706, a Tunican tribe settled among the Houma and shortly thereafter carried out a massacre of their hosts. The surviving Houmas, forced to establish a new home, moved to the banks of Bayou St. John, a site presently within the City of New Orleans. After a short period, they moved to Ascension Parish, where they established what were known as the Little and Great Houma villages. The former was on the Mississippi River, a few miles below the head of Bayou Lafourche; the latter was about a mile and a half inland. While occupying these villages, they were joined by remnants of the Bayogoula and Acolapissa tribes. Somewhat later they moved into Terrebonne Parish, where they occupied six settlements. Remnants of the tribe are still found in the area south of Houma, Louisiana.

## LOCATION AND PHYSICAL SETTING OF COTE BLANCHE ISLAND

The Island is a piercement salt dome with marked topographic expression located in the coastal marshes of south-central Louisiana (Figure D-4). It is one of a trend of five such domes in which the salt is at shallow depths or has reached the surface. Pleistocene and older sediments uplifted by the salt plug have created topographic highs which, in the flat prairie and marsh country of the coastal region, stand as anomalous hilly areas. They are not islands in the strict sense of the word, but their relief and vegetation mark them as distinct entities. The domes are, in effect, uplifted plugs of hard "rock" surrounded by coastal marshes.

The Island is approximately two miles in diameter and has a maximum elevation of 92 feet +MSL (Figure D-5). Its topography is highly irregular, with fault-controlled ridges, steep-sided gullies, solution ponds, and radial drainage. These surface features are a direct reflection of movement and near-surface exposure of the underlying salt plug. A distinctive canal pattern around the margin of the island reflects oil and gas production from structural and stratigraphic traps flanking the dome. Canals and slips have been dredged to provide access for barge-mounted drilling rigs. Surface and near-surface sediments, predominantly clayey silts, sands, and gravels, have been described as Pleistocene.

The plug of salt which makes up the island core is extremely old, originally deposited in an ancient Jurassic or Triassic sea millions of years ago. In contrast, most geomorphic features of southern Louisiana are products of relatively recent geological events. The features and surfaces in this region are a direct or indirect result of erosion or sedimentation by the Mississippi River during late Pleistocene.

Large Mississippi River-sized stream scars covering the surface of late Pleistocene deposits in the vicinity of Abbeville, Louisiana, attest to the fact that this terrace was once an active floodplain of the Mississippi. This surface, known as the Prairie terrace, forms a gently southward-sloping plain with negligible surface relief. Belts of meander scars, clearly visible on aerial photographs, are believed to have formed during Paleo-Indian times (12,000 - 8,500 years B.P.) and have associated archaeological sites.

More recent deposits, which accumulated in the last 6,000 or 8,000 years, form a prism of sediments that laps onto the Prairie terrace surface. These relationships are shown diagrammatically in Figure D-6. The contact between Recent coastal marshes and the slightly higher Prairie terrace forms an irregular line trending east-west and passing just north of Avery Island.

Other than salt dome islands, the only high places along this portion of the coast are ridges formed along old shorelines and streams. These relict beach ridges (cheniers) mark successive positions of the Gulf shoreline during minor retreats in a general progradation, which has taken place in the last 3,500 to 4,000 years since sea level reached its present stand. Natural levee ridges form along rivers. Width and meander size of such ridges are indicative of the size of the stream which formed them. A glance at the map of Louisiana will reveal that size and configuration of natural levee ridges along Bayou Teche are comparable to similar features along the present Mississippi River. In fact, Bayou Teche was once the major course of the river. Geological studies have disclosed that the Mississippi occupied this position from about 5,800 to 3,800 years ago. About 3,800 years ago, the river shifted its course to the east side of the alluvial valley.

Many stream scars on the Prairie terrace surface and abandoned distributaries in the coastal marshes indicate not only the important position of the salt dome islands in respect to ancient Mississippi drainage systems, but also the dynamic nature of the surrounding area. It should be noted that in contrast to a regional pattern of rapid deposition and subsidence, the islands are positive features undergoing periodic uplift.

The Island presently enjoys a warm, marine-type climate influenced by its subtropical, coastal location. The mean annual temperature is 69.7° F, and the average precipitation is about 64 inches. Mean surface temperatures along this part of the Louisiana coast range from 64° F in February to 84° F in August.

During summer months, moist tropical air from the south, accompanied by frequent showers, usually dominates the weather pattern. Alternate intrusions of cold continental and warm tropical air dictate local conditions during winter months.

Frost normally occurs between late November and the end of February, but occasionally winters are free from frosts and below-freezing temperatures. Plant growth is favored by the long growing seasons and frost-free days. When first visited by Europeans, the Island was covered with dense forest.

During winter months, the area is occasionally visited by intense fronts, but more significant are tropical hurricanes. These storms are accompanied by heavy winds, storm-induced tides, and torrential rains. Unlike the surrounding lowlands, the island is a haven to animals and man during such storms, but hurricanes pose a great threat to trees on the exposed slopes and hilltops.

The variety of physiographic features on and surrounding the island (Figure D-6) results in a corresponding variety of biotic communities and ecological settings, ranging from upland forests to saline marshes. Each of these different environments offered a unique situation to people with an economy based on hunting and gathering or primitive agriculture. McIntire (1958:29-50) has discussed in detail the elements of prehistoric economy of coastal Louisiana Indians. He identifies some 35 native plant species which were used for food, seasoning, or medicinal purposes. Most of these plants were found on or near the Island. The same situation exists in regard to animals. A high percentage of all species indigenous to south Louisiana can be found within a radius of 15 miles of the Island, including migratory waterfowl, deer, bear, rabbits, small marsh animals, reptiles, freshwater fish, and marine shellfish.

Chert gravel found in salt dome island stream beds was a prized commodity for prehistoric peoples of the coastal area. Other than neighboring salt domes, the nearest source of stone was approximately 70 miles to the north, in older graveliferous Pleistocene terraces.

Even though the gravel is relatively small, it was collected and utilized in the manufacture of projectile points, knives, scrapers, and other chipped stone tools.

Freshwater springs occurred on most of the salt dome islands, but they only flowed during rainy seasons because of the limited catchment area. However, ponds provided a dependable supply of fresh water. Brine springs or seeps, known and utilized by both early European settlers and prehistoric Indians, led to the discovery of rock salt at Avery Island. Considering the many attractions, the salt dome islands are considered to be high probability areas for the occurrence of cultural resources.

## HISTORY OF COTE BLANCHE ISLAND

Although one of Louisiana's least developed salt dome islands, Cote Blanche was once described as "one of the most beautiful and productive sugar plantations in Louisiana" (St. Mary and Franklin Banner, 1959). Old Spanish maps designated the island as "Cap Blanche," but the French name for it was more enduring and descriptively translates as white bluff (although, in Louisiana, cote is also used in reference to the shore of a river).

When John Middleton Huger purchased the island for $240,000 in 1846, he did so with plans to eventually transform it into a resort, and planted live oak, magnolia, sweet and sour orange, pecan, and walnut trees with this purpose in mind. However, Huger lost the property before he could fulfill his ambition and, in 1856, Cote Blanche Island was taken over by a Mr. Huff, who held it only until the Civil War.

William Fellows of Staten Island, New York, was the post-war owner of the island, and he hired J. P. Kemper's father as caretaken in 1869. After William died, his son, Burney Fellows, assumed ownership from 1878-1884, when he sold it for $80,000. In 1905, the island changed hands again, this time bringing only $30,000 to its owner.

J. P. Kemper leased the Cote Blanche Island in 1907 and 1908, although by this time, sugar operations had dwindled considerably. The sugar house no longer existed, and the old road formerly used for hauling cane was in a state of disrepair. Kemper had spent part of his childhood on the island, an experience which left him with a reverence for its natural beauty. Many of his feelings are expressed in a manuscript in which he describes the island's many environmental attractions.

F. F. Miles financed explorations for salt on Cote Blanche Island soon after it was discovered on Avery Island in 1862. Explorations were successful, and the island's salt production is currently controlled by the Domtar Chemical Company.

A gas well on the Cote Blanche Island was completed by Shell Oil Company in 1955, after the discovery of petroleum deposits. Known as

Shell's Caffery et al. #1, this was the first producing well on the northern flank of the Cote Blanche dome. The Shell Company drilled through a 13,000-foot salt overhang to reach oil at a total depth of 16,479 feet.

## FIELD SURVEY OF COTE BLANCHE ISLAND

### Construction Area

A field survey was made of the proposed construction site and vicinity on the Cote Blanche salt dome island on March 4, 1976 (Figure D-7). As shown in Figure D-5, the construction site is located in a hilly area on the west-central part of the island. The area is slightly undulating, with elevations ranging from approximately 10 to 75 feet mean gulf level (MGL). Most of the new mine development area is occupied by a mature mixed hardwood forest. Heavy undergrowth and leaf cover over most of the construction site made intensive survey difficult.

A small clearing on the northwest corner of the new mine development area (Figure D-7) was relatively free of grass with good surface exposures. This area was very carefully inspected. Inspection was also possible along a small creek running roughly parallel to the northern boundary of the new mine development area and south of Shell Road, where excellent natural exposures of the surficial material occur. From three to eight feet of vertical exposures were examined along the bank at six locales. In the wooded area on the hills, a series of small shovel holes were randomly made at depths of 1-1/2 to 2 feet. In addition, a number of overturned trees in woods provided exposures to one or two feet of surface material. The following composite section is typical of the deposits in the new mine development area.

| Depth | Description |
|---|---|
| 0 to -1.5 feet | Black to medium gray. Topsoil or humus. |
| -1.5 to -3.0 feet | Brown silty clay. |
| -3.0 to -5.0 feet | Brown silty clay grading to light gray silty clay mottled brown with oxidation. Soft nodules of iron-manganese. |
| -5.0 to -8.0 feet | As above, less oxidation with depth. |

Gravel and shell were present near an old road bed in the northwest corner of the site, but were not found in the test holes or creek bottom away from this area. The examination failed to disclose a single artifact.

Spoil deposits from the existing production shaft and vent shaft were spread over a large, vegetation-free area near the present mine. Small to medium gravel was found to be abundant in this highly mixed spoil. The gravel consisted primarily of tan to brown steam-rounded chert, some of which had a secondary coating of black iron manganese. Although numerous broken pieces of gravel were found, there was no evidence of deliberate chipping. Fossil bone was also conspicuously absent from the spoil piles.

An examination of the spoil deposits along the barge slip was somewhat more fruitful. The deposits consisted primarily of oxidized, light brown, silty clays, with abundant iron-manganese nodules. Lumps of medium-gray clay also occur in the spoil 500 to 1,000 feet from the terminal end. These represent surficial Holocene marsh deposits that wedge onto the older oxidized material around the flanks of the island.

Two undecorated pottery sherds and a fossil horse tooth (_Equus_ sp.) were found in the barge slip spoil. The pottery was not distinctive enough to allow a determination of the culture period during which it was made. The tooth appears to be that of an extinct Pleistocene horse. Two species are known to occur in the area: _Equus_ cf. _Scotti_, the large plains horse, and _Equus complicatus_, the eastern horse. The species could not be determined from the specimen found.

## Other Cultural Resources on the Island

Prior to the present survey conducted for the new mine location, only two archaeological sites were found on Cote Blanche Island.

The first is the Burk Hill Site (16 SMY 100), discovered in 1966 (Figure D-5). It appears to be an earth or shell midden, probably representing a small camping area. Associated with this site were sherds belonging to the Marksville, Troyville, and Plaquemine Periods. The site is located approximately 100 feet northwest of the current Domtar Salt Mine Shaft.

The second site is Alligator Hole (16 SMY 101), 1500 feet northwest of the Burk Hill Site. It is a shell midden also discovered in 1966. No data was obtainable on its cultural affiliations.

Discussions with Mr. Tom Powell, a local resident who knows the island very well, and a general reconnaissance survey disclosed a number of features of interest on various parts of the island (see Figure D-5). While none of the features falls within the proposed construction area, they are worthy of future consideration.

Deposits of wave-washed shells of the brackish water clam Rangia cuneata occur along the base of the wave-washed cliff at Red Bluff. Medium, gravel-sized, limey concretions, weathering from the cliff, are intermixed with the shell, along with modern trash and garbage. Since Rangia shells are commonly associated with prehistoric shell middens, these wave-washed deposits may have been reworked from a site which formerly existed on the southwestern corner of the island. Mr. Powell reports that a relative once found a single, chipped-stone projectile point on the east end of the bluff. Although a careful search was made, no pottery, stone tools, or other artifacts were found.

Soft red bricks are also abundant in the wave-washed area at the base of the bluff. These are probably remnants of an old building foundation that has been lost to erosion.

Mr. Powell also reports that a chipped-stone projectile point (type unknown) was found at the east end of the ridge at Cote Blanche Landing. Two old cemeteries are also associated with Cote Blanche Landing. One which was formerly on the ridge has been lost to erosion. A second spot, on the west side of the ridge which terminates at the landing, though unmarked, is traditionally known as the burial ground of twenty slaves who died as the result of an epidemic resulting from a storm.

Mr. Powell reports finding a small lens of Rangia shells on the eastern side of the island, but did not locate the spot specifically.

Groves of mature live oaks, a citrus tree, and scattered bricks on the crests of the ridge that terminates at Red Bluff mark the probable location of an old house site. The locus of the site lies approximately 0.4 miles northwest of the bayshore on the crest of the ridge.

## CONCLUSIONS AND RECOMMENDATIONS

The intensive survey of the proposed construction area yielded only two pottery sherds and one fossil tooth of an extinct Pleistocene horse (*Equus* sp.) in the barge canal spoil. This material can be classed as an incidental occurrence and does not indicate the presence of a significant archaeological site. The intensive survey revealed no evidence that cultural resources would be endangered by the proposed construction.

There are no sites on the island or in the immediate vicinity that are listed on the National Register of Historic Places. The survey disclosed no sites or structures that would qualify for nomination to the National Register.

Known sites and locales on other parts of the island are of archaeological and historic interest and may warrant future study, but will not be affected by the proposed project.

Because of the heavy vegetation cover on much of the proposed construction site, it is recommended that the site be inspected by a qualified archaeologist after it is cleared. Furthermore, the materials taken from the new mine excavation to the depth of 50' should be examined by a qualified archaeologist for two reasons: 1) because the age of the surficial clays, sands and gravels has not been established; and 2) similar artificial deposits at Avery Island salt dome have produced highly significant archaeological material. These inspections and examinations should be coordinated between the construction engineer and the archaeologist before construction begins to insure maximum recovery of archaeological data and to also insure that there will be no delays in the construction schedule.

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TABLE D-1 Coastal Louisiana culture sequence.

| STAGE | Period | Phase | Interval |
|---|---|---|---|
| Formative | Historic | Various Tribes | 1700 A.D. - |
| | Mississippian | Delta Natchezan | 1400 A.D. - 1700 A.D. |
| | | Bayou Petrie[1] | 1400 A.D. - 1700 A.D. |
| | Plaquemine | Medora[2] | 1000 A.D. - 1400 A.D. |
| | Coles Creek | Bayou Cutler[1] | 700 A.D. - 1000 A.D. |
| | Troyville | Whitehall[7] | 300 A.D. - 700 A.D. |
| | Marksville | Magnolia[7] | 100 B.C. - 300 A.D. |
| | | Mandalay[7] | 100 B.C. - 300 A.D. |
| | | Veazey[7] | 100 B.C. - 300 A.D. |
| | | Labranche[7] | 100 B.C. - 100 A.D. |
| | Tchefuncte | Pontchartrain[3] | 500 B.C. - 100 B.C. |
| | | Grand Lake[4] | 500 B.C. - 100 B.C. |
| | | Lafayette[7] (Teche[3]) | 500 B.C. - 100 B.C. |
| Archaic | Poverty Point | Bayou Jasmine[5]-Garcia[5] | 1500 B.C. - 500 B.C. |
| | | Rabbit Island[7] | 1500 B.C. - 500 B.C. |
| | "Late" Archaic | Copell[3] | 3000 B.C. - 1500 B.C. |
| | | Pearl River[6] | 3000 B.C. - 1500 B.C. |
| | "Middle" Archaic | Monte Sano Bayou | 5000 B.C. - 3000 B.C. |
| | | Amite River[6] | 5000 B.C. - 3000 B.C. |
| | "Early" Archaic | (Kirk Points) | 6000 B.C. - 5000 B.C. |
| Lithic | Paleo-Indian | Vatican | 8000 B.C. - 6000 B.C. |
| | | Avery Island[8] | 10000 B.C. - 8000 B.C. |
| | "Early" Lithic (Pre-projectile Point) | | ? - 10000 B.C. |

1. Kniffen, 1935.
2. Quimby, 1950.
3. Ford and Quimby, 1945.
4. McIntire, 1958.
5. Gagliano and Saucier, 1963.
6. Gagliano, 1963.
7. Phillips, 1970.
8. Gagliano, 1967.

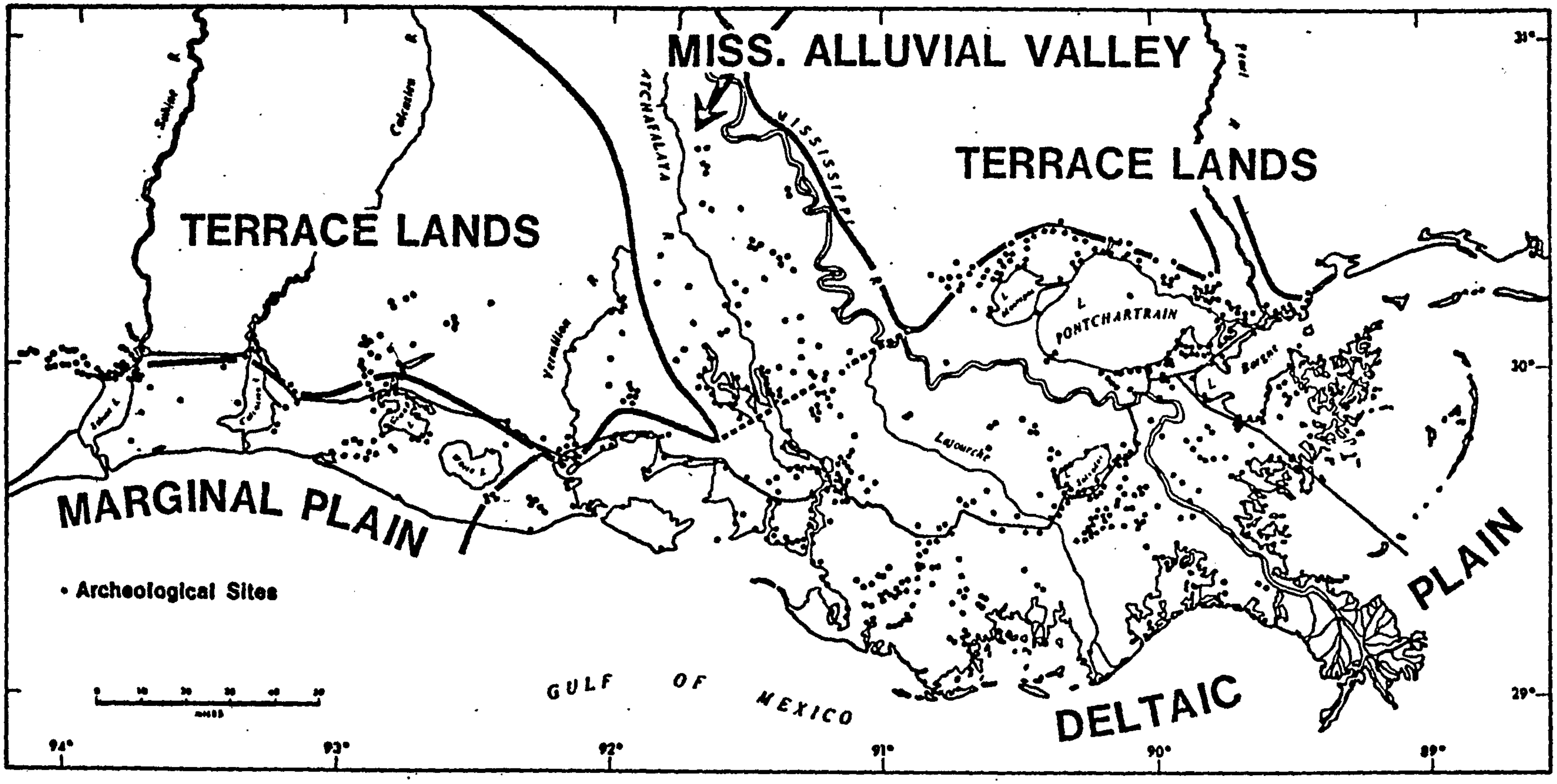
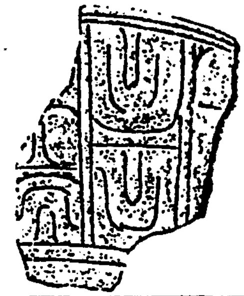
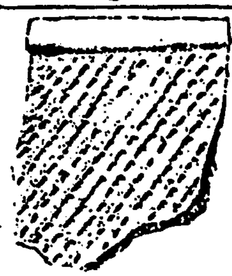
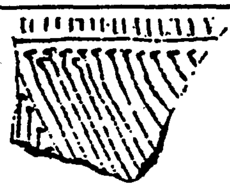
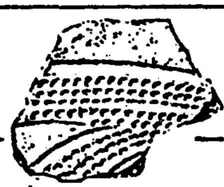



FIGURE D-1 Distribution of archaeological sites in coastal Louisiana.

| ARTIFACT DESIGNATION | TYPICAL ARTIFACT | INDIAN CHRONOLOGY | TIME SPAN est. radiocarbon |
|---|---|---|---|
| L'eau Noire Incised, <u>var. Bayou Bourbe</u> |  | HISTORIC<br>MISSISSIPPIAN<br>PLAQUEMINE | 1700<br>1500<br>1000 |
| Pontchartrain Check Stamped, <u>var. Pontchartrain</u> |  | COLES CREEK | 700 |
| Alligator Incised, <u>var. Alligator</u> |  | TROYVILLE | 300 |
| Marksville Stamped, <u>var. Manny</u> |  | MARKSVILLE | AD<br>BC<br>100 |
| Tchefuncte Stamped, <u>var. Tchefuncte</u> |  | TCHEFUNCTE | 500 |
| Poverty Point Objects |  | POVERTY POINT | |

SHERD FIGURES AFTER PHILLIPS, 1970
POVERTY POINT OBJECTS AFTER FORD AND WEBB, 1956

FIGURE D-2 Chronology chart for the most recent Lower Mississippi Valley ceramic periods.

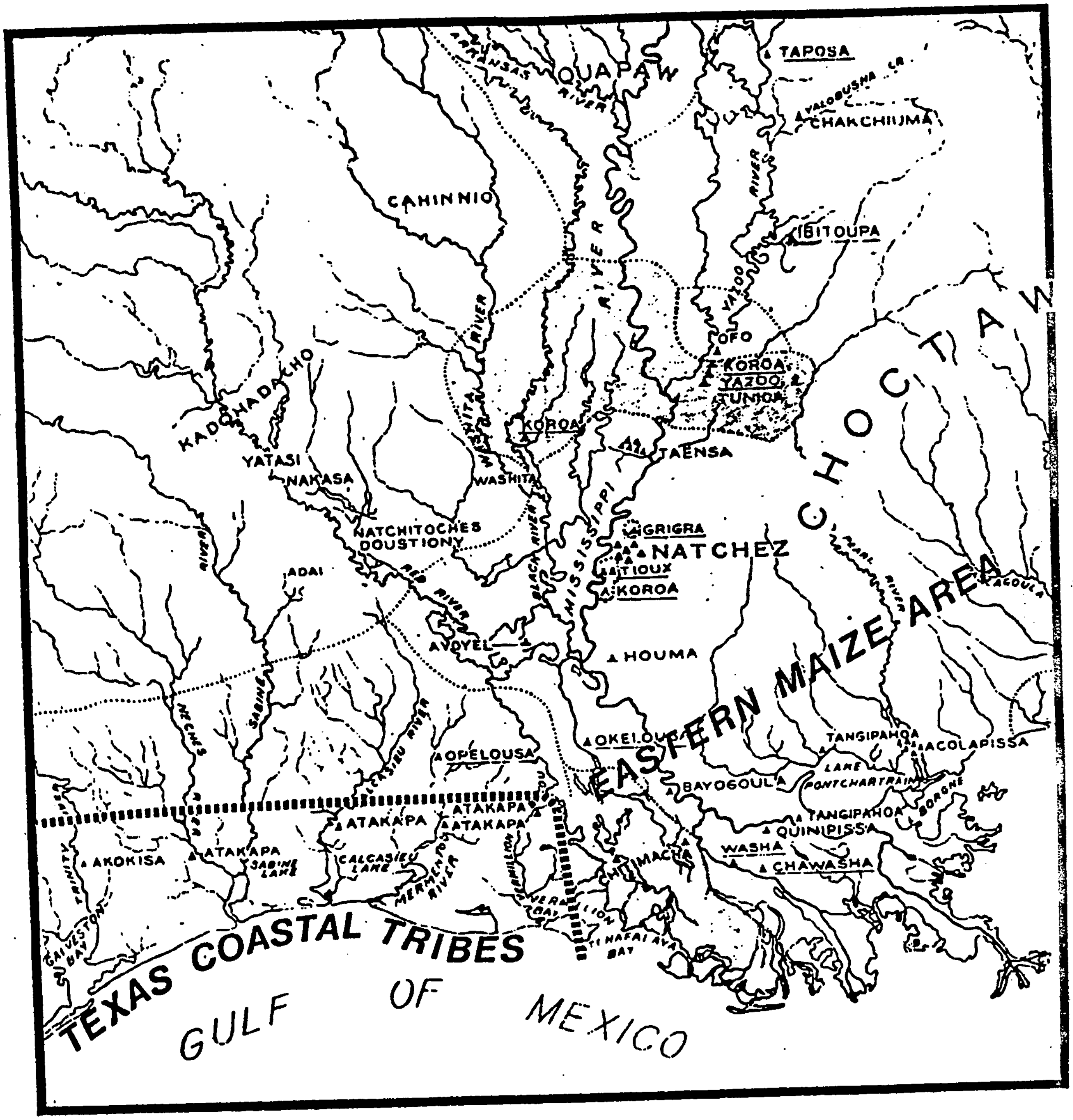



FIGURE D-3 Indian tribes of the Lower Mississippi River and adjacent gulf coast (Modified from Swanton, 1911).

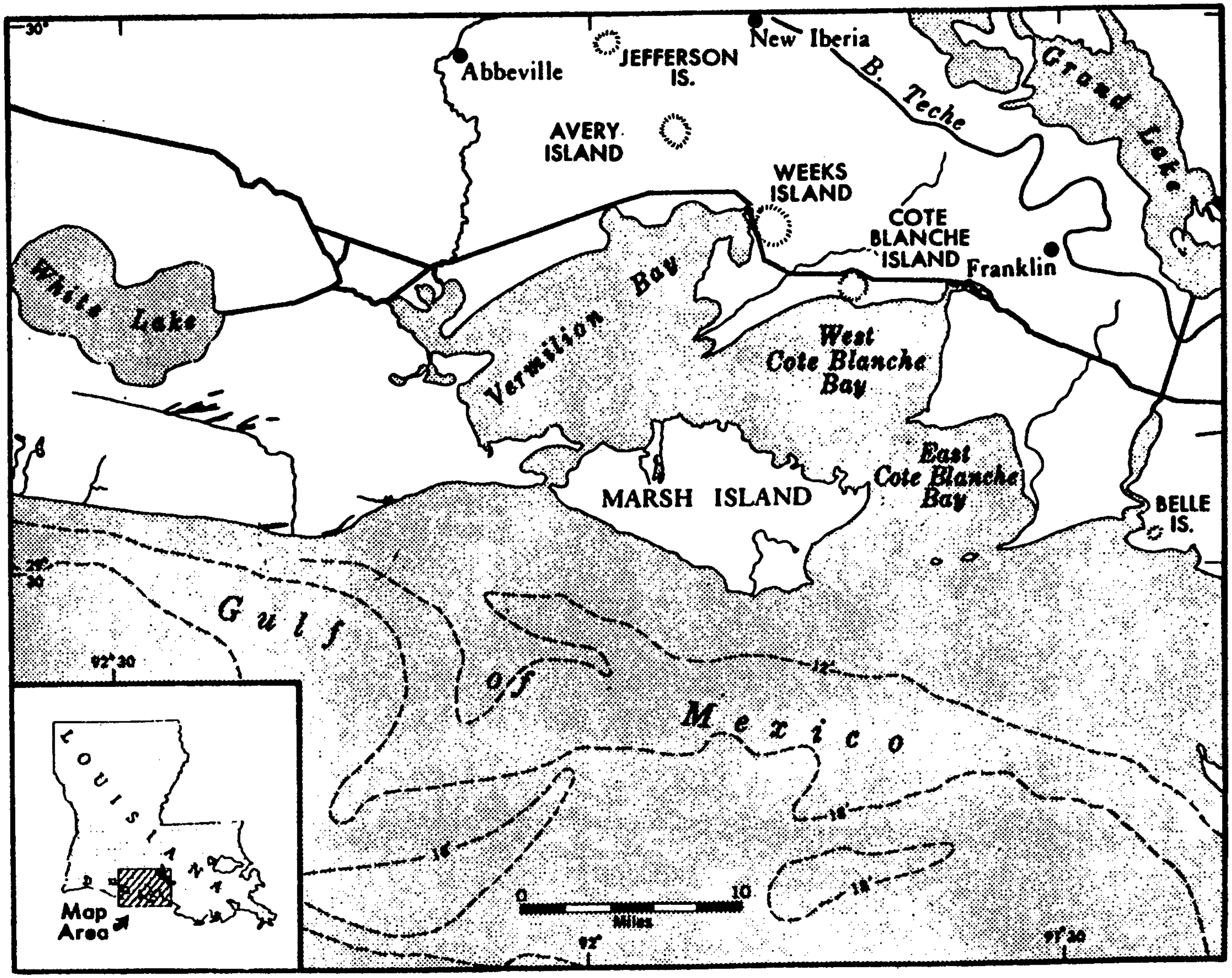



FIGURE D-4 Map of south-central Louisiana showing the locations of Avery Island and other salt domes.

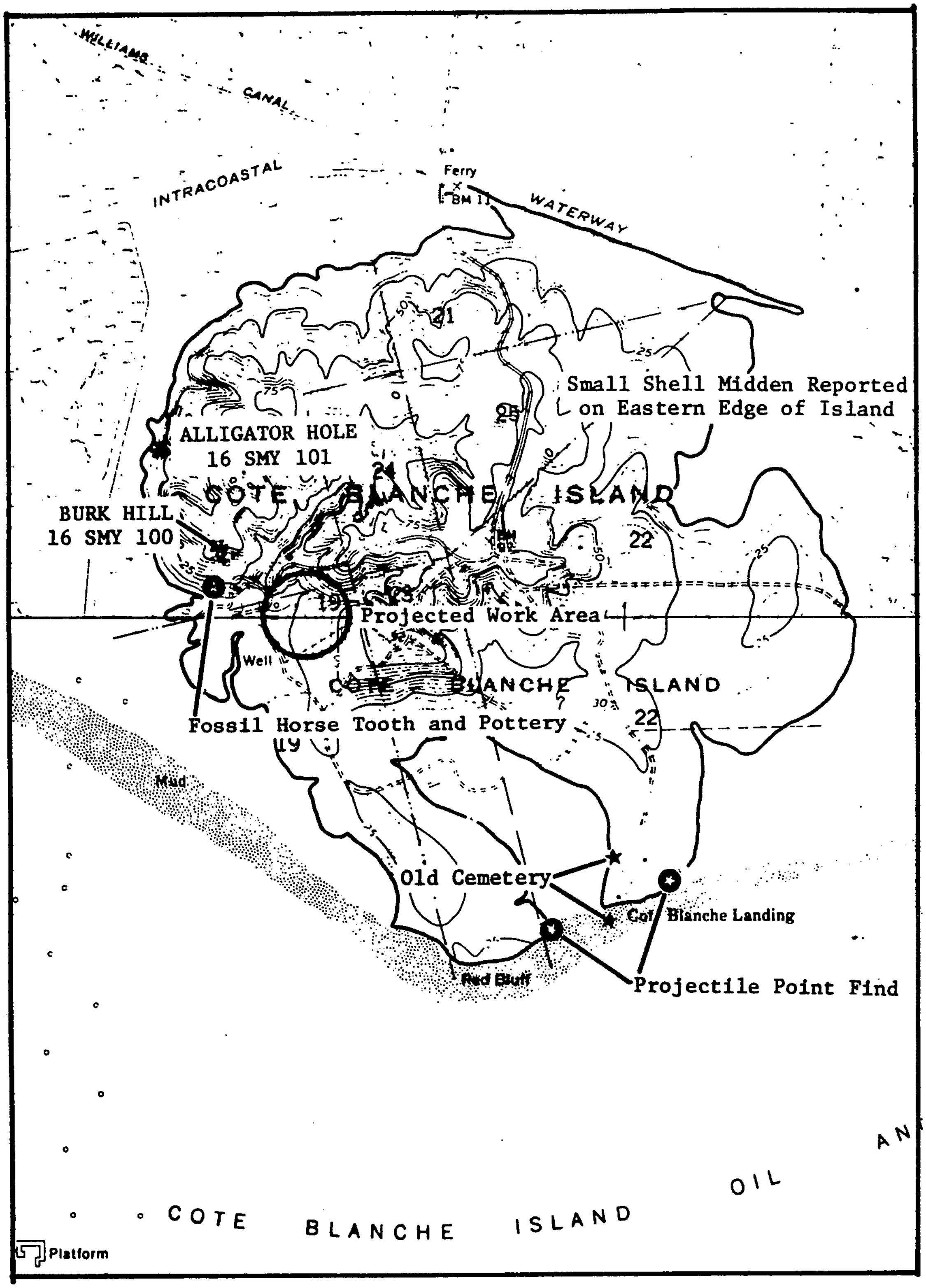



FIGURE D-5 Index map of Cote Blanche Island

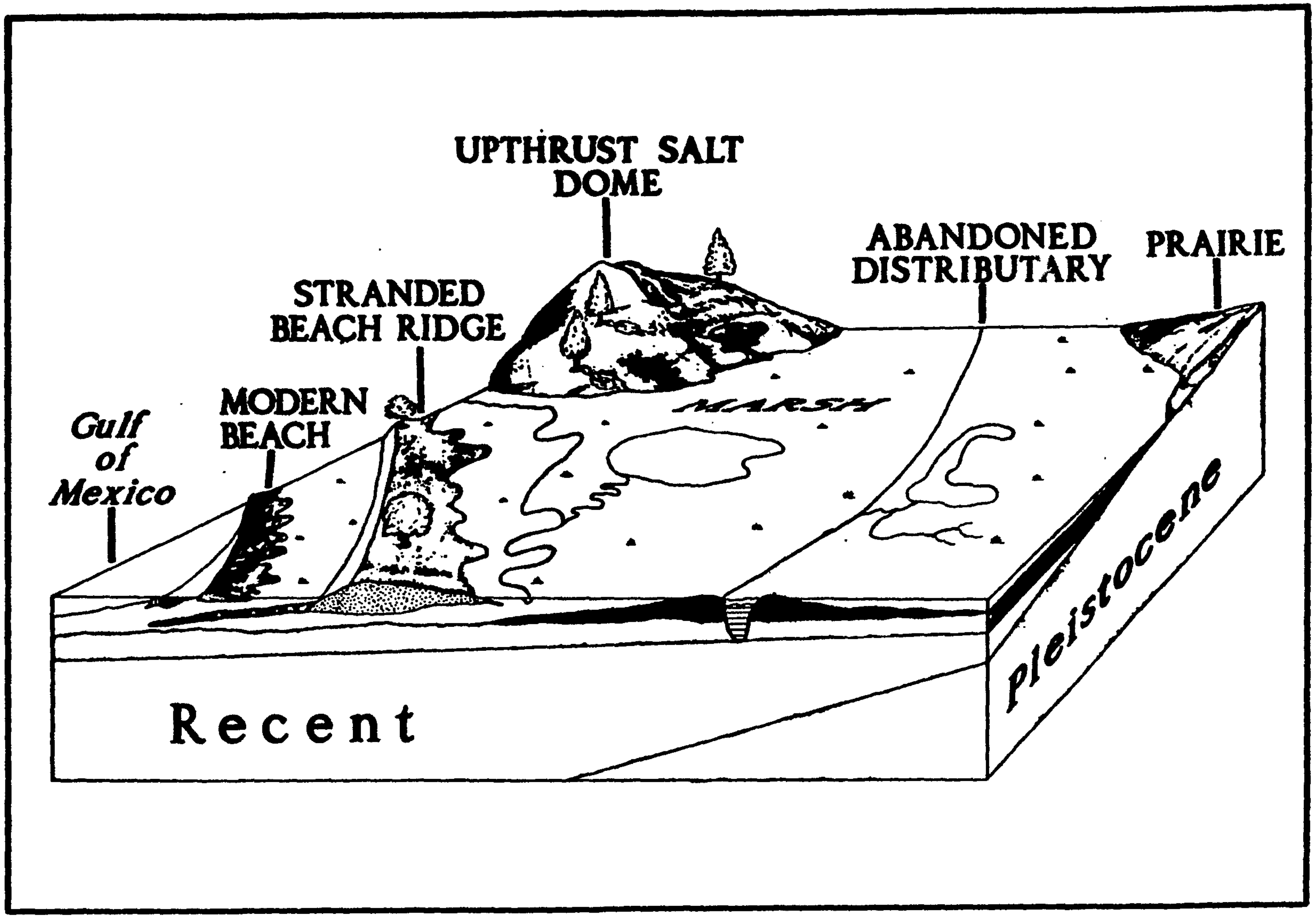



FIGURE D-6 Block diagram illustrating major physiographic features of south-central Louisiana

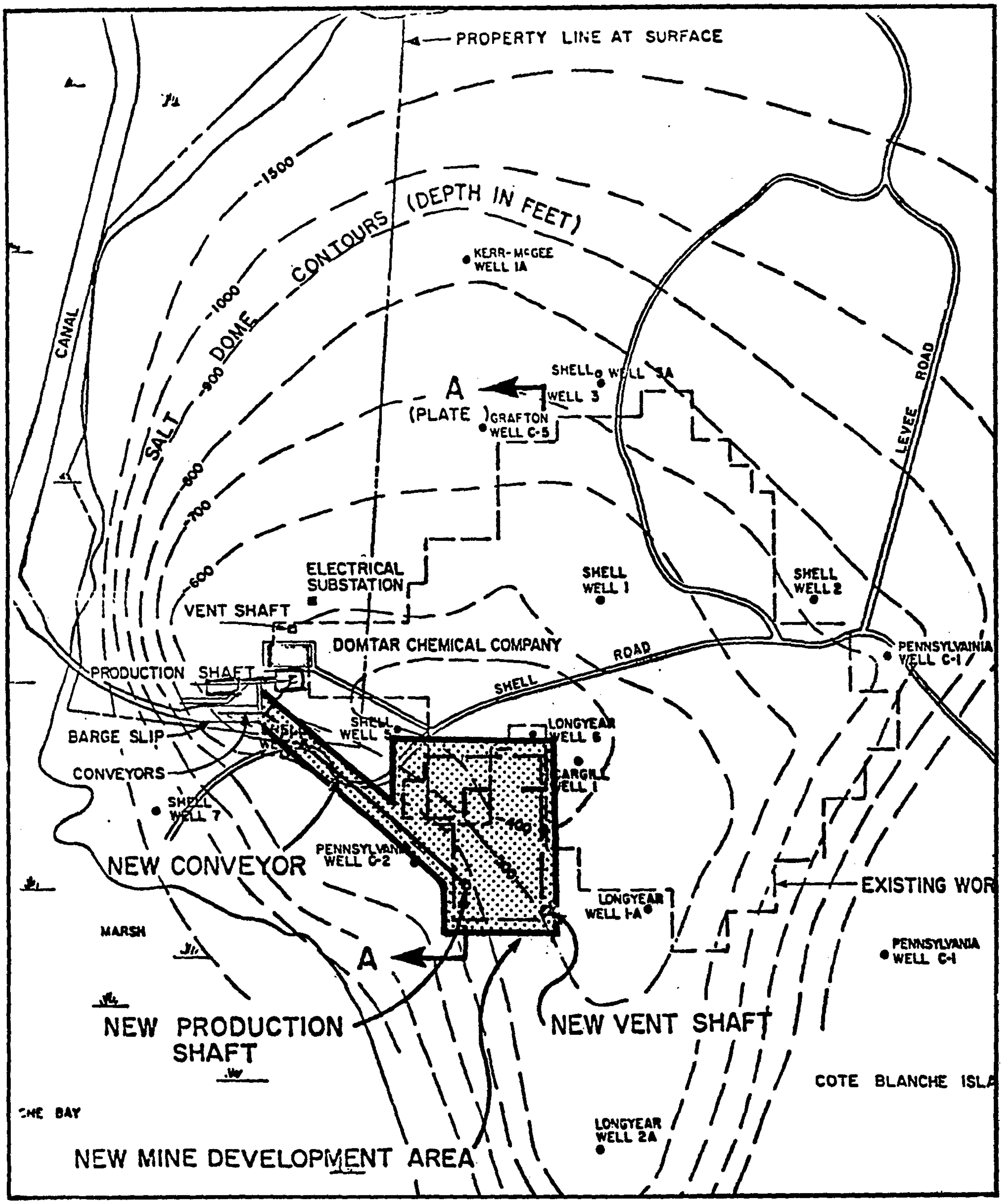



FIGURE D-7 Proposed construction area on Cote Blanche Island. Approximate scale: 1.55 inches = 1500 feet.

## APPENDIX E

## INVENTORY OF RECREATIONAL FACILITIES ADJACENT TO COTE BLANCHE ISLAND

TABLE E-1 Inventory of recreational facilities, Vermilion Parish

| | Acreage | Owner | Facilities |
|---|---|---|---|
| State Wildlife Refuge | 15,000 | State | |
| Delcambre Boat Ramp | 1 | State | 1 boat ramp |
| Rockerfeller Refuge | 21,500<br>1,200-water | State | 1 scenic point |
| Little Prairie Boat Ramp | 1 | Parish | 1 boat ramp |
| Playground | 10 | Parish | 1 baseball diamond |
| Kaplan City Swimming Pool & Ball Field | 5 | Local | 1 baseball diamond, 1 pool (4,000 sq. ft.) |
| Kaplan Fair Grounds | 5 | Local | 1 grandstand for 2,000 |
| Godcheaux Park & Pool | 5 | Local | 1 baseball diamond, 1 playground, 1 pool (6,000 sq. ft.) |
| A. A. Comeaux | 50 | Local | 6 baseball diamonds, 2 football fields, 5 tennis courts, 1 playground, 1 playfield, 4 picnic tables, 2 acres for picnicking, 1 grandstand for 5,400 |
| McKinley Scott Park Pool | 10 | Local | 1 baseball diamond, 2 basketball courts, 1 pool (3,200 sq. ft.), 2 picnic tables, 1 picnic acre |
| Motty Memorial Park | 1 | Local | |
| McKinley Scott | 3 | | |
| Don's Boat Ramp | 2 | Commer. | 1 boat ramp |
| Maxie Pierce | 2 | Commer. | 1 boat ramp |
| Nunez Boat Ramp | 2 | Commer. | 1 boat ramp |
| Sosthene Broussard | 3 | Commer. | 1 boat ramp |
| Freddie Broussard | 3 | Commer. | 1 boat ramp |
| Bergeron Arena | 10 | Commer. | 2 miles of horseback trails |
| Clark's Horse Arena | 4 | Commer. | 2 miles of horseback trails |
| Hazel Boat Landing | 2 | Commer. | 1 boat landing |
| Public Boat Ramp | 1 | Non-Profit | 1 boat ramp |
| Paul J. Rainey Wildlife Sanctuary | 21,000 | Non-Profit | 1 boat ramp, 1 scenic point |
| Abbeville Country Club & Golf Club | 100 | Non-Profit | 1 pool (4,000 sq. ft.), 18-hole golf course |
| Maurice Little League Park | 1 | Non-Profit | 1 baseball diamond, 1 playfield |
| Camp Steen (Boy Scout Camp) | 3 | Non-Profit | 1 baseball diamond, 1 playfield, 4 picnic tables, 2 acres for picnicking |
| Vermilion Boat Club Camp | 2 | Non-Profit | 1 boat ramp |
| K. C. Recreation | 3 | Non-Profit | 1 baseball diamond, 1 pool (2,400 sq. ft.) |

Table E-1 Continued

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Charlie Ball Park | 5 | Non-Profit | 2 baseball diamonds |
| Abbeville K.C. | 1 | Non-Profit | 1 pool (4,000 sq. ft.) |
| Avery Dubois Riding Arena | 3 | Non-Profit | |



Source: Regional Recreation System Plan, 1975. Acadiana Planning and Development District.

TABLE E-2 Inventory of recreational facilities, Lafayette Parish

| | Acreage | Owner | Facilities |
|---|---|---|---|
| City Park Complex | 104 | Local | 3 baseball diamonds, 3 football fields, 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment, 2 playfields, 4 picnic tables, 1 picnic acre, 1 18-hole golf course |
| Girard Park | 33 | Local | 1 baseball diamond, 1 football field, 2 basketball courts, 3 tennis courts, 2 volleyball courts, 1 playground with equipment, 3 playfields, 1 (9,000 sq. ft.) swimming pool, 31 picnic tables, 20 picnic acres, 1 outdoor concert stand, 1 8,000-seat grandstand |
| Beavers Park | 77 | Local | 5 baseball diamonds, 8 tennis courts, 2 playgrounds with equipment, 4 playfields, 29 picnic tables, 15 acres for picnicking, 1 750-seat grandstand |
| Oak Lawn Playground | 6 | Local | 2 baseball diamonds, 2 football fields, 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment, 1 playfield, 1 picnic table, 1/10 acre for picnicking |
| Henry Heyman Park | 28.5 | Local | 2 baseball diamonds, 2 football fields, 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment, 2 playfields, 1 (9,000 sq. ft.) swimming pool, 18 picnic tables, 20 acres for picnicking, 1 boat ramp, 1 sports grandstand for 800 |
| Broadmoor Park | 8 | Local | 1 baseball diamond |
| Thomas Park | 18 | Locat | 2 baseball diamonds, 1 football field |
| Acadiana Park | 117 | Local | 1 playground with equipment, 1 playfield, 25 trailer camping spaces, 13 acres for camping, 3.5 miles of nature trails |
| Mouton Park | 6 | Local | 1 baseball diamond, 1 playground with equipment, 1 playfield, 2 picnic tables, 1/2 acre for picnicking |

TABLE E-2 Continued

| | Acreage | Owner | Facilities |
|---|---|---|---|
| L'Acadien Sertoma Park | 6 | Local | 1 playfield, 2 picnic tables, 1/2 acre for picnicking |
| Chawgois Park | 10 | Local | 2 baseball diamonds, 1 playground with equipment, 1 playfield |
| Debaillon Park | 33 | Local | 2 baseball diamonds, 1 playground with equipment, 1 playfield |
| Neyland Park | 30 | Local | 3 baseball diamonds, 1 playground with equipment, 1 playfield, 2 picnic tables, 1/4 acre for picnicking |
| West End Playground | 2 | Local | 1 baseball diamond, 1 playground with equipment, 1 playfield |
| J. W. James Playground | 4 | Local | 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment |
| Little Woods Playground | 3 | Local | 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment |
| Pa Davis Park | 10 | Local | 2 baseball diamonds, 1 playground with equipment, 1 playfield, 5 picnic tables, 1 acre for picnicking, 1 sports grandstand for 75 |
| Dorsey Playground | 3 | Local | 2 baseball diamonds, 1 football field, 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground with equipment, 1 playfield, 1 sports grandstand for 100 |
| St. Anthony Playground | 2 | Local | 2 baseball diamonds, 1 basketball court, 1 playground with equipment, 1 playfield |
| Youth Park | 8 | Local | 2 baseball diamonds, 1 football field, 2 basketball courts, 1 tennis court, 2 volleyball courts, 1 playground, 1 playfield, 1 sports grandstand for 200 |
| Peck Area Park | 6 | Local | 1 baseball diamond, 1 football field, 1 basketball court, 1 playground |
| Truman Park | 3 | Local | 2 baseball diamonds, 2 basketball courts, 1 tennis court, 2 volleyball courts, playground, 1 100-seat grandstand |

TABLE E-2 Continued

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Bernard Park | 3 | Local | 1 baseball diamond, 1 50-seat grandstand |
| Langlanais Park | 3 | Local | 1 baseball diamond, 4 picnic tables on 1 acre of land |
| Oaklawn Playground | 7 | Local | 2 baseball diamonds, 1 50-seat grandstand |
| Southside Swimming Club | 2 | Commer. | 2 swimming pools, 8 picnic tables on ½ acre of land |
| Evangeline Downs Corp. | 336 | Commer. | 1 1,750-seat grandstand |
| Mr. Voorhies Pond | 3 | Commer. | |
| Trahan Crawfish Pond | 75 | Commer. | |
| Legers Crawfish Pond | 31 | Commer. | |
| Broussard Race Track | 47 | Commer. | |
| Acadian Hills Country Club | 144 | Non-Profit | 1 swimming pool, 10 picnic tables on 1 acre of land, 1 18-hole golf course |
| Lakebourne Country Club | 150 | Non-Profit | 1 swimming pool, 1 tennis court, golf course |
| Veterans of Foreign Wars Boat Ramp | 2 | Non-Profit | 1 boat ramp |
| Scott Liar | 6 | Non-Profit | 1 baseball diamond, 3 picnic tables on 1 acre of land |
| Boy's Club & Playground | 14 | Non-Profit | 1 basketball court, 1 volleyball court, 4 picnic tables on 1 acre of land, 1 cabin |
| Oakbourne Country Club | 170 | Non-Profit | 5 tennis courts, 1 swimming pool, 1 18-hole golf course |
| Lafayette Aquatic & Racquet Club | 9 | Non-Profit | 8 tennis courts, 1 volleyball court, playground, swimming pool, 14 picnic tables |

Source: Regional Recreation System Plan, 1975. Acadiana Planning and Development District.

TABLE E-3 Inventory of recreational facilities, St. Martin Parish

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Evangeline State Park | 157 | State | 1 baseball diamond, 1 basketball court, 2 volleyball courts, 1 pool (6,000 sq. ft.), 75 picnic tables, 7 acres for picnics |
| Lake Fausse Point Boat Ramp | 2 | State | 1 boat ramp |
| Lake Martin Ramp | 2 | State | 1 boat ramp |
| Pelba Boat Ramp | 5 | State | 1 baseball diamond, 1 basketball court, 2 volleyball courts, 1 pool, 75 picnic tables on 7 acres, 3 boat ramps |
| Bayou LaRose Launch | 3 | Parish | 1 boat ramp |
| Dick Davis Park | 6 | Parish | 2,000 sq. ft. beach area, 6 picnic tables on 6 acres, 1 boat ramp |
| Coteau Holmes | 1 | Parish | |
| Clayton Boudreaux Memorial Park | 7 | Parish | playground, 5 picnic tables on 2 acres |
| Breaux Bridge Pool #1 | 1 | Local | pool is 3,000 sq. ft. |
| Breaux Bridge Pool #2 | 1 | Local | pool is 3,000 sq. ft. |
| Wiltz Boat Landing | 1 | Commer. | 1 boat ramp, 30 ft. fishing pier, 30 rental boats |
| LeBlanc's Boat Landing | 1 | Commer. | 1 boat ramp, 30 rental boats, 25 ft. pier |
| Robin's Boat Landing | 1 | Commer. | 1 boat ramp, 50 rental boats |
| McGee Boat Landing | 1 | Commer. | 1 boat ramp, 25 rental boats, 22 ft. pier |
| West Atchafalaya Floodway | 2 | Commer. | 1 boat ramp, 37 rental boats |
| Veteran's Home Playground | 5 | Non-Profit | 1 boat ramp |
| Bayou Council Girl Scout Camp | 105 | Non-Profit | 2 picnic tables, 1 acre for picnicking, camp capacity for 40 |
| Breaux Bridge Saddle Club Arena | 2 | Non-Profit | |
| Cajun Riding Club | 2 | Non-Profit | |
| Jaycees Tiny Tot Playground | 1 | Non-Profit | 1 volleyball court |
| Tri-Parish Golf Club Inc. | 75 | Non-Profit | 1 18-hole golf course |
| Ringo Area Rodeo Arena | 3 | Non-Profit | |
| Catahoula Boat Ramp | 1/3 | Parish | 1 boat ramp |

Source: Regional Recreation System Plan, 1975. Acadiana Planning and Development District.

TABLE E-4 Inventory of recreational facilities, Iberia Parish

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Marsh Island Refuge | 79,000 | State | |
| Spanish Lake | 20 | State | 1 boat ramp |
| Cypremort Point | 185 | State | |
| Avery Island Boat Ramp | 1 | Parish | 1 boat ramp |
| Sheriff's Baseball Park #2 | 3 | Parish | 1 baseball diamond, 50-seat sports grandstand |
| Sheriff's Baseball Park #1 | 10 | Parish | 2 baseball diamonds, 300-seat sports grandstand |
| Marsfield Boat Ramp | 1 | Parish | 1 boat ramp |
| Lake Dautrieve Boat Ramp | 1 | Parish | 1 boat ramp |
| Jeanerette Canal Ramp | 1 | Parish | 1 boat ramp |
| Lydia Ball Park | -- | -- | |
| Rynella | -- | -- | |
| Bank | 18 | Local | 2 baseball diamonds, 2 football fields, 2 tennis courts, playground, playfield, 1 500-seat grandstand |
| West End Park | 17 | Local | 1 baseball diamond, 1 football field, 1 basketball court, 1 swimming pool, 12 picnic tables on 4 acres of land, 1 archery range, 1 200-seat sports grandstand |
| Acadian Park | 9 | Local | 1 baseball diamond, 1 football field, playground, playfield, 3 picnic tables on 1 acre of land, 1 1,500-seat sports grandstand |
| Hillenic Playground | 5 | Local | 1 playfield |
| Bachimala Playground | 3 | Local | 1 playfield |
| Decuir Playground | 2 | Local | 1 baseball diamond, playground, playfield |
| Rex Playground | 2 | Local | 1 baseball diamond, playfield |
| Broussard St. Playlot | 1 | Local | playground |
| Hacker St. Playlot | 1 | Local | 2 basketball courts, playground |
| City Park | 45 | Local | 2 baseball diamonds, 1 football field, 1 basketball court, 6 tennis courts, 2 playgrounds, 2 playfields, 1 swimming pool, 35 picnic tables on 5 acres of land, 1 boat ramp, 1 archery range, 1 200-seat sports grandstand |
| Johnson St. Playground | 2 | Local | 1 baseball diamond, 1 basketball court, playground |

TABLE E-4 Continued

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Jeanerette City Park | 8 | Local | 2 baseball diamonds, 3 tennis courts, 2 playgrounds, playfield, 1 swimming pool, 6 picnic tables on 1/2 acre of land, 1 boat ramp, 1 500-seat sports grandstand |
| 8th Ward Recreation Center | 12 | Local | 2 baseball diamonds, 1 tennis court, playground, 1 playfield, 1 250-seat sports grandstand |
| Jed Kapsas Baseball Field | 3 | Local | 2 baseball diamonds, 1 100-seat sports grandstand |
| Belmont Camp Ground | 15 | Commer. | 1 playfield, 125 trailer camping spaces, 125 electric hook-ups, 15 camping acres, 65 group camp, nature trails (.75 mile), bicycle trail (.75 mile) |
| Shermac Camp Ground | 58 | Commer. | 1 playfield, 12 picnic tables on 10 acres of land, 20 tent camping pads, 54 trailer camping spaces on 12 acres of land, 54 electrical hook-ups, 25 group camp, 3-mile nature trail, 1-mile bicycle trail |
| Kiper Campground | 3 | Commer. | playfield, 10 trailer camping spaces, 10 electrical hook-ups, 5 camping acres, group camp capacity 10 |
| Falgout Horse Arena | 4 | Commer. | 3 acres horse trail |
| Loreauville Heritage Museum | 2 | Commer. | 1 historical site |
| Bayou Jack Marina | 90 | Commer. | 1 swimming pool, 1 boat ramp |
| Avery Island Jungle Gardens | 300 | Commer. | 1 boat ramp, 5-mile nature trail, 1 scenic point, 1 historical area |
| King Joseph Recreation Center | 10 | Non-Profit | 1 baseball diamond, playground, playfield, 1 300-seat grandstand |
| St. Nicholas Recreation Area | 15 | Non-Profit | 1 baseball diamond, playfield |
| Coteau Church Recreation Area | 15 | Non-Profit | 2 baseball diamonds, playfield, 5 acres horseback riding |
| Shadows | 2 | Non-Profit | 1 historical area |
| Iberia Golf & Country Club | 30 | Non-Profit | 1 nine-hole golf course |
| Sugar Oaks Country Club | 150 | Non-Profit | 1 swimming pool, 1 18-hole golf course |

Source: Regional Recreation System Plan, 1975. Acadiana Planning and Development District.

TABLE E-5 Inventory of recreational facilities, St. Mary Parish

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Canal Boat Ramp | 1 | Parish | 1 boat ramp |
| Burns Point Picnic Area & Beach | 10 | Parish | 3,000 sq. ft. beach area, 10 picnic tables, 3 acres for picnics, 1 boat ramp, 20 trailer camper spaces, 20 electrical hook-ups |
| Hanson Field Sheriff's League | 8 | Parish | 2 baseball diamonds, 1 grandstand for 300 |
| Public Boat Ramp | 1/2 | Parish | 1 boat ramp |
| Todd Recreation Park | 1/2 | Parish | 2 picnic tables, 4 picnic areas, 1 boat ramp |
| Cypremort Beach | 25 | Parish | 650,000 sq. ft. beach area |
| Berwick Boat Ramp | 1/2 | Parish | 1 boat ramp |
| Glenwild Boat Ramp | 1/2 | Parish | 1 boat ramp |
| Verdunville Boat Ramp | 1/2 | Parish | 1 boat ramp |
| Willow St. Boat Ramp | 1 | Local | 1 boat ramp |
| Baldwin Baseball Park | 4 | Local | 2 baseball diamonds |
| Caffrey Park | 5 | Local | |
| Broussard Park & Pool | 4 | Local | 1 pool (3,600 sq. ft.), 2 picnic tables, ½ acre for picnicking |
| Franklin City Park & Pool | 5 | Local | 1 baseball diamond, 2 tennis courts, 1 pool (4,000 sq. ft.) |
| Patterson Baseball Park | 4 | Local | 2 baseball diamonds |
| Morgan City Beach & Picnic Area | 10 | Local | 10 picnic tables, 2 acres picnic space, 2 boat ramps |
| Lake End Park | 37 | Local | 30,000 sq. ft. beach area, 18 picnic tables, 1 boat ramp |
| Swamp Gardens | 3 | Local | 1 three mile hiking trail |
| Carillion Towers | 2 | Local | 1 two mile hiking trail, 1 historical area |
| Morgan City Recreation Complex | 12 | Local | 1 baseball diamond, 8 tennis courts, 1 playground, 1 pool (12,000 sq. ft.), 6 picnic tables, 1 acre for picnicking, grandstand for 400 |
| Lawerence Park | 3 | Local | 1 basketball court, 1 tennis court, playground, playfield, 4 picnic tables, 1 acre for picnicking, outdoor concert stand for 1,000 |
| Greenwood Street Playground | 1 | Local | 1 basketball court, playground |

TABLE E-5 Continued

| | Acreage | Owner | Facilities |
|---|---|---|---|
| Jacquet Park | 2.5 | Local | 1 playfield, 1 pool (5,000) |
| Spinella | 2 | Local | 1 baseball diamond, grandstand for 250 |
| McGee Park | 7 | Local | 3 baseball diamonds, playfield, grandstand for 250 |
| Youngs Park | 5.5 | Local | 1 baseball diamond, 1 football field, 1 playfield, grandstand for 250 |
| Bowman Street Playground | 1/2 | Local | 1 playground, 1 picnic table, .1 picnic acreage |
| Norman Park | 5 | Local | 1 baseball diamond, 1 football field, 1 playfield, 4 tennis courts, 1 poot (11,000 sq. ft.), 1 wading pool, 2 picnic tables, .1 picnic acreage |
| Oak Lawn Manor | 30 | Commer. | 1 grandstand for 1,510 |
| Myette Point Boat Ramp | 1/2 | Commer. | 1 boat ramp |
| Private Boat Ramp | 1/2 | Commer. | 2 boat ramps |
| Kattbridge Boat Ramp | 1/2 | Commer. | 1 boat ramp |
| Franklin Boat Ramp | 1/2 | Commer. | 1 boat ramp |
| Cypremort Boar Ramp | 1/2 | Commer. | 1 boat ramp |
| Bayou Bouef Locks Boat Ramp | 1/2 | Commer. | 1 boat ramp |
| Joe C. Russo Ramp | 1/2 | Commer. | 1 boat ramp |
| Bellview Golf Course | 20 | Non-Profit | 2 tennis courts, pool (3,600 sq. ft.), 1 18-hole golf course |
| Albania Historical Site | 10 | Non-Profit | 1 historical area |
| St. Mary Golf Course | 20 | Non-Profit | pool (3,600 sq. ft.), 1 18-hole golf course |
| Cypremort Camping | 15 | Commer. | playground, 300 camper spaces, 200 electric hook-ups, 15 acres for camping |
| Brownell Memorial Park | 10 | Non-Profit | 1/2 mile nature trail |

Source: Regional Recreation System Plan, 1975. Acadiana Planning and Development District.

# APPENDIX F

## ESTIMATES OF EMISSIONS PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

# APPENDIX F

## ESTIMATES OF EMISSION PRODUCED BY HYDROCARBON FLARING AND VAPOR LOSSES AND MODEL USED TO CALCULATE DOWNWIND GROUND LEVEL CONCENTRATIONS

### Odor

A number of substances, both man-made and naturally occurring, can cause odors in air and water; for example, petrochemical facilities or the musty earthy odors typical of freshly plowed soil, or stagnant marsh areas. Only traces of some organic compounds are required to produce noticeable effects. However, one problem in odor research is the isolation and identification of specific chemical compounds which cause the odors; another problem is determining the source of the compounds.

Man-made sources of hydrocarbon odors are incineration of waste products, evaporation of industrial solvents, or the combustion of coal, oil and wood. The leading source of hydrocarbon emissions, however, is the processing and use of petroleum products. In this processing-use chain, gasoline is the major source of hydrocarbons due to emissions from evaporation or use of the internal combustion engine.

Natural sources such as forests and vegetation also emit large amounts of hydrocarbons of the terpene class. In addition, bacterial decomposition of organic matter produces large amounts of methane. Hydrogen sulfide is naturally produced in large quantities during the decay of organic matter on land or in swamps or marshy areas. Hydrogen sulfide is also emitted by some industrial operations. The sketchy data available for a comparison of natural and man-made sources of hydrogen sulfide suggests that the industrial contribution of this gas, on a global basis, is not significant. Most hydrogen sulfide is believed to be produced from natural sources.

Contaminant losses from petroleum storage and production facilities consist of escaping or vented natural gas, and evaporative hydrocarbons derived principally from storage tanks. These losses consist mostly of ethane and methane. Negligible quantities of sulfur dioxide, nitrogen oxides and particulate matter are released from internal combustion engines or other combustion equipment associated with crude oil production facilities.

Hydrocarbons (HC) emitted from storage sources are mostly of the lower boiling volatile hydrocarbons. These HC are not significant in smog formation but do produce odors and, therefore, they are prevented from entering the atmosphere by use of storage control systems. These systems involve the collection of the vapors or their redistribution to other storage areas by means of a vapor balancing system. This collection is followed by absorption or incineration (flaring) of the excess odor producing vapors. Control system efficiencies of 85 to 100 percent are possible when vapor recovery or vapor disposal systems are in operation.

Estimate of $H_2S$ and $SO_2$ Emissions Produced by Hydrocarbon Flaring

The odor compounds emitted from an unflared cavern vent can be estimated by assumed worst case conditions: all the vapor is HC, with a content of 0.1 percent (1000 ppm) odor compounds. Vapor density is calculated by assuming: 1.2 X the specific gravity of air at standard temperature and pressure (0.075 $lb/ft^3$), which equals 0.09 $lb/ft^3$; the volume of a barrel of oil is 5.65 $ft^3$.

Therefore: 100,000 bbls/day = 564,000 $ft^3$/day
= 50,760 lbs/day

0.1 percent of this is $H_2S$ or 51 lbs/day = 0.27 gm/sec $H_2S$

If this concentration is flared, the weight of $SO_2$ is about double that of the converted $H_2S$.

Therefore: 100 lbs/day = 0.53 gm/sec $SO_2$

Estimate of Vapor Losses of Hydrocarbons and $H_2S$ by Leakage

About 5 percent of the crude oil pumped can be considered volatile, with a leakage rate of about $10^{-4}$ of the throughput. The leakage rate for the remainder may be of order $10^{-6}$ or less, and can therefore be neglected. Odor compounds can be conservatively estimated as 0.1 percent of the leaking material. Consequently, per 100,000 barrels per day, the hydrocarbon loss is estimated by:

$$\left(100{,}000\ \frac{\text{barrels}}{\text{day}}\right)\left(300\ \frac{\text{lbs}}{\text{barrel}}\right)(5\%)\left(10^{-4}\right) = 150 \text{ lbs/day or } 0.8 \text{ gm/sec hydrocarbons.}$$

The odor compound, or 0.1 percent of this rate, would amount to 0.15 lbs/day or 0.0008 gm/sec $H_2S$.

Vapor Losses from Storage Caverns

Petroleum vapor loss from the cavern will occur as the cavity is vented during filling. Vapor loss may also occur during storage if the cavern is vented and permitted to "breathe" with changes in atmospheric pressure. Petroleum fluids of lower molecular weight evaporate readily on contact with air which is not already saturated with petroleum vapors. As the cavern is initially filled, the vapor space above the liquid will become charged with hydrocarbon vapor evolving from the rising liquid. If the vapor-air mixture is not expelled from the cavern at the same rate as liquid entry, pressure buildup from compression will result.

As the cavern is evacuated, fresh air may be introduced to prevent a vacuum. Additional vapor will be evaporated to saturate this fresh air, but no vapor loss will be experienced during withdrawal. These accumulated vapors will be expelled during the next filling cycle, along with a small amount of additional vapors evolved during the filling.

If the cavern is not vented during storage, there will be a small pressure buildup due to continued boil-off of dissolved petroleum fractions in the crude which are normally in vapor form at storage temperature and pressure. This pressure buildup would amount to about one-half atmosphere for crudes contemplated in the storage program, but could range to more than 2 atmospheres for crudes rich in $C_2$ and $C_3$ components fresh out of the ground. Boil-off is distinct from evaporation of compounds which are normally liquid at storage conditions, the distinction being whether the vapor pressure of the fraction is less than or greater than atmospheric pressure at the storage temperature.

"Breathing" of a vented cavern involves inflow and outflow of air due to fluctuations in barometric pressure. The liquid level in the cavern remains steady, but the vapor space density fluctuates slightly Even gauge holes into the vapor space would permit significant breathing. Gauge tubes immersed into liquid, however, do not permit breathing venting, and the evaporation losses from the liquid surface in the tubes is generally insignificant. It is not expected that the caverns would be vented during storage, so breathing losses are not anticipated. Operation of the caverns at greater than atmospheric pressures caused by boil-off does not affect any of the considerations of oil-water interchange during a shaft or fill-pipe failure. Water sealing in the sumps will still occur so long as the shaft seals are intact.

The vapor pressure of the crude at storage conditions (75° to 98° F) will range from 2 to 3 psia for the types of crude specified in the program. Thus a saturated mixture of air and vapor would consist of about 15 to 20 percent hydrocarbons, with the specific gravity of the mixture ranging between 1.2 and 1.5 relative to air. Since 80 percent saturation may be used as representative of average conditions, the density of vapors during initial fill would be about .09 lbs per cubic ft -- 20 percent being hydrocarbons. The average amount of hydrocarbons expelled per 100,000 barrels introduced into the cavern initially would total 11,280 pounds, or 0.04 percent by weight. In time, however, the average molecular weight of the hydrocarbons will increase as heavier fractions ($C_7$ - $C_{15}$) evolve into the vapor space. Under the worst conditions considered in flaring vent emissions, the weight loss would amount to nearly 0.17 percent.

Emissions from Barge and Tanker Transfers

The following emission factors are given in EPA (1975) for tanker and barge transfer operations:

| | |
|---|---|
| Tanker Loading: | 0.008 percent per psia true vapor pressure (TVP) |
| Tanker Unloading: | 0.007 percent per psia TVP |
| Barge Loading: | 0.002 percent per psia TVP |
| Barge Unloading: | 0.007 percent per psia TVP |

Loading emissions are released as the vessel is filled, displacing the fumes in the storage compartment. For tankers, unloading emissions are vented as ballast is taken aboard, displacing the vapors left in storage compartments. Typically, 40 percent ballasting would produce 0.0028 percent release per psia true vapor pressure. For barges which do not ballast, the unloading emission would not be vented until refilling. Thus, the emissions at the storage docks would be:

| | |
|---|---|
| Withdrawal cycle: | 0.009 percent per psia TVP |
| Filling cycle: | 0 |

For barge-tanker transfers:

Withdrawal cycle (barge to tanker): 0.008 percent per psia TVP

Fill cycle (tanker to barge): 0.016 percent per psia TVP, less adjustment for incomplete tanker ballasting.

To provide worst case impacts, the calculations of hydrocarbon emissions in section 4.3.3 assume 100 percent tanker ballasting.

Losses in Transit

Transit losses are estimated at 0.001 percent per psia TVP per week in transit. Transit time from the Gulf to the storage site (excluding transfer time) is approximately two days. The design Reid Vapor Pressure (RVP) for the storage site is 3 psia, which is a 2 psia TVP at 75°F mean temperature (used in calculations). For light Arabian crudes at high temperatures (RVP = 8 psia, T = 90°F), emission losses could be four times as high for all loss modes.

Model Used to Calculate Downwind Ground Level Concentrations

Calculation of the downwind concentrations of hydrocarbons released during crude oil transfer uses the sector spread technique (Turner, 1969). A point source emission was assumed at ground level. The effluents are assumed to be evenly distributed over a 22-1/2° wind sector via meandering of the plume, and the wind is assumed to be constant over the entire trajectory.

The equation used is:

$$C = (Q)\left(\frac{2.032}{u\ \sigma_z\ X}\right)$$

where:

X is the downwind distance (meters), u is the wind speed (meters/sec), $\sigma_z$ is the vertical dispersion coefficient (meters), Q is the effluent source term (gm/sec), and C is the downwind concentration (gm/meters$^3$).

In addition, continuous emission from the source is assumed; therefore, diffusion in the direction of transport may be neglected. None of the material emitted is assumed to be lost from the plume as it moves downwind and there is complete reflection at the ground. Finally, the material diffused is assumed to remain suspended in the air over long periods of time (i.e., a stable gas or aerosol less than ~ 20 microns in diameter).

Because the construction activity will take place over an area of several acres, an area source model was used to calculate downwind concentrations. For the purposes of computation, the area was assumed to be .25 km on a side. A worst case concentration 500 meters downwind was computed at the center point of the plume.

The equation used is:

$$C = \frac{Q}{\pi \sigma_y \sigma_z u}$$

where:

u is the mean wind speed (meters/sec), $\sigma_z$ and $\sigma_y$ are the vertical and horizontal dispersion coefficients respectively (meters), Q is the pollutant source term (gm/sec), and C is the downwind concentration ($gm/m^3$).

To allow for the area source, a virtual distance $X^1$ is found that approximates the distance required for a point source to disperse into an area equivalent to the site. The distance $(X + X^1)$ is then used to determine a new horizontal dispersion coefficient of the plume ($\sigma_y$). The above equation is then used with the new value for $\sigma_y$.

In addition, the area source method uses the following assumptions: The effluents are assumed to be normally distributed along the plume centerline; continuous emission from the source is assumed; there is no removal of pollutants from the plume and there is complete reflection at the ground; the diffused material remains suspended in the air over long periods of time.

# APPENDIX G

# OIL SPILL RISK ANALYSIS METHODOLOGY

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## OIL SPILL RISK ANALYSIS METHODOLOGY

The material in Appendix G illustrates the method of calculation used in assessing oil spill risks.

### G.1 BARGE SPILLS

Barge spill risk modes include collisions, ramming (collision with fixed objects), structural failures (generally leaks), foundering (buoyancy loss), fire and explosions, groundings, and breakdowns (drifting and uncontrolled movements resulting from a power failure of the tug vessel, or the barge breaking loose from a tow or mooring). Data available are not sufficient to establish mode spill rates. Overall spill rates taken from 1970 data show 548 incidents in 380 billion ton-miles (AEC, 1972), for an incident rate of $1.4 \times 10^{-9}$ accidents per ton-mile. Fire was estimated to occur in 0.2 percent of accidents. Oil discharge has occurred in 6 to 16 percent of the incidents, depending on vessel energy conditions. The higher rate correlates with a data set for all tank vessels in coastal waters; the lower rate is consistent with the severity profile estimated by the AEC for barge accidents. A reasonable maximum rate of 10 percent for barge accidents of the type associated with Cote Blanche oil storage is assumed to result in oil discharge, although 6 percent is possibly more representative of vessel energy (speed) conditions on inland waterways.

The estimated oil discharge frequency expectation for one complete fill at Cote Blanche is based upon barge transport (exposure) of 880 million ton-miles (same basis of transport spill exposure as used by the AEC):

$$27 \times 10^6 \text{ barrels} \times 218\text{-mile transport from Venice} \div 6.67 \text{ barrels per ton} = 880 \times 10^6 \text{ ton-miles}$$

Discharge Frequency Expectation = exposure x rate x oil discharge factor

$= (880 \times 10^6 \text{ ton-mile})(1.4 \times 10^{-9} \text{ per ton-mile})(0.10)$

= 0.123 accidents per filling (or withdrawal)

The chance of spills in 5 fill/withdrawal cycles can be computed from the binomial distribution for 10 events, where:

$y$ = number of events

$n$ = chance of no spill per event = 0.877

$p$ = chance of a spill per event = 0.123

$k$ = number of spills

such that $p(k) = \frac{y!}{(y-k)!k!} p^k n^{y-k}$

or $p(0) = n^{10}$ (chance of no barge spill in project lifetime)

$p(1) = 10\ pn^9$ (chance of one barge spill)

$p(2) = 45\ p^2n^8$ (chance of two barge spills)

Specifically, $(0.877)^{10}$ = 26.90 percent for no spills

$10(0.123)\ (0.877)^9$ = 37.75 percent for 1 spill

$(45)\ (0.123)^2\ (0.877)^8$ = 23.8 percent for 2 spills

$\frac{10 \times 9 \times 8}{3!} (0.123)^2\ (0.877)^7$ = 8.9 percent for 3 spills

2.65 percent for 4 or more spills

This calculation approach does not permit consideration of two or more spills in a single filling. To examine the error involved in the approach consider the spill risk in a single barge trip.

One barge trip = 3750 tons X 218 miles = $8.2 \times 10^5$ Ton-miles.

Accident frequency = $(1.4 \times 10^{-9})\ (8.2 \times 10^5)\ (0.10) = 11.5 \times 10^{-5}$.

One filling requires 1080 trips.

Chance of no accidents $(0.999885)^{1080}$ = 88.32 percent

Chance of one accident (1080) (0.000115) (0.999885) = 10.97 percent

Chance of two accidents = 0.71 percent

Then, the chance of no accidents in 5 full cycles:

none - $(0.999885)^{10800}$ = 28.88 percent

one = 35.87 percent

two = 22.28 percent

three = 9.22 percent

all others = 3.75 percent

These two sets of calculations do not vary significantly, particularly if one assigns a probable error of ± 10 percent to the accident rate itself. This results in a range of about $\pm 6$ percent in the chance of no accidents, $\pm 5$ percent for one accident, $\pm 15$ percent for 2 accidents, $\pm 25$ percent for 3 accidents, etc., with percentage error increasing for the rarer, multiple events. The simplest method is adequate for the final outcome, if one realizes that multiple accidents in a single filling are not in fact excluded.

The average barge spill size in the historical data is 206 barrels. However, for 25,000-barrel barges, a conservative average spill size of 428 barrels, (based on tank vessel incidents in harbors - Coast Guard, 1972), has been used. The size distribution of spills can be determined by numerically fitting the applicable probability function f(s) to the expectation integral:.

$$\int_0^\infty sf(s) = 428$$

The probability function that is judged most applicable is the log normal, because of its use in describing many natural random events (earthquakes, rainfalls), and its position in the theory of extremes:

$$f(s) = \frac{1}{rs\sqrt{2\pi}} \exp\left(-\ln s/s_0\right)^2 / 2r^2)$$

where $s_0 = 428$, and r is between 1.1 and 1.5.

Published numerical fits of oil spill data have focused on gamma-family distributions, which diverge from log normal only at the upper extreme. The distribution given in Table 4.3-2 for the 25,000-bbl barge transport shows the numerically approximate result:

| Size (bbl) | Percent Occurrence | Contribution to Expectation (bbl) |
|---|---|---|
| 0 - 200 | 45.8 | 46 |
| 200 - 500 | 35.0 | 122.5 |
| 500 - 1,000 | 13.1 | 98.3 |
| 1,000 - 2,000 | 4.3 | 64.5 |
| 2,000 - 5,000 | 1.3 | 45.5 |
| 5,000 - 10,000 | 0.4 | 30 |
| 10,000 - 20,000 | 0.1 | 15 |
| | | 421.8 bbl |
| | | (428 bbl exact, 1.4% error) |

This distribution has not been carried to infinite size, but has been truncated at a maximum credible size of 20,000 barrels. The maximum credible size is the largest spill which can reasonably be expected from barge tank accidents. The basis for such a limit is both physical and actuarial. The physical basis depends upon (1) compartmentalization of barge tanks so that containment integrity of most of the barge remains unimpaired after a collision; and (2) water sealing the tanks when their water level rises above the rupture. The actuarial basis depends upon the fact that rupture of more than two compartments in the primary (initial) failure mode is extremely rare.

Loss of an entire barge cargo, including rupture of all the tanks, generally results from factors such as pounding surf and strong tidal fluctuations. These factors would not usually be expected in the section of the Intracoastal Waterway used for Cote Blanche oil transport, unless hurricane warnings were ignored or transport were conducted during storms.

Large spill modes considered include:

| | |
|---|---|
| Bottom rupture of tow (two barges in tow) by submerged hazard 25 percent of 50,000 bbl | - 12,500 bbl |
| Foundering of two 25,000-bbl barges 15 percent loss by rupture, 10 percent loss by leakage | - 12,500 bbl |
| Collision with sharp prow 50 percent of barge | - 12,500 bbl |
| Collision between two 25,000-bbl barges 25 percent by rupture | - 12,500 bbl |
| Collision with exploding barge 100 percent loss of two, 60 percent burnup | - 20,000 bbl |

The largest of these spills (20,000 bbl) was selected as the maximum credible spill size. By comparison, the largest recorded barge spill in the world from 1966 to 1972 was 9,500 bbl.

The increase in waterway traffic generated by Cote Blanche operations, compounded by similar operations at nearby Weeks Island, would not generate traffic densities sufficient to invalidate the application of the AEC barge spill rates used here (i.e., $1.4 \times 10^{-9}$ per ton-mile).

The barge spill rates from the data set include U.S. harbor exposures, some of which have as many as 200 transit-exposures daily.

An estimate of maximum traffic densities can be made for the ICW. Corps of Engineers data show 70 million tons of traffic on the entire Gulf section of the Intracoastal Waterway in 1970. Note that this traffic is much greater than the 19 million tons reported for the subportion of the waterway in the Acadiana district (section 3.9.1.3). By using the total traffic figure, the highest possible traffic density can be estimated. Assuming that: 1) 93 percent of the traffic is petroleum, using average barges of 2500 DWT (maximum is 4200 DWT); 2) the remainder of the traffic uses barges of 1300 DWT; 3) waterway tows average 2 barges; and 4) 50 percent of the barges return empty, the maximum number of daily tow transits at a given point on the ICW is estimated at 61. To that number would be added a maximum of 17 tows daily from Cote Blanche and Weeks Island (corresponding to 70 inland waterway barges to Venice and 10 seagoing barges to the Gulf), totalling about 80 daily passages. During emergency withdrawal, the oil storage tows would operate evenly around the clock, but the remainder could at worst be assumed to operate on 14-hour days. The maximum average transit would then be 5 tows per hour. Even if all tows were headed in the same direction, average tow separations of approximately a mile would be available. This distance gives about 10 tow lengths of separation, and the stopping distance (at 5 to 6 knots) for each tow would be on the order of 2 to 3 tow lengths.

## G.2 PIPELINE SPILLS

The risk for pipeline spills is considered to be a function of operation time and pipeline length. Historically, the U.S. rate of crude spills (1968-1973 data base) in pipelines has been about 185 spills per year for an estimated exposure average of 145,000 miles of pipeline. This rate is $128 \times 10^{-5}$ spills per year per mile (also expressed as 1.28 spills per year per 1000 miles), compared to a European rate of $110 \times 10^{-5}$ spills per year per mile. However, the historical data base includes pipe over 30 years old. It is appropriate to adjust the spill basis for new pipelines:

| Failure Mode | Historical Basis | Projected Basis New Pipe |
|---|---|---|
| External Corrosion | 54 X $10^{-5}$/yr/mi | 5 X $10^{-5}$/yr/mi |
| External Equipment | 32 | 24 |
| Defective Pipe | 12 | 5 |
| Miscellaneous | 9 | 7 |
| Internal Corrosion | 9 | 4 |
| System Defects | 5 | 2 |
| External Events | 5 | 2 |
| Defective Repairs | 2 | 1 |
| | 128 X $10^{-5}$/yr/mi | 50 X $10^{-5}$/yr/mi |

If an 80-mile pipeline is always full of oil, as is standard practice in order to take advantage of additional storage volume and simplify operation, the estimated spill risk each year would be (80 miles) (50 X $10^{-5}$/year/mile) = 0.0400 spills per year.

Over a 22-year life of the pipeline (1978-2000), calculations using the binomial formula give spill probabilities as follows:

no spill - $(0.9600)^{22}$ = 40.73 percent

one spill - $(0.4073)\ (22)\ (\frac{0.0400}{0.9600})$ = 37.34 percent

two spills - $(0.3734)\ (\frac{21}{2})\ (\frac{0.0400}{0.9600})$ = 16.34 percent

Although the computational method implies no more than one spill per year, by computing daily risk the chance of two spills in one year can be estimated at 0.0824 percent. For 22 years, the chances would be:

no spill = 40.130 percent

one spill = 36.638 percent

two spills = 16.723 percent

The difference between the two probabilities is small.

If the pipeline were emptied when not in use, and the filling and emptying rates were the same as for the barges, the period of use could be calculated as follows:

for 5 fills, (27 million bbl X 5) / 85,000 bbl/day = 1588 days

for 5 empties, 150 days X 5 = 750 days

2338 days = 6.41 years

The probability of spills during the project lifetime would be estimated as:

$$\text{none} - (0.9600)^{6.41} = 76.98 \text{ percent}$$

$$\text{one} - (6.41)(0.7698)\left(\frac{0.0400}{0.9600}\right) = 20.56 \text{ percent}$$

$$\text{two} - \left(\frac{6.41}{2}\right)(0.2056)\left(\frac{0.0400}{0.9600}\right) = 2.75 \text{ percent}$$

There is less risk than would be incurred using the pipeline for additional oil storage.

If the filling and emptying rates were both 150 days, the oil spill risk would be further reduced. The use period would be 4.11 years and the probabilities over the project life would become:

no spills = 84.55 percent
one spill = 14.48 percent
two spills = 1.24 percent

In considering risk reduction by increasing pumping rates and cutting down the use period, it is axiomatic that the pumping pressure be within the pipeline design rating. The pipeline itself would still be at risk during standby periods: instead of oil, the surging fluid would be susceptible to spill.

The maximum credible spill for the pipeline can be judged from various combined static and pumping losses. The maximum pumping rate would be about 125 barrels per minute to handle 27 million barrel in 150 days. A 40-inch line would contain 8300 barrels per mile. The leak detection capability would vary with the size of the leak. However, a state of the art system has been assumed, with some allowances for operator hesitation:

| Break Severity | Loss Description | | Volume of Oil Loss |
|---|---|---|---|
| Total break: | 1 mile of line + 10 minutes pumping | = | 9,550 barrels |
| 10 percent break: | 1 mile of line + 1 hour pumping | = | 9,050 barrels |
| 2 percent break: | 1 mile of line + 12 hours pumping | = | 10,100 barrels |

The latter situations are contrived by assuming worst conditions. The metering system should be able to react to a cumulative difference of 200 barrels in one hour or more, but it could be set for lower sensitivity to avoid unnecessary shutdowns due to line operating pressure surges. A maximum credible spill of 10,000 barrels has been assumed. Suction could be applied to the pipeline from the pumping station or terminal to minimize oil loss after shutdown.

The average crude spill from the Office of Pipeline Safety data base (DOT, 1969-74) is 1083 barrels. The size distribution may be approximated as:

| Spill Size (bbl) | Percent Occurrence | Contribution To Expectation (bbl) |
|---|---|---|
| 0 - 200 | 10 | 10 |
| 200 - 500 | 20 | 70 |
| 500 - 1,000 | 27 | 202.5 |
| 1,000 - 2,000 | 36 | 540 |
| 2,000 - 5,000 | 5.7 | 199.5 |
| 5,000 - 10,000 | 1.3 | 97 |
| | | 1,119.5 bbl (1083 bbl exact, 3.4% error) |

## G.3 TERMINAL SPILLS

The average rate of occurrence of terminal spills (Department of Transportation data base, 1968-73) is about 50 per year, based on an estimated 9.1 million barrels per day average throughput. This is an accident rate of $1.5 \times 10^{-8}$ incidents per barrel throughput. However, oil moving from production to market can pass through from 5 to 15 separate terminals, so the average incident rate per terminal is much lower.

The chance of spilling oil in a terminal also varies with thé number and type of operations involved. For example, distributing oil among several tanks is more risk-prone than filling a single tank, because about one-sixth of the spills are due to operator error, rather than equipment failure. The Cote Blanche terminal, with a single reservoir, is the simplest type of terminal.

A spill frequency of $1.5 \times 10^{-9}$ per barrel (10% of total rate) can be assigned to an average U.S. terminal. Because of the comparative simplicity of the Cote Blanche terminal -- the lack of switching operations and interconnecting linkages -- this terminal is estimated to have a failure rate of one-third the U.S. 1968-73 average, or $5 \times 10^{-10}$ events per barrel throughput. Since the throughput per fill or withdrawal would be 27 million barrels, the frequency of terminal spill per fill would be 0.0135, or 1 chance in 74.

The chance of a spill in 10 fill-empty events would be:

$$\text{no spills} = (0.9865)^{10} = 87.291 \text{ percent}$$

$$\text{one spill} = 10(0.87291)\left(\frac{0.0135}{0.9865}\right) = 11.946 \text{ percent}$$

$$\text{two spills} = 4.5(0.11946)\left(\frac{0.0135}{0.9865}\right) = 00.736 \text{ percent}$$

A negligible error is introduced by a computing basis which excludes the chance of two spills in one filling. By taking the chance per million barrels, one finds the chance of two spills in one filling to be:

$$351\ (0.9995)^{25}\ (0.0005)^2 = 0.00867 \text{ percent,}$$

which is insignificant.

The use of throughput as the parameter basis for exposure may not be completely valid. Volume in storage would appear to be equally suitable as a risk variable in terminals, and some combination of these two may be the most appropriate descriptor of an average terminal spill risk. Adequate data to establish such a descriptor do not exist, however, so the use of judgmental models in describing terminal spills is necessary. Underground salt dome storage terminals, however, are not typical of the average terminal in the 1968-73 data base. If terminal spill risk is equally dependent on events related to throughput and events related to volume, the assertion that the Cote Blanche (and similar) terminals would result in one-third the spill frequency of an average terminal is equivalent to assuming that volume-related spills would be virtually eliminated, and throughput-related spills (mainly pumping) would be reduced 30 percent.

The average spill size for terminals is not separable from that for pipelines, since both are reported in the same data base. The average spill is reported to be 1,083 barrels. However, with the elimination of storage reservoir spills, Cote Blanche becomes an atypical sample. Using accidental draining of the piping system associated with one barge dock as an average instead of the historical value, the estimated average spill would be 300 barrels.

The maximum credible spill size which would be determined using situations applicable to pipelines (full flow rupture, and slowly detected partial rupture plus drainage from the system) leads to a maximum credible spill of about 1,000 barrels for the barge supply alternative. However, since pipelines have been considered as an alternative, the maximum credible spill size has been taken arbitrarily (and conservatively) to be half that of a 40-inch pipeline (i.e., 5,000 barrels).

The fitted spill distribution (by a histogram approximation) is:

| Spill Size (bbl) | Percent Occurrence | Contribution To Expectation (bbl) |
|---|---|---|
| 0 - 200 | 45.5 | 34.10 (adjusted) |
| 200 - 500 | 41.5 | 145.25 |
| 500 - 1,000 | 10.0 | 75.00 |
| 1,000 - 2,000 | 2.5 | 37.50 |
| 2,000 - 5,000 | 0.5 | 17.50 |
| | | 309.83 (3% error) |

## G.4 BARGE LOADING SPILLS

The two most generally applied measures of loading and unloading spill occurrences are:

a. Volume loss rate: The amount of gross throughput spilled over a substantial operating period, generally ranging from $0.5 \times 10^{-6}$ to $9 \times 10^{-6}$ units spilled per unit throughput.

b. Port call spill rate: The number of spills per tanker call, or per barge call, generally ranging from 1 per 18 to 1 per 20.

U.S. data collection rules were changed in 1970, which required many terminals to include as an event those spills that create a sheen on the water. (Some operators had done this previously.) The effect of including more small events is to shift the average spill size to rather low values. It has been observed that wave and/or roughness exposures increase the frequency of transfer spills. It is possible that average spill size may be correlated to cargo sizes and pumping rates. Such trends can be noted in comparing records of different ports, but have not been correlated into a form suitable for predictive estimation.

An estimate of $0.3 \times 10^{-6}$ for the volume loss rate in sheltered single point and conventional moorings was made in a 1974 projection for Washington State (Oceanographic Institute of Washington, 1974). Part of the data base used in that study was supplied by the Standard Oil Company of California, for which the pertinent parameters are (COFRC, 1975):

| | |
|---|---|
| Volume loss rate | - $1 \times 10^{-6}$ |
| Spills per port call | - 1 in 62.5 |
| Average spill size | - 7.1 bbl |

These data covered two sites, one of which had a port call record of one spill per 120 calls. This was the more sheltered site, and its performance record has been used as an estimate of the unloading spill frequency. Loading spills have been generally documented as more frequent than unloading spills, but applicable exact comparisons are not available. The loading spill frequency has been estimated such that the average projected spill frequency is 1 in 90 barge calls.

The volume spill rate of $0.5 \times 10^{-6}$ may be reasonable, but a more pessimistic rate of $1 \times 10^{-6}$ has been assumed for unloading the vessels. For loading spills, the volume spill rate was assumed to double to $2 \times 10^{-6}$.

The resultant projected spills per cycle became:

| Volume | | 27 million bbl |
|---|---|---|
| Barge calls | | 1080 |
| Cavern fill | - volume spilled | 27 bbl |
| | - number of spills | 9 |
| | - average size | 3 bbl |
| Cavern withdrawal | - volume spilled | 54 bbl |
| | - number of spills | 15 |
| | - average size | 3.6 bbl |
| Total project lifetime (5 cycles) | - volume spilled | 405 bbl |
| | - number of spills | 120 |
| | - average size | 3.4 bbl |

For vessel-to-vessel or vessel-to-SPM transfer, both fill and withdrawal operations occur simultaneously. For these situations, the volume spill rate has been taken as $3 \times 10^{-6}$.

## G.5 COMMENTS ON TECHNICAL ASPECTS OF RISK

### G.5.1 Maximum Spills

The risk analysis in an EIS is aimed at revealing both a reasonable picture of what is likely to occur, and also a reasonable picture of the worst that may occur. The use of maximum credible spill events which are not the worst imaginable might seem incompatible with this latter goal. In particular, discounting the chances of a spill of 27 million barrels may not seem reasonable. A pipeline spill of 160,000 barrels has been recorded in the United States, as has a barge spill of 5,000 barrels. The key ingredient in those large spills was negligence. The pipeline was reported to have flowed ruptured for 10 days. The barge was loaded with an open porting valve, which no one noticed. It can be considered likely that, at some time in the program, someone could repeat such an error, but it would not go unnoticed beyond the required inspection period.

There are also ways to spill the cavern contents (for example, by permitting uncontrolled solution mining in adjacent salt), but these can be disregarded as results of irresponsible actions.

Another common factor in catastrophic incidents is frequently unrecognized risks. The primary factor in discounting the chances of releasing the total cavern contents is recognition of the necessity of a fail-safe shaft seal.

### G.5.2 Expectation

Statements of expectation, such as: "the expected number of spills is 0.2"; "the spill expectation is 40 barrels per year, with maximum credible spill of 1,000 barrels"; frequently confuse readers not familiar with the concept. Expectation is the average over a hypothetical, large sample. Hypothetically, if the event described above were replicated 5 times, then a spill would be expected in one of them. If the situation were hypothetically extended over several thousand years, some of the events would be of thousand-barrel size.

For the barge spills, in a 22-year period, there may be from none to two (or more) casualty spills. The chances of having a spill between 5,000 and 20,000 barrels is about 1 chance in 163, or about once every 3600 years. One could occur in the 22-year period of the project, but it would be unlikely.

G.5.3 Distribution

The statement that spill sizes are log normally distributed, means basically that larger spills tend to occur less frequently than do smaller ones. The use of spill size intervals (histogram fitting) and the truncation of the distribution at a maximum credible spill size introduce some mathematical error, relative to the log normal formula, which does not detract from the descriptive usefulness of the results.

The applicability of using log normal distribution has not been indicated historically for all of the types of spills considered here -- terminals, loading spills, etc. -- but has been shown to be a valid descriptor for several types of oil spills over a broad range of sizes. It is considered appropriate to use it as the best likely estimator because of its fundamental relation to the theory of extremes (predicting the large event from a data set of small events), and because of the wide base of random causes generating oil spills.

G.5.4 Accuracy

The parameters used to describe spill risks are subject to many sources of error, such as:

- Error in the data, primarily size estimation of reported spills
- Error in the exposure base
- Use of incomplete exposure bases (as discussed for terminal spills)
- Finite size of the data record
- Systemic changes which change event probabilities from those recorded in the data base. In many instances, such systemic changes have been projected in the parameters.

The accuracy of the data typically ranges from ± 2 percent to ± 10 percent; the accuracy of the exposure base, from ± 5 percent to ± 10 percent; and the overall accuracy of projection, from ± 10 percent to ± 20 percent. With introduction of judgmental factors and approximations, probable error could range even more widely. Because the full impact of regulatory action in reducing casualty and operating spills is largely ignored in spill estimations, the most likely error is overpredicting spillage.

The major source of variability in the results lies not in errors in the projection parameters, but with the random occurrence of events over a short time period. Suppose there is one spill in 22 years from a large collision. Such a spill could involve any size outflow (with the larger less likely) from 10 to 20,000 barrels. This variability of impact from Cote Blanche storage makes the question of whether the return period for a 5,000- to 20,000-barrel spill should be 4320 or 2880 years, instead of 3600 years, somewhat academic. In the context of storing one billion barrels, however, the error is more significant. If the expectation of spillage (0.002 percent) is applied to one billion barrels, one is speaking of 20,000 barrels ± 4,000 barrels as the expectation. However, one cannot say that other storage methods and locations in the program would have as low an expectation as the salt dome caverns.

## G.6 DEGRADATION AND CLEANUP OF OIL

The prototypical spreading of petroleum on the surface of water involves three phases. The areal spreading passes first quickly through a gravity-controlled regime, then into a viscous-spreading regime (area varying as the square root of the time) and finally a surface tension spreading regime (area varying as the 3/2 power of time). Eventually, at a theoretical ultimate area, spreading will cease because surface tension forces between the oil and water are balanced.

In nature, oil slicks tend to be patchy, with some lumping of oil globules and oil-water emulsions resulting from any turbulent mixing. The prototypical homogeneous model remains a convenient description of averaged conditions, however. The shift to surface tension spreading occurs within 10 hours for a 2000-barrel spill, and within 20 hours for a 10,000-barrel spill. The average surface density of the slick at the onset of surface tension spreading is about 10 barrels per acre and, at the theoretical spreading limit, about 1-2 barrels per acre. Wind can accelerate spreading up to a factor of 10. The spreading velocity at the onset of surface tension spreading is a deceptively low 0.03 feet/second in still water, increasing up to 0.3 feet/second with the wind.

The action of skimmers is to concentrate the oil film behind sweeping booms, and then to skim and separate the film, generally with an oleophilic wick or belt. The relative velocity of a boom with respect to the water is limited to about 1.0 knot (maximum 1.5 knots) to avoid underflow of the oil. In open bay waters, 150- to 400-foot widths can be covered (20 to 50 acres per hour). In waters restricted by banks, jetties, sandbars, etc., widths of only 15 to 50 feet can be achieved (2 to 7 acres per hour). In particular, the Intracoastal Waterway has an area of 15 acres per mile, so maximum skimming capacity is about 0.5 mile per hour for one skimmer. In the side channels, depth restrictions limit skimmer entry. In some marsh areas, men in hand-poled scows would have to do the cleanup by spreading and collecting sorbents.

Booms across the channels are effective in holding oil spills in or out of low current areas. However, oil spreading into wet marsh is very difficult to contain until a channel deep enough to set a shallow boom is reached. The use of surface tension agents (herders) in channels and other enclosed waters required advance approval in developing the spill contingency plan. Because of toxicity, it is likely that detergents will be used sparingly for cleaning boats, and perhaps rocks. Currently, sinking agents are explicitly prohibited. EPA regulations also preclude petroleum-based oil solvents for cleaning vessels, since their ultimate deposition in the water is equivalent to a spill -- i.e., a sheen is created. Such solvents can also be toxic to local marine life.

If a spill is contained in an area with sand-defined banks (as opposed to marsh edge along the channel), then between 60 and 75 percent of the oil can ultimately be recovered. If the spill disperses into a marsh, or dissipates into open water, recovery efficiency will decline. Spills occurring during squally, windy weather may also be dispersed by the wind, reducing ultimate recovery.

Up to 25 or 30 percent of the lighter oil fractions can be assumed permanently lost into the air and water (primarily the air) by evaporatior and dissolution. The ultimate fate of oil not evaporated or recovered will depend on the exposure to air and potential microbial action. The three major competing processes are:

1. Degradation - chemical breakdown and consumption of the material by bacteria, photo-oxidation, or other chemical paths.
2. Weathering - continuing evaporation of lighter fractions until only residue tars remain.
3. Preservation - Formulation of globules at the surface which weather and develop a hard protective shell, so that inner portions are protected from further degradation and are preserved.

For oils deposited in the swamps, slow degradation is the most probable ultimate fate. For globules in the water, eventual deposition in sediments and preservation in the sediments is likely.

APPENDIX H - COMMENTS RECEIVED

Advisory Council on
Historic Preservation
1522 K Street N.W.
Washington, D.C. 20005

October 1, 1976

Mr. Robert L. Davies
Deputy Assistant Administrator
Strategic Petroleum Reserve
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Davies:

This is in response to your letter of September 10, 1976 for comments on the draft environmental statements for the proposed storage of crude oil at the Weeks Island salt mine located in Iberia Parish, Louisiana and at the Cote Blanche salt mine located in St. Mary Parish, Louisiana. The Advisory Council notes that cultural resource studies to date indicate no properties included in or known to be eligible for inclusion in the National Register of Historic Places will be affected by the proposed project, but that an archeologist will be on site to monitor construction activity. Accordingly, we wish to remind Federal Energy Administration that should previously unknown cultural resources be encountered during construction which are subsequently determined to be eligible for inclusion in the National Register, it is required to afford the Council an opportunity to comment in accordance with the "Procedures for the Protection of Historic and Cultural Properties" (36 C.F.R. Part 800) prior to taking any action with respect to the undertaking, including salvage of the cultural resource.

Should you have questions or require additional assistance in this matter, please contact Michael H. Bureman of the Council staff at P.O. Box 25085, Denver, Colorado 80225, telephone number (303) 234-4946.

Sincerely yours,

Louis S. Wall
Assistant Director, Office
of Review and Compliance

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
FIRST INTERNATIONAL BUILDING
1201 ELM STREET
DALLAS, TEXAS 75270

November 1, 1976

Mr. Robert L. Davies
Deputy Assistant Administrator
Executive Communications - Room 3309
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Davies:

We have reviewed the Draft Environmental Impact Statement for the Strategic Petroleum Reserve at Weeks Island Mine in Iberia Parish, Louisiana. The purpose of the Reserve is to mitigate the social and economic impacts of any future interruptions of petroleum imports to the United States of America. The Reserve will store 150 million barrels of oil by December of 1978 in the Early Storage Reserve (ESR), and 500 million barrels by 1982 under the entire program.

Petroleum will be stored underground in conventional mines or solution-mined salt cavities, or above-ground in conventional tanks. The proposed action at Weeks Island is part of the ESR and is to store 89 million barrels of oil in a conventional salt mine presently owned and operated by Morton Salt Company.

The statement discusses many of the impacts which could be associated with the project; however, we offer the following comments for your consideration in developing the Final Environmental Impact Statement (EIS):

1. The discussion on page 2.1-2 regarding disposal of dredged spoil and possible overburden from shaft excavation should specify the location of the disposal site. Likewise, information should be given on the degree of treatment that will be given to the oil-contaminated brine to be released into the Intracoastal Waterway (ICW).

2. The description of the operation of this facility on page 2.3-8 should detail the arrangements for withdrawing oil from storage, i.e., whether it is to be pumped directly or displaced by water. We assume direct pumping is to be used; however, if the mine will be cycled with water, there should be a full discussion of the impacts of the treatment and disposal of this oil-contaminated brine. Included should be a quantitative discussion of the evaporative hydrocarbon emissions that may be emitted to the atmosphere from the brine.

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3. The discussion of pipeline construction on page 4.2-7 does not specify the manner of pipeline coating and the possibility of such material leaching into the soil. This information should be included in the final statement.

4. There appears to be a contradiction of estimates of the maximum credible oil spill that could occur while filling or emptying the storage cavity. Page 4.3-37 states that such a spill would equal 500 bbls, while page 4.3-67 estimates the spill would equal 5000 bbls. This inconsistency should be clarified in the final statement.

5. The section on alternatives describes a possible pipeline to link the storage facilities to the Saint James terminus of the Alpine System. Provision should be made for hydrostatic testing of this line as well as for the pipelines at both the Cote Blanche and Weeks Island storage facilities.

6. The discussion on alternatives should also address the possibility of later use of the LOOP Deepwater Port facility and St. James connecting pipeline (assuming construction of the proposed line between Cote Blanche/Weeks Island and St. James) to provide for SPR filling after 1980. Pipeline delivery of oil to the storage facility would significantly decrease the probability of oil spills associated with other transport modes.

7. In Section 5.2, vapor control systems are discussed in general for reducing hydrocarbon emissions to the atmosphere. Selection of a specific system should be made and described as part of the project design to prevent the addition of hydrocarbon burden on the ambient air and associated photochemical oxidant levels that may be encountered in the affected area.

8. The discussion in Section 3.4.3 on existing air quality should include the existing levels of photochemical oxidants in the project area. Oxidant air quality data recorded in 1975 in the Southern Louisiana-Southeast Texas Air Quality Control Region (AQCR) recorded second-high oxidant levels for the Baton Rouge area at 0.170 parts per million (ppm), New Orleans at 0.094 ppm, and Lake Charles at 0.174 ppm. The standard for photochemical oxidant is 0.08 ppm for one hour, not to be exceeded more than once per year, and this should be documented in Table 3.4-13. In the discussion on air quality impacts (Section 4.3.3) it is stated that the Louisiana State Implementation Plan (SIP) "has not yet been developed to detail projected levels of air quality by region, but the primary standards are expected to be met by the end of 1976 in all areas." However, the Louisiana SIP required revision for photochemical oxidants for the Louisiana portion of the Southern Louisiana-Southeast Texas AQCR (41 Federal Register, No. 138, July 16, 1976). The state is required to submit a revision of the SIP to achieve emission

limitations needed to provide for the attainment of the national standard for photochemical oxidants by July 1977. The inclusion of the above information would strengthen the final statement.

These comments classify your Draft Environmental Impact Statement as LO-2. Generally, we have no objections to the project as proposed in the Draft Environmental Impact Statement. However, we are requesting more information on facility operation and existing air quality within project area. The classification and the date of our comments will be published in the Federal Register in accordance with our responsibility to inform the public of our views on proposed Federal actions, under Section 309 of the Clean Air Act.

Definitions of the categories are provided on the attachment. Our procedure is to categorize our comments on both the environmental consequences of the proposed action and on the adequacy of the impact statement at the draft stage, whenever possible.

We appreciate the opportunity to review the Draft Environmental Impact Statement, and we would be happy to discuss our comments with you. Please send us two copies of the Final Environmental Impact Statement at the same time it is sent to the Council on Environmental Quality.

Sincerely yours,

John C. White

John C. White
Regional Administrator

Enclosure

FEDERAL POWER COMMISSION
WASHINGTON, D.C. 20426

IN REPLY REFER TO:

OCT 14 1976

Executive Communications
Room 3309
Federal Energy Administration
Washington, D.C. 20461

245001

Gentlemen:

We appreciate the opportunity to comment on the five site-specific Draft Environmental Impact Statements for the proposed Strategic Petroleum Reserve (SPR) mandated by Congress under the Energy Policy and Conservation Act of 1975 (P.L. 94-163). We note that this act requires that by 1983 the SPR contain a reserve of approximately 500 million barrels of crude oil to provide protection from potential disruptions to the national supply of petroleum products.

The Federal Power Commission, Bureau of Natural Gas staff has reviewed the SPR impact statements and offers the following comments:

> At the five site locations analyzed, there does not appear to be any conflict between the development of the SPR and the continued production, transportation, and sale of natural gas from domestic sources. It therefore does not appear that the proposed project presents any conflict with FPC jurisdictional interests.
>
> The staff believes that the development of an SPR would protect the supply of energy sources other than oil itself during an emergency. A drastic reduction in oil availability could, for example, be accompanied by increased demand for natural gas for use in electric generation. Such use is regarded as inferior and as having a low priority in view of the needs of industrial, commercial, and residential customers who are feeling the impact of a worsening natural gas shortage. The SPR would lessen the impact of a simultaneous shortage in oil and gas which together provide about three-quarters of the energy consumed in this country.

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The Federal Power Commission is actively directing its attention and efforts toward regulatory actions to improve the current imbalance between natural gas supply and demand. After reviewing the SPR site-specific draft environmental impact statements, we believe that the proposed project would be in the national interest.

S. William Yost, Chief
Bureau of Natural Gas

UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

NOV 4 1976

Executive Communications
Room 3309
Federal Energy Administration
Washington, D. C. 20461

00001

Dear Sirs:

This is in response to your letter of September 10, 1976, inviting our comments on the draft environmental statements concerning the following projects:

West Hackberry Salt Dome, DES 76-4
Bayou Choctaw Salt Dome, DES 76-5
Bryan Mound Salt Dome, DES 76-6
Cote Blanche Mine, DES 76-7
Weeks Island Mine, DES 76-8

We have reviewed the statements and have determined that the proposed actions, per se, have neither radiological health and safety aspects nor will they adversely affect any activities subject to regulation by the Nuclear Regulatory Commission. Accordingly, we have no comments to offer.

Thank you for providing us with the opportunity to review these draft environmental impact statements.

Sincerely,

Voss A. Moore

Voss A. Moore, Assistant Director
for Environmental Projects
Division of Site Safety and
Environmental Analysis

TENNESSEE VALLEY AUTHORITY
CHATTANOOGA, TENNESSEE 37401

October 28, 1976

Mr. Robert L. Davies
Deputy Assistant Administrator
Federal Energy Administration
Room 3309, Executive Communications
Washington, D.C. 20461

Dear Mr. Davies.

We have determined that we have no significant substantive comments on any of the five sites or statements involved in the Strategic Petroleum Reserve.

Sincerely,

Peter A. Krenkel, Ph.D., P.E.
Director of Environmental Planning

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U.S. DEPARTMENT OF TRANSPORTATION

REGIONAL REPRESENTATIVE OF THE SECRETARY
9-C-18 FEDERAL CENTER
1100 COMMERCE STREET
DALLAS, TEXAS 75202

SWFRC
Consumer Aff.
EEO
PIO
Legal
Area Mgrs.

October 27, 1976

Mr. Delbert Fowler
Regional Administrator
Federal Energy Administration
P. O. Box 35228
Dallas, Texas 75235

Dear Del:

Enclosed are comments concerning Environmental Impact Statements covering Weeks Island and Cote Blanche Mines and West Hackberry and Bayou Choctaw Salt Domes. One additional copy has been provided for your Washington office.

Thank you for the opportunity to review the Statements.

Sincerely,

Ed Foreman

ljb
Enclosures

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Form FHWA 121 (Rev. 5-73)

UNITED STATES GOVERNMENT

DEPARTMENT OF TRANSPORTATION
FEDERAL HIGHWAY ADMINISTRATION

# Memorandum

SUBJECT: Other Agency Statements
Federal Energy Administration
Strategic Petroleum Reserve
Weeks Island and Cote Blanche Mines
West Hackberry and Bayou Choctaw Salt Domes

DATE: October 15, 1976

In reply refer to: 06-22.2

FROM: Division Administrator
Baton Rouge, Louisiana

TO: Mr.J. W. White, Regional Administrator
06-00.8 Fort Worth, Texas

Your September 27, 1976, memorandum requested our review and comments on the subject statements.

The following comments are offered for your consideration in responding to the Federal Energy Administration:

Circulation of the draft environmental impact statements to state agencies was handled through the state clearing houses. It would appear that for states where the proposed sites are located, direct circulation to affected state agencies would be appropriate.

For both the Bayou Choctaw and the West Hackberry Salt Dome facilities associated proposed pipeline alternatives will cross or utilize highway right-of-way. Coordination with the Louisiana Department of Highways is recommended, if not already done.

Table 9.2, page 9-5, in the West Hackberry statement, list Texas regulatory bodies instead of appropriate Louisiana regulatory bodies.

Consultation with the Louisiana Department of Highways is recommended if overweight construction traffic is anticipated during construction of the facility.

The proposed Strategic Petroleum Reserve sites should not have any adverse effect on the highway transportation facilities in the affected areas.

for M. C. Reinhardt

THE DEPARTMENT OF THE TREASURY
WASHINGTON, D.C. 20220

ASSISTANT SECRETARY

NOV 1 1976

Dear Mr. Davies:

This is in response to your letter of September 16 requesting that this Department review and comment on the draft environmental impact statements for the first five candidate sites selected for possible use as petroleum storage facilities for the Early Storage Reserve. We find the statements to be objectively directed to their stated purpose and it appears that the salt dome and mine storage facilities addressed in the statements are superior to above ground storage from both the economic and environmental viewpoints.

The Department supports the concept of a strategic petroleum stockpile and considers it to be an essential national need. However, we wish to reiterate that such facilities and the petroleum stored therein should be owned by the Government and that the costs should be borne directly by the beneficiaries -- the U.S. energy consumers.

One other comment applicable to the five statements concerns the implication that among the benefits or costs of each project is the employment effects, positive in the case of employing construction workers to build storage facilities and negative in the case of "laying-off" salt mine workers. Conventional cost-benefit analysis deals with a national rather than a regional perspective and assumes a full employment economy. Under such assumptions employment effects are considered neither costs nor benefits since one more job in any region implies one less job elsewhere.

Similarly the "cost" of laying-off salt mine workers is not a cost at all if alternative employment opportunities exist. Some social costs of lay-offs, such as unemployment compensation paid during the time workers are between jobs, might be expected, but these costs relative to the "normal" job turnover costs for the region involved can be expected to be miniscule and probably need not be considered in the analyses.

Thank you for the opportunity to review the statements and I trust that our comments will be of assistance in the preparation of the final environmental impact statements.

Sincerely,

Warren F. Brecht
Assistant Secretary (Administration)

Mr. Robert L. Davies
Deputy Assistant Administrator for
Strategic Petroleum Reserves
Federal Energy Administration
1726 M Street, N.W.
Washington, D.C. 20461

DEPARTMENT OF THE ARMY
NEW ORLEANS DISTRICT. CORPS OF ENGINEERS
P O BOX 60267
NEW ORLEANS LOUISIANA 70160

IN REPLY REFER TO
LMNPD-RE

10 November 1976

Mr. Steven E. Ferguson
Executive Communications
Room 3309
Federal Energy Administration
Washington, DC 20461

Dear Mr. Ferguson:

Your draft environmental impact statements (EIS) for the first five candidate sites selected for possible use as petroleum storage facilities for the initial phase of the Strategic Petroleum Reserve (SPR) were referred to this office from our Washington Office for comment.

We have reviewed the EIS's for the following candidate sites: West Hackberry salt dome, Bayou Choctaw salt dome, Cote Blanche Island mine, Weeks Island mine, and Bryan Mound salt dome. They have been reviewed in accordance with our areas of responsibility and expertise as outlined in the Council on Environmental Quality guidelines, Title 40 C.F.R., part 1500, published in the Federal Register dated 1 August 1973, and US Army Corps of Engineers administrative procedures for permit activities in navigable waters or ocean waters, Title 33, C.F.R., Part 209, published in the Federal Register dated 25 July 1975.

We offer the following comments regarding the five draft impact statements for your consideration:

c. Comments on Cote Blanche Island mine and Weeks Island mine sites.

(1) General Comments.

(a) The EIS's for both these sites are almost identical except for site description and page numbering. Comments here are applicable to both sites; however, for reference purposes, the page numbers used are those in the Cote Blanche mine EIS.

(b) Site-specific information on the flora and fauna on these two islands is lacking. Data cited in most cases are from studies which did not include sampling in the project area. Deletion of non-site-specific data and inclusion of data from on-site investigations would substantially improve the statements.

(c) Due to the limited area that would be affected, the Cote Blanche and the Weeks Island sites would be the most environmentally acceptable, as far as the impacts upon the water quality are concerned. The lack of pipeline canals and associated construction activities for these two alternatives appears to impact wetlands the least. The water quality data in EIS's for these two sites are deficient. Additional water quality data is required to more readily quantify the impacts in order to choose the most acceptable alternative site.

(d) Note General Comments d(4) and d(5) below.

(2) Specific comments.

(a) Page 3.1-1, paragraph 3, sentence 3. This sentence should be revised as follows: "The bays are generally shallow and are rimmed by brackish, intermediate, and fresh marshes to the north and by predominantly brackish marsh to the south."

(b) Page 3.1-1, paragraph 3, sentence 5. The only island which provides protection to the Atchafalaya Bay-Vermilion Bay complex is Marsh Island. Several oyster reefs between Marsh Island and Pointe Au Fer to the east could also provide similar protection. Gulf Coast Barrier Islands usually refer to such islands as the Timbalier Chain, Isles Dernieres, and Chandeleurs.

(c) Pages 3.4-15 through 3.4-26. Data presented in tables 3.4-1 through 3.4-12 were obtained from study areas which are located 60 and 90 miles from the project area. The utility of these data with regards to the project area is questionable. Site-specific data should be used.

(d) Page 3.4-31. Comment (c) above applies here also.

(e) Page 3.6-13, paragraph 1, sentence 1. The blue goose is the dark color phase of the lesser snow goose. This sentence should be revised as follows: "Snow geese are also...."

(f) Page 3.6-13, paragraph 1, sentence 5. The reddish egret is uncommon to rare in the project area.

(g) Page 3.6-19, paragraph 5. Change "blue goose" to "lesser snow goose."

(h) Page 3.6-20, paragraph 1, sentence 1. The American alligator was not listed as a game species in portions of Louisiana. The discussion of the American alligator should be removed from the Game Species section and moved to the Threatened and Endangered Species section.

(i) Page 3.6-21, paragraph 2, sentence 3. Change "Vermilion" to "Calcasieu."

(j) Page 3.6-22, paragraph 4. Two additional reptilian species that occur in the coastal region of Louisiana, and which are currently considered rare and endangered should be added to this section. These are the hawksbill and the leatherback turtles.

(k) Page 3.6-28, paragraph 1. The choice of studies conducted in Barataria Bay and in the Gulf of Mexico to help characterize the primary producers that could be expected to be found near these two islands is a poor one. Prevailing environmental conditions in the vicinity of the subject study areas are near marine as opposed to near freshwater conditions in Cote Blanche and Weeks Island areas.

(l) Page 3.6-28, paragraph 2, last sentence. None of the representative marsh species cited in this sentence occur in the project area.

(m) Page 3.6-40, paragraph 4. The Atlantic menhaden and the Gulf menhaden are separate species. The Gulf menhaden is the most important fish in terms of harvested weight.

(n) Page 3.6-43, sentences 1 and 2. The dollar/acre values cited are in gross error.

(o) Page 3.6-47, line 4. The American alligator is not a controlled game species.

(p) Page 3.6-58, table 3.6-6. This table should be revised to agree with Federal Register, Volume 41, No. 117, 16 June 1976, "Endangered and Threatened Species, Plants."

(q) Page 3.6-59, table 3.6-7. The hawksbill and the leatherback turtles should be added to this table, as they are known to occur in coastal Louisiana.

(r) Page 3.6-61, table 3.6-9. Data presented in this table are of no value in predicting the primary producers of the project area because the surrounding ecosystem is predominantly freshwater and the primary producers presented here are primarily marine.

(s) Page 3.6-71, table 3.6-14. Comments in (r) above apply for the same reason.

(t) Page 4.2-18, paragraph 2. The statement that the area to be excavated is similar to other Louisiana marsh systems (e.g.; Barataria Bay) is incorrect. The marshes surrounding Barataria Bay are predominantly saline as opposed to the predominantly freshwater marshes of the project area.

(u) Page 4.3-54, paragraph 2. High ambient turbidity restricts growth of submerged aquatic plants in the project area. This paragraph should be deleted.

(v) Page 8.2-28, paragraph 1. The loblolly pine is generally absent from the Mississippi River flood plain and should therefore be deleted from this paragraph.

(w) Page 8.2-28, paragraph 2. The turkey is not common in the wooded swamp traversed by the pipeline routes.

(x) Page 8.2-30, paragraph 6. Comment a(2)(b) above applies here also.

(y) Page 8.2-31, paragraph 2. Experience has shown that subsidence and oxidation limit the quantity of backfill material resulting in permanent loss of marsh habitat.

# Louisiana Air Control Commission

State Office Building
Phone (504) 527-5115

P.O. Box 60630
New Orleans 70160


October 11, 1976

Mr. Robert L. Davies
Deputy Assistant Administrator
Executive Communications, Rm. 3309
Federal Energy Administration
Washington, D.C.

RE: Strategic Petroleum Reserve. Draft Environmental Impact Statements for: Weeks Island Mine, Cote Blanche Mine, West Hackberry Salt Dome, and Bayou Chactaw Salt Dome.

Dear Mr. Davies:

This agency has reviewed the above referenced impact statements. The review indicated the section of the reports dealing with the air quality impact was not supplied. Until such data is made available to this office we are unable to comment on the proposals impact on air quality.

Very truly yours,

Orey Tanner Jr

Orey Tanner, Jr., P.E.
Air Quality Section
Louisiana State Division of Health

OT/yw

cc: Mr. DeWitt H. Braud, Jr.
Environmental Coordinator
State of Louisiana
Commission on Intergovernmental Relations
P. O. Box 44455
Baton Rouge, Louisiana 70804

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STA.E OF LOUISIANA

COMMISSION ON INTERGOVERNMENTAL RELATIONS

EDWIN EDWARDS
GOVERNOR
SENATOR MICHAEL H O'KEEFE
CHAIRMAN
LEON TARVER
EXECUTIVE DIRECTOR

P O BOX 44455
BATON ROUGE, LOUISIANA 70804
389-5864


October 13, 1976

Mr. Orey Tanner, Jr., P.E.
La. Air Control Commission
Air Quality Section
P. O. Box 60630
New Orleans, Louisiana 70160

RE: Strategic Petroleum Reserve, Draft Environmental Impact Statements for: Weeks Island Mine, Cote Blanche Mine, West Hackberry Salt Dome, and Bayou Choctaw Salt Dome.

Dear Mr. Tanner:

As indicated in our letter of transmittal of September 27, 1976, you were forwarded only excerpts from selected portions of each of the documents referenced above. As the number of available statements was limited, we hoped to provide you with enough information to make a determination of need for additional data, which we could provide.

Enclosed, please find excerpts from each document specifically pertaining to air quality impact.

If we can be of further assistance, please let us know.

Sincerely,

DeWitt H. Braud, Jr.
Environmental Coordinator

DHB:dn

Enclosures

cc: Mr. Robert L. Davies
Federal Energy Administration

ATE OF LOUISIANA
DEPARTMENT OF CONSERVATION
LOUISIANA GEOLOGICAL SURVEY

GEOLOGY BUILDING
BOX G
UNIVERSITY STATION
BATON ROUGE, LA. 70803

October 21, 1976

Mr. Robert L. Davies, Deputy Assistant Administrator
Executive Communications
Federal Energy Administration
Room 3309
Washington, D. C. 20461

Re: Stratigic Petroleum Reserve
Draft Environmental Impact Statement:
Weeks Island, Cote Blanche, West
Hackberry and Bayou Choctaw

Dear Mr. Davies:

Our staff has reviewed those sections of the (five) impact statements relative to the geological consideration involved in the Stratigic Petroleum Reserves plan.

It is our opinion that the geological presentations are well done and adequate for the purposes intended.

Thank you for the opportunity to comment.

Very truly yours,

LOUISIANA GEOLOGICAL SURVEY

Leo W. Hough, State Geologist

by: Harry L. Roland, Jr.
Assistant State Geologist

HLR:FMM

LOUISIANA STATE SOIL AND WATER CONSERVATION COMMITTEE

LOUISIANA STATE UNIVERSITY
P. O. DRAWER CS
Telephone 389-5017
BATON ROUGE, LOUISIANA 70893



October 1, 1976

Mr. Robert L. Davies
Deputy Assistant Administrator
Executive Communications, Room 3309
Federal Energy Administration
Washington, D. C. 20461

Dear Mr. Davies:

Re: Strategic Petroleum Reserve,
Draft Environmental Impact
Statements for:
Weeks Island Mine - DES 76-8
Cote Blance Mine - DES 76-7
Bayou Choctaw Salt Dome - DES 76-5
West Hackberry Salt Dome DES 76-4

A copy of the above documents have been received.

We have no additional comments to make at this time on information furnished us.

If you require further information concerning these documents, please let us know.

Sincerely,

Charley S. Staples
Executive Director

CSS:ry
cc: DeWitt H. Braud, Jr.
Fred Huenefeld, Jr.

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MORTON SALT COMPANY · 110 NORTH WACKER DRIVE · CHICAGO, ILLINOIS 60606 · (312) 621-5200

October 27, 1976

245003

Executive Communications
Box IY, Room 3309
Federal Energy Administration
Washington, D.C. 20461

Re: Draft Site-Specific EIS-Strategic Petroleum Reserves-Weeks Island Salt Mine, Iberia Parish, La.

Gentlemen:

The Federal Register, Volume 41, Number 178 of Monday, September 13, 1976 announced the availability of Draft Site-Specific Environmental Impact Statements for the Strategic Petroleum Reserve Program and invites interested persons to submit data, views or arguments. Morton Salt Company, a Division of Morton-Norwich Products, Inc. is the owner and operator of the Weeks Island salt mine in Iberia Parish, La., one of the five sites being considered for the storage of the Early Storage Reserve. Morton Salt Company is therefore an interested person and wishes to comment on the Draft Environmental Impact Statement for the Weeks Island mine, DES 76-8 as follows.

Numerous references are made to the socio-economic impact of temporarily shutting down the existing mine operations. For example, paragraph 5.3.4 states, "If a decision were made to temporarily close down the existing mine operations, an estimated 140 employees would not be able to find suitable work in the area. Despite efforts to hire as many of these as possible for project construction, many will not be suited to the available jobs. Resulting social and economic impacts from these individuals and their families will likely be severe though of relatively short duration."

At weeks Island, Morton Salt Company conducts two, somewhat independent operations. One is the mining and processing of rock salt, the other is the production of evaporated salt. Rock salt is produced by "dry mining" methods

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DIVISION OF MORTON-NORWICH PRODUCTS INC

similar to those employed in coal mining. Evaporated salt is produced by "solution mining" from brine wells, with the brine then being processed through vacuum pans and associated equipment to yield screened dry salt.

In the event of a temporary shut down of the rock salt mine only those employees directly associated with the rock salt mining operation would be affected. If the timing of the temporary shut down was such that a stockpile to draw upon could be developed ahead of time, then only about 53 employees would be expected to be displaced. On the other hand, if the timing was such that a stockpile could not be developed, then about 71 employees would probably be displaced. These figures must be considered in light of the following facts:

(1) According to the Draft Environmental Impact Statement, the FEA has estimated that 60 displaced workers could be employed in the constructions projects, an additional 15 in transporting the oil to the reserve and an additional 15 in transporting the oil from the barge location to the mine.

(2) The typical labor turnover at the Weeks Island operation of the Morton Salt Co. is 20 employees per year.

(3) The total employment in Iberia Parish is approximately 20,000 and in the Acadiana Region 140,000.

In this context, the socio-economic impact of a temporary shut-down of the Weeks Island mine would be insignificant.

Yours very truly,

H. W. Diamond

H. W. Diamond

HWD:bc