DOE/EIS-0029

Final Environmental Impact Statement

(Final Statement to FEA-DES-77-8)

STRATEGIC PETROLEUM RESERVE

Texoma Group Salt Domes

(West Hackberry Expansion, Black Bayou, Vinton, Big Hill)

Cameron and Calcasieu Parishes, Louisiana and Jefferson County, Texas

U.S. DEPARTMENT OF ENERGY

November 1978
Volume 1 of 5

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Responsible Official

Ruth C. Clusen
Assistant Secretary for Environment

U.S. DEPARTMENT OF ENERGY
Washington, D.C. 20545

November 1978
Volume 1 of 5

SUMMARY

STATEMENT TYPE: ( ) Draft (X) Final Environmental Statement

PREPARED BY: The Strategic Petroleum Reserve Office, U.S. Department of Energy, Washington, D.C. 20461

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

2. Brief Description of the Proposed Action:

This document is a site specific Environmental Impact Statement (EIS) for four proposed candidate sites from the Texoma group of salt domes located in the Gulf Coast region of southwestern Louisiana and southeastern Texas. It also serves to supplement the Sulphur Mines Final Environmental Impact Statement by examining a new alternative water intake pipeline to the ICW, allowing use of a single water intake for Sulphur Mines and West Hackberry. The primary site for Strategic Petroleum Reserve (SPR) development in the Texoma group is an expansion of the West Hackberry Early Storage Reserve (ESR) facility located in Cameron Parish, Louisiana. The three other candidates are new sites. They are the Black Bayou salt dome located in Cameron Parish, Louisiana, the Vinton salt dome in Calcasieu Parish, Louisiana, and the Big Hill salt dome in Jefferson County, Texas. One or a combination of these three sites may be developed as an alternative to the expansion of the West Hackberry ESR facility.

This project is part of the Strategic Petroleum Reserve (SPR) program currently being implemented by the Department of Energy (DOE). 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 reserve to minimize the effects of any future oil supply interruption.

3. Summary of Environmental Impacts and Adverse Environmental Effects:

This site specific EIS analyzes the environmental impacts which would occur during site preparation and operation of oil storage facilities at each of the four locations.

The construction activities necessary to develop storage cavities, terminal facilities and pipelines required for the Texoma Group of SPR sites would result in topographical modification of the site areas due to onsite fill, excavation and surface grading; degradation of water quality due to increased sediment load caused by resuspension during dredging and by erosion; degradation of air quality due to fugitive dust, vehicle emissions and paint vapors; and impacts to the aquatic and terrestrial flora and fauna resulting from construction activities. These impacts are expected to be short term and would terminate soon after completion of project construction.

The most significant impacts of project operation would be the impacts on air quality due to hydrocarbon emissions associated with tanker loading and unloading; impacts on water quality due to brine disposal in the Gulf of Mexico and due to possible oil and brine spills; and impacts on flora and fauna resulting from such oil and brine spills.

Most of these impacts are expected to result regardless of which of the sites are developed. However, the extent of the impacts may vary depending on the surface characteristics of the site and lengths of pipelines constructed to connect with water supply, brine disposal and oil distrubution systems.

4. <u>Alternatives Considered</u>:

Alternative Storage Sites

- Black Bayou
- Vinton
- Big Hill

Alternative Facility Components

- West Hackberry Expansion
  - Alternative Raw Water System
  - Alternative Brine Disposal System
- Black Bayou
  - Alternative Raw Water System
  - Alternative Brine Disposal System
- Vinton
  - Alternative Raw Water System
  - Alternative Brine Disposal System
- Big Hill
  - Alternative Brine Disposal System
  - Alternative Raw Water System
  - Alternative Oil Distribution System

5. <u>Comments on the Draft Statement have been received from the following:</u>

<u>Federal</u>

U.S. Army Corps of Engineers
National Oceonic and Atmospheric Administration; St. Petersburg, Florida
National Oceonic and Atmospheric Administration; Rockville, Maryland
Environmental Protection Agency

6. <u>Date made available to EPA and the Public:</u>

The final statement was made available to the Environmental Protection Agency and the public in December 1978.

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1.0 BACKGROUND

This document is a site specific Environmental Impact Statement (EIS) for four proposed candidate sites from the Texoma group of salt domes located in the Gulf Coast region of southwestern Louisiana and southeastern Texas. The primary site for Strategic Petroleum Reserve (SPR) development in this group is an expansion of the West Hackberry Early Storage Reserve (ESR) facility located in Cameron Parish, Louisiana. The three other candidates are new sites. They are the Black Bayou salt dome located in Cameron Parish, Louisiana, the Vinton salt dome in Calcasieu Parish, Louisiana, and the Big Hill salt dome in Jefferson County, Texas. One or a combination of these three sites may be developed as an alternative to the expansion of the West Hackberry ESR facility.

This project is part of the Strategic Petroleum Reserve (SPR) program currently being implemented by the U. S. Department of Energy (DOE). 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.

On February 16, 1977, FEA transmitted the SPR Plan to Congress as Energy Action No. 10. The plan described the manner in which the Program was to be implemented. As an amendment to the Plan, an acceleration of the development schedule became effective under Energy Action No. 12 on April 18, 1977. Whereas the Act required the attainment of an Early Storage Reserve volume of 150 million barrels (mmb) of oil in storage by the end of 1978 and an SPR volume of 500 mmb of oil in storage by the end of 1982, the present accelerated schedule has established new targets of attaining 250 mmb by the end of 1978 and 500 mmb by the end of 1980. In addition, a second amendment to the Plan proposing expansion of the SPR to one billion barrels became effective under Energy Action, DOE Number 2 on June 13, 1978. These initiatives are an integral part of the President's National Energy Plan and represents a major effort to provide the U. S. with protection against the consequences of a severe petroleum supply interruption as soon as practicable.

A final programmatic environmental impact statement (FES 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 December 16, 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 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.

A total of nine sites were identified as candidates for the Early Storage Reserve program by means of a screening process involving the application of six criteria.* Five of these alternative sites were considered 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. They 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), the Cote Blanche salt mine (St. Mary Parish, Louisiana), and the Weeks Island salt mine (Iberia Parish, Louisiana). Final Environmental Impact Statements on all five candidate sites (FES 76/77-4 through FES 76/77-8, December 1976, January 1977) have been filed with the Council on Environmental Quality (CEQ) and made available to the public so that the environmental impacts associated with the possible use of these sites may be compared with one another. In addition, four final supplements addressing design changes for all five candidate sites (April, May, August and December, 1977) have been filed with CEQ. A sixth Gulf Coast site, the Sulphur Mines salt dome (Calcasieu Parish, Louisiana) was identified as a candidate site to provide additional existing storage capacity when the requirements of the accelerated schedule became known. The final EIS (DOE/EIS-0010) was made available to the Environmental Protection Agency in April, 1978. The other three candidate sites, Central Rock Mine (Fayette County, Kentucky), Ironton Mine (Lawrence County, Ohio), and Kleer Mine (Van Zandt County, Texas) were considered for distribution to inland refineries. Final EISs on these sites (FES 76/77-9 and FES 76/77-10, July 1977 and FES 77-2, September, 1977), have also been made available. To date, five sites (West Hackberry, Bayou Choctaw, Bryan Mound, Weeks Island, and Sulphur Mines) have been selected for use in the SPR.

*These criteria are existing storage capacity (or potential storage capacity for SPR), distribution accessibility, technical feasibility, potential environmental concerns, ease of acquisition and cost. Section II.E.I 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 sites, including the eight candidate ESR sites.

Three groups of candidate sites are being considered for the purpose of selecting SPR storage sites. Most of the sites are centered around three major inland pipeline terminals which transport U. S. and foreign crude oil from the Gulf Coast region to the upper mid-west area refineries. Distribution centers include the Seaway Pipeline Terminal (Freeport, Texas), the Texoma Pipeline Terminal (Nederland, Texas), and the Capline Pipeline Terminal (St. James, Louisiana), (see Figure 1.0-1). The candidate sites of each group would use the particular pipeline terminal associated with that group as the proposed location of an SPR terminal for distribution of strategic oil. A portion of the stored oil would be distributed through the pipeline to the upper midwest markets while the remainder would be distributed to local refineries and loaded onto tankers at the terminal for distribution to the East Coast and the Caribbean.

The four sites included in this document are the proposed SPR candidates from the Texoma group of salt domes. Together they total 450 million barrels of potential storage space. Thus, this document in conjunction with the final EIS for the West Hackberry ESR development (FES 76/77-4) presents the option of developing 510 million barrels of storage to provide the SPR requirements for the Texoma area. At this time, DOE projects that a maximum of approximately 210 million barrel of this capacity will be needed and has assessed the impacts accordingly. On June 13, 1978 the SPR Plan Amendment expanding the reserve to 1 billion barrels became effective. If it is determined that additional capacity must be developed in the Texoma Group in order to meet the requirements of the expanded SPR, this EIS will be supplemented as needed to assess any additional impacts which could result from increased development.

The Sulphur Mines SPR site, located 17 miles north of the West Hackberry site, is one of the Texoma group of salt domes for which a separate environmental impact statement has already been published (DOE/EIS-0010). Due to recent evidence indicating that the supply of freshwater may be inadequate to supply the oil displacement needs of the site during drawdown, a new intake location and associated pipeline corridors have been examined as a possible alternative to the water intake system proposed in the Sulphur Mines Final Environmental Impact Statement. The new intake location would be the same as that proposed for the West Hackberry SPR development and was chosen as an environmentally desirable withdrawal point. Impacts relating to the new Sulphur Mines intake location and pipeline corridors will be addressed in this document as a Supplement to the Sulphur Mines Final Environmental Impact Statement.

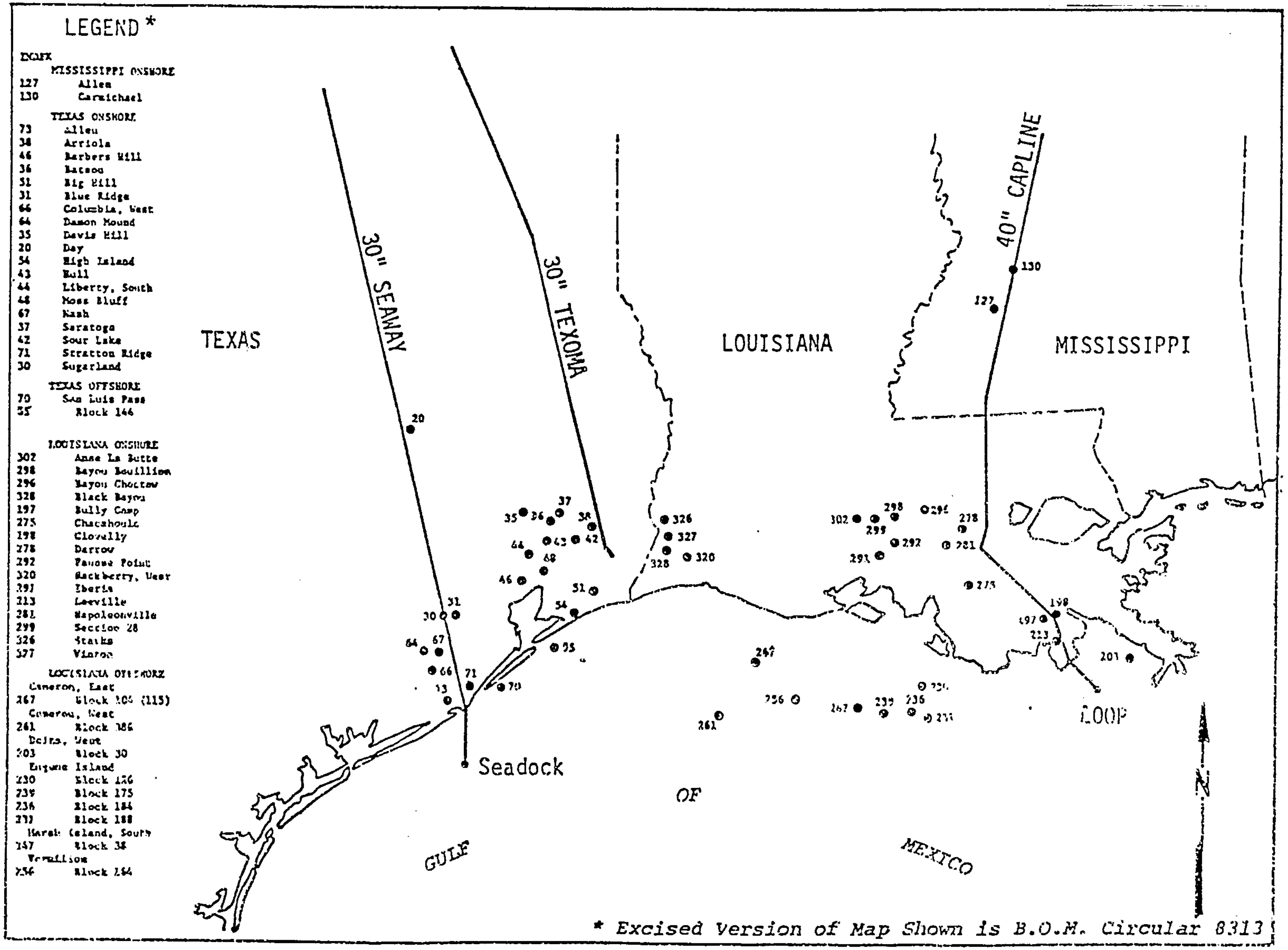

Figure 1.0-1 Gulf Coast Region Salt Domes

2.0 DESCRIPTION OF THE PROJECT

2.1 INTRODUCTION

The candidate SPR sites in the Texoma group of salt domes are located in the southwestern corner of Louisiana and the adjacent southeastern corner of Texas within a 40 mile radius of Nederland, Texas (see Figure 2.1-1). The Sun Oil Company terminal at Nederland would serve as the crude oil supply terminal for the proposed SPR storage sites in this group. During subsequent strategic oil distribution, the SPR oil would be transported to inland refineries through existing pipelines including the Texoma Pipeline, which initiates at the Sun Terminal, and also reloaded onto tankers for distribution to East Coast or Caribbean refineries.

The West Hackberry salt dome, located in Cameron Parish of southwestern Louisiana, is the proposed site for SPR development in the Texoma group of salt domes. The storage of 60 million barrels of oil in existing solution caverns at West Hackberry is being developed by DOE as part of the ESR program. An expansion of the site for an additional storage capacity of 150 million barrels is discussed in this document.

Three alternative sites are proposed as possibilities for SPR development associated with the Texoma system. The Black Bayou dome, also located in Cameron Parish, could be developed to a capacity of 150 million barrels of oil storage. The Vinton dome, located in Calcasieu Parish of southwestern Louisiana, could provide 50 million barrels of storage capacity. The Big Hill dome located in Jefferson County, Texas, could be developed to a 100 million barrel storage capacity. One or a combination of these sites may be developed, as an alternative to the expansion of the West Hackberry ESR Facility, such that the total SPR storage capacity for the Texoma group of salt domes would be an additional 150 million barrels. In this document, however, each candidate site is treated separately for organizational purposes. The proposed water intake location for West Hackberry has been changed from Black Lake to the ICW as a result of comments received from and discussions held with several federal and state agencies. This change in location thereby would allow the same water intake structure to serve the Sulphur Mines site. The use of the same intake by both sites is discussed.

In this section, a brief description of the project is given to provide the reader with an overall understanding of the nature of the proposed SPR facilities and the developments necessary for their implementation. For a detailed description of each candidate site and its associated facilities, see Appendix A of this document.

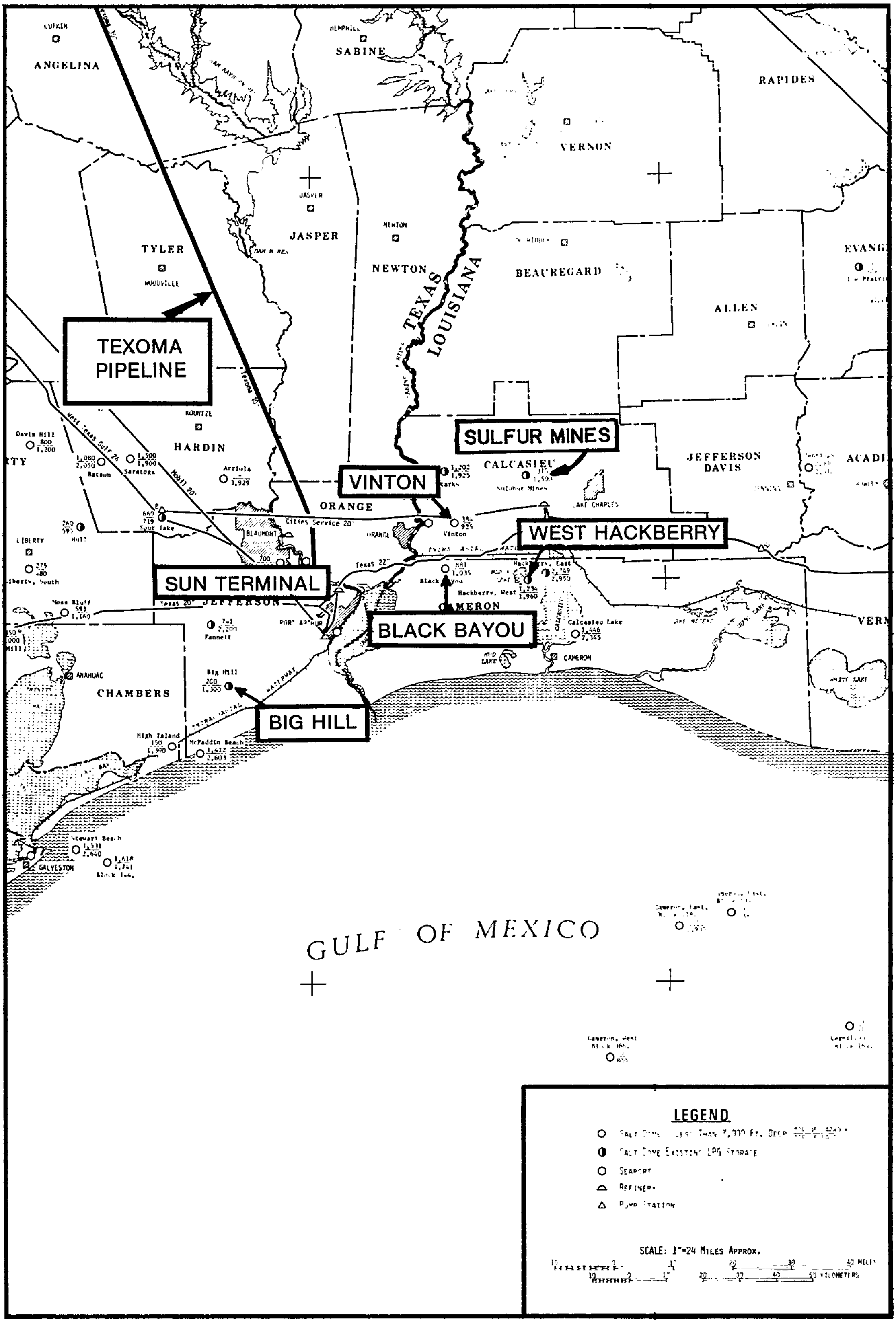

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Figure 2.1-1 TEXOMA GROUP SALT DOMES

2.2 CONCEPT OF STORAGE IN SOLUTION MINED CAVERNS IN SALT DOMES

The use of salt domes for petroleum storage is attractive because of both the relatively low cost of such bulk storage and the extreme geological stability of rock salt masses. In addition, oil storage deep underground provides security from natural catastrophes or sabotage.

All development of new storage capacity for the four proposed salt domes in the Texoma group of SPR sites would require newly mined caverns. A system of wells would be constructed and the storage space in the salt would be created by a solution mining process. Solution caverns are formed by leaching, which involves dissolving the salt with circulating water and pumping out the resulting brine. The process requires a large volume of leach water, about 7 barrels of fresh water or about 8 barrels of seawater for every barrel of space created. This type of cavern is currently used to store a number of petroleum products. In the U. S., the products stored in solution caverns are primarily LPG (liquefied petroleum gas) products such as propane, ethylene, etc., as well as some fuel oil. Although crude oil storage in solution caverns does not present particular technical problems, it has been practiced principally in other countries.

2.3 GENERAL CAVERN CONSTRUCTION TECHNIQUES

There are two basic approaches under consideration for the construction of the new SPR solution mined caverns for oil storage in salt domes. They are being addressed in this document as co-proposals.

In the first process, the caverns would first be leached to full size by injecting only raw water and displacing the resulting brine. Then oil would be injected during a separate operation. Since the various flow rates and development time-tables associated with this process present the worst-case condition (see Appendix A.1 and A.3), the engineering system descriptions used in this document are based upon the separate leach then fill process of cavern development.

As a co-proposal, a newer simultaneous leach and fill process would be tried. This process would allow for the early storage of oil in the upper portions of the developing cavern as the leaching continues in the lower portion. This process is still an untried technology in this country, and DOE plans to verify it through a test well before it is implemented for the general program. This technology is being used successfully in West Germany for the creation of a storage facility.

For a detailed description of the necessary steps in cavern development using either the separate leach then fill or the simultaneous leach and fill approach, see Appendix J.

2.4 PROPOSED STORAGE SITE - WEST HACKBERRY EXPANSION

2.4.1 General

The West Hackberry facility as currently designed would satisfy a total of 210 million barrels of the combined ESR and SPR crude oil storage requirements in the Texoma/Lake Charles/ Beaumont storage region. The proposed development would be a 150 million barrel expansion of the ESR facility. The ESR facility is now under construction and will have a capacity of 60 million barrels, as described in the Final Environmental Impact Statement for the West Hackberry Salt Dome Early Storage Reserve (FES 76/77-4, FEA 1977a) and Supplement (FEA, 1977b).

The West Hackberry salt dome is located in north-central Cameron Parish of southwestern Louisiana (see Figure 2.4-1). The proposed site is approximately 20 miles southwest of the city of Lake Charles, Louisiana, and 16 miles north of the Gulf of Mexico. Black Lake, a 3.4 square mile shallow body of water, lies just to the north and partly covers a portion of the area over the salt dome. Hackberry, a local unincorporated town of 1,300 population, and the Calcasieu Ship Channel are approximately 4 miles east of the site. The Sabine National Wildlife Refuge lies approximately 2 miles to the south. The Sun Terminal at Nederland, Texas, which would serve as the oil supply and distribution terminal for West Hackberry, is about 40 miles west of the site (see Figure 2.4-1).

The proposed SPR expansion of the West Hackberry storage site would entail the development of 15 new solution caverns of 10 million barrels (mmb) each, thus accommodating 150 mmb of new storage capacity. The ESR facility would have a capacity of 60 mmb in five existing caverns, giving a total capacity of 210 mmb for the combined ESR and SPR facilities.

The general systems components required for an SPR storage facility include the oil storage wells, a central plant for all pumping and metering equipment, a raw water supply system, a brine disposal system, and a crude oil distribution system. A schematic diagram of a typical DOE facility is shown in Figure 2.4-2.

2.4.2 Site Development

The proposed expansion of the West Hackberry site involves the construction of 15 new caverns on a site adjacent to the ESR site presently being developed on the dry land portion of the dome (see Figure 2.4-3). The central plant location would be the same as that being constructed for the ESR facility. The central leach plant, including pumps, surge ponds, and surface tanks, would be located on the ESR site

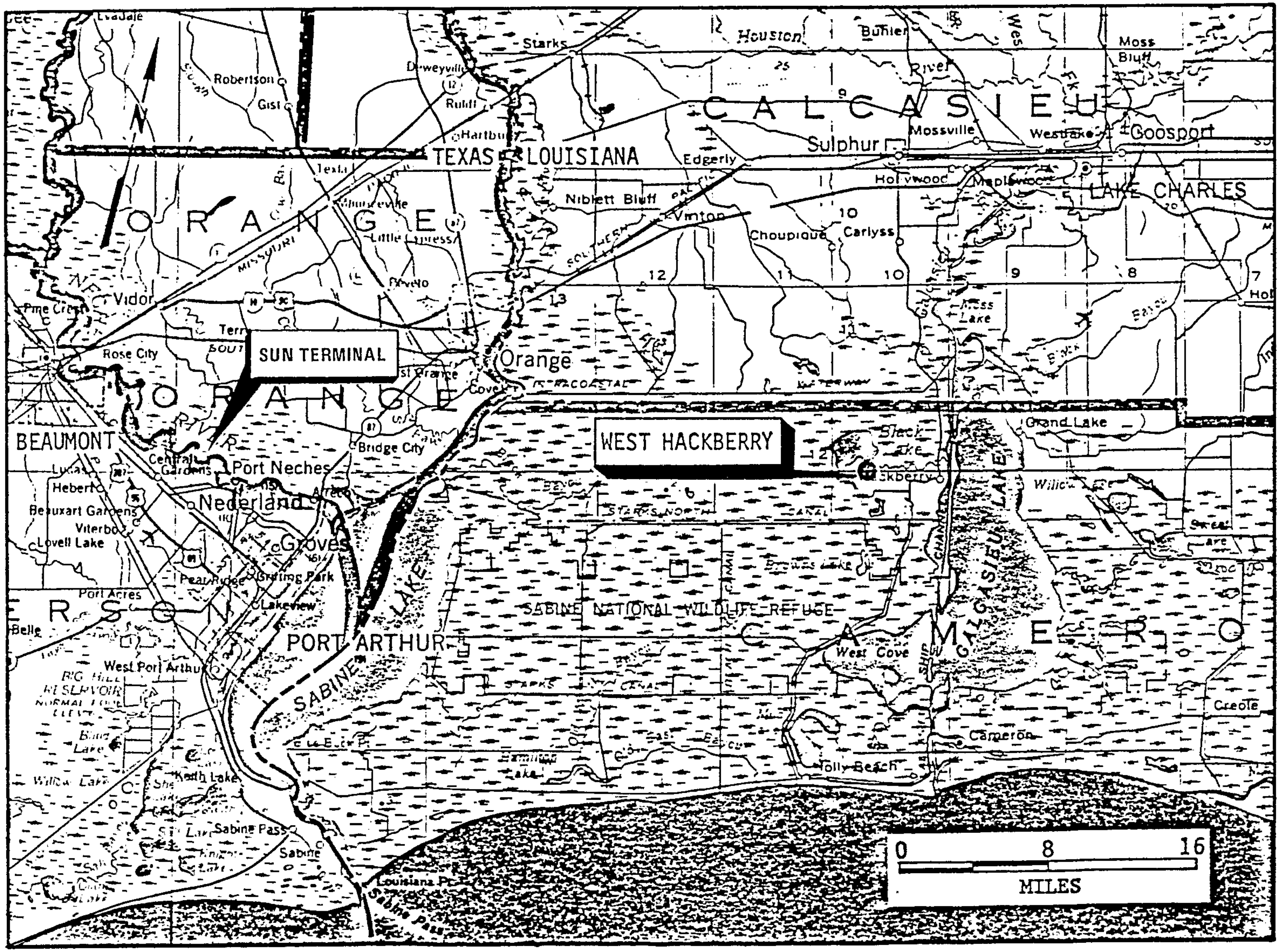

Figure 2.4-1 Location Map - West Hackberry Dome

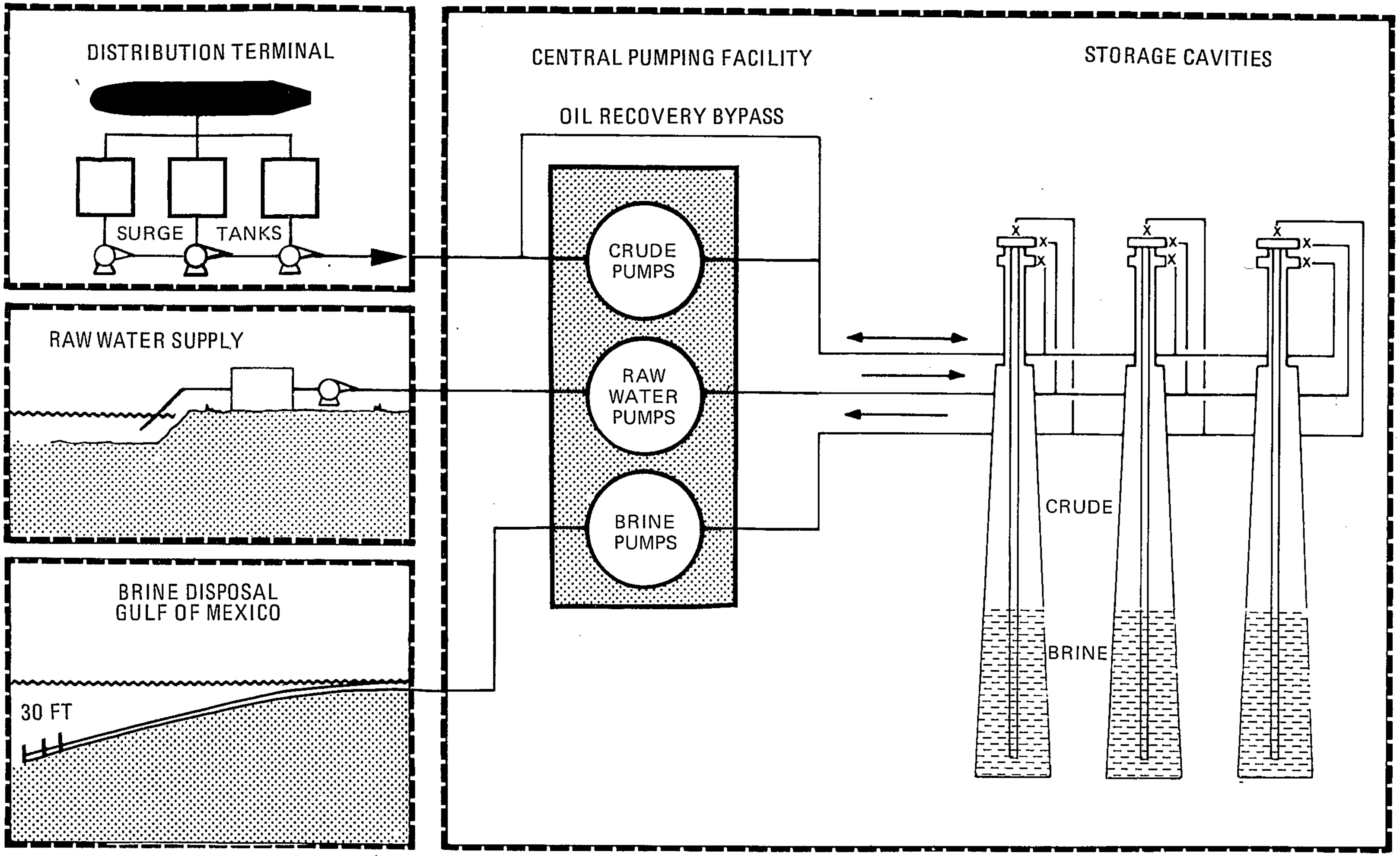

Figure 2.4-2 Schematic Diagram of Typical DOE Facility

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near the site of the former Olin brine plant (see Figure 2.4-4). The raw water intake station would be located on the Intracoastal Waterway, approximately 4 miles from the central plant. The major development required for the SPR expansion of the facility would be the construction of the 15 new wells with connecting roads and pipelines on a 160 acre tract immediately west of the ESR facility.

The brine disposal system for the ESR facility is a deep well injection system. These wells are being constructed south of West Hackberry dome. However, because of the increased volume of brine produced during new cavern leaching the expanded SPR facility would require a pipeline to be constructed to the Gulf of Mexico for direct disposal offshore (see Figure 2.4-5).

The crude oil supplies to fill the existing caverns would be piped from the Sun Terminal at Nederland, Texas through a 41.5 mile pipeline which is under construction for the ESR system (see Figure 2.4-6). The pipeline is designed to carry the increased flow capacity so that it could be used if a decision is made to expand the site or create storage on one of the other alternate sites which could use the pipeline. For a brief description of the terminal facilities, see Section 2.8.

For withdrawal of the stored oil, the intake/pumping station on the Intracoastal Waterway (ICW) would be designed to supply the water necessary to displace the 150 million barrels (mmb) of oil stored at the expansion site as well as the 60 mmb stored at the original ESR site. Water pumps at the ICW would be electric powered and supplied with power via submarine power cables laid along the water intake pipeline corridor. The intake/pumping station would also be sufficient to handle the 24 mmb to be stored at Sulphur Mines (see DOE/EIS 0010). The displaced oil would be transported by the same pipeline to the Sun Terminal for distribution by tanker and inland pipelines. More detail on each of the proposed system components is discussed in Appendix A.4.4.1.

The feasibility of several alternative systems components were considered for the West Hackberry SPR expansion facility. Black Lake, the Calcasieu Ship Channel and the Gulf of Mexico were examined as alternatives to the ICW for a raw water supply source. Also, an expansion of the ESR brine injection well system was considered as an alternative to building a pipeline to the Gulf. These and other alternatives are discussed in Appendix A.4.4.2.

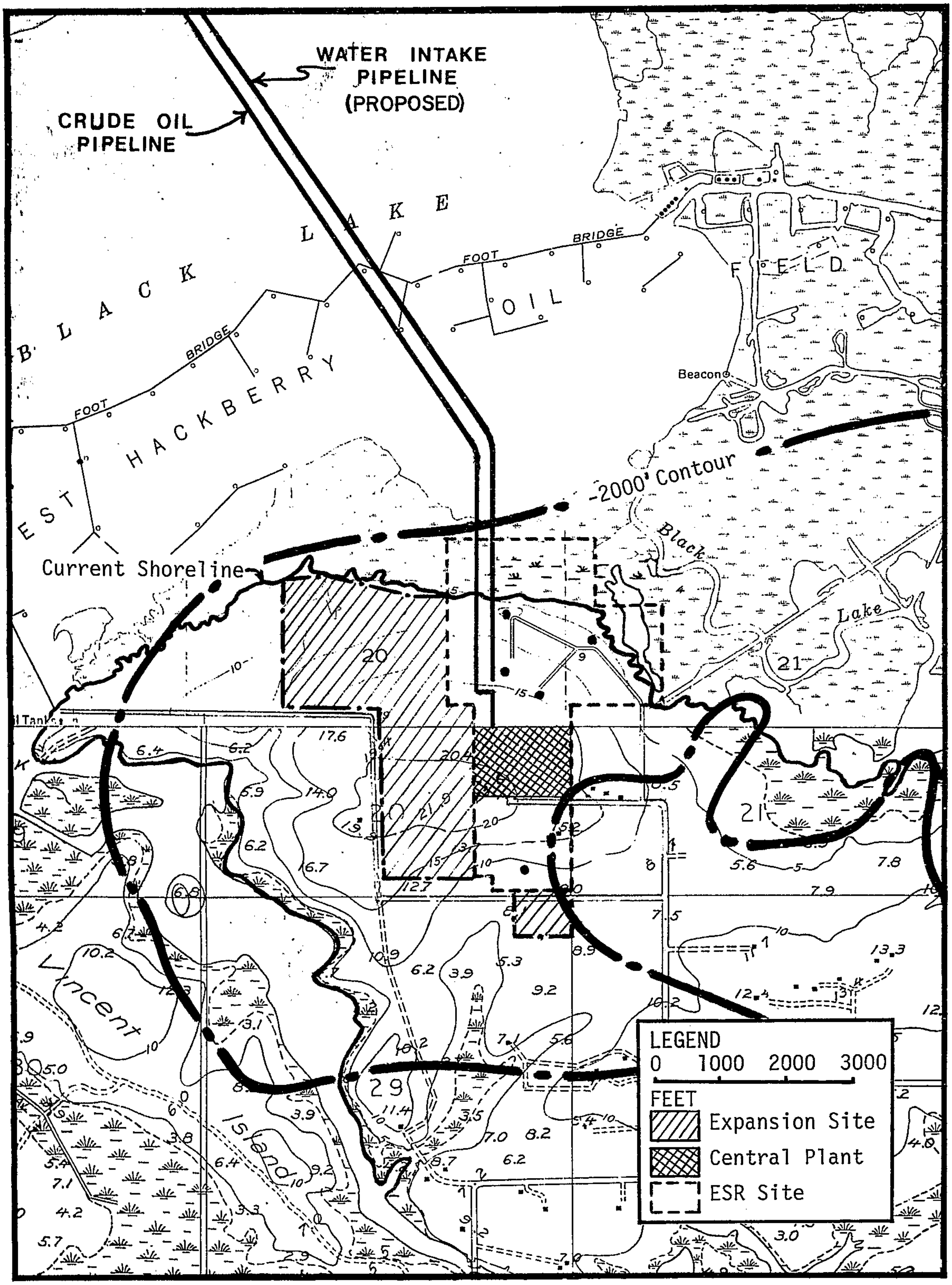

Figure 2.4-3 Site Development Plan - West Hackberry

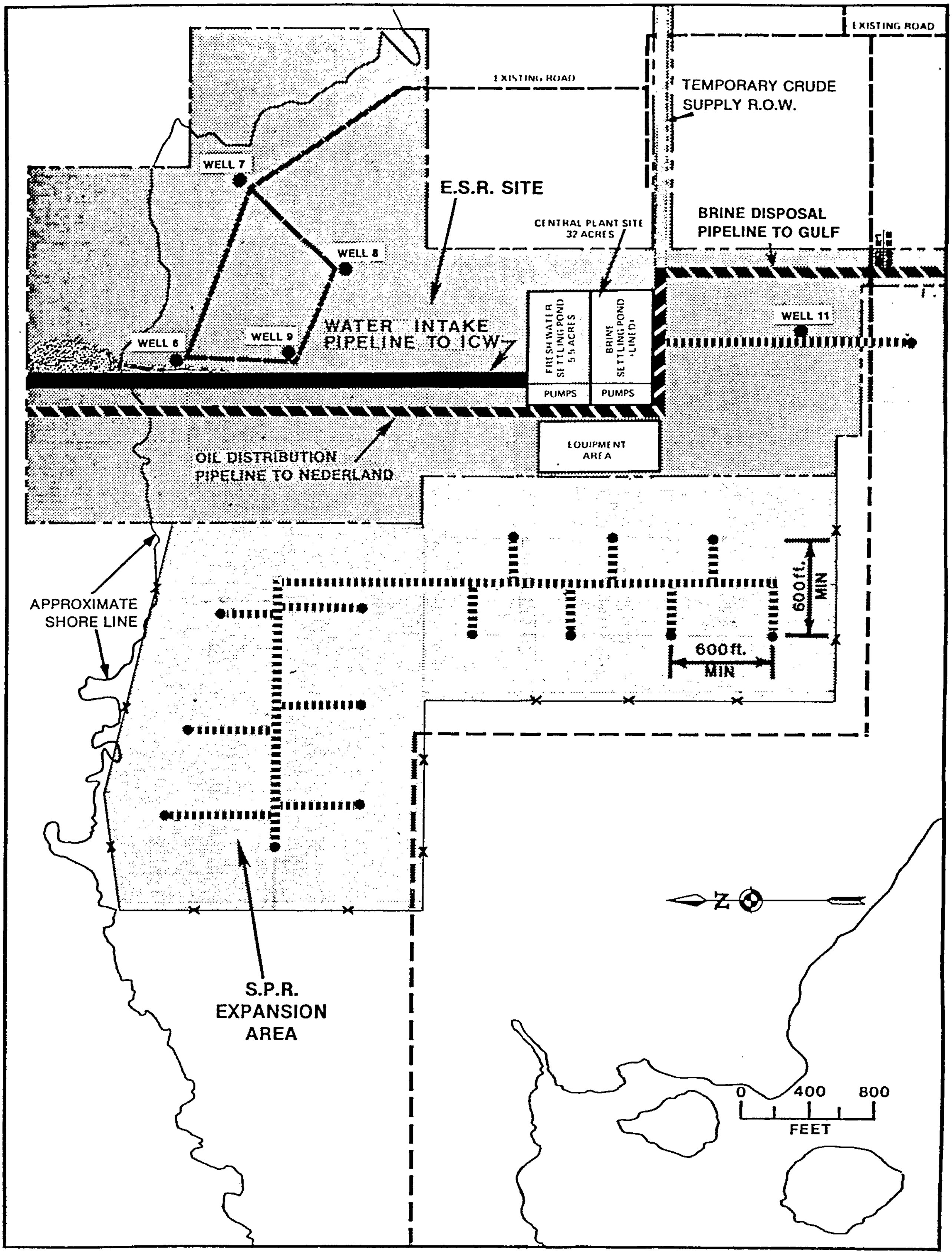

Figure 2.4-4 Storage Site Layout-West Hackberry

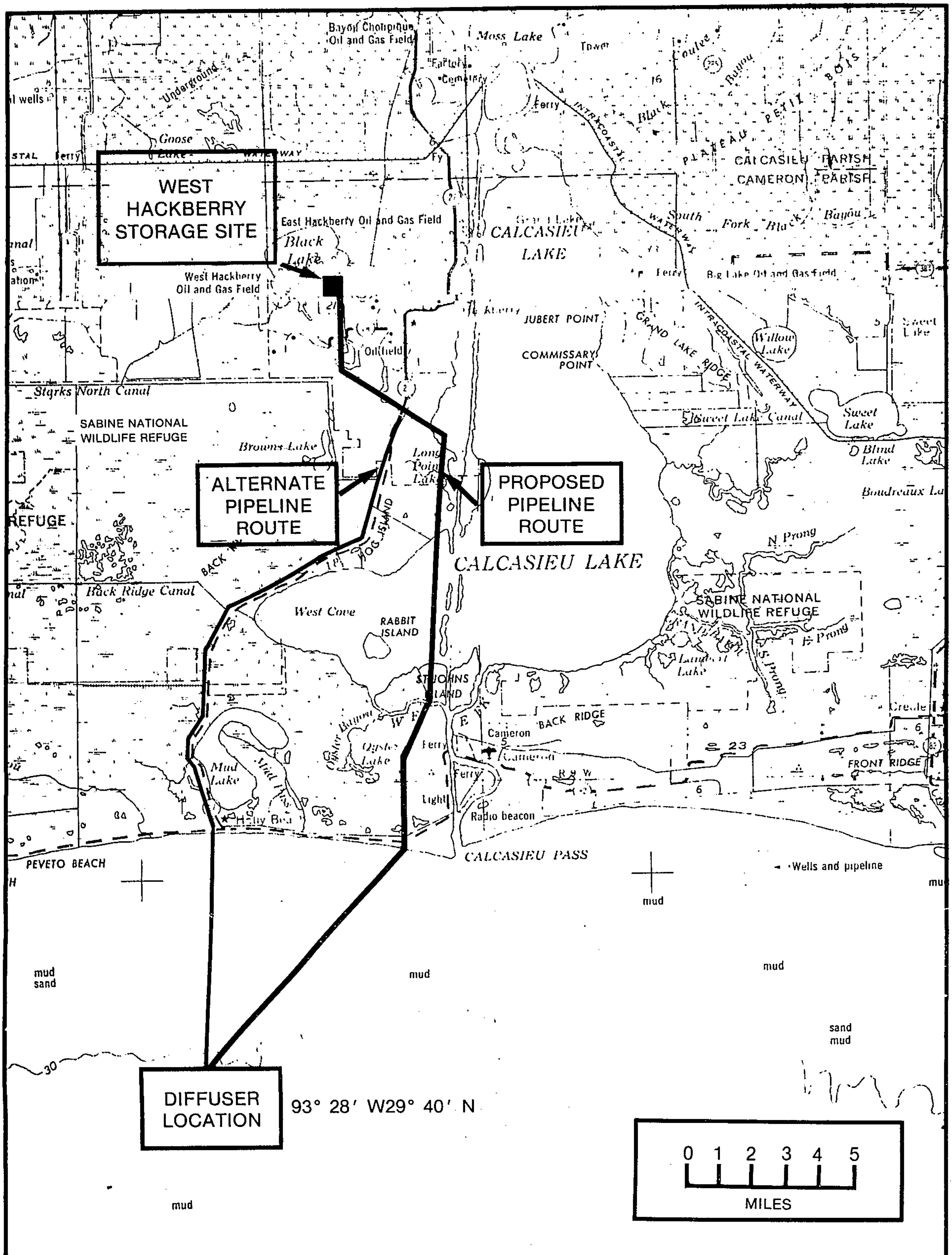

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Figure 2.4-5 Brine Disposal Pipeline Routes

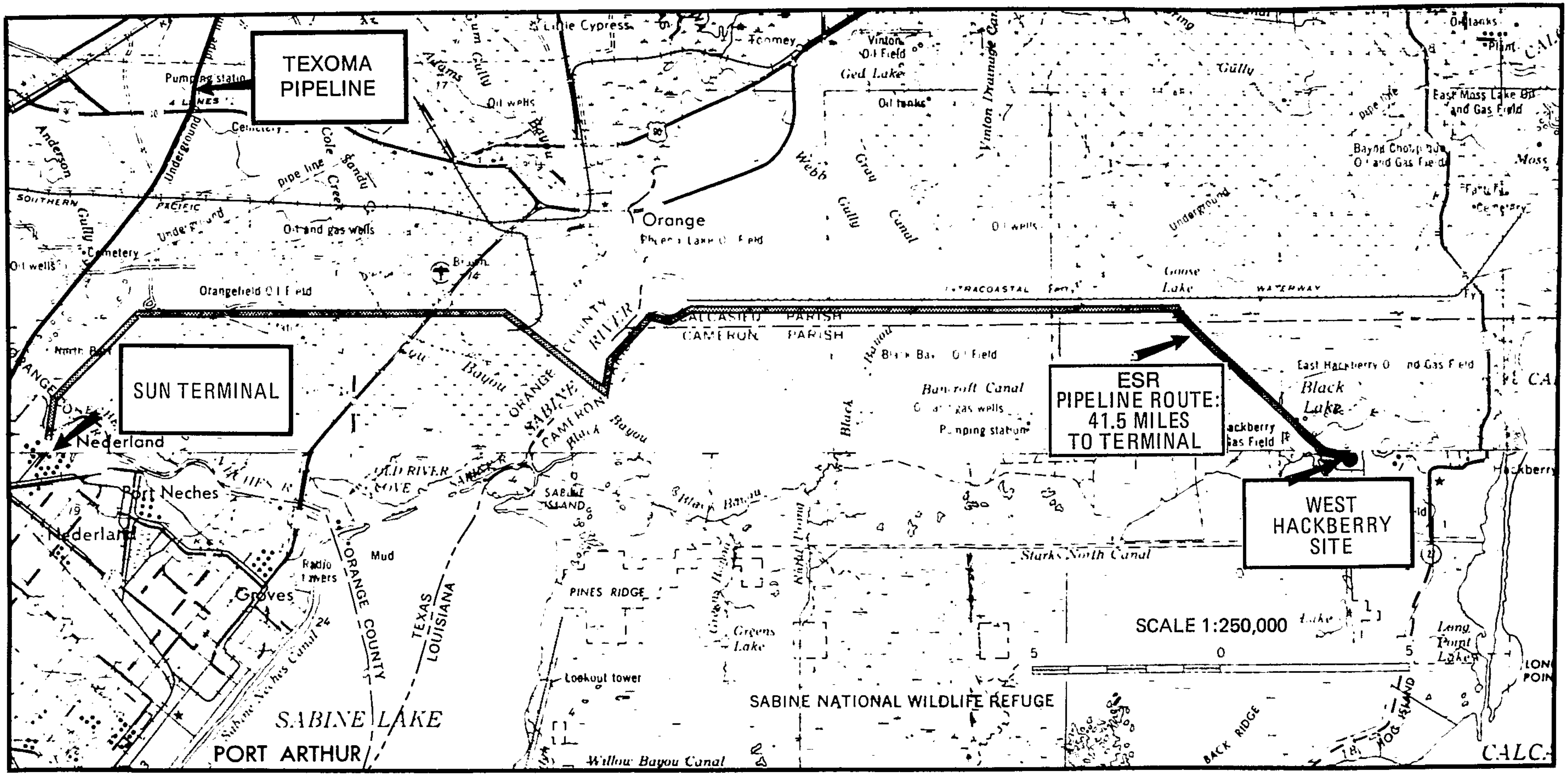

Figure 2.4-6 Oil Distribution Pipeline Route

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2.4.3 Operation

Assuming a separate leaching then oil fill process of cavern development as a worst-case condition (see Appendix A.3), during the initial leaching operations, a water supply rate of 1.03 million barrels/day over a period of 38 months would be required to leach out the 15 caverns for the expansion site. This water, taken from the ICW, would be pumped into the 175,000 barrel water surge pond onsite and then into the wells. The resulting unsaturated brine of about 230 ppt (parts per thousand) or more would empty from the caverns into the lined 175,000 barrel brine pond, and then after a minimum 4 hour settling time would be piped to the Gulf of Mexico for disposal.

When the caverns have reached full size by leaching, the wellheads would be converted for oil injection and brine displacement. Oil would be delivered to the site and injected into the new caverns at an average rate of 175,000 barrels/day. Thus it would take an additional 28 months to fill the 150 million barrel expansion facility.

When the storage facility has been completed and design capacity is reached, there would be an interim period during which the only activities at the site would be security and maintenance checks. However, readiness for activation during an emergency requires keeping operations personnel available.

The SPR program requirements plan for an emergency withdrawal of stored oil over a period of not less than 5 months. Thus, the maximum delivery rate for a 210 million barrel combined ESR and SPR facility at West Hackberry would be 1.4 million barrels per day. Crude oil stored in each salt cavity would be recovered by pumping raw water into the bottom of the cavity, thus displacing the oil through the concentric tubing at the top of the cavity.

The Sun Terminal at Nederland, Texas would handle all of the oil from the West Hackberry SPR site (see Section 2.8). The present plan is that about 40 percent of the stored oil would be transferred by pipeline to local and regional refineries, and to mid-western states through the Texoma pipeline system which originates at Sun Terminal. The remainder would be reloaded onto tankers for shipment to the East Coast and Caribbean refineries.

After an oil supply interruption has ended, refill of the combined ESR and SPR storage facilities is planned. The rate of fill would depend on the availability of crude but is currently planned for refill at a rate of 175,000 barrels/day over a 40-month period. The refill process is the reverse of the recovery process. The crude oil is injected into the top of the storage cavity, thus displacing the brine, which in turn goes to the disposal system.

The SPR facility is designed for 5 fill and withdrawal cycles. Although for leached cavity facilities the cavern capacity enlarges during each cycle due to the introduction of fresh water, it is assumed that only the original design capacity for each cavity would be refilled during each cycle.

2.5 ALTERNATIVE STORAGE SITE - BLACK BAYOU

2.5.1 General

The development of Black Bayou for the SPR program is considered as an alternative to the proposed expansion of the West Hackberry ESR facility described in Section 2.4. As currently designed, the facility would satisfy an additional 150 million barrels of the SPR crude oil storage requirements in the Texoma/Lake Charles/Beaumont storage region.

Black Bayou salt dome is located in northwestern Cameron Parish of southwestern Louisiana, and is approximately 8 miles southeast of Orange, Texas, and 12 miles south of Vinton, Louisiana. The Gulf of Mexico is 19 miles south of the dome and the Intracoastal Waterway (ICW) is two miles north. The site is 12 miles west of the West Hackberry dome (see Figure 2.5-1).

The dome underlies a marsh that is crisscrossed by a canal and bayou network. Black Bayou, which crosses over the center of the dome, is a large bayou extending from Sabine Lake and is connected to the Intracoastal Waterway (ICW) due north from the dome by Black Bayou Cutoff Canal.

The site is well situated for distribution of oil by connection to the proposed ESR line from West Hackberry to the Sun Terminal at Nederland, Texas, some 20 miles west of Black Bayou dome. From the Nederland facilities, which is also the terminus for the Texoma pipeline, the oil can be moved inland via pipeline or loaded onto tankers for delivery to Eastern and Caribbean refineries (see Section 2.8).

Total storage capacity for the Black Bayou site design has been established by FEA at 150 million barrels. A total of 15 new solution caverns would be constructed to accommodate this capacity.

2.5.2 Site Development

The presently proposed development of Black Bayou as an alternative site would involve a relatively irregular placement of wells on platforms over the marsh on the eastern half of the salt dome. The wells would be drilled from barge mounted rigs using existing and new canals for access (see Figure 2.5-2).

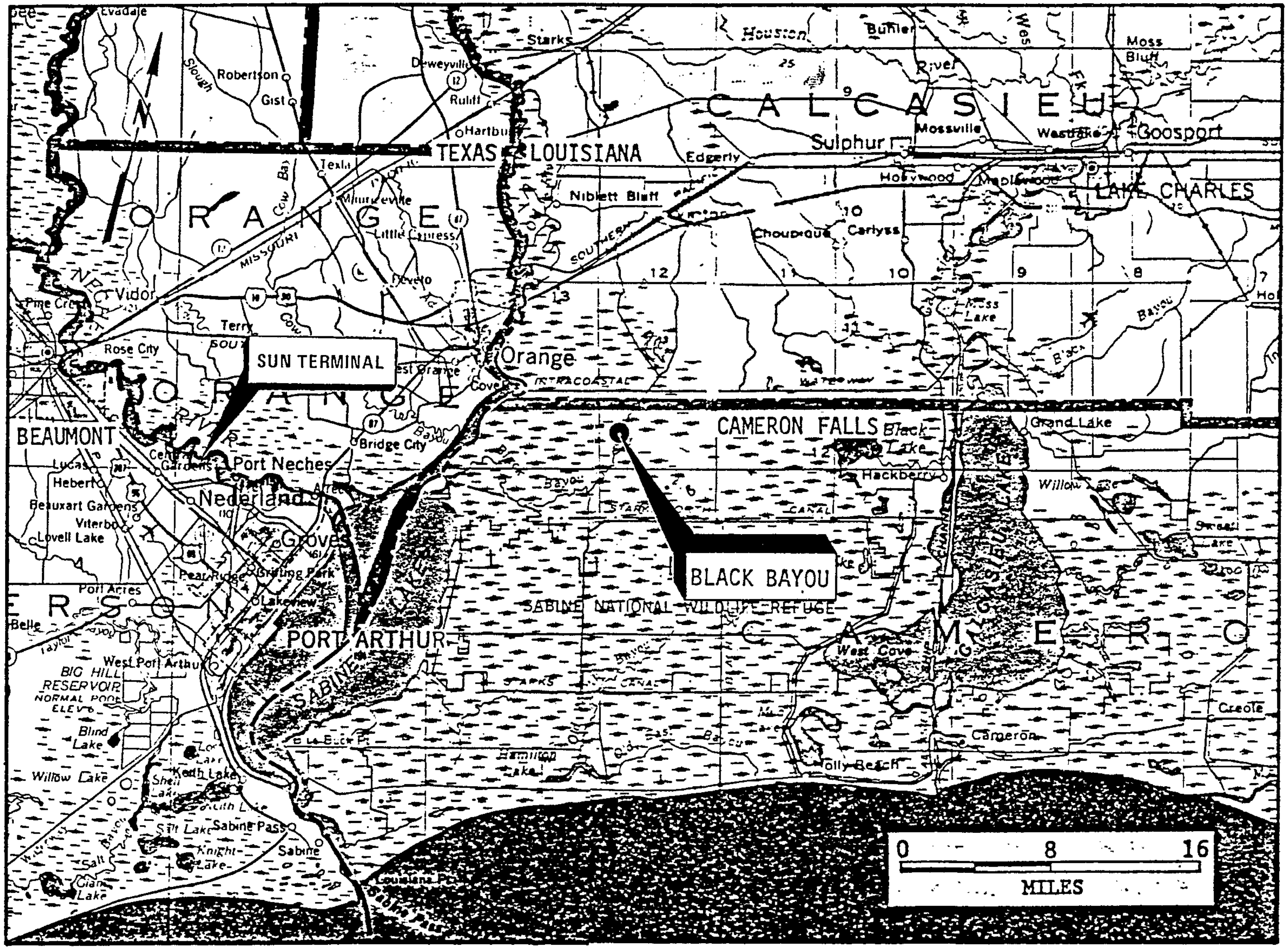

Figure 2.5-1 Location Map - Black Bayou Dome

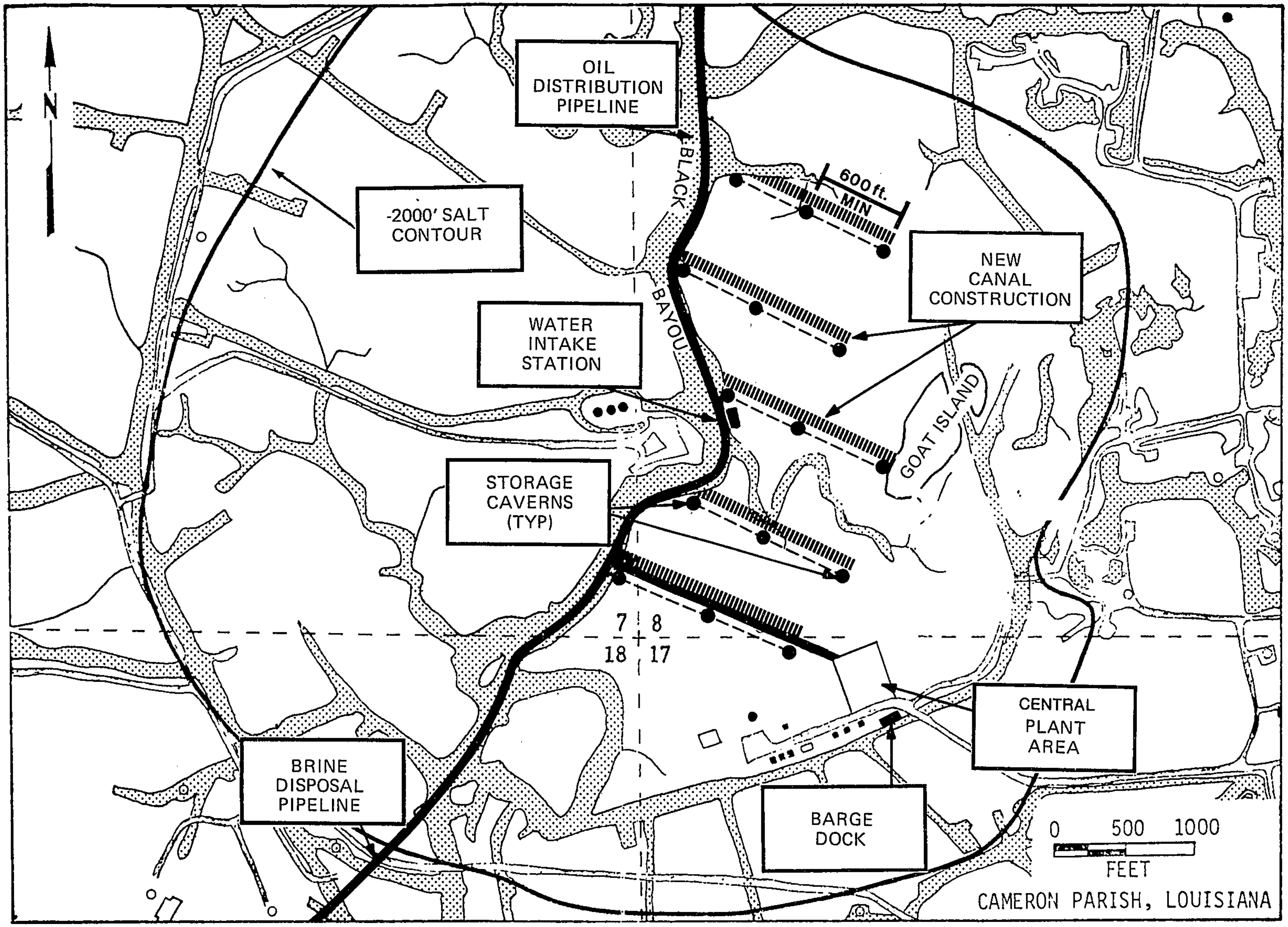

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Figure 2.5-2 Site Development - Black Bayou

The central plant, including pumps, surge ponds, and surface tanks, would be located adjacent to the access roads at the southeast corner of the storage site (see Figure 2.5-2). An area of approximately 10 acres would be landfilled so that the central plant and equipment yard could be located on dry land.

As currently planned, the raw water intake station would be located on the Black Bayou channel (see Figure 2.5-2). Brine disposal would be by pipeline to the Gulf of Mexico for direct disposal offshore. The proposed route for this pipeline must pass through the Sabine National Wildlife Refuge directly south of the site, but would follow an existing pipeline corridor as shown in Figure 2.5-3.

Oil distribution to and from the site would be by a short pipeline connection to be constructed along Black Bayou Cutoff (see Figure 2.5-4) to the ESR pipeline between West Hackberry and the Sun Terminal at Nederland, Texas. The ESR pipeline is sized to carry the increased flow capacity due to the proposed expansion, either at West Hackberry or at Black Bayou. More details on each of the proposed system components are given in Appendix A.5.4.1.

The feasibility of several alternative systems components were considered for the Black Bayou facility. The Gulf of Mexico, the Intracoastal Waterway, and Sabine Lake were examined as alternatives to Black Bayou for a raw water supply source. As an alternative to a brine disposal pipeline to the Gulf, the possibility of deep well injection into saline aquifers was also considered. These and other alternatives are discussed in Appendix A.5.4.2.

2.5.3 Operation

The operations of the Black Bayou facility during cavern leaching, filling, and oil withdrawal would be similar to those described for the West Hackberry expansion facility in Section 2.4.3 except that the oil withdrawal rate from Black Bayou would be a maximum of 1.0 million barrels/day, over a period of not less than 5 months.

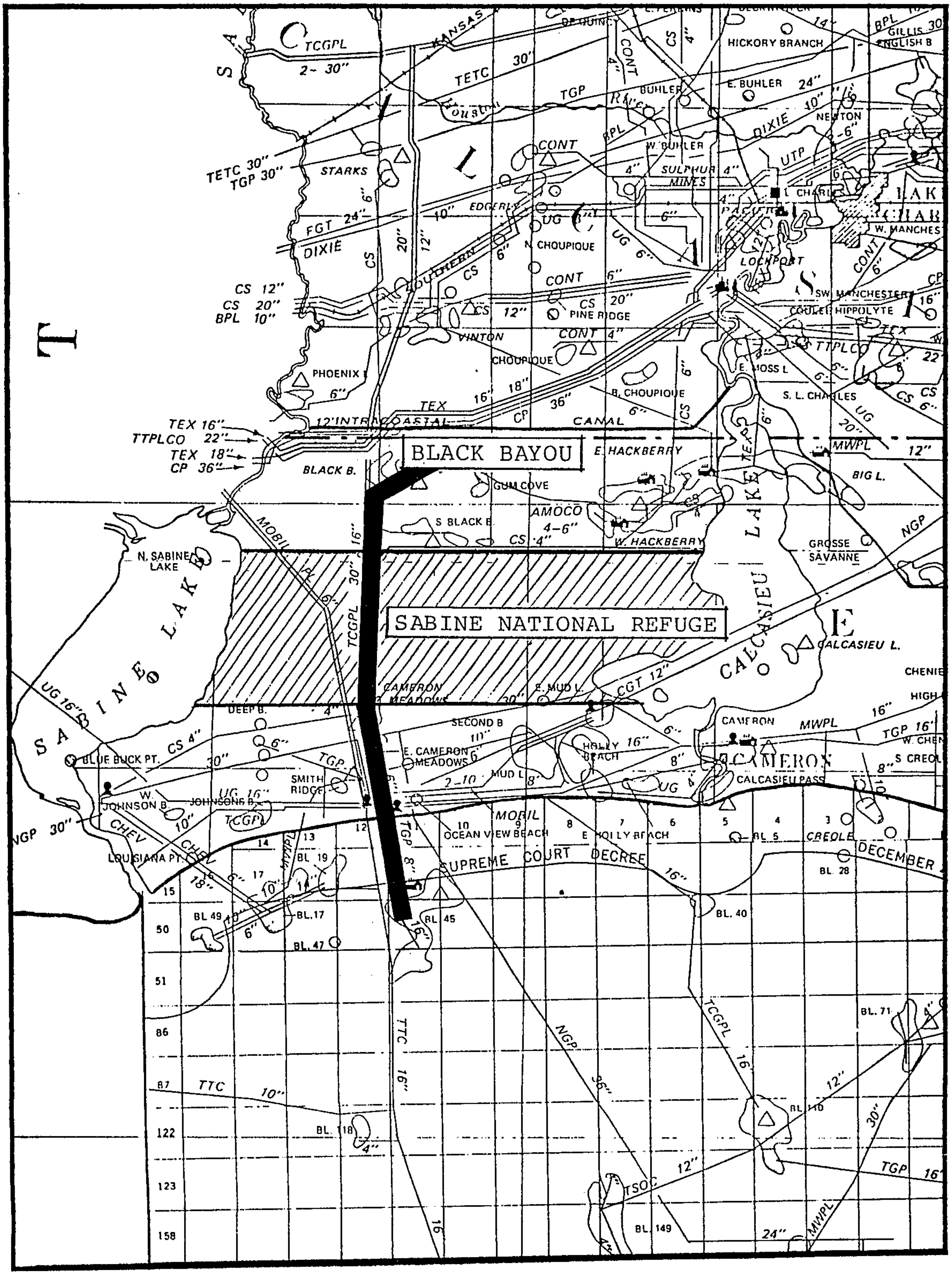

Figure 2.5-3 Brine Disposal Pipeline Route

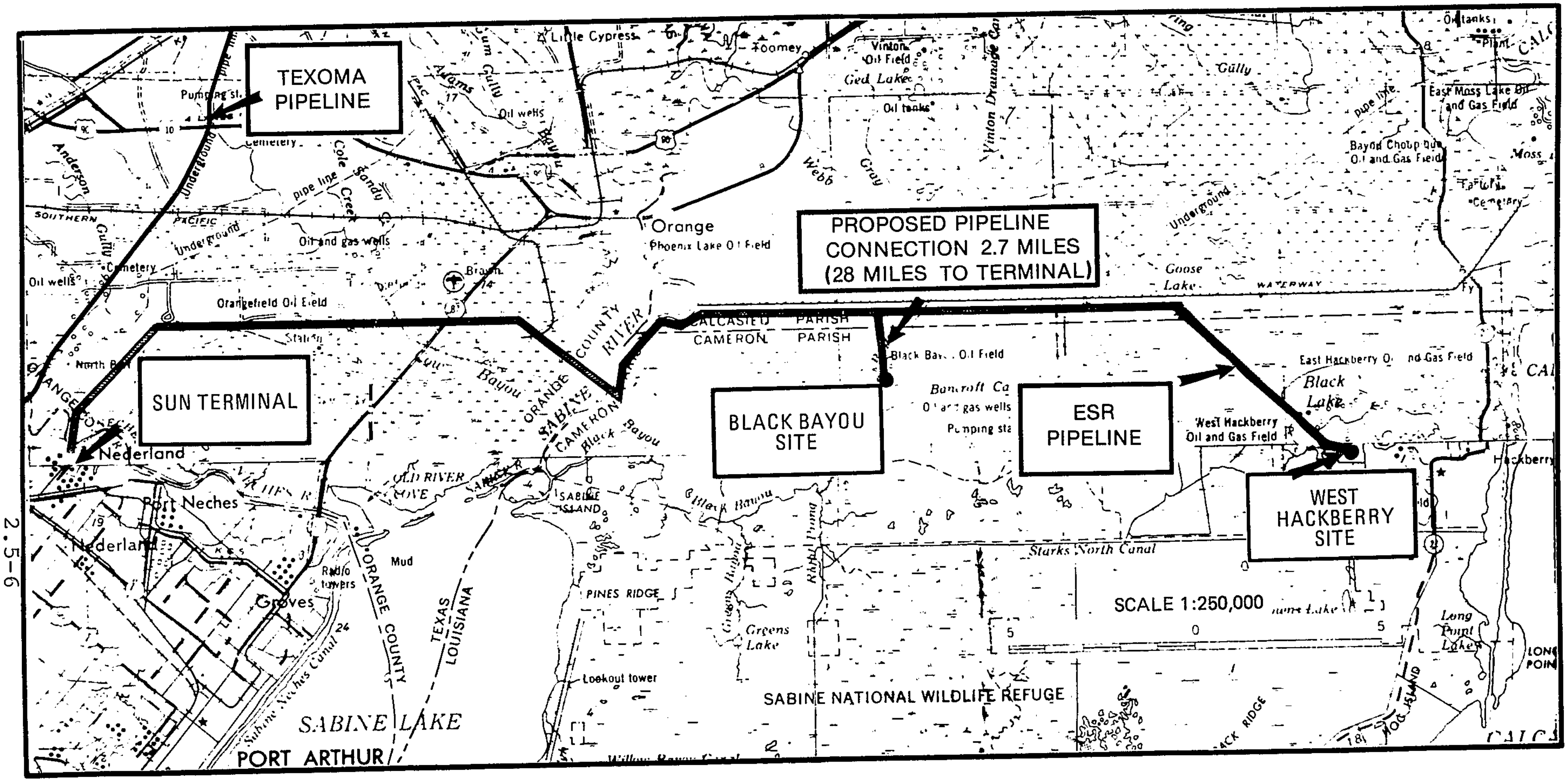

Figure 2.5-4 Oil Distribution Pipeline Route

2.6 ALTERNATIVE STORAGE SITE - VINTON SALT DOME

2.6.1 General

The development of the Vinton dome for the SPR program is considered as an alternative to the proposed expansion of the West Hackberry ESR facility described in Section 2.4. As currently designed, the facility would satisfy 50 million barrels of the SPR crude oil storage requirements in the Texoma/Lake Charles/Beaumont storage region.

Vinton salt dome is located in southwestern Calcasieu Parish of southwestern Louisiana, approximately 8 miles east of Orange, Texas, and 3 miles south of Vinton, Louisiana. The Gulf Intracoastal Waterway (ICW) is 5.5 miles to the south. The site is about 14 miles northwest of the West Hackberry dome (see Figure 2.6-1).

The dome is small and has a large lake (Ged Lake) covering approximately one third of the area. The remaining surface area is mainly pasture. All the land above the dome is part of the J. G. Gray Estate with leases held by Tribal Oil Company and Union Oil Company.

The site is well situated for distribution of oil via a 7.5 mile pipeline connection to the ESR pipeline from West Hackberry to the Sun Terminal at Nederland, Texas, which is 26 miles southwest of the Vinton dome. From the Nederland facilities, which is also the terminus for the Texoma pipeline, the stored oil would be moved inland via pipeline, or loaded on tankers for delivery to Eastern and Caribbean refineries (see Section 2.8).

The capacity under consideration for this site is 50 million barrels. Initial plans, according to engineering feasibility studies, call for five 10 million barrel caverns. However, if in drilling some of the wells, severe lost circulation zones are experienced necessitating a reduction in casing sizes, the cavern would be reduced to 5 million barrels capacity and additional caverns developed to make up for the 50 million barrel total; hence the appearance of 6 caverns in Figure 2.6-2 (four 10 million barrel and two 5 million barrel caverns).

2.6.2 Site Development

The proposed development of Vinton dome would involve the leaching of up to 6 new caverns (four 10 mmb and two 5 mmb) along the northern and western shore of Ged Lake (see

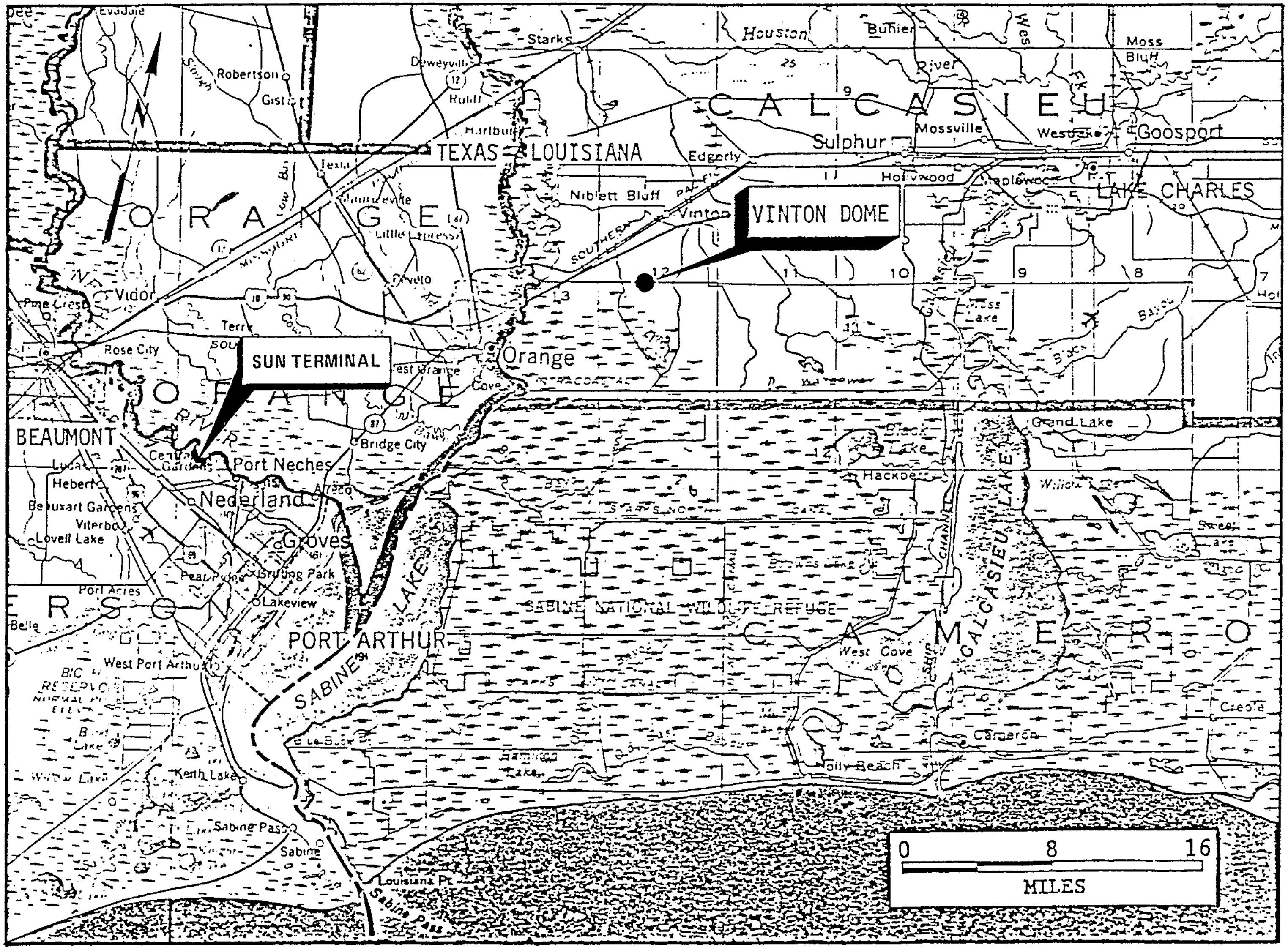

Figure 2.6-1 Location Map - Vinton Dome

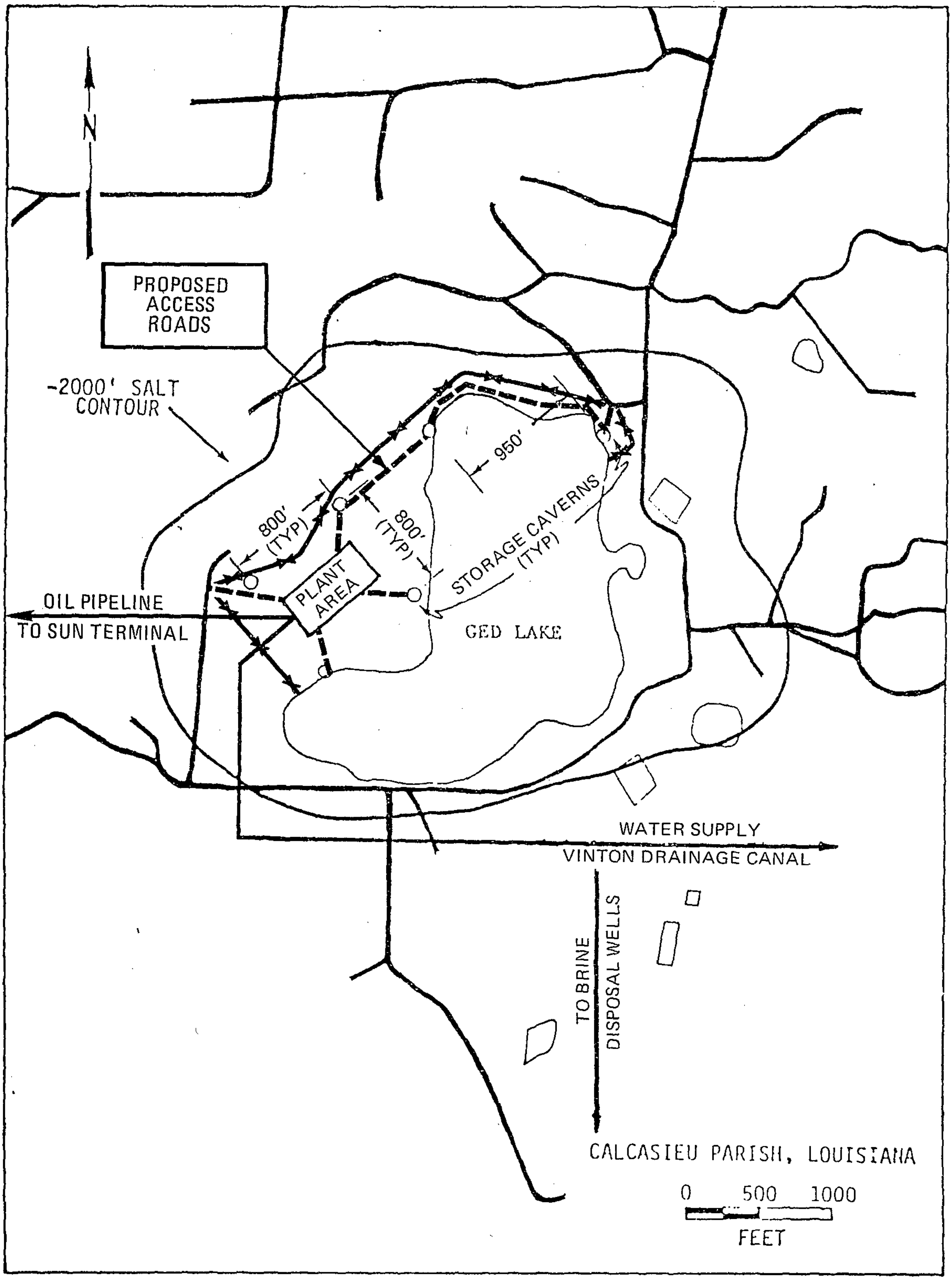

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Figure 2.6-2 Storage Site Layout - Vinton

Figure 2.6-2). The central plant, including pumps, surge ponds and surface tanks, would be located on dry land to the west of Ged Lake.

As currently planned the raw water intake would be located on the Vinton Drainage Canal approximately 1.5 miles east of the site. Dredging of an inlet at that point would be required to ensure constant water supply independent of waterway traffic.

Brine, created by construction and operation of the solution mined storage facility, would be disposed of by injecting it into subsurface saline aquifers. A deep well injection system with 10 wells is proposed and would be located about 2.0 miles south of the site (see Figure 2.6-3).

Crude oil supplies and distribution would be handled through Sun Terminal following the construction of a new pipeline (see Figure 2.6-3) connecting the Vinton site with the ESR pipeline between West Hackberry and Sun Terminal (Figure 2.6-4). More detail on each of the proposed system components is discussed in Appendix A.6.4.1.

The feasibility of several alternative systems components were examined for the Vinton dome facility. As an alternative to the Vinton Drainage Canal, the Intracoastal Waterway was considered for a raw water supply source. Also, the construction of a brine disposal pipeline to the Gulf of Mexico was considered as an alternative to subsurface injection. These and other alternatives are discussed in Appendix A.6.4.2.

2.6.3 Operation

The operations of the Vinton dome facility during cavern leaching, filling, and oil withdrawal would be similar to those described for the West Hackberry expansion facility in Section 2.4.3 except that the flow rates would be reduced proportionately based on the smaller storage capacity. The water supply rate and brine disposal rate during leaching would be about 343,000 and 336,000 barrels/day respectively. The oil fill rate would be 58,300 barrels/day and the maximum oil withdrawal rate would be 334,000 barrels/day. See Appendix A.6 for a complete listing of the flow requirements.

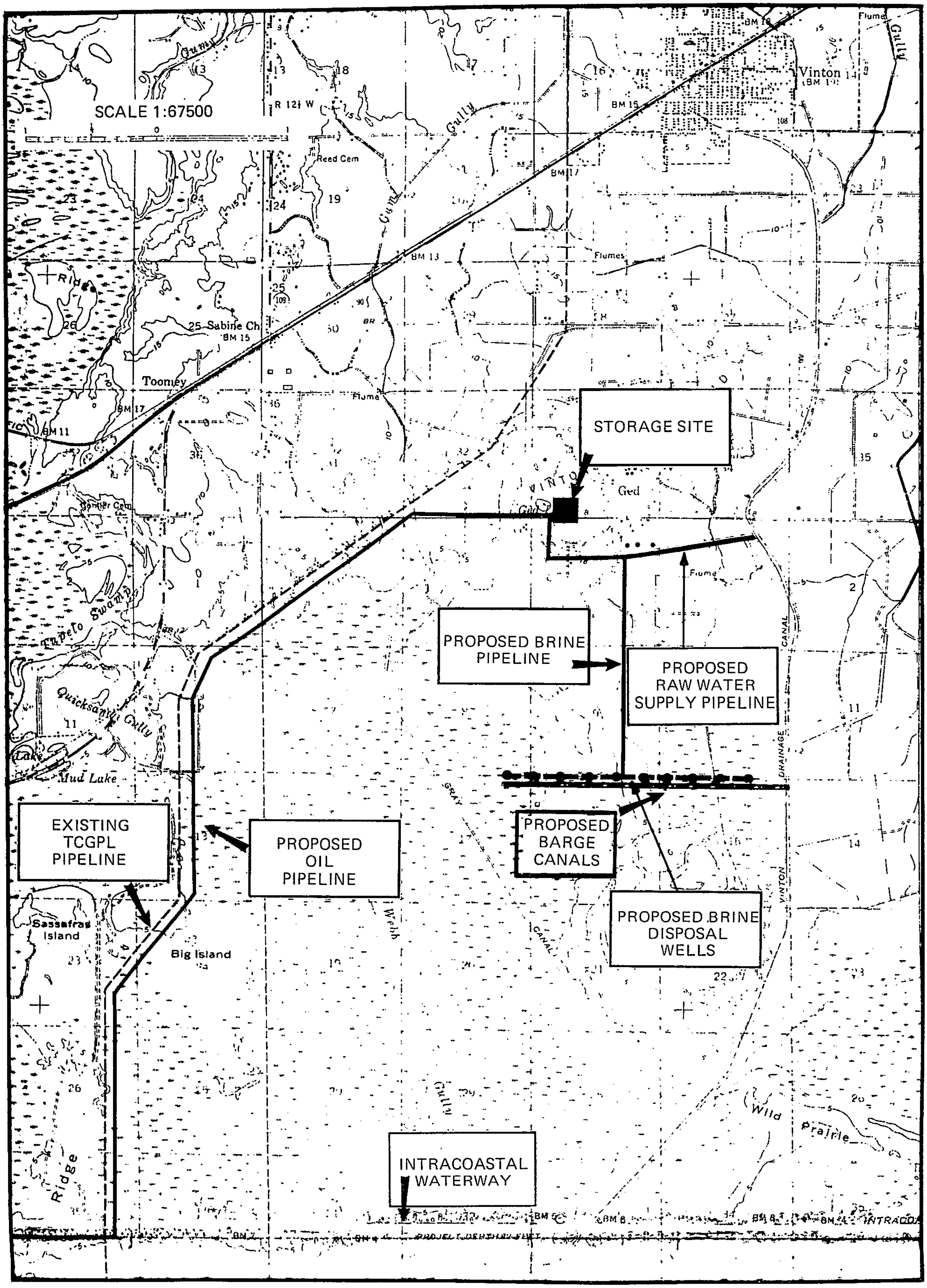

Figure 2.6-3 Systems Components Layout

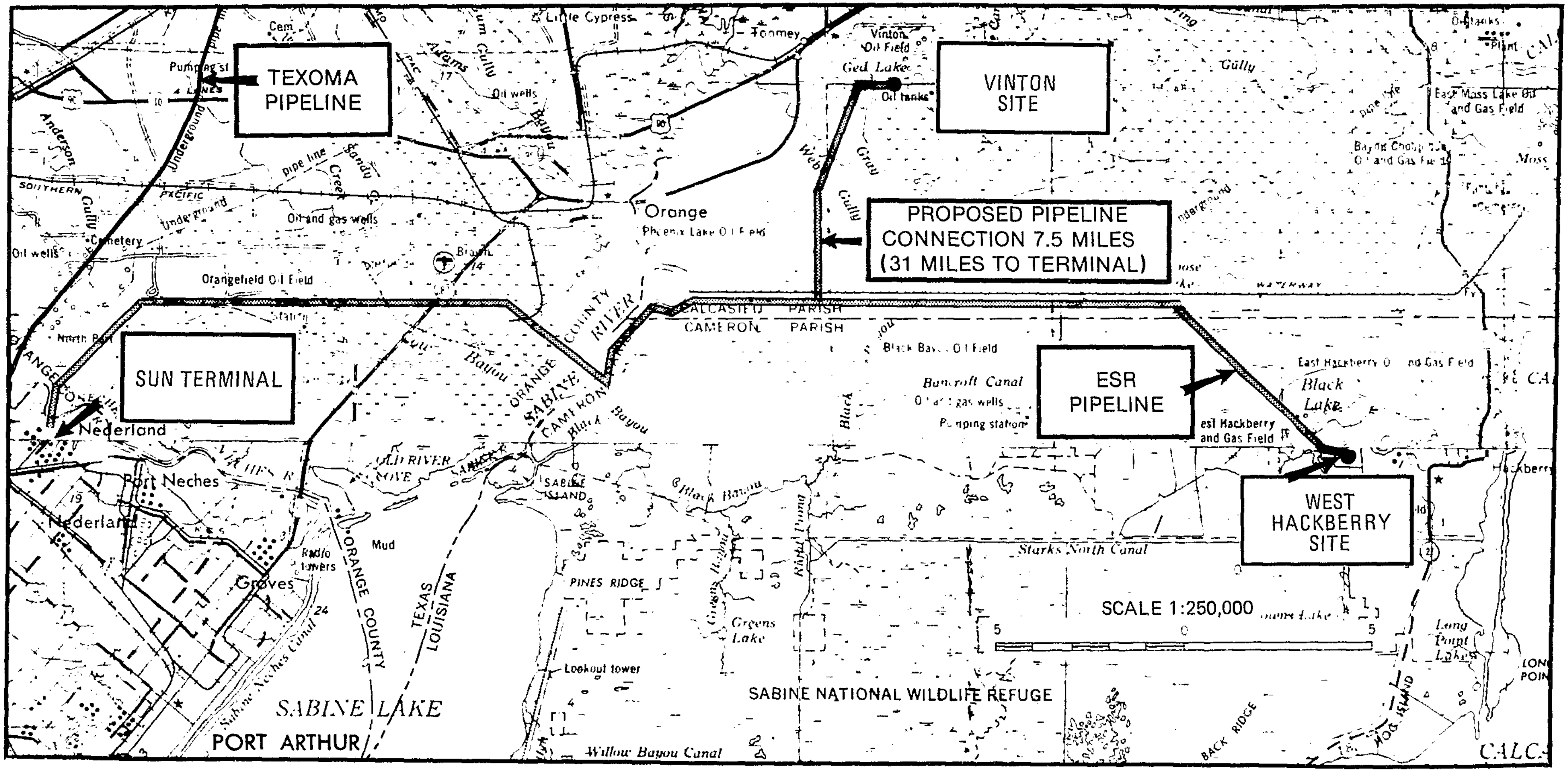

Figure 2.6-4 Oil Distribution Pipeline Route

2.7 ALTERNATIVE STORAGE SITE - BIG HILL SALT DOME

2.7.1 General

The development of the Big Hill salt dome for the SPR program is considered as an alternative to the proposed expansion of the West Hackberry ESR facility described in Section 2.4. This facility, as planned, would contain 100 million barrels of stored oil in the Texoma/Lake Charles/Beaumont storage region.

The Big Hill salt dome is located in southwestern Jefferson County, Texas (see Figure 2.7-1), approximately 26 miles southwest of Nederland, Texas and 70 miles east of Houston. It is positioned nine miles northwest of the Gulf of Mexico, 5.3 miles north of the Intracoastal Waterway (ICW), 3.2 miles north of the Spindletop Ditch (which is a barge canal connecting to the ICW), and immediately north of an extensive marsh area stretching to the coast.

The site is favorably located with respect to Sun Terminal located at Nederland (Figure 2.7-1). This terminal has existing capabilities for 130,000 DWT (910,000 bbl) tankers. The Neches River Channel presently accommodates 65,000 DWT tankers, because of the existing 40 ft. channel depth (see Section 2.8). Sun Terminal is also the initiating point for the Texoma Pipeline which transports crude oil to the Cushing, Oklahoma area. Both pipelines and tankers would be used for SPR distribution.

The capacity being considered in the assessment of this site is 100 million barrels. According to the engineering feasibility studies, ten 10 million barrel caverns are planned. However, if in drilling some of the wells severe lost circulation zones are experienced necessitating a reduction in casing sizes, the cavern would be reduced to 5 million barrels capacity and additional caverns developed to adhere to the 100 million barrel design capacity. Thus the configuration of the caverns as appears on Figure 2.7-2 includes eight - 10 million barrel caverns and four - 5 million barrel caverns.

2.7.2 Site Development

The presently planned SPR facilities involves the leaching of 12 new cavities (eight 10 mmb and four 5 mmb). Oil supplies of 100 million barrels of crude oil would be supplied from

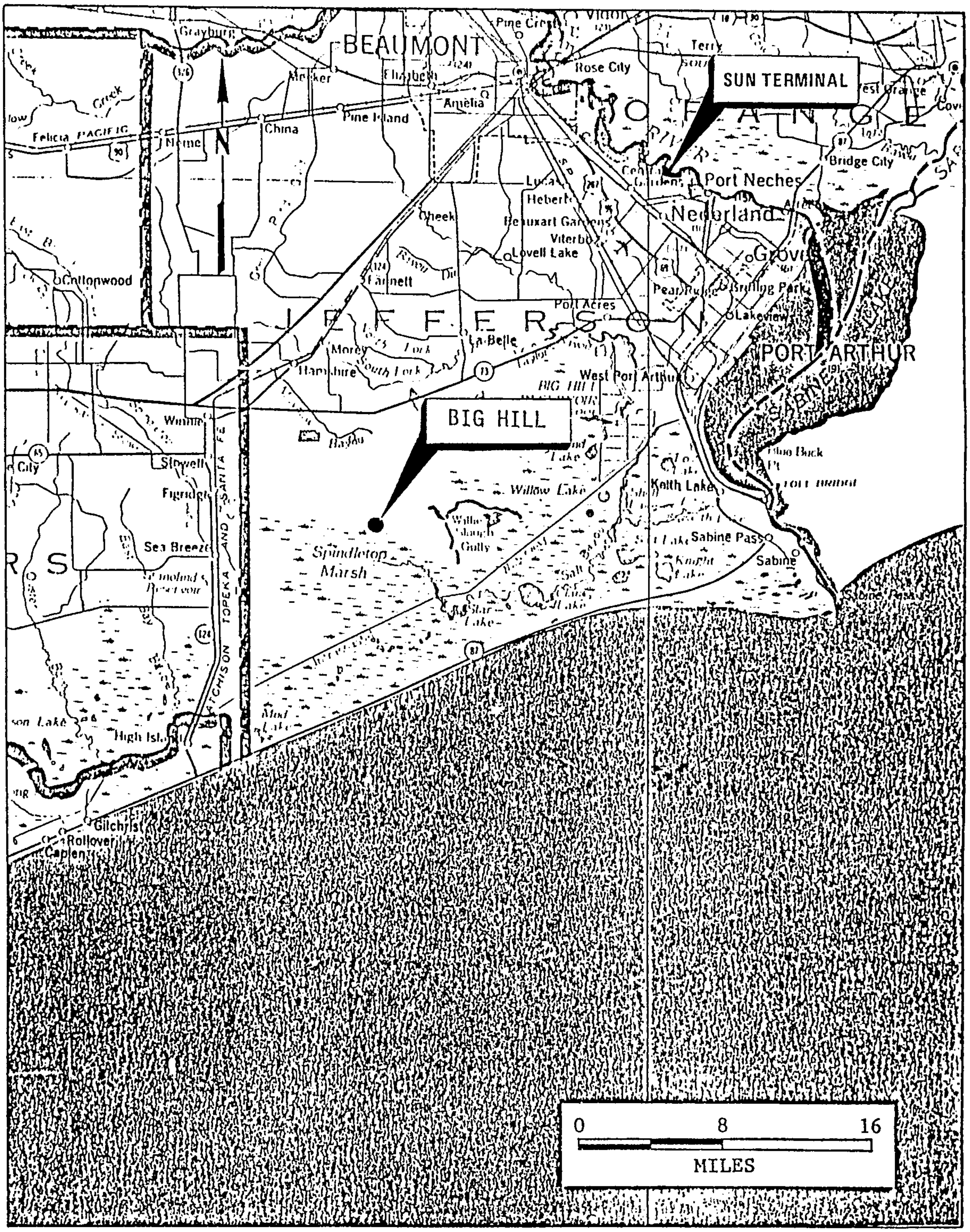

Figure 2.7-1 Location Map - Big Hill Dome

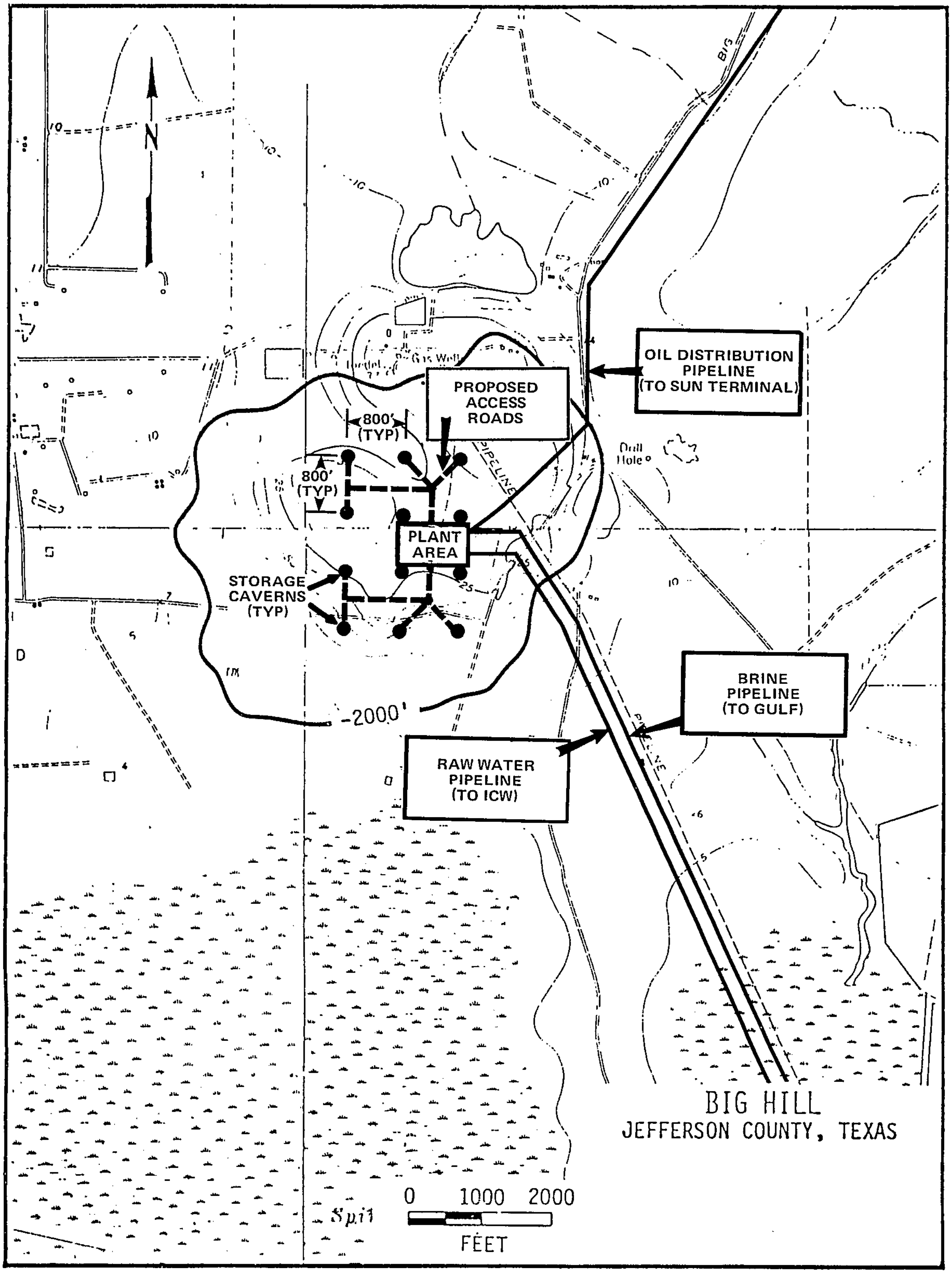

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Figure 2.7-2 Storage Site Layout - Big Hill

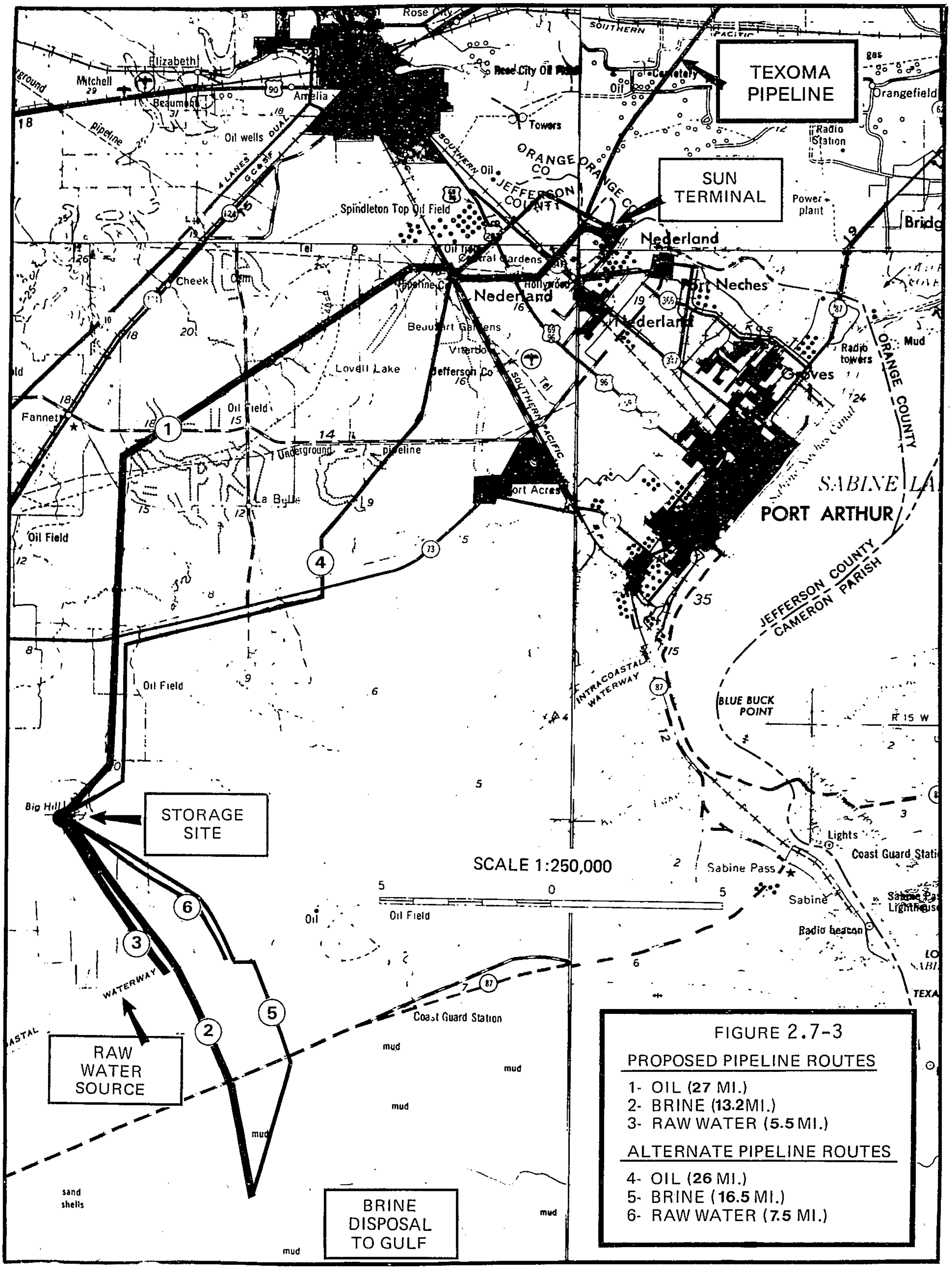
Sun Terminal via a new proposed 27 mile oil pipeline (Number 1 on Figure 2.7-3). The central plant, including pumps, surge ponds and surface tanks, would be located on dry land approximately in the center of the dome.

The proposed plan for brine disposal is to the Gulf of Mexico through the 13.2 mile pipeline numbered 2 on Figure 2.7-3. For the leaching of the storage caverns and the withdrawal of the stored oil, water would be supplied from the ICW using the 5.5 mile pipeline numbered 3 on Figure 2.7-3.

There would be three alternatives to the above mentioned pipelines (numbers 4, 5 and 6 on Figure 2.7-3). These and other alternative system components are discussed in Appendix A.7.4.2.

2.7.3 Operation

The operations of the Big Hill facility during cavern leaching, filling, and oil withdrawal would be similar to those described for the West Hackberry expansion facility in Section 2.4.3 except that the flow rates would be reduced proportionately based on the smaller storage capacity. The water supply rate and brine disposal rate during leaching would be about 687,000 and 672,000 barrels/day respectively. The oil fill rate would be 117,000 barrels/day and the maximum oil withdrawal rate would be 667,000 barrels/day. See Appendix A.7 for a complete listing of the flow requirements.


TEXOMA
PIPELINE
SUN
TERMINAL
STORAGE
SITE
RAW
WATER
SOURCE
BRINE
DISPOSAL
TO GULF
SCALE 1:250,000
PORT ARTHUR
Nederland
Port Neches
Groves
JEFFERSON COUNTY
CAMERON PARISH
ORANGE COUNTY
Big Hill
Fannett
Spindletop Oil Field
Sabine Pass
Coast Guard Station
FIGURE 2.7-3
PROPOSED PIPELINE ROUTES
1- OIL (27 MI.)
2- BRINE (13.2 MI.)
3- RAW WATER (5.5 MI.)
ALTERNATE PIPELINE ROUTES
4- OIL (26 MI.)
5- BRINE (16.5 MI.)
6- RAW WATER (7.5 MI.)

PA0767-8-7

2.8 DISTRIBUTION TERMINAL

2.8.1 General Description

The Sun Terminal, which is proposed as the oil distribution terminal for the Texoma group of SPR storage facilities, is located on the Neches River at Nederland, Texas, approximately 25 miles north of the Gulf of Mexico (see Figure 2.7-1). The Sun Terminal, operated by Sun Oil Company (Sunoco), has been in existence for many years. Sun receives crude oil from tankers and barges on the Neches River as well as from other small pipelines. They regularly handle oil for the Mobil, Union, Fina, Texaco, and Gulf refineries in the area.

Also located at the Sun Terminal is the Texoma Pipeline Company which operates a private 30-inch diameter pipeline transporting up to 500,000 barrels of crude oil per day to the Cushing, Oklahoma area. This pipeline would be one of several inland pipelines which would transport SPR oil in the event of a national crude oil supply interruption.

2.8.2 Existing and Proposed Facilities

The tanker and barge dock facilities at Sun Terminal are being rapidly expanded. Sun has two tanker docks in operation. Both docks are capable of handling up to 100,000 DWT (deadweight ton) tankers although current navigational river depths are only 40 feet and tankers of this size cannot be fully loaded. Now under construction are two additional tanker docks designed for 130,000 DWT tankers (see Figure 2.8-11).

Although Sun Terminal has planned a fifth tanker dock, it is probable that its construction schedule could be accelerated if a commitment is made to transport oil from an expansion of the Texoma Group SPR system through the Nederland facility. Therefore, in order to present a worst case analysis of those activities attributable to the SPR program, an assessment of a new tanker dock is included in this document (see Figure 2.8-1).

Sun currently has 5.3 million barrels of tankage with plans to add more. Full utilization of their tankage is expected as Texoma pipeline rates increase. Thus, it is anticipated that three 200,000 barrel oil surge tanks would be constructed for the SPR program and employed during fill operations (see Figure 2.8-1).

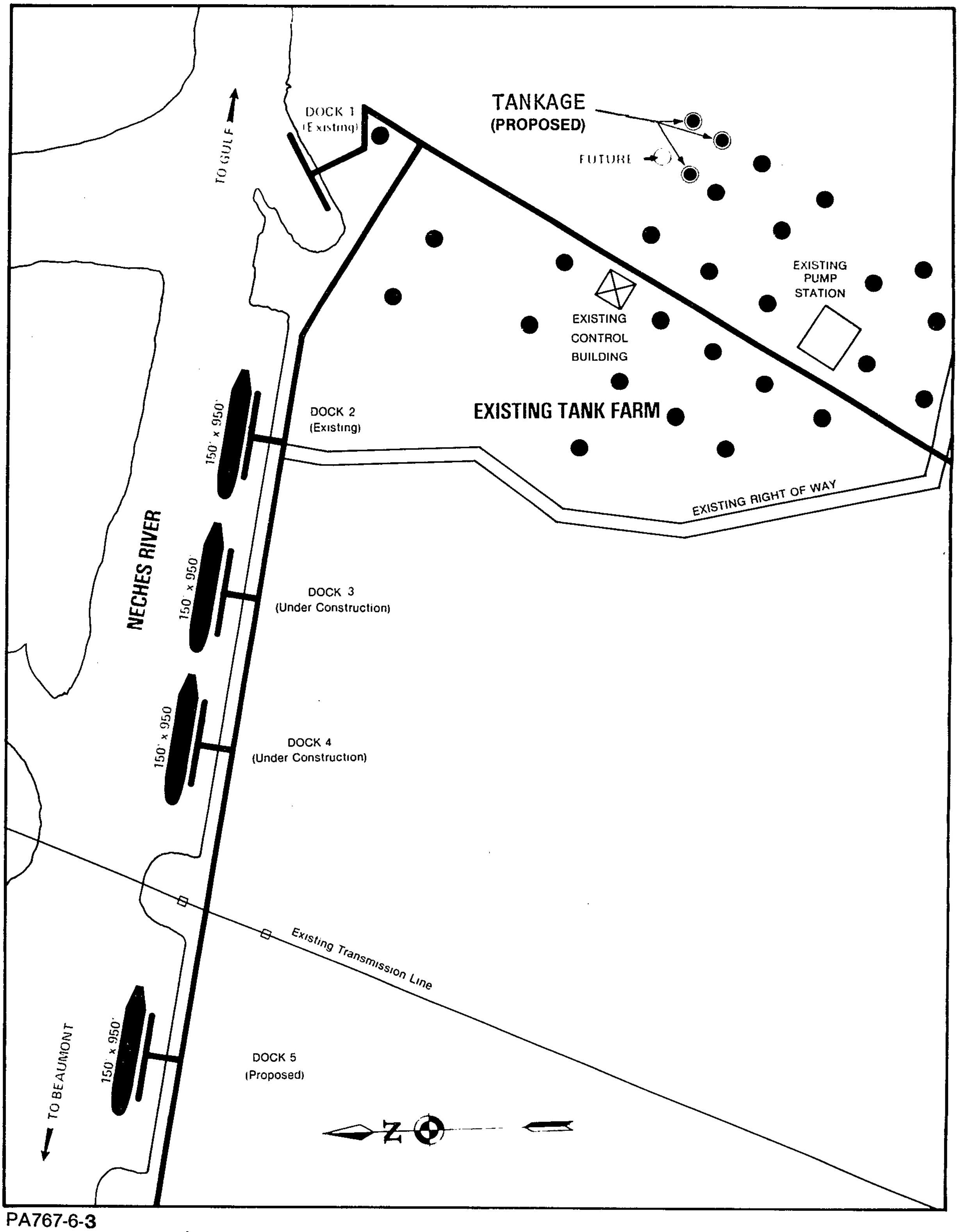


Figure 2.8-1 Sun Terminal Site Plan

The existing ballast treatment facility would be available as needed for treating ballast water displaced during tanker loading, for those tankers without segregated ballast holds. The facility consists of two 55,000 barrel ballast water tanks and the associated water cleanup systems capable of treating and discharging water at an average rate of 476 barrels/hour with a maximum oil concentration of 7.5 ppm (parts per million). The treated water would be discharged into a surface drainage ditch that drains directly into the Neches River.

The present Neches River navigation channel is 40 feet deep and 400 feet wide. Fully loaded tankers are limited to about 65,000 DWT (450,000 barrels), and light loaded tankers up to 122,000 DWT have been accommodated (personal conversation, J. P. Clubb, March 1977). The Corps of Engineers is now studying a proposal by Sun Oil Company to increase the channel dimensions to 50 feet deep and 500 feet wide. This work may be completed within about 5 years, allowing fully loaded tankers of up to 130,000 DWT to serve the Sun Terminal. For the purpose of this assessment, however, based on the existing channel depth and the greater availability of smaller tankers, 45,000 DWT (320,000 barrels) tankers would be used for the SPR tanker distribution. Also, light loaded tankers of larger sizes may be used, but the same carrying capacity is assumed.

2.8.3 Operation

Due to the limited size of tankers which can navigate the Neches River channel to the Sun Terminal, a "lightering" operation may be employed for SPR oil supplies coming into the terminal. Lightering is a common oil transport practice by which VLCC tankers (very large crude carriers 200,000 DWT and larger) unload at sea onto smaller tankers which can navigate the harbor channels. For the purposes of analysis, it is assumed that lightering onto 45,000 DWT tankers would be used. The lightering operations would occur from 50 to 100 miles offshore in at least 80 feet of water. The smaller tankers would dock along side the VLCC, connected by flexible transfer lines. Rendezvous times would commonly vary between 12 and 24 hours. The smaller tankers would then transport the oil to the Sun Terminal for transfer to the storage site via the proposed pipelines.

During oil fill operations, at the maximum proposed supply rate of 175,000 barrels/day, the resulting tanker traffic on the Neches River would be an average of one tanker per 44 hours. During emergency withdrawal, at a maximum proposed distribution rate of 1.4 million barrels/day, the present plan is to distribute approximately 60 percent of this oil (840,000 barrels/day) by tankers loading at Sun Terminal to the East Coast and Caribbean markets. The resulting tanker traffic on the Neches River would be an average of 2 to 3 tankers per 24 hour day. The remaining 40 percent of oil distributed (560,000 barrels/day) would be transported inland by available pipelines, including the Texoma Pipeline, or distributed to local refineries.

3.0 DESCRIPTION OF THE ENVIRONMENT

3.1 INTRODUCTION

This chapter contains a description of the regional environment of the proposed salt dome site, West Hackberry, and the environment of the three alternate sites - Black Bayou, Vinton, and Big Hill. Regional geology, water environment, climatology, air quality, ecosystems, natural and scenic resources, archaeological and historical resources, and socioeconomic characteristics are discussed. The regional environment of the Sulphur Mines site is also discussed. The environmental setting of the sites, the crude oil distribution systems, brine disposal systems, and the displacement/leaching water systems are also briefly discussed. Detailed discussions of regional and site specific environments are contained in Appendix B. The site specific discussion of the Sulphur Mines site is in the Final Environmental Impact Statement (DOE/EIS-0010) except for the new proposed water intake location and associated pipeline which is discussed along with the West Hackberry site environment.

3.2 REGIONAL ENVIRONMENT

3.2.1 Land Features

3.2.1.1 Evolution of Salt Domes

There are nearly 500 salt domes in the Gulf Coast region of the United States and Mexico. The salt in these domes was originally deposited in a broad shallow sea during Upper Triassic to Lower Jurassic time and eventually became buried beneath thousands of feet of fluvial and marine sediments.

According to widely accepted theory, salt dome growth is initiated and maintained by a process of isostatic adjustment which occurs when a mass of lower density rises to compensate for the sinking of a mass of greater density (Halbouty, 1967; Kehle, 1968). As additional sediments are deposited above the salt, the average density of the sediment column increases because of compaction and over-burden weight, resulting in a density difference between the salt and the overlying sediments, which must be compensated for by the salt flowing upward. As the salt stock rises, it begins to push overlying sediments slightly upward. Due to their elasticity, these sediments at first stretch, but eventually faulting occurs and sediment blocks are either tilted and pushed to the side or are displaced vertically ahead of the rising salt (Smith and Reeve, 1970).

Salt dome growth is maintained by continuous deposition and possibly by density changes associated with erosion of the vertically displaced sediments (Halbouty and Hardin, 1956). The postulated rates of salt dome growth throughout geologic time range from as high as .153 mm per year for the most rapid movement during Upper Jurassic to approximately .006 mm/yr for the past 50 million years. If these rates are accurate, the implication for the Strategic Petroleum Reserve (SPR) program is that salt dome movement is extremely slow and would not threaten cavern integrity.

Another important element of salt dome evolution is the formation of a mantle of well-compacted rock over the dome, called cap rock, which forms from the insoluble residues of the dissolution of salt as the dome rises through water-saturated sediments. The Gulf Coast salt domes are nearly pure salt (NaCl), with an anhydrite content estimated at about 3 percent (Kupfer, 1963). Anhydrite ($CaSO_4$) constitutes 99 percent of the insoluble residues (Taylor, 1938); other minerals include gypsum, dolomite, pyrite, calcite, quartz, sulfur, iron minerals, celestite, and barite. Fractures in the cap rock form as the salt rises and may remain open, allowing free flow of water, or may be filled by secondary mineral deposition and infiltration of surrounding sediments. Cavities which allow circulation of groundwater are common in cap rock and in some cases contain oil and gas. Saline or hydrogen sulfide springs originating in the cap rock can indicate communication between cap rock and the surface.

3.2.1.2 Geology

The Gulf Coast salt dome basin is among the most extensive in the world, underlying most of the Gulf of Mexico, Mississippi, Louisiana, Texas, southeastern Veracruz and western Tabasco in Mexico, and Cuba. The United States portion of the Gulf Coast basin is Triassic to Jurassic in age and lies under a broad portion of the Gulf Coastal Plain. In Louisiana and Texas, this Plain has a gulfward slope of about 5 feet per mile (Carsey, 1950), and the coastal prairies give way southward to marshes and eventually to coastal estuaries. See Figure 3.2-1 for a diagrammatic map outlining the major structural features of the U. S. Gulf coastal region, including the five salt dome subbasins.

Both the subbasins and the positive structural features separating them predate salt deposition, effectively confining most deposition to the separate basins. Hanna (1959) and Andrews (1960) postulated that, after burial, the three interior basin domes developed before the coastal basin domes because of the greater depth of Mesozoic sediment there. As the Mississippi River Delta grew southward, relatively more sediment was deposited in the coastal dome area, which promoted

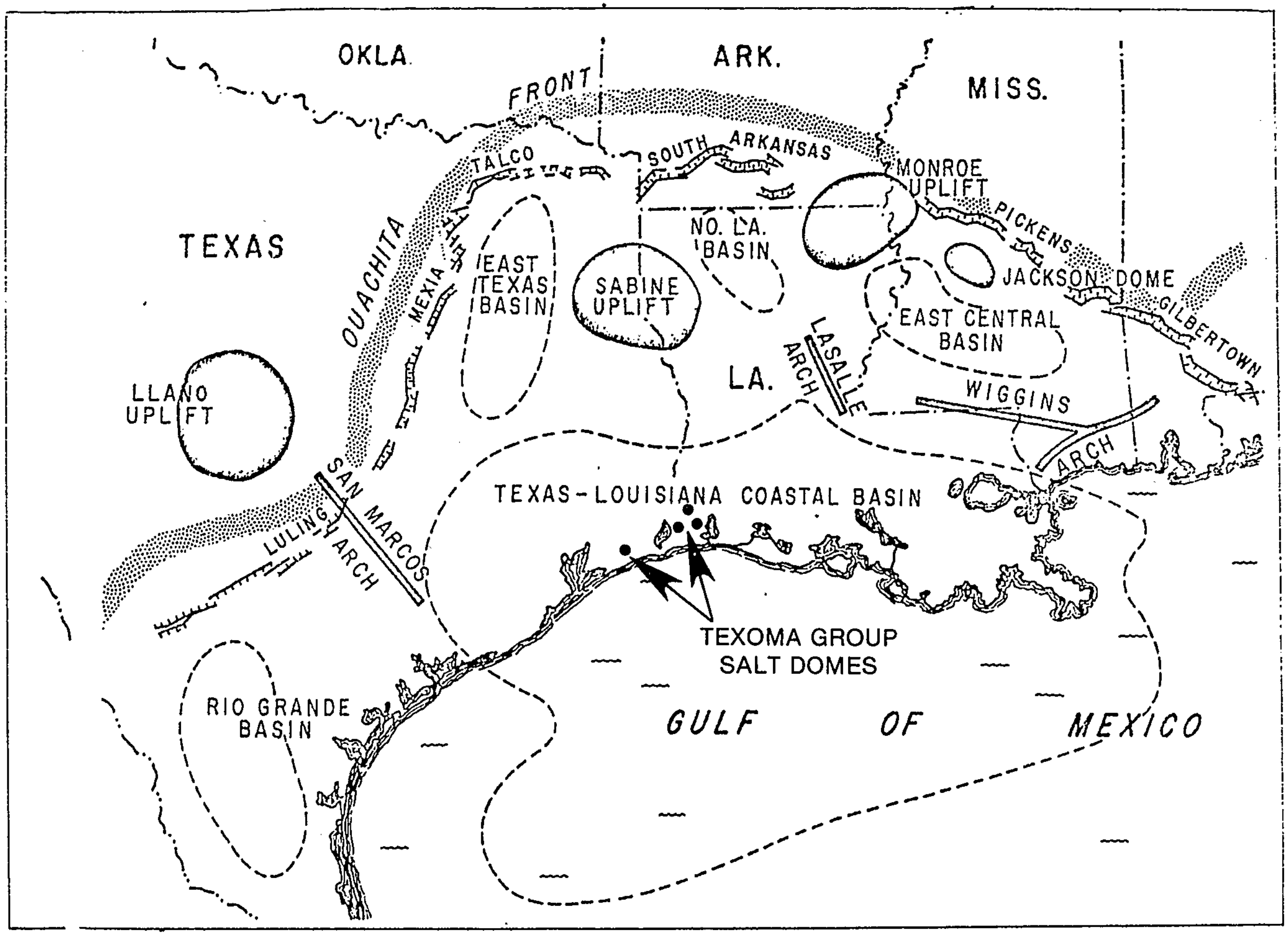


Figure 3.2-1 Diagrammatic map outlines the major structural features of the U.S. Gulf region including the five salt dome basins and their relationship to positive elements. Salt-controlled structural features are located in the salt dome basins and are enclosed within dashed lines. The remainder of the area shown is part of the evaporite basin of deposition but in these areas the salt source layer is less thick and no salt structures are known to exist. (Halbouty 1967)

dome growth along the coast and decreased the growth of the interior domes. Today the area of maximum sediment deposition is seaward of the coastal domes, and it is reasonable to assume that the growth rate of the coastal domes is decreasing or in some cases may have stopped.

Analyses of stratigraphic columns (see Appendix B, Figure B.3-28) indicate that sediments are generally unconsolidated to poorly consolidated at depth, with alternating sequences of gravels, sands, silts, and clays corresponding to the advance and retreat of ancient shorelines.

Because of the pattern of sediment transport to the Gulf and continued subsidence in response to the deposition of this sediment, the interior and coastal salt dome basins are aligned parallel to the axis of the Gulf Coast Geosyncline, which is offshore and parallel to the shores of Mississippi, Louisiana and Texas.

Two important topographic features of coastal Louisiana and Texas are mounds raised above some shallow salt domes and cheniers, which are stranded beach ridges formed during successive progradations of the shoreline. Cheniers are 10 to 20 feet above the mean terrain, running roughly parallel to the present Gulf Coast line, and are 150 to 1,500 feet wide and several tens of miles long; mounds can cover several acres.

3.2.2 Water Environment

3.2.2.1 Surface and Subsurface Systems

The Gulf coastal region of southwestern Louisiana and southeastern Texas is characterized by a complex surface and subsurface hydrologic system. The surface water system consists of an intricate network of rivers, bayous, waterways, and canals linking numerous lakes, ponds, and reservoirs (see Figure 3.2-2). These are interspersed with extensive marsh and swamp areas. Two sizeable river systems, the Calcasieu and the Sabine-Neches, empty into the Gulf of Mexico, which exercises considerable influence over the entire surface water system through tidal and atmospheric effects. The primary manmade water channel in the region is the Intracoastal Waterway (ICW), located 5 to 20 miles inland from the Gulf, running roughly parallel to the coastline.

Rainfall is the major source of replenishment in the area and is relatively heavy, averaging 52.7 inches/year. The intensity of rainfall, combined with the level of precipitation, is normally expressed in terms of the rainfall factor, R. The value of this factor for the region is 350, which represents the maximum value within the continental United States (U. S. Department of Agriculture, 1975).

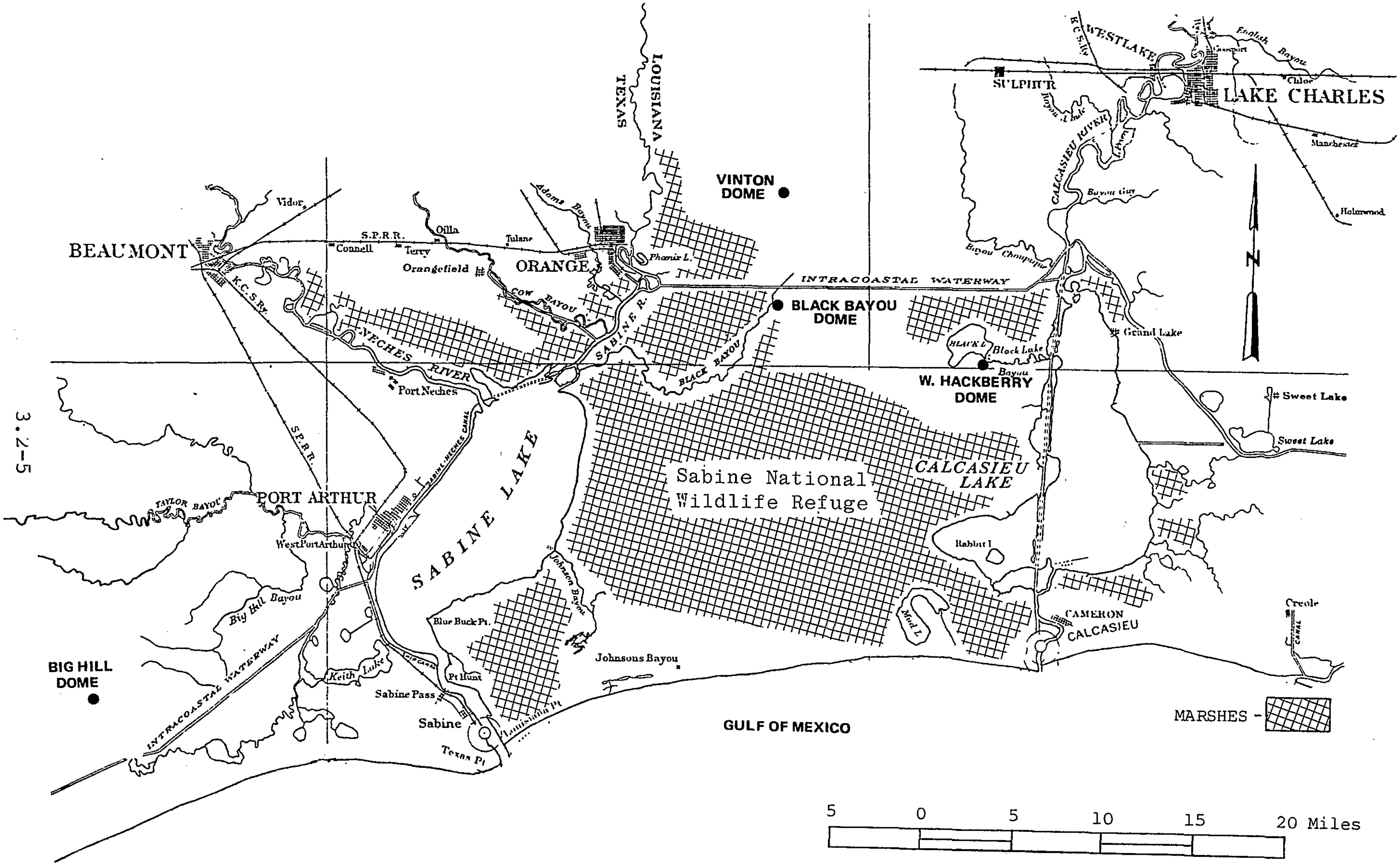


Figure 3.2-2 Regional Surface Water Bodies

The surface water system is used extensively for a variety of purposes, including transportation, industrial activities, commercial fishing, rice farming, livestock watering, irrigation of crops, and as a habitat for wildlife. Water quality varies considerably from site to site. The surface water is generally soft with an intermediate pH level. Brackish water is common between the Gulf and the ICW, while freshwater occurs further inland. The tendency for saltwater from the Gulf to intrude into freshwater areas during periods of low river flow constitutes the most important water quality problem in the region. A closely related problem is the consumption of surface water by industry and agriculture and subsequent release of various contaminants. Both the water and sediment of portions of the Calcasieu and Sabine-Neches River systems are polluted as a result of such releases.

In describing the existing water quality environment it is useful to identify any water quality parameter which appears, for some reason, to be too high or low. In order to make such an identification, the available measured water quality and sediment quality data must be compared with appropriate standards and criteria. Some confusion exists concerning the distinction between, and the proper usage of, the terms standards and criteria. For purposes of organization and clarity in this document the term standard will be used to refer to any enforceable water quality regulation, such as established by a state. The term criterion will be used to refer to any recommended limit placed on a water or sediment quality parameter. As discussed in Appendix D, criteria are not enforceable. If a measured water quality parameter falls outside of the prescribed standard it will be described as violating the standard. When a measured parameter lies outside of an applicable criterion it will be referred to as exceeding the criteria. In certain cases because of (1) detection of threshold limitations for the measured data, or (2) the absence of applicable standards or criteria, or (3) ambiguities in existing standards or criteria, a precise judgment is not possible. In such cases, if there is good reason based on the experience of the water quality analyst to expect some particular water or sediment quality problem, the appropriate parameter will be described as posing a possible problem.

The subsurface (geohydrologic) water system consists of a vertical series of aquifers*. The upper aquifers generally contain freshwater, but with increasing depth and/or proximity to the Gulf, more saline water is encountered. In order of increasing depth and geologic age, the aquifers present are the Chicot, the Evangeline, and the Jasper aquifers. See Section B.2.2.2,

*Water-bearing strata, normally composed of sand.

Appendix B, for a discussion of deposition and for comparisons of the aquifers underlying the proposed SPR sites in the Texoma region. Ground water production figures and breakdown of water usage are also given in Section B.2.2.2, for the Texas counties and Louisiana parishes in the area.

The position of the freshwater-saltwater interface is influenced by natural recharge and discharge conditions, and by man-made effects such as ground water pumping. As a result of pumping at Lake Charles, the saltwater interface is moving northward at rates between 30 and 200 feet per year (Harder et al., 1967). The interface may also be affected by the introduction of saline water into the aquifers by the dissolution of salt from domes or by vertical movement of deeper saline water around these domes.

The surface and subsurface water systems within the region are not totally isolated from one another, but the connections are somewhat indirect and are generally of secondary importance. It is significant to note, however, that in both systems a problem of primary concern is saltwater intrusion.

3.2.2.2 Oceanographic and Sedimentary Information

Oceanographic and sedimentary analyses are presented in detail in Appendices O and P. Appendix O treats background oceanographic information, and Appendix P discusses sedimentology and geomorphology of the Gulf Coast.

Bathymetry

Bottom topography in the region from 93° to 95°W longitudes is generally regular, with no prominent features to break the pattern of isobaths paralleling the shoreline, except in offshore regions of the Sabine and Calcasieu Rivers.

Hydrology

Monthly maps of sea surface temperature (see Figures 3-8, Appendix O) indicate that isotherms generally parallel the coast, reaching their maximum during January over the study area. From June through September, the sea surface is in a near-isothermal condition. For most of the year, cooler water is found nearshore and warmer water is found southward.

Like surface isotherms, the monthly pattern of isohalines parallel the coast during most of the year. Beginning in May, the isohalines, under the influence of less saline water introduced from the east, become increasingly perpendicular to the coast. By September, the isohalines are again parallel to the coast, and they maintain this pattern throughout the remainder of the year (30.0 ppt to 31.0 ppt salinity east of

Galveston). Throughout the year, the freshest water is found nearshore east of Galveston.

The least dense surface water throughout the year is also found east or southeast of Galveston, with minimum density in May as a result of the fresher water originating in the east (see Figure 9-15 in Appendix O).

Hydrographic sections taken offshore between longitudes 92°W and 96°W show that the relatively shallow water column responds rapidly to meteorological phenomena, such as cold fronts, which results in vertically homogeneous temperature and salinity profiles for 50-100 kilometers offshore in mid-winter after passage of a front.

Salinity and temperature conditions are seasonal. Winter storms cause vertically homogeneous waters, fresher onshore because of river discharge, and spring and summer conditions are determined by a combination of increased discharge, enhanced surface evaporation, and large-scale current structure in the Gulf of Mexico. In the offshore region of West Hackberry to Galveston Bay, fresher, warm surface water lies onshore, enhanced by the generally westward surface currents draining Mississippi discharge into that region.

Tides

The tidal regime in the region is mixed, with diurnal tides dominant over semidiurnal components. Spring tides tend to be semidiurnal, while neap tides are primarily diurnal. According to tidal cophase lines, the Gulf of Mexico acts as a circular basin in co-oscillation with tidal driven forces. Because of a rotary component, however, tidal current shifts continuously, rather than passing through periods of slack water. Tidal range is measured at one to two feet in open water and somewhat less in coastal waterways. Tidal harmonic analysis reveals that the dominant diurnal component of tide is nearly in phase throughout the western Gulf basin, while the semidiurnal component is of a much lower amplitude and acts as a perturbing factor on the dominant diurnal component. A tidal cophase map drawn for the region indicates that tidal crests move shoreward at Calcasieu, thence east and west, confirming the behavior of the western Gulf of Mexico as a quasi-co-oscillating basin.

Currents

Analyses of the ship drift data gathered by the Surface Current Data System (SCUDS) developed by NOAA's Environmental Data Service indicate that a current flows in a westerly direction along the Texas-Louisiana coast approximately parallel to the shoreline at speeds from 0.2 to 0.4 knots. Flow is parallel to isobaths in the study area and relatively stable. These surface currents are related both to wind conditions and baroclinic effects due to river runoff (see Figures 19 and 20 in Appendix C).

Mean currents in the shallow coastal waters of the study region are determined by winds, density differences, and larger-scale offshore flow patterns (see Figures 21 through 23, Appendix O for illustration of Seadock monthly current roses and wind roses). East winds in fall and winter create northward flowing currents; in spring and summer, currents flow to the northeast; February and September are transition periods between these flow fields. Lowest density waters are nearshore from September through April; isopycnals parallel the shoreline and isobaths. March shows an anticyclonic eddy pattern, and May through August is a transition period in which isopycnals become more perpendicular to the coastline. Such a pattern is not typical for coastal waters in other areas and is probably related to strong spring water runoff.

Although the region west of the Mississippi delta to the Texas border has not been well surveyed for current fields, one long current record from a single station does exist (see Appendix O). Surface water currents were predominantly toward the west from March through June, to the northeast from July through September and variable from October to February. Mid-depth water currents were more directional than surface currents. From March through June currents flow to the west, and from July through January they flow to the northeast.

Waves

Distribution of wave heights follows that of the winds for the area. Insufficient data exists for a conclusive climatological conclusion on waves, so that wave height can only be estimated.

In deeper waters within the study area, one occurrence every ten years will have a significant wave height (average of one-third highest waves) of thirty-three feet. In shallow waters, wave heights are limited by breaking to about 0.78 of the water depth.

Sedimentology

Sediment deposition off the Texas-Louisiana coast is a dynamic process. Fine-grained materials (clastics) from the Mississippi, Sabine, Neches, and Calcasieu Rivers are constantly in suspension along the coastline. Relatively strong longshore and inshore currents sporadically distribute the fines together with relict sands and old shell material.

The beach ridges of the region are marked by distinct recent and relict features (e.g., cheniers or strandplains, spits, barrier islands, offshore berms, dunes and bars, and interfingering deltaic systems). Erosion from the Beaumont outcrops results in a predominance of clays (e.g., smectites) which form a narrow, coastal band. Seasonal fluctuations of sediments are observed quite frequently along the beaches. Northern winds during the winter months tend to distribute fine-grained material from inshore to offshore, whereas southern winds during the summer and fall months tend to distribute sands from relict deposits inshore.

Erosion is occurring in the proximity of Clam Lake westward beyond High Island, with a landward shift of the shoreline eroding approximately 5 to 40 feet/year. (Erosion is from both Pleistocene and Holocene.) Deposition on the updrift side and in large gyral eddies on the downcurrent side occurs when it encounters hydrodynamic obstacles (e.g., jetting obstacles). The coastal sediment portrayed in the hydraulic regime is progressively moving from east to west.

Topographic relief of the area is very gentle. Slopes dip in the southward direction at the rate of 2 m/km (or 1 fathom/mile). The smooth substrate is predominantly compacted mud and silt combined with local patches of sand and shells. Small mounds of relict beach rock are exposed further gulfward, but no topographic projections are observed in the immediate vicinity. Specific area of deposition grade (from east to west) from deltaic sediments to shelf mud and sand, and then grade into a shoreface mud area. The shoreface mud environment gradually grades into the shoreface sand and muddy sand. It is interesting to note that the proposed brine disposal area is a transition zone of shelf mud and sand, bordered with shoreface mud deposits. See Appendix P for a more detailed discussion of the sedimentology and geomorphology of the upper Gulf Coast.

3.2.3 Climatology and Air Quality

3.2.3.1 Climatology*

The regional climate of the SPR site area including West Hackberry expansion site, Black Bayou, Vinton, and Big Hill, is classified as "humid-subtropical with strong marine influences" Seasonal fluctuations are moderate. Winters are cool and

*The following data are not site specific in that the nearest weather monitoring stations are 6 to 20 miles away, depending on the site in question. Data presented are from the station nearest to West Hackberry (Lake Charles).

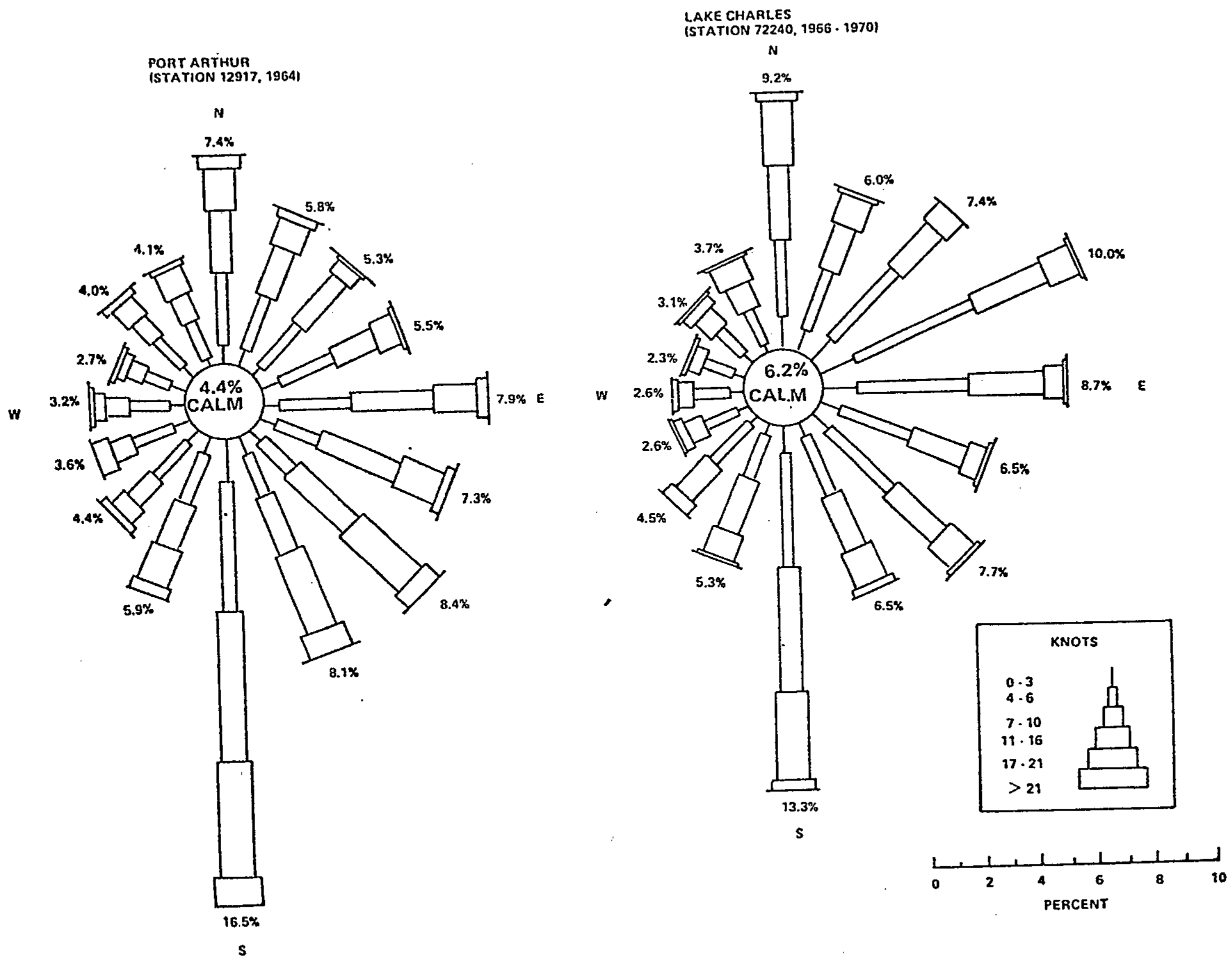


Figure 3.2-3 Annual wind rose data for Lake Charles (1966-1970) and Port Arthur (1964)

clear with occasional periods of overcast and summers are warm and humid with little daily variation. Afternoon showers and thundershowers occur frequently.

Temperatures average in the 50°s from November through March, and the average freezing season extends from mid-December to mid-February, with temperatures of 32°F or below recorded for 4 to 8 days. December and January are the foggiest months. November through May are usually the windiest, with mean wind speeds of 9 to 10 mph; calms occur most frequently during summer and fall. The annual rainfall at Hackberry is approximately 54 inches, and the average lake evaporation losses are roughly 50 to 51 inches. The monthly precipition averages approximately 4 inches throughout the year with the exception of July and August, when thunderstorm activity is greatest. Rainfall reaches a monthly maximum of 6.83 inches in July, with an average of 14 thunderstorm days. Within the past 20 years, two storms passed through the area with winds of 100 mph or greater. See Section B.2.3.1, Appendix B, for a more detailed discussion of regional climatology and in particular for severe storm statistics and risk projections for the area.

The nearest wind rose data to the SPR site region, for Port Arthur and Lake Charles, are presented in Figure 3.2-3. Figure B.2-11, Appendix B, gives a general profile of the wind rose patterns for the western Gulf Coast. Eighty percent of the winds in the Lake Charles area and seventy percent in the Port Arthur area are less than 12 mph. Extreme winds at 30 feet above ground with a 50-year recurrence interval are around 95 mph, and with a 100-year recurrence interval, around 100 mph (Thom, 1968).

3.2.3.2 Climatological Factors Affecting Dispersion

Dispersion climatology provides an evaluation of the capability of the atmosphere to disperse airborne effluents in a given geographic region. This capability depends largely on three critical climatological factors: (1) atmospheric stability, (2) mixing height, and (3) the mean wind field within the mixing layer.

Atmospheric Stability

Table 3.2-1 summarizes the annual distribution of atmospheric stability classes in terms of unstable, neutral, and stable conditions for four weather stations encompassing the Texas-Louisiana Gulf Coast region.

Stability in the lowest part of the atmosphere depends primarily on net thermal radiation and wind speed. The increase in wind speeds with westward progression along the Gulf Coast is reflected in an associated increase in the

TABLE 3.2-1
Regional Distribution of Atmospheric Stability Class

Location	Annual Frequency (%) of		
	Unstable Conditions [1]	Neutral Conditions [2]	Stable Conditions [3]
Galveston, Texas	16.0	61.4	22.6
Lake Charles, Louisiana	19.4	40.9	39.7
Baton Rouge, Louisiana	20.0	43.4	36.6
New Orleans, Louisiana	26.0	29.8	44.2

1. Includes Pasquill Stability Classes A, B and C.
2. Pasquill Stability Class D.
3. Includes Pasquill Stability Classes E and F (G not available for above sites).

frequency of well-mixed or neutral conditions. Unstable and stable conditions occur more frequently in the eastern portions of the region. Although neutral conditions are dominant at four of the five stations, stable, light wind speed conditions comprise an important portion of the annual distribution. Such conditions tend to maximize the ground level impact of surface, non-buoyant emissions, while neutral conditions tend to maximize the impact of sources with moderately high release heights. The actual meteorological worst-case scenario for each of the SPR sources would vary as a function of source exit characteristics.

At certain times a stable air layer can be found in the atmosphere which increases in temperature from lower to higher altitudes. The term "inversion" is used to describe this situation, since air temperature normally decreases with increasing height. See Section B.2.3.2.2, Appendix B, for a discussion of the two basic types of inversions, radiation inversions and subsidence inversions.

Inversions, in general, restrict the dispersive ability of the atmosphere, and an inversion aloft acts as a barrier to vertical mixing. The layer of air between the earth's surface and the inversion aloft, within which pollutants are mixed by turbulence and diffusion, is called the mixing layer. The height of this layer is determined by the position of the elevated inversion layer and typically shows large diurnal and seasonal variations. Mixing layers are usually lowest at night and grow in vertical extent after sunrise in proportion to the degree of insolation. Seasonally, mixing heights tend to be lowest in fall and winter and highest in summer.

Figures B.2-12 and B.2-13, Appendix B, provide monthly values for mixing height during the morning and afternoon hours, respectively, at four stations along the western Gulf Coast. The data indicate the expected diurnal and seasonal trends, with morning readings for the four stations ranging from 350-475 meters in winter to 475-1350 meters in summer, and afternoon readings ranging from 525-1000 meters in winter to 1200-2000 meters in summer. Holzworth (1972) has summarized the available temperature sounding data for the contiguous United States and developed seasonal and annual contours of morning and afternoon mixing height. The data for the four proposed SPR sites are presented in Table B.2-3, Appendix B, showing similar values for the four sites. Average annual mixing height varies from 475 meters in the morning to 1200 meters in the afternoon, with the expected winter lows and summer highs.

Wind Fields Within Mixing Layer

Wind speeds increase with elevation above the ground as a function of surface roughness characteristics and atmospheric stability class. Since the SPR sites are located in areas of flat terrain and the SPR sources are low level with little buoyancy, it is reasonable to employ the mean wind speed within the mixing layer for the study of regional transport potential of airborne effluents. Figures B.2-14 and B.2-15 in Appendix B present monthly averages of diurnal wind speed averaged through the mean mixing layer for the four Gulf Coast stations. Wind speeds tend to reach a minimum during the summer and early fall and a maximum during winter and spring. Morning wind speeds are slightly slower than afternoon speeds.

Holzworth (1974) has compiled the total number of forecast days of high meteorological potential for air pollution in the contiguous United States, based on the prediction of a low ventilation factor which would result in a regional accumulation of airborne effluents. Figure B.2-16, Appendix B, presents the historical frequency of such "episodes" within the SPR study region for a 5-year period, with frequencies ranging from 0 at Big Hill to 5 at the West Hackberry, Black Bayou and Vinton sites. The mean position of the high pressure region typically found over the southeastern states is reflected in the pattern of high potential for air pollution, and project emissions would tend to have a more significant impact at sites located further east along the coastline.

3.2.3.3 Air Quality

The existing air quality for the region in which the four proposed SPR sites are located is summarized in Table 3.2-2, based on the available sources of data for existing ambient pollutant levels (see Figure B.2-17 in Appendix B for monitoring sites). The data indicate regionally high levels of non-methane hydrocarbon (NMHC) and photochemical oxidants (O_x), reflecting the extensive development of petrochemical and fuel handling facilities at Gulf Coast ports coupled with favorable conditions for the initiation of photochemical processes. Sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO) and hydrogen sulfide (H_2S) concentrations are presently in compliance with all applicable standards, indicating a lack of heavy regional concentrations of combustion processes.

Projections of air quality levels, based on population and industry growth considerations under reasonable proposed controls, indicate that the NAAQS will be exceeded beyond 1985 for non-methane hydrocarbons and photochemical oxidants (see Section B.2.3.3, Appendix B, for figures and assumptions). SO_2, NO_2, CO, and particulates are not expected to persistently

TABLE 3.2-2

Existing Baseline Air Quality in the SPR Region *

Monitoring Location	Pollutant	CONCENTRATION (µg/m³)[1]				
		1-hour	3-hour[2]	8-hour	24-hour	Annual[3]
Clute, Texas	OX	310				53
	NMHC		2,335			533
	NO_2					20
	SO_2		27.		0	0
	CO	10,171		3,886		457
	Part/H_2S[4]	/14			154/	89/ 0
Nederland, Texas	OX	954				56
	NMHC		2,067			400
	NO_2					20
	SO_2		240		27	0
	CO	3,543		1,600		229
	Part/H_2S[4]	/14			129/	56/ 0
West Orange, Texas	OX	376				54
	NMHC		939			200
	NO_2					20
	SO_2		0		0	0
	CO	6,057		4,800		457
	Part/H_2S[4]	84/43				50/ 0
New Orleans, LA	OX	182				
	NMHC					
	NO_2					
	SO_2					
	CO					
	Particulate				162	72
Baton Rouge, LA	OX	294				
	NMHC					
	NO_2					
	SO_2				117	
	CO					
	Particulate				145	56
Clovelly, LA	OX	183				
	NMHC	812				
	NO_2	44				
	SO_2	51				
	CO	0				
	Particulate				164	
Plaisance, LA	OX	174				
	NMHC	479				
	NO_2	34				
	SO_2	20				
	CO	0				
	Particulate				68	
Lake Charles, LA	OX	250				
	NMHC					
	NO_2					
	SO_2					
	CO					
	Particulate				154	68

* The location of the monitoring stations, the period of record, and the parameters measured are listed in Figure 8.2-17. Shaded boxes indicate violation of standards.

[1] Values given are the second highest for the appropriate time interval with the exception of annual values and the hydrogen sulfide readings.

[2] The HC 3-hour value is the second highest 6-9 a.m. reading.

[3] The arithmetic mean is provided for all the data with the exception of particulate matter for which the geometric mean is presented.

[4] The Texas H_2S standard is based on a 30-minute averaging period and is not to be exceeded at all.

exceed standards in the following 10 years, with the possible exception of sulfur, should low sulfur fuels become scarce.

3.2.4 Background Ambient Sound Levels

Background noise levels in and around the region of the proposed SPR sites are typical of a secluded, essentially flat area. In winter and spring the major contributing noise sources are wind and periodic bird calls. The day-night weighted levels are estimated at 48 dBA (for definition of day-night levels see Appendix F). In summer, due to high humidity and warmth, noise is dominated by sounds of insects, frogs, and crickets in addition to bird calls and the sounds of wind in the foliage and brush, yielding evening noise levels as much as 10 to 15 dBA higher than winter levels. See Section B.2.4, Appendix B, for sampling sites and further discussion.

3.2.5 Species and Ecosystems

3.2.5.1 Introduction

The region in which the storage facilities and their water supply, brine disposal, and oil distribution connections would be situated is ecologically varied, with a large number of habitat types. For purposes of clear reference, this region is defined as the Calcasieu River its associated lakes in Cameron and Calcasieu Parishes, Louisiana; the areas to the west of these water bodies in the same parishes; Orange and Jefferson Counties in Texas; and the offshore areas in the Gulf of Mexico paralleling the foregoing continental areas. The width of this offshore strip extends slightly beyond the proposed brine diffuser locations, as far as the limit of potential influence from brine release.

The dominant natural vegetation types in the land area of the region were historically prairie and marshland. Most of the original prairie has been put under cultivation or is used as pasture and range land. The marshland is still largely preserved and some is in federal and state refuge systems. Forests are found along some water courses inland from the coastal swath of marshes and in the northern-most inland parts of the region. Deep channels dredged in the main rivers, the Calcasieu, the Sabine, and the Neches, have resulted in salinity intrusion many miles inland along these rivers and connected water courses. Canals extend into the marsh and elsewhere which in many cases cut across the natural hydrologic drainages. The ICW at the north end of the marshes has significantly altered this drainage pattern. Large reservoirs are present in and adjacent to the marshes in some locations within the region. New habitats have been created and former ones reduced and modified by spoil disposal, levee construction, and sedimentation. Oil and gas production is prevalent.

Many areas have been filled or drained. Most, if not all, of the marshland and water bodies have a species composition which is much different from what it would be in the absence of large-scale environmental modifications derived from human activities.

While the value of agricultural and forest areas is generally apparent, the value of marshland is a more complex matter and must be understood in terms of nutrient cycles and the interdependence of natural systems. Inorganic nutrients are introduced into the marsh systems via freshwater and tidal inflows. Much of this nutrient influx is trapped on and in the sediments where it becomes available to the marsh vegetation. Nutrients are incorporated into plant material which is eventually decayed and recycled by abundant micro-organisms. The average salt marsh is twice as productive as the best farmland. This high level of productivity supports extensive food chains, both within the marsh itself and in adjacent estuaries, to which as much as half the organic matter produced may be carried. Tidal marshes serve as nursery areas for various estuarine species and provide food and refuge for a number of furbearing animals. They also aid in erosion control and act as temporary floodwater buffers.

Some saltwater is necessary to maintain most tidal marshes. The amount determines the general type of marsh and assemblage of plants and animals present. Chabreck (1970) subdivided the Louisiana coastal marshes into four vegetation types, based primarily on salinity of the surface water: fresh (average water salinity 1.5 ppt), intermediate (3.3 ppt), brackish (8.1 ppt), and saline (15.9 ppt). Marshes closest to the coast generally have the highest salinities, but exceptions to this rule are fairly numerous, especially along drainage systems. The saline marshes have higher standing crops of organisms and lower species diversity in comparison with the other types. Chabreck (1970) lists 93 species for the freshwater marsh, making it the most diverse. The species compositions for the marsh types are shown in Table K.1-2, Appendix K, and are discussed extensively in Section B.2.5.2.1, Appendix B.

3.2.5.2 Ecosystems

Characteristics of Ecosystems in Western Cameron Parish

The western part of Cameron Parish, Louisiana, where the West Hackberry and Black Bayou salt domes are located, is composed mainly of marshland, Calcasieu Lake, the western part of Sabine Lake and some smaller areas of former prairie. Agricultural and urban/industrial uses are quite restricted and forests are not present. The most extensive area in western Cameron Parish is part of the coastal Chenier Plain which consisted, in its primitive state, of marshlands with natural ridges extending in a general east-west direction. These ridges or cheniers are stranded former beach lines which play a large role in directing water flow through the marshes. Man-made levees and spoil have changed the topographic features in many parts of the marshes. Calcasieu Lake is the dominant open-water estuarine area influenced by the marshes in western Cameron Parish, with Sabine Lake next in importance. See Table B.2-1, Appendix B, for a listing of the species found in these lakes. Benthic, epiphytic, and periphytic algae characteristic of coastal Louisiana are presented in Appendix B, Table B.3-1, and are discussed in Section B.2.5.2.1, Appendix B.

The Gulf offshore area adjacent to southwestern Louisiana extends over the continental shelf to a distance of more than 100 miles (Stone and Robbins, 1973). This area is important to fish and invertebrates such as menhaden, Atlantic croaker, mullet, and brown and white shrimp, especially during winter spawning. Little benthic vegetation is present and food webs are based largely on phytoplankton.

The sand beach zone has a rich floral and faunal community adapted to periodic exposure to the atmosphere (Stone and Robbins, 1973). Many mollusks, annelids, and burrowing crustaceans are present in this zone, and minute organisms are present in the interstitial spaces between sand grains. See Appendix Q for a detailed discussion of the Gulf offshore and beach environments.

Much land which was formerly prairie is now farmland and improved pastureland. Natural prairie vegetation is predominantly switch grass, big bluestem, Indian grass, and prairie wildgrass. Typical pasture species are signal grass and goatweed.

Characteristics of Ecosystems in Western Calcasieu Parish

The western part of Calcasieu Parish, Louisiana, where the Vinton dome is located is mainly prairie grassland which has been put to agricultural use. Swamp forest and bottomland hardwood communities are present in the extreme western portion along the Sabine River and north of Lake Charles along the Calcasieu River flood plain. Most of this area has been greatly altered by lumbering. Commercially-managed timber stands are present in some locations, but timber production is limited. Fingers of intermediate, brackish, and freshwater marsh project into the southwestern part of the parish creating a complex wetlands environment. Occasionally salinity intrusion occurs in this area above the level of Sabine Lake on the Sabine River system and above the level of Lake Charles on the Calcasieu River system. A saltwater barrier has been constructed above the level of Lake Charles to reduce such intrusion.

Dredged sediments transferred to waterway banks or used as fill have created new habitats. A large island (Choupique Island) north of Calcasieu Lake and adjacent to the Ship Channel has been built up with fill, while other elevated areas have been created by the deposition of spoil along part of the Intracoastal Waterway and the Calcasieu Ship Channel. Dredged material areas support a wide range of plant species, particularly pioneer species which invade disturbed sites. See Section B.2.5.2.2, Appendix B, for a discussion of the species found in these areas. The spoil banks along the ICW have not been disturbed within the past 30 years, and succession has proceeded to a near climax situation except on maintained right-of-ways. Dredging along the Calcasieu Ship Channel, as far north as the saltwater barrier above Lake Charles, occurs on an as-needed basis. Therefore, spoil banks in various stages of revegetation are present along nearly the entire extent of the channel in western Calcasieu Parish. These plant populations usually develop within 12 to 18 months following the deposition of new sediment.

Urban or industrial areas in western Calcasieu Parish include Westlake, Maplewood, the Hollywood Industrial Park, Sulphur, and Vinton. All but Vinton are considered part of the Lake Charles greater metropolitan vicinity.

Characteristics of Ecosystems in Orange County

Orange County, Texas, is bounded by the Neches River on the south and west and by the Sabine Lake and River on the east. The two largest cities, Orange and Bridge City, both industrial cities, lie in the southeastern part of the county. The areas which were historically natural prairie are now mostly cultivated in crops. Ranching is common on higher marshland, fallow cropland, and within wooded river valleys. Scattered oil and gas fields are present.

Figure 3.2-4 is a generalized vegetation map of the county, with representative organisms listed for the vegetation types. The plant species composition for forests, prairies, and dredge disposal areas are essentially the same as those listed for western Calcasieu Parish. Those characteristic of the different marsh types have been discussed previously, except for a distinct vegetation category called high marsh present on higher elevations within the general marsh area. The ferns, grasses, trees, and weeds found in the high marsh environment are listed in Table K.6-1, Appendix K.

Sabine Lake is relatively shallow with a depth of less than 9 feet. Lantz (1970) surveyed fish, plankton, and benthos in the Sabine River, above the lake, and the results of this survey are listed in Section B.2.5.2.3, Appendix B. The study indicates that plankton counts and weights were lowest during

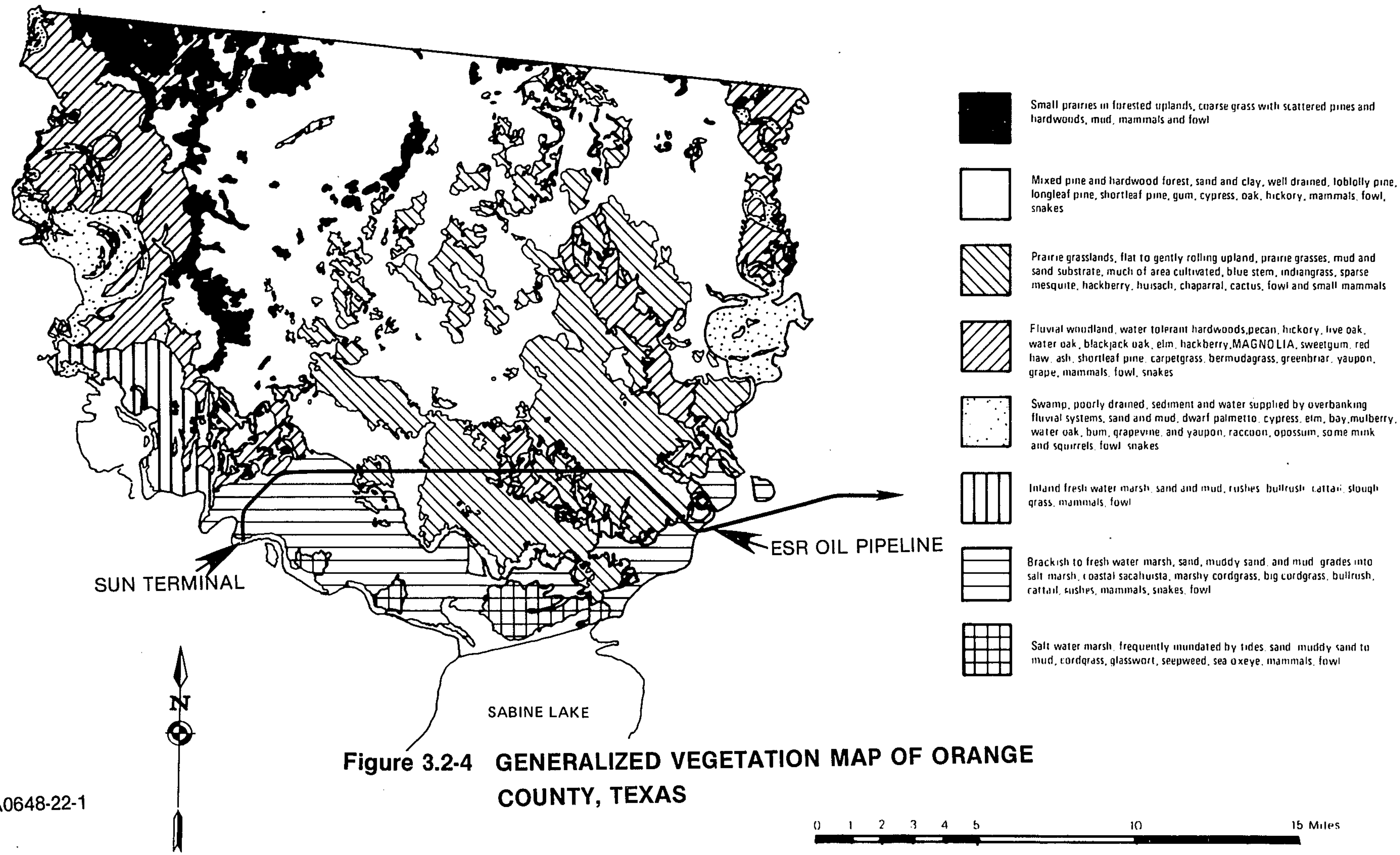


Figure 3.2-4 GENERALIZED VEGETATION MAP OF ORANGE COUNTY, TEXAS

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late fall and winter, with productivity increasing by February of each year and pulsing during the warm months. During peak occurrence, zooplankton was dominated by rotifers, while Chrysophyta (yellow-green algae) was the dominant algal group.

Characteristics of Ecosystems in Jefferson County

Jefferson County lies to the southwest of Orange County on the Gulf Coast of Texas. The main area of industrial and residential-urban development is in the northeastern part of the county near the Neches River and Sabine Lake. Port Arthur, Beaumont, Port Acres, Port Nederland, and Nederland are clustered there. The ICW passes through the coastal marshes from Port Arthur, through Jefferson and Chambers Counties, to East Galveston Bay. Sun Terminal and the Big Hill salt dome site are located in Jefferson County (Figure 3.2-5).

Ecosystem distribution is partially determined by elevation and proximity to the Gulf. Ecosystems extend in a transition from lowland salt and brackish water marshes near the coast, through brackish-to-freshwater marsh systems which occur further inland, to prairie grassland systems of central Jefferson County, and finally into the mixed pine and hardwood forests of the upland areas of northern Jefferson County. The distribution of these ecosystems is shown in Figure 3.2-5. A general textual discussion of each ecosystem type is presented in Section B.2.5.2.4, Appendix B. Total acreage for each ecosystem as well as the dominant plant species are listed in Table K.7-1, Appendix K.

Natural water systems in the county include the eastern half of Sabine Lake (10 to 20 ppt average salinity) and fresh to brackish lakes and ponds which are landlocked and accumulate saltwater following high tides and storms. The principal freshwater streams of the area are the Neches River, Taylor Bayou, and the Hillebrandt Bayou, which are influenced by tides in their lower reaches where they are classified as estuarine. Artificial water bodies include canals and reservoirs, which generally contain freshwater; and the ICW, which is brackish.

The bottom substrate of Sabine Lake has been changing in recent years from predominantly sand and shell to mostly mud, especially in the western portion of the lake. This has been due largely to spoil deposition with subsequent erosion and runoff. Other causal agents involve the failure of levees surrounding disposal areas and the altered circulation patterns resulting from ill-advised placement of spoil. The high turbidity resulting from these activities has caused a rather severe reduction in the number of benthic organisms in the Sabine-Neches waterway area. Since 1966, there has been a precipitous decline in the annual white shrimp harvest from

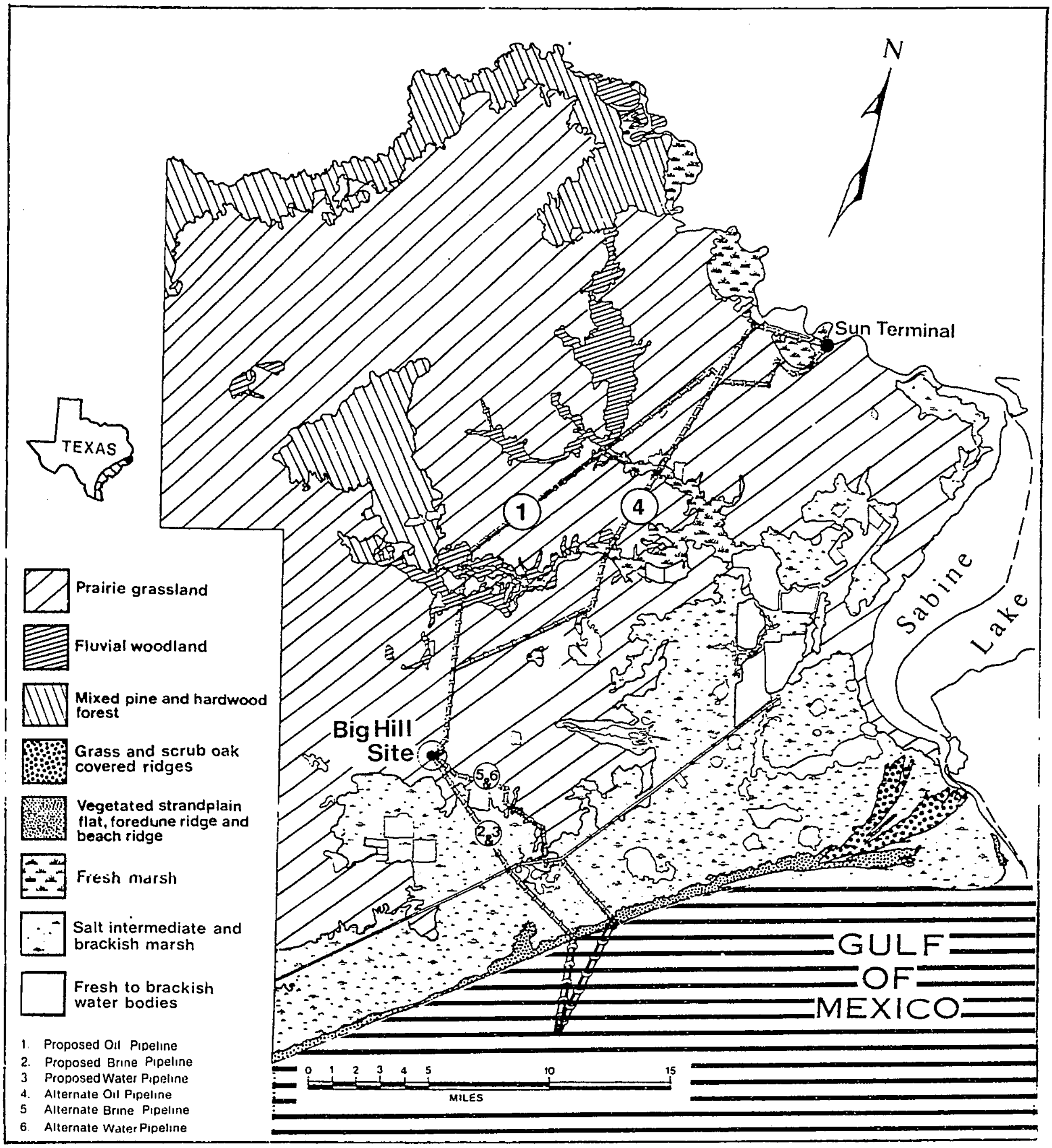

FIGURE 3.2-5 **ECOSYSTEM DISTRIBUTION, JEFFERSON COUNTY, TEXAS**

Source: Fisher, et al. 1973

Sabine Lake due to the loss of shallow water nursery grounds (marshes), increases in pollution and salinity, and disruption of benthic habitat. Another factor which has been linked to the decline in shrimp harvests is a change in salinity conditions resulting from the operation of Toledo Bend Dam. Release of water during late spring and summer lowers salinities in the lake when the natural pattern was for the salinity to increase.

Along the ICW in Jefferson County are one to two hundred-foot wide spoil banks of dredge material, which have an elevation greater than that of the surrounding marshland. Dredge material is also found adjoining the spoil banks, averaging 40-60 acres per mile in some areas. In the vicinity of the proposed Big Hill pipeline crossing, the width of these disposal areas is approximately 1500 feet. Vegetation on the banks of the ICW is dependent on several factors, including time since disturbance, drainage (as influenced by soil characteristics and elevation), and characteristics of the adjacent landscape, especially the salinity of the water. The dredge spoil embankments bordering the ICW are relatively barren areas. Where succession has occurred, the vegetation is different from that of the surrounding brackish and intermediate marshland.

Ecosystems - Terrestrial Vertebrates

Mammals. A number of species of mammals inhabit the Texoma study area. Muskrats are abundant in the rice fields and marshes throughout the area, with brackish marsh the preferred type. Nutria are most abundant in the fresh and intermediate coastal marshes of Jefferson County, where they feed on marsh vegetation. Mink are most common in the cypress-tupelo swamps along the Sabine and Neches Rivers, but also occur in marshes where some high ground is available for refuge. The raccoon occurs in brackish and fresh marshes, swamps, and bottomland forests. River otters, which are not common in the area, seek permanent open water areas with intermittent high ground, preferring fresh to brackish marsh types. White-tailed deer prefer the bottomland forest, especially where an ecotone with cleared land is available, but they are also found in the marshes. The highest populations of deer are found in Calcasieu Parish. Many marsh inhabitants make use of dredged material banks for feeding areas and refuge from high waters.

The two species of rabbits common in the Texoma area are the swamp rabbit, which frequents wet woodlands, marsh ridges, and dredge disposal areas, and the eastern cottontail, found in dryer habitats. Two species of squirrels found in woodlands are the gray squirrel, preferring the dense bottomland hardwood and swamp forests, and the flying squirrel found in drier, less dense woodlands. Skunks, opossum, the nine-banded armadillo, the cotton mouse, and the hispid cotton rat are also found in the bottomland forests. The bobcat is a major predator in the bottomland and swamp forests, with red and gray foxes present but not common. In the prairie type vegetation, the main mammalian predator is the coyote, which feeds mainly on rodents such as the cotton rat and the plains pocket gopher. Rodents typical of developed areas such as Beaumont and Orange include the house mouse, roof rat, and Norway rat. Table K.8-1, Appendix K, is a more complete list of the mammals characteristic of the Texoma study area, with references to local abundance.

Birds. The vast marshlands of the Gulf Coast provide an array of habitats suitable for use by a wide variety of resident and transient species of birds. This area is especially important as a wintering area for many species of waterfowl. Ducks may be broadly classified as dabblers which feed near the surface, and divers which submerge to feed. Common dabbler ducks of the area include the Mallard, Gadwall, American Wigeon, Shoveler, Pintail, and Mottled ducks. The preferred habitat of these ducks is freshwater marsh and rice fields, but they are generally found in all marsh types within the study area. Diver ducks such as the Canvasback, Lesser Scaup, and Red-breasted Merganser are generally found on the larger bodies of water. The Wood Duck, the only common species of duck that has established permanent populations in the area, prefers swamp and bottomland forests. All common migratory ducks are winter residents. The Canada Goose, the Snow Goose, the White-fronted Goose, and the American Coot are also present. Other common winter residents of the marsh and lake shores are the Common Snipe, Marsh Hawk, Gull-billed Tern, Tree Swallow, Marsh Wren, and the Greater and Lesser Yellowlegs.

Common inhabitants of the farmlands, old fields and other early successional habitats include the Bobwhite, several species of doves, the Killdeer, Crow, European Starling, and the Savannah and Field Sparrows. Forest residents include the Mourning Dove, Common Snipe, and several species of owls, woodpeckers and warblers. Many forest songbirds are classified as "transient" and are found in the study area only during the spring or fall, when they are passing through to either their breeding or wintering grounds.

Some shore birds which are common residents of the area are the King and Clapper Rails, found along the marshes, and the Purple and Common Gallinules, found in shallow freshwater ponds. Red-winged Blackbirds, Marsh Wrens, and Seaside Sparrows are also permanent residents of the marsh environment. Resident waders include: the Willet, Great Blue Heron, Louisiana Heron, Black-crowned Night Heron, Yellow-crowned Night Heron, Snowy Egret, the Least Bittern, and American Bittern.

The Red-tailed Hawk, the Marsh Hawk, and the American Kestrel are top predators in the area, while the Turkey Vulture is an important scavenger. Table K.8-2, Appendix K, is an annotated list of the birds in the Texoma study area with notations on their local abundance.

Amphibians and Reptiles. The American alligator is widespread in the flooded river bottoms, swamps, and brackish to fresh-water marshes in the study area, especially in the Louisiana parishes. The common and alligator snapping turtles are found in freshwater rivers, swamps, and lakes. Midland smooth and pallid spiny softshell turtles are found mainly in open waters, while the Texas diamondback terrapin inhabits brackish and salt marshes of Jefferson County and Cameron Parish. Mud and musk turtles are mainly aquatic, inhabiting marshes, rivers, swamps, and lakes in the study area.

Most of the toads in the area inhabit fields bordering on water. One exception is Hurter's spadefoot toad, found mainly in woodlands. The squirrel and southern gray treefrogs, the northern spring creeper, and the upland chorus frog inhabit moist forested areas. The green treefrog prefers areas with permanent bodies of standing water, as do some species of salamanders, the central newt, the bullfrog, and the southern leopard frog. The small-mouthed and marbled salamanders breed in the open water and live much of their lives underground in woodlands.

Of the common lizards in the Texoma area, the western slender glass lizard, the six-lined racerunner, the Texas horned lizard and the eastern fence lizard frequent dry fields, grasslands, and dry open woods. Several common species, including the ground skink, the five-lined skink, and the broad-headed skink prefer wetter sites. The ground skink and the green anole also adapt to urban and residential habitats.

Various water snakes are found throughout the Texoma area in low-lying swamps and bottomlands near permanent bodies of water. All the poisonous species (western cottonmouth, western pygmy rattlesnake, canebrake rattlesnake, southern copperhead and Texas coral snake) are found in these wetter habitats. Moist woodlands are also preferred by the western ribbon snake and the western mud snake. Drier woodland areas are usually inhabited by the eastern hognose snake and the Mississippi ringneck snake. Earth snakes are usually found in fields, and the brown snake, garter snake, eastern coachwhip, rough green snake, rat snakes, and king snakes are found in a wide variety of habitats. Table B.8-3, Appendix B, is an annotated list of the reptiles and amphibians found in the Texoma area.

3.2.5.3 Rare or Endangered Species of the Region

Plants

At the present time, no plant species have been officially designated as endangered or threatened, but two listings have been proposed and are being studied by the Fish and Wildlife Service (U. S. Fish and Wildlife Service, 1975; 1976). None of the plant species proposed for Louisiana have been cited in Cameron or Calcasieu Parish (Robertson, 1977). Of those proposed for eastern Texas, none have been cited in Jefferson or Orange County, but three *Neolloydia gautii*, *Phlox nivalis taxensis*, and *P. nivalis*, have been reported in neighboring counties.

The Rare Plant Study Center at the University of Texas at Austin has identified seven plant species in Jefferson County and three in Orange County as being rare and endangered, but they are presently considering only two of these for submission to the Federal Office of Endangered Species. These are *Ruellia pinetorium*, a prickly herb in the Acanthus family occurring in low pine barrens of the coastal plain, and *Aureolaria dispersa*, a herb in the Scrophularinceae family, found in sandy thickets and oak stands and sometimes occurring along streams in the long-leaf pine belt (Pennell, 1935).

Animals

Within the Texoma study area there are two terrestrial and four marine mammals, eight birds, and four reptiles which are classified as either endangered or threatened as defined by the Endangered Species Act of 1973.

The two endangered terrestrial mammals are the gray wolf and the red wolf. The gray wolf is occasionally found in the Trans-Pecos region of west Texas and is only of historical interest in southeast Texas. The red wolf is now restricted to the Gulf Coast counties and is on the verge of extinction. There are currently fewer than 100 red wolves left in Jefferson, Chambers, and southern Liberty Counties in Texas and Cameron and Calcasieu Parishes in Louisiana.

There are four endangered marine mammals in the study area, the blue whale, the common finback whale, the black right whale, and the sperm whale.

Birds on the federal list of endangered species in the area are the Brown Pelican, Bald Eagle, Peregrine Falcon, Atwater's Greater Prairie Chicken, Whooping Crane, Red-cockaded Woodpecker, and Ivory-billed Woodpecker. In the 1950's and 1960's the Brown Pelican population declined dramatically and is only now slowly recovering. The decline was due to a combination of factors, the most important of which was an increase in chlorinated hydrocarbons in the food chain. This same decline in numbers has been observed in the past for the Bald Eagle, with chemical contaminants also being responsible for much of the decline.

Whooping Cranes were last seen in Louisiana in 1949, while the last Ivory-bill was recorded in 1943 (Lowery, 1974). The Prairie Chicken, last recorded in the area in 1919, is now found only on the coastal plains of the central Gulf Coast of Texas (Oberholser, 1974). Peregrine Falcon, and Red-cockaded Woodpecker are very infrequent visitors to the study area.

The six reptiles on the federal list of endangered species are the hawksbill turtle, Atlantic ridley turtle, leatherback turtle, Atlantic green turtle, Atlantic loggerhead turtle, and the American alligator. All of the turtles on the federal list are marine and uncommon off the coast of Jefferson County and Cameron Parish.

The status of the American alligator is unique in Cameron, Vermilion, and Calcasieu Parishes in Louisiana. In other areas of the United States, the alligator is classified either as threatened or endangered, but because of its abundance in the above mentioned parishes, it is not given protection under the Endangered Species Act. In Texas, the status of the alligator has also recently been changed from "endangered" to the less restrictive "threatened" classification.

3.2.5.4 <u>Important Commercial Species of the Region</u>

<u>Plants</u>

The principal cash crops in Cameron and Calcasieu Parishes are rice, soybeans, and corn (see Table B.2-8, Appendix B, for acreage and production figures). Much of the arable land in Cameron Parish is in the eastern part; most of the western part of the parish is marshland. There is some timber production in Calcasieu Parish, mainly pine saw timber. Tree plantations in the parish covered 33,387 acres in 1970-71 (Bobo and Charlton, 1974).

In Orange County some 49.5 square miles are devoted to agriculture, including cropland, orchards, forest nurseries, silage crops for grazing, and significant acreage in rotation. Rice was grown on approximately 2,777 acres in 1970. The commercial timber in Orange County is mainly mixed pines and bottomland hardwoods.

Most of the extensive rice production within the Texas part of the Texoma region is in Jefferson County (979,994 acres in 1974). See Table B.2-10 in Appendix B for farmland production and income figures. Rice and other crops have been planted on what was originally prairie grasslands. Because of the high water-holding capacity of prairie grassland soil, the area has excellent rice production.

Some former prairie grassland has been planted with commercial grasses and is used as pastureland. Cattle are also grazed on marshlands, although the productivity is low.

Timber is an important source of income for Jefferson County, with 50,400 acres in commercial forests. Important softwood trees are longleaf, slash, shortleaf, and loblolly pine; oak and sweetgum are the principal commercial hardwoods.

The marsh vegetation of coastal southeast Texas and Louisiana provide a valuable source of detritus which is the basis for the highly productive food web of the coastal zone. Many marine organisms are dependent, for at least part of their life cycle, on this food source.

Animals

Some cattle production is based in western Cameron Parish near the coast and on the fingers of former prairie which extend into the western part of the parish from the north.

The Louisiana Coastal zone is an exceedingly productive area for fish and wildlife because it contains an extensive amount of estuarine habitat. Louisiana leads all the states in volume of catch of commercial fisheries products. The lakes and bayous of western Cameron Parish, especially Calcasieu Lake, are extremely important as a nursery area.

The most important commercial species in Cameron Parish as of 1975 are menhaden, shrimp, blue crabs, spotted sea trout, red drum, flounder, red snapper, and catfish. Calcasieu Lake contains the major shrimp fishing grounds of western Louisiana, and Black Lake is reported to be rich in shrimp and fish (White and Rocca, 1976). Oyster production in Calcasieu Lake was historically good, but productivity has declined in recent years in the northern and eastern portions of the lake, possibly due to an altered circulation pattern resulting from the creation of channel levees from the disposal of dredged material. An effort is being made by the Louisiana Wildlife and Fisheries Commission to reestablish oyster populations in these areas. Table B.2-15 in Appendix B presents a detailed breakdown of the commercial fishery resources in Louisiana inshore and offshore waters and in Calcasieu Lake.

The most important commercial wildlife species of Calcasieu Parish are the furbearers: nutria, muskrat, mink, otter, and raccoon. Almost all trapping is confined to the swamp and marsh areas near waterways, with trapping leases averaging 100 to 300 acres. The Sabine National Wildlife Refuge is located within the study area and is divided into three lease areas for trapping.

The marshes along the coast of east Texas also support large populations of these furbearing animals. Muskrats feed primarily on the olney and bulrushes found in salt and brackish water marshes, while fresh and intermediate marsh types are more valuable for nutria production. The marshes also serve as nursery areas for most of the commercially important species which make fishing a multimillion dollar business along the Texas coast.

Brief life history descriptions are included in Appendix B, Section B.2.5.4.2 for the major commercial marine species of Jefferson County: brown, white, and pink shrimp, members of the croaker family (including the sea trout, drum, and Atlantic croaker), the blue crab, and the American oyster. Shrimp are the single most valuable marine product in Texas, accounting for 92 percent of the total dollar value of finfish and shellfish in 1970 and 1971 (Boykin, 1972).

3.2.5.5 Important Recreational Species of the Region

Cameron Parish

The most important game mammals in marsh areas of western Cameron Parish are white-tailed deer and rabbits. Squirrel hunting is more important in wooded areas in Calcasieu Parish to the north. Most of the deer population in the coastal marshes is free from hunting pressure since marsh conditions are not conducive to hunting. During periods of high water, they move to natural ridges and elevated dredge disposal areas; they may starve if high water persists long enough to deplete their food supply. The two game species of rabbits in coastal Louisiana are the swamp rabbit and the eastern cottontail. Both species have a diverse diet, feeding especially on grasses and legumes.

Ducks, geese and waterfowl are important for hunting and bird watching. Approximately 20% of the waterfowl of North America winters in the marshes of Louisiana. Additional millions stop over in the area to feed and rest before continuing across the Gulf of Mexico to wintering areas in South and Central America. Five species of the 31 recorded from Louisiana are known to have breeding populations in the state, but only one, the Mottled Duck, probably breeds in western Cameron Parish. See the regional section on birds and Section B.2.5.5,

Appendix B, for a discussion of the types of ducks and for a listing of ducks encountered in this area.

In the 1973-74 duck season, 79,000 hunters in Louisiana harvested over 2 million ducks; 71 percent of this harvest was in the coastal area. Management practices used to improve coastal duck habitat involve primarily manipulation of water levels. Fresh to brackish water one to six inches deep produces preferred food plants and ideal feeding conditions.

Three species of geese winter in coastal Louisiana: the Canada Goose, the Snow Goose, and the White-fronted Goose. See Appendix B, Section B.2.5.5, for feeding requirements and management practices. The American Coot, a small duck- like bird which nests in freshwater lakes and marshes, is also frequently hunted. In 1973-74, 457,000 Coot were harvested from Louisiana waters (U. S. Army Corps of Engineers, 1975). Other game birds include the King Rail, Clapper Rail, and Virginia Rail in marshes; the Purple Gallinule and Common Gallinule in shallow fresh ponds; and the Common Snipe and American Woodcock in marshes, wet meadows, and swamps.

Such sport fish as buffalo, freshwater drum, and white, yellow, and largemouth bass are found in freshwater. Bowfin, chain pickeral, warmouth, bluegill, largemouth bass, white and black crappie, and longear, redear, and green sunfish are found in backwaters, ponds and impoundments. Sport species of more saline waters include spot, red drum, sea trout, black drum, southern flounder, and sheepshead (U. S. Army Corps of Engineers, 1975 and 1976).

Calcasieu Parish

Calcasieu Parish is typical of most of the Texoma study area in its suitability for game birds, although it probably ranks after Cameron Parish and Jefferson County in importance in waterfowl hunting. Because of the numbers of birds and the interest in waterfowl hunts, Louisiana acquires a sizable revenue from the sale of hunting permits.

Orange County

Most of the waterfowl which visits Orange County are transients from marsh areas to the south. These species are generally the same as those listed for western Cameron Parish.

The main game mammals in the county include white-tailed deer, gray and fox squirrels, and eastern cottontail rabbits. Bobwhite and doves are also hunted in the area.

Fishing is popular on Cow and Adams Bayous (Fisher, et al., 1973), on the Sabine River, and on ponds, lakes, and other water bodies in the interior of the county.

Food and game fish recorded from the Sabine River are regarded as typical species in the area. They include: largemouth bass, spotted bass, white crappie, black crappie, bluegill, longear sunfish, orange-spotted sunfish, spotted sunfish, carp, river carpsucker, spotted sucker, blue sucker, striped mullet, channel catfish, flathead catfish, blue catfish, yellow bullhead, and the spotted gar (Lantz, 1970).

Jefferson County

Texas ranks among the leading states in the sports of hunting and fishing. These sports constitute a major part of the state's $4.8 billion tourism and recreation industry.

Hunting of ducks and geese in the marshlands of Jefferson County in winter provides income to the county through hunting lease sales and related hunting expenditures. The white-tailed deer, the most important Texas game animal, has been successfully transplanted to eastern Texas and could be a valuable commercial species in Jefferson County in the future.

Important recreational freshwater fish include many of the species listed above for Orange County. The most popular saltwater fish are croakers, sea trout, flounder, redfish, sheepshead, and drum. Crabbing for blue crabs is also a popular recreational activity.

3.2.6 Natural and Scenic Resources

Sabine National Wildlife Refuge, the largest waterfowl refuge on the Gulf Coast (142,846 acres), was originally established to protect marsh habitat important to wintering Snow Geese and ducks. Access canals dug through southeast Louisiana have altered the ecological and hydrological situation of the coastal marshes considerably by blocking drainage of fresh-water and allowing the intrusion of saltwater. One of the management goals of the Sabine Refuge is the reestablishment of a high quality marsh habitat over a large area through proper manipulation of water levels (U. S. Department of Interior, 1974).

Sydney Island, a private 126 acre wildlife refuge managed by the National Audubon Society at the northern end of Sabine Lake, was created in 1915 as a spoil island from sand and silt dredged from the adjacent waterway. In contrast to similar but unprotected islands on Sabine Lake, Sydney Island has an extremely large concentration of nesting birds, including egrets, herons, night-herons, ibis, and Roseate Spoonbills.

Big Thicket Natural Preserve (84,500 acres) was created recently to preserve examples of southern swamp and upland forest habitat. Nibletts Bluff State Park, located near the Sabine River 10 miles northeast of Orange, Texas, and Sea Rim State Park, about 12 miles west of Sabine Pass along Highway 87, are the only officially designated park area in the vicinity of the proposed Texoma sites. Sea Rim State Park has marsh and beach areas and provides camping and picnicing facilities. Two miles west of Nibletts Bluff is the Sabine Wildlife Management area (9,000 acres), managed primarily for waterfowl hunts. The J. D. Murphee Wildlife Management area, also managed primarily for waterfowl, is located on the north side of the ICW close to Sabine Lake.

Figure 3.2-6 indicates the location of parks, preserves, refuges, and management areas in the Texoma area.

3.2.7 Archaeological, Historical, and Cultural Resources

Coastal Louisiana and Texas are rich in archaeological sites. Most of these sites are shell middens, composed of refuse discarded by Indians who lived in the area. Sites have been dated from 1500 B.C. to A.D. 1500.

Although few archaeological investigations have been made of salt dome areas, it is suspected that they would yield valuable information once they are studied. Because of their comparatively high topography, they are thought to have been used from very early times as hunting or village sites.

Twenty-five known archaeological sites in Texas and 12 in Louisiana are known to occur within a one-mile radius of the proposed sites and pipeline routes. See Appendix B, Section 3.2.7, for a list of the officially designated historical sites in the four county/parish study area.

A Cultural Resource Survey has been recently completed for Black Bayou, Vinton, and Big Hill storage sites and associated pipeline routes. The West Hackberry facility and pipeline route were evaluated by a separate survey. The purpose of the Texoma cultural reserve survey was to evaluate, using a statistically valid sampling

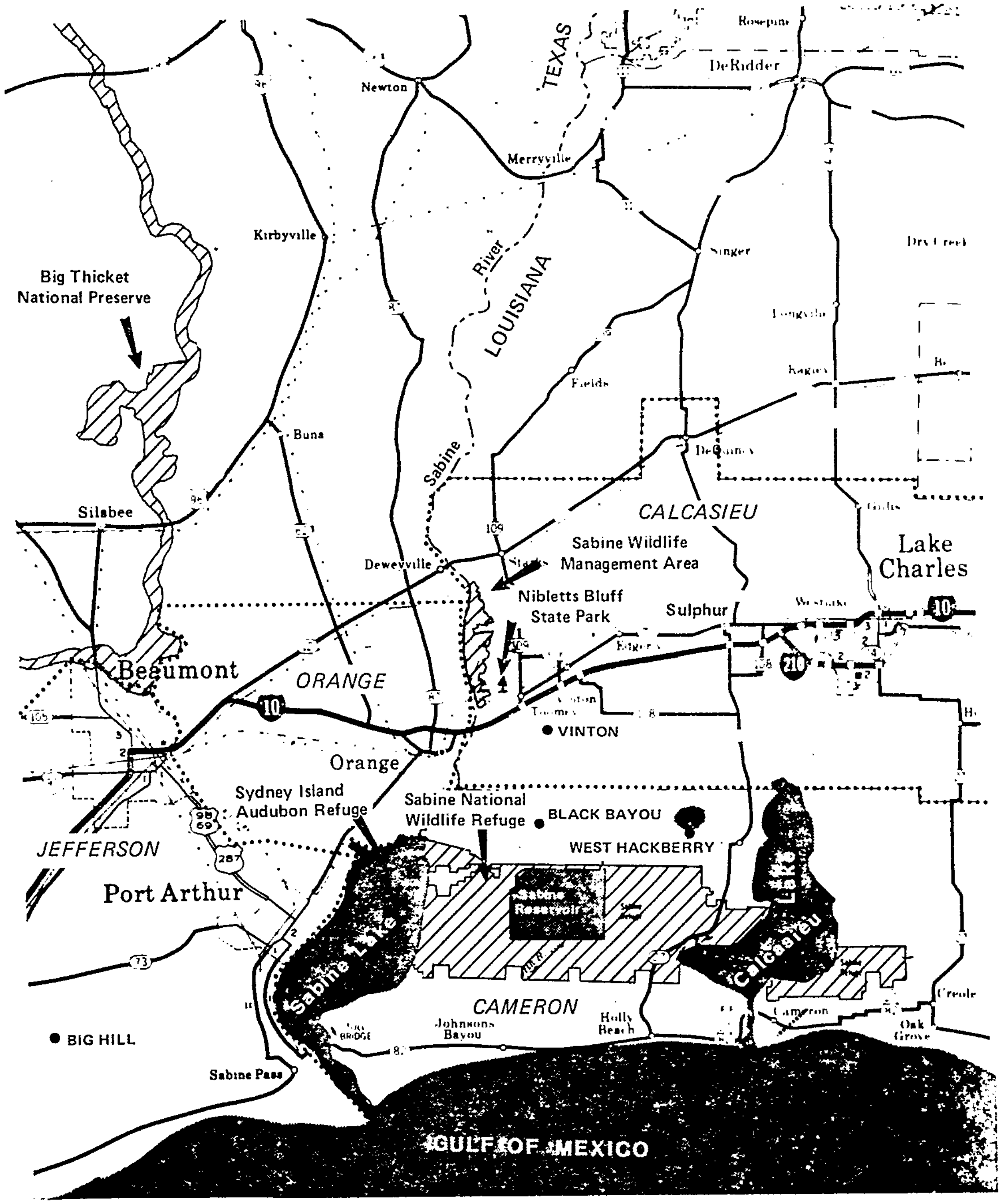

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FIGURE 3.2-6 Locations of parks, preserves, refuges and management areas in the Texoma area.

procedure, the probability of encountering valuable archaeological or historical sites around any of the storage facilities or pipelines. In this way potential storage areas could be evaluated and compared to determine which particular area would be least affected by the proposed action. Once the site which would function as the SPR facility is chosen, a more intensive cultural resource survey would be undertaken. This second survey would supply information necessary for compliance with the National Historical Preservation Act of 1966 and Federal Executive Order 11593.

3.2.8 Socioeconomic Characteristics

In addition to the two Texas counties and two Louisiana parishes in the Texoma region, Chambers County, Texas, which is within 7 miles of the Big Hill site, has also been included as part of the study area. All the salt domes under consideration are located in rural areas, and the labor force required by the proposed project would be derived primarily from urban areas within this region.

3.2.8.1 History and Cultural Patterns

The region retains many of the unique cultural aspects of the people who settled it. Family names, place names, and the local cuisine indicate its Indian, French, and Spanish heritage. A period of rapid industrialization followed the discovery of oil in Calcasieu Parish in 1886 and at Spindletop in Texas in 1906, prompting many refineries and petrochemical plants to be built around the major port cities. The extensive coastal marshlands of the region are sparsely populated and provide large areas for hunting, fishing, and trapping.

3.2.8.2 Population

Table 3.2-19, Appendix B, shows the population distribution of the five parishes and counties in the study region and shows the balance between urban and rural sectors. Jefferson County has the highest population, due primarily to the high proportion of urban development. Regional population, in general, is concentrated in the inland areas, away from the coast. Cameron Parish and Chambers County lie along the coast and have no communities with populations in excess of 2,500. Similarly, the coastal subdivision of Jefferson County is entirely rural and has a population of only 1,486 (Census, 1970).

The major cities in the region with their 1970 population figures are: Lake Charles (78,000) in Louisiana; and Beaumont (115,900), Port Arthur (57,400), and Orange (24,500) in Texas. These are shown in Figure 3.2-7 and are described in Appendix B, Section B.2.8.2. Population growth and projections for the region are shown in Table B.2-20 in Appendix B.

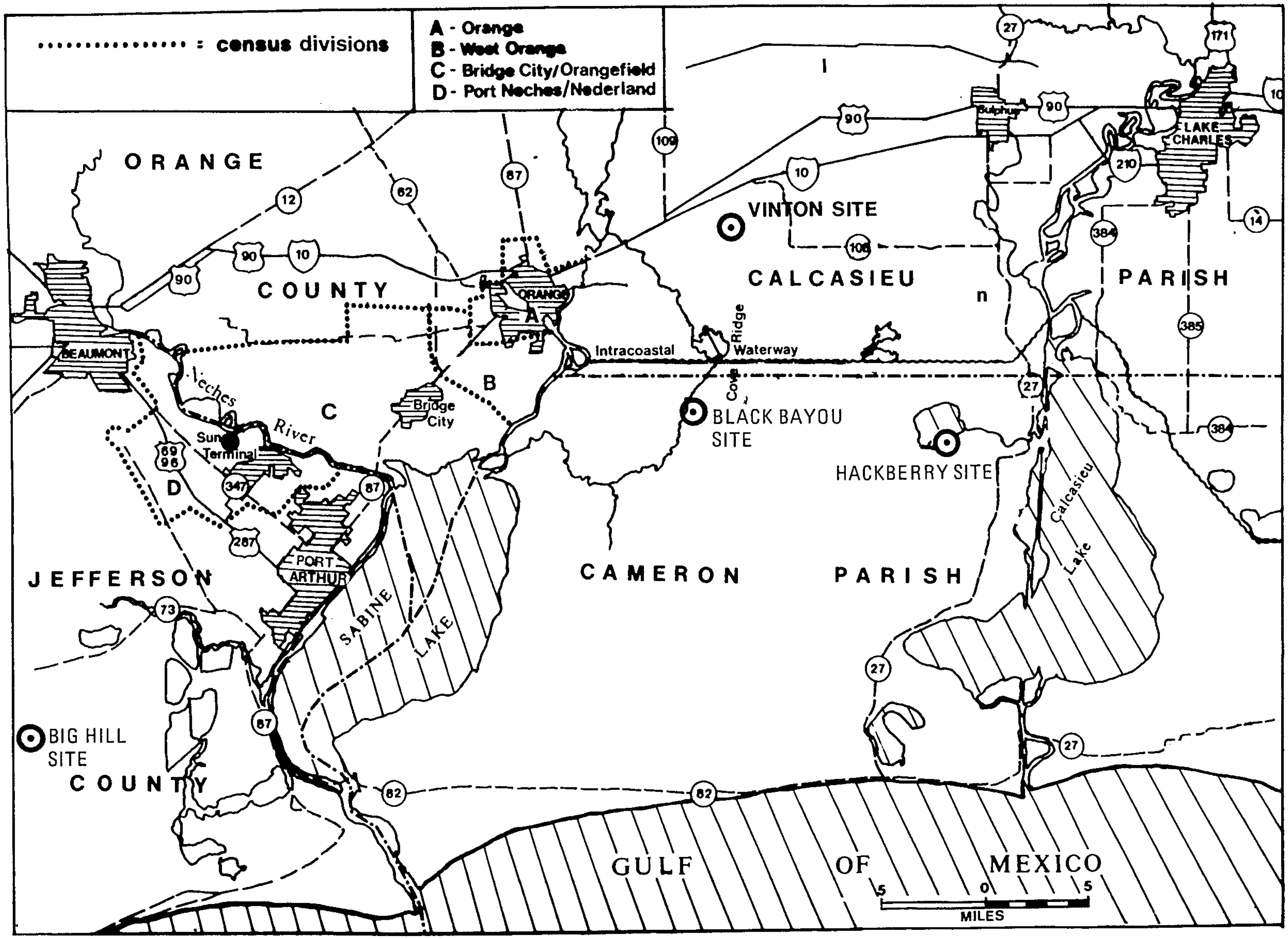

Figure 3.2-7 MAJOR CITIES IN TEXOMA REGION

3.2.8.3 Land Use Patterns and Plans

The land use patterns for the region are shown in Figure 3.2-8. A dominant feature of current land use is the lack of development along the coast of the Gulf of Mexico. Most of the land along the coast is part of an extensive salt and brackish marsh that is unsuitable for agricultural use. Lack of freshwater sources and the seasonal threat of hurricanes make the coastal area less desirable for urban development than inland areas. The large area of public land shown in the figure is the Sabine National Wildlife Refuge and is part of the marsh area.

Despite the lack of coastal development, the major urban centers of the region are port cities with facilities for handling cargo from ocean vessels and from barges that move along the Intracoastal Waterway.

The lands adjacent to the urban centers and inland from the marshes are rich farmlands. The abundance of rainfall aids the growing of rice, the dominant crop of the region, but also necessitates the construction and maintenance of drainage canals throughout the farming area. Cattle are grazed in the border area between rice fields and brackish marshes. Further inland are the forests, most of which are privately owned and are periodically harvested for lumber. Oil and gas fields are scattered throughout the region, but the highest levels of production tend to be from fields in the coastal wetlands and offshore.

Land use patterns anticipated to prevail in 1990 are shown in Figure B.2-31 in Appendix B. Major changes predicted relate to the expansion of urban centers into present agricultural areas.

Land use planning in the region is being developed by two separate agencies: the Imperial Calcasieu Regional Planning and Development Commission and the South East Texas Regional Planning Commission, neither of which has authority to limit patterns of development. Calcasieu Parish is the only governing agency with authority to place zoning restrictions on lands outside of city limits.

3.2.8.4 Transportation Systems

Highways

The region is crossed from west to east by Interstate 10 and U. S. 90, which connect the major cities to Houston, Baton Rouge, and New Orleans. See Appendix B, Section B.2.8.4, for a discussion of the state highways and bridges.

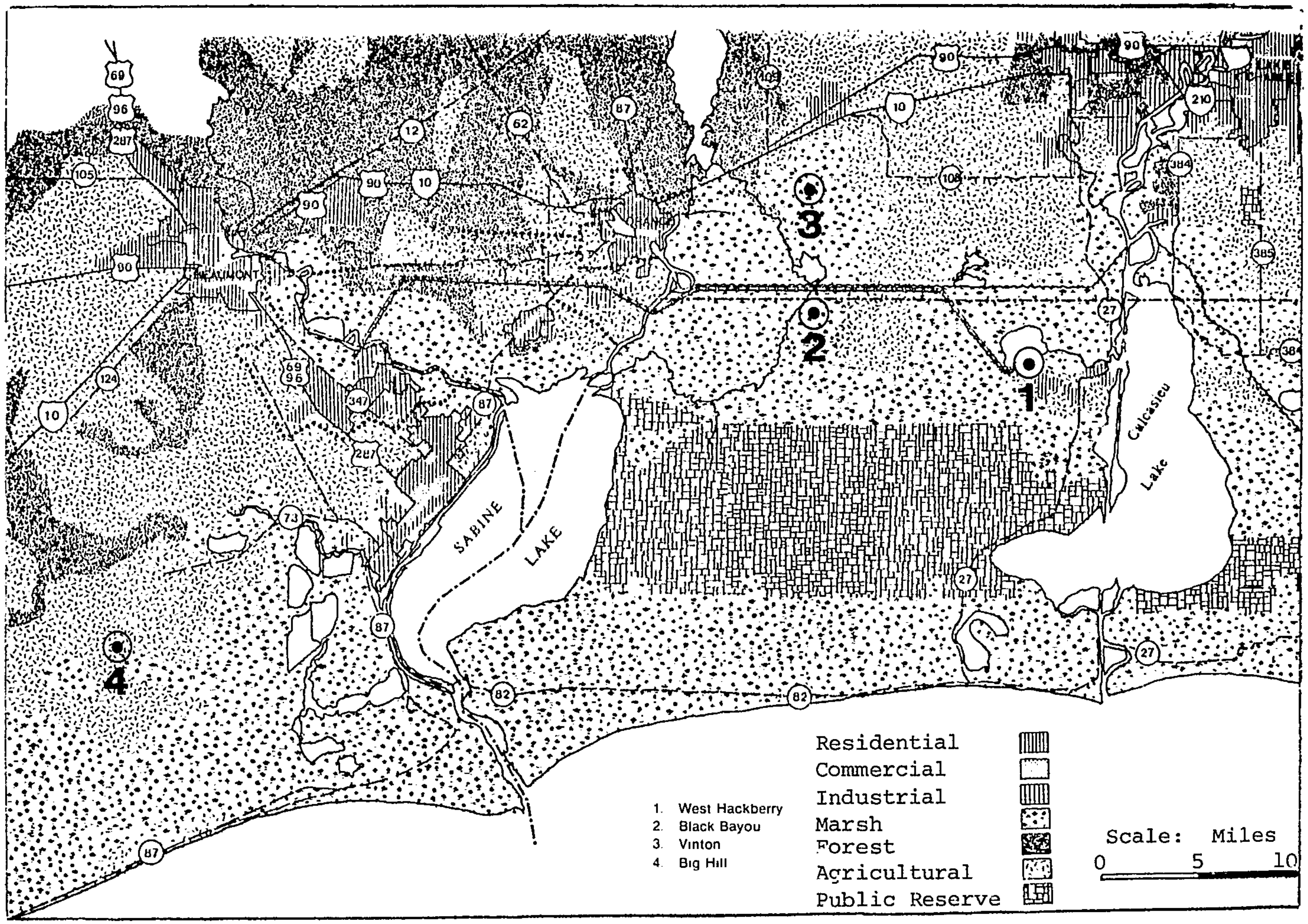

Figure 3.2-8 CURRENT LAND USE IN THE REGION

Railroads

The major cities in the Texas portion of the study region are served by the Kansas City Southern, the Missouri Pacific, and the Southern Pacific, which crosses the Sabine River into Lake Charles, Louisiana.

Waterways

The major rivers of the area - the Neches, the Sabine, and the Calcasieu - are also shipping lanes, and all three deposit sediment in shallow coastal lakes on their way to the Gulf, necessitating periodic dredging to maintain the shipping channels and keep inland ports open to ocean vessels. The Intracoastal Waterway passes through this region from east to west; its use is limited in some portions to barges and small boats.

Airports

The four major airports of the region are the Beaumont Municipal, Jefferson County, Orange County, and Lake Charles Municipal airports.

Pipelines

A vast network of pipelines is arrayed along the coastal area of Texas and Louisiana. There are three main systems of pipelines: crude oil pipelines, natural gas pipelines, and refined hydrocarbon product pipelines. A portion of the crude oil system is shown in Figure B.2-33 in Appendix B, including the proposed Texoma pipeline which would carry oil to Oklahoma. Figure B.2-34 shows a portion of the natural gas system. The hydrocarbon product pipelines have a network similar to that for crude oil.

3.2.8.5 Housing and Public Services

While the number of housing units available for sale or rent in the counties and parishes is typically 3 to 5 percent, an examination of the availability of housing in the major cities of the region indicates that while the opportunities for purchasing a home are limited (homeowner vacancy rates range from 0.8 to 2.2), the cities would be able to accommodate some population expansion in rental units (see Tables B.2-21 and B.2-22 in Appendix B).

Calcasieu and Cameron Parishes are part of the Lake Charles Health Service Planning Region, with medical services for the planning region concentrated in Lake Charles, which has an independently-owned ambulance service and three hospitals with a total of 583 beds. There is also a hospital in Sulphur, with 111 beds and an ambulance service, and a small hospital in Cameron with 27 beds.

The Texas portion of the region has more numerous medical facilities. There are three general hospitals in Beaumont (794 beds), two in Port Arthur (409 beds), and two county hospitals, in Orange and Jefferson Counties, with 205 and 1,200 beds respectively.

Helicopter ambulance services operating out of Lafayette, Louisiana and Houston, Texas provide emergency rescue services to isolated parts of the coastal region as well as to offshore oil and gas drilling operations.

3.2.8.6 Economy

The region lies principally within two BEA areas*: Calcasieu and Cameron Parishes are included in the larger Lake Charles BEA area, while Orange and Jefferson Counties are included in the Beaumont-Port Arthur-Orange BEA. A BEA area is defined as a functional labor market, meaning there is a minimum of commuting across area boundaries to place of work. Economic and employment data for these areas are given in Table 3.2-3. The dependence on petroleum refining and petrochemicals (included under manufacturing) is great in both areas, but the Beaumont area economy is less diverse and would show the greatest effects of any changes in these industries. Table 3.2-4 shows sources of income and distribution of the labor force for the two counties and two parishes in the study area. Within the manufacturing sector, Orange County relies heavily on petrochemicals, while refining operations are more important in Jefferson County. Other manufacturing in the region includes production of synthetic rubber, plastics, and paper, and construction of ships, barges, and offshore drilling rigs. Agricultural products include rice, soybeans, and timber. In Louisiana, Calcasieu Parish has a fairly diverse economy, but Cameron Parish is heavily dependent on oil and gas extraction (see Mining, Table 3.2-4).

See Appendix B, Section B.2.8.6, for a more detailed discussion and for data on farm acreage, county government finances, buying power, and bank deposits.

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*Areas established by the Bureau of Economic Analysis, U. S. Department of Commerce.

Table 3.2-3 EMPLOYMENT AND INCOME OF THE REGIONAL BEA AREAS

	Louisiana 1970	Louisiana 1980**	Texas 1970	Texas 1980**
Population, midyear	750,632	695,800	396,723	432,800
Per capita income relative U.S.	.71	.72	.89	.89
Employment/Population ratio	.33	.36	.35	.39
Earnings per worker relative U.S.	.82	.84	1.01	1.01
		In thousands of 1969 dollars		
Total personal income	1,849,029	2,407,000	1,231,945	1,832,800
Total earnings	1,426,247	1,834,100	1,006,132	1,479,700
		Sources of Income*		
Agriculture, forestries, fisheries	119,200 (8.4)	141,300 (7.7)	(2.0)	5,500 (0.4)
Mining	141,049 (9.9)	171,200 (9.3)		10,500 (0.7)
Contract Construction	113,950 (8.0)	129,900 (7.1)	84,602 (8.4)	102,200 (6.9)
Manufacturing	199,552 (13.2)	295,900 (16.1)	424,657 (42.2)	625,800 (42.3)
Trans., comm., public utilities	99,976 (7.0)	134,600 (7.3)	87,942 (8.7)	115,200 (7.8)
Wholesale ' Retail trade	211,657 (14.8)	266,000 (14.5)	133,040 (13.2)	192,000 (13.0)
Fin., Ins., Real Estate	33,592 (2.4)	51,000 (2.8)	30,073 (3.0)	53,700 (3.6)
Services	159,355 (11.2)	238,900 (13.0)	121,143 (12.0)	211,000 (14.3)
Government	347,919 (24.4)	404,900 (22.1)	105,314 (10.5)	163,400 (11.0)

Source: Obers Projections done for the Water Resource Council.
*Numbers in parenthesis are percent of total earnings.
**Projected

TABLE 3.2-4 SOURCES OF EARNINGS AND DISTRIBUTION OF LABOR FORCE

	Texas Counties				Louisiana Parishes			
	Jefferson		Orange		Calcasieu		Cameron	
Total Payroll* (1000)	777,894		158,744		66,856		5,079	
Total Employment	91,948 (1975)		27,588 (1975)		35,246 (1973)		2,636 (1973)	
	%total payroll	%total empl.	%total payroll	%total empl.	%total payroll	%total empl.	%total payroll	%total empl.
Agricultural Services, Forestries, Fisheries	.1	.2	.06	.1	.2	.2	1.2	1.1
Mining	.9	.7	.6	.6	5.0	3.9	70.3	60.7
Contract Construction	8.8	.8	7.4	7.1	13.3	11.1	.2	.7
Manufacturing	50.1	35.2	69.2	52.3	40.0	28.1	9.6	11.7
Trans., Comm., Public Utilities	8.6	8.0	3.1	4.0	3.8	7.3	7.8	7.2
Wholesale & Retail Trade	17.5	27.1	10.9	20.3	14.7	28.0	4.5	7.8
Fin., Ins., Real Estate	3.0	3.9	2.2	3.2	4.4	5.0	1.1	1.6
Services	10.4	16.5	6.1	11.5	9.9	16.0	5.1	8.0

*Totals include non-classifiable establishments

Source: U. S. Department of Commerce, County Business Patterns, 1973 and 1974 and Texas Employment Commission, 1977.

3.2.8.7 Government

Certain jurisdictional concerns of local governments in the region would have a bearing on the proposed oil storage project. The state responsibilities include control of air emissions and discharge into surface and ground waters, preservation of historical and cultural resources, and construction on state-owned lands.

Local parish and county governments also have jurisdictional interests in the proposed work, as in granting use of rights-of-way of parish and county roads for pipelines and in providing building permits. Cameron Parish, which lies in a hurricane-prone area, has general authority to permit or withhold permission for construction on flood plains and in flood hazard areas.

The parishes and counties of the Texoma region are further divided into drainage districts. District commissioners have responsibility for the maintenance of the drainage channel systems that protect agricultural and urban lands and would have a jurisdictional interest in any proposed pipelines which would cross under these channels.

3.3 SITE SPECIFIC ENVIRONMENT

3.3.1 West Hackberry Salt Dome

3.3.1.1 Land Features

Geomorphology, Geologic Structure and Stratigraphy

The West Hackberry Salt Dome is located in north central Cameron Parish, Louisiana, 20 miles southeast of the city of Lake Charles, 16 miles north of the Gulf of Mexico and 4 miles south of the ICW, near the western end of Hackberry Ridge.

The dome is an elliptical piercement structure, having a broad nearly flat top, with an average depth to salt of 2,000 feet below sea level. The slope of the sides varies from 60° to 75°. The surface area within the 2,000 foot depth contour of the salt stock is about 1,750 acres, of which approximately 850 acres are above water; the area enclosed by the 3,000 foot contour is 2,600 acres. The dome is part of a larger salt mass which is more than 9 miles long and 2 miles wide.

This dome appears to be typical of most Gulf Coast piercement domes (Halbouty, 1967); thus the characteristic normal, radial, and concentric faults probably exist in the sediments around the dome. The displacement along these faults generally increases with depth.

Above the 3,000 foot depth contour the entire salt mass is covered by an intensely fractured and faulted cap rock, which ranges in depth from 1,500 and 4,000 feet and has a maximum thickness of 525 feet (see Figures B.3-1 and B.3-2, Appendix B). Geologic cross sections (Figure 3.3-1 and 3.3-2 show the lateral extent of the cap rock, the local sedimentary sequences, and the relationship of these sediments to the salt structure.

The sequence of geologic formations deposited in the coastal basin is generally consistent throughout the region. Therefore the discussion of the stratigraphy of the Vinton Dome as described in Section B.3.3.1.3, Appendix B can be used to characterize the underlying geologic structure of the West Hackberry area.

Soil Characteristics

The soils at the West Hackberry site (Figure B.3-6 in Appendix B) are silty soils with clayey and silty subsoils belonging to the Crowley-Morey-Mowata Association. The brine disposal and oil distribution pipeline route would cross areas of Harris soil. The brine disposal line would also cross Morey-Beaumont

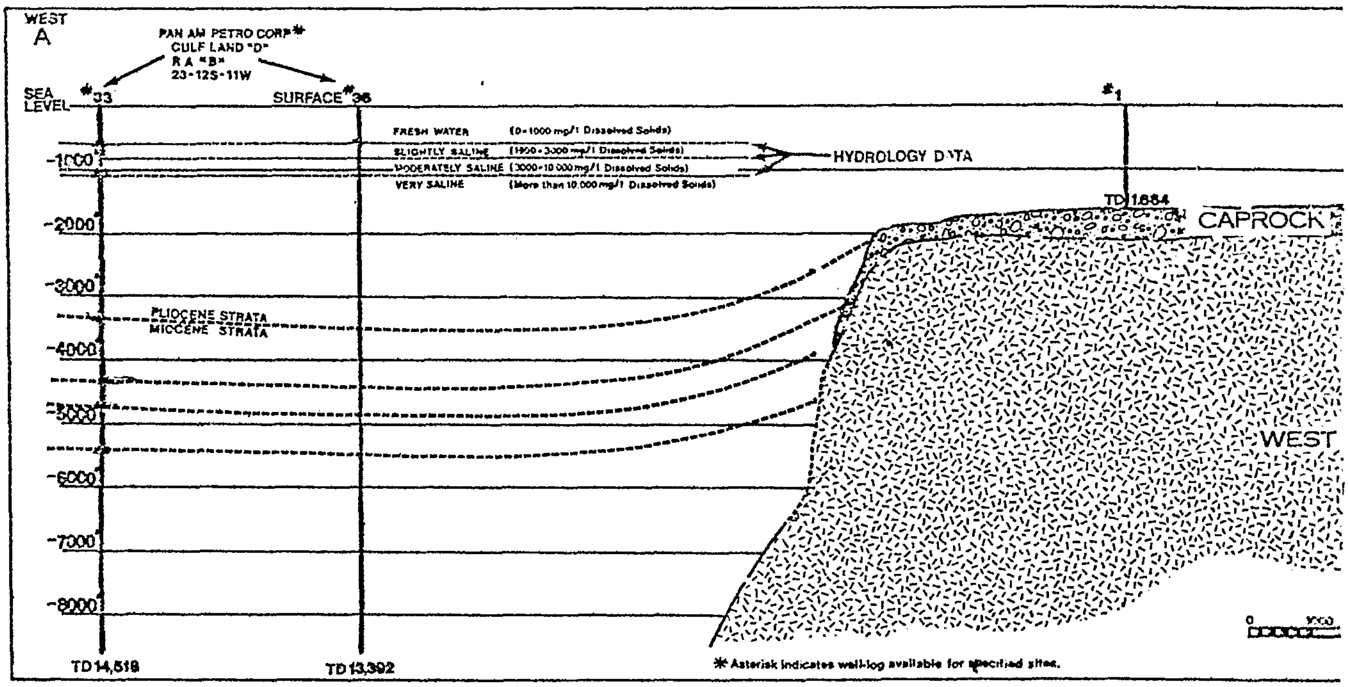

Figure 3.3-1 Geological East/West Cross Section
West Hackberry Dome A-A'

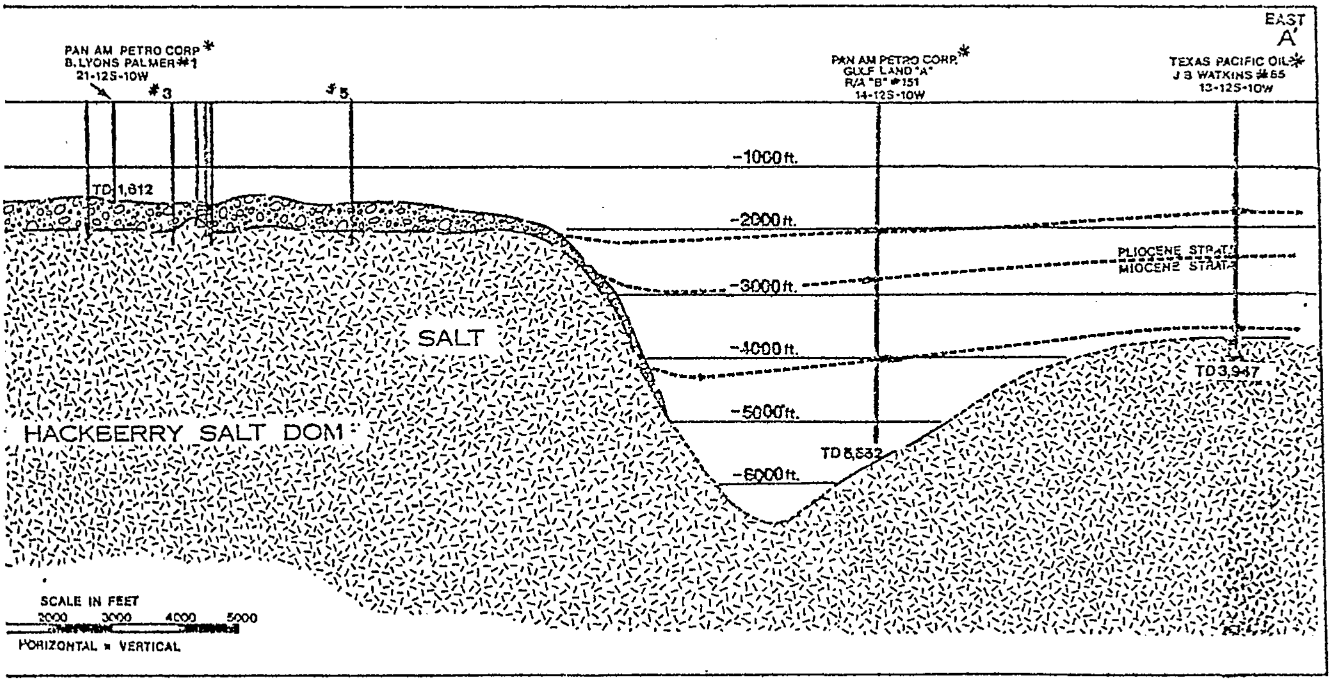

Figure 3.3-1 Geological East/West Cross Section
West Hackberry Dome A-A' (Continued)

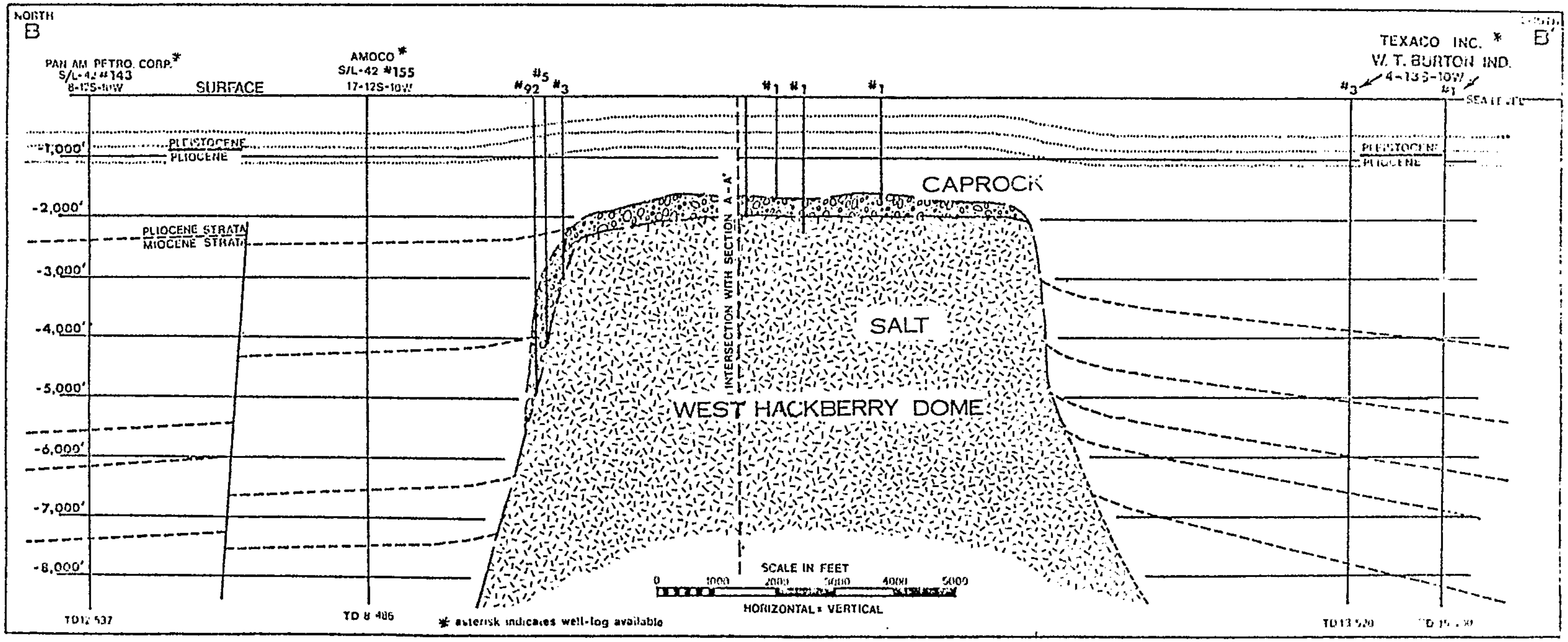

Figure 3.3-2 Geological Cross Section, West Hackberry Dome B-B'

soils which border soils of the Harris Chenier Variant- Palm Beach Association. A detailed description of the soil types in each association is presented in Appendix B, Section B.3.1.1.4.

Mineral Resources

Since oil was first commercially produced in the dome area in 1928, oil or gas has been produced from at least 15 different horizons around the perimeter of the dome. No known oil or gas production, however, is located over the top of the dome in the area proposed for the solution mined storage cavity facility. In addition, no sulfur has been found at this dome.

Portions of the dome have been developed by Olin Chemical for use in brine production (500 acres) and by City Services for subsurface storage of liquid petroleum (9 caverns on 80 acres). Five of these 9 caverns have been selected for use by the SPR program. A description of these caverns and a discussion of cavern stability appears in Appendices H and I respectively of the Final Environmental Impact Statement for West Hackberry Salt Dome (FEA, 1977a).

3.3.1.2 Water Environment

The West Hackberry Salt Dome is located in Hydrologic Unit 9 of southwestern Louisiana within the estuarine part of the Calcasieu River Basin (see Figure B.3-7, Appendix B). Hydrologic Unit 9 consists largely of ponds, lakes, and marshes, with less than 10 percent dryland. The southwestern Louisiana marshes are part of the Chenier Plain, which is characterized by natural barriers to north-south drainage. Numerous man-made levees are also present.

The northwest rim of the dome lies beneath Black Lake, with the remaining portions covered by dry pastureland. To the south and west are marshes. Surface water in the general area is brackish with a salinity of 5 to 10 ppt, due to salt-water intrusion. Surface levels in the region are underlain by clays which are nearly impervious to water passage (Chabreck, 1972). Although precipitation in the area is fairly heavy (55 inches per year), there is an average deficit of about 6 inches of precipitation in the vicinity of West Hackberry dome during the growing season (from February through November).

The inland surface water system represents the proposed source of leaching/displacement water, while the Gulf of Mexico is the proposed site for brine disposal. The system in the vicinity of West Hackberry dome consists of a brackish marsh interlaced by a network of bayous and canals which connect with Black Lake, Calcasieu Lake, Calcasieu River, Calcasieu Ship Channel, and the Intracoastal Waterway (ICW). Pertinent characteristics of the surface water bodies nearest the dome are tabulated in Table 3.3-1, and the general arrangement of these water bodies is depicted in Figure 3.3-3. Section B.3.1.2 in Appendix B deals with each body of water separately, discussing pertinent hydrologic data and applicable water quality standards. Water quality data from these water bodies, including recent preliminary samplings taken for the purpose of this statement are given in Appendix D.

The oil pipeline route in southwestern Louisiana and south-eastern Texas extends from the western fringe of the Calcasieu River Basin, through the Sabine River Basin to the Neches River Basin, crossing Black Lake, the Sabine and Neches Rivers, and two major bayous (Black and Cow). For more than 12 miles the pipeline is laid along the southern bank of the ICW. For the SPR two brine pipeline routes to the Gulf from West Hackberry are under consideration. The proposed route would run essentially parallel to the Calcasieu Ship Channel, passing through the West Cove of Calcasieu Lake, and crossing State Highway 27/82 before entering the Gulf of Mexico. The alternate route would avoid any sizable water body, crossing only Starks Canal, Hog Island Gully, Second Bayou, and First Bayou before reaching the Gulf (see Figure 3.3-4).

The dominant bodies of water in the dome area are Calcasieu Lake and the Calcasieu River which feeds the lake. The Calcasieu Ship Channel provides direct connection between Calcasieu Lake and the Gulf and is largely responsible for the saltwater intrusion problem which extends up the Calcasieu River to the vicinity of Lake Charles. Currents in both Calcasieu Lake and the lower portions of Calcasieu River are strongly influenced by tidal conditions. With strong southerly winds, incoming tides can be increased by as much as one foot above the normal tidal fluctuations, and prolonged periods of such winds may flood the marshes. Similar flooding can result from strong tropical storms and hurricanes which push saline water far inland (Chabreck, 1972).

The most significant water quality problems in this area are associated with: (1) saltwater intrusion into the freshwater systems; (2) contamination by agricultural fertilizers and pesticides; (3) industrial and municipal discharges, and (4) extensive engineering modification of surface water flow patterns.

The shallow coastal waters of the Gulf of Mexico south of West Hackberry would constitute the primary brine disposal site. To attain the desired 30-foot depth for disposal, the site would be a minimum of 5 miles offshore. The bottom composition in this area is clayey sand south of Calcasieu Pass, but changes to silt south of Holly Beach (Bureau of Land Management, 1975).

Table 3.3-1 Surface Water Bodies in the Vicinity of West Hackberry Dome (Barrett, 1970)

Name	Location Distance (mi)	Location Direction	Length (miles)	Width (ft)	Depth (ft)	Area (sq. miles)
Black Lake	0.6	NW	-	-	4.0	3.40
Black Lake Bayou	0.5	NE	6.4	100	4.0	0.12
Browns Lake	3.9	SW	-	-	3.0	0.36
Calcasieu Lake	4.7	E	-	-	1.5	11.30
			-	-	4.5	34.90
			-	-	7.5	20.60
			-	-	10.5	0.03
Calcasieu River*	7.0	NE	24.9	850	22.0	6.10
Calcasieu Ship Channel*	4.0	E	26.0	250	35.0	1.20
First Bayou	15.0	SSW	2.5	50	1.5	0.02
Hog Island Gully	6.0	S	4.9	60	1.5	0.06
Intracoastal Waterway*	4.1	N	104.5	300	8.0	5.90
Long Point Lake	6.0	SE	-	-	2.5	0.20
Mud Lake	6.5	NE	-	-	1.5	0.58
			-	-	4.5	0.29
			-	-	7.5	0.07
			-	-	10.5	0.06
			-	-	13.5	0.06
			-	-	20.0	0.10
Second Bayou	12.5	S	2.0	30	1.5	0.01
Starks Canal	2.8	SE	21.6	40	2.5	0.16
Starks North Canal	2.6	SW	18.2	40	2.5	0.14
West Cove	8.0	S	-	-	1.5	9.80
			-	-	4.5	6.00
West Cove Canal	6.3	S	-	40	1.5	0.02
West Fork	12.0	S	2.6	200	4.0	0.10

*Includes only portions within Hydrologic Area 9.

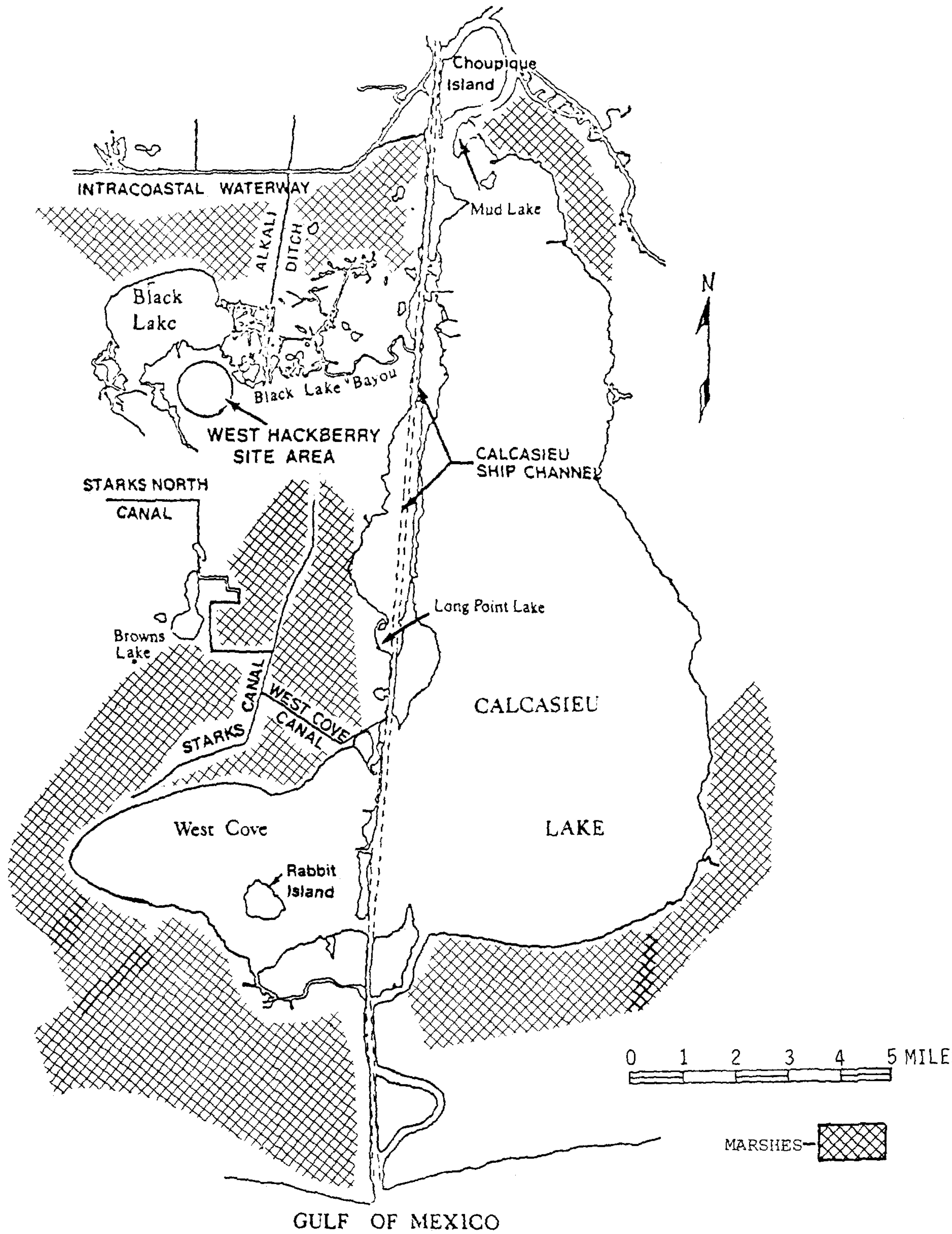

Figure 3.3-3 Surface Water System in the Vicinity of the West Hackberry Site

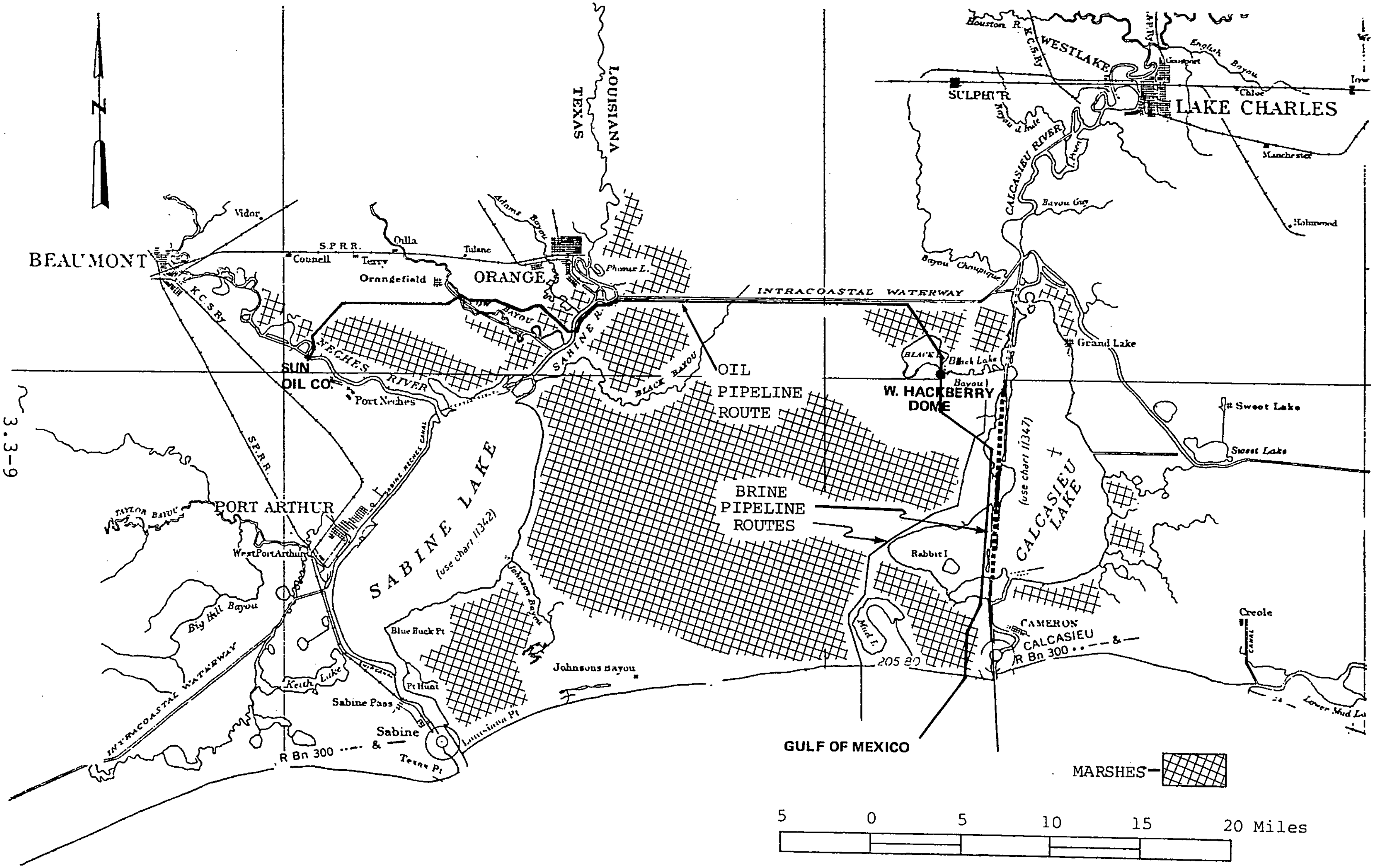

Figure 3.3-4 Surface Water System Associated with Pipelines from West Hackberry Dome

Because of the high turbidity of the Calcasieu River, the Gulf waters in the area are likewise somewhat turbid. The concentration of trace metals such as cadmium, lead, chromium, zinc, and manganese is on the order of 10 times the concentrations typically observed in open ocean waters (Corcoran, 1972).

Southwestern Louisiana contains three shallow aquifers in the area of interest. In order of increasing depth and geologic age, these are the Chicot, Evageline, and Jasper aquifers. The Chicot aquifer contains mostly fresh water north of Cameron Parish and saline water in the coastal region. The Evangeline aquifer contains fresh water north of Calcasieu Parish and saline water from southern Calcasieu Parish to the coast. The Jasper aquifer contains saline water from the middle of Beauregard Parish south to the coast (Harder et al., 1967).

Before large scale water pumping started, the general direction of water flow in the Chicot aquifer was southward. Heavy water use in the Lake Charles area has lowered the water level and reversed aquifer flow near West Hackberry (see Figure B.3-13, Appendix B), resulting in the northward movement of the interface between fresh and salt water. The Chicot is not recharged from the surface in the West Hackberry area. The major recharge occurs at the outcrop more than 30 miles north of West Hackberry dome (Jones and Turcan, 1954).

3.3.1.3 Air Quality

Available air quality data, presented in Section 3.2.3.3, indicates that the standards for non-methane hydrocarbons and oxidants were violated at each of the monitoring locations nearest the proposed SPR sites, and levels are expected to continue to exceed standards in the next 10 years. Particulate, sulfur dioxide (SO_2), nitrogen dioxide (NO_2), carbon monoxide (CO), and hydrogen sulfide (H_2S) concentrations for the SPR site area are presently in compliance with all applicable federal and state air quality standards and are not expected to exceed standards in the next 10 years.

3.3.1.4 Background Ambient Sound Levels

Background noise levels in and around the alternate SPR site at West Hackberry are typical for a secluded, essentially flat area. See Section 3.2.4 for assessment of ambient noise levels for the region.

3.3.1.5 Species and Ecosystems

Environmental Setting of the Displacement/Leaching Water System

The leach water and water supply plant, water line, and water intake to be used for expansion are the same as those under consideration for the West Hackberry ESR facility. The only nearsurface engineering changes would be pipelines to the new oil storage caverns to be developed immediately to the west of the caverns proposed for ESR storage. The immediate biotic environment includes estuarine organisms, such as penaeid shrimp, blue crab and fish, in Black Lake and the associated Black Lake Bayou and canal system, organisms on the dry land above the dome and in adjacent areas, and marsh biota in areas peripheral to the storage location. The sump for the water supply intake would be located in a relatively depauperate area, the Intracoastal Waterway. The water supply pipeline would extend from this sump to the southeast paralleling the crude oil pipeline through Black Lake to the West Hackberry site. The water supply pipeline would pass from the shore of Black Lake across dry land to the storage caverns. This land is mostly improved pastureland with sparse stands of trees.

The water supply pipeline from this same sump to the Sulphur Mines site would extend due west 3.5 miles, paralleling the existing crude oil pipeline. At this point it would then cross the ICW and continue to parallel the proposed Sulphur Mines crude oil pipeline to the site.

Environmental Setting of the Brine Disposal System

The proposed and alternate routes for the brine disposal pipeline are discussed in detail in Appendix B, Section B.3.1.5.2. The environmental setting of the routes include farmland and pastureland and the floor of the continental shelf and overlying waters of the Gulf of Mexico. See Appendix Q for a detailed discussion of the Gulf offshore and beach environments. The proposed route would parallel Calcasieu Ship Channel crossing the West Cove of Calcasieu Lake and brackish marsh to the Gulf, while the alternate route would parallel scenic Highway 27 through the Sabine National Wildlife Refuge before reaching the Gulf. Both lines would be buried along their entire extent.

Environmental Setting of the Site

The central plant at the storage site is the same plant that will be utilized for the ESR project at West Hackberry Salt Dome. It occupies 32 acres of pastureland bordered on the east by a tree line extending north-south. Oil and brine lines to the storage caverns would be buried in what is presently mostly grassland with scattered small trees and shrubs. An east-west road passes through the expansion storage cavern field and connects at its western end with the Amoco pumping station on the southwest shore of Black Lake.

Environmental Setting of the Oil Distribution System

The crude oil distribution pipeline, its environmental setting, and impacts associated with their construction and operation are described in detail in the West Hackberry Supplement to the Final Environmental Impact Statement for oil storage at West Hackberry Salt Dome FES 76/77-4, (FEA, 1977b), and the environmental setting is summarized in Appendix B, Section B.3.1.5.4.

3.3.1.6 Natural and Scenic Resources

The proposed route for brine disposal would cross 9.4 miles of marsh the majority of which is flooded. This area is a natural resource supporting a rich variety of wildlife.

The alternate route for brine disposal for the West Hackberry site would involve placing the pipeline adjacent to Highway 27 south of the town of West Hackberry to the Gulf of Mexico. This highway is considered a scenic route for 11 miles as it passes through the Sabine National Wildlife Refuge. It is the only major access road for the public to the refuge and is heavily traveled during periods when waterfowl are abundant. No other prominent natural or scenic resources are associated with the proposed West Hackberry site or pipeline.

3.3.1.7 Archaeological, Historical and Cultural Resources

On the extreme west end of West Hackberry salt dome, south of Black Lake, there are two recorded archaeological sites, both shell middens, within 400 feet of the ESR pipeline. Another recorded site, near the Sabine River in Louisiana, is within 200 feet of the ESR pipeline.

No sites listed in the "National Register of Historic Places" (National Park Service, 1977) were found to be in the vicinity of the West Hackberry dome or pipelines.

3.3.1.8 Socioeconomic Characteristics

History and Cultural Patterns

The Indian tribes which once lived on the cheniers of the Gulf coastal wetlands vanished at about the time Louisiana was first being explored by the French and Spanish. The first major group of settlers in the vicinity of the Sabine and

Calcasieu Lakes were people of Scotch-Irish descent who had bought land grants after the War of 1812. They were later joined by French and Acadian families from the eastern and central coastal parishes of Louisiana.

Population. The proposed site for petroleum storage is located in a rural area composed of marshes and pasturelands in Cameron Parish, the largest and least populous parish in the state (population 8,194 in 1970). There are three small communities near the site: Hackberry (population 1,300), located just east of the site; Cameron (3,200), near the alternate brine pipeline route; and Holly Beach, a resort village with fewer than 1,000 residents, near the proposed brine pipeline route (see Figure 3.3-5).

The majority of workers at the salt dome would probably be supplied by the cities of Calcasieu Parish, including Sulphur (15,247) and Westlake (4,000). In contrast, the construction of the ESR oil distribution pipeline to Nederland will draw its labor supply from the major cities of Orange and Jefferson Counties, including Beaumont, Port Arthur, and Orange, with a combined population of over 300,000.

See Section B.3.1.8.2, Appendix B, for projected rates of population increase.

Land Use Patterns

Present land-use designations for Cameron Parish reflect the fact that it is located in a coastal marsh. The distribution of total area in the parish (1,064,131 acres) is as follows:

Nondevelopable wetlands	53.31%
Public/semi-public lands*	21.54%
Water bodies	16.18%
Agricultural lands	8.06%
Residential, commercial, and industrial areas	1.01%

See Figure B.3-10, Appendix B, for maps showing present and projected land use. Due to the limited dryland available, a substantial part of future development is anticipated to occur in a strip along Highway 27 south of the present commercial area.

*Includes the Sabine National Wildlife Refuge, the Lacassine Migratory Waterfowl Refuge, and the Rockefeller Wildlife Refuge and Game Preserve.

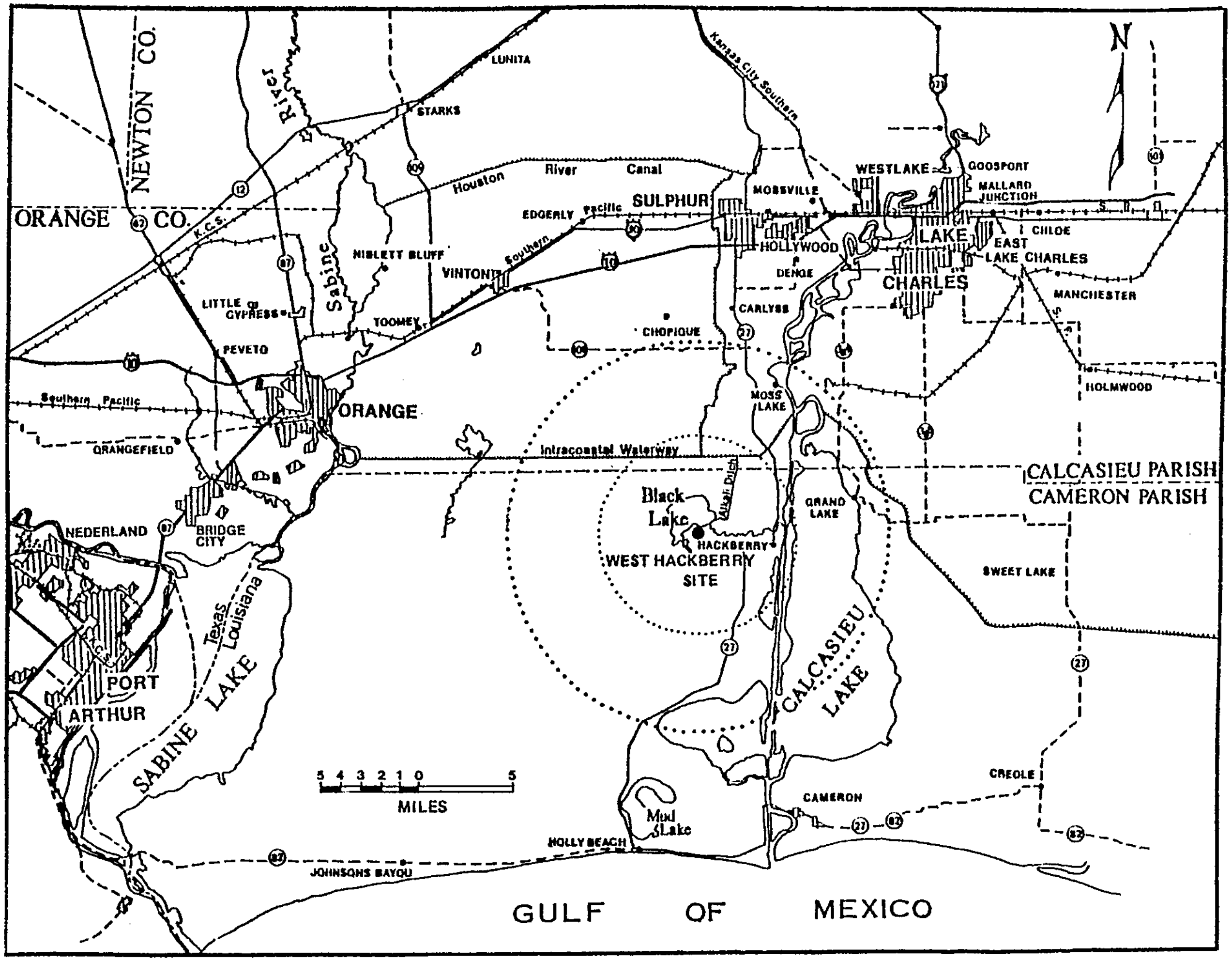

Figure 3.3-5 Towns and Cities Around the West Hackberry Site

Hackberry is an unincorporated community, and neither it nor Cameron Parish has established zoning regulations to govern areas affected by the proposed project.

Transportation

Extensive marshes and sparse population in the vicinity of Hackberry limit roadways. Highway 27, divided into two branches, is one of the few major roads in the area; it connects coastal Cameron Parish to inland metropolitan Calcasieu Parish. The west branch connects the center of Hackberry with neighboring towns and cities and is the more traveled of the two branches. Highway 27 passes within four miles of the oil storage site, with access to the site provided by Route 390 and a parish road.

Interior portions of the parish can be reached only by various canals across the wetlands. The ICW lies north of the parish border, within four miles of the oil storage site, which is located on the edge of Black Lake. Black Lake Bayou connects Black Lake with the ICW by means of Alkali ditch. Both the ICW and the Alkali ditch could be used for transport of materials to the site.

Railway and airport facilities are fifteen to twenty miles away in Sulphur and Lake Charles. Small pipelines (4 and 6 inches in diameter) lie around the rim of the dome because the salt dome lies in an area productive of oil and gas.

Housing and Public Services

Due to the rural character of Cameron Parish, much of the impact of the project would be experienced in the urbanized areas of Calcasieu Parish. While the health and protective services of Cameron Parish communities may be impacted, it is primarily Calcasieu Parish that would be called upon to supply residential services to workers and their families. Workers would probably settle in Lake Charles, about 30 miles from the site, and in Sulphur, 21 miles from the site. See B.2.8.5, Appendix B, for data on the availability of housing in these cities.

There is one school in Hackberry, with 360 pupils. In Lake Charles there are 40 public and 9 parochial schools, a university, and several trade schools. Sulphur schools have an enrollment of about 6,600 students, including 230 in parochial schools.

There is a doctor in Hackberry, but the closest medical facilities to the site are at Sulphur.

Fire protection would be provided at the site; auxiliary assistance would be available from the fire station at Hackberry.

Economy

The local economy of Hackberry is based on fishing and fish processing, producing gas and oil, and raising cattle. Cameron is a main port for fishing in the Gulf of Mexico, ranked second among the nation's ports in terms of the volume of commercial fish landings in 1975. Lake Charles, the largest city within commuting distance of the West Hackberry Salt Dome, is a manufacturing center with a labor force estimated at 26,442 in 1970.

Government

Since Hackberry is an unincorporated community, the basic public services for its citizens are administered on the parish level. No municipal tax is levied, but each district of the parish is taxed separately, as are school districts and drainage districts.

The total assessed value of Cameron Parish in 1973 was $40,648,690, of which 13 percent was real estate value, 53 percent personal property, and 34 percent public corporations. The Cameron Parish Police Jury, which has jurisdiction over any construction within the parish, is responsible for permits regarding erection or modification of buildings in flood hazard areas, as well as pipeline crossings of public roads and waterways.

3.3.2 Alternative Site - Black Bayou

3.3.2.1 Land Features

Black Bayou Salt Dome is located in the northwest corner of Cameron Parish, Louisiana. There is no topographic expression of the salt stock and the entire dome site is covered by marsh and a network of bayous and barge canals. These canals are arranged in radial and concentric patterns and are connected to the ICW by Black Bayou and the Black Bayou Cutoff Canal.

Black Bayou Dome is a shallow piercement structure with steep, nearly vertical sides, circular horizontal cross section, and relatively flat top. The average depth to salt is 1,750 feet below sea level (see Figures 3.3-6 and 3.3-7).

Sequences of poorly consolidated to unconsolidated marine, deltaic and fluvial clays, shales, and sands and overlying Pliocene strata is extensive and complex (see Figure B.3-18, Appendix B).

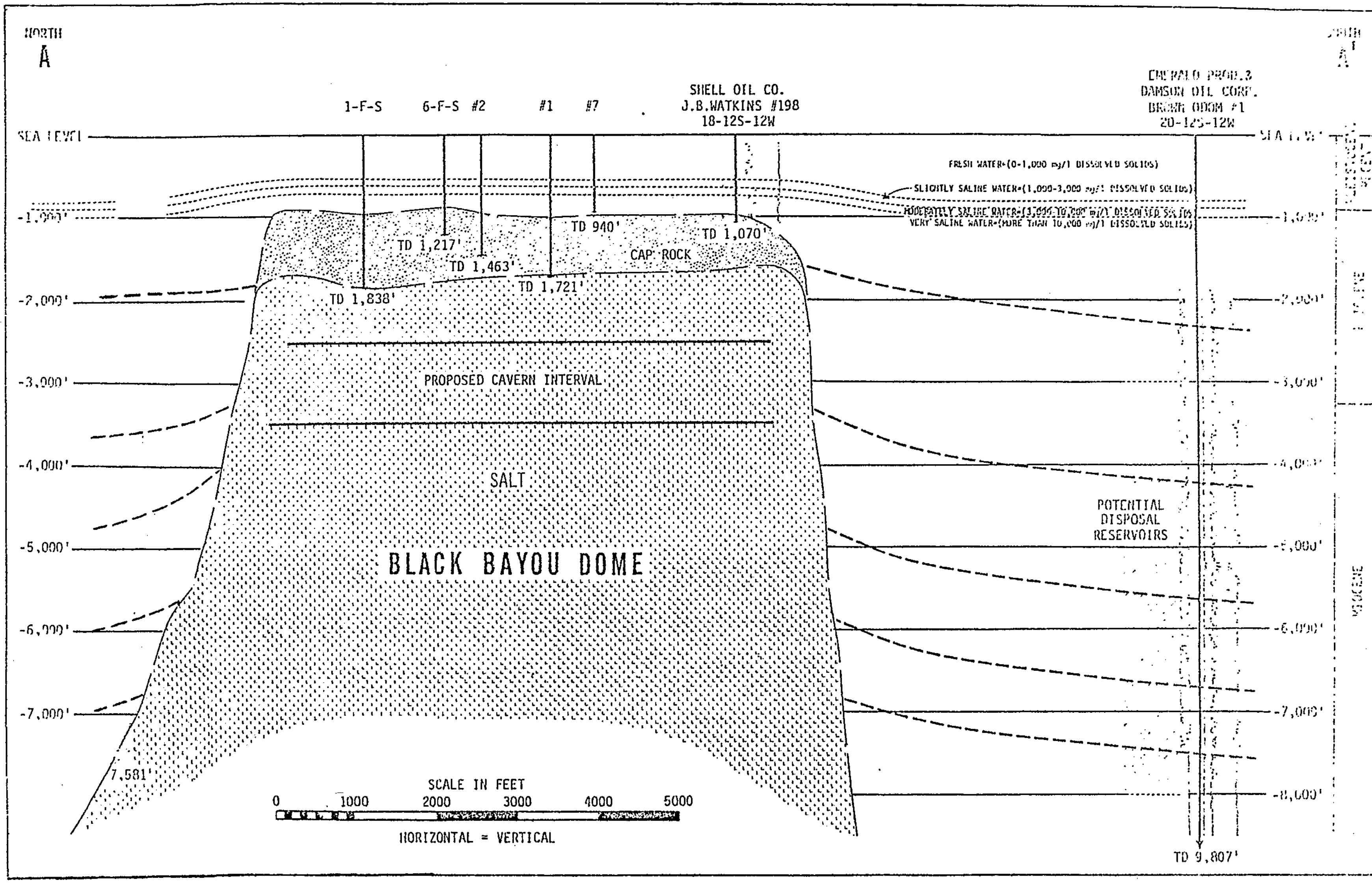

Figure 3.3-6 Geologic Cross-Section of Black Bayou Dome (North-South).

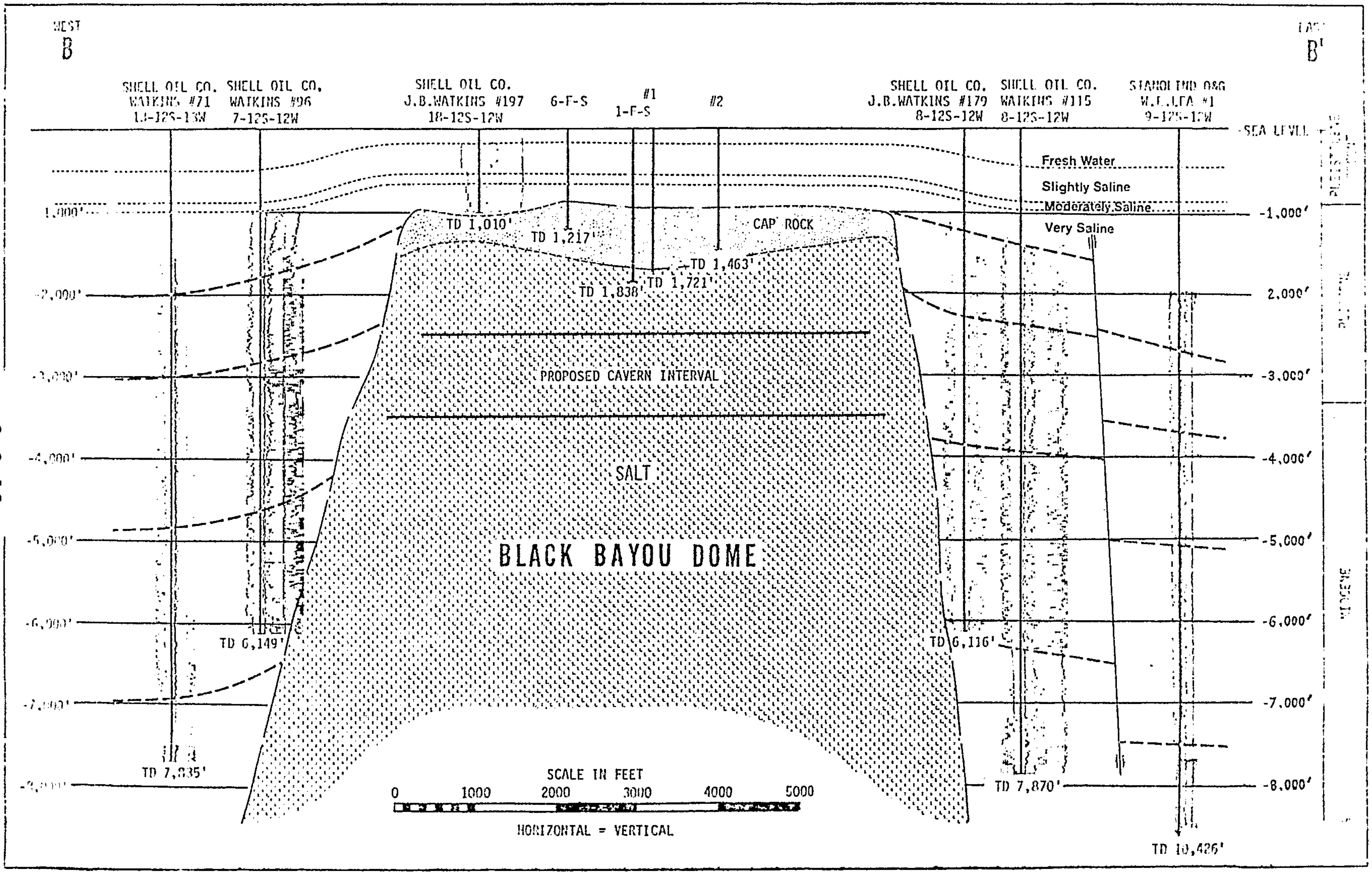

Figure 3.3-7 Geologic Cross-Section of Black Bayou Dome (West-East).

The shallowest known salt occurs at 1,035 feet, while the deepest known salt top is at 8,553 feet on the northwest periphery of the dome. Approximately 723 acres are enclosed within the 2,000 foot depth to salt contour and about 813 acres are in the area enclosed by the 3,000 foot depth contour. The east-west axis of the dome above the 2,000 foot depth contour is slightly over 6,000 feet long, while the north-south axis is just over 5,600 feet.

Cap rock at Black Bayou is composed of an average (from top to bottom) of 76.3 feet of calcite, 66 feet of gypsum, and 800 feet of anhydrite. Cap rock depth ranges from 881 feet to a maximum of 1,369 feet. Drill holes indicate that cap rock does not cover the entire dome, but extends outward to cover only the area underlain by the 2,000 foot salt contour (see Figure B.3-21, Appendix B).

The soils at Black Bayou belong to the Harris-Salt Water Marsh Association (see Figure B.3-20, Appendix B). This association is described in Section B.3.2.1.4, Appendix B.

Oil and gas production has occurred all around the dome, especially on the southeast and northwest flanks. None is known to have been produced over the top of the dome in the area proposed for the storage facility. No record of sulfur mining was found, and no known salt mining has occurred. Therefore, there are no existing caverns suitable for storage of crude oil.

3.3.2.2. <u>Water Environment</u>

The Black Bayou salt dome is located in Hydrologic Unit 9 of southwestern Louisiana within the estuarine part of the Sabine Basin (see Figure B.3-7, Appendix B). The dome lies primarily beneath marshland interlaced with a network of natural channels and man-made canals. The surface water system is underlain by clays which are nearly impervious to water passage. As at West Hackberry, the annual rainfall is heavy, but the area generally experiences a moisture shortage for vegetation during the growing season (from February through November).

The general arrangement of the surface water bodies in the vicinity of Black Bayou is depicted in Figure 3.3-8, and pertinent measurements for these water bodies are given in Table B.3-12, Appendix B.

Black Bayou (approximately 19 miles long with a mean width of 170 feet and a depth of 3 feet) would be the primary source of leaching/displacement water at the Black Bayou site. State water quality standards for Black Bayou are provided in Appendix D. As indicated by these standards the bayou is to

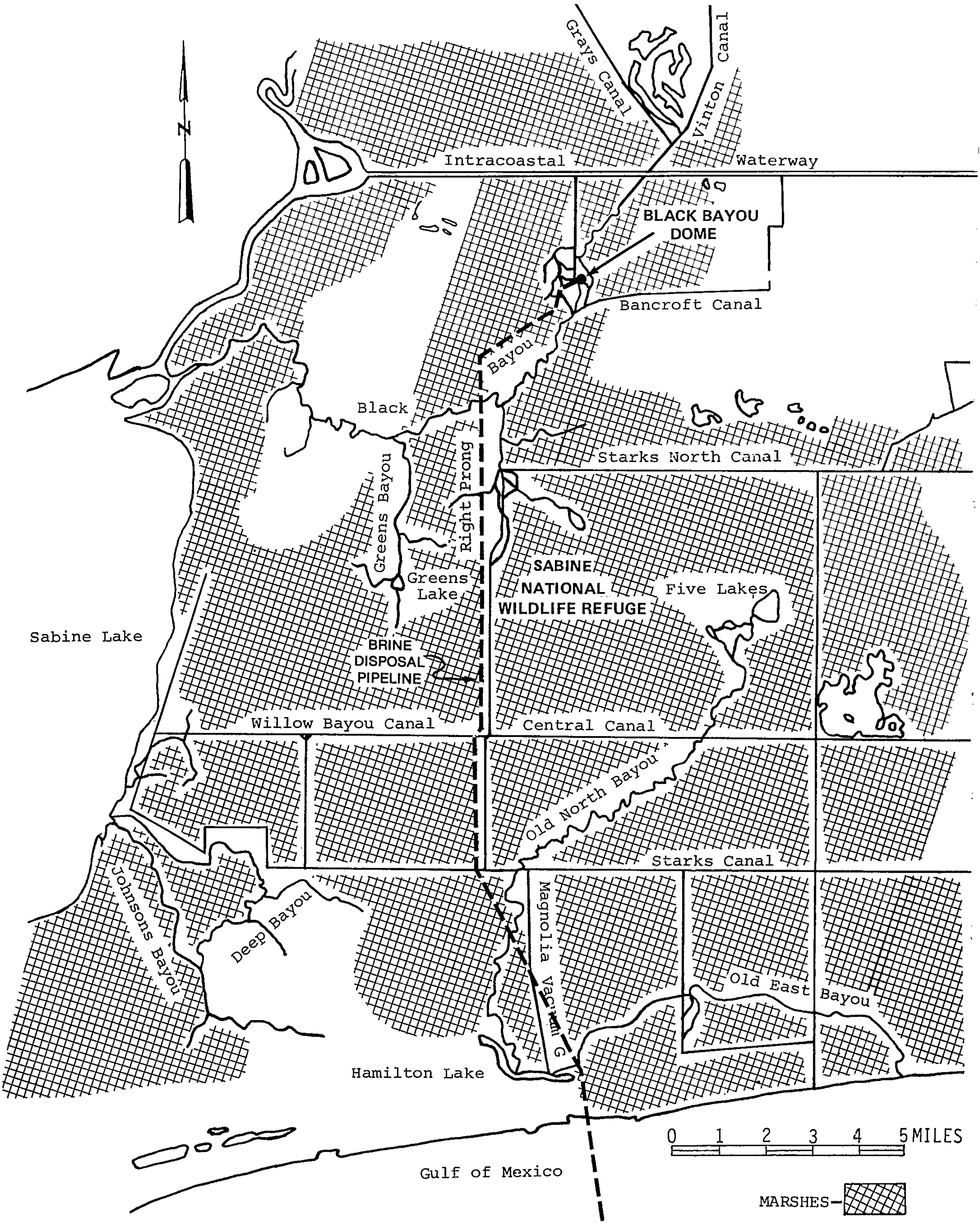

Figure 3.3-8 Black Bayou Surface Water System

be used for secondary contact recreation and for the propagation of fish and wildlife. The bayou is classified as tidal by these standards.

In order to reach a depth of 30 feet, the brine diffuser site would be located at least 5 miles offshore. The bottom composition and salinity are similar to those previously discussed for the West Hackberry site. Surface currents in the area are variable, being strongly affected by winds, tides, and other conditions. Mean surface currents 15 miles southeast of the disposal area tend to set to the west with a drift of 1 knot. The diurnal tidal range is approximately 2 feet. The most likely wind is from the southeast at 11.6 knots. See Figures B.3-11 and B.3-12 in Appendix B for the pertinent wind and current roses, respectively.

The base of fresh ground water in the Black Bayou dome area is -500 feet msl (mean sea level). Slightly saline water occurs in the approximate depth interval of -500 to -900 msl. The strongest influence on local ground water movement is the regional effect of ground water pumping at Lake Charles, Louisiana; ground water movement is currently about 200 feet per year at Black Bayou. Due to the marsh conditions and limited fresh ground water supplies, no ground water use is developed within 5 miles north, west, or south of the site.

3.3.2.3 Air Quality

Based on extrapolations from regional air quality data, the levels of non-methane hydrocarbons and photochemical oxidants are predicted to be high and are expected to continue to exceed standards during the next 10 years due to the increased marine terminal operation. All other pollutants with the possible exception of sulfur oxides are expected to be in compliance with the applicable standards.

3.3.2.4 Background Ambient Sound Levels

Background noise levels in and around the alternative SPR site at Black Bayou Salt Dome expansion are typical of those described for the SPR region in Section 3.2.4.

3.3.2.5 Species and Ecosystems

Environmental Setting of the Displacement/Leaching Water System

The water supply system would result in extensive alteration to the eastern side of Black Bayou. The point where the intake structure and sump would be placed is immediately to the north of an east-west trending marsh channel. The water line would pass for only a short distance east in fresh to intermediate marsh to the 40,000 bbl surge tank. From the surge tank a line would pass south across the marsh channel and in marsh to the central plant. Organisms present along the water supply system components include fresh and intermediate marsh biota. The marsh and water channels near the water lines probably contain salt-tolerant freshwater fish, insect larvae, oligochaetes, mollusks, crustaceans, birds, mammals, reptiles, phytoplankton, zooplankton, epiphytic and periphytic algae, and perhaps benthic algae. There are birds and small mammals in the stand of oak woods, called Goat Island or Bird Island, north of the surge tank.

Environmental Setting of the Brine Disposal System

The brine lines would pass from the wellheads along the same paths as the oil and water supply pipelines and would pass through marsh and water channels in the marsh near the raw water surge tanks and the central plant. From the central plant area the brine line would pass to the southwest along a water-course and then pass more to the south across expanses of water connected to Black Bayou, roads, marsh, and the Bayou itself before intersecting with Transcontinental Gas Pipeline Company's right-of-way leading south through the Sabine National Wildlife Refuge, across the beach and into the Gulf of Mexico. From the beach the pipeline would be buried in the ocean floor. The types of marsh plants and animals present along the route from the central plant are discussed in Sections B.2.5.2.1, B.2.5.2.5, B.2.5.4, and B.2.5.5 in Appendix B. Aquatic and marine organisms are also discussed in these sections. See Appendix Q for a detailed discussion of the Gulf offshore and beach environments.

Environmental Setting of the Site

The central plant location at the southeast corner of the storage site would be near the roads and main office of the Shell Oil Company main plant. The general area where the storage caverns and associated facilities would be located is in the midst of a vast maze of canals running through marshland. A peripheral road nearby encircles the proposed storage area and would have numerous connections to well pads and some to spur roads.

Environmental Setting of the Oil Distribution System

The oil supply and distribution line would be buried in the Black Bayou Cutoff, a canal which passes nearby due north from the site through the surrounding canals and wetlands to the ICW where it would join the ESR oil distribution line from West Hackberry. The banks of the Black Bayou Cutoff are lined with trees over much of this route. Further away from the Cutoff banks, marsh and open water generally predominate. The pipeline route along the ICW runs mainly across marsh, cultivated and cleared lands, and spoil banks.

3.3.2.6 Natural and Scenic Resources

Black Bayou is a relatively high quality marsh habitat with a large complex of open water canals and protected inlets into the marsh grass. This type of habitat attracts many waterfowl. The proposed brine line from Black Bayou would pass through an 11-mile portion of the Sabine National Wildlife Refuge, following an existing Transcontinental Gas Pipeline Company right-of-way for most of the distance. This pipeline corridor is adjacent to the western edge of the large fresh water impoundment in the central portion of the refuge.

3.3.2.7 Archaeological, Historical and Cultural Resources

There are three recorded archaeological sites, all shell middens, in close proximity to the proposed Black Bayou oil and brine pipelines. One is a small shell midden complex within 500 feet of the brine pipeline route in the vicinity of Hamilton Lake. Another is within 2000 feet of the oil pipeline route adjacent to the Sabine River in Louisiana. The third shell midden is within 200 feet of the ESR oil pipeline.

No sites listed in the "National Register of Historic Places" (National Park Service, 1977) were found to be in the vicinity of the Black Bayou dome or proposed oil and brine pipelines.

3.3.2.8 Socioeconomic Characteristics

History and Cultural Patterns

The first settlers in Cameron Parish lived along the bayous near the Gulf Coast and the shores of Calcasieu Lake and raised cotton and cattle, leaving the vast interior wetlands to the hunters and trappers. The discovery of oil in 1929 resulted in an economic oil boom, and people of this area continue to make a living in the oil and gas fields and by raising cattle. Hunting, trapping, and fishing are the major forms of recreation.

Population

The proposed Black Bayou site is located in a rural section of Cameron Parish, in a marshland that has been explored extensively for oil and gas. The road to the site travels along Gum Cove Ridge through a small settlement known as Cameron Farms. The proposed brine pipeline would follow a gas pipeline right-of-way along the Burton-Sutton Canal south and would cross Highway 82 near an unincorporated community called Johnsons Bayou (population 700 in 1970) (see Figure 3.3-9).

Land Use Patterns

The land in the immediate vicinity of the Black Bayou site has been designated as an area for mineral extraction (Imperial Calcasieu Regional Planning and Development Commission, 1974). The land surrounding the site on its northern, western, and southern boundaries is marshland, unsuitable for development. The eastern side of the site is connected to Gum Cove Ridge, a natural topographic rise which is used for farming and grazing cattle. Gum Cove Ridge is listed as one of several potential state park sites in southwestern Louisiana by the State Parks and Recreation Commission (1974 publication).

Along the coast in the Johnson Bayou area where the brine pipeline would enter the Gulf waters is a small resort community, Ocean View Beach. Just east of this area is Constance Beach, and further east is Peveto Beach. There are now a number of lodges in this area, and these beaches will be increasingly used as recreational areas as the population of the region grows. Traffic counts along Highway 82 near Johnson Bayou register an average of 700 to 800 vehicles per day.

Transportation

Since there are no towns of appreciable size within a distance of 10 miles from the site, workers for the project would commute to the Black Bayou site, probably from Lake Charles, Sulphur, and Orange. These cities would provide schools and medical facilities for the workers' families. Firefighting equipment and security guards would have to be provided at the site. Workers traveling to the site would turn off Interstate 10 at Vinton and travel south on Route 108 and an unnamed road (which is not state maintained). There is a ferry, Gum Cove Ferry, at the point where this road crosses the Intracoastal Waterway, which takes an average of 140 vehicles daily (Louisiana Department of Highways, 1971).

The access road is built on land fill and material dredged from the construction of the Bancroft Canal, and the site itself is surrounded by wetlands which are reached by canals rather than roads. The Black Bayou Cutoff Canal has been dredged from the ICW to the site and connects with the network of channels that surround the salt dome. Airports are at Lake Charles and Port Arthur. The Southern Pacific Railway passes through Vinton, twenty miles north of the site.

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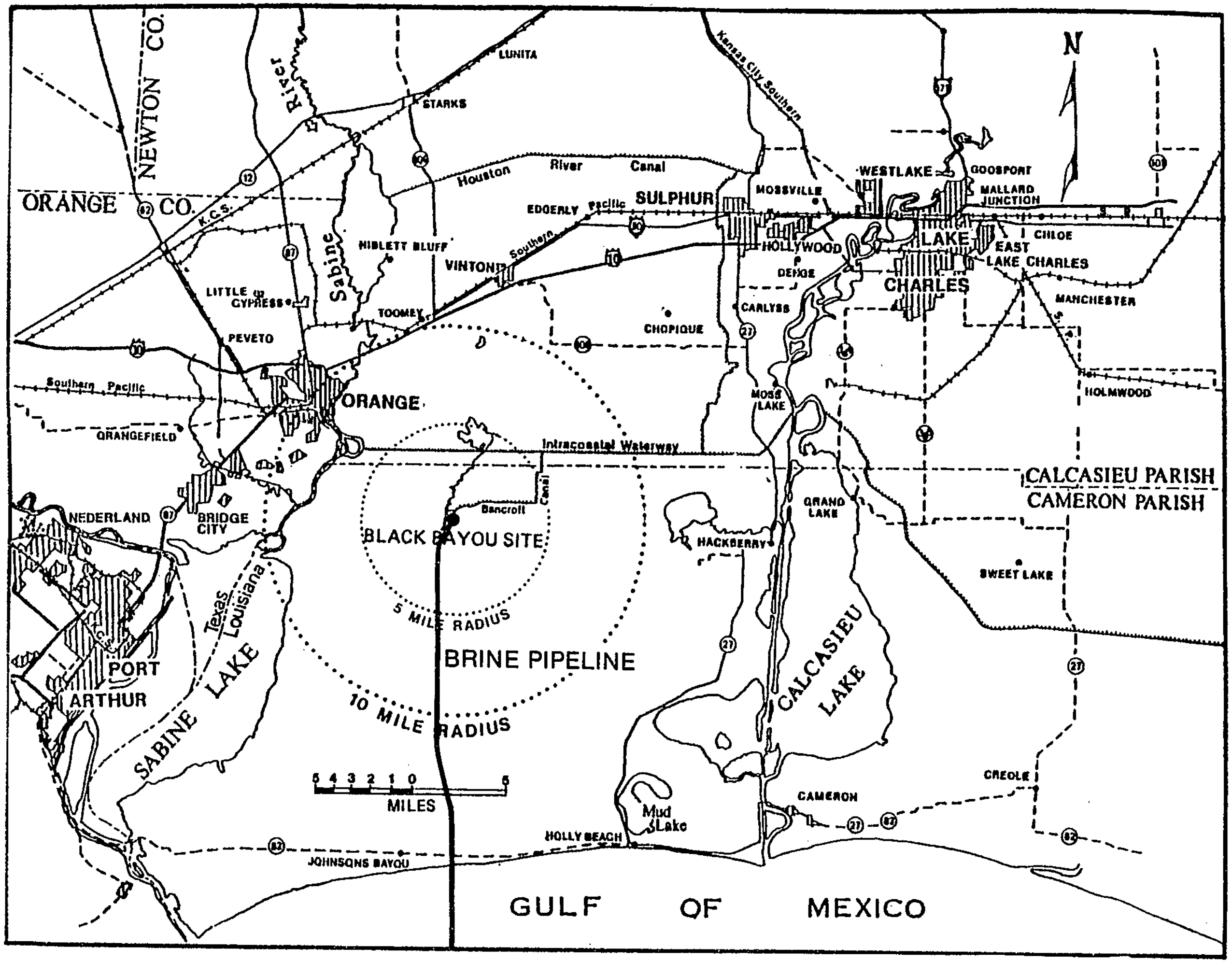


Figure 3.3-9 TOWNS AND CITIES AROUND THE BLACK BAYOU SITE

Economy

The major urban area near Black Bayou is Orange, Texas, which had a median family income of $8,839 in 1969. The economy of Orange is heavily dependent on the petrochemical industry and other industries requiring the use of oil and gas products. The town of Vinton, Louisiana, (median family income $7,402 in 1969), located north of the site, is partially dependent on oil and gas production and also serves as a commercial center for the rice farming region of western Calcasieu Parish.

Government

The Cameron Parish Policy Jury would have jurisdiction over construction and operation of Black Bayou facilities. Neither Cameron Farms nor Johnsons Bayou is an incorporated community and, of the two, only Johnsons Bayou has a separate specialized taxation assessment district for public services, the Johnsons Bayou Recreational District.

3.3.3 Alternative Site - Vinton

3.3.3.1 Land Features

Vinton Salt Dome is located in southwestern Calcasieu Parish, Louisiana. It is a centrally sunken type dome; the sink contains a freshwater lake, 3 feet deep, known as Ged Lake, which is about 30 feet above sea level and 15 feet above the surrounding plain.

The dome is 3.5 miles southwest of the town of Vinton, 1 mile west of the Vinton drainage canal, and 5.7 miles north of the ICW.

Vinton is a shallow-lying piercement salt dome (see Figure 3.3-10 and 3.3-11). It is nearly circular in cross section with steep, nearly vertical sides. The shallowest reported depth to salt is 700 feet. Areas within the 1000, 2000, and 3000 foot salt depth contours are approximately 155, 265, and 355 acres, respectively. Both axes of the dome at the 1000 foot depth contour are about 2500 feet long. The major axis at the 2000 foot level is 4200 feet long and the minor axis is 3360 feet; at the 3000 foot contour, the major axis is 4800 feet long and the minor axis length is 3800 feet.

The general character of faulting at Vinton can be assumed to be similar to that for other piercement domes. Cap rock at Vinton is composed of an average (from top to bottom) of 104 feet of calcite, 232 feet of gypsum, and as much as 83 feet of anhydrite, for an average thickness of 419 feet. Average depth to the top of the cap rock is 528 feet; the extent of its coverage has not been determined.

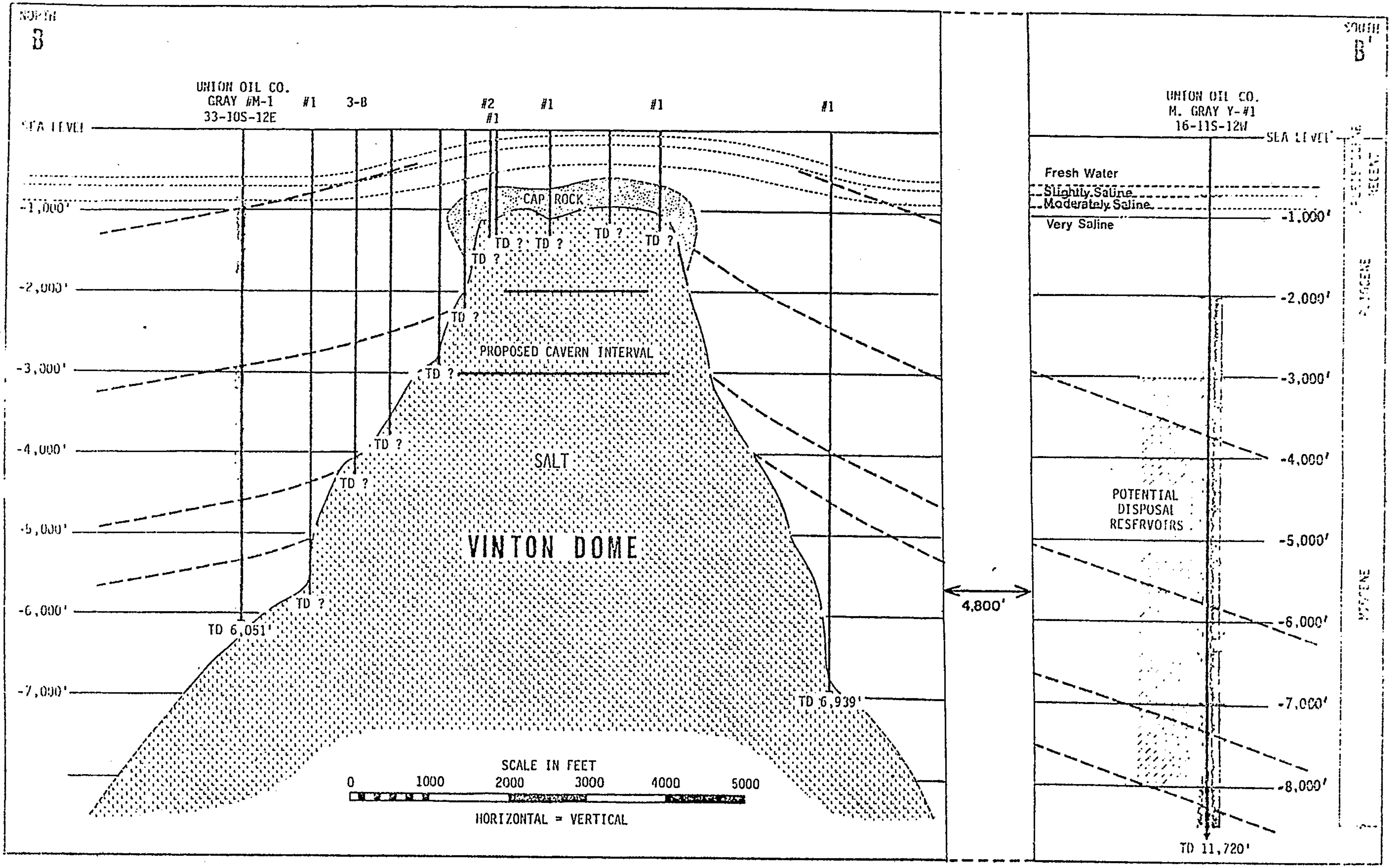


Figure 3.3-10 Geologic Cross-Section of Vinton Dome B-B'

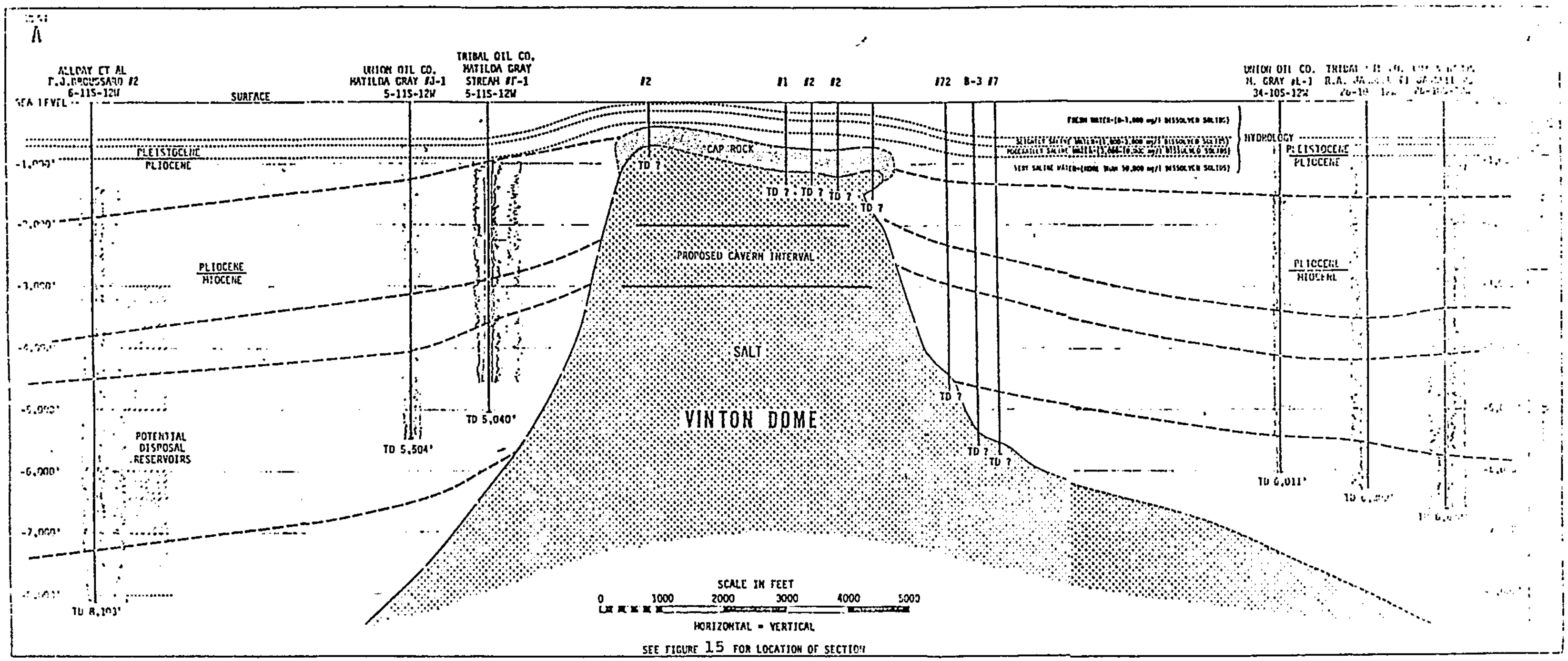


Figure 3.3-11 Geologic Cross-Section of Vinton Dome A-A'

The soils at the Vinton site belong to the Morey-Beaumont Association. The oil distribution pipeline route and the brine injection site encounter Morey-Beaumont and Harris-Fresh Water Marsh Associations. These associations are described in Section B.3.3.1.4 of Appendix B; see Figure B.3-28, Appendix B, for a soil distribution map of southwestern Calcasieu Parish. Stratigraphy is shown in Figure 3.3-12.

Since 1910 minor oil production has occurred all around Vinton dome, with the greatest density of drilling on the north and east sides. Oil and gas is currently being produced from five zones, but no known production is located over the top of the dome. Sulfur is also not known to occur in the immediate vicinity of the dome. Salt has not been mined at Vinton dome; so there are no existing caverns suitable for crude oil storage. Sulfur is not know to occur at this dome.

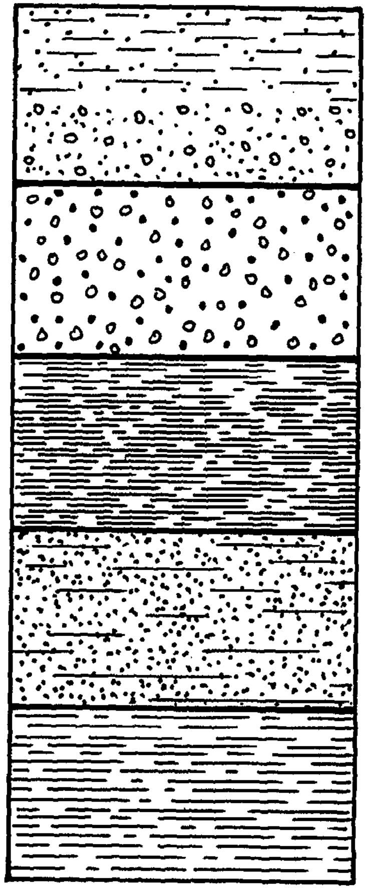
3.3.3.2 Water Environment

The Vinton salt dome is located in southwestern Louisiana between the Calcasieu and Sabine River basins. The surface water system, depicted in Figure 3.3-13, consists primarily of Ged Lake, located directly over the dome and surrounded by a network of canals, gulleys, and flumes. Most of this network nearest the dome drains to the south and east into the Vinton Canal. All available data concerning the physical dimensions of water bodies in the area are summarized in Table B.3-14, Appendix B.

State water quality standards for the Vinton Canal are provided in Appendix D. As indicated by these standards, the bayou is to be used for secondary contact recreation and for the propagation of fish and wildlife. The canal, classified as tidal by state standards, contains fresh water, although some saltwater intrusion does occur.

The surface water system in the region is underlain by clays which are nearly impervious to water passage. As is the case at West Hackberry and Black Bayou, the annual rainfall appears plentiful, but the area generally experiences a moisture shortage for vegetation during the growing season.

The geohydrologic description of Vinton salt dome is similar to that of Black Bayou dome, located 8 miles to the south (see Figure B.3-30, Appendix B, and additional data in Appendix D). Analysis of available data indicates that the base of freshwater at the Vinton dome is between -900 and -600 msl, generally coincident with the base of the Chicot aquifer. In the vicinity of the dome, the Chicot behaves as a confined aquifer, separated from the surface by nearly 200 feet of clay or shale. Vinton dome is slightly closer to the center of pumping at Lake Charles than Black Bayou dome. Thus, the



Lithology	FORMATION NAME	APPROXIMATE THICKNESS
SAND AND CLAY SAND AND GRAVEL	Beaumont Clay	400 Ft
	Lafayette Gravel	600—1000
	Fleming Clay	400—3000
SANDS AND SANDY SHALES	Oligocene Formation	300
	Jackson Shale	1700—3500

Figure 3.3-12 **STRATIGRAPHY IN THE VICINITY OF VINTON DOME, LOUISIANA**

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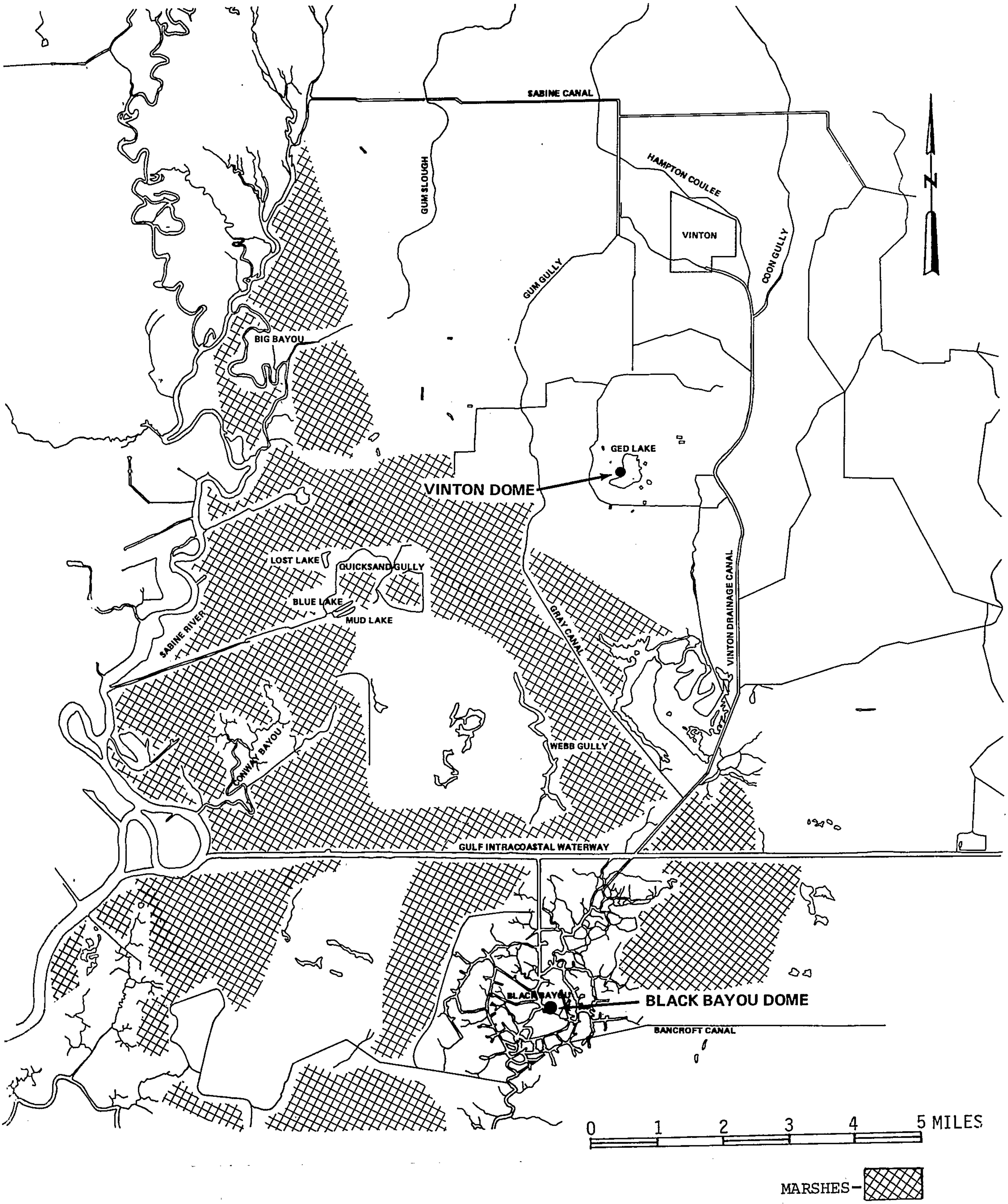

Figure 3.3-13 Vinton Surface Water System

same or slightly greater effects of the local decline in water levels and movement of ground water are present.

Locations of the several wells in the Vinton area are indicated in Figure B.3-31, Appendix B, and their use, depth, and water quality records as of 1960 are given in Table B.3-15, Appendix B. Deep aquifers are discussed in Section B.3.3.2.2, Appendix B.

Brine injection into Miocene sands is proposed in an area south of the Vinton dome. Fourteen wells exist within an area extending 10 miles east and west and tangent to the southern flank of the dome. The lateral continuity of sands in this area may be limited by faulting (see Figure B.3-34, Appendix B). Study of 3 well logs revealed that 11 sands, each 50 feet thick; 7 sands, each 100 feet thick; and 3 sands, each 150 feet thick were present at each well.

3.3.3.3 Air Quality

Based on extrapolations from regional air quality data, the levels of non-methane hydrocarbons and photochemical oxidants are predicted to be high and are expected to continue to exceed standards during the next 10 years due to the increased marine terminal operation. All other pollutants, with the possible exception of sulfur oxides, are expected to be in compliance with the applicable standards.

3.3.3.4 Background Ambient Sound Levels

Background noise levels in and around the alternative SPR site at Vinton salt dome expansion are typical of a rural area in the SPR region.

3.3.3.5 Species and Ecosystems

Environmental Setting of the Displacement/Leaching Water System

Displacement/leaching water would be drawn from the Vinton drainage canal about 5000 feet east of the dome. Initially the pipeline would proceed from the central plant area south across the dome, through pastureland. It would then turn east and then southeast, crossing disturbed land with second-growth grasses and open forests before intersecting with the Vinton drainage canal. The pipeline would parallel a light-duty road for the last mile of the route.

Environmental Setting of the Brine Disposal System

The current design specifies brine disposal into subsurface saline aquifers. The brine pipeline to the disposal wells would follow the displacement/leaching water system corridor south for .5 miles and then east for .75 miles through pastureland and disturbed grassland. The route would then turn south across dryland passing through disturbed grassland and scattered trees. The pipeline at this point would join the well head area which would consist of 10 wells in a linear array with 1000 foot intervals. The well head area would lie within a complex of fresh water marsh and grassland with 6 of the 10 wells lying within the marsh.

Environmental Setting of the Site

The plant area would require approximately 60 acres of land, with an adjacent equipment yard of roughly the same size. The plant and equipment yard would be placed on pastureland west of Ged Lake and east of buildings which are already on the dome. The existing buildings consist of a large summer house, horse stables, barn and 4-6 smaller houses. Trees on the dome are found only in the immediate vicinity of the buildings and it is anticipated that no clearing of land would be necessary for site installation. From the buildings, the pastureland is relatively flat with a gentle slope in the direction of the lake.

Environmental Setting of the Oil Distribution System

Crude oil would be transported by a 31-mile pipeline system between Vinton and Sun Terminal. The proposed pipeline corridor would proceed west crossing pastureland and second-growth grassland. Marshland is encountered as the corridor turns south, with increasingly saline waters being found the further south the route extends. After the pipeline reaches the ICW, it crosses the waterway and joins the ESR distribution pipeline between West Hackberry and Sun Terminal.

3.3.3.6 Natural and Scenic Resources

The surface land around Vinton dome is currently being used as a cattle and horse ranch. Although it is on private land and closed to the public, it is a very scenic ranch with several large houses, stables, and barns. Adjacent to the houses is Ged Lake, a freshwater impoundment on the high ground of the dome. It is one of the few freshwater lakes in the area which is not partially surrounded by marshland.

3.3.3.7 Archaeological, Historical and Cultural Resources

A recently completed cultural resources survey of Vinton dome indicates the presence of several shell midden sites in the Ged Lake area (Thomas, et al., 1977). The extent and significance of these areas has yet to be determined. However, a detailed survey would be performed if the site is selected.

3.3.3.8 Socioeconomic Characteristics

History and Cultural Patterns

The area around the Vinton dome site was part of the disputed border territory between Spanish and French land claims, an area occupied by outlaws, pirates, and smugglers. The first trading post in West Calcasieu was established at Niblett's Bluff, near the present town of Vinton. Vinton was established in 1880 along a major trade route from the Mississippi River to Texas and has strong ties to the Western influences of Texas as well as to the Acadian French culture of south central Louisiana.

Population

The Vinton Salt Dome is in Calcasieu Parish about 1.5 miles south of the town of Vinton (population 3,454 in 1970). Residential growth has spread westward from Vinton toward the small village of Toomey and toward Niblett's Bluff (see Figure 3.3-14). Vinton is best known as the home of Delta Downs, a horse race track which seats 1,200 people. Populations projections for Vinton indicate a growth rate of 24 percent in the current decade and 19 percent in the next, slightly higher than the growth rate projected for Calcasieu Parish as a whole.

Land Use Patterns

Calcasieu Parish is one of the five parishes that compose the Imperial Calcasieu Planning Region. The current distribution of land in the parish (685,327 acres) is as follows:

Agricultural lands	49.16%
Forests	26.75%
Undeveloped wetlands	13.56%
Residential, commercial and industrial areas	7.47%
Public/semi-public and recreational lands*	2.23%
Water bodies	0.83%

*Includes the Lake Charles Municipal Airport, Chennault Air Force Base, Sam Houston State Park, and the Sabine Island Wildlife Management Area.

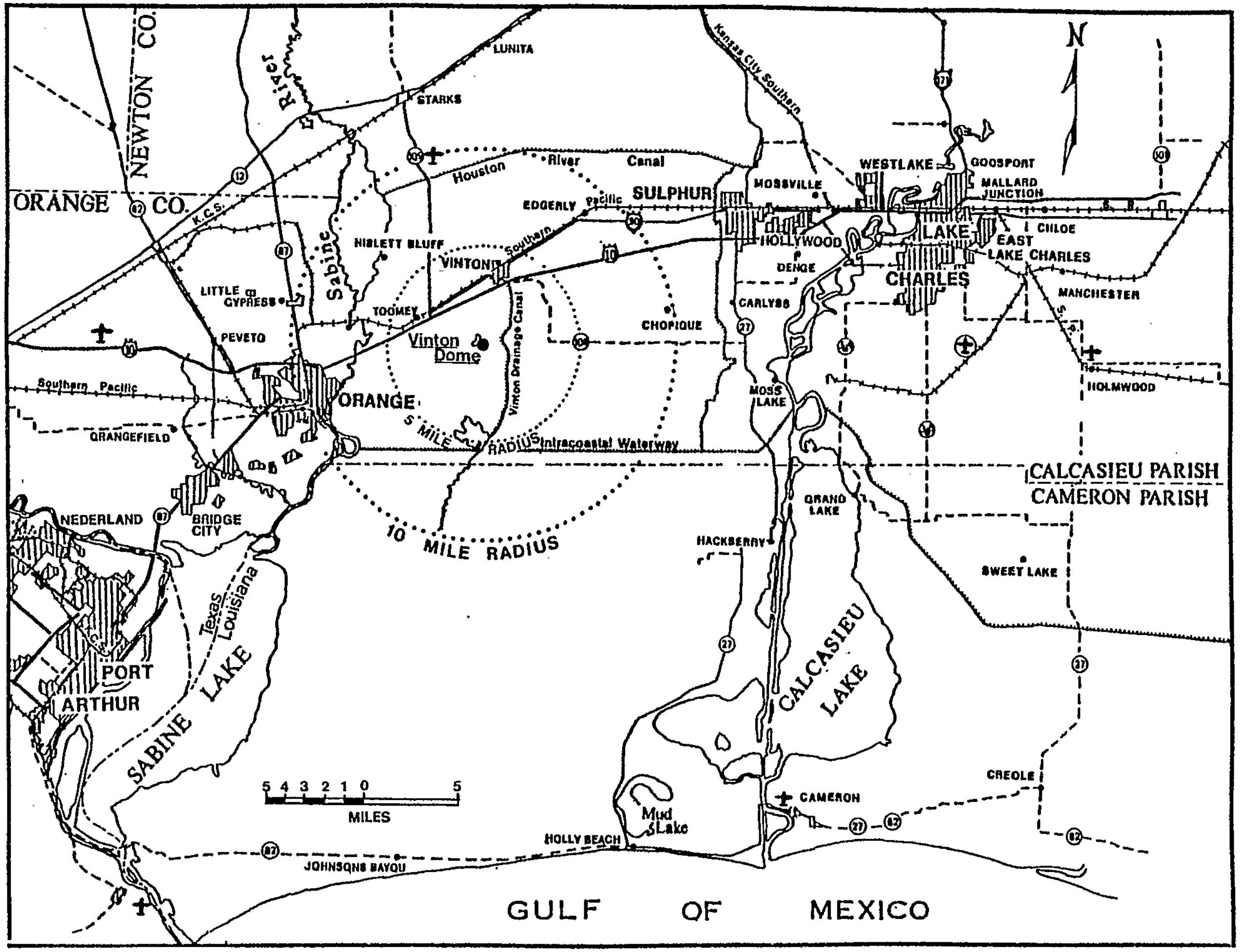

Figure 3.3-14 Towns and Cities Around the Vinton Site

Future residential development for the town of Vinton is projected to occur westward of the present town, along Interstate 90. Some industrial growth is expected to occur south of Vinton, on State Highway 108 (Imperial Calcasieu Planning and Development Commission, 1974).

Transportation

Workers traveling to the Vinton salt dome would arrive at Vinton via Interstate 10 from Sulphur and Lake Charles, which are 13 and 22 miles east, respectively, and from Orange which is 11 miles west. Workers would then travel over a gravel road (not state maintained) to the storage site at an average of 60 vehicles per day.

The dome lies within 6 miles north of the ICW, and 1.5 miles west of the Vinton Drainage Canal. Vessels in the ICW can reach Vinton port facilities via the canal, which handles an estimated six self-propelled vessels per year with a draft of up to 9 feet (Corps of Engineers, 1975).

Airports are at Lake Charles and Port Arthur. The Southern Pacific Railroad passes through Vinton, 1.5 miles north of the site.

Several oil and gas pipelines cross the area around the dome, which include a six-inch Continental line running northeast to southwest, and the Transcontinental Gas Pipe Line's 20-inch and 12-inch lines running north and south about a mile west of the site.

Housing and Public Services

Housing to accommodate project workers would be provided by Vinton and by the major cities nearby, the closest of which is Orange, Texas. Health facilities at Vinton are limited to a few private doctors' offices. Emergency fire protection is available in Vinton. Workers would reach Vinton via Interstate 10 and would then travel over a gravel road (which is not state-maintained) to the proposed storage site. Current use of this road averages 60 vehicles per day.

Economy

The economy of western Calcasieu Parish is dependent on agriculture and the production of oil and gas. The primary crop is rice, and the parish is a prime rice growing part of the state. Cattle production is also an important source of income. The land surrounding the Vinton Salt Dome is part of the Vinton oil and gas field, one of over 25 oil and gas fields in the parish west of the Calcasieu River. A small port facility at Vinton ships out local products via the ICW.

In 1975 about 8,000 tons of crude petroleum and 6,000 tons of unmanufactured marine shells were shipped.

Government

Vinton was incorporated in 1910 and is governed by a mayor and board of alderman elected by the population at large. Vinton's local utility system has for many years been a source of revenue for the town. Vinton and Vinton salt dome are in Calcasieu Parish, with an assessed value of taxable property of $307,172,760 in 1973, with real estate value 32 percent, personal property 51 percent, and public service corporations 17 percent. Taxes levied for schools are higher than those for roads, drainage, and general administration, and contribute more for education than most other parishes.

Calcasieu Parish has the authority to pass zoning restrictions affecting lands outside municipal boundaries. The Parish Police Jury issues permits for construction of buildings and crossing of roads and waterways.

3.3.4 Alternative Site - Big Hill

3.3.4.1 Land Features

The Big Hill salt dome is located in southeastern Jefferson County, Texas, 22 miles southwest of Port Arthur and 9 miles north of the Gulf of Mexico.

The roughly circular surface mound overlying the Big Hill dome is 35 feet above sea level on the north side and 31 feet on the south, with a shallow saddle between these two points. The surrounding coastal plain dips toward the Gulf at approximately 5 feet per mile. The average elevation of the plain around the mound is 10 feet above sea level. Less than a mile south of the dome is the northern boundary of the intermediate marsh which grades into brackish and saline marsh toward the coast.

Big Hill dome is a piercement dome with a nearly circular horizontal cross section, irregular top, and steep sides with an overhang on the southeast side. As with most piercement domes, the sediments flanking Big Hill dome have been dragged upward by the rising salt, creating characteristic fault patterns (see Figure 3.3-15 for a geologic cross section of the dome). Appendix B contains structural maps of the dome.

Approximately 1200 to 1300 feet of cap rock are present over the dome, apparently covering the entire salt mass. The outer edge of the cap is a very porous limey sandstone, with porous dolomitic limestone, gypsum, and anhydrite further down (Henley, 1928). The estimated thickness is two or three times that

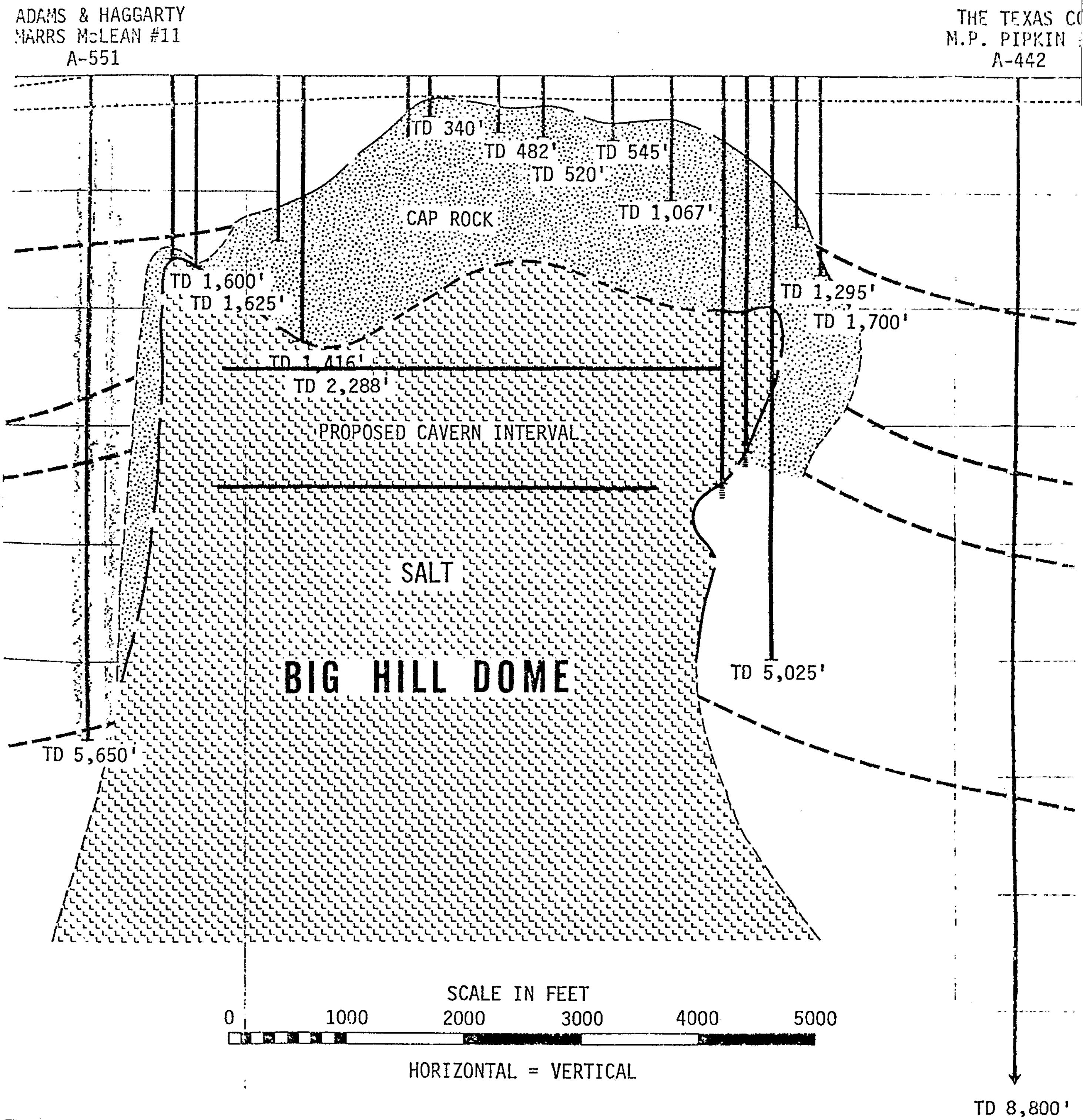

Figure 3.3-15 Geologic Cross Section of Big Hill Dome.

usually found over Gulf Coast domes and would probably increase the difficulties of drilling at Big Hill.

Drilling indicates that the top of the salt lies between 1600 and 1700 feet below sea level. Surface area enclosed within the 2000 foot depth to salt contour is 507 acres, and the area within the 3000 foot depth contour is about 613 acres. However, the salt overhangs that exist on the west, southwest, southeast, and east significantly decrease the area of the dome available for solution mined storage cavern construction.

There are three soil types overlying and surrounding Big Hill dome: Hockley, Crowley, and Morey. These soils are described in Section B.3.4.1.4, Appendix B, see Figure B.3-40, Appendix B, for a soil distribution map.

Since 1923, oil has been produced on all but the east rim of the Big Hill dome, with the greatest density of drilling on the dome's southeast flank. No known oil or gas production is located over the top of the dome in the area proposed for the storage facility. There are two solution mined LPG storage caverns on the north rim of the salt mass, with capacities of 326,000 and 314,000 barrels. No active salt mining is reported, and there is no evidence of sulfur production or exploration at Big Hill.

3.3.4.2 Water Environment

The Big Hill Salt Dome is located in the southeastern Texas coastal zone approximately 17 miles west of Sabine Lake, on the southwestern fringe of the Sabine-Neches River basin. The land in the immediate vicinity of the dome is dry, but extensive marshlands are encountered approximately one mile south of the site. Annual rainfall in the area averages approximately 47 inches, slightly less than amounts recorded for the Louisiana sites.

The general arrangement of the surface water system in the vicinity of Big Hill is shown in Figure 3.3-16. Surface drainage is generally to the south and east. A summary of locations, connections, and directions of flow is presented in Table B.3-17, Appendix B, for all water bodies in the area, and the following are discussed individually in Section B.3.4.2.1, Appendix B: Taylor Bayou and its tributaries; the Intracoastal Waterway and Spindletop Ditch; Spindletop Marsh and Salt Bayou Marsh; Salt Bayou, Star Lake, and Clam Lake; and the Gulf of Mexico.

Taylor Bayou is a tidal river which receives inflows from nine significant tributaries and empties into the Sabine-Neches Canal near its southern junction with the ICW. The segment of the ICW under consideration extends from the Sabine-Neches

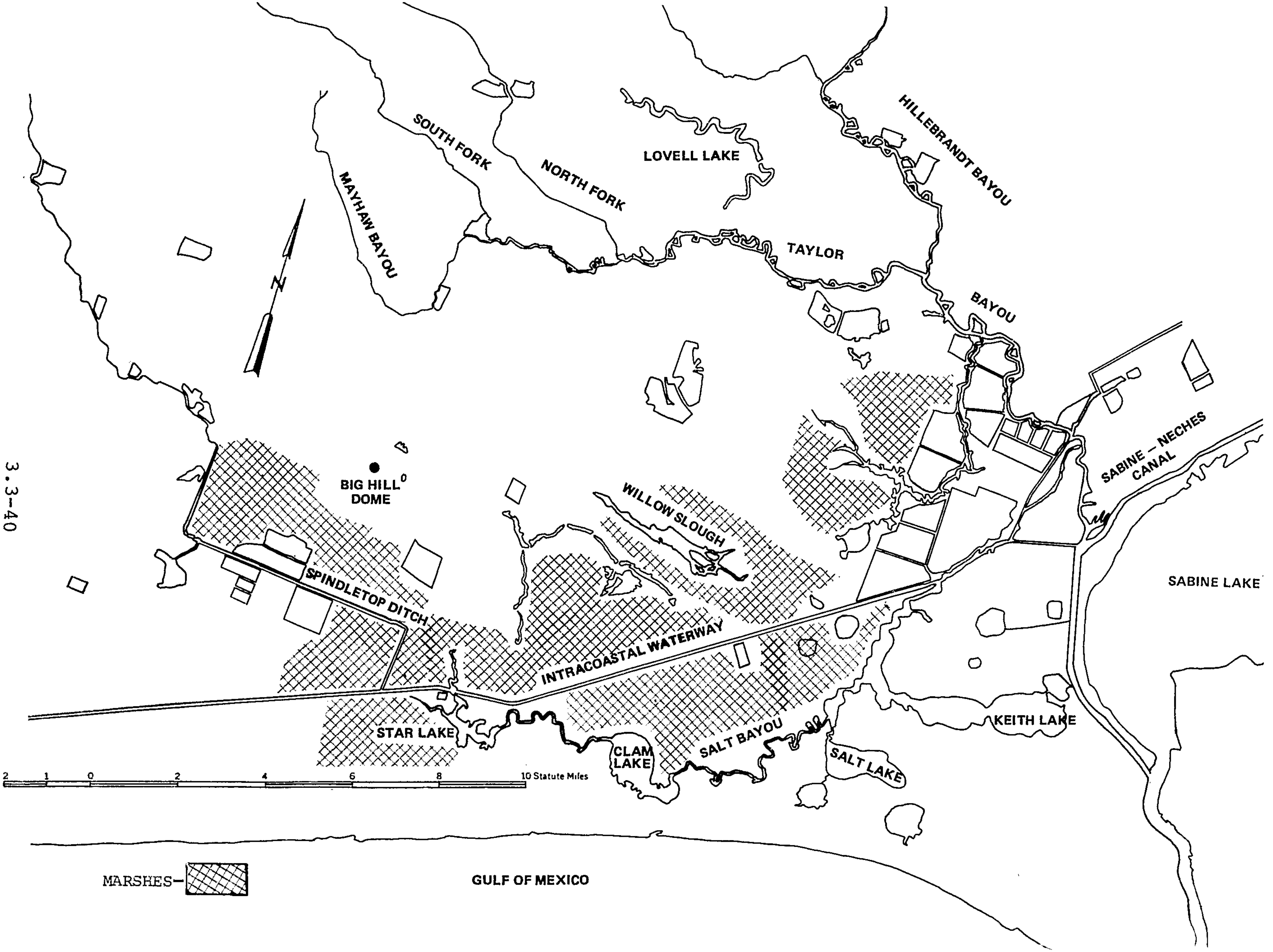

Figure 3.3-16 Big Hill Surface Water System

Canal southwestward along the Gulf Coast toward Galveston and is approximately 250 feet wide with a controlled depth of 12 feet.

The Gulf of Mexico, lies approximately 10 miles southeast of the dome. The proposed brine disposal location is 3.5 miles offshore in shallow water 30-35 feet deep. The bottom composition in this area is silty clay (Bureau of Land Management, 1975). As in the case of the Louisiana coastal waters, surface currents in the area are variable, being strongly affected by winds, tides, and other conditions. Mean surface currents 30 miles to the west of the disposal site tend to set to the west with a drift 50 miles to the southeast of the site. The surface current also sets to the west with a slightly greater drift. Winds 45 miles south of the disposal area tend to blow from the southeast at 11.6 knots.

The Big Hill dome penetrates an undetermined thickness of the Chicot aquifer, which normally is as deep as -1200 feet msl in the local area (Wesselman, 1971). Freshwater occurs in the Chicot aquifer to a depth of less than -100 feet msl immediately above the dome and to a depth of -200 feet msl less than 2 miles northwest of the dome. Saline water is probably introduced into the shallower sands of the Chicot aquifer by dissolution of salt from the dome or from vertical movement of deeper saline water around the flanks of the dome. See Table B.3-21, Appendix B, for hydraulic characteristics of the Upper Chicot aquifer near Big Hill.

3.3.4.3 Air Quality

Based on extrapolations from regional air quality data, the levels of non-methane hydrocarbons and photochemical oxidants are predicted to be high and are expected to continue to exceed standards during the next 10 years due to increased marine terminal operations. All other pollutants, with the possible exception of sulfur oxides, are expected to be in compliance with the applicable standards.

3.3.4.4 Background Ambient Sound Levels

Background noise levels in and around the alternate SPR site at Big Hill Salt Dome expansion are typical of those described for the SPR region in Section 3.2.4.

3.3.4.5 Species and Ecosystems

The proposed Big Hill storage facility and all of its associated pipeline and system components would be located within or offshore of Jefferson County, Texas. The ecosystems which occur within this area, and which would potentially be impacted by construction and operation of the facility, have been discussed in Section 3.2.5.2.4 and, in greater detail, in Section B.2.5.2.4 in Appendix B. The ecosystem distribution of the Big Hill project area is shown in Figure 3.3-17. Aquatic ecosystems for the project area are shown in Figure B.3-43 in Appendix B.

<u>Environmental Setting of the Displacment/Leaching Water System</u>

Raw water for leaching new caverns and for the displacement of stored oil will be supplied from the ICW, which is located 5 miles south of Big Hill dome. Two pipelines have been proposed which would connect the storage facility with the ICW. They would follow the two proposed rights-of-way for the brine disposal system through prairie, brackish marsh, and intermediate marsh. Both the primary raw water pipeline (Route #3) and the alternate route (Route #6) would originate in an intake station which would be built on an inlet dredged in the ICW. Route #3 would reach the ICW at an area of brackish marsh; the area surrounding the point at which alternate Route #6 would reach the ICW embankment is grassland.

<u>Environmental Setting of Brine Disposal System</u>

According to the primary facility design, the proposed pipeline, Route #2 (Fig. 3.3-17), for the brine disposal system at Big Hill would cross 9.2 miles of dry land and marsh and 4 miles of open water. The first 5.2 miles of pipeline would extend in a southeasterly direction from the dome until it intersects with the ICW, crossing 1.2 miles of prairie grasslands and 4 miles of brackish and intermediate marsh and the dredge disposal areas and spoil banks of the ICW. The pipeline would then proceed another 3.5 miles over brackish and saltwater marshes, crossing State Route 87 on its way to the coastal prairie and beach. On reaching the coast, the pipeline would extend 4 miles into the Gulf at an oblique angle from the shore. This would place the end of the diffuser approximately 3.5 miles off shore in approximately 30 feet of water. Three distinct open water environments would be crossed by the pipeline: upper shoreface, shoreface, and shelf. See Appendix Q for a detailed discussion of these Gulf coastal environments.

The alternate brine disposal pipeline route, Route #5, would be slightly longer than the primary route, 16.5 as opposed to 13.2 miles, but would traverse fewer miles of marshland (see Figure 3.3-17).

<u>Environmental Setting of the Site</u>

Big Hill dome is a moderately large dome which lies in an area of typical prairie grassland, used primarily for pastureland. The mound overlying the dome rises more than 25 feet

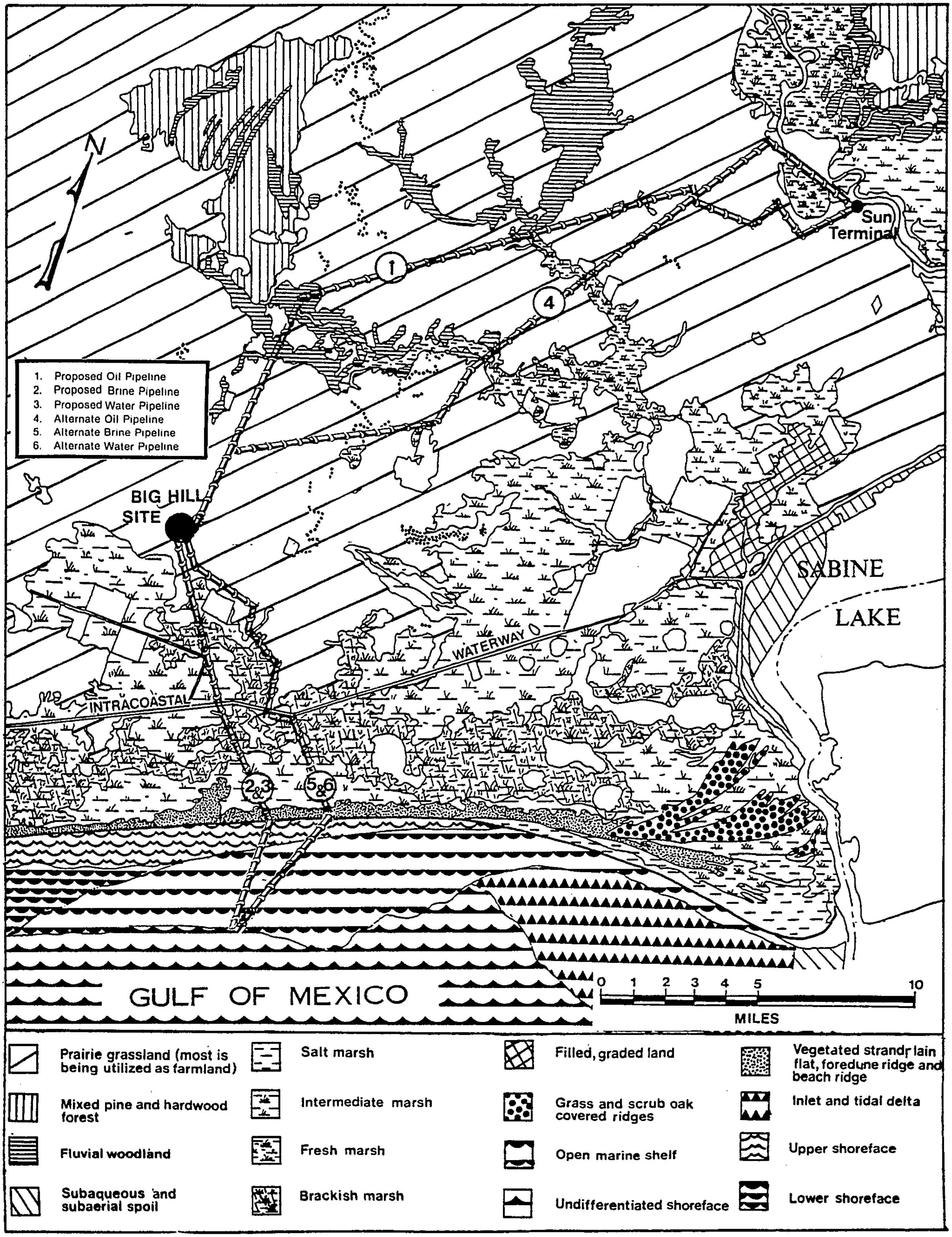

Figure 3.3-17 ECOSYSTEM DISTRIBUTION—BIG HILL PROJECT AREA

above the surrounding plain to a maximum elevation of 37 feet above sea level and is located about one mile north of a band of brackish and intermediate marshes which border the Gulf. The dome is covered by tall prairie grass species including bluestem, Indian grass, and Johnson grass. Since the dome is used for grazing, little secondary succession has occurred. A small stand of oaks, however, is situated on the northeast corner of the dome. Agricultural lands are found to the northeast and directly to the west of the dome. Roadways exist in the area and on the dome itself.

Environmental Setting of the Oil Distribution System

Crude oil would be transported between Big Hill and the Sun Terminal in Nederland, Texas, via one 36-inch pipeline. Two pipeline routes have been proposed (#1 and #2 in Figure 2.2-17). Both routes would travel in a northeast direction and would cross prairie grassland, agricultural, and pastureland ecosystems. The alternative route (#2) is more northern and inland; and crosses the higher and drier woodland ecosystems rather than marshlands.

3.3.4.6 Natural and Scenic Resources

Big Hill Salt Dome and its associated pipelines are within a relatively homogeneous land area. Most of the land is either under cultivation or is used as grazing land. As such, the scenic value of the area can be described as a rural coastal Texas agricultural setting.

3.3.4.7 Archaeological, Historical and Cultural Resources

There are no recorded archaeological sites with 0.5 mile of the Big Hill Salt Dome or the proposed oil and brine lines. There are also no sites listed or proposed for inclusion in the "National Register of Historic Places" in the Big Hill project area (National Park Service, 1977). A recently completed Cultural Resources Survey revealed no new sites along the pipeline routes.

3.3.4.8 Socioeconomic Characteristics

History and Cultural Patterns

In the early 1500's when Spanish and French explorers arrived on the Texas coast, the region was inhabited by several tribes of Indians. Permanent white settlements did not appear along the Sabine and Neches Rivers until after the Civil War. The railroad connecting the east Texas coast to the interior plains states arrived in the 1890's, marking the start of industrialization in the area. The discovery of oil in Jefferson County in 1901 added further impetus toward growth.

Marked contrasts appear within Jefferson County. The northern sections are highly developed, with urban centers concentrated along the Neches River and Sabine Lake, and suburban areas stretching south and west. The Gulf Coast section contains vast expanses of marsh wilderness that remain inaccessible by road. The people of these rural areas share a culture that is distinctively Texan in its progressiveness, individualism, and enthusiasm for wide open spaces.

Population

The Big Hill site is in a rural part of Jefferson County. The county census in 1970 recorded 244,773 people; the Sabine Pass subdivision, in which Big Hill is located, had a population of 1,486. Over 99 percent of the population of Jefferson County lives in the northern part of the county, away from the Gulf Coast. The proposed pipeline routes from Big Hill to Nederland would cross the LaBelle subdivision, an area of farms, villages, and small towns, and would also cross a sparcely-populated section of the Port Neches-Nederland subdivision. The fairly rapid population growth experienced by these three subdivisions between 1960 and 1970 is not expected to continue.

The only towns within a 10-mile radius of Big Hill are the unincorporated communities of Hamshire (population 350), Winnie (5,512), and Stowell (1,592). These communities are centers of social and commercial activity for the surrounding rural areas. Farmers of this region make their living primarily from growing rice and raising beef cattle.

Land Use Patterns

The Big Hill site is in an area used for grazing cattle and producing oil and natural gas. Land use patterns in this part of Jefferson County are not expected to change substantially in the future, due to limitations imposed by the marshy terrain and the lack of major roadways between Routes 73 and 87. There is sufficient land area available north of Route 73 to absorb urban expansion from the Beaumont-Port Arthur metropolitan centers.

Both pipeline routes to Nederland would cross a rice farming region; and Memorial Highway and Twin City Highways, which are the main traffic arteries between Beaumont and Port Arthur.

Transportation

Main highway arteries leading toward the site are Interstate 10 and Texas Highway 124 leading southeast out of Beaumont, and Highway 73 leading westward from Port Arthur. The interstate route has a daily average traffic volume of over 14,000 vehicles. Highway 124 bears a daily average of about 2,000 vehicles. The unpaved road, which provides access to Big Hill, also provides access to several rural dwellings along the roadway, and the traffic count near the junction with 73 recorded a volume of 175 vehicles daily (Texas Highway Department, 1973).

The salt dome lies about 6 miles north of the Intracoastal Waterway. Approximately 9,500 to 9,800 self-propelled vessels traveled in each direction through this section of the waterway in 1975 (Corps of Engineers). This compares with the passage of about 7,500 such vessels each way along the Neches River from Beaumont to the Sabine Lake, and 5,600 to 5,700 self-propelled vessels in and out of the Sabine Pass which connects Sabine Lake with the Gulf of Mexico.

Several landing strips for small planes are available in the area of Winnie, Texas, about eight miles west of Big Hill. Major airports, however, are twenty to thirty miles north, at Nederland and Beaumont.

Several roadroad companies provide freight service, The Atchison, Topeka, and Santa Fe Railway runs through Beaumont, which is also served by Kansas City Southern, Missouri Pacific, and Southern Pacific.

Many pipelines cross the area. A large number of them would be crossed by the proposed pipeline from the storage site to the Sun Terminal.

Housing and Public Services

The nearest communities offering significant numbers of available housing units are Port Arthur, 25 miles northeast of the site, and Beaumont, 30 miles from the site. Winnie, in Chambers County, is the nearest town of sufficient size to provide commercial services, while protective services would be under the jurisdiction of Jefferson County.

Main highways leading toward the site are Interstate 10 and Texas Highway 124 extending southeast from Beaumont, and Highway 73 extending west from Port Arthur. The unpaved road leading to Big Hill intersects with Highway 73 and provides access to several rural dwellings along the highway.

Economy

The economy of the area around Big Hill is based on agriculture and oil and gas production. The lands bordering the coastal marshes are used as pasture for grazing cattle.

The two alternate pipeline corridors leading to port facilities at Nederland cross extensive, highly mechanized rice farming areas. Rice ranks third in value among Texas crops, exceeded by cotton and sorghum.

Oil has been produced in Jefferson County since the discovery of the Spindletop reserve in 1901, with production totaling over 5.5 million barrels in 1974. Petroleum refining is the major industry in Beaumont and Port Arthur. Manufacturing, wholesale and retail sales, and large port facilities are concentrated in the urban areas in the northeastern part of the county.

Government

The major cities in Jefferson County have home rule. Beaumont received its home-rule charter in 1913. Port Arthur in 1915, and Nederland in 1955. All three cities are governed by a city council with a city manager. Construction must be authorized by building permit.

Each county in Texas establishes its own ratio of assessed valuation to actual value and its tax rate for assessment of property taxes. The Jefferson County ratio is 15 percent, and total assessed valuation in 1974 was over $35 million.

Each county in Texas is governed by a "commissioners court" which acts as an administrative body, not a judicial court. There are four commissioners in the court, each elected from one of four separate precincts within the county. The commissioners court is headed by a county judge elected by the county population at large.

The state has been divided into 24 regional councils which have the responsibility to establish plans for unified development, efficiency, and the promotion of the economy of their area. Jefferson County is served by the South East Texas Regional Planning Commission, along with Orange County. Chambers County, which lies about 8 miles west of the Big Hill site, is served by the Houston-Galveston Area Council.

4.0 ENVIRONMENTAL IMPACTS OF THE PROPOSED AND ALTERNATIVE ACTIONS

4.1 INTRODUCTION

This chapter contains an evaluation of the environmental impacts which would be associated with the construction and operation of the four candidate SPR salt dome sites. A brief discussion of impacts associated with alternative facility components is provided. Basically, conclusions regarding environmental impacts are presented here; detailed analyses and discussion of specific impacts are provided in Appendix C.

4.2 ENVIRONMENTAL RISKS RELATED TO TRANSPORT AND STORAGE OF OIL

Summary

The potential for accidents and natural disasters is discussed in this section with particular emphasis on the possible occurrence of spills of crude oil. This discussion pertains to West Hackberry, both ESR and expansion, and the three salt dome sites which are currently alternatives to West Hackberry expansion.

The probabilities of occurrence were generated from historical accident and natural disaster data. Care was taken to use probabilities generated for circumstances and environments similar to those existing for the SPR project.

A comparison of the estimated oil spill risk for the several operations of transporting and storage at the West Hackberry expansion and alternative sites, during their initial fill is presented in Table 4.2-1. For comparison, Table 4.2-2 summarizes the risk of oil spills for the West Hackberry ESR and interim fill programs. Risk is presented both as the <u>probability of a spill exceeding a given size</u> and as an expectation quantity.* There is no additional risk of oil

*The expectation quantity of oil spilled is an ensemble average, i.e. if a very large number of identical sites operating under identical procedures are assumed, then the expectation quantity is the total amount of oil spilled at all sites divided by the total number of sites.

Table 4.2-1 Summary Comparison of Risk of Oil Spills During Transport and Storage at the West Hackberry Expansion Site and Alternative Sites During the Initial Fill Period (38 Months)

OPERATION	WEST HACKBERRY EXPANSION 150 x 10^6 bbls SPILL RISK	AREA AFFECTED	BLACK BAYOU 150 x 10^6 bbls SPILL RISK	AREA AFFECTED
Marine Transport				
Number of Tankship Trips	375		375	
Spills During Lightering and Transshipment		Gulf Coast Beaches between Matagorda Bay and Calcasieu Pass		Same as for West Hackberry
>100 bbls	0.040		0.040	
>1,000 bbls	0.0062		0.0062	
>10,000 bbls	0.0007		0.0007	
Expectation Quantity of Oil Spilled, bbls	54		54	
Spills in Harbors and Docks		Banks & shore of Sabine Pass, Sabine-Neches Canal, Northern Part of Sabine Lake & the Neches River		Same as for West Hackberry
>100 bbls	0.058		0.058	
>1,000 bbls	0.019		0.019	
>10,000 bbls	0.0045		0.0045	
Expectation Quantity of Oil Spilled, bbls	257		257	
Pipeline Transport				
Spills at the Site		Dry land at West Hackberry		Marsh
>100 bbls	0.0043		0.0033	
>1,000 bbls	0.0021		0.0016	
>10,000 bbls	0.0023		0.00022	
Expectation Quantity of Oil Spilled, bbls	11		10	
Spills Between Marine Terminal & Site				Marsh in the Sabine National Wildlife Refuge
>100 bbls	a		0.0038	
>1,000 bbls			0.0022	
>10,000 bbls			0.00041	

Table 4.2-1 Continued

OPERATION	WEST HACKBERRY EXPANSION 150×10^6 bbls SPILL RISK	AREA AFFECTED	BLACK BAYOU 150×10^6 bbls SPILL RISK	AREA AFFECTED
Expectation Quantity of Oil Spilled, bbls			16	
Storage				
Number of Caverns	15		17	
Expectation Quantity of Oil Spilled, bbls	5		5	
Spills <100 bbls from Caverns	0.00005 .0005	Dry land at West Hackberry	0.00005	Marsh

OPERATION	VINTON 50×10^6 bbls SPILL RISK	AREA AFFECTED	BIG HILL 100×10^6 bbls SPILL RISK	AREA AFFECTED
Marine Transport				
Number of Tankship Trips	125		250	
Spills During Lightering and Transshipment		Same as for West Hackberry		Same as for West Hackberry
>100 bbls	0.013		0.027	
>1,000 bbls	0.0021		0.0042	
>10,000 bbls	0.0002		0.0065	
Expectation Quantity of Oil Spilled, bbls	18		36	
Spills in Harbors and Docks		Same as for West Hackberry		Same as for West Hackberry
>100 bbls	0.019		0.039	
>1,000 bbls	0.0062		0.012	
>10,000 bbls	0.0015		0.0030	
Expectation Quantity of Oil Spilled, bbls	86		172	
Pipeline Transport				
Spills at the Site		Dry land, Ged Lake		Pasture
>100 bbls	0.0025		0.0046	
>1,000 bbls	0.0011		0.0021	
>10,000 bbls	0.00010		0.00022	

Tabe 4.2-1 Continued

OPERATION	WEST HACKBERRY EXPANSION 150 x 10^6 bbls SPILL RISK	AREA AFFECTED	BLACK BAYOU 150 x 10^6 bbls SPILL RISK	AREA AFFECTED
Expectation Quantity of Oil Spilled, bbls	6		11	
Spills Between Marine Terminal & Site		Marsh & prairie north of the Intracoastal Waterway		Mostly prairie & pasture, but some marsh & woodland
>100 bbls	0.011		0.038	
>1,000 bbls	0.0060		0.022	
>10,000 bbls	0.0011		0.0040	
Expectation Quantity of Oil Spilled, bbls	44		159	
Storage				
Number of Caverns		5		12
Expectation Quantity of Oil Spilled, bbls				
Spills <100 bbls from Caverns	0.00002	Dry land, Ged Lake	0.00004	Pasture

[a]There is no increased risk from pipeline oil spills for West Hackberry expansion. This pipeline is part of the West Hackberry ESR system.

Operation	Initial Fill (By Barge) Spill Risk	Initial Fill (By Barge) Area Affected	ESR Facility Risk Spill	ESR Facility Area Affected
Marine Transport				
Number of Vessel Trips	288		150	
Spills During Lightering and Trans-Shipment				Gulf Coast beaches between Matagorda Bay and Calcasieu Pass
>100 bbls	N/A		0.016	
>1,000 bbls	N/A		0.0025	
>10,000 bbls	N/A		0.0003	
Expectation quantity of oil spilled, bbls			22	
Spills in Harbors and Docks		Banks and marsh areas along the Alkali Ditch and the ICW to the Calcasieu Ship Channel		Banks and shore of Sabine Pass, Sabine Neches Canal, northern part of of Sabine Lake and the Neches River
>100 bbls	0.045		0.023	
>1,000 bbls	0.012		0.0076	
>10,000 bbls	0.0014		0.0019	
Expectation quantity of oil spilled, bbls.	68		103	
Pipeline Transport				
Spills at the Site				
>100 bbls	N/E		0.012	
>1,000 bbls	N/E		0.0055	
>10,000 bbls	N/E		0.00066	
Expectation quantity of oil spilled, bbls.			31	
Spills Between Marine Terminal and Site				The ICW in Western La., marsh areas in the Sabine Wildlife Refuge, and Woodlands and prairie between the Sabine and Neches Rivers
>100 bbls	N/A		0.11	
>1,000 bbls	N/A		0.064	
>10,000 bbls	N/A		0.012	
			490	
Storage				
Number of Caverns			5	
Spills >100 bbls from Caverns			0.00002	Dry land at West Hackberry

N/A - Not Applicable
N/E - Not Evaluated

spills from the twin 36-inch pipeline between the Sun Terminal and West Hackberry for the expansion storage caverns at West Hackberry. For Black Bayou and Vinton, only the incremental risk associated with short lengths of pipelines connecting to the twin 36-inch line is given. The reason for assessing the risk in this way is that the twin 36-inch pipeline also serves the West Hackberry ESR storage caverns, and is therefore full of oil and can experience accidental spills whether or not the West Hackberry expansion, Black Bayou or Vinton Dome sites are used.

In general, the risk of spills is small, amounting to no more than a few percent. For spills greater than 1,000 barrels, the risk of spills is generally less than one percent, except during tankship transport in the Sabine-Neches Channels, and at the dock at Sun Terminal.

Details of the development of the risk of spills of oil and brine are presented in the following subsections. Since the pipelines would contain oil at all times, and not just during filling or distribution, the risk of oil spills from these lines during the projected 25-year lifetime of the SPR project are discussed below.

4.2.1 Oil Spill Risks

4.2.1.1 Oil Spills from Salt Dome Caverns

A failure mode and effects analysis determined that the most significant loss mechanisms involve various failures of the wellhead and associated piping. The most frequent of these is the development of a leaky gasket on the isolation valves or the wellhead connections. Such leaks, as based on industrial experience, would occur rather frequently, 0.05 per year per wellhead, but would be small, much less than 100 bbls, and easily contained by a proposed dike system. These leaks, if too small to be detected by abnormal behavior of pressure at the wellhead, would be detected during routine daily checks of the wellhead.

Much larger spills, but with a very much smaller probability, could occur from more substantial damage to the wellhead such as "shearing off" or fracture of the wellhead as the result of some accident. This, together with such failures as corrosion or rupture because of a defective weld or pipe seam, were estimated to occur at a frequency of 1×10^{-6} per wellhead per year. This estimate is believed to be conservative since it is based on the reported failure frequency for ordinary line pipe for transporting liquid petroleum products (see Section 4.2.1.3). Wellhead components are made of much thicker steel. Large volumes of oil could also be spilled in the event of an accident or equipment failure in workover operations during the fill phase.

Such failures can result in substantial losses of oil because of a subsequent relief of pressure and elastic expansion of the stored oil, brine in the sump, and the salt. These expansions combine to squeeze oil out of the cavern. Assuming that the brine-oil interface would be at a depth of 3000 feet below the surface of the ground in a typical cavern, the planned storage mode is to maintain the oil under a pressure of 450 psig, which is equivalent to the differential pressure between 3000-foot heads of oil and brine plus 50 psi. If the wellhead is sheared off or the oil-side piping fractured, the entire 450 psi pressure on the oil is relieved since the heavier column of brine sinks to a level such that the oil head and brine head are equal at the oil-brine interface in the cavern. Because the cavern is so large ($1\text{x}10^{7}$ bbls), the resulting elastic expansions are also large (but less than 1 percent of the cavern volume): 22,500 bbls, based on a compressibility of $\Delta V/V = 5\text{x}10^{-6}$ per psi, for the oil; 15,200 bbls, based on a compressibility of $\Delta V/V = 3.4\text{x}10^{-6}$ for the salt and 2,250 bbls for the brine in the sump (assumed to 10 percent of the oil). The total oil displaced would be 40,000 bbls, and this oil would escape from the cavern very rapidly. As mentioned above this would be a very rare occurrence.

The higher working pressures required during the oil fill phase would result in larger quantities of spilled oil during cavern depressurization in the event of serious wellhead damage or equipment failure during workover operations.

A sudden loss in pressure caused by the fracture or shearing off the wellhead, could lead to rapid expansion followed by severe slabbing (falling away of large masses of salt) from the roof of the cavern and the triggering of a general collapse. Because the top of the caverns would be located 500 to 1000 feet below the top of the salt, this occurrence is believed to be unlikely. This, combined with the already low probability of fracturing or shearing of the wellhead, makes cavern collapse by this mechanism extremely remote, $1\text{x}10^{-6}$ per wellhead per year.

4.2.1.2 Risk of Oil Spills During Marine Transportation

This section presents estimates of both the probability and the size of oil spills arising from accidents during marine operations and transport. Marine operations considered include: (1) for the ESR initial fill only, the voyage of the barge tow along the Calcasieu Ship Channel and associated waterways from the Gulf to the terminal (Amoco Dock) at West Hackberry, and loading and offloading operations at that terminal, (2) for the permanent dock at Sun Terminal. The voyage of a 45,000 DWT tankship through the Sabine Pass, the Sabine-Neches Canal and the Neches River to the terminal, and loadings and offloadings at that terminal, and (3) lightering from VLCCs onto the 45,000 DWT tankship and its voyage to the entrance to the Sabine Pass.

The estimates are based on statistical analyses. The number of vessel casualties, which would result in the spill of oil, were derived primarily from the Coast Guard's listing of Commercial Vessel Casualties for fiscal years 1969 through 1974. The count of the ship transits in the Calcasieu and Sabine Channels was obtained from Waterborne Commerce of the United States and Engineer's Annual, both publications of the U. S. Army Corps of Engineers. Combined, these data yielded the expected frequency of spills per transit of a tankship or tankbarge from the Gulf to the terminal. This procedure was followed for all vessel casualties except tankship collisions in the Sabine channels for which the frequency was estimated via a model. This model allows the use of a much broader data base and accounts for the length of the channel, traffic density, and the speed and dimensions of the ships. The frequency of spills for loading and offloading oil at the terminal was obtained from incidents reported by the Coast Guard's Pollution Incident Reporting System and Corps of Engineer traffic data, both for the U. S. Gulf Coast region. Because of the high degree of similarity between lightering and offloading at terminals, the spill frequency for the former was assumed to be the same as for the latter. The distribution of the quantity of oil spilled, with the number of spills, was developed from Coast Guard Commercial Vessel Casualty data for losses from tank barges in Western Rivers* and the inland Gulf Region. The quantities spilled are distributed log normally versus number fraction of spills. This relationship was modified for application to tankship casualties. The distribution of quantity of oil spilled during loading and offloading at marine terminals was developed from the Pollution Incident Reporting System data.

*Primarily the Mississippi River System.

The above methodology is based on the assumptions that the planned crude oil transport operation is essentially the same as that for which the accident experience has accrued. This assumption seems justifiable since the facilities, tankships and barges to be used would be nearly the same as those now used in the area.

The estimates of risk of accidential oil spills is summarized in Table 4.2-2 and 4.2-1 for the West Hackberry ESR program and the alternative expansion programs, respectively. The estimates assume the transport of crude oil to fill the salt dome caverns in a nominal 45,000 DWT tankship containing 400,000 bbls to or from the Sun Terminal. Only 60 percent of the stored oil would be distributed by tankship, the remainder would be distributed by pipeline. Larger tankships, up to 100,000 DWT, might be used but would be light loaded so that their draft would not exceed 40 feet. In this case it is assumed that they would contain approximately 400,000 bbls, also. The tank barges used in the Calcasieu Channel during the initial fill of the ESR program are assumed to be nominal 3,000 DWT containing 21,000 bbls.

The expectation quantity of crude oil spilled per trip from vessel accidents, such as collisions, groundings, rammings (striking fixed objects, submerged or on or above the water surface), structural failure, fires and explosions, etc., is 0.15 barrels per trip for the barges, and 0.60 barrels per trip for the tankship in the Sabine Channel and 0.058 barrels per trip in the Gulf between the lightering point and Sabine Pass. (Expectation quantity is in effect the average amount spilled per trip - the total amount spilled for a very large number of trips divided by the number of trips. However, the amount spilled in any one accident will be very much larger than the expectation value as indicated by the size of the median spill.) The median spill from barge casualties is 1,100 bbls, and the median spill from tankship casualties is 3,100 bbls. Accidents at the marine terminal, such as overfilling a tank, opening the wrong valve, etc., have an expectation quantity of 0.086 barrels spilled per trip for either barges or tankships. The median spill during transfer at the dock is 0.5 bbls. The total expected quantity of oil spilled during the transport of the oil to fill or to be distributed from the various salt dome caverns are listed in Tables 4.2-1 and 4.2-2. These tables also list the probability of a spill exceeding certain amounts during the movement of the stated amount of oil.

Oil spilled onto water produces a very extensive slick. The following relationship between spill quantity, and ultimate slick area or radius, assumes unhindered (no wind, currents, or surface obstacles) spreading and a circular-shaped slick:

$$A = \pi r^2 = 2.52 \times 10^4 \ (V)^{3/4}*$$

Where A is square meters, r is the radius of the slick in meters, and V the volume spilled in barrels.

These dimensions are achieved 24 to 48 hours after the spill. For median spill quantities listed above, the ultimate slick dimensions were computed:

	Quantity Spilled (Barrels)		
	0.5	1,100	3,100
Slick Area (m^2)	0.015×10^6	4.8×10^6	10.5×10^6
Slick Radius (m)	123	1,237	1,826

The ultimate slick areas calculated above correspond to an average coverage of oil ranging from 0.1 bbl/acre for the 0.5-barrel spill to approximately 1 bbl/acre for the largest spill. These coverages are somewhat lower than those estimated to cause environmental damage, as discussed in Sections 4.3.2, 4.4.2, 4.5.2 and 4.6.2. Hence, the ultimate slick diameter in open water may be 5 to 50 times the area in which actual environmental damage may occur.

With respect to the temporary barge-fill system, spills at the Amoco Terminal are expected to remain at the site, and in the absence of booms or other containment measures, they would spread into the surrounding marsh areas rather evenly. There are no known major water currents in the area and the vegetation above the water surface in the marshes would greatly limit the effect of wind on the movement of the slicks. Spills in the Alkali ditch and the Intracoastal Waterway would be expected to behave similarly during periods of light winds (occurring 19 percent of the time). However,

*The derivation of this relationship is described in J. Premack, G. A. Brown, "Predictions of Oil Slick Motions in Narragansett Bay," Proceedings of Joint Conference on Prevention and Control of Oil Spills, Washington, D. C.

during periods of higher winds, the slick would be blown along these waterways at about 2 to 3 percent of the wind velocity (Premack and Brown, 1973). An oil slick in the Intracoastal Waterway would move in a westerly direction about 25 percent of the time. However, the edges of the slick which have penetrated into the bordering marshes would tend to remain in place, unaffected by the wind.

Spills from a tankship in the Sabine Pass or jetty channel would tend to be confined by the jetties, land or spoil banks. However, the tidal currents (1 to 2 knots typical in Sabine Pass) would carry a slick out to sea or into Sabine Lake if not confined in time by booms. Contamination of marsh and shore along Sabine Pass would be expected from any spills.

Similarly, spills from accidents in the Port Arthur Canal and the Sabine-Neches Canal also would be confined by adjacent land and spoil banks, which would become contaminated. In these canals there is a negligible current and the spread of the slick in either direction could be readily prevented by booms. However, spills in the upper part of the Sabine-Neches Canal near the mouth of the Sabine River might spread into Sabine Lake and contaminate adjacent shore and marsh lands. Because of the predominance of easterly and southerly winds in the area, oil slicks entering the lake would probably contaminate only the lake's western shore and not the marsh of the Sabine National Wildlife Refuge bordering the eastern shore.

Spills from accidents in the Neches River and at the Sun Terminal probably would contaminate the marshy banks of the river. The current in the river is weak except during periods of high water after heavy rains and hence oil slicks are expected to be carried downstream into Sabine Lake only during these periods.

Spills during lightering and trans-shipment across the Gulf to the entrance to Sabine Pass could affect any of the shore both east and west of Sabine Pass.

Analysis of the ocean currents and winds in the area indicate that oil spilled during lightering could drift ashore somewhere between the Calcasieu Pass and the Matagorda Bay areas approximately 60 percent of the time in summer and 40 percent of the time in winter. In either season, a slick when reaching these areas would be well weathered, having been at sea for at least 3 days.

4.2.1.3 Oil Spills from Pipelines

Estimates of the frequency and the amount of oil spilled because of possible pipeline accidents are based in part on statistics collected by the Office of Pipeline Safety (OPS), Department of Transportation (Ulrich, 1977). By law, U. S. pipeline operators must report spills to the OPS if they exceed 50 barrels, or if there is an injury or death associated with the accident. The population of pipelines to which the spill statistics apply were obtained from the Bureau of Mines, Department of Interior. As of January 1, 1974, there were 222,355 miles of pipeline in the U. S. Of this total, 190,331 miles were 12 inches in diameter or less. Only 32,024 miles of pipeline were larger than 12 inches, and only 2,272 miles were 36 inches in diameter or larger.

Information on spills from pipelines is reported to OPS on DOT Form 7000-1, and includes the owner of the pipeline, the spill location, the cause of the spill, the installation date of the pipeline, the diameter, the product carried, and the amount of oil spilled (usually a best estimate). The major cause of spills from older pipelines, those installed before 1950, is external corrosion. Since the 1940's, much improved techniques have come into usage to prevent corrosion. Thus, the major cause of spills in newer pipelines is accidental breakage by excavation or construction equipment. Most larger pipe, that greater than 12 inches in diameter has been installed since 1950, and for it, too, the major cause of spills is damage by excavation equipment.

The spillage data were broken down into two categories according to size. There are insufficient data, statistically, for a breakdown for each individual size of pipeline. In general, pipe 12 inches or less in diameter is used for individual lines to a salt dome cavity. Larger pipe is used for trunklines and manifolds.

The spill frequency from pipelines less than 12 inches in diameter, 1.32×10^{-3} spills/mile-year*, was estimated by dividing the total number of spills by the mileage existing at the beginning of 1974, and normalizing to one year. For pipelines greater than 12 inches in diameter, a similar treatment gave 5.31×10^{-4} spills/mile-year.

The data from OPS also were used to estimate the spill size frequency distribution. For the larger diameter pipelines,

*Spills/mile-year - The frequency of spills are determined on a per mile basis per year.

these data show the median spill size to be approximately 850 barrels. For pipelines less than 12 inches in diameter, the median spill size is 360 barrels. Spill frequency together with the spill size distribution were combined to yield the spill risk estimates for pipelines shown in Tables 4.2-1 and 4.2-2.

The areas affected by spills from pipelines vary from open water to dry land. For the West Hackberry expansion site, the crude oil lines would be located in (buried), or on dry land. The modest amount of oil expected to be spilled accidently would be confined to an area near the spill. Because of the high water table in the area, leaks of oil from the buried portions of the pipelines would not be expected to move very far in a downward direction. During rainy periods, oil migrating to the surface would behave as runoff material. The crude oil trunkline between the site and the Sun Terminal crosses through marsh (27 percent of its length), and passes along a spoil bank (39 percent). In marshes, the oil would tend to rise to the water surface and spread out. However, the spreading is much more limited compared to that on open water because of absorption and retention by grass and organic debris. Water, soil, and vegetation would be contaminated. Cleanup and removal would be difficult and even undesirable since such an effort in itself may cause substantial environmental damage in such areas. Oil from pipeline leaks in the spoil bank would migrate either into the parallel Intracoastal Waterway or into the marsh on the other side. Oil escaping onto the ICW would be confined by the banks, and would be relatively easy to cleanup. Most of the remainder of the pipeline route is through woodlands (13 percent), or prairie (17 percent). In these areas, the oil would tend to be absorbed in the surface layers of soil. However, if these are saturated with water, the oil would behave as runoff material.

For the Black Bayou alternative, spills at the site would be into marsh where, as noted above, the oil is difficult or undesirable to clean up, but the oil does not spread as far as an open water. The oil distribution line which connects with Sun Terminal-West Hackberry line is 30 percent under marsh and 70 percent under water. Most of the latter is the Black Bayou Cutoff Channel and leaks would rise, spread out on the water surface, and accumulate in the marshy borders of the Bayou.

The crude oil pipelines at the Vinton dome site would be buried on dry land, and on above water pilings in Ged Lake. Because of the high water table, oil escaping from leaking or damaged pipe would tend to saturate the top most soil layers and run off onto Ged Lake. Leaks from the trunkline, connecting to the West Hackberry Sun Terminal pipeline, could affect either prairie or marsh; 26 percent of the pipeline route would be through marsh and 74 percent would cross prairie.

At the Big Hill alternative site, all wells and crude oil pipelines are on solid ground, primarily pasture for grazing cattle. The pipelines would be buried and any leaks would tend to saturate the surface soils above the pipelines. Oil reaching the surface would behave as runoff material. The trunkline connecting Big Hill and Sun Terminal would cross prairie land (82 percent of the route), marsh (11 percent of the route), woodland (5.6 percent of the route), and would parallel an existing roadway for 1.4 percent of the route. The behavior of leaks of oil in these types of terrain has been discussed above.

4.2.2 Risk of Brine Spills

The primary source of accidental brine spills are accidents to the various pipelines that collect the brine at the sites and the trunklines that transport the brine to the disposal area (injection wells or the sea). Accidents to brine pipelines are treated in the same manner as was done for crude oil pipelines. Additionally, it was assumed that the accident data (frequency and spill size) derived from oil pipeline experience also is valid for brine pipelines. This last assumption seems reasonable since the lines would be made of the same materials and laid in the same manner as for the crude oil pipelines.

It was assumed that the pipelines would contain brine only during leaching and oil refilling operations. At all other times that brine would be emptied from the pipelines and the lines flushed with water. For all sites the initial leaching period is estimated to be 38 months except the West Hackberry SPR expansion site, for which the initial leaching period is planned to be 26 months. The refill period for all sites is 30 months, except for the combined ESR and Expansion wells at West Hackberry, for which the refill period would be 40 months. A total of four refills were assumed during the 25 year lifetime.

These data were applied to develop the estimates of brine spill risk presented in Table 4.2-3. Both the probability of spills exceeding a stated quantity and the expectation quantity of brine spilled during the operational lifetime of the brine lines are listed. The results, of course, are similar to those for the crude oil pipelines; the longer the pipeline and/or the greater the number of operational years, the greater the probability of a spill. However, in no case does the probability of a spill greater than 100 barrels exceed 20 percent.

The highest spill probabilities are associated with brine lines that terminate offshore in the Gulf (West Hackberry, Black Bayou and Big Hill). These lines extend approximately 4 to 7 miles offshore and hence approximately 25 percent of the predicted spills for these lines would occur in the Gulf. Most of the remainder of the spills from these lines would occur in marshland or prairie. Spills from the brine lines on sites would affect prairie land except for the Black Bayou site which is in a marsh. Brine is readily miscible with water, and accordingly, any spills are expected to disperse readily into the soils and waters of the area. At present no effective means are available to clean up spills of brine, but some soils may be treated with gypsum or other soil chemical additions to ameliorate the effects of the brine.

4.2.3 Related Risks

The risk of fire and explosions to people and private property offsite is expected to be negligibly small. The reason for this is the relatively low vapor pressure of the crude oil to be stored. Although flammable plumes may be generated from leaks and spills of the crude oil, calculation show that these can extend no more than 1000 to 1500 feet in the downwind direction even under the most adverse meteorological circumstances. Hence fires from such spills are primarily a hazard to onsite personnel and to the crews of vessels transporting the oil. In the event of an explosion and fire resulting from a large oil spill, large quantities of black smoke would be produced which could create serious air pollution episodes during stagnant conditions.

The crude oil itself does not explode; only mixtures of its vapor with air or oxygen. Thus explosive mixtures may exist within the ullage* spaces of fixed roof storage tanks and vessel cargo tanks. However, ignition of these mixtures is

*The amount that a container lacks of being full.

Table 4.2-3 Risk of Brine Spills From Pipelines During Operational Lifetime

Quantity Spilled	West Hackberry ESR	Proposed West Hackberry Expansion[a]	Alternate West Hackberry Expansion[b]	Black Bayou Alternative	Vinton Dome Alternative	Big Hill Alternative	
BRINE TRUNKLINE							
Length, miles	2.5[c]	24.8[a]	28.4[b]	27.0[d]	2.75[c]	13.2[d]	16.5[e]
Probability of Spill							
> 100 bbls	0.018	0.19[a]	0.18[b]	0.15	0.016	0.075[d]	0.093[e]
> 1,000 bbls	0.0095	0.11[a]	0.010[b]	0.083	0.0089	0.043[d]	0.053[e]
>10,000 bbls	0.0019	0.020[a]	0.020[b]	0.017	0.0017	0.0084[d]	0.010[e]
Expectation Quantity of Brine Spilled bbls.	72	192[a]	180[b]	664	68	325[d]	406[e]
BRINE, SITE PIPELINES							
Total Length, miles	2.5	2.0		1.7	2.7	2.0	
Probability of Spill							
> 100 bbls	0.027	0.023		0.014	0.023	0.019	
> 1,000 bbls	0.013	0.011		0.0067	0.011	0.0089	
>10,000 bbls	0.0016	0.0012		0.00091	0.0014	0.00093	
Expectation Quantity of Brine Spilled, bbls.	74	59		40	64	47	

a. The Calcasieu route for disposal into the Gulf.
b. The Highway 27 route for disposal into the Gulf.
c. Lines to injection wells.
d. Proposed Route
e. Alternate Route

rare, provided the tank vents are equipped with flame arrestors and precautions are taken to reduce the presence of nearby ignition sources (e.g., no smoking near facilities handling crude oil).

Historically, accidental deaths of non-employees from fires and explosions at bulk petroleum products terminals in the U. S. are rare, 6×10^{-5} deaths per year per terminal. More than 90 percent of these deaths resulted from accidents with more volatile products than crude oil, such as gasoline and fuel oil. Moreover, many of the terminals experiencing accidents were located in metropolitan areas. Because Sun Terminal and the storage sites would be in sparsely settled areas, fire and explosion caused accidental deaths of non-employees are expected to be even fewer than the nationwide figure.

The most significant risk of injury and death would occur in the case of onsite employees during the construction and fill phase, particularly in the case of drilling rig crew members. While the morbidity and mortality-causing accident record of the petroleum industry as a whole is substantially better than that for industry overall, it is generally recognized that drilling and oil well workover is a relatively high risk occupational category.

Oil spills caused by natural events such as earthquakes, hurricanes and tornados are not expected. The area in which Sun Terminal and the alternative storage sites are located have been classified by the National Oceanographic and Atmospheric Administration as having zero seismic risk. Both hurricanes and tornados lack sufficiently intense winds to damage the aboveground piping of a storage facility. A direct hit of a storage tank by a tornado could damage its roof and cause the loss of some oil. However, such an event would be very rare. Storage tanks if left full, would be resistant to damage and would survive flooding and the strong winds associated with the worst hurricanes.

4.2.4 Accident Risk Reduction

As discussed in the above sections, the risk of oil spills and attendant fire hazards are an ever-present factor in petroleum handling operations. There are practices which can be employed during the development and operation of the Strategic Petroleum Reserve sites which would reduce the risk of spills and fires. Generally, such risk reduction equipment and techniques are employed as standard practice throughout the petroleum industry. During construction at the storage caverns the risk of blowouts can be greatly reduced in some operations through the use of blowout preventers on drilling rigs. During well-workover operations, depressuring the system with strict control of potential ignition sources could substantially reduce the risk of accidents. Radiographic inspection of all pipeline welds, cathodic protection of buried pipelines and proper identification of pipeline location can greatly reduce the chances of pipeline spills.

Redundant high and low pressure detection mechanisms as well as pump vibration and high temperature detection devices integrated into the oil delivery system can greatly reduce the probability of spills resulting from equipment failure. Downhole safety valves can also be employed for certain well designs in order to reduce the volume of oil spilled in the event of major damage to the wellhead during the static storage phase of the program.

The use of specific equipment, instrumentation and operational procedures is a function of the detailed system design. As this detailed design is developed, appropriate oil spill risk reduction measures will be incorprated into the system consistent with the goals and operational philosophy of the SPR. Human error is by far the most common cause of oil spills. Proper training and close supervision of both terminal and site operations personnel is the most effective means of reducing the risk of spills caused by human error.

4.3 PROPOSED SITE - WEST HACKBERRY EXPANSION AND POTENTIAL MODIFICATION OF THE WATER INTAKE FOR THE SULPHUR MINES FACILITY

The proposed expansion of the ESR facilities at the West Hackberry dome would provide 150 million barrels of additional storage capacity. The new storage wells would be located on a 160-acre tract of dry land adjacent to the ESR development. The ESR oil distribution pipeline to the Sun Terminal at Nederland, Texas, would be available for use by the SPR expansion facility, whether located at West Hackberry, Black Bayou, or Vinton. Impacts to Sun Terminal due to the SPR program are summarized in Section 4.7. Other ESR facilities which would be used for expansion at West Hackberry are the central plant and the raw water supply system. Brine disposal for the expansion facility would be by a new 24.8 mile pipeline into the Gulf of Mexico. In order to place in perspective the additional impacts which would occur as a result of the SPR expansion, the ESR impacts of presently ongoing activities are summarized in appropriate locations in this section. In this way, the total impacts which would accrue from development of West Hackberry are discussed. However, nothing described herein should be construed as affecting the decision which has been made to develop the site as an ESR storage facility.

The proposed ICW water supply system at West Hackberry is a potential alternative to provide water to the Sulphur Mines oil storage site. The plans for use of the Sulphur Mines site and impacts related to construction and operation of those facilities, including the oil distribution pipeline and brine disposal wells, have been discussed in the Sulphur Mines Final Environmental Impact Statement (DOE/EIS-0010) published in March 1978. Modification of the water intake supply system for Sulphur Mines would require no additional land for rights-of-way. Should the ICW site be selected for Sulphur Mines, the water supply pipeline would be laid in the right-of-way planned to accommodate the oil distribution pipeline spur leading from the Sulphur Mines site to the Intracoastal Waterway. The water line would then use the West Hackberry oil pipeline right-of-way along the south bank of the Intracoastal Waterway for a distance of approximately 3 miles to the point where the water intake structure is to be built. Portions of the following discussion related to Sulphur Mines will address impacts resulting from the construction and operation of this water supply pipeline and use of water from the Intracoastal Waterway.

4.3.1 Land Features

4.3.1.1 Construction Impacts

No major impacts on either landforms (at the site) or drainage patterns on site would occur from the construction of 15 new dry-land wells or from road construction for the expansion of the SPR facility at West Hackberry. Since the ESR oil distribution pipeline from West Hackberry to Sun Terminal was constructed as part of the ESR development, no new impacts to land forms or drainage patterns would result from the manifolding of the expansion facility into the pipeline.

Minor impacts to soils are confined to construction sites and service roads, and would include erosion, compaction, and destruction of surface soil structure. The addition of gravel or shell to road surfaces would also slightly alter soil composition along roadways.

Construction of the brine pipeline in marsh, at the site, and east of the site, would not disrupt the internal structure of the soil or seriously affect soil drainage. Well drained Palm Beach soils along the alternate brine disposal pipeline route could experience localized decreases in internal drainage characteristics.

There would be no impacts to stratigraphy or geologic structure during construction at the West Hackberry storage site, along the brine pipeline routes or at the terminal and dock facilities. There would also be no construction impacts on salt or sulfur mining within the area of proposed expansion.

4.3.1.2 Operations Impacts

No impact on soil characteristics, geologic structure or oil production on the flanks of the dome or along the pipeline routes would occur during normal operation and maintenance activities. Future salt production, however, in the area of the new storage caverns would be incompatible with the SPR program. Sulfur (if any exists in the cap rock above the expansion site) also could not be mined.

4.3.2 Water Supply and Water Quality

4.3.2.1 Construction Impacts

No significant impacts on the supply or availability of surface water would result from withdrawal of water for the leaching operation associated with the creation of new caverns. The withdrawal would also have little effect on either the supply or quality of surface water. The proposed point of withdrawal would be on the south side of the ICW, 3.5 miles east of Goose Lake. The rate of withdrawal would be 1.03 million bpd (barrels per day) or 30,000 gpm (gallons per minute), and would extend over 1140 days (38 months).

The impact from the withdrawal of leaching water should be slightly less than that due to the displacement process. During the leach water cycle, 1.03 million bpd would be withdrawn to create new caverns at West Hackberry. Later as oil is displaced for the West Hackberry and Sulphur Mines sites, the maximum withdrawal of 1.47 million bpd would be utilized. The MIT Water Quality Network Model (Harleman et al, 1976) was used to predict the impact of the withdrawal process for leaching water on the surface water system of the ICW. Based on this model flow velocities throughout the ICW would be altered by 0.03 ft/sec or less.

During the 150-day withdrawal process the increased salinity would be small in the ICW and would be similar for both sets of salinity regimes given in Appendix D.27. The dual salinity regimes were used to approximate the seasonal salinity variations of the ICW near the withdrawal point. The maximum salinity increase observed in the vicinity of the withdrawal point was less than 0.2 ppt. The maximum salinity increase at any location in the ICW was less than 1 ppt. A detailed description of salinity increases along the entire waterway under the two sets of boundary conditions is presented in Appendix D.27.

Black Lake has been proposed as an alternative source of leaching water for the West Hackberry site. If the lake were completely isolated from other water bodies the withdrawal rate previously noted would lower the water level of the lake 6.05×10^{-2} ft/day (as explained in Appendix D.12). Because the lake is connected with both Calcasieu Ship Channel via Black Lake Bayou and with the ICW via Alkali Ditch, the actual rate of fall of water would be much less than the value noted. Induced currents in both the bayou and the ditch would serve to replenish the water withdrawn from the lake. Thus, essentially all of the replenishment water would actually come indirectly from the Calcasieu Ship Channel or the ICW.

Based on the MIT Water Quality Model results presented in Section C.3.2.2.1, and in Appendix D.12, the withdrawal of leaching water would depress the level of Black Lake less than .17 feet. Induced flow effects in Black Lake Bayou would produce current changes of less than .13 ft/sec while in Alkali Ditch such changes would amount to less than .11 ft/sec. Because more of the replenishment water entering Black Lake would be supplied via Alkali Ditch (which connects with the Intracoastal Waterway) than via Black Lake Bayou (which connects with the Calcasieu Ship Channel), the salinity in Black Lake would decrease during the withdrawal process. A decrease in salinity in Alkali Ditch and in that portion of Black Lake Bayou between Black Lake and Alkali Ditch would also be expected. In that portion of Black Lake Bayou between Alkali Ditch and Calcasieu Ship Channel, the salinity would increase due to more saline water being drawn from Calcasieu Ship Channel. The maximum increase in salinity in this reach of the bayou would be less than 3.2 ppt.

None of the predicted impacts on water level or salinity resulting from the withdrawal of leaching water from Black Lake under normal environmental conditions appear significant. Under special conditions involving wind-driven tides, as described in Section C.3.2.2.1, the combined effect of withdrawal and a depressed water level could prove significant for a period of a few days in portions of the lake less than one foot deep.

In addition to changes in the water level or salinity of Black Lake, certain other potential impacts exist. Near the mouth of Black Lake Bayou the water in the Calcasieu Ship Channel exceeded the EPA numerical criteria* for phenols, mercury, and phosphorus. In addition, the level of oil and grease at the Corps of Engineers sampling stations was excessive (see Appendix D). To the extent that Calcasieu Ship Channel serves as a secondary replenishment source for Black Lake, a portion of such contaminants in the channel would be transported via Black Lake Bayou into Black Lake.

The ICW represents the primary replenishment source for Black Lake via Alkali Ditch. The limited water quality data for the ICW indicates that the levels of phosphorus, arsenic, mercury, toxaphene, lindane, heptachlor, aldrin, chlordane, dieldren, endrin and O,P'-DDT exceed the EPA numerical criteria. In addition, the level of oil and grease, heptachlor, epoxide, methoxychlor, P,P'-DDT, O,P'-DDE, P,P'-DDE, O,P'-DDD and P,P'-DDD pose possible problems. Because the ICW would be the primary replenishment source for Black Lake, the contaminants previously noted would be introduced into the lake at a higher rate than normal via Alkali Ditch.

The Calcasieu Ship Channel has also been proposed as an alternate source of leaching water for the West Hackberry site. The impact of such withdrawal should be less than that occurring during the displacement process (which is described in

*For marine aquatic life - given in Appendix D.3 and discussed in Section B.3.1.2.1.

Section C.3.2.2.1 and Appendix D.13) because the rate of withdrawal during leaching is less than that during displacement. Based on the results presented in Section C.3.2.2.1 the surface height of the Calcasieu Ship Channel in the vicinity of the withdrawal point would be reduced less than .01 feet. Induced flow effects in Calcasieu Ship Channel due to withdrawal would be insignificant. Likewise in Calcasieu Lake induced flow velocities would be small, with maximum change amounting to less than .02 ft/sec. In West Cove, velocity changes would be less than .03 ft/sec.

If Calcasieu Ship Channel was used as the withdrawal source, the change in salinity of the Ship Channel, Calcasieu Lake, and West Cove would be small. Actually, during the 150-day withdrawal process, the salinity would decrease or remain essentially constant throughout most of the water system. The salinity decreases are generally not considered to be the result of the withdrawal operation, but are primarily due to the presence of nonequilibrium conditions existing in portions of the water bodies at the time the withdrawal process commenced.

Brine Disposal

During the leaching process at West Hackberry, 230 ppt brine would be discharged at a maximum rate of 1.03 million bpd or 30,000 gpm for 1140 days. The operation of the brine diffuser shown in Figure 4.3-1 was simulated by a mathematical model developed by the Department of Civil Engineering at the Massachusetts Institute of Technology (MIT). The model was applied by the National Oceanographic and Atmospheric Administration (NOAA) for a study undertaken at the request of DOE to determine the effects of brine dispersion connected with the SPR.

The MIT model described in Appendix D.25, is a time dependent model which simulates the transient plume conditions when wind-driven current speeds and direction are input. The model uses results from diffuser performance studies conducted by the U. S. Army Corps of Engineers Waterways Experiment Station to determine the mathematical dilution factors in the near and intermediate fields (0-100 feet from the diffuser). The concentrations in the far-field region were calculated using the MIT transient plume model which has been calibrated through thermal discharge studies.

A summary of the predicted salinity increases and excess salinity contours are presented in Appendix D.25 and D.28. As discussed in Appendix D.25 the base case involved a non-tidal current cycle with a period of 96 hours, a maximum upcoast (eastward) current of 0.5 ft/sec and a maximum downcoast (westward) current of 1.0 ft/sec. The predicted field

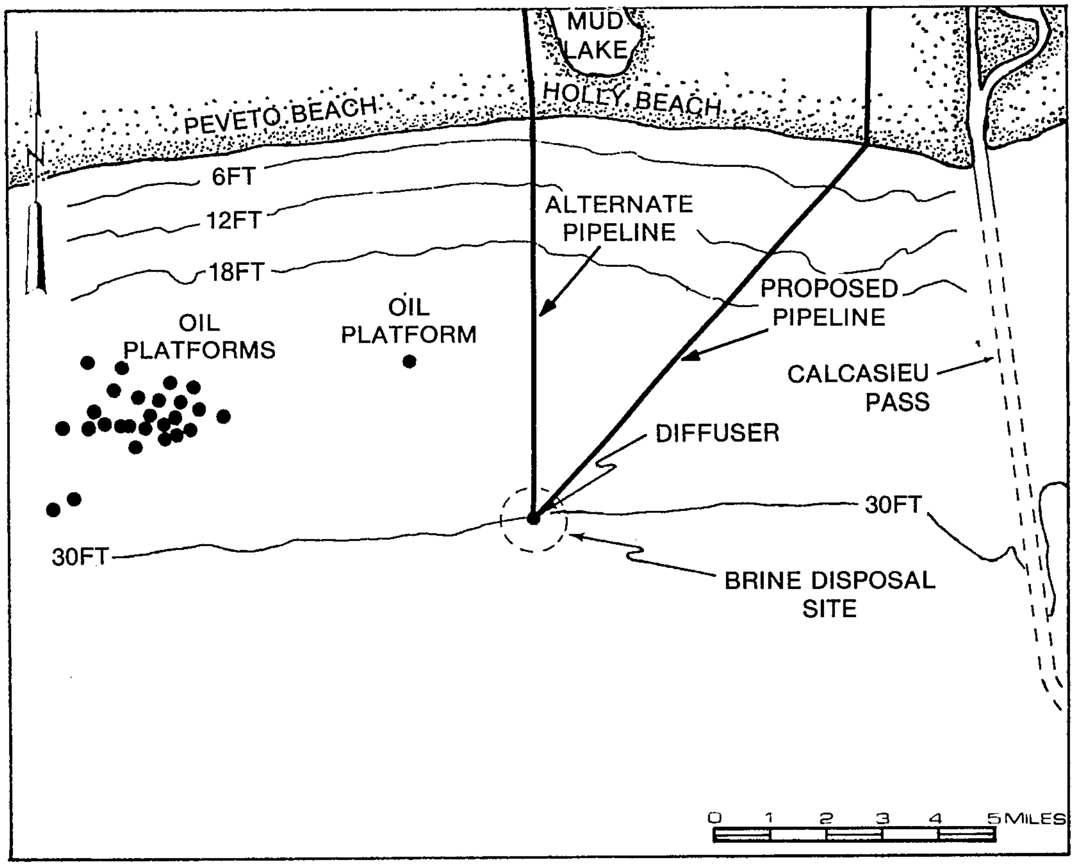

Figure 4.3-1 BRINE DISPOSAL SITE FOR WEST HACKBERRY

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excess salinity contours, corresponding to the end of the 21st hour of the fourth current cycle, are presented in Figures C.3-4, C.3-5, and C.3-6 for the bottom, mid-depth and surface planes respectively. As might be expected, due to the negative buoyancy of the brine plume, the excess salinities are greatest in the bottom plane and become progressively smaller toward the surface. The predicted field excess salinity contours, corresponding to the end of the 93rd hour of the 4th cycle are presented in Figure C.3-7. The contours at this point appear to be circular in shape, reflecting the near-completion of one cycle.

The variation of exposed bottom area with excess salinity level for the base case is presented in Figure C.3-8. As indicated in the figure, an area of approximately 5.2 x 10^7 ft^2 (1200 acres) would be exposed to salinities in excess of 1 ppt. The variation of exposed bottom area with excess salinity under stagnation conditions* is presented in Figure C.3-9. As expected, for any given salinity level, a larger bottom area is involved, with approximately 1.6 x 10^8 ft^2 (3700 acres) exposed to salinities in excess of 1 ppt.

In addition to the runs with the MIT model based on estimated currents, runs were made with the model using field oceanographic and meteorological data gathered during September 1977 - February 1978. In general salinity plume orientations are east-west (alongshore) and most likely drifting to the west. No more than 1860 and 207 acres would experience salinities greater than 1 and 3 ppt as a typical case.

Another potential area of impact is chemical equilibrium between brine and sea water. MINEQL, a computer program for calculation of chemical equilibrium composition in aqueous systems, was used to solve the chemical equilibrium. See Appendix D.15 for a detailed discussion of the model and conclusions.

Environmentally significant changes in chemical composition predicted to occur in brine-sea water mixtures include:

- Ratio of free concentrations of magnesium and calcium would remain relative constant with changes in the excess** salinity.

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*A description of the stagnation conditions is provided in Appendix D.25.

**Salinity concentration above ambient.

- o Free concentrations of heavy metals would generally decline with increasing excess salinity.
- o Speciation of the heavy metals would change with increasing excess salinity to give greater amounts of chloro-complexes and other soluble species.
- o The types of precipitates would remain relatively constant across the excess salinity scale with concentrations of most precipitates increasing with salinity increases.

These predictions dictate a number of conclusions:

- o Changes in calcium to magnesium free concentration ratios appear to be small. This is significant because changes in this ratio can be detrimental to marine organisms.
- o The availability of heavy metals to marine organisms may be increased or decreased by predicted formation of chloro-complexes at higher salinities.
- o The number and types of precipitates predicted remained essentially constant as the excess salinity increased with increasing amounts of most precipitated compounds at higher salinities.

Biological tissues examined were from White Shrimp, Croaker, zooplankton, and Squid. The metal burdens correspond quite well for all metals to historic data gathered for these species from other parts of the Northern Gulf of Mexico. Metal burdens of organisms from the Black Bayou and Big Hill diffuser sites were remarkably similar to those at West Hackberry considering that West Hackberry has a distinctively different sedimentary geochemistry. In particular, the West Hackberry sediments carry a greater metal burden than the Big Hill site. Water column chemistry data were very similar for the three sites.

Dredging Operations and Spoil Disposal Operations

The laying of pipelines for the transport of oil, water, and brine would require a significant amount of dredging in the Bayou Choupique, the ICW, Wing Gully, Spring Gully, the Neches River, Cow Bayou, Black Bayou, Black Lake, Stark's Canal, First and Second Bayou, Hog Island Gully, Calcasieu Ship Channel, and several marshes. Oil pipeline construction impacts have already been evaluated in the supplement to the Final EIS for West Hackberry (FES 76/77-4). Impacts of constructing a pipeline from the Sulphur Mines site to the southern bank of the ICW, including the dredging required to place pipe under the ICW, have been evaluated in the Sulphur Mines Final EIS (DOE/EIS-0010) and are not appreciably different from the laying of the parallel pipe for water transport. Table 4.3-1 contains the general impacts which would occur at some or all of the required dredging sites. Table 4.3-2 gives the places where dredging would occur, the approximate amount of dredged material involved and the impacts which would be expected to occur.

Increases in turbidity due to dredging would be a significant impact. This would result in a decrease in light penetration and an increase in temperature during and for up to several days following completion of dredging. Dredging would, in areas where little or no dredging has previously occurred, alter the composition and nature of bottom sediments. Damage to benthic and other biological populations would occur and this is further discussed in the ecological section.

Dissolved oxygen decrease, nutrient level increase and release of toxic materials such as heavy metals and pesticides would vary depending on sediment contamination at each site. However, these impacts should be more significant at the Calcasieu Ship Channel than at other dredging sites due to sediment content in this location.

Impacts of effluent runoff into nearby waterbodies from contained disposal areas should be relatively (as compared to other impacts) minor if containment areas are properly designed and constructed.

Grading, Excavation, and Filling

The site preparation and construction activity would involve a significant amount of earth movement during a 5-month period. Approximately 200 acres of land would be disturbed. Approximately 3220 tons or 3180 cubic yards of sediment would be washed into the surface water system around the West Hackberry site as a result of erosion of this distrubed land by rainfall. Of this total, 3758 tons would be deposited in Black Lake with the remaining 462 tons entering Black Lake Bayou. Because the soil is of a silt loam composition, the minimum rate of soil particle settling would be .018 mm/sec. The introduction of such sediment into Black Lake would increase the average level of suspended solids in the lake by 1.21 ppm (See Appendix D.16). The increase would persist over the entire 5-month period.

TABLE 4.3-1

GENERAL IMPACTS ASSOCIATED WITH DREDGING OPERATIONS

Impact	Major Controlling Factors
(1) Turbidity Increase	Type, number and size of dredges in operation. Skill of dredge operators. Duration of dredge operation. Bottom sediment characteristics. River flow conditions.
(2) COD Increse/DO Decrease	COD content of bottom sediments.
(3) Release of Aquatic Nutrients/Creation of Eutrophic Conditions	Phosphorus and nitrogen content of bottom sediment.
(4) Release of Sulfides	Amount of sulfides (from sour crude oils) in sediment.
(5) Release of Pesticides and/or Toxic Hydrocarbons	Content of pesticides and petrochemicals in the bottom sediments. Nature and composition of bottom sediments.
(6) Toxic Metals	Levels of toxic metals in the sediment and the water column. Concentration of substances which can complex and/or precipitate these metals. (Such as sulfides or sulfates)
(7) Loss of Wetlands Habitat	Amount controlled by volume of spoil, density (densification of spoil) and stacking depth in disposal areas

TABLE 4.3-2

SUMMARY OF DREDGING INFORMATION AND EXPECTED IMPACTS OF DREDGING FOR THE WEST HACKBERRY SITE EXPANSION

Location	System*	Amount of Dredged Material (yd^3)	Dredge** Type	Expected*** Impacts
Neches River	Terminal (dock)	2,000,000	H	all (1-7)
Marshes	BDP (proposed)	790,000	B	(1),(2), & (3)
Calcasieu Lake & West Cove	BDP (proposed)	407,000	B	(1) & (2)
Long Point Bayou	BDP (proposed)	2,000	B	(1) & (2)
West Cove Canal	BDP (proposed)	1,000	B	(1),(2), & (3)
West Fork	BDP (proposed)	64,000	B	(1),(2), & (3)
Unnamed Bayou	BDP (proposed)	10,000	B	(1),(2), & (3)
Starks Canal	BDP (alternate)	1,500,000	B	(1),(2), & (3)
First Bayou	BDP (alternate)	5,000	B	(1) & (2)
Second Bayou	BDP (alternate)	5,000	B	(1) & (2)
Hog Island Gully	BDP (alternate)	5,000	B	(1) & (2)
Marshes	BDP (alternate)	---	B	(1),(2), & (3)
Black Lake	RWP (proposed)	111,000	B	(1),(2), & (3)
ICW	RWP (proposed)	5,000	B	all (1-7)

*BDP is a brine disposal pipeline. These will be used in later tables.
RWP is a raw water pipeline.
** H represents Hydraulic Dredging, B represents Bucket Dredging.
*** Numbers refer to numbered list of general impacts in the preceding table.

For the case of Black Lake Bayou, the introduction of 462 tons of sediment would increase the average level of suspended solids by 5.88 ppm for essentially the entire 5-month period (See Appendix D.16).

Pollutants of Miscellaneous Construction Activities

Numerous solid and liquid products, both organic and inorganic, used in construction are potential sources of chemical and biological water pollution.

Petroleum products, herbicides, pesticides and fertilizers are well-known and documented sources of chemical pollution. Fertilizers would be used in the revegetation of areas affected by grading operations.

Regardless of their origin, biological pollutants have an adverse effect on the water. The pollutants of major concern at West Hackberry would be the pathogenic organisms associated with human wastes. The biological pollutants which generally enter receiving streams and other water bodies as a result of construction activities are bacteria, fungi, worms, viruses, and other less prevalent organisms. The disturbance, exposure and subsequent erosion of surface soils that contain bacteria and other organisms would be contributing factors. Pollution can be minimized to an insignificant level by proper instruction of personnel coupled with good housekeeping practices.

4.3.2.2 Operations Impacts

Water Supply and Water Quality

The only significant impact on the supply or availability of surface water would result from the withdrawal of water for the displacement operation. The maximum rate of withdrawal would be 1.47 million bpd (barrels per day) or 42,900 gpm (gallons per minute). The period of withdrawal would extend over a minimum of 150 days (5 months). The same discussion of impacts presented in Section 4.3.2.1 for the withdrawal of leaching water would also apply for the withdrawal of displacement water (see also Appendix D.12).

During displacement, oil may be simultaneously withdrawn from both West Hackberry and Sulphur Mines. In order to predict the impact of water withdrawal from the proposed intake location on the ICW, the MIT Water Quality Network Model was utilized. Detailed results from the use of the model are presented in Appendix D.27. The results indicate that for the given conditions, the surface heights of the ICW would not be appreciably altered during withdrawal of displacement water. In addition, changes in flow velocities would be small (0.03 ft/sec or less) throughout the ICW.

With salinity boundary conditions established to simulate conditions of high salinity in the Sabine River and Calcasieu Ship Channel, a salinity increase of less than 0.05 ppt was indicated for the withdrawal point. The largest salinity increase observed anywhere in the ICW was less than 1 ppt. Predicted salinities along the ICW before and after the withdrawal operation are presented in Appendix D.27.

If the alternate site, Black Lake, were chosen as the withdrawal location, salinity changes in the lake would be greater than those predicted for the ICW as discussed in Appendix D.12. Because of its greater depth, Alkali Ditch, would supply the major portion of the replenishment water to Black Lake. Such water would be fresher than that passing through Black Lake Bayou. Thus the salinity of Black Lake would decrease approximately 1.3 ppt during the withdrawal process. Likewise the salinity of Alkali Ditch would decrease, along with salinity in that portion of Black Lake Bayou between its junction with Alkali Ditch and Black Lake. In that portion of Black Lake Bayou east of its junction with Alkali Ditch, however, the salinity would increase by as much as 3.2 ppt due to the intrusion of the saltier water from the Calcasieu Ship Channel.

If the Calcasieu Ship Channel were chosen as the source of displacement water as described in Appendix D.13, the withdrawal process would produce very little change in salinity. The model indicated that at the end of the 150-day withdrawal process the salinity would generally be on the order of .2 ppt less than the salinity prior to withdrawal. Similar decreases ranging as high as 2 ppt in Calcasieu Lake and 4 ppt in West Cove were observed. These decreases in salinity are not considered to be the result of the withdrawal process but instead are primarily the result of the existence of nonequilibrium conditions (with respect to salinity) in portions of the water network at the time the withdrawal of displacement water commenced.

In addition to normal environmental conditions involving lunar (diurnal) tides, special consideration must be given to wind-driven tides. Under certain meteorological conditions, normally associated with the passage of a front, winds in the area may persist in one direction for periods as long as one week (Coleman, 1977). In such a situation the water level in Calcasieu Lake may be depressed (or elevated) 2 to 3 feet below (or above) its normal value. At Hackberry, the maximum depression observed in the period from 1944 to 1976 amounted to approximately 2 feet below mean sea level and persisted for approximately 3 days (Dement, 1977). An analysis has been performed with the Network Model to determine the effects of such a depression of the water level in both the Calcasieu Ship Channel and the Intracoastal Waterway. The results of such an analysis are also presented in Appendices D.12 and D.27. Such results indicate that under the influence of a wind-driven tide the level of Black Lake would temporarily drop approximately .86 feet. This drop, combined with the drop of .17 feet resulting from the withdrawal process, would produce a total decrease in the water level of 1.03 feet. The lake is reported to have a mean depth of 4 feet, but in the vicinity of the withdrawal point it may be much shallower. In such shallow regions a drop on the order of one foot could be significant. During the withdrawal phase, the added effect of wind-driven tides may occasionally cause the lake bottom to be exposed. These tides normally last for no more than three days in the area of Black Lake.

Brine Disposal

The displacement operation would vary from the leaching operation only in the placement of excess salinity contours within the brine plume and the size of the plume. Thus the discussion presented in Section 4.3.2.1 concerning chemical composition for the leaching operation is equally applicable to the fill operation. Data is given in Appendix D.15 for the chemical composition at various excess salinity contours. The impacts described for the leaching operation apply equally for the case of filling.

The anticipated oil in brine would be less than 15 ppm (Appendix S) and would be rapidly diluted still further at the diffuser location. Thus, no visible sheen is expected to form as a result of discharge.

Pollutants of Miscellaneous Maintenance Activities

The major sources of maintenance-related chemical and biological pollution are generally similar to those present during the construction of the facility, but the magnitude of such sources would in general be smaller than those resulting from construction.

Subsurface Water

Current design for the West Hackberry SPR facility does not involve use of the shallow aquifers as a source of displacement water, nor does it involve use of the deeper aquifers as a site for brine disposal. Thus the subsurface water system would experience no impact as a result of facility operation.

4.3.3 Air Quality

4.3.3.1 Construction Impacts

The construction of the proposed oil storage facility at West Hackberry would result in combustion and fugitive emissions along the brine pipeline right-of-way, the water supply right-of-way, and at the dome.

Fugitive dust emissions (1.2 tons per acre per month of construction) would also be generated during land clearing and grading of roads. Annual tonnage emission rates are summarized in Table 4.3-3.

Vehicular emissions of 6.9 pounds of particles per vehicle mile during site construction would occur due to the use of heavy-duty construction equipment, such as bulldozers, caterpillars and graders, and light-duty vehicles such as pickup trucks and automobiles. Drill rigs used in drilling new wells, also produce significant quantities of exhaust output. Emissions emanating from the above sources include particulates, sulfur oxides (SO_x and SO_2), carbon monoxide (CO), non-methane hydrocarbons (NMHC), nitrogen oxides (NO_x and NO_2), and small amounts of aldehydes and organic acids. Actual emission strengths would be a function of fuel use preference, i.e., gasoline or diesel.

Exhaust emissions would occur due to the use of heavy duty construction equipment. The USEPA (1976) has indicated that at a distance of 100 meters from a highway, annual NO_2 concentrations would be no greater than 40 $\mu g/m^3$. As a result, combustion emissions from these sources as well as light-duty vehicle sources are expected to have minimal impact on the ambient air quality (Table 4.3-3) and are not included in the model analysis.

A final source of construction emissions involves grinding and subsequent painting of the large storage tanks. The painting of these tanks would comprise a significant source of hydrocarbon vapors during application (See Table 4.3-3).

The use of abrasives during the construction phase in preparing storage tanks prior to the application of light colored paint results in the emission of fugitive dust. Approximately 1 percent of the applied material is emitted in this manner.

Table 4.3-3 Annual Tonnage Emission Rates At West Hackberry During Construction*

Source or Activity	Annual** Emissions (Tons)				
	HC	Pa	SO_2	NO_2	CO
Site Preparation	-	5990	-	-	-
Unpaved Roads	-	295	-	-	-
Paved Roads	-	0.7	-	-	-
Heavy Duty, Diesel Powered Equipment(1)	0.5	0.3	0.5	7.4	1.4
Light-Duty Vehicles	0.3	0.05	0.01	0.5	3.8
Surface Grinding Tanks	-	3.1	-	-	-
Painting - Tanks(2)	5.3	-	-	-	-
Total - Construction	16	6298	9	134	32

* Includes construction activities at dome and terminal sites and along pipeline right-of-way

** If activity persists for less than a year (e.g. painting - tanks) then total emissions for this shorter period are listed

1. The dome and terminal sites considered as independent construction sites of equal magnitude.
2. Two coats of paint

The application of paint to the SPR storage tanks during the construction phase would also result in the emission of hydrocarbons due to evaporative losses (Table 4.3-3). The USEPA (1976) recommends an emission factor of 1120 lbs of hydrocarbons per ton of paint applied for use in estimating emissions.

The total annual tonnage of hydrocarbon, particulate, SO_2, NO_2 and CO emissions from all sources of construction activity at West Hackberry are summarized in Table 4.3-3. A detailed analysis presenting the assumptions used to produce the values in Table 4.3-3 is contained in Appendix C, Section C.3.1.3; while technical details and calculations are in Appendix E.

Air Quality Impact

Modeling analyses were performed to estimate impacts to ambient air quality. The modeling consisted of: (1) the use of the model PTMAN to predict the frequency of occurrence of violations of applicable standards and the distribution of pollutant concentrations at downwind receptor locations and (2) the prediction of annual centerline pollutant ground level concentrations by the model CDM utilizing nearby historical meteorological data.

Conclusions regarding the construction impacts to air quality for the West Hackberry site are summarized as follows:

- Paved and unpaved roads account for less than 5 percent of the construction phase particulates with the vast majority (300 tons/year) from unpaved roads.

- Combustion contaminants would be well dispersed and the overall impact on air quality would be insignificant.

- The 3-hour standard for nonmethane hydrocarbons (NMHC) would be violated within one Km of the source at a maximum annual frequency of approximately 1 percent.

- The 3-hour NMHC standard would be violated for tank painting at the West Hackberry site at a downwind distance of 4 Km (see Figure 4.3-2). The maximum frequency of violation would be 1 percent of the time annually and the violation would occur to the west of the dome. Actual painting would take less than a month.

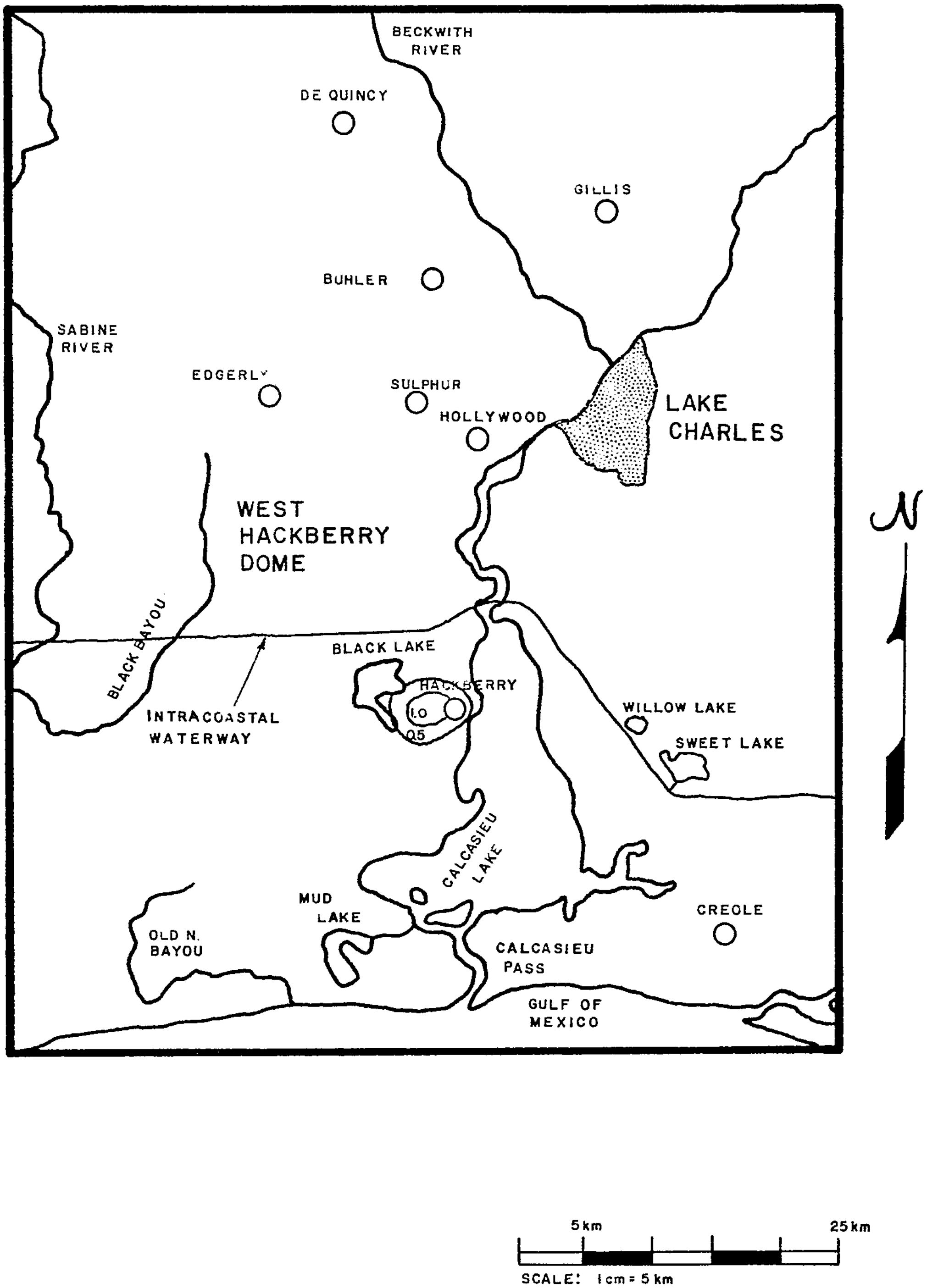

Figure 4.3-2 Annual Frequency of Occurrence (%) of Violations of the 3-hour NMHC Standard for Tank Painting at West Hackberry Dome During the Construction Phase

- Preparing (grinding) tanks would violate the 24-hour particulate standard 1 Km downwind.

- Because a water spraying program which would reduce fugitive dust emissions by 50 percent is to be used, particulate emissions from roads and cleared areas would be in compliance with applicable standards.

Ground level particulate concentrations are shown in Figure 4.3-3.

In summary, the construction of SPR facilities at the West Hackberry dome would not result in offsite violations of the applicable ambient air quality standards. With the possible exception of the painting of the project storage and treatment tanks, all indicated violations would be within the probable plant site boundaries. Maximum construction phase impacts on local ambient air quality can be attributed to: (1) tank preparation and (2) land preparation activities. The remainder of the construction phase sources are mobile and are fairly widely distributed. As a result, their impact on ambient air quality tends to be very local and of a short duration. Such sources include vehicular usage and fugitive dust losses from project roadways. All calculations are conservative in that they do not include the use of abatement techniques.

4.3.3.2 Operations Impacts

The emission sources from operational activities at the West Hackberry dome would be primarily from dissolved hydrocarbons which are present in the brine discharged during oil refill. These emissions would be the result of evaporative losses of gaseous hydrocarbons from exposed liquid surfaces of crude oil and are estimated to result in a maximum emission rate of 210 tons/year during the fill phase. The initial filling of the caverns will not result in this higher rate of emissions because of the short period of time for diffusion of the hydrocarbon into the brine. In this analysis, it is assumed as a worst case that all of these emissions are in the form of reactive non-methane hydrocarbons (NMHC).

Annual tonnage emission rates have been developed for individual operational phase sources from the emission rates presented in Appendix E. These tonnage emissions for West Hackberry expansion are presented in Appendix C, Table C.3-11. The worst case tonnage emissions of 265 tons per year at West Hackberry would occur during refill following withdrawal of the stored oil.

Modeling analyses have been conducted for substaintial sources or those which may result in a violation of applicable air quality standards. The modeling consists of (1) the use of the model PTMAN to predict the frequency of occurrence of violations of applicable standards, and the distribution and pollutant concentrations at downwind receptor locations, and (2) the prediction of

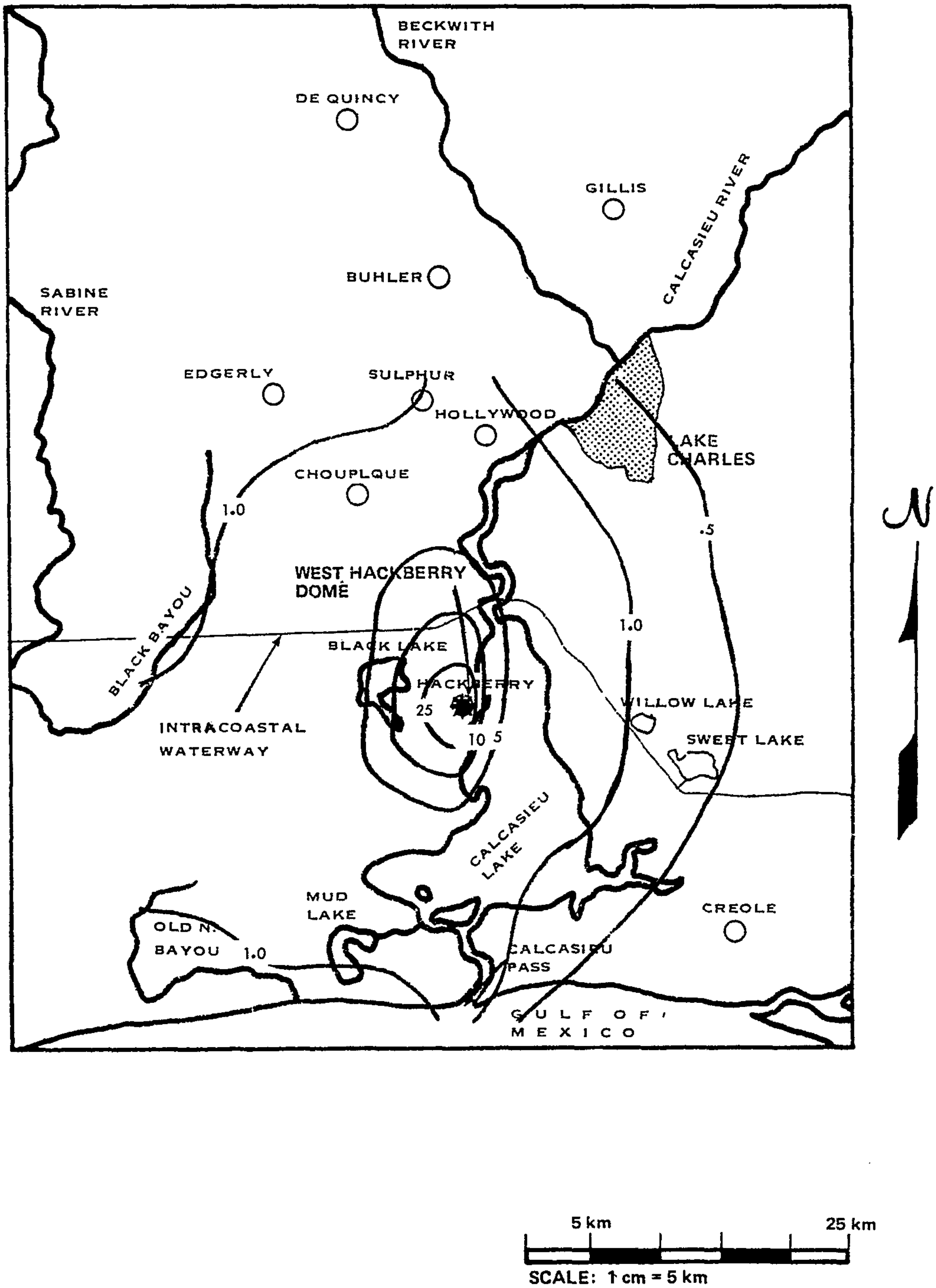

Figure 4.3-3 Annual Average Particulate Ground Level Concentrations ($\mu g/m^3$) for the Dome Site During the Construction Phase at West Hackberry

annual centerline pollutant ground level concentrations by the model CDM utilizing nearby historical meteorological data. These models are discussed in greater detail in Appendix C, Section C.3.2.3.2.

The operational phase of the program would consist of three types of activity: (1) initial fill, (2) drawdown, and (3) refill. Evaporative losses of hydrocarbons would emanate from exposed surfaces of crude oil during each of these project phases. At the dome site, hydrocarbon losses would emanate from onsite tanks (up to 48 tons/year) and the dome pump house (up to 8 tons/year). Additional emissions would occur during the operational phase due to the use of paved and unpaved roads by light-duty vehicles; however, the overall impact of these sources on ambient air quality would be insignificant. The most significant source of hydrocarbon emissions would be the brine ponds which could produce up to 210 tons/year during the refill phase.

Short-term modeling calculations have been performed for projected hydrocarbon emissions at the dome. The calculations are based upon concomitant emissions from all sources including tanks and pump houses. At the dome site, short-term NMHC ground level concentrations would exceed the 3-hour standard 0.5 Km downwind from the brine holding pond during oil refill due to the release of dissolved hydrocarbons in the brine (see Appendix N). This would be a localized air quality problem and would be confined within the site boundaries.

Annual NMHC ground level concentrations have been calculated for the dome. Figure 4.3-4 provides the results of this analysis for the storage site. This calculation is based upon the conservative (worst case) assumption that both the fill and drawdown phases would occur, at least in part, during the same annual period. Annual NMHC concentrations would be generally less than 0.5 $\mu g/m^3$ downwind of the dome site sources.

In summary, the annual tonnage emission rate for the West Hackberry expansion is relatively small (see Table C.3-9) in comparison to regional hydrocarbon emission levels in this region of heavy petrochemical activity. This fact, coupled with the presently accepted rationale that local oxidant levels are not directly related to emission strengths from local, isolated sources, indicates that it is unlikely that the proposed facility would have a significant impact on observed levels of photochemical oxidant. The facility would not result in violations of standards for other contaminants.

Current Regulations

Current regulations restricting air pollutant emissions from operations necessary for the development and use of the SPR

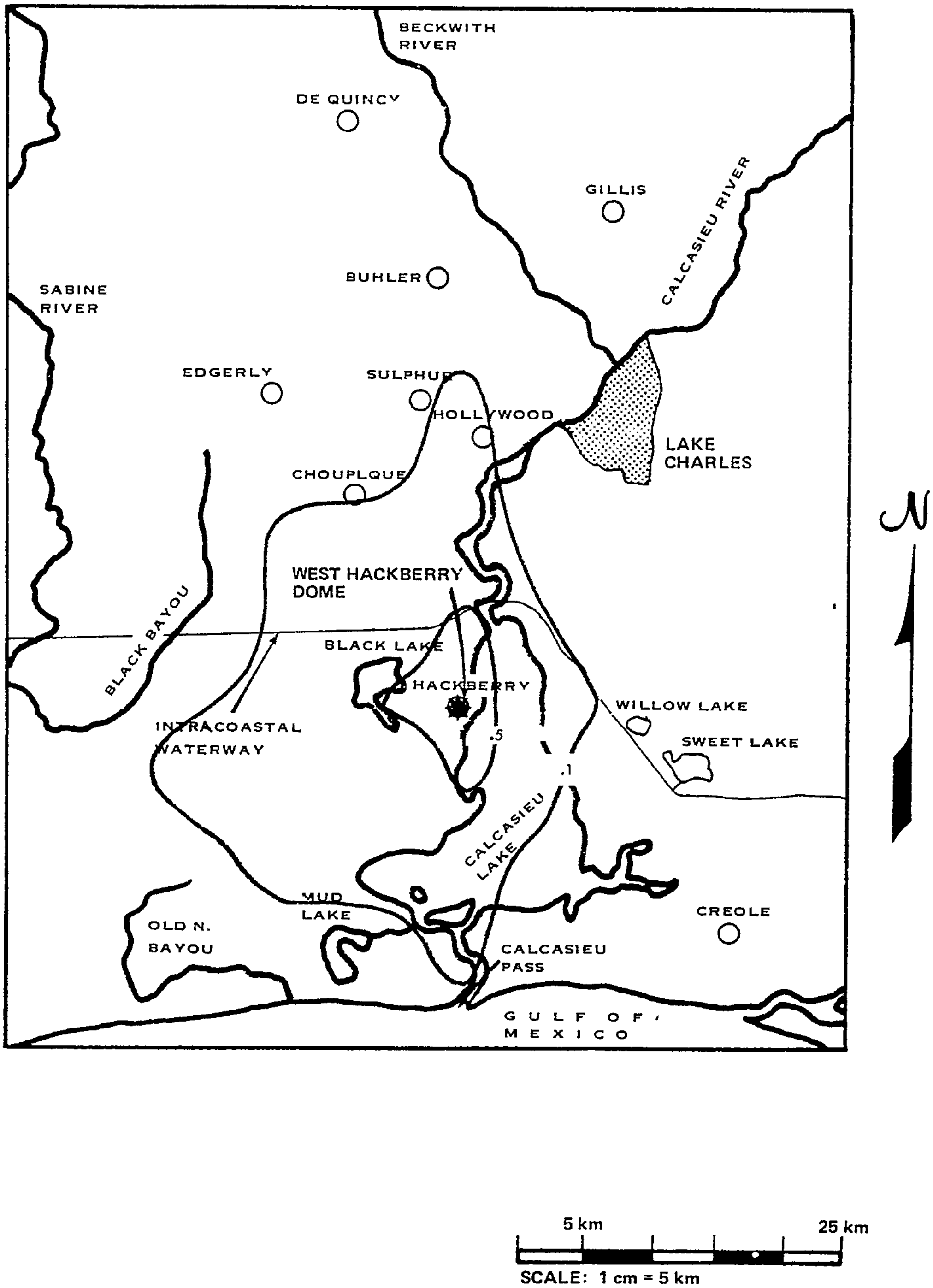

Figure 4.3-4 Annual Average NMHC Ground Level Concentrations ($\mu g/m^3$) at the Dome Site During the Operational Phase for the West Hackberry site.

facilities can be grouped into emission regulations and ambient air quality standards. Federal and State (Louisiana and Texas) emission regulations are summarized in Appendix C, Section C.3.1.3.3. National ambient air quality standards are presented in Table C.3-6 and Louisiana Standards in Table C.3-7. In December 1976, USEPA adopted an "emission offset" policy as part of its "new source review" procedures. Under this policy new sources are required to show that their emissions plus reductions in emissions from existing sources required under the State Implementation Plan equal a net decrease in emissions. That is, the new source should not delay progress in achieving the National Ambient Air Quality Standard (NAAQS). However this regulation applied only to permanent onshore facilities and is expected to exclude new sources with "potential" emissions totaling less than 100 tons/year. During the initial implementation of the SPR, the EPA determined that the offset policy did not apply to SPR facilities due to the temporary and intermittent nature of its associated emissions. DOE is currently coordinating with EPA to determine to what extent the precedent established by this decision is applicable to other SPR sites. DOE has been further advised by EPA that the offset policy is under review and that a clarification will be forthcoming in the near future. DOE will take any necessary actions consistent with this clarification.

4.3.4 Noise

4.3.4.1 Construction Impacts

Construction activity associated with the West Hackberry expansion site would contribute to acoustical impacts for residential, recreational, farming and other land use areas in the West Hackberry area during the site preparation.

The contributing noise sources at the storage site area during site preparation would be air compressors, trucks, diesel engines, drilling rigs, concrete mixers and general construction related equipment. Noise levels typical of this equipment are given in Table F-2 of Appendix F. The evaluation of the construction noise sources indicates that diesel engines would provide the most consistent source of noise and that drilling equipment would create the peak sound levels. The areas adjacent to the storage site are sparsely populated marshlands. Assuming both day and night time drilling activity of two drill rigs, it is estimated that the equivalent sound level contribution (Leq) of the site preparation activity would be no more than 55 decibels (dB) at 2,000 feet from the center of the site. The contribution of storage site construction activity to annual day-night levels (Ldn), assuming 6 months of drilling activity is estimated to be no more than 55 dB at 2,000 feet from the center of the site.

Assuming daytime activity only, it is estimated that pipeline construction noise would contribute no more than 55 dB to the equivalent sound level (L_{dn}) at a distance of 500 feet from the pipeline right-of-way. The annual L_{dn} levels along the pipeline are not expected to be affected because of the relatively short period of construction activity at specific sites.

Noise impacts from the construction associated with the site preparation for the West Hackberry expansion are summarized in Table 4.3-5.

4.3.4.2 Operations Impacts

During fill and/or discharge operations, there would be noise generated from the continuous operation of pumps at the storage facility. During oil withdrawal, as during cavern leaching, there would be noise from pump operations on the ICW. The noise is expected to be continuous day and night during operations. However, since the pumps at both the storage and terminal facility would be placed in some noise dampening enclosure, it is anticipated that there would be a negligible impact on existing ambient levels in the vicinity of these facilities.

4.3.5 Species and Ecosystems

4.3.5.1 Construction Impacts

Displacement/Leaching Water System Impacts

Dredging in Black Lake would destroy benthic fauna where the pipeline trench is to be located. This loss is not expected to be significant because the location of the pipeline trench would be within the area previously disturbed by the laying of the oil pipeline. Visually-oriented fish would temporarily vacate the area of the dredging activity and the more turbid portions of the turbidity plume. Feeding would also decrease in these areas as the denuded bottom would have few organisms suitable as fish food for several months. For a short period, the nutrients placed in the water column due to the agitation of the bottom substrate would stimulate planktonic and epiphytic plant growth. This increase in productivity, however, would not be great enough to offset the losses where the trench is dug. It is expected that one to two years would be required for the stabiliation and recolonization of the bottom habitat.

North of the lake, pipeline construction would impact 20 acres of marshland/open water habitat. Release of specific toxic materials into the water column cannot be predicted as water and sediment quality data for the marshes are not available. However, because of the absence of appreciable currents,

Table 4.3-4 Summary of Sound Level Contributions (dB) from Construction Activities for the West Hackberry Expansion

Construction Site	L_{eq}	L_{dn}	Distance from Center of Site
Storage Site Area	<55	<55	2,000'
Pipeline Corridors*	<55	<55	500'
Terminal and Dock Area*	64	<55	1,800'

*Assumes daytime activity only.

the turbidity increase and dissolved oxygen decrease would be intensified at the construction site.

An important concern in the pipeline construction would be the integrity of the levee which would be crossed between the marsh and the dry land management area north of the marsh. Blowouts, which are large breaches in levees, would have a harmful effect on the biota of the pasture by allowing saline water to flow into the area. The breaches normally occur as a result of storm damage, but inappropriate construction techniques can also bring about similar impacts. As a worst case, if a blowout occurs in the levee separating the marshes north of Black Lake with the pasture, recovery of the management area vegetation may take as long as 3 years.

Except for the possibility of blowouts, impacts to the dry land management area would be less severe than to any other ecological habitat through which the pipeline would cross. During the digging of the pipeline trench, cattle would be excluded from the immediate area and, during the winter, waterfowl would not feed where pipelaying activities are taking place. During the hunting season in November and December, this area is normally opened for 15 to 20 hunters for approximately 10 out of 50 days (Lowery, 1977). Construction over this area during these months would disrupt this recreational activity.

Although the construction right-of-way is 75 feet, the only area to receive a significant impact would be a strip approximately 25 feet wide where the pipeline trench is dug and the temporary spoil bank is located. After the soil is replaced in the trench and reseeded with grasses, approximately 6 months to one year would be required for recovery of the area depending on the time of year of construction. Assuming a 25-foot wide strip along the pipeline route would be unavailable for food production for cattle, approximately 14.6 acres would be excluded from use.

The excavation of 117,500 cu. yds. of material for the intake and barge slips on the Intracoastal Waterway would increase the amount of solids suspended in the water column. The size of the turbidity plume from this activity would depend on several environmental factors which would be interacting during the time of construction (i.e. tides, input from freshwater streams, winds, barge traffic, etc.). Visually-oriented fish would temporarily vacate the area and benthic organisms close to shore would suffer increased mortality due to siltation. In general, however, because of the relatively poor aquatic environment in the Intracoastal Waterway, the proposed additional dredging would not significantly affect the biota in the area.

The water supply pipeline for Sulphur Mines would be about 20 miles long. The portion which would parallel the Sulphur Mines oil line would be laid in land which is primarily uncultivated dry land. Here, the pasture grasses redisturbed (installation of oil pipeline would be original disturbance) by pipeline construction are expected to be reestablished within 2 years. Where the line must be laid across cultivated fields, a longer period of impact would result due to the mixing of subsoil into the more fertile and better-drained topsoil. Slightly over 2 miles of wooded land would be crossed, where trees cut for the pipeline right-of-way would be replaced by low shrubs whose roots will not interfere with either the oil line or the proposed water pipeline. Due to the more intensive activity of laying two lines instead of just one, there may be more impact on the waterways and marsh areas. The siltation and turbidity caused by dredging would destroy benthic organisms. In the ICW, these include mollusks, polychaetes, amphipods, fly larvae, and oligochate worms. Increased excavation and use of vehicles in the marshes would damage and destroy marsh grasses, epiphytic organisms, and benthos. However, only about 0.2 mile of open water must be crossed and 0.4 mile of marsh.

The water line would be laid along the West Hackberry oil pipeline right-of-way on the south bank of the ICW for a distance of about 3 miles. This would require reexcavation of the spoil bank, resulting in some erosion. Revegetation is expected to occur, however, within 1 year.

Brine Disposal System Impacts

Proposed Brine Pipeline Route. Impacts on biota from construction of the proposed brine pipeline to the Gulf would be locally significant, but substantial recovery would occur within two years. Construction of the brine pipeline from the central plant to the east would destroy nonmobile and slightly mobile pasture organisms in the path of the pipeline and increase erosion and sedimentation. The marsh and canal system in the vicinity of the dome would assimilate the small and transient increased sediment load with little effect on the organisms present. Pipeline construction across small drainage channels would probably cause slight increases in turbidity and sedimentation in the adjacent channels with which the drainage channel connects. Sediment transport in conjunction with rain, could reduce production by submerged aquatic plants while the associated nutrient enrichment could ultimately stimulate production. Some fish probably would avoid the area of increased turbidity, and benthic animals might be physiologically harmed or their microhabitats degraded by deposition of sediment. Such aquatic impacts would be small and short-lived. Although bushes and trees would require several growing seasons to recover to preconstruction conditions, a ground cover of weeds, grasses, and shrubs would probably be well established by the end of one growing season.

Increases in the sediment load where the line would pass across aquatic environments would directly impact benthos, fish and plankton (including migratory larval forms). In addition, the dredging would initially destroy most of the benthic organisms along the pipeline route.

Construction of the brine line west of the Calcasieu Ship Channel would impact organisms in the marshland and marsh channels, in West Cove of Calcasieu Lake; and in dry grassland, sandy areas and marshes near the coast.

Land denuded of vegetation along this north-south section of the proposed brine route would be revegetated within 1 to 2 years. Direct impacts to plankton and benthos would be relatively short-lived away from the area actually dredged, but effects on future population sizes, age structures, and dynamics could persist for two years or longer. Reduction in the food of estuarine fish could bring about a slight decline in their numbers. On the other hand, enrichment with plant nutrients of the impacted estuarine waters would probably stimulate primary production and, subsequently, secondary production. These increases could offset losses caused by direct destruction and degradation of water quality caused by pipeline construction. The structure of the impacted biological communities would probably also change slightly.

For the remainder of the proposed route, a considerable amount of marshland, grassy areas above the beach, the beach itself, and the floor of the Gulf of Mexico would be impacted. Organisms in the marsh and coastal grass areas would probably be reestablished within one to two years. Organisms would be reestablished at former levels at the beach crossing point in a fraction of a year. Waterfowl, shore birds, passerine birds, mammals and other mobile vertebrates would be temporarily disturbed and displaced along the proposed brine disposal route during construction.

Direct stress on organisms resulting from degradation of water chemistry during brine line construction beyond that now present or projected would be slight. Brine line construction would contribute to a slightly higher level of PCB's and pesticides in biota but the increase would be short-term and insignificant.

Alternate Brine Pipeline Route. The alternate pipeline route to the Gulf beyond the initial section which is coincident with the proposed line, would place the line in the Stark's Canal for most of its length. Prior to reaching the canal, the pipeline would parallel State Highway 27 for approximately one mile. The route along this highway is an artifically maintained habitat consisting of a mowed easement with occasional small shrubs. After refilling and reseeding of the pipeline ditch, this area would essentially revert to the same habitat type as existed before the ditch was dug.

For 15.9 miles the pipe would be placed in the Stark's Canal. Both during and after pipeline construction, this canal would be subjected to greatly increased turbidity and sedimentation until the bottom and road bank had reestablished.

Plant species present might not completely return to the earlier composition for an additional year or two. It seems likely that the increase in suspended solids in the Stark's Canal would be confined and would not be manifested in lateral canals connecting to the West Cove of Calcasieu Lake and the interior of the Sabine National Wildlife Refuge.

Plankton, fish, and particularly bottom organisms would be adversely affected. Fish would lose a food source and the use of the affected area for a time. Bottom organisms would probably experience high mortality, reduction or temporary cessation of reproduction, and slowed growth. These effects would be localized and short term.

Settling of the suspended sediments would interfere with settling of planktonic larvae and reduce or eliminate cover and food for some of the smaller animals present on or near the bottom. Temporarily reduced plankton production as a result of increased turbidity possibly would be regained after the water cleared because of the release of inorganic nutrients. Waterfowl and small mammals along Highway 27 would also be disturbed during construction and would feed and nest near the route to a lesser extent for some time after construction. This would temporarily reduce the recreational value of the scenic highway.

Many more birds would be impacted by increased noise from November through March when most of the migratory waterfowl which use the Refuge are present. An indeterminate, but large number (thousands) of birds and mammals could be affected in any season. Recreational fishing and crabbing along the route would be curtailed during construction and until they recovered from the construction impacts.

Aquatic impacts similar to those produced in the Refuge would be caused by construction of the brine line in Stark's Canal along the western side of Mud Lake. There are no connections from the canal to Mud Lake and it would not be directly impacted. Birds and other wildlife frequenting the pastures bordering Stark's Canal would be temporarily disturbed by construction activities.

Waterfowl and aquatic organisms would be impacted in the shallow marshy arm off Stark's Canal through which the pipeline would pass. Full recovery would probably occur within two years. This part of the route is bordered by pasture having wildlife and livestock which would be distrubed only during construction.

South of Highway 82 the brine pipeline would cut through a band of tall coastal grasses on a slight ridge above the beach. This disturbed vegetation, and the associated animal life probably would recover within one year. Wildlife, particularly shorebirds, would be disturbed both in these coastal grasses and the beach to the south.

Small biotic constituents of the beach would be destroyed or disturbed in the immediate construction area and fish in the tidal zone could be briefly disturbed. In general, there would be a relatively rapid recovery of the biota in this ecosystem.

Construction of the 7-mile brine line in the floor of the Gulf, would temporarily eliminate a maximum of approximately 42.5 acres of benthic organism habitat. Turbidity resulting from suspension of bottom materials dislodged during and after pipeline burial would also temporarily reduce phytoplankton and benthic algae production for a short period. Some of the benthic organisms near the route could be affected by sediment settling during and for a relatively short period after construction. Such sediment, if taken in by filtering benthic animals, could interfere with their feeding and respiration. Release of the chemical nutrients from these sediments may have a slight stimulating effect on phytoplankton after turbidity has diminished close to the pipeline.

Storage Site

Forty acres on the site will be cleared of pasture vegetation in order to construct the central plant as part of the ESR facility. The impacts on biota which will result from this construction were assessed in the West Hackberry EIS (FES 76/77-4). In addition to the soil organisms and biological production lost for the lifetime of the project, a total of 40 to 60 cow-calf units* of beef production per year will be excluded. This loss is valued at $10,880 per year. An indeterminate part of some 160 additional acres needed for expansion would also be lost from cattle production for varying time periods as a result of pipeline and road construction.

As a result of erosion associated with construction activities 3,220 tons of sediment would enrich the lake-marsh-bayou system. Short-term turbidity increases would inhibit primary

*Cow-calf unit - One brood cow and her calf.

production, while contaminants such as herbicides, insecticides or spilled hydrocarbons would stress most aquatic life in the area.

Oil Distribution System

Impacts on biota which would be associated with construction of the oil distribution system have been discussed in the West Hackberry Environmental Impact Statement Supplement, FES 76/77-4 (FEA, 1977b). Marshes, dry land, spoil banks, woodlands, roads, and water and waterways would be impacted. A summary of these impacts is presented in Appendix C, Section C.3.1.5.4.

4.3.5.2 Operations Impacts

Displacement Water Systems Impacts

The greatest impacts on biota of withdrawal of displacement water from the ICW would be the loss of organisms in the water. This would be particularly important with respect to the loss of plankton standing crop, detritus, and nutrients. The smaller organisms, dissolved material in suspended material in up to 2,277 million barrels of water could be removed from the ICW over the life of the project. However, since the ICW is a flow-through system these losses would be readily replaced and the impact from this source is expected to be minimal. A much smaller (non-significant) impact would probably result from impingement of organism (entrapment against intake screens). The types of organisms which would be affected by water withdrawal include: zooplankters (copepods; rotifers; protozoans; and young stages of shrimp and crabs, Atlantic croakers, menhaden, mollusks, polychaetes, and barnacles), bacteria, yeasts, and algae (generally diatoms or dinoflagellates).

Alternate Withdrawal Location: Black Lake

Total densities for zooplankton in Black Lake are approximately 540 animals/liter, with 8 percent of these animals being larger forms over 1 mm long. Some 2.33×10^{14} zooplankters, 4.11×10^{26} bacterial cells, 2.03×10^{24} yeast cells, 1.81×10^{7} kg of suspended material (50 percent organic matter), and 1.73×10^{6} kg of dissolved organic carbon would be lost to the aquatic system in and around Black Lake over the course of leaching and five oil displacements. The loss, in terms of zooplankton biomass, would be approximately 1.08×10^{6} kg. The lost algal biomass is expected to be even greater than the zooplankton loss.

Potential food and nutrients which would have been available to other aquatic organisms would also be lost. The continuous reduction in standing crop of plankton and in nutrient detritus would progressively reduce the production base of the ecosystem. This production base would be replenished by two means: (1) material produced outside of Black Lake that was transported into the system by currents and tides and (2) resident production. Significant resident production of organic detritus to replace that which would be entrained would require approximately one year after cessation of withdrawal. Imported detritus could reach significant levels very rapidly, but this would depend upon the season and flushing rate of the estuary. Since zooplankton and benthic animals are highly dependent on detritus, their numbers in Black Lake would be greatly influenced by the availability of these nutrient materials.

Since the physical and chemical changes induced in Black Lake and associated water bodies would be slight, the habitat of commercially important species would not experience any irreversible changes. Thus, no permanent changes in the capacity to support fisheries species would be expected. However, some fisheries species, such as brown shrimp, would experience some degree of entrainment due to water withdrawal during susceptible stages of their life cycle. The effect of this mortality on population dynamics would be influenced by several factors in the life cycle of the animals. One of the most important factors is that shrimp populations are adapted to heavy mortality, especially in the younger life stages. An adult female can produce 500,000 to 1 million eggs during her life. Obviously only a few of these offspring reach maturity and reproduce. Therefore, by virtue of the tremendous reproductive capacity and movement of shrimp annually into Black Lake, populations would be expected to recover the year after water withdrawal ceases (see Appendix R).

Impingement on the water intake screens would present little hazard to animals since the intake velocity is low, or to larger plants since they are unlikely to be floating free near the intake.

Brine Disposal System Impacts

During normal leaching and fill operations, impacts to biota would largely be restricted to the diffuser area in the Gulf of Mexico. The following discussion details the results of (1) the initial model runs based on literature and regional data and (2) later results based on actual site specific oceanographic and meteorological data.

Outputs of the MIT Transient Plume Model (NOAA, 1977a) predict that, under a worst case situation of eight days of stagnant currents, 3700 acres and 140 acres would be impacted by 1 ppt and 3 ppt salinities above ambient, respectively. Under base case conditions up to 1200 and 70 acres would experience salinities of 1 ppt and 3 ppt above ambient respectively.

Discharge would be maintained during the 38 months of leaching and subsequent fill periods of 40 months each. At the 5 ppt level above ambient, model outputs for worst case stagnant conditions show that approximately 28 acres would be impacted.

Various runs presented by NOAA (1977a) show longshore extensions of the brine plume at the bottom of the water column as varying from .75 miles to 2 miles in extent at the 3 ppt above ambient isohaline and 2 to 5 miles projected for the 1 ppt above ambient area. Figure 41a in NOAA (1977a) (see Appendix D.25) shows the results of a run during the period of upcoast current regime (0.5 ft/sec), and delineates the longshore extension of the plume as approximately 1.25 miles and 3.75 miles for 3.0 and 1.0 ppt above ambient salinity levels. Residence times for a water mass to pass through this area would be approximately 3-1/2 hours and 11 hours for the 3.0 and 1.0 ppt above ambient areas. Figure 42 of NOAA (1977a) (see Appendix D.25) shows the longshore extent of the plume as approximately 2 miles and 3-1/2 miles respectively for the 3.0 and 1.0 ppt above ambient salinity areas. This run was during a period of downcoast current of 1.0 ft/sec. Based on this, the residence time of a water mass in the 3.0 and 1.0 ppt areas is approximately 3 hours and 5 hours respectively. During stagnant conditions, the residence time is essentially equal to the period of stagnation (except for tidal influences), and maximum impacts are expected during this time due to the prolonged exposure of the biota to elevated salinity levels. Under no conditions tested by NOAA (1977a) can an appreciable effect be seen on the surface waters.

The model runs were based on reasonable assumptions needed to exercise the model. These inputs to the model have been refined by field collection of oceanographic and meteorological data from the West Hackberry site and new runs conducted. These runs, based on data collected during September 1977-February, 1978, indicate that up to 1860 and 207 acres would be impacted by 1 and 3 ppt salinities above ambient respectively under typical conditions. Thus, for typical conditions the initial model results and those using site-specific data are quite comparable, with the 3 ppt contour encompassing approximately three times the area in the latter runs as compared to the former.

The topography of the area shows a gentle slope (less than 1°) and would not cause any problems regarding downslope density flow of brine. Irregular topography, present in the Sabine Bank area (15 miles offshore), would not act as a "brine sink," due to the prevalence of numerous breaks in these shoals which would allow passage of a brine slug (See NOAA, 1977a and Ocean Survey Nautical Chart 11341).

Water quality impacts related to biotic functioning would be minor in regard to trace metals. Table 4.3-5 shows the concentration of elements in West Hackberry brine compared to

Table 4.3-5

COMPARISON OF EXPECTED BRINE CONSTITUENTS WITH SEA WATER COMPOSITION AND EPA DISCHARGE RECOMMENDATIONS

PARAMETERS	EXPECTED BRINE QUALITY INITIAL DISCHARGE (A)	AVERAGE SEA WATER (B)	DISCHARGE CONCENTRATIONS RECOMMENDED FOR MARINE AQUATIC LIFE BY EPA (C)
TEMPERATURE (^oc)			
PH			6.5-8.5
DO (mg/1)			
SALINITY (PPT)		35.0	
PHENOL (mg/1)			
TSS (mg/1)			
VSS (mg/1)			
OIL & GREASE (mg/1)			
CYANIDE (ug/1)			5
Cd (ug/1)	<2	0.05	5
Cr (ug/1)	<2	0.6	5
Cu (ug/1)	<2	3	0.1x96 h LC50
Pb (ug/1)	<2	0.03	
Hg (ug/1)	.4*	0.05	0.1
Ni (ug/1)	<2	2	0.01x96 h LC50
Zn (ug/1)	<2	5	
Sb (ug/1)	<2	0.2	
Ba (ug/1)	<400	30	
B (ug/1)		4,500	
Mn (ug/1)	160	2	100
Se (ug/1)	<2	0.45	0.1x96 h LC50
Ag (ug/1)	<10	0.1	0.1x96 h LC50
As (ug/1)	4	2.3	
Na (mg/1)	120,800	11,050	
K (mg/1)	5	476	
Ca (mg/1)	420	422	
Mg (mg/1)	5	1,326	
Cl (mg/1)	200,000	19,870	
SO_4 (mg/1)	1,440	2,712	

*All brine samples analyzed after April, 1977 showed no detectable mercury levels. It is therefore suspected that this detectable level may be a sampling artifact.

REFERENCE
(A) Brine Analysis Results, April, 1977
(B) Introduction to Marine Chemistry by Riley & Chester, p.64 (1971) (1)
(C) Water Quality Criteria 1976, EPA - 440/9-76-023, September 1976.

average sea water and discharge concentrations recommended for marine aquatic life by EPA (1972). While Na and Cl levels in the brine are substantially higher than in sea water, no discharge recommendations have been considered for these generally "non-toxic" forms. Only manganese (160 μg/liter) is somewhat higher in the brine than in recommended discharge levels, and, because of diffuser design, should reach background levels within a very short distance from the discharge point. It appears that levels of trace elements in the brine would be more related to the leachwater source than the salt of the dome. In this respect, the water source (ICW) represents water of quite acceptable quality (see Appendix T, Tables T-2 and T-3).

Data on dissolved oxygen from the September-December 1977 field collection period indicated supersaturated conditions in the mid and upper water layers. However, even if a dissolved oxygen problem were to become evident during some part of the year a tenfold to one hundredfold dilution (near field) would increase the dissolved oxygen content of the water. Thus, there should be no problem as far as dissolved oxygen is concerned except in the immediate vicinity of the diffusers.

It thus appears that the biological impacts would not be directly related to any one or several chemical species. The major difference in the brine versus sea water is mainly due to the higher sodium and chloride levels and the lower magnesium and potassium levels in the brine; with calcium levels virtually identical in brine and sea water. Calcium-magnesium ratios are 84 for West Hackberry brine and .3 for sea water; indicating a large ion imbalance. The ecological significance of this imbalance is uncertain, but due to the rapid dilution at the diffuser site, the normal oceanic Ca/Mg ratios would be reestablished in the near field. Also, since the disposal areas are near shore and near tidal passes, ambient Ca/Mg ratios are expected, at least seasonally, to be higher than those of sea water. Therefore, outside of the near field, only osmotic effects associated with overall increased salinities should be operative in the water column, and concentrations of toxins should be at ambient or below ambient levels within the confines of the mixing zone.

It should not be overlooked, however, that a situation can exist in which no one factor or chemical species by itself is in high enough concentration to be toxic, but a number of species acting synergistically can induce toxicity with accompanying effects on growth, respiration and survival. This analysis has indicated that in the near field a number of factors are at unsuitably high levels, and synergistic effects are expected to influence the well-being of the organisms exposed to this chemical regime. Seasonal differences in physical factors, such as temperature, can further modify the effects.

While scanty data are available, indicators are that sea surface temperatures range from 12°C in January to 30°C in August, while salinities range from 24 in May to 34 ppt in August (see Appendix O). Wind data, correlated with current data, shows that August has a relatively large proportion of currents greater than 51 cm/sec with stagnant conditions occurring only sporadically. October has a large proportion of its currents in the slack category, especially those on the bottom. October salinities are ∿30 ppt and temperatures approximately 24 ppt, lower than the August maximum. Thus, the period of maximum probability of stagnant water does not coincide with seasons having environmental extremes in temperature and salinity, thus reducing the probability of adverse effects in the vicinity of the diffuser.

The biota of the West Hackberry diffuser site, as delineated by the 4-month field study described in Appendix U.4, is generally typical of the coastal waters of the northern Gulf of Mexico at the 30-foot contour interval. This is particularly true of the phytoplankton, zooplankton and demersal nekton communities whose species compositons are readily comparable to those found along the Louisiana-Texas coastline. Standing crops for these communities are also roughly comparable to those elsewhere in this region. The benthic community on the other hand is dominated by a limited number of species most of which are typical of degraded conditions such as associated with oil spillage. A significant finding is that standing crop for the benthic community is low.

The phytoplanktonic community is dominated by a mixture of estuarine and marine diatoms. This probably reflects the mixing of estuarine waters from Calcasieu Pass with offshore marine waters. Species composition varies dramatically from month to month but *Skeletonema*, *Coscinodiscus centralis*, *Biddulphia* spp. *Rhizosolenia imbricata*, *R. robusta*, *Chaeotoceros currisetum*, and *C. decipiens* are typical dominants. Interestingly September and December were wholly dominated by just one or two species (particularly *Skeletonema*) while October and November showed a diverse, equitably distributed species composition. Dinoflagellate numbers, as expected, were low for this time of year.

The most abundant zooplankton species at the West Hackberry brine disposal sites are nearly all copepods. Densities attained high levels. They attained the order of 100 fold greater than desities of estuarine zooplankton as determined in the *Cooperative Gulf of Mexico Estuarine Inventory and Study, Louisiana*. The peak abundances at West Hackberry were higher than the South Texas Outer Continental Shelf by a factor of five. The species lists from this work are closer to those at West Hackberry than in the Louisiana estuarine data. The species list inshore contained only on the order of a third of the species obtained in the brine disposal location. Average densities for all zooplankton combined generally were somewhat higher than obtained in long-term data obtained by NOAA from the South Texas Outer Continental Shelf.

The species composition of the nekton community is fairly constant from month to month, and is typical of Louisiana-Texas coastal waters. Standing crop varies markedly from month to month, but these fluctuations appear to be driven by random variation in the populations of the top dominant species, Acetes americanus, a sergestid shrimp, and Anchoa mitchilli, the Bay Anchovy. An influx of species during November probably reflects the fall offshore migration of estuarine summering forms.

The benthic community is almost wholly dominated by either the marine worm (polychaete) Magelona sp. (October, November, December) or the clam Mullinia lateralis (September). In both cases the second ranked species was only about half as abundant as the top dominant. Such a community structure is typical of environmentally degraded conditions. This is supported by the remarkably low standing crop in the benthic community. Both Mullinia and Magelona are known to be indicator species for degraded environments.

The most severely impacted region would be that nearest the diffuser port where highest salinities overages would be encountered. Based on MIT transient plume model, utilizing limited real world current observations for the West Hackberry site, no more than 207 acres would be enclosed by the 3 ppt excess salinity isohaline. If total mortality within this region is assumed, about 1.1×10^6 benthic individuals/acre would be eliminated. In the context of the broadly distributed nearshore benthic community, this is not a significant impact. Beyond the 3 ppt isohaline brine impacts on the benthic community would be expected to be minimal. Inasmuch as the planktonic and demersal organisms are either quickly carried through the diffuser site, or can otherwise avoid this region, impacts on these communities should be slight.

Based on residence times of a water mass in the area of the brine plume (discussed above), significant mortality could occur in the area of 3.0 ppt above ambient salinity. This would be especially true when other environmental stresses (such as high temperature or low light regimes) are operative, and will be complicated by rate of change of environmental factors experienced by the plankton. This applies only to the plankton in the near bottom waters. Since projected brine plume outputs from the model show no appreciable change in surface salinity in the area of the diffuser, no impacts are expected as long as the plankton remain in the surface layers.

Another important factor is the effect of jetting from the diffuser ports. There is the possibility that the diffuser could form a "screen" disrupting normal larval migrations into the estuaries (Calcasieu and Sabine Lakes). This question was discussed at the SPR Brine Disposal Conference (Texas A & M, 1977). Given the rapid falloff in the brine plume with distance from the diffuser (as predicted by the MIT model) this is not likely to be a problem.

Nekton and mobile benthos would avoid the area if they find conditions unsuitable and presumably, this area (166 acres) would be temporarily less suitable as a spawning and feeding ground to the more stenohaline members.

An important factor to consider is the effect of diffuser design and disposal site location on plankton mortality and meroplankton migration patterns. These migrations are discussed in Appendix Q, and involve all commercially important crustaceans and fishes in the region. Since these plankton depend on currents for their distribution, and for the transport of meroplankton into the estuarine nursery grounds; and since the diffuser is designed to intercept these currents (longshore) with maximum efficiency, then maximum impact is expected for both the meroplankton and the other plankton from this design, the width of influence being greater than 3,000 feet. While the actual response of the plankton to the abrupt salinity change is unknown, the rate of change of salinity or ionic composition can be very important, and under most conditions (plankton floating with the currents) the transition from sea water to brine would be very abrupt. Due to the length of diffuser involved, a large fraction of the near shore current mass (1/10 of the current from 0-7 miles offshore) pass through the diffuser area. Again, this would apply only to the plankton in the near bottom waters.

Since the West Hackberry disposal area lies close to the mouth of Calcasieu Pass (5-7 miles) and the adjoining ship channel, it is expected that this area would experience some increases in salinity above ambient, at least seasonally. Salinity intrusion into the estuary, already a problem, would be accelerated. Brine could conceivably flow down into the ship channel due to density effects and subsequently move into the estuary as part of the salt wedge.

Brine would be heated while in the storage cavities to a maximum of 150°F but generally less than 120°F. Because of the insulating properties of the pipe coatings the brine would enter the Gulf as a heated effluent (assuming little heat loss while the brine is in the brine pond). Rapid dilution in the near field would mean that only organisms very close to the diffusion would be affected (see Appendix I).

Accidental releases of brine could occur onshore along the pipeline route. Harm to biota would be localized in the immediate vicinity of the break. Recovery of terrestrial biota from brine spills which resulted in brine uptake by soil or marsh sediments would require many years if remedial measures were not taken. The addition of chemicals to mitigate this spill would be made shortly after the break occurred. This action would reduce the recovery time to an estimated 5 to 10 years. Only a few acres would be likely to be impacted by a single release of brine on land.

Storage Site Impacts

Impacts from the site during the operations phase of the facility would stem from maintenance and the other human activity there. During filling or displacement, machinery noise would increase and wildlife in the area would be disturbed. Some animals would adjust to this noise after a certain period. The periodic mowing of vegetation would disturb wildlife, but would also attract some species which prefer a short-grass habitat. The dust and hydrocarbons which would be produced as a result of vehicular traffic would have a negligible effect on most biota. Releases of chemical and biological contaminants would not occur on a large scale and most discharges could be easily controlled.

Oil Distribution System Impacts

Oil related risks associated with the expansion of the West Hackberry facility involve accidental releases from tankers, pipeline and wellhead ruptures and accidental spills and ballast water discharges at Sun Terminal. Such releases pose potentially adverse impacts to marshes and bayous bordering the West Hackberry site, the Neches and Sabine Rivers, the Intracoastal Waterway, Sabine Lake and Black Lake, and the marshes and other land along the pipeline route.

Oil spills in the Neches or Sabine Rivers, Sabine Lake, Black Lake, and other inland water bodies would impact various species depending upon the particular location and the specific behavior of the spilled oil. General effects of oil on biota are discussed in Appendix H and are not repeated here. Particular species likely to be impacted are identified in Chapter 3.0, and specific impacts associated with an oil spill from the crude oil pipeline from West Hackberry to Sun Terminal are discussed in the supplement to the West Hackberry Final Environmental Statement, FES 76/77-4 (FEA, 1977b).

A spill that would contaminate portions of Black Lake is of particular concern because Black Lake is an active area for sport fishermen and is also an important area for commercially important menhaden and brown shrimp (Rocca, personal communication). White shrimp (P. setiferus) are marginal producers here, and crab (Callinectes sapidus) fishing is a recent but active industry.

Canals, bayous, and other water connectors are important migration routes for juvenile shrimp and fish. Alkali Ditch serves such a purpose and also has commercially important redfish and flounder in it (Rocca, personal communication). Marshes bordering the ditch and Black Lake have the long-nosed killifish (Fundulus similis), variegated cyprinedon (Cyprinedon variegatus), and mosquitofish (Gambusia affinis). Crude oil concentrations required to produce acute mortality and other effects for several of these species are indicated in Appendix C. Data on lethal crude oil concentrations are available for some blue and fiddler crabs (see Appendix H). Planktonic forms such as Chlamydomonas spp., Acartia tonsa, and brown shrimp larvae are present in these water bodies. Lethal oil concentrations for these species are listed in Table H.1 in Appendix H.

An oil spill would rapidly form a surface slick and, unless contained, would eventually be deposited in the marshes and along the shoreline of Black Lake. This oil would very likely produce localized reductions in aquatic life in Black Lake. It is anticipated that most species of fish would avoid the spilled oil and, unless trapped in coves or bayous where escape routes are shut off, fish populations would not suffer extensive losses.

Impacts to bird populations are difficult to predict because of their transient nature. Bird mortality due to oil coating is well documented and a discussion of the mechanics of oil toxicity is provided in Appendix H. Black Lake and the West Hackberry site are utilized by a large number of bird species. Migratory diving and wading birds, by virtue of their extensive use of marshes and water bodies, would be particularly susceptible to an oil spill.

Above ground shoots of marsh vegetation that are oil coated would die back in approximately 3 to 10 days. Production of new shoots would be expected after 3 weeks, and recovery of both plant and animal populations would be relatively rapid.

An oil pipeline rupture on dry land would impact primarily invertebrates and plants. Effects on soil organisms (collembola, mites, nematodes, earthworms, etc.) and plants can be expected to be severe, but very localized in the immediate area of the spill. The oil would be eventually degraded and/or leached away over a period of years. Based on an oil spill of 1000 bbls, (which is larger than the median spill size of 850 bbls of crude oil), a soil porosity of 30% and assuming an oil penetration depth of 3 feet or less, it is expected that 1 to 3 acres of soil would be oil saturated. The exact coverage depends on soil types, viscosity of oil, pipeline pressure, soil moisture, and other factors. If oil reaches the water table, which along the pipeline route is approximately 3 feet deep, a slow discharge of oil into a body of water (the Intracoastal Waterway, Black Lake, Sabine River, Neches River, or the bordering marshes) via the water table may occur. Thus, a spill of approximately 1,000 bbl can act as a source of low level contamination for several years. Steps could be taken to prevent seepage of this oil into navigable waters. One method that is frequently employed is to dig a trench near the point of entry into such a water body, and when oil collects (generally after rains) it can be pumped off.

Containment and cleanup operations of oil spills from tankers at dock facilities and spills from oil pipeline ruptures are the responsibility of the polluter. The U.S. Coast Guard must be notified whenever a spill occurs, and an On-scene Coordinator oversees cleanup operations and takes whatever steps necessary to assure appropriate cleanup operations are implemented. Biological effects of cleanup operations at docks and in open water are generally minimal.

Cleanup operations in marshes, on beaches, and along river banks would involve removal of damaged vegetation and dead animals as well as oil removal. Such operations would result in trampling and other detrimental effects on vegetation within and adjacent to the oil-coated areas. However, properly supervised, cleanup operations would generally produce only minor impacts in and near an oil spill area. The use of heavy equipment would result in more extensive impacts, and in certain areas could result in soil erosion. Since toxic chemical cleansing agents would not be used, vegetative regrowth would be rapid.

The cost of cleaning up an oil spill in a marsh is approximately $90 to $120 per barrel. The cost of cleaning up a river or lake is generally less.

The amount of sorbent materials used in any given oil spill situation is highly variable. One sorbent material that is used for relatively viscous oils will recover as much as 1 barrel of oil per 10 lbs of sorbent. After the oil is removed, such materials are generally transported to designated landfill sites for disposal.

4.3.6 Natural and Scenic Resources

4.3.6.1 Construction Impacts

Construction activities at the site and along the pipelines are expected to be short-term with the only significant impact occurring along the alternate West Hackberry brineline. This line would parallel scenic State Highway 27 for a distance of 11 miles through Sabine National Wildlife Refuge. During construction, there would be localized disturbance along the highway due to the activity of construction crews causing waterfowl to retreat away from the roadside. When this occurs, the waterfowl, which represent the most conspicuous wildlife of the marshes, would not be accessible for public viewing. This impact would be short-term, as the effect would be restricted to the immediate vicinity and time of construction. Construction of the other components of the facility are not expected to appreciably affect the surrounding natural and scenic resources.

All parks in the West Hackberry area are located far enough from construction areas so that no impacts are anticipated on these recreational sites.

4.3.6.2 Operations Impacts

Normal operation of the West Hackberry facility would not have an adverse impact on the Sabine National Wildlife Refuge. However, if a break occurred in either of the two proposed brinelines, the resulting brine spill diffusing through the soil would have a significant impact on the surface vegetation. A release of brine would increase salinity values in aquatic systems of the marsh in the proximity of the pipeline break. This change in salinity close to the break would be expected to be beyond the tolerance levels of the marsh vegetation which would cause a die-off of plant life in this area. The extent of this die-off would vary depending on the amount of brine spilled, with a large spill creating an unsightly mass of dead vegetation in an otherwise living marsh environment. Recovery may take 10 years or longer.

All parks in the West Hackberry area are located far enough from operation and maintenance areas so that no impacts are anticipated on these recreational sites.

4.3.7 Archaelogical, Historical, and Cultural Resources

4.3.7.1 Construction Impacts

Random sampling from a cultural resources survey indicated a low probability for archaeological sites on the vicinity of the proposed and alternate West Hackberry brine pipelines. An extensive archaeological survey of West Hackberry dome and oil pipelines is currently underway, the results of which will be used for compliance with the National Historical Preservation Act of 1966 and Executive Order 11593.

Indian artifacts have been found in scattered areas throughout western Calcasieu Parish, but there are no known Indian mounds on other archaeological sites in the area of potential impact from the Sulphur Mines water supply line alternative. Archaeological surveys along the pipeline right-of-way would be conducted prior to construction of the line.

4.3.7.2 Operations Impacts

Known archaeological and historical sites in the vicinity of the West Hackberry dome and pipelines would receive no adverse impact from the operation of this facility.

4.3.8 Socioeconomic Impacts

4.3.8.1 Construction Impacts

Construction activities for the expansion of oil storage facilities at West Hackberry would employ several hundred people for a relatively short period of time (See Figure 4.3-5).

The labor force at the salt dome would reach a peak level of about 200 workers during the third and fourth months of construction. Drilling and leaching activities would operate continuously, employing about 30 workers on each of two evening shifts. The peak number of workers on site during the day, therefore, would reach about 140.

It would take approximately four months to lay the brine pipeline from the salt dome to the disposal area in the Gulf of Mexico. Approximately 140 to 180 workers would be employed on the pipeline crews. The majority of these would be drawn from the extended Lake Charles metropolitan area, which has a civilian labor force of about 57,000 persons (Louisiana Department of Employment Security, 1976).

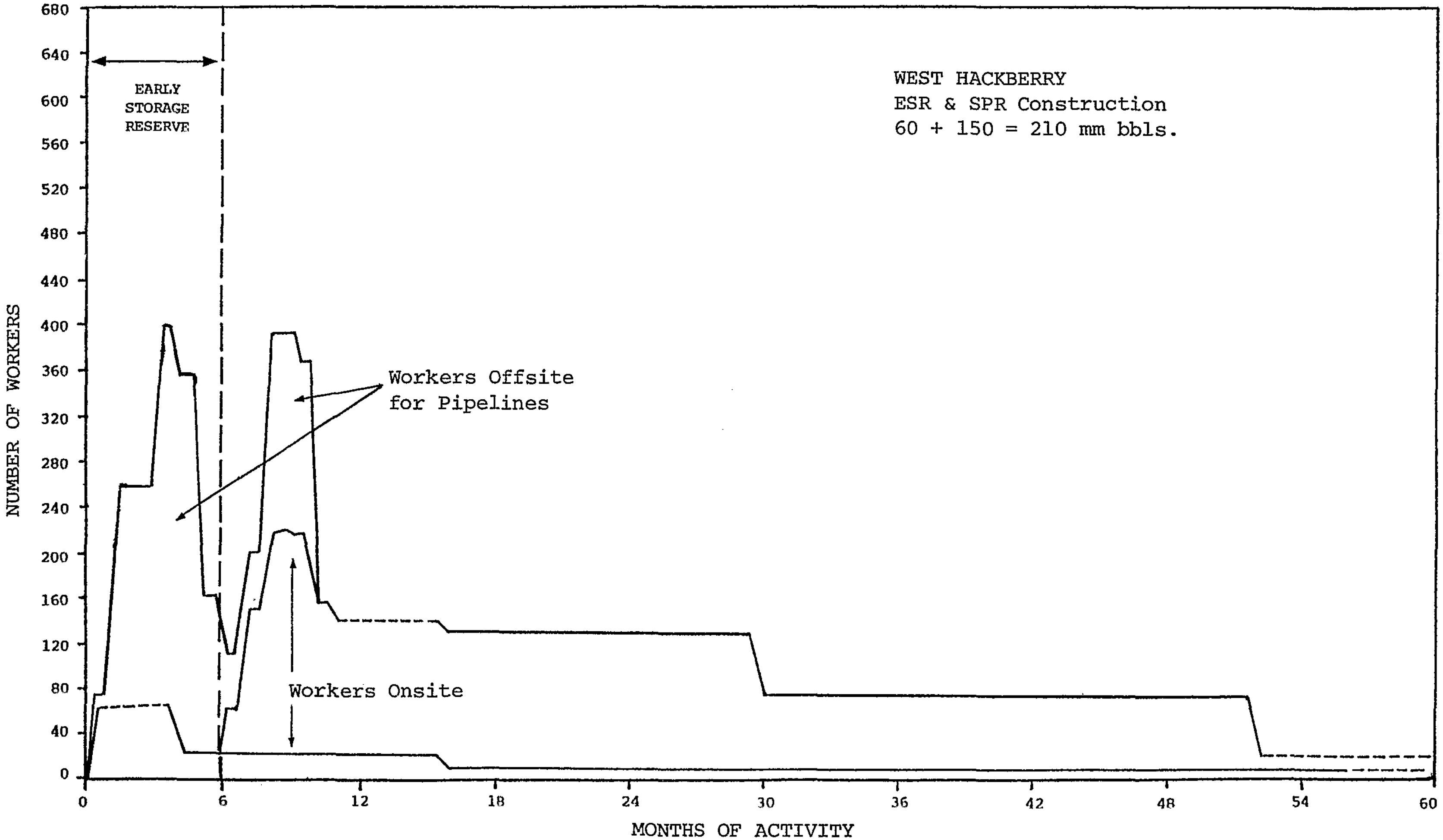

FIGURE 4.3-5 Labor Requirements at the West Hackberry Site

Construction would take nearly a year, but the labor force requirements would peak at about 110 during the third month. Assuming that work started simultaneously at both West Hackberry and Nederland (a "worst case" assumption), then the combined employment needs would reach nearly 500 workers. The Nederland facilities would draw workers from the Beaumont-Port Arthur-Orange metropolitan area. After the initial period of construction at West Hackberry, the labor force would be reduced to about 120 persons. Approximately 46 of these workers would be drilling access wells, a task which would continue until the 25th month of activity on site. Another 50 to 55 workers would be engaged in the leaching of the storage caverns, which continues through the 41st month. Both of these tasks require the workers to work in shifts; the day labor force amounting to about 60 workers, during the drilling, and dropping to about 40 during leaching and initial filling. This estimate includes workers engaged in maintenance activities and in monitoring the flow of oil into the caverns.

The oil storage site at West Hackberry would be expanded from the 220 acres developed in the Early Storage Program to 380 acres. The additional land needed to expand the storage capacity is presently used for pasture.

The village of Hackberry, which is 3 miles east of the storage site is expected to grow at a rate of about 10 percent every 10 years. Use of the West Hackberry dome would not prohibit any anticipated urban growth, and would not interfere with continued use of adjacent lands for agricultural purposes.

Land north of the salt dome is being used for oil production. The use of the land on the dome surface would not preclude further development of the oil field.

Construction of the alternate pipeline across the shore and the shallow water off-shore would temporarily reduce the value of the beach area. Holly Beach lies about half a mile east of the right-of-way, and is a resort area. The right-of-way would be a restricted area during the construction period, which would last a few weeks. Stationing equipment off-shore for laying the 7 remaining miles of pipeline would interfere with the aesthetic appearance of the shore, but would not preclude the use of adjacent waters for commercial or recreational purposes.

The impacts of project construction on local traffic patterns would be basically of three kinds: the increased number of vehicles on the roads carrying workers and materials to the site, the disruption of traffic while pipelines are being laid beneath the road bed, and the additional tankers bringing oil to the docks at Nederland.

The most severe instance of increased traffic would occur if all workers drove to the site in their own vehicles. It is more likely, however, that about one-third of the vehicles would carry more than one worker, making the shift traffic reach a peak level of 245 vehicles going one direction and 25 the opposite way.

About 60 workers would be expected to move into the region attracted by job openings. This would represent about 15 percent of the peak labor requirements. Approximately 35 may settle in Lake Charles, 15 in Sulphur, and as many as 10 in Hackberry. In Lake Charles and Sulphur, the small increase in housing demand is not likely to cause any change in the cost of rental units.

Injuries to workers occurring in the course of construction activities would increase admissions to the West Calcasieu-Cameron Hospital in Sulphur and the South Cameron Memorial Hospital. These hospitals would be adequate for most emergencies. Accidents that inflict serious injuries may require the services of hospitals in Sulphur and Lake Charles.

Increased activity at the site during construction and heavy traffic on the roads to and from the site at the beginning and end of the day work shifts, would increase demands on existing police services.

The local economy of the area would generally benefit from the project. The wages earned by local workers and part of the costs of materials and supplies would be additional income for the area and would circulate within the region, creating the multiplier effect.

The payroll of workers on the project would reach a peak level during the first six months of SPR construction, then diminish gradually until the storage facilities were completed. The following table shows the approximate average payroll levels that would be reached during various segments of the West Hackberry project:

Early Storage Reserve

1st through 6th month:	$475,000 per month

SPR Expansion

7th through 12th month:	$497,000 per month
13th through 18th month:	321,000 per month
19th through 30th month:	258,000 per month
31st through 50th month:	150,000 per month

The monthly payroll would reach high levels of between $700,000 and $800,000 during months 8 through 10 when pipelines are being laid. The payroll levels are based on an assumed average worker wage of $2,000 per month.

The overall economic gain of the SPR program to the region is based on a combination of workers' income and the local purchase of services, materials, equipment, and supplies for the project. The amount of expenditures would be about $150,300,000.

The total income supplied by SPR expenditures and secondary gains (such as local spending stimulated by regional income) can be estimated by applying the regional economic multiplier. Once the multiplier for the Lake Charles area (2.04) is used, an increase of $306,600,000 can be predicted for local earnings.

The total of SPR expenditures and secondary spending would amount to 7 percent of the combined earnings in the Lake Charles BEA area and the Beaumont-Port Arthur-Orange BEA areas,* in 1980. Considering only these two standard metropolital areas, the earnings attributable to the project would constitute a 12 percent gain over the anticipated 1980 level.

While most of the SPR purchases of materials and equipment would be concentrated in the first year of construction, economic input to the area and secondary stimulation to local businesses would extend over several years. The total economic gain stemming from the oil storage project would represent a 39 percent increase over the anticipated growth in earnings between 1980 and 1985 for the two combined BEA areas, and 65 percent over the expected growth in earnings of the two metropolitan areas over the same period of years.

State, parish, and city revenues would be increased indirectly by the generally higher level of economic activity in the area. This activity stems from project construction through the purchase of pipe, building materials, and various services.

The sales tax, which in Louisiana includes a 3 percent state tax, 1 percent parish tax, and 1 percent city tax, would contribute the following revenues to state and local governments: about $219,000 in the first year, $131,000 in the second year, $92,000 in the third year, and $68,000 in the fourth year of construction.

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*The Lake Charles BEA (Bureau of Economic Analysis) area is comprised of 14 parishes; the Beaumont-Port Arthur-Orange area incorporates 7 counties.

Materials and equipment purchased specifically for use and installation at the federal facility would not be subject to local sales tax. Similarly, federal ownership of the site and pipeline rights-of-way would exempt these properties from local taxation.

The construction of the water supply pipeline for Sulphur Mines may not necessarily coincide with the construction of facilities to expand the West Hackberry site. Assuming that the Sulphur Mines oil pipeline and the proposed water supply line would be built simultaneously, saving costs of clearing and excavation, the only additional labor required would be for welding, coating, and laying that portion of the water line, and hauling supplies. This would increase the number of jobs created by pipeline construction from about 175 to a number in the range of 225 to 250. The portion of the water supply line to be laid along the ICW would require a smaller crew. The period of pipeline construction would last for 5 to 7 weeks, depending on weather conditions. Due to the short term of construction, the economic impact on the community and the region of modifying the water supply system for Sulphur Mines would not be significant.

4.3.8.2 Operations Impacts

Operation of both the ESR and SPR expansion programs have, for the most part, similar activities and impacts. For this reason, the following discussion on operational impacts will treat both programs as being essentially similar. The main difference between them being that the expansion is basically a larger program.

The labor requirements of the storage facility would remain essentially static during the period of standby. The standby work crew would consist of about 20 people.

Land Use

The expansion of the West Hackberry dome would not appreciably change land-use patterns of the area. The community of Hackberry is not expected to grow rapidly. Urban growth is restricted by the wetlands surrounding the dome. The use of the land for oil storage would probably not affect long-term land values nor make adjacent lands less desirable for the purposes for which they are currently used.

Traffic

The number of additional vehicles using the roads leading to the site would not differ significantly from the present number.

Housing and Public Services

During operation of the facility there would be minimal impacts to housing. As construction ceases some housing would become available as workers leave; this would be most conspicuous in Hackberry. Since the work force required for operation of the facility is quite small and the size of it would remain stable, there would be no appreciable impact of operation on public services provided in the local area.

Economy

The direct economic impacts of facility operation would be very small. The greater economic importance of the oil storage facility at West Hackberry would be its value in mitigating the adverse effects to the local area of an interruption in foreign oil supplies.

Since the permanent staff on site would be small, the payroll would amount to only about $45,000 per month. Additional expenses incurred for supplies and parts, power, transportation and contingencies would raise the cost of the storage operation to about $93,000 per month. This amount can be considered as money brought into the local area, and the local economic multiplier can be applied to indicate the extent of economic gains in earnings as a result of the circulation of the money. Application of the multiplier indicates a yearly increase in local earnings of about $2,277,000. This represents a gain of less than one percent over the anticipated earnings of the combined Lake Charles and Beaumont-Port Arthur-Orange standard metropolitan statistical areas in 1985.

During a period of oil withdrawal from the storage caverns, additional workers would be hired at the storage site. Costs of withdrawal would be in the vicinity of $520,000 per month for up to 5 months.

Refill costs, excluding the purchase of the oil itself, would amount to about $250,000 per month over the refill period. The pumping rate is lower, reducing the power costs, and the number of workers at the storage site would be reduced to nearly the level needed during the standby period.

In the event that an interruption in foreign oil supplies should occur, the economic impact to the Lake Charles and Beaumont-Port Arthur-Orange areas would be great. Oil refineries and petrochemical plants constitute the major manufacturing industries of the area, and these industries imported over 18 million tons of crude oil in 1975 alone. A foreign embargo would result in the partial shutdown of refineries and petrochemical plants, and a consequent loss of jobs in the area. These adverse effects would be mitigated by use of the storage reserve. While much of the oil would be shipped to other parts of the nation, the local handling and more immediate availability of the stored oil would be an advantage to the region.

Government Revenues

The operation of the facility would have very little effect on local government revenues. There would be no local tax revenue from the use of the land as a federal facility, nor would there be any income from the extraction of the oil since it would be taken from storage rather than primary oil production. Since the oil would almost certainly be sold to oil companies which are registered wholesalers, this sale would be exempt from state sales tax.

The local governmental agencies would benefit from the tax revenues from worker wages and increased sales indirectly attributable to the project.

4.3.9 Impact Due to Termination

After termination of the SPR program, if the facility were not used for any other government purposes, it would be disposed of in accordance with applicable laws and regulations.

4.3.10 Relationship of the Proposed Action to Land Use Plans, Policies, and Controls

The West Hackberry site lies in Cameron Parish, and is outside of any city boundaries. There are no zoning restrictions governing the use of the land, although the Parish Police Jury does regulate construction in flood plains and flood hazard areas. The site, however, lies on high ground and is susceptible to damage only in very severe storms. The use of parish road rights-of-way for pipelines, and the laying of pipelines across parish roads and canals are regulated by the Police Jury, so they would be consulted regarding the proposed brine disposal pipeline which would cross the parish road leading to the site, and would also cross the small canals that lead from Calcasieu Lake into the interior marshlands west of the lake.

The planning for the brine disposal pipeline to the Gulf of Mexico would also involve state agencies. Where state highways would be crossed, the Louisiana State Department of Highways would be consulted. The Louisiana State Land Office has jurisdiction over state-owned lands that might be crossed, including the bottoms of lakes and navigable waters.

If the proposed brine disposal pipeline were used, the State Land Office would be consulted regarding the right-of-way through Calcasieu Lake. Regardless of which pipeline route is selected, the State Land Office would have jurisdiction over the beach and the offshore area which would be crossed by the pipeline.

The Imperial Calcasieu Regional Planning and Development Commission has prepared a general future land-use plan for the five adjacent parishes in southwestern Louisiana, including Cameron Parish. This plan projects land use in 1990 and focuses primarily on the expansion of urban areas in the region. There is no change in land use indicated for the West Hackberry site which is shown as agricultural land bounded on three sides by marshes, mineral extraction areas, and Black Lake. Use of the site for oil storage would be compatible with the land use plans for the area.

The U.S. Army Corps of Engineers has jurisdiction over surface water bodies and adjoining wetlands.

4.3.11 Summary of Adverse and Beneficial Impacts

There would be little or no impact on geomorphology or drainage patterns as a result of grading and filling at the West Hackberry expansion site. Only minor topographic changes would occur from spoil deposition. These changes would be temporary in marshes because the spoil would be used as backfill material. Some minor soil erosion would be associated with site construction. Brine pipeline burial could alter drainage characteristics of upland soil types. There would be no impacts to stratigraphy or geologic structure except for the salt mass itself and extraction of other minerals and petroleum off the flanks of the dome would not be affected.

Withdrawal of leaching water would cause negligible induced velocities in the Intracoastal Waterway. In addition, no significant changes in the salinity of the waterway would be expected during, even during the maximum withdrawal rate of 1.47 million bpd.

From 1800 to 3700 acres of ocean bottom would experience a 1.0 ppt increase in salinity as a result of offshore brine disposal.

Site preparation would result in a significant, short-term increase in fugitive dust emissions. Increased traffic would contribute to these emissions, but effects would be localized and the total contribution relatively small. Exhaust emissions would produce a minimal impact to the existing air quality.

The grinding of tanks would violate the 24-hour particulate standard at 1 kilometer, and painting tanks would violate the 3-hour NMHC Standard at 4 kilometers (1 percent of the time annually).

Increased noise levels would be relatively insignificant. Construction activities would destroy floral and faunal components onsite, along pipeline routes, and at spoil disposal sites. Biota would rapidly recover along pipeline routes, but the habitat would be permanently lost where buildings, tanks, ponds, and wellheads are constructed. Spoil deposition would result in permanent alteration of the biotic community. Overall, temporary losses of biological productivity and disruption to wildlife from construction activities are relatively minor and habitats would recover. Construction of the alternate brine disposal pipeline bordering Highway 27 through the biologically sensitive Sabine National Wildlife Refuge would disturb bird populations near the road. The recreational value of this natural resource would be reduced only during the construction period.

There are no known archaelogical or historical sites in the vicinity of the West Hackberry dome that would be impacted by site construction.

A maximum demand for approximately 400 workers would occur as a result of SPR construction for the West Hackberry site, but would not strain the available labor supply.

Use of the West Hackberry dome would not affect land use plans in the area.

Traffic would increase on local roads and would nearly double on the county road to the site. Ship traffic would experience a moderate increase.

Payroll would reach levels of $700,000 per month for a short period. Material and equipment procurement would amount to $150,300,000. Local spending would increase and government revenues would likewise increase as a result of money flow associated with the SPR construction.

Operational impacts are generally not as significant as construction activities except for oil and brine spills, and certain air quality impacts.

Oil or brine spills can produce significant environmental damage. Of particular concern would be an oil spill in Sabine Lake or in marshes and brine spills from the alternate brine disposal pipeline along Highway 27. Barren patches of ground could be created by such brine spills and the effects would be relatively long-term.

4.4 ALTERNATIVE SITE - BLACK BAYOU

4.4.1 Land Features

4.4.1.1 Construction Impacts

Since the storage site at Black Bayou is marsh covered, the 15 storage wells proposed would be constructed on elevated platforms; therefore, no fill or alteration of landforms or drainage patterns would occur. For the central plant, however, 9-10 acres would be filled to a height of 8 feet, which would be a significant, localized topographical change. The required dredging of new canals and the disposal of the estimated 125,000 cubic yards of spoil over 15 acres would also be significant topographic impacts. This dredging of waterways would alter the flow pattern in existing waterways.

The 14,000-foot oil pipeline connecting Black Bayou with the ESR pipeline for West Hackberry would cause a temporary alteration of the topography during pipeline construction. Similar temporary construction impacts would occur during the construction of the 3,500-foot raw water supply pipeline. For both pipelines, the dredging of trenches, even though back filled, could alter surface drainage patterns adjacent to the pipeline.

The brine disposal system would require that a 25-mile pipeline be built from the storage site to the diffuser in the Gulf of Mexico. The topographic impact during construction would be minor and temporary. As discussed above, drainage patterns would be temporarily altered. Construction impacts associated with a new dock at Sun Terminal have already been discussed in Section 4.3.1.1.

Soil impacts at the Black Bayou storage site would be severe where new canals would be dredged for access to cavern well platforms, and at the central plant areas where 10 acres of fill are required. In the canals the clay subsoil of the Harris soil association would be exposed, and the spoil would probably be used at the central plant as fill. The Harris soils at the central plant would be buried by Harris soil from other areas. The fill area would significantly affect the drainage pattern of the marsh surrounding it.

4.4.1.1 Operations Impacts

Operation and maintenance activities would have no impact on geomorphology (topography, drainage) at the Black Bayou storage site or along the oil or brine pipeline routes. Maintenance dredging for the barge dock at the storage site would be required; this would alter the bathymetry at the dock, and alter the topography at the spoil disposal site. Disposal of the spoil material would result in minor geomorphic alterations in the disposal area.

4.4.2 Water

4.4.2.1 Construction Impacts

Water quality within Black Bayou is dependent upon the quality of the water entering from the replenishment source. Limited water quality data for the ICW, a replenishment source via the Black Bayou Cutoff, indicates that levels of phosphorus, arsenic, mercury, toxaphene, lindane, heptachlor, aldrin, chlordane, dieldrin, endrin, and O.P'-DDT exceed the EPA numerical criteria. In addition, the levels of oil and grease (heptachlor, epoxide, methoxychlor, P.O'-DDT, P.P'-DDE, O.P.'-DDE, O.P'-DDD, and P.P'-DDD) pose possible problems. The levels of cadmium and mercury exceed the EPA numerical criteria for marine water constituents, and concentrations of copper and zinc may pose possible problems.

The salinity of the Sabine River near its junction with the ICW is about 6-9 ppt; that in the ICW, 0.17 ppt. Therefore, if the Sabine River is the ultimate source of replenishment water, as predicted by the MIT Water Quality Network Model (Appendix D.18) an increase in the salinity of water in the ICW would occur during the 38-month leaching process. A decrease in salinity in Black Bayou Cutoff would be expected. In general, Black Bayou and Right Prong would experience an increase in salinity due to more salty water being drawn from the East Pass of the Sabine River. The maximum increase in salinity in these water bodies would be less than 2.5 ppt.

During the leaching process at Black Bayou, 230 ppt brine would be discharged at a rate of 1.18 million bpd or 34,500 gpm for a period of 1,144 days. Current design calls for the disposal of the brine by means of discharge into the Gulf of Mexico as described in Appendix U. Construction of new canals for access to storage wells at Black Bayou would require the removal of approximately 125,000 cubic yards of dredged material. Dredging would also be necessary for about 300 feet of stream crossings for the oil pipeline spur and an additional 200 feet of stream crossings by the brine disposal pipeline, a total of about 96,000 cubic yards of dredged material.

Dredging and/or burial of pipeline would take place along the existing Trancontinental Gas Pipeline right-of-way across the Sabine National Wildlife Refuge, which consists almost entirely of marshland with one to two feet of water depth. Push-ditch dredging along this 18-mile route would move about 1,700,000 cubic yards, which would then be used to back-fill the trench after the pipeline is in place. The impact of such dredging would be a short-term turbidity of marsh waters with a minor dispersal of sediment. In addition, a compaction of the replaced dredge material, which commonly occurs after dredging in marshes, may slightly alter the drainage patterns and microhabitat structure of a localized area of marsh.

Sixty-two acres of wetland habitat at Black Bayou would be converted to spoil area. No long term impact is anticipated on the marsh south of Black Bayou as the dredged material would be used to back-fill the pipeline trench.

The site preparation and construction would involve a significant amount of earth movement during a 5-month period. Approximately 230 acres of land would be disturbed. Also, 99 tons or 97.8 cubic yards of sediment would be washed into the surface water system during this period as a result of erosion. Much of the sediment would be deposited in Black Bayou. The introduction of sediment into the bayou would increase the average level of suspended solids by 0.99 ppm for most of the entire 5-month period.

Chemical and biological pollutants would be generated during construction activities at Black Bayou. Most problems with chemical pollutants arise from excessive or improper use of industrial or agricultural chemicals on or near the site. Biological pollutants are generally the result of poor sanitary conditions at a construction site. The degree of pollution can be minimized by thorough training of construction personnel and adherence to reasonable housekeeping practices.

Since the Black Bayou SPR facility would not involve use of the shallow or deep aquifers for a water source or brine disposal site, the subsurface water system would experience no impact as a result of site preparation or facility construction.

4.4.2.2 Operations Impacts

The rate of withdrawal of water for displacement of the stored oil, 1.05×10^6 bpd or 30,680 gpm, would be only slightly higher than that for leaching. If Black Bayou were completely isolated from all other water bodies, this withdrawal rate would lower the water level at a rate of .351 ft/day. Because the bayou is connected with the ICW and the Sabine River, the actual rate of water level descent would be less. Induced currents* would replenish the water withdrawn from the bayou.

*Induced currents - Flow into a region produced by viscous or pressure effects within the region.

If the ICW were the sole replenishment source, the resulting induced velocity for Black Bayou would be 0.15 ft/sec, while in Black Bayou Cutoff such changes would amount to less than 0.08 ft/sec. The water level at the withdrawal point would drop 0.06 ft below the level at the junction of Black Bayou Cutoff with the ICW. If the Sabine River were considered to be the ultimate replenishment source, an induced velocity of less than 0.02 ft/sec would occur in the ICW. Impact on water supply should be minimal under normal wind and tide conditions.

The water quality within Black Bayou is dependent on the quality of water from the replenishment sources. Because the ICW would serve as a replenishment source for Black Bayou, the contaminants such as pesticides, oil, and grease present in the ICW would be introduced into the bayou via Black Bayou Cutoff. The levels would be less than those currently found in the ICW, and thus none of the recommended criteria would be exceeded.

The Sabine River shows levels of cadmium and mercury in excess of those recommended by the EPA. Levels of copper and zinc ~~also~~ appear to be high but violate no current standard or criteria. Salinity in the ICW would rise slightly since the Sabine River would serve as a portion of the source of replenishment.

During the refill of the Black Bayou storage caverns, 165 ppt brine would be discharged at a rate of 175,000 bpd, or 5,100 gpm for a period of 857 days. Current design calls for discharging brine into the Gulf of Mexico, using the same brine disposal system used during the leaching operation.

The disposal site and the proposed specific criteria for the diffuser for Black Bayou are similar to those proposed for West Hackberry (National Oceanic and Atmospheric Administration, 1977). As described in Appendix U, the impacts produced by the brine plume at the Black Bayou disposal site would be similar to that at West Hackberry. For excess salinities greater than 1 ppt the exposed bottom area would amount to less than 1960 acres. The bottom exposed to excess salinities greater than 3 ppt would amount to less than 104 acres.

4.4.3 Air Quality

4.4.3.1 Construction Impacts

The construction of the proposed oil storage facility at Black Bayou would result in combustion and fugitive emissions along the pipeline right-of-way and at the dome site. A detailed discussion of emission sources and their characteristics was presented in Section C.3.3. Annual tonnage emission rates from various sources are summarized in Table C.4-1, Appendix C.

Emission control technologies, regulations, standards, as well as the short-term and long-term modeling used to assess Black Bayou air quality impacts, are the same as those discussed in Section C.3.3.

The greatest impact on local ambient air quality during construction at the dome is due to to tank preparation and land preparation activities. Short-term modeling of tank surface preparation indicates that the 24-hour particulate standard would be out to a downwind distance of 1 km, or well within plant boundaries. Painting would exceed the 3-hour non-methane hydrocarbon (NMHC) standard to a downwind distance of approximately 4 km. The maximum frequency of violation would amount to roughly 1 percent annually, based upon annual meteorological data, and would occur to the west of the dome. Painting would require less than one month, and its effects would be a function of the meteorological conditions during that period. The indicated violations would be limited to within the plant site boundaries.

Long-term or annual pollutant ground-level concentrations would be insignificant for construction activities with the exception of large-scale land-clearing activities at the dome. Modeling results indicate that the Federal Primary Standard for particulates would be exceeded within approximately 2 km of the construction area at the dome site.

Other pollution sources during construction would be mobile and widely distributed, with local and brief impact on ambient air quality.

The Nederland terminal and dock proposed for the West Hackberry expansion would also be used for the Big Hill site. See Section C.4.1.3 of Appendix C for an assessment of the impacts on air quality resulting from terminal and dock construction.

4.4.3.2 <u>Operations Impacts</u>

The emission sources for Black Bayou from operational activities include 1) the offloading of crude oil from tankers at Sun Terminal during fill (estimated at 144 tons/year), 2) the loading of the oil onto tankers during withdrawal (estimated at 1093 tons/year), and 3) the emissions from dissolved hydrocarbons which are present in the brine discharged during oil refill (estimated at 210 tons/year). A summary of these emissions can be found in Table C.4-3 of Appendix C.

Short-term modeling calculations have been performed for project hydrocarbon emissions at both the dome and terminal sites. At the Black Bayou dome site, short-term NMHC ground level concentrations would exceed the 3-hour standard 0.5 Km downwind from the brine holding pond during oil refill due to the release of dissolved hydrocarbons in the brine (see Appendix N).

This would be a localized air quality problem and would be confined within the site boundaries. However, during tanker loading and unloading operations at the Sun Terminal, the standard would be exceeded. During tanker loading in the distribution phase, the 3-hour NMHC standard would be violated 1 percent or more of the time annually to a distance downwind of 25 km. The maximum impact would occur 5 or more percent of the time annually to a downwind distance of approximately 10 km. During ship ballasting operations following the completion of tanker unloading, the applicable standard would be exceeded to a downwind distance of approximately 20 km, with maximum impact occurring west of the facility where the frequency of violation is in excess of 2.5 percent annually. These calculations do not include the minor additional dilution attributable to structural wake effect.

Annual NMHC ground level concentrations from various activities for the dome and terminal sites would be less than 5 ug/m^3, based upon the conservative assumption that both the fill and drawdown phases could occur, at least in part, during the same annual period. For the dome site, annual NMHC concentrations would be generally less than 0.45 ug/m^3 downwind of the dome site sources.

In summary, the emissions from the brine pond at the Black Bayou site and tanker related emissions at the Sun Terminal facilities would be the principal sources of NMHC, and, to a lesser extent, combustion contaminants. However, the emissions from the terminal operations would constitute the largest source of the total emissions. Violations of the 3-hour standard for NMHC are predicted onsite for the dome facility and downwind of the Sun Terminal facility. The facility would not result in violations of air quality standards for other contaminants.

4.4.4 Noise

4.4.4.1 Construction Impacts

Construction activity at Black Bayou would affect ambient noise levels at the storage site and in adjacent areas where construction would coincide with site preparation. Noise sources at the storage site during site preparation would be trucks, earth moving equipment, compressors, drilling rigs, concrete mixers, and construction equipment. Diesel engines would provide the most consistent source of noise, and drilling equipment would create the peak sound levels. Areas adjacent to the storage site are sparsely populated marshlands. Assuming 24-hour drilling activity for two rigs, it is estimated that the equivalent sound level would be no more than 55 decibels (db) at 2,000 feet from the center of the site. The contribution of storage site construction to annual 24-hour levels, assuming 6 months of drilling, would also be no more than 55 db at 2,000 feet from the center of the site.

Assuming daytime activity only, pipeline construction noise would contribute no more than 55 db to the equivalent sound level (Ldn) at 500 feet from the pipeline rights-of-way. Annual noise levels along the pipelines would not be affected significantly because of the relatively short construction period at any one pipelaying location.

4.4.4.2 Operations Impacts

The major noise associated with operation at the Black Bayou site and at the Sun Terminal would be from on-site pumping operations, tanker traffic, and tanker pumps for discharging, loading, and transfer of crude oil. The analysis of pump noise at West Hackberry, a site having similar ambient sound levels, was estimated to increase the noise level at the site perimeter no more than 3 db during operation (FEA, 1977). An increase of about 20 percent in terminal and tanker operations is predicted at the Sun Terminal on the Neches River.

Noise is expected to be continuous day and night during these operations. However, since the pumps at both the storage and terminal facilities would be enclosed in pumphouses, or other sound attenuating structures, their impact on existing ambient noise levels would be negligible.

4.4.5 Species and Ecosystems

4.4.5.1 Construction Impacts

Displacement/Leaching Water System Impacts

Construction of the intake sump and installation of intake structure pilings in the eastern side of Black Bayou would result in the direct destruction of the benthic organisms, such as clams, rotifers, and nematodes, present in the vicinity of sump and pilings. Spoil deposition would destroy marsh fauna and vegetation in the spoil disposal area.

Burial of the water intake pipeline would also result in direct destruction of marsh organisms. Increases in suspended sediments would increase turbidity and enrich the local ecosystem with nutrients. Pollutants or naturally occurring chemically reactive or toxic materials could also be released from the sediments. The marsh along pipeline routes would probably revegetate within two years, and vegetation would be expected to reestablish itself on unsubmerged spoil within two years. Increased turbidity would reduce primary production of submerged plants, and chemically reactive materials such as oxygen-demanding substances would briefly be a stress to the submerged biota. The nutrients added from construction of the water system would be a relatively small quantity compared to the amount naturally present and would be readily dispersed except perhaps at the dredge disposal site. Material may drain from disposal areas for years, and continue to silt over marsh vegetation, slowing the process of recovery.

Brine Disposal System Impacts

The on-site brine pipeline would run parallel with the water supply and oil distribution pipelines. Impacts on biota associated with laying similar lines at Black Bayou salt dome have been discussed above.

Construction of the disposal pipeline south to the Gulf of Mexico from the central plant across marshland, water channels, and open water would directly destroy marsh vegetation in the pipeline path, displace wildlife, and temporarily disturb the environment by increasing erosion and sedimentation. Approximately 351 acres of marshland, 3.6 acres of inland water and 42.5 acres offshore in the Gulf of Mexico would be disturbed by construction of the brine pipeline. The marshland consists of alternating stretches of the brackish and intermediate marsh types. Organisms present along the pipeline route before construction would be expected to reestablish within two years.

An estimated 24,006,966 kg dry wt of organic matter production would be lost over a two year period. Gross primary production (benthic plants) lost in 3.6 acres of estuarine open water over two years would amount to 20,378 kg. Aquatic vegetation which makes up most of the primary production is a major food source of numerous species of waterfowl which spend the winter season in the area.

Sediment exposed or dislodged by dredging would probably not be dispersed far from the pipeline right-of-way. After dredging and before backfilling, the sediment would be placed on top of marsh vegetation, thus crushing and smothering these oxygen-using organisms beneath it.

Turbidity resulting from suspended solids would probably remain high during the period of construction, and subsequently as water motions resuspend the backfilled material, so that plant production and feeding of some animals would be reduced. Siltation would interfere with respiration, reproduction, settling, and attachment of larval stages of benthic organisms. Reduced oxygen levels would inhibit the metabolism of organisms and, if too low, would cause mortality among many species. Eventually, suspended sediment along the brine disposal route would settle and biota would reestablish itself. The more easily dispersed pesticides would probably be dispersed within several months. Also, water would be somewhat enriched, from resuspended nutrients and present biological communities would be temporarily stimulated to show increased productivity.

Near the coast, the brine line would cross slightly sandy ridges (cheniers), Highway 82, and sand beach onto the floor of the Gulf. The small amount of pasture or cultivated land to be crossed in this vicinity would be expected to revegetate within one or two years. However, it could take several years for vegetation of the original type (trees, cacti, brush) to be reestablished. Small areas of pasture or cropland which were affected would be usable within a year after construction.

As in the construction of other parts of the pipeline, birds and wildlife near the coast would be temporarily disturbed and displaced by the increased human activity and noise in the area. Many of the less mobile vertebrate and invertebrate animals, including their nesting areas, would be sacrificed along with the vegetation. Construction effects on beach and shore biota and on organisms of the Gulf of Mexico would be similar to those discussed for the brine line from the storage facility at West Hackberry (Section 4.3.5.1).

Impacts at the Storage Location

Plant and animal life would be affected by varying degrees during the construction of the central plant facility, the access canals the equipment barge dock and slip, the leaching/ displacement water system and the brine and oil pipelines. Pipeline, intake sump, and platform construction have already been discussed in relation to leaching and displacement impacts (see Section C.4.1.5.1).

The central plant would be constructed on a land-filled area of about 10 acres. The nonmobile and slightly mobile marsh organisms in the entire 10 acres would be destroyed during construction. These organisms include mollusks, oligochaetes, polychaetes, shrimp, crabs, amphipods, and midge larvae. Ten acres of marsh habitat would be permanently altered. Sediment levels in the adjacent marsh and nearby canals would increase for a limited time. The gross primary production loss assumed for these 10 acres is 9,750 g dry wt of organic matter/m^2/year or 394,582 kg/year for marsh within 50 m of a channel. This would amount to at least 9,864,562 kg for at least 25 years.

Dispersal of the suspended solids as a result of land-filling would affect biota minimally in the area around the central plant location, since the materials used would be clays selected for low erosion under wetland conditions. Dredging the access canals, equipment barge slip, and constructing the equipment barge docks would destroy organisms similar to those found at the central plant area in the direct path of the dredging. Organisms of the peripheral wetland and canal areas would be affected by increased suspended solids.

Water turbulence and high suspended solid levels would persist throughout construction, and would not return to normal until after construction and drilling were complete. Also, since the amount of dredging would be relatively large compared to the total area of the site, and since dredged material would be disposed of in the immediate vicinity of the site, all of the on-site and surrounding surface water would show appreciable increases in suspended solids. The water within a 2,600-foot radius, largely a mixture of marsh and open water, would experience the increases.

All animals and vegetation in approximately 7.4 acres of marsh would be destroyed in constructing the access canals. Similar organisms would be destroyed and the habitat permanently altered in the 10 acres of marsh allotted to spoil disposal. Gross primary marshland production (1.7×10^7 kg) would be lost for the 17.4 acres over the 25 years of the storage project. Some biota would appear on spoil in the disposal area, however, but estimation of productivity of the spoil bank community remains uncertain.

Another 459.7 acres would be affected by increases in dissolved solids from filling, dredging, or spoil disposal beyond the immediate impact area. Most of the increase would occur within a few hundred feet of a single source. However, the multiple sources in this large area would be present for a prolonged period, and suspended solid levels might be expected to build up in the site vicinity beyond this distance. At worst, complete interference with aquatic biota is assumed for 459.7 acres (60 percent of which is marsh; 40 percent, open water) for 31 months after beginning of construction, which would result in a loss of up to 2,056,088 kg dry weight of organic matter of gross primary production.

Nutrient enrichment could stimulate production in the marsh and aquatic community at the periphery of the highest levels of suspended sediments. A minor impact may be that organic detritus stirred up by dredging may temporarily be made more available to mobile consumers (U. S. Army Corps of Engineers, 1976). New open water habitats would be created by construction of access canals and the barge slip. Populations of benthic organisms could be well established within six months after sedimentation and other stresses are reduced.

Short-term sedimentation of dredged material has been reported to eliminate as much as 70 percent of the average number of benthic organisms in a covered area and to cause a considerable reduction in the number of species present (Cronin et al, 1970; Sailla et al., 1971, cited in U. S. Army Corps of Engineers, 1976). Burrowing animals are not generally harmed by being covered once by sediments. Waterfowl, mammals, and reptiles would be disturbed and would emigrate from the site because of increased noise, human activity, and habitat disruption during construction.

Oil Distribution System Impacts

Organisms would be destroyed in the path of the oil lines, which would be laid in Black Bayou Cutoff. Dredging would be required along 1.9 mile of channel in a strip perhaps 20 feet wide over a period of no more than a few weeks. The total excavated area (4.61 acres) would eliminate benthic standing crop and production indefinitely, but new populations of organisms would probably become established within six months (U. S. Army Corps of Engineers, 1976). Full recovery of the predredging community structure could require two years or longer. A complete loss of benthic gross primary production for one year in 4.61 acres is estimated at 13,022 kg dry wt of organic matter.

Suspended solid levels would be raised in the Black Bayou Cutoff for a period during and after the oil lines are laid and would probably subside rather quickly as backfilled dredged material stabilizes and organisms become established on and in it. Suspended solid levels would probably return to predredging levels within no more than a few months. Nutrient additions to the aquatic system in the vicinity would stimulate primary and dependent secondary production so that the deleterious impacts of the initial high sediment loads would be partially compensated.

The 0.8 miles of marsh on the site through which the oil distribution lines would pass would be disturbed by other construction activities in the area as well. Effects of suspended solids generated by construction in this segment have been discussed in connection with onsite impacts. Burial of oil lines would destroy slightly mobile and nonmobile biota such as marsh grasses, epiphytic organisms, and benthic organisms in the excavation path, and would kill and injure some organisms on the banks of the burial trench. Biota on trench banks would be injured to an indeterminate extent by vehicles which would guide the pipeline into place and by temporary storage of excavated sediment. Assuming that one-half of the vegetation and other biota are destroyed, and recovery is half completed within a year and completely recovered within two years, standing crop and productivity would be lost in 7.2 acres over the equivalent of a year, which is equivalent to approximately 312,441 kg dry wt of organic matter. The estimated loss of food by bacteria and marsh animals is 2,197 kg dry wt of organic matter.

4.4.5.2 Operations Impacts

Displacement/Leaching Water System Impacts

Withdrawal of leaching and displacement water from the Black Bayou Channel would entrain organisms and nutrients, displace organisms in the connected water bodies, and impinge or trap organisms against intake screens. The local surface water level would remain fairly constant because of tidal replenishments, but pollutants could be introduced thereby.

It is estimated that during each displacement more than 2.04×10^{12} phytoplankters and more than 5.64×10^{10} zooplankters could be killed. Large numbers of microorganisms and large amounts of organic and inorganic nutrients would also be lost from the aquatic system in the area during leaching and displacement. Production losses resulting from withdrawal of organisms with the displacement and leaching water would occur out of time phase since the organisms responsible for production would be withdrawn progressively over long time intervals. Entrainment of plankton would occur continuously during leaching and oil displacement. Production losses caused by lateral displacement of small mobile and nonmobile organisms into the new environmental settings presumably would be diffused, thus difficult to measure, but they may be significant when considered cumulatively.

Meroplankton* passing into the Black Bayou aquatic system would probably be withdrawn with leaching and displacement water resulting in a reduction in fish and shellfish in the area. Salinity changes could be induced during leaching/displacement water withdrawal. Consideration of the normal salinities in the Sabine River near its junction with the ICW in comparison with the normal tidal regime suggests that salinity would not be increased more than two or three parts per thousand for more than a week under ordinary limiting conditions. However, any such increases would have an impact on other areas as well as Black Bayou since the water would have a certain residence time in the estuary.

Occasional salinity increases similar to those given above for the suggested maximum interval probably would not be permanently injurious to most benthos, nekton, and rooted marsh plants in the area. However, salinity-sensitive organisms would probably be impaired. If induced salinity increases occurred with great enough frequency, species composition, and community productivity would probably be altered. Planktonic organisms would be transported with water and presumably

*Meroplankton - Animals which are adapted to planktonic existance only during the first stages of their life cycles.

would not be subjected to as rapid a change in salinity as other organisms.

Water quality in the ICW is degraded by high levels of phosphorus, pesticides, arsenic, mercury, oil, and grease. Cadmium, mercury, zinc, and copper are at high levels in the Sabine River compared to recommended EPA levels for this area. Such pollutants would be introduced into the Black Bayou system along with replenishment water. Most of these contaminants are toxic materials which would stress the aquatic and marsh biota in the area. Mercury and hydrocarbon pesticide levels would be of special concern since such materials can be concentrated through the food chains of commercially important animals, as well as the other animals.

Brine Disposal System Impacts

The biota of the Black Bayou site is generally typical of the coastal waters of the northern Gulf of Mexico at the 30-foot contour interval. This is particularly true of the phytoplankton, zooplankton and demersal nekton communities whose species compositons are readily comparable to those found along the Louisiana-Texas coastline. Standing crops for these communities are also roughly comparable to those elsewhere in this region. The benthic community on the other hand is dominated by a limited number of species most of which are typical of degraded conditions such as associated with oil spillage. A significant finding is that standing crop for the benthic community is low, as discussed in Appendix U.4.

The phytoplanktonic community is dominated by a mixture estuarine and marine diatoms. This probably reflects the mixing of estuarine waters from Calcasieu Pass with offshore marine waters. Species composition varies dramatically from month to month but Skeletonema, Coscinodiscus centralis, Biddulphia spp. Rhizosolenia imbricata, R. robusta, Chaeotoceros currisetum, and C. affine are typical dominants. Interestingly September and December were wholly dominated by just one or two species (particularly Skeletonema) while October and November showed a diverse, equitably distributed species composition. Dinoflagellate numbers, as expected, were low for this time of year.

The zooplankton at Black Bayou brine disposal site, as with the other disposal areas studied during September through December, 1977, had many copepods as its main dominants. Acartia (a calanoid), calanoid sp. 1, calanoid sp. 3, nauplii (larvae), Corycaeus (a cyclopoid), Euterpina (a harpacticoid), Okopleura (a tunicate), Oithona (a cyclopoid), and Temora were among these dominants. This location is of high quality with respect to zooplankton abundance, with the abundances being of a similar order of magnitude to average combined densities at West Hackberry and Big Hill.

The species composition of the nekton community is fairly constant from month to month, and is typical of Louisiana-Texas coastal waters. Standing crop varies markedly from month to month, but these fluctuations appear to be driven by random variation in the populations of the top dominant species, Acetes americanus, a sergestid shrimp, and Anchoa mitchilli, the Bay Anchovy. An influx of species during November probably reflects the fall offshore migration of estuarine summering forms.

The benthic community is almost wholly dominated by either the marine worm (polychaete) Magelona sp. (October, November, December) or the clam Mullinia lateralis (September). In both cases the second ranked species was only about half as abundant as the top dominant. Such a community structure is typical of environmentally degraded conditions. This is supported by the remarkably low standing crop in the benthic community. Both Mullinia and Magelona are known to be indicator species for degraded environments.

The most severely impacted region would be that nearest the diffuser port where highest salinities overages would be encountered. Based on MIT transient plume model, utilizing limited real world current observations for the Black Bayou site, for typical current regimes no more than 104 acres would be enclosed by the 3 ppt excess salinity isohaline. If total mortality within this region is assumed, about 1.3×10^6 benthic individuals/acre would be eliminated. In the context of the broadly distributed nearshore benthic community, this is not a significant impact. Beyond the 3 ppt isohaline brine impacts on the benthic community would be expected to be minimal. Inasmuch as the planktonic and demersal organisms are either quickly carried through the diffuser site, or can otherwise avoid this region, impacts on these communities should be slight.

Impacts on biota from operation of the brine disposal system would be essentially the same as those described in connection with brine disposal at West Hackberry (see Section C.3.2.5.2 for a full discussion).

Impact at the Storage Location

On-site operation of the storage facility would have a minimal effect on biota. During filling or displacement, machinery noise and road traffic would increase. Some of the animals initially disturbed in the area would adjust after a certain period. Air pollutants would be increased slightly, and waste materials and chemicals used in pest control could become small sources of water pollutants. Most release of contaminants into water could be easily controlled.

Oil Distribution System Impacts

Because much of the crude oil pipeline route for the Black Bayou site would be common to the West Hackberry pipeline route, only those impacts which might result from a break in the connector line or are otherwise germane to the Black Bayou site are considered here.

An oil spill from the crude oil connector line would form a slick on the surface waters of Black Bayou Cutoff, Black Bayou, and possibly the canals associated with Black Bayou. Oil would very easily be carried into the marshes where recovery is more difficult than on open water. Assuming an oil-holding capacity* for marshland of 25 barrels of oil per acre, it is obvious that several acres of marsh could be contaminated (depending on the amount of oil spilled). A 1000 bbl spill would, based on this assumption, cover 40 acres of marsh. A die off of vegetation and pollution of surface waters would significantly degrade the habitat of wildlife such as nutria, muskrat, mink, beaver and waterfowl (herons, egrets, ibises, and gallinules). Effects are expected to be relatively short-term, with recovery of vegetation starting within a month and wildlife habitat restored, within one or two years, assuming proper cleanup procedures are employed.

4.4.6 Natural and Scenic Resources

4.4.6.1 Construction Impacts

The brineline from the Black Bayou facility would follow an existing pipeline corridor for approximately 11 miles through the marshland within the Sabine National Wildlife Refuge. Effects on the natural and scenic resources of the refuge during construction would be minor and temporary. All parks in the Black Bayou area are located far enough from construction areas so that no impacts are anticipated on these recreational sites.

4.4.6.2 Operations Impacts

Normal operation and maintenance of the Black Bayou facility is not considered to have an adverse effect on the Sabine

*Oil-holding capacity - The ability of soils to absorb oil for a period of time.

National Wildlife Refuge. In the case of a break in the brineline during operation, the resulting brine spill could affect significantly the scenic and natural resource values of a localized area of the refuge by destroying marsh vegetation.

4.4.7 Archaeological, Historical, and Cultural Resources

4.4.7.1 Construction Impacts

The known archaeological and historical sites in the vicinity of Black Bayou dome and pipelines would receive no adverse impact from site preparation or construction. After the results of a Cultural Resource Study are analyzed, appropriate procedures would be initiated for any compliance with the National Historical Preservation Act of 1966 and Executive Order 11593.

4.4.7.2 Operations Impacts

The known archaeological and historical sites in the vicinity of the Black Bayou dome and pipelines would receive no adverse impact from the operation and maintenance of this facility.

4.4.8 Socioeconomic Impacts

4.4.8.1 Construction Impacts

During construction of the proposed Black Bayou storage facility, a substantial number of workers would be hired for a short time. The peak manpower level occurs in the second and third months and results primarily from the labor requirements for laying pipelines for brine disposal, raw water intake, and connection to the crude oil pipeline along the ICW.

The marsh terrain would require the use of barges for part of the onshore pipeline installation, and for all pipeline work offshore. Labor estimates assume that two crews of 120 to 180 workers each would work simultaneously, one on land, and one on a barge. Construction of buildings and installation of equipment at the storage site would be completed during the initial six months, with a peak manpower level (260 workers) in the fourth month. Wells to the storage caverns would be made by using two drill rigs on barges, and one land rig.

The majority of workers, pipefitters, welders, and equipment operators would be hired from the region. Workers could be drawn from the metropolitan districts of Sulphur and Lake Charles on one side, and Orange and Port Arthur on the other. Workers would also be hired from Vinton, but it is not large enough to supply all the labor needs of the project. Construction of the brine disposal pipeline through the remote areas of Cameron Parish would employ people of that area.

Drawing the peak level of workers from Calcasieu and Cameron Parishes and Orange and Jefferson Counties would reduce the unemployment rate in these areas. The peak labor needs of the project could be met almost entirely from Calcasieu Parish, Cameron Parish, and Orange County. Unemployment in Calcasieu Parish would drop from 8.6 percent to 8.1 percent; in Cameron Parish, from 8.2 percent to 7.7 percent; in Orange County from 7.7 percent to 7.1 percent; and in Jefferson County the unemployment rate would be affected by less than 0.1 percent. Workers in Jefferson would be employed by the expansion of the oil port facilities at Nederland.

After the completion of the brine disposal pipeline and the construction of surface facilities at the salt dome, the labor force would be reduced to levels of 160 and 120 workers over a period of a year, then stabilize at about 60 workers for two years. The resulting number of workers on the site during the day would be in the range of 50 to 60 until the drilling is complete, and 30 to 40 during the two years of leach and fill.

Since the land around the periphery of the Black Bayou salt dome is currently being used for oil production by the Shell Oil Company, the construction of tanks, wellheads, pump structures, or similar structures would not constitute an alteration of the existing land use patterns.

The access canals that would be dredged through the marsh would be extensions of an existing network. The disposal areas would be designated by the Corps of Engineers permit application and the impacts associated with their construction would be minimized through the use of the best available dredging technology.

Construction of the brine disposal pipeline would have a temporary adverse effect on land use. Although the pipeline route would follow an existing pipeline right-of-way, the movement of heavy equipment and daily transport of workers through the wildlife refuge would be at variance with the intended use of the land. South of the refuge, Highway 82 would be crossed near Johnsons Bayou, and the Louisiana Highway Department would be consulted regarding procedures to be followed to maintain use of the roadway while pipeline is laid beneath it. The beach between the highway and the Gulf of Mexico would also be crossed. The beach habitat and its scenic value of the beach would be marred during the laying of the pipeline, but the effect would be short-term.

Traffic in the area would be affected by workers commuting to and from the site, equipment and materials being brought by barges to the site, and by the brine pipeline being laid under Highway 82 near the coast. Increases in traffic near the site during the operational phase is shown below.

	Recorded Traffic	Peak Period Increase	12 Month Average Increase
Interstate 10 at Vinton	8,800	8%	3%
Route 108 South	180	405%	169%
Gum Cove Road	140	521%	217%

There is a free ferry where the parish road crosses the Intracoastal Waterway; however, arrangements for bus transportation from the ferry site or construction of a bridge at the crossing would have to be made.

After the peak traffic period is reached, the average number of vehicles traveling to and from the site would decrease to about 55. This represents an increase of less than one percent on Interstate 10, 30 percent on Route 108, and 40 percent on the parish road.

Transportation of heavy materials and equipment by barge would constitute a 15 percent increase in traffic on the Intracoastal Waterway between the Sabine and Calcasieu Rivers and the Black Bayou Cutoff Channel.

When the brine disposal pipeline is laid beneath Highway 82 east of Johnsons Bayou, there would be some disruption of traffic along the road; however, since the highway is used as an evacuation route during hurricanes, cars would be allowed to pass while the pipeline is being laid under the road bed. There are no parallel roads that would serve as detour routes.

If the construction and fill of the Black Bayou Dome begins 6 months after construction starts for the early storage facility at West Hackberry, the impact on ship traffic to supply oil for the initial fill would be the same as for the West Hackberry facility expansion. Considering the Black Bayou site by itself, and using the timetable for construction and fill shown in Section 2.5.6, the yearly increase in tanker trips on the different sections of the waterway would be as follows:

	Additional Tanker Trips	Sabine Pass Port Arthur Increase	Neches River Increase
10th - 28th month	220	12%	23%
28th - 42nd month	136	9%	17%

Job openings created by the project are expected to attract about 15 percent of the peak labor force from outside the local region, bringing nearly 90 workers into the area. An estimated 35 workers may seek housing in Lake Charles, 25 in Orange, 15 in Sulphur, and 15 in Vinton.

The impact on housing availability in the three cities would be quite small and would probably not affect rental costs. It can be assumed in all four localities that because the homeowner vacancy rate is below 3 percent, the workers would move into rental units rather than buying a home. The availability of rental units would be reduced by less than one percent in both Lake Charles and Orange, and would decrease by about one percent in Sulphur. The availability of housing in Vinton is very limited.

Workers who incur minor injuries at the site would be brought to the community hospital at Vinton. More serious injuries, particularly those affecting workers laying pipeline through the remote marsh area of Cameron Parish, would require evacuation by helicopter ambulance services operating out of Lafayette and Houston. The additional activity at the site during construction, and the congestion on roadways leading to the site would place an additional burden on the police services in the area. The regional economy would benefit from the additional income to workers and from the supply of a large part of the materials and equipment needed by the project. The average payroll of workers employed by construction of the facility is shown as follows:

1st through 6th month:	$611,700 per month
7th through 12th month:	$286,700 per month
13th through 18th month:	$244,000 per month
19th through 42nd month:	$127,000 per month

During the second and third months of construction when pipelines are being laid, the payroll would reach a peak of $1,160,000 per month. The payroll levels are based on an assumed average wage of $2,000 per month.

The total of all expenditures for materials, equipment, and construction services for building the facilities would be approximately $193,900,000 of which over 80 percent, or $160,400,000 would be spent in the region. Application of a 2.05 multiplier factor, based on the assumption that the money spent for the oil storage construction would circulate in the area, results in an estimated increase in local earnings of $328,800,000 shared by both the BEA* area of Lake Charles and the BEA area of Beaumont-Port Arthur-Orange. The increase

*BEA - Bureau of Economic Analysis.

would constitute a 7 percent gain over the local earnings anticipated for 1980 in the two regions combined. The economic activity induced by the project would amount to a 13 percent increase over the level expected to be reached in 1980.

Comparing the additional earnings which would accrue to the two adjacent BEA regions because of the SPR project at Black Bayou to the anticipated growth in earnings shows that regional growth in earnings would be increased by 39 percent. Growth in earnings of the metropolitan areas would be increased by 65 percent between 1980 and 1985.

In the event that the Black Bayou dome is chosen for an oil storage site, there would be no appreciable cost to Cameron and Calcasieu Parishes. There would be a loss of revenue associated with the transfer of property at the dome to federal ownership since federal lands are exempt from property tax.

On the whole, local governments would benefit from the increase of sales taxes and in general economic activity derived as a secondary effect of the construction work. Sales taxes on workers wages collected as local revenue would amount to about $203,000 in the first year, $84,000 in the second year, $29,000 in the third year, and $14,000 in the remaining six months of construction. This revenue would be divided proportionally between Louisiana and Texas according to the residences of the workers.

4.4.8.2 Operations Impacts

The operation of the storage facilities would employ about 20 workers at the site. There would be workers at the site on a 24 hour basis, working in shifts.

Current land use patterns of the lands around the site are not likely to change during the life of the project. The future land use plans developed for Southwest Louisiana by the Imperial Calcasieu Regional Planning and Development Commission show the site and adjacent areas designated as being used for industrial purposes, a category which includes mineral extraction. The use of the land for the proposed oil storage facility would conform to this plan. Coastal zone management plans are being developed by the Louisiana State Planning Office, but specific regulations governing development in this area have not been formulated.

In the event that part of the Gum Cove Ridge, 5 miles east of the site, is selected as a recreational park, the presence of the storage facility would not interfere with the aesthetic value of the park.

During the operation of the storage facility, workers traveling to and from the site would constitute the major impact on roadway traffic. The portion of Route 108 leading south from Vinton would have an average daily traffic flow about 22 percent higher than that recorded in 1971, and the Gum Cove Road traffic flow would be 29 percent higher.

During a period when oil is withdrawn from the storage caverns, the impact on tanker traffic along the Sabine-Neches Waterway would be insignificant. Refilling the caverns at Black Bayou, however, would increase traffic on the waterway. The period of refill for Black Bayou alone would be only 28 to 30 months, but the Early Storage Reserve caverns at West Hackberry, which hold 60 million barrels, would be filled, extending the period of increase to 40 months. Tanker traffic along the Sabine Pass and at Port Arthur would be increased by 12 percent, and such traffic on the Neches River would be increased by 23 percent.

The emigration of workers who moved into the region to take jobs during the construction of the project would probably have no noticeable effect in Lake Charles, Orange, and Sulphur. Effects would be greater in Vinton because of the smaller housing market. The incremental increase in the population of the town over the 1980 projected population of 4,300 would be less than 2 percent. The increased need for public services to accommodate these workers and their families would be very small.

Economic impacts during the storage phase of the Black Bayou facility would be on a scale similar to a small business enterprise. There would be expenditures for payroll, supplies and parts, transportation and contingencies. Payroll would amount to about $45,000 per month of a total expenditure of $125,000 per month. Applying an economic multiplier, a total increase in local earnings of $3,075,000 can be predicted. This represents a gain of less than one percent over the anticipated 1985 level of earnings for Lake Charles and Beaumont-Port Arthur-Orange. During a period of oil withdrawal, site expenditures for operations and maintenance would reach a level of about $520,000 per month for up to 5 months. After the supply interruption, the caverns would be refilled at an operations and maintenance cost that lies between the normal standby level and the oil withdrawal level, and would probably be approximately $250,000 per month. This does not include the cost of the oil itself.

The use of Black Bayou as a storage site would primarily benefit the town of Vinton. It is there that many of the workers would live during the operational phase, because it is the closest town. Vinton is about 20 miles from the site, and the trip is slowed by having to use the ferry to cross the Intracoastal Waterway, and by the condition of the road that stretches for about 5 miles along the Bancroft Canal.

The storage project by itself would not generate revenues for the local governments. There would be gains in local government revenues derived from the secondary economic effects. The major portion of this would be from the increase in local earnings. Revenues from sales tax alone, applied to the spending of wages of workers employed permanently at the site, would amount to a contribution of about $20,000 per year.

4.4.9 Impact Due to Termination

After termination of the SPR program, if the facility is not to be used for any other government purpose, the project would be shut down in accordance with applicable laws and regulations. At Black Bayou, the sensitive nature of the site would dictate that environmental concerns associated with marshlands be fully considered prior to termination.

4.4.10 Relationship of the Proposed Action to Land Use Plans, Policies, and Controls

Except for a portion of the oil distribution pipeline that would cross into Calcasieu Parish to intersect the ESR oil distribution pipeline from West Hackberry to Nederland, the Black Bayou facility would lie wholly within Cameron Parish. Cameron Parish does not have zoning regulations restricting the use of lands needed at the site or along pipeline rights-of-way.

Part of the wetlands and all of the offshore land used for the brine disposal pipeline and diffuser are Louisiana state lands. For this reason the Louisiana State Land Office would be consulted regarding the use of rights-of-way across these lands. The pipeline would cross State Highway 82 near the Gulf Coast, so the State Highway Department would be consulted regarding the arrangements for laying the pipeline beneath the road bed.

The land use plans for the Black Bayou site, as prepared by the Imperial Calcasieu Regional Planning Commission, indicate no change from current land use patterns through the year 1990. The site is shown on the land use map as an area for mineral extraction, a usage that falls within the category of "Urban and Built-Up" land. Oil and gas production fields are in this category. Usage of the site for oil storage would be compatible with this land use designation.

The brine disposal pipeline would cross the Sabine National Wildlife Refuge. This land is owned by the Federal Government. Although an existing right-of-way would be followed, permission to cross the refuge would have to be granted by the U. S. Department of Interior.

The project would require the use of wetlands for pipeline corridors, and would necessitate dredging canals to provide access to wellheads. These activities require approval from the Corps of Engineers. It is also the responsibility of the Corps to approve the use of lands where dredge spoil would be deposited.

4.4.11 Summary of Adverse and Beneficial Impacts

Table 5.2-2 in Chapter 5 contains a detailed summary of the adverse and beneficial impacts associated with site preparation and construction at the Black Bayou site. In Section 4.3.5 the impacts of the proposed site, West Hackberry, were summarized. Only the major differences between the proposed and the alternate site are discussed here.

The Black Bayou brine disposal pipeline would traverse the Sabine National Wildlife Refuge and other sensitive marshlands, but would be located in a designated pipeline corridor, where no such corridor exists at West Hackberry. The location of the offshore diffusers would be different and impacts would not be identical to the West Hackberry location.

Construction of canals on-site would result in significant local alterations of drainage patterns. The placement of storage wellheads on platforms over the marsh rather than on landfill would reduce the amount of permanent damage to the marshland; however, the resulting absence of containment dikes around the wellheads could pose serious problems in the event of a minor oil leak which would otherwise be contained by dikes. On the other hand, a major spill at the site such as a sheared wellhead would be detrimental to the sensitive marsh environs regardless of whether the wellheads are diked.

Because of the wet nature of the site, dust emissions would be restricted to roads and small fill areas.

Transportation may be a serious problem in that traffic on local roads would be greatly increased and access to the site is limited. Workers would have to cross the ICW via the Gum Cove Ferry to get to the site.

4.5 ALTERNATIVE SITE VINTON

4.5.1 Land Features

4.5.1.1 Construction Impacts

Minimal effects if any, on geomorphology are anticipated for the Vinton site. Wellheads for six proposed storage caverns would be located on dry land, so that no filling would be required for these or for access roads. The raw water supply system from the Vinton canal also would have no significant effect on land forms. A retention dike to surround surface tanks, brine pond, and raw water pond would effect a permanent, though minor, change in topography. Also, construction of the oil pipeline from Vinton to join with the line between the West Hackberry ESR facility and Sun Terminal would have minor temporary effects on land forms. The pipeline trench would be backfilled to restore original land contours without disruption of drainage patterns. The ten injection wells specified in the brine disposal design would require no fill and only minimal grading for construction of platforms and access roads.

Construction of wellheads and service roads would have little affect on soils on the Vinton site itself. On-site pipeline construction would mix surface and subsurface layers of the Morey-Beaumont soils, but would not affect their drainage capabilities. Construction of dikes, the brine pond, and the raw water pond would destroy the internal structure of the soil, though not its composition. Along the pipeline trench, the two affected soil types (Morey-Beaumont and Harris-fresh water marsh) would lose their internal structure as well. The brine disposal system would affect these two soil types in much the same way. No effects on stratigraphy or geologic structure are anticipated during construction at the storage site, the pipeline routes, or the terminal and dock facilities.

4.5.1.2 Operations Impacts

Operation and maintenance activities would have no impact on geomorphology (topography and drainage patterns) or soil characteristics at the Vinton storage site, or along the oil and brine pipeline routes. Soils could be affected, however, by accidental spills, the effects of which are summarized in Section 4.2.1. Oil production would not be affected, but salt mining in the area of the new storage caverns would be impractical.

4.5.2. Water

4.5.2.1 Construction Impacts

Site preparation and construction at Vinton would affect both surface and subsurface water environments. Surface water supply would be affected by the leaching operation. Withdrawal of water for leaching from the Vinton Canal would take place at a rate of 1.00 x 10^4gpm for 1144 days. All replenishment water would come indirectly from the ICW, and primarily from the Sabine River. (Rates of flow are discussed in detail in Appendix D.18). The withdrawal rate at Vinton (22.3 ft^3/sec) is less than 3 percent of the minimum flow of the river.

Surface water quality would be affected by leaching, dredging, grading, excavation, filling, and miscellaneous construction. Water quality and salinity of the ICW directly determines that of the Vinton Canal. Any chemicals or pollutants in the ICW would be directly transported to the canal, so that the salinity level of the canal would rise as a result of drawing water from the ICW.

Bucket dredging would be used for burial of the oil pipeline at 4-5 feet below the bottom of Gray Canal. The dredged material is expected be used as backfill for the pipeline trench. Some turbidity would result from this dredging, but these effects would be local and brief. Approximately 7,000 feet of marsh would be dredged for the brine disposal lines to the injection wells. The effects would be similar to those predicted for the Black Bayou brine disposal pipeline, but the magnitude of the operation is much smaller, resulting in no permanent loss of wetlands habitat. Thirty-five acres of marsh, however, would be lost to the permanent barge canal.

Grading, excavation, and filling would disturb approximately 30 acres of land for 5 months. The 630 tons of sediment would be deposited in Ged Lake, where the minimum rate of settling would be .0186 mm/sec. (Appendix D.16 analyzes the rates of sediment deposit and their effects for the 5-month period).

Chemical and Biological pollutants would be generated during construction at Vinton. Sanitation would be encouraged and regulations regarding the removal of potential pollutants would be established.

The only significant effect on the subsurface water system would result from injection of brine into the deep aquifers. Ten brine-injection wells, (described in Section A.6.4.1.4, Appendix A) at a depth of 5,000 feet would accommodate the disposed brine. Brine disposal from the leaching process would involve 39,500 bpd per well. Aquifer fracture or leakage might contaminate fresh ground water or surface water, cause earthquakes, or interfere with oil and gas production. Section C.5, Appendix C discusses in depth special preventive measures for the use of aquifers with these three hazards in mind.

4.5.2.2 Operations Impacts

Supply and quality of surface and subsurface water would be affected by operation of the facilities at the Vinton site. Surface water supply would be affected by water withdrawal for the displacement operation. Water withdrawn for 150 days at a rate of 1.02×10^4 gpm or 3.50×10^5 bpd from the Vinton Canal would be replenished by induced currents in the ICW and ultimately by the Sabine River which feeds into the canal. The flow rate on the river is at least 33 times greater than the withdrawal rate from the Vinton Canal. Surface water quality would also be affected by withdrawal of water for displacement. Some increase in salinity and contaminants is anticipated for the Vinton Canal.

Discharge of treated ballast water which would affect the Neches River is discussed in Section C.3.2.2.1, Appendix C. Chemical and biological pollutants could affect surface water quality, but the extent of these impacts would depend on the ability of personnel to exercise proper care in waste disposal.

Subsurface water supply would be affected by the use of deep aquifers for brine disposal. During each of four refill cycles for fifteen to twenty years, 265 ppt brine would be displaced by crude oil at approximately 59,500 bpd or 1,740 gpm. As described above, three major environmental impacts are predicted for subsurface brine disposal: 1) contamination of fresh ground water, 2) possible aquifer fracture or leakage and 3) interference with gas and oil production in the immediate area.

4.5.3 Air Quality

4.5.3.1 Construction Impacts

Combustion and fugitive emissions along the pipeline right-of-way and at the dome would affect ambient air quality very little, and would be confined to the construction area. Section C.3.1 of Appendix C provides detailed discussions of 1) emission sources, 2) technologies applicable to Vinton SPR facilities, 3) appropriate emission regulations and standards and 4) short-term and long-term modeling approaches to assess the effects on air quality.

Tank preparation and construction activities would affect ambient air quality. Short-term modeling of tank surface preparation indicates that the 24-hour particulate standard would be exceeded to a downwind distance of 1 km., well within plant site boundaries. Paint application would exceed the

3-hour NMHC standard to a downwind distance of approximately 4 km. Maximum frequency of violation would be approximately 3-4 days per year to the west of the dome. Long-term or annual pollutant ground level concentrations would be insignificant for construction phase activities with the exception of large scale land clearing operations at the dome. Other construction activities that would affect air quality are temporary in any one location, so that their effects would be local and brief.

The Nederland terminal and dock proposed for the West Hackberry expansion would also be used for the Big Hill site. See Section C.5.1.3 of Appendix C for an assessment of the impacts on air quality resulting from terminal and dock construction.

4.5.3.2 Operations Impacts

Emission sources at Vinton from operational activities include 1) the offloading of crude oil from tankers at Sun Terminal during fill (56 tons/year). 2) the loading of the oil into tankers during withdrawal (estimated at 374 tons/year) and 3) the emissions from dissolved hydrocarbons which are present in the brine discharged during oil refill (estimated at 70 tons/year). Short- and long-term emission rates are listed in Appendix E for sources used in the modeling analysis. An evaluation of the hydrocarbon emissions from the brine pond is given in Appendix N. Annual tonnage emission rates are presented for all sources in Table 4.5.1.

During the fill phase, the terminal would be the primary source of emissions; during refill, the brine ponds on site would be the primary source; and during withdrawal, the terminal would be in the main source of emission. Violations of the three-hour standard for NMHC are predicted downwind of the Sun Terminal facility. Operation of the Vinton facility would not result in violations of air quality standards for other contaminants.

4.5.4 Noise

4.5.4.1 Construction Impacts

Construction areas that would affect ambient noise levels at Vinton are the oil storage dome area, the pipeline corridors, the brine disposal area, and the terminal and dock areas, (for an explanation of terminology, propogation model, and noise impact guidelines, see Appendix F).

The Vinton site is undeveloped. Contributing noise sources at the storage site would be heavy transport trucks, earthmoving equipment, compressors, drill rigs, impact equipment, and concrete mixers. Appendix F, Table 5-2 presents typical noise levels for this equipment.) Diesel engines and drilling equipment would create the greatest sound.

Table 4.5-1 Annual Tonnage Emission Rates for Development of Vinton to 50 mmb

Source or Activity	Annual Emissions (Tons)				
	HC	Particulate	SO_X	NO_X	CO
Site					
Brine Ponds*	70				
Valves & Seals	4.8				
20,000 bbl (standing loss)	0.5				
Surge Tanks** (working loss)	15.8+				
3,000 bbl Blanket Oil Tank	0.1				
Total	91.2				
Terminal - Fill Phase					
Surge Tanks** (standing loss)	10.7				
Surge Tanks** (working loss)	3.6				
Valves and Seals	1.9				
Tanker Ballasting	37.5				
Tanker Engine	1.5	10.7	148.5	48.3	0.9
Tug Engine	0.8	1.8	0.7	1.2	1.0
Total	56.0	12.5	149.2	49.5	1.9
Terminal - Withdrawal Phase					
Tanker Loading	346				
Surge Tanks** (standing loss)	10.7				
Surge Tanks** (working loss)	8.5				
Ballast Treatment Tanks** (standing loss)	3.6				
Ballast Treatment Tanks** (working loss)	1.8				
Valves and Seals	1.9				
Tanker Engine	0.6	4.1	56.8	18.4	0.3
Tug Engine	0.8	1.8	0.7	1.2	1.0
Total	373.9	5.9	57.5	19.6	1.3

*Fill Phase Only: the values are the maximum predicted at any time during use. The initial fill is expected to be only a small fraction of this amount.

**Working losses interact with the standing storage losses, such that the resultant emission is less than the sum of these values.

+Emissions in fill phase.

levels. Twenty-four hour drilling of two drill rigs would create a noise level of no more than 55 db at 2,000 feet from the center of the site. Storage site construction noise, assuming six months of drilling, is estimated at the same level.

Construction of three pipelines would be necessary to service the Vinton site, the oil distribution line (7 miles), the water supply line (1.5 miles), and the brine disposal line (2.75 miles). The areas over which the pipeline would travel are on dry land and marshland, so that conventional dryland and push-ditch pipeline construction methods would be possible. Assuming daytime activity only, estimated pipeline construction noise would contribute no more than 55 db to the equivalent sound level (Ldn) at a distance of 500 feet from the pipeline right-of-way. Construction workers are expected to be the only people who would be affected at this distance. Annual noise level rates would not be affected.

Drill rig equipment would be operated on a 24-hour basis for construction of the two brine disposal wells and the barge canal. Over the 15-month period of construction, the noise impact (Ldn >55) is estimated to extend approximately 1,800 feet from the drilling sites. Because these sites would be in remote areas, they would have little effect on residences.

Terminal and dock facilities at Nederland assessed for the West Hackberry - Sun Terminal Pipeline would also be used for the Vinton site. No variation from the noise assessment presented in Section C.3.1.4, Appendix C is anticipated.

4.5.4.2 Operations Impacts

The main source of noise during operation would be from pumps at the site for the fill and discharge operations. Twenty-four hour fill operations would last 32 months; five fill/discharge cycles are planned for the life of the facility. An increase in noise level of no more than 3 db during operation is predicted (Final Impact Statement - West Hackberry Salt Dome FES 76/77-4). Tanker loading and unloading during these fill/discharge operations would increase 20 percent, while noise from diesel engines powering tankers and tanker discharge pump operation would contribute negligibly to existing ambient levels (<20% increase).

4.5.5 Species and Ecosystems

4.5.5.1 Construction Impacts

Displacement/Leaching Water System Impacts

The intake structure for the displacement/leaching water system would be located in a small inlet dredged from the west bank of the Vinton drainage canal. When construction begins, grasses and small shrubs which presently grow on spoil banks would be lost, but most of this area would revegetate with native grasses in the following growing season. A major, but localized effect, in creating the inlet would be a temporary turbidity caused by the removal of approximately 8,060 cubic yards of spoil. Fish in the canal would be expected to emigrate until tolerable conditions are regained, within three to four weeks after dredging and construction ceased.

The raw water system pipeline from the intake structure to the central plant area would involve removal of vegetation from twenty acres of surface land. Approximately 4.4 acres of this land is presently used as pasture and during construction there would be a potential beef cattle production loss of $1,197/year. This estimate is based on the beef cattle production average of $272/acre/year. Removal of trees and shrubs, which cover three-quarters of the pipeline route, would also eliminate habitats and food for wildlife, especially birds and small mammals.

Brine Disposal System Impacts

The ten wells spaced linearly at 1,000-foot intervals that would compose the brine disposal system would require no land fill, but considerable earth movement is anticipated in digging the 2.75 - mile brineline trench and the 2.2-mile servicing canal. The 241,000 cubic yards of material removed from the servicing canal trench would be disposed of over 35 acres of marsh. The resulting siltation of marsh waters would suffocate benthic organisms, (clams, polychaetes) while mobile organisms would temporarily emigrate from the area until the turbidity subsides. The turbid waters would eventually disperse into the Vinton canal. Effects of this dispersal would be similar in quality and magnitude to that of the raw water intake inlet.

The brine pipeline, laid parallel to the leaching/displacement line for 1.25 miles beyond plant boundaries, would affect the land similarly. Construction of the brine pipeline would affect approximately 25 acres of dry land. Construction of the brine disposal field would affect 0.6 acres of dry land and 22 acres of marshland. Effects related to pipeline construction in marsh and grassland is described in detail in Appendix C, Section C.3.1.5 and C.4.1.5. Generally, the earth-moving activities would increase turbidity and add nutrients to the aquatic environment. Benthic invertebrates would be affected to varying degrees.

Impacts at the Storage Location

Since the storage location is used partly for recreational purposes and partly as pastureland, construction would affect both human and domestic animal use. Cattle would be excluded from the construction site; and the use of residences on the dome would be restricted. Noise and air pollution that result during construction would probably make the dome area unsuitable for any other alternate activity.

Ged Lake would experience temporary turbidity and siltation from 630 tons of soil which would be deposited in the lake as a result of earthmoving at the storage site. Domestic animals would not be affected by the silt placed in lake water because they will already have been excluded from the area. Prior to project completion the silt will need to be removed from the lake in order to restore depth and volume.

Oil Distribution System Impacts

Construction of the oil pipeline to the ICW would affect 51 acres of dry land and 39 acres of marsh. Since pastureland beef production averages of $272/acre/year in the region (Knox and Oates, 1963), total pastureland losses would be $2,475. Removal of vegetation from grassland-shrub acreage would be detrimental to the habitats of songbirds and small mammals. Where the pipeline would cross Grays Canal, temporary turbidity and siltation would destroy benthic organisms and cause emigration of mobile forms. The 150-foot pipeline right-of-way would affect 39 acres of marsh, causing a loss of 1.01 x 10^7Kcal/yr. (Odum, 1971). Section C.3. 2.5 of Appendix C discusses in detail the effects of pipeline construction through marshland.

4.5.5.2 Operations Impacts

Displacement/Leaching Water System Impacts

Effects of the operation of the displacement/leaching water system at Vinton would entrain organisms in the intake water and cause lateral displacement of water in connected water bodies. The Vinton Canal has several fresh water tributaries, which would be the primary contributors of water to the Vinton Canal during withdrawal operations. The other contributor would be the ICW, which contains slightly brackish water. At times when the influence of the ICW is greatest, the salinity in the Vinton Canal might increase and cause a corresponding emigration of freshwater fish species. See Section C.4.2.5.1 of Appendix C for a general description of the effects of salinity intrusion.

Brine Disposal System Impacts

The most serious potential danger of the brine disposal system would be an accidental break in the pipeline or spill at a wellhead. In each case, the magnitude of the effect would depend on the size and location of the accident. See Section C.3.2.5.2 of Appendix C for the effects of accidental spills. Brine wells are deep enough that biota, which rarely reach those depths, would not be affected by brine intrusion.

Impacts at the Storage Location

Machinery noise and emissions would be the principal effect of operation at the storage location, which would seriously affect recreational use of the dome area. Noise levels would not affect grazing animals, however.

Oil Distribution System Impacts

The freshwater marshes south of the Vinton site would be affected in the event of an oil spill near Ged Lake, the Gray Canal, or in one of the many drainage ditches. Recovery would be rapid, but the settled oil may act as a recontaminant for several years.

4.5.6 Natural and Scenic Resources

4.5.6.1 Construction Impacts

A scenic ranch complex surrounds the Vinton dome. Although the ranch buildings do not occupy sites presently proposed for wellheads, pumps, or other facilities, they may be removed to expedite construction. Noise and increased traffic associated with construction activities would detract from the scenic value of the area.

4.5.6.2 Operations Impacts

Normal operation and maintenance of facilities at the Vinton dome would have no additional effects on the natural and scenic resources in the area than those discussed regarding construction.

4.5.7 Archaeological, Historical, and Cultural Resources

4.5.7.1 Construction Impacts

The cultural resources survey of the Vinton dome identified several significant sites near the proposed storage location. If the Vinton site were to be chosen as an SPR facility, a more intensive archaeological survey utilizing a test excavation program would be initiated which would comply with the National Historical Preservation Act of 1966 and Executive Order 11593.

4.5.7.2 Operations Impacts

Known archaeological and historical sites in the vicinity of the Vinton dome and pipelines would receive no adverse effects from operation and maintenance of this facility.

4.5.8 Socioeconomic Impacts

4.5.8.1 Construction Impacts

Because the Vinton site would require fewer storage caverns than other sites, and because injection wells would be used for brine disposal, the employment profile is somewhat different. (See Figure 4.5-1 for an illustration of labor needs.)

A maximum of about 360 workers would be required during the second month of construction, when the crew would lay pipeline to the brine disposal field, to the raw water intake structure, and to the oil distribution pipeline connection. Workers in Calcasieu Parish and Orange County could satisfy peak labor needs, which would reduce unemployment in these areas by 0.4 percent and 0.5 percent respectively.

At the site and in the brine disposal field, about 165 workers would be required to drill wells. Two drill rigs would be in operation in shifts, so that there would be only 130 workers at the site during the day shift and 20 during each of the two night shifts.

Construction of surface facilities would require five months; and drilling would require twenty months. In the final construction phase (about two years), only 30-40 persons would be needed at the site to monitor the leaching of the caverns and the concurrent filling with oil.

Land Use

Construction of the Vinton facility would affect both the site and the pipeline corridors. If Vinton were selected, 160 acres would be purchased for surface facilities. This land now belongs to the Gray Estate. Existing homes, barns and other storage buildings on the property would be moved, dismantled, or utilized for the project. Oil wells on the periphery of the dome, which have been producing since 1910, would continue to produce. The historic post office would also remain, but construction noise and traffic might distract from the scenic value of the landmark.

Pipeline construction to the Vinton Canal would last for about one month, and would cross farmland, pasture, and forests. Normal use of these areas would be interrupted during construction. The brine disposal pipeline and oil distribution pipeline would also cross pasture and marsh with these areas receiving a similar interruption in use.

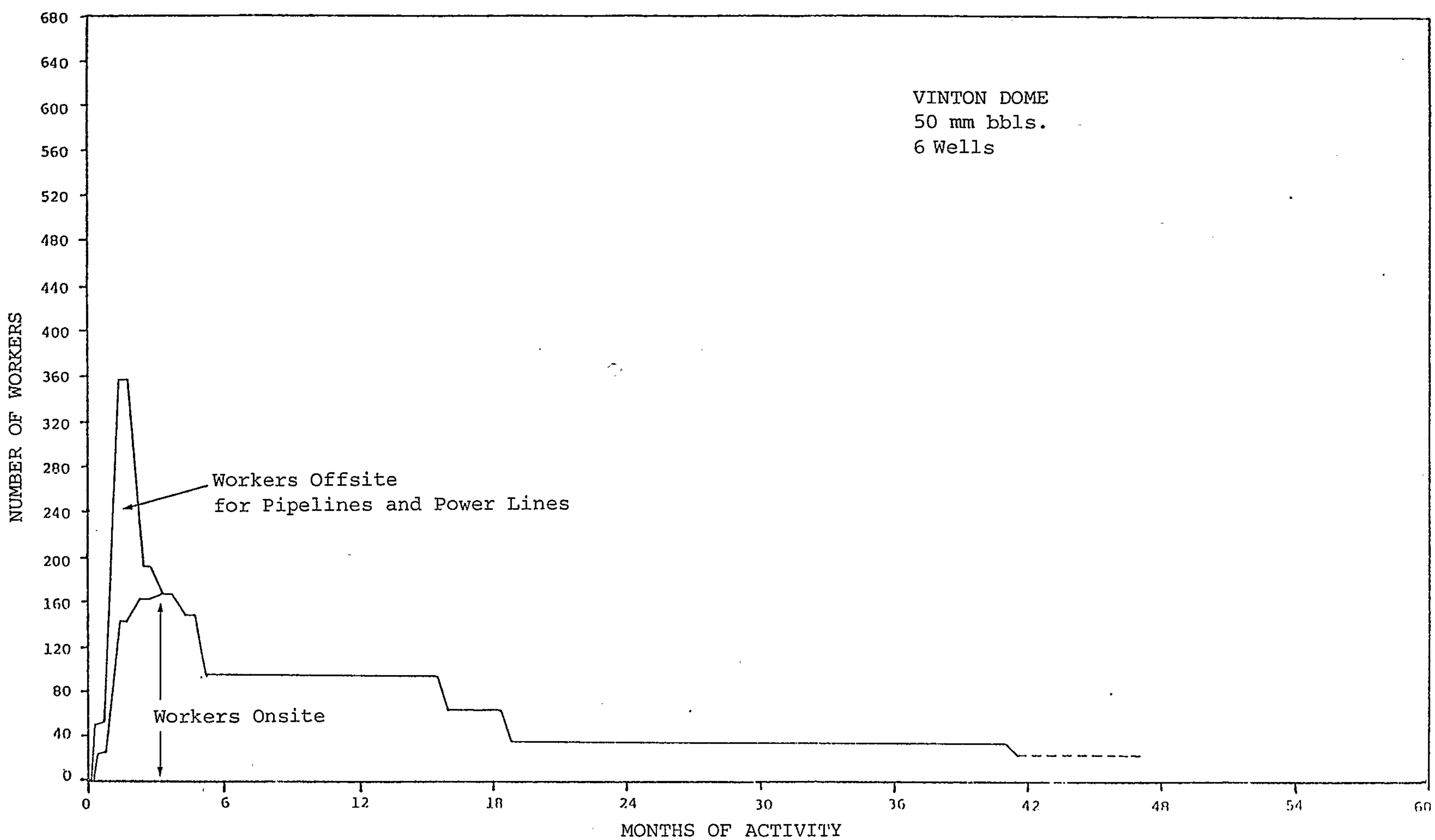

Figure 4.5-1 Labor Requirements at the Vinton Site

The area affected by construction of the storage site and associated pipelines would lie in an unzoned part of Calcasieu Parish.

Traffic

Three sources of increased traffic are predicted: 1) commuting patterns of construction workers, 2) laying the oil distribution pipeline across the ICW, and 3) additional tankers bringing oil to Nederland for the Vinton caverns.

The effect of increased road usage from commuting is estimated as follows:

	Recorded Average Daily Traffic	Peak Period Increase	12 Month Average Increase
Interstate 10 (at Vinton)	8,800	7%	3%
Ged Road	60	967%	367%

After the initial year of construction, during which an average of 110 vehicles would be traveling to and from the site, the traffic level would decrease to about 35 vehicles going each way. Traffic induced by the project would reach this lower level in the 20th month of activity and remain at that level for about 2 years.

When the oil distribution pipeline is laid across the ICW, it would be buried at sufficient depth to allow normal shipping activities and periodic maintenance activities to continue without interruption. Arrangements would be made to allow passage of vessels (about 28/day) during the time that pipeline is laid beneath the channel.

Additional tanker traffic in the Sabine-Neches Waterway for bringing oil to the dock at Nederland for filling the caverns is estimated as follows:

	SPR Expansion Tanker Trips (Assuming 410,000 bbl/tanker trip)	Sabine Pass Port Arthur Increase	Neches River Increase
10th - 28th month	78	4%	8%
28th - 42nd month	46	3%	6%

Housing and Public Services

Since the labor force can be drawn from the surrounding communities, migration of workers from other towns and cities would be unlikely. Therefore, construction activities would not affect local housing. For the same reason, public services would not necessarily be placed under any strain. The community hospital would help with minor injuries from construction, and the parish police would be enlisted to assist with possible traffic congestion.

Economy

The economy of the region would benefit from the additional earnings of its workers and from the local procurement of a substantial portion of the materials and equipment for construction of the facilities. The payroll is expected to average according to the following schedule:

1st through 6th month:	$336,700 per month
7th through 12th month:	188,000 per month
13th through 18th month:	166,700 per month
19th through 42nd month:	66,500 per month

During the second month, when the pipelines are being laid and the labor force reaches its maximum level, the payroll would reach a peak of about $718,000 paid in the course of the month. These payroll levels are based on an assumed average worker wage of $2,000 per month.

Materials, equipment, and labor would total approximately $90,000,000. Over 80 percent of this amount (about $74,000, 000) would be spent within the local region. Since the Vinton dome would be situated between Lake Charles and the Beaumont-Port Arthur-Orange area, economic gains would benefit both regions.

The average of the economic multiplier of both regions (2.05) is about $151,700,000 when applied to the total amount that would be spent in the region. This figure represents both direct and indirect earnings from the proposed construction, and indicates a 3 percent increase over the anticipated 1980 level of earnings for the area. Added earnings for the period 1980 to 1985 represent a rise of 32 percent over the predictions for the standard metropolitan areas of Lake Charles and Beaumont-Port Arthur-Orange.

Government Revenues

Choice of the Vinton dome as an oil storage site would result in the transfer of land at the site and along pipeline corridors from private ownership to Federal ownership. Since Federal land is exempt from local taxes, there would be some loss of local revenues. The increase in worker earnings, however, would contribute to local government revenues. The total contribution is estimated to be $118,000 in the first year, $52,000 in the second year, $15,000 in the third year, and $7,500 in the last year of construction. This revenue would be divided proportionally between Louisiana and Texas, based on the residences of workers employed by the construction project.

4.5.8.2 Operations Impacts

Employment

About 15 workers would be employed in shifts at the storage site during operation of the facility to monitor the instrument panel and to be available in an emergency. Mechanics, electricians, craftsmen and maintenance workers would test and maintain the equipment regularly.

Land Use

The town of Vinton is expected to spread southward, closing the distance between present municipal boundaries and the proposed storage site. Although there are no major industries in Vinton now, the storage site would possibly attract some temporary businesses to service the Vinton construction. Their most likely location is in the south near the drainage canal and the storage site.

Traffic

During operation of the storage facility, daily average traffic of about 16 vehicles is expected over Ged Road. This represents a 53 percent increase over the present use of this road. The interstate highway would experience a 7 percent increase in traffic. Tanker traffic may decrease along the Sabine-Neches Waterway since tankers bringing oil from foreign ports could be used to carry oil from the Vinton dome. During refill operations, however, tanker traffic is expected to increase by 4 percent in the Sabine pass and at Port Arthur, and by 8 percent in the Neches River. If both the Early Storage Reserve caverns at West Hackberry (60 million barrels) and the new caverns at Vinton (50 million barrels) were refilled simultaneously, tanker traffic would increase by 9 percent in the Sabine Pass and at Port Arthur, and 17 percent in the Neches River.

Housing and Public Services

Because of the permanency of the positions offered by operation of the Vinton facility, probably all of the fifteen workers would be residents of Vinton. Even if all fifteen workers were hired from other vicinities, the effect on housing and public services would be slight.

Economy

Effects on local economy would be less than at other sites. The combination of payroll and expenses for maintenance and repair would amount to $77,000/month. Incremental increase in local earnings ($157,850) represents only a fraction of a percent of the anticipated 1985 level of earnings in the Lake Charles and Beaumont-Port Arthur-Orange standard metropolitan areas. During a period of oil withdrawal from the site, the level of expenditure from the project would rise to about $347,000/month. The cost of the project during refill of the caverns would be approximately $160,000/month.

Government Revenues

Use of the Vinton site would reduce local revenues because, as a federally-owned facility, its land and capital are tax-exempt. An indirect contribution to local government, however, would be through taxes paid by workers. Sales tax alone would contribute approximately $14,500/year.

4.5.9 Impact due to Termination

After termination of the SPR program, if the facility was not to be used for any other government purpose, it would be disposed of in accordance with applicable laws and regulations.

4.5.10 Relationship of the Proposed Action to Land Use Plans, Policies, and Controls

Various parish, state, and federal agencies have jurisdiction over the lands proposed for the Vinton site. The approval of the Parish Police Jury would also be required prior to laying the raw water pipeline across Ged Road. Lands which would be affected by the proposed facilities at the Vinton site, the brine disposal field, and the pipeline corridors have not yet been classified for zoning regulations. However, land use plans prepared by the Imperial Calcasieu Regional Planning and Development Commission indicate that the Vinton site is in an area classified for mineral extraction. Use of the site for oil storage would not conflict with continued use of the adjacent lands for their established purposes.

The Louisiana State Land Office would be consulted for the oil pipeline right-of-way since it crosses wetlands south of the dome. The permission of the U. S. Army Corps of Engineers would be required for construction of pipelines as well as the water intake structure.

4.5.11 Summary of Adverse and Beneficial Impacts

Only the major differences between the effects for the West Hackberry site and those summarized in Table 5.2-2 in Chapter 5.2 are listed here. First, the Vinton site would have one-third the capacity of an expanded West Hackberry site, so impacts would generally be less extensive at Vinton. Next, the Vinton site is partially covered by a private ranch complex, so that there would be a potential alteration of the existing recreational and agricultural use. Last, underground acquifers would be used for brine disposal. These aquifers would need to be 36 square miles in extent and 100 feet in average thickness to minimize the possibility of fracture. Testing would be required to determine if acquifers in the region provide this amount of injection capacity.

4.6 ALTERNATIVE SITE - BIG HILL

4.6.1 Land Features

4.6.1.1 Construction Impacts

Since the Big Hill storage site is on dry land, no land fill would be necessary. Dikes around the brine pond, raw water ponds, and surface tanks would be the only alteration in topography. The three pipelines for oil, raw water supply, and brine removal would cause no permanent effects on land forms or drainage patterns along the route. Pipeline connection to existing facilities at Sun Terminal would be the only necessary additional construction at the terminal.

Only minor impacts to soils would be experienced during the construction of well heads and service roads and would be confined to the construction site. The pipeline trench and dike from Big Hill to Sun Terminal, however, would destroy soil structure and alter drainage characteristics of several soil types: the Morey-Crowley-Hockley soil association, the Harris-made land-soil association, and the Sabine coastal land-soil association. No effects are anticipated on stratigraphy or geologic structure during construction at the Big Hill storage site, along any pipeline routes, or at terminal and dock facilities. Oil production on the flanks of the dome would not be affected.

4.6.1.2 Operations Impacts

Operation and maintenance would have no effect on geomorphology (topography and drainage patterns) at the storage site or along the oil or brine pipeline routes. Soil characteristics would also remain stable at all locations, except for accidental spills that would discourage vegetation. (See discussion of oil spills in Section 4.2.1.) Stratigraphy, geologic structure and oil production would also be unaffected. The SPR program however, would make future salt production and sulfur mining in the area of the new storage caverns impossible.

4.6.2 Water

4.6.2.1 Construction Impacts

The subsurface water would experience no change since aquifers would not be used for leaching or brine disposal. Surface waters, however, would be altered during site preparation and construction at Big Hill by six activities: 1) withdrawal of water for leaching, 2) brine disposal, 3) dredging operations, 4) disposal of dredged material, 5) grading, excavation, and filling and 6) miscellaneous construction.

The supply of surface water would diminish as water is withdrawn from the ICW for the leaching operation at a rate of 6.86×10^5 bpd (barrels per day) or 2.00×10^4 gpm (gallons per minute) for 1,144 days (38 months). As discussed in Appendix D.24, the water level of the ICW would fall at a rate of .067 ft/day if the waterway were isolated from all other water bodies in the region. Because other bodies of water feed into the ICW, the actual rate of descent of the water level would be somewhat lower than the value noted. Withdrawal of water would not alter significantly the amount fed into the ICW from Galveston Bay, nor would it affect the level of contaminants or salinity in the ICW and elsewhere.

Big Hill's system for brine disposal into the Gulf of Mexico is generally similar to that proposed for the West Hackberry expansion. The location of the disposal site is shown on Figure 4.6-1. The results of an analysis using the MIT Transient Plume Model for Big Hill is presented in Appendix U. Because the rate of discharge at Big Hill is only two-thirds that of West Hackberry, the magnitude of the environmental impact is somewhat reduced. The bottom area exposed to excess salinities greater than 1 and 3 ppt amounted to 724 and 52 acres respectively, based on site-specific current data for the September 1977 to February 1978 period.

Bucket dredging would be the primary method of dredging used at Big Hill. Based on available water quality information, as discussed in detail in Section C.6.1.2.1, the following water quality effects are predicted. In both the South and North Forks of Taylor Bayou, dredging would cause turbidity and a consequent release of toxic pesticides or industrial chemicals as well as oxygen depletion for a short while. Lovell Lake, Spindletop Ditch, Hillebrant, Taylor, and Salt Bayous would experience similar conditions. No long-term effects from marsh dredging are anticipated. Dredging in the ICW might produce slightly higher levels of pollutants because of its proximity to heavily contaminated tributaries. Dissolved oxygen levels would be lowered subsequent to release of materials with high COD values from the ICW sediments.

Disposal of dredged material is confined to areas around the dredging site. Effluent from the disposal areas would affect the confinement area (mostly marsh) as well as the adjacent water bodies through the reintroduction of contaminants. These effects are discussed specifically in Appendix C, Section C.3.1.2.1. A major effect of the spoil disposal is the loss of wetlands habitats, the most extensive of which would occur near the ICW where 6 to 7 acres would be permanently altered.

Biological pollutants are generally the results of poor sanitary conditions at a construction site. A major concern would arise from the potential release of pathogenic organisms

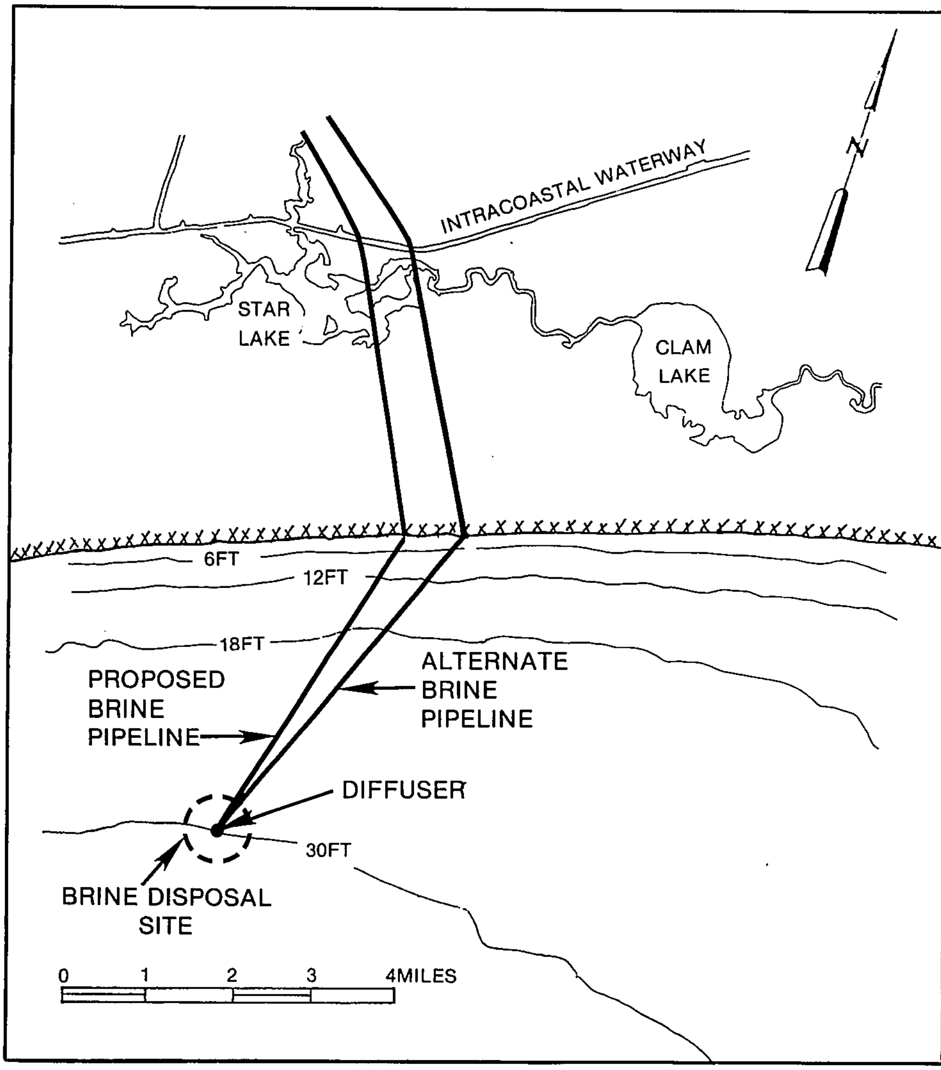

Figure 4.6-1 BRINE DISPOSAL SITE FOR BIG HILL

associated with human waste into nearby water bodies. The degree of pollution can be minimized through proper disposal practices.

Grading, excavation, and filling involved in site preparation and construction would involve a significant amount of earth movement (approximately 140 acres disturbed) for five months. Erosion by rainfall would wash approximately 1,427 tons, or 1,409 cubic feet (see Appendix D.15), into the surface water system. The introduction of this sediment into the various local water bodies would slightly increase the level of suspended solids for the entire five-month dredging period.

4.6.2.2 Operations Impacts

Subsurface water would experience no impacts because neither shallow nor deeper aquifers would be used as sites for displacement water or brine disposal. Surface water, withdrawn from the ICW, would be affected only slightly by the withdrawal of water during the displacement operation. Natural flow within the waterway, in addition to input from several tributaries, would act as replenishment sources to prevent significant drawdown of the ICW. The rate of withdrawal would only be slightly greater than the withdrawal rate for leaching (7.0×10^5 bpd or 2.04×10^4 gpm).

The quality of the surface water would also be affected by the withdrawal of displacement water, brine disposal, discharge of treated ballast water, and maintenance activities. Generally the effect of water withdrawal would be an increased flow into the ICW from Galveston Bay. No significant change in quality is anticipated. The effects of the brine disposal system into the Gulf during cavern refill would be similar to the effects which occur during the leaching operation. Even though the brine discharged is 15 percent more saline than that discharged during leaching, the rate of discharge is 15 percent of the leaching rate. Therefore the effect of brine disposal should be less than that already described for leaching. Discharge of treated ballast water would occur at or near the Sun Oil Terminal on the Neches River; the effect of these discharges is treated in Appendix C, Section C.3.2.2.1.

4.6.3 Air Quality

4.6.3.1 Construction Impacts

Combustion and fugitive emissions along the right-of-way at the dome would affect ambient air quality very little. A summary of the source of emissions during construction appears in Section C.3.1.3.1 of Appendix C. Annual tonnage emission rates appear in Table 4.6.1.

Table 4.6-1

Annual Tonnage Emission Rates
At Big Hill During Construction*

Source or Activity	Annual** Emissions (Tons)				
	HC	Pa	SO_2	NO_2	CO
Site Preparation	-	12,571	-	-	-
Unpaved Roads	-	269	-	-	-
Paved Roads	-	0.6	-	-	-
Heavy Duty, Diesel Powered Equipment(1)	0.5	0.3	0.5	7.4	1.4
Light-Duty Vehicles	0.3	0.05	0.01	0.5	3.5
Drill Rigs	9.9	9.0	8.1	126	27
Surface Grinding Tanks	-	3.1	-	-	-
Painting - Tanks(2)	5.3	-	-	-	-
Total - Construction	16	12,853	9	134	32

* Includes construction activities at dome and terminal sites and along pipeline right-of-way

** If activity persists for less than a year (e.g. painting - tanks) than total emissions for this shorter period are listed

1. The dome and terminal sites considered as independent construction sites of equal magnitude.
2. Two coats of paint

Emission control technologies that affect Big Hill SPR facilities are the same as those described in Appendix C, Section C.3.1.3.2. Emission regulations and standards are treated in Section C.3.1.3.3, while short-term and long-term modeling to assess air quality are discussed in Section C.4.3.1.3.4.

Tank and land preparation activities would have the greatest effect on ambient air quality in the area of the dome. The twenty-four hour particulate standard would extend to a downwind distance of 1 km, well within plant site boundaries. Painting fumes would exceed the three-hour NMHC standard to a 0downwind distance of approximately 4 km. Maximum frequency of violation would not exceed 3 to 4 days per year. Annual meteorological data would ultimately determine frequency of violation and extent of area affected. Long-term or annual pollutant ground level concentrations would be insignificant except for large-scale land clearing at the dome. Other pollutants would be temporary in any one location and fairly well distributed, so that their effect would be local and brief.

The Sun Terminal proposed for the West Hackberry expansion would also be used for the Big Hill site. See Section 4.7 for an assessment of the impacts on air quality resulting from terminal and dock construction.

4.6.3.2 Operations Impacts

Emission sources from operational activities for Big Hill include 1) the offloading of crude oil from tankers at Sun Terminal during fill (estimated at 99 tons/year), 2) the loading of the oil onto tankers during withdrawal (estimated at 732 tons/year) and 3) the emissions from dissolved hydrocarbons which are present in the brine discharged during oil refill (estimated at 140 tons/year). A detailed discussion of emission rates associated with each source appears in Section C.3.2.3.1 of Appendix C. Short and long-term emission rates appear in Appendix E; and an evaluation of hydrocarbon emissions from the brine pond is given in Appendix N, while annual tonnage rates are presented in Table 4.6-2.

A modeling analysis was done for each significant emission source at Big Hill; descriptions of the process are the same as those discussed in Section C.3.1.3.4 of Appendix C. That analysis (discussed in detail, pp. C.6-52 to 57) found that the Big Hill dome and Sun Terminal facilities would be the principal sources of NHMC and, to a lesser extent, combustion contaminants. However, the emissions from the terminal operations would constitute a great majority of the total. Violations of the 3-hour standard for NMHC are predicted downwind of the Sun Terminal facility, through tanker loading and ballasting emissions.

Table 4.6- 2 Annual Tonnage Emission Rates for Development of Big Hill to 100 mmb

Source or Activity	Annual Emissions (Tons)				
	HC	Particulate	SO_X	NO_X	CO
Site					
Brine Ponds*	140				
Valves & Seals	5.4				
20,000 bbl (standing loss)	0.5				
Surge Tanks** (working loss)	32+				
3,000 bbl Blanket Oil Tank	0.1				
Total	178				
Terminal - Fill Phase					
Surge Tanks** (standing loss)	10.7				
(working loss)	7.3				
Valves and Seals	1.9				
Tanker Ballasting	75.5				
Tanker Engine	2.9	21.4	269.9	96.5	1.8
Tug Engine	1.6	3.6	1.5	2.5	2.1
Total	99.9	25.0	298.4	99.0	3.9
Terminal - Withdrawal Phase					
Tanker Loading	693				
Surge Tanks Tanks** (standing loss)	10.7				
(working loss)	17.0				
Ballast Treatment Tanks** (standing loss)	3.6				
(working loss)	3.5				
Valves and Seals	1.9				
Tanker Engine	1.1	8.2	113.6	36.9	0.7
Tug Engine	1.6	3.6	1.5	2.5	2.1
Total	732.4	11.8	115.1	39.4	2.8

*Fill Phase Only: the values are the maximum predicted at any time during use. The initial fill is expected to be only a small fraction of this amount.

**Working losses interact with the standing storage losses, such that the resultant emission is less than the sum of these values.

+Emissions in fill phase.

However, the level of hydrocarbon emissions at Sun Terminal would probably be insufficient to have an important impact on regional levels of photochemical oxidant. The annual tonnage emission rate for the Big Hill facility is relatively small in comparison to regional hydrocarbon emission levels in this region of heavy petrochemical activity. The operation of the facility would not result in violations of air quality standards for other contaminants.

4.6.4 Noise

4.6.4.1 Construction Impacts

Construction activity in the oil storage site area, the pipeline corridors, and the terminal would slightly increase ambient noise levels (See Appendix F for terminology, propagation model, and noise guidelines.) Neither site preparation nor site construction activity is estimated to be more than 55 db (decibels) at 2,000 feet from the center of the site, assuming six months' drilling and 24-hour activity.

Assuming daylight activity only, pipeline construction noise would contribute no more than 55 db to the equivalent sound level at 500 feet from the center of the site. (See Tables F-2 and F-3, Appendix F for typical equipment sound levels for pipeline construction.)

4.6.4.2 Operations Impacts

The major source of noise would be the operation of pumps for the fill and discharge activities at Big Hill. Estimated increases in ambient levels for similar operations at West Hackberry (Reference Final Impact Statement-West Hackberry Salt Dome, FES 76/77-4) would be no more than 3 db during the period of operation. Another source of noise would be tanker loading and unloading at the Sun Terminal on the Neches River. These operations include tanker traffic, tanker pumps discharging crude oil, tanker loading pumps, and pipe transfer pumps which would increase noise levels by twenty percent. Additional noise from the diesel engines which power the tankers and tanker discharge pumps would contribute negligibly to existing ambient levels.

During fill and discharge operations, noise would be generated from continuous operation of pumps at storage and terminal facilities. The effect on existing ambient levels is expected to be negligible, however, because the pumps at both the storage and the terminal facilities are enclosed in pump houses or other noise-dampening structures.

4.6.5 Species and Ecosystems

4.6.5.1 Construction Impacts

Displacement/Leaching Water System Impacts

Raw water would be used to leach the cavities in the Big Hill salt dome and to displace the stored crude oil during withdrawal. The proposed water source is the ICW, 5.0 miles southeast of the dome. Transporting raw water to the dome would require the following facilities: 1) a raw water tank (30,000 barrel capacity), 2) an on-site pond (40,000 barrel capacity), 3) pumps, 4) an intake station on the ICW dredged spoil bank, and 5) either the proposed 5.5-mile or the alternative 7.5-mile raw water pipeline.

Proposed Intake Station. Dredging of 8,600 cubic yards would be required for the intake station. This disturbance would temporarily eliminate benthic plants and animals, increase turbidity, and reduce plankton productivity. Dredge spoil would smother 1.8 acres of vegetation and soil organisms. The productivity of the marsh, about 1,518 grams dry wt/m^2/yr would be permanently destroyed. That is, approximately 11,055 Kg/year of productivity would be lost if vegetation were not re-established. Increased noise and human activity would force wildlife, especially birds, to evacuate the area temporarily. Benthic organisms would recover rapidly; phytoplankton and zooplankton productivity would increase after settling; and mobile animals would return 2-3 months after construction ceased.

Turbidity would initially decrease phytoplankton and zooplankton productivity, which is approximately 906 g dry wt/m^2/yr, for phytoplankton and benthic algae, and approximately 25 g dry wt/m2/yr for zooplankton (Day, 1973). Finfish and mobile plankton would emigrate until turbidity decreases. Sump dredging in the ICW for water withdrawal would increase local turbidity temporarily and would eliminate benthic organisms in the dredged area.

Clearing of vegetation for the pipeline right-of-way would be the greatest effect of the displacement water system. The primary water displacement pipeline (50-foot permanent right-of-way) would affect 6 acres of prairie grassland and 25 acres of marshland, while 9 acres of grassland and 75 acres of marshland, would be temporarily disturbed by construction of the 150 foot right-of-way.

The U. S. Soil Conservation Service estimates that for every acre of prairie grassland in Jefferson County, 10 percent is natural vegetation, 30 percent is pastureland, and 60 percent is cultivated with rice (Soil Conservation Service, 1971).

According to this analysis, of the 9 acres of prairie grassland affected by construction of the 75-foot right-of-way, one acre is natural vegetation, 2.5 acres are cattle-grazing pastureland, and 5.5 acres are rice cropland. The cost of the disturbance of beef production would be $680 the first year, but grazing would return to normal after the second year. The cost of disturbance to the rice crop for one year would be approximately $1250. For future farming the land would take more than one year to recover completely and therefore would be somewhat less productive during that time.

The primary displacement pipeline would affect 75 acres of marshland for construction of the 150-foot right-of-way. Net primary production of typical Gulf coast marshlands is 1578 g dry wt/m2/yr (excluding phytoplankton and benthic algae), plus an additional 906 g dry wt/m2/yr. A temporary primary productivity loss of 7.3 x 105Kg is predicted (4.6 x 105Kg in standing vegetation productivity and 2.7 x 105Kg in phytoplankton and benthic algae). The organic material provides nutrients for offshore organisms which in turn support the extensive Louisiana and Texas offshore fisheries. Marshes also serve as nurseries for fish and shellfish. At $100/acre/year for marsh byproducts, estimated losses would amount to $7,500 during the year in which construction activities occur. Recovery of the marsh system is anticipated one to two years after the end of construction.

Waterfowl, wading birds, alligators, and small fur-bearers such as nutria, muskrat, mink, and otter have marshland habitats. Pipeline maintenance would disturb these animals only infrequently, and would not prevent the return of wildlife to the right-of-way.

Alternative Intake Station. Construction of the alternative displacement/leachwater system would have the same effects on species and ecosystems as the primary system. The alternative pipeline right-of-way would affect 51 acres of prairie grassland and 25 acres of marshland. Using the same assumptions as for the primary pipeline, the following net losses could be expected: $7,130 in the rice crop, $4,080 in calf production, and $2,500 for marshland production over one year. These estimated economic losses are greater in total than for the proposed route although more marsh would be crossed in the proposed route.

Brine Disposal System Impacts

The proposed method of brine disposal for the Big Hill site would be via a pipeline that feeds directly into the Gulf of Mexico. Components of the brine disposal system are 1) an on-site pond (46,000 barrel capacity) for surge or detection and removal of oil trapped in the brine, 2) an on-site pump system (five 500 hp main pumps and six 175 hp charge pumps), and 3) 13.2 miles of pipeline. Effects of construction of 1) and 2) are discussed later, with the central plant facilities.

<u>Proposed Brine Pipeline.</u> The right-of-way for the proposed pipeline for brine disposal would encompass 15 acres of prairie grassland and 133 acres of marshland. This pipeline would lie in the same right-of-way as the displacement/leachwater pipeline until it crosses the ICW. After reaching the coast, the pipeline would extend 4 miles into the Gulf.

With a pipeline construction right-of-way of 75 feet, a total of 15 acres of dry land will be affected. Based on Soil Conservation Service estimates, a net production loss of $2,070 for rice and between $1,224 and $1,904 for calf production is anticipated for this environment (Soil Conservation Service, 1976). Since the displacement/leach water pipeline would be located in the same right-of-way, the potential losses from pipeline construction would be minimized.

At worst, one hundred thirty-three acres of marshland would also be disturbed by the proposed brine disposal pipeline, using the 150 foot right-of-way over marsh. A primary productivity loss of 1.3 x 106 kg/yr is predicted for this area. (8.2 x 105 kg for standing crop and 4.8 x 105 Kg for benthic algae and phytoplankton) (Day et al., 1973). However, because the brine disposal pipeline would be located for part of the way in the same right-of-way as the displacement water pipeline, the net production loss for both pipelines is only 5.7 x 105 kg/yr. As discussed earlier, half the standing vegetation productivity would remain available to help support the marsh ecosystem. Using a minimum direct value of marsh byproducts, a $100/ acre loss would amount to $5,800 during the one-year construction period. Construction noise would force the wildlife (waterfowl, alligators, some mammals) to emigrate from the area, with most species returning when construction ceased.

Pipeline burial in the Gulf would disturb an area up to 50 feet wide and 4 miles long. Mobile, nectonic and benthic animals would emigrate from this area for a short time. Alterations in aquatic populations, and reduction of primary production along the immediate route, which result from a slight increase in turbidity, would be evident for only a few days. Relatively immobile benthic organisms, however, would be eliminated where trenching takes place. Trenching in coastal areas would also destroy submergent aquatic macrophytes and periphyton. Populations of organisms from the large undisturbed Gulf environment would quickly recolonize the disturbed area.

Alternative Brine Pipeline. The alternate route would traverse 61 acres of prairie grassland and 76 acres of marshland. The net loss of production on prairie grassland is $8,418 for rice and $4,978 for calf production. Because the alternative leachwater pipeline runs in the same right-of-way, the net increase of production loss on dry land would be only $2,372. The net productivity loss for the 76 acres would be a total of 7.5 x 105 Kg/Yr (4.7 x 105 standing vegetation and 2.8 x 105 benthic algae and phytoplankton). At $100/acre, the cost would be $7,600. The net marsh productivity loss difference for the alternative brine disposal pipeline would be 5.5 x 105 kg/yr or $5,700. Although the loss of marsh production would be greater with the proposed route, the total estimated direct economic loss would be greater with the alternative.

Impacts at the Storage Location

The proposed Big Hill storage site, located in a prairie-pastureland ecosystem, provides grazing land for local cattle. The environmental setting is described in detail in Section B.3.4.5.3. of Appendix B. Approximately two miles of additional access road would be necessary for access to wellheads. A total of 230 acres of pastureland, which includes the central plant area and the wellheads, would be fenced surrounding the site. Such an enclosure would prevent cattle from grazing there, but the site would be mowed periodically; little change in species composition by succession is therefore anticipated. Only a small portion of the 230 fenced acres would be directly affected by construction activities. Construction would cause emigration of wildlife from the area and destroy burrows of small animals. Following construction, the exposed soil would be reseeded so that the area would return to its former level of productivity during the next growing season. Construction-related noise would have a minimal impact on species. Most species which emigrate would return shortly after construction ceased.

Oil Distribution System Impacts

Crude oil would travel between Big Hill and Sun Terminal in a pipeline 26 miles long. Table 4.6-3 describes the acreage required for construction of each pipeline as well as loss of primary productivity from construction of the proposed route (#1), and alternate route (#4).

Proposed Oil Pipeline Route (#1)

Effect on Prairie-Farmland Route. Construction of pipeline Route #1 would temporarily remove 213.6 acres of prairie-farmland community from active production. According to the Bureau of Census, 11 percent produces rice, 1 percent produces hay, and 1 percent produces soybeans. The remainder of this acreage is fallow fields or farm buildings and grounds. Pipeline construction would alter the habitats of various small mammals which inhabit the prairie farmland. Noise would also displace several species of birds, such as species of ducks and geese which find food in rice fields. Certain predator species including the coyote and the marsh hawk would also avoid the site during construction.

Effect on Woodland and Swamp. In addition, construction of Route #1 would eliminate 20.5 acres of fluvial woodland and 4.5 acres of swamps, and this alteration would last much longer than that on the prairie-farmland ecosystems since pipeline rights-of-way through woodlands would be continuously maintained for the life of the project.

Two species which would suffer habitat disruption as a result of pipeline construction are the mink, which reside in the cypress-tupelo swamps, and the white-tailed deer, which are common to fluvial woodlands. Other affected species would include the swamp rabbit, gray squirrel, and predators such as bobcats and foxes.

The loss of these woodlands and swamps would represent a loss of less than 1 percent of timber acreage in Jefferson County. Revegetation of this area by grasses, weeds, and other pioneer species would stimulate immigration of animals.

Effect on Freshwater Streams. Between the Big Hill site and Sun Terminal, Pipeline Route #1 would cross 4 freshwater streams: North and South Fork, Taylor Bayou, Lovell Lake, and Hillebrant Bayou. This would result in the temporary loss of 2.75 acres of stream and lake bottom. The number of individual organisms that would be destroyed would range from 9.0×10^6 for early spring to 7.5×10^6 for summer. In view of the total freshwater acreage in the area, however, the effect would be of only minor significance. Fish in these waters are expected to emigrate from the area of pipeline construction to relatively undisturbed areas.

Because of the increase in turbidity and the consequent lower light levels, phytoplankton productivity would be greatly reduced. Maximum impact on plankton production would occur if pipeline burial occurred in spring because of seasonal plankton blooms; the inhibition of plankton growth would last for several months after construction. An influx of nutrients from large freshwater areas, however, would help to minimize the reduction of plankton productivity.

Three additional effects of pipeline burial are, first, an increase in suspended sediments downstream from the pipeline crossing, which would reduce light availability. Second, an increase in pesticide and/or heavy metal concentrations would generally be detrimental to plankton growth and reproduction. Last, the release of nutrients, from the substrate would tend to increase phytoplankton productivity.

Alternate Oil Pipeline Route (#4)

The effects associated with construction of Alternate Route #4 are largely similar to those suggested for Route #1. See Table 4.6.3 for the projected alterations of primary productivity for affected areas. The effects for stream crossings would also be similar (discussed regarding Route #1). Route #4 differs from Route #1 mainly in that it would cross no fluvial woodland ecosystem and would affect approximately 4.5 acres of freshwater marsh. The marsh system is valuable for high primary productivity (e.g., fresh marsh macrophytes and for its contribution of fresh-water to adjacent biotic food chains). Aquatic macrophytes on the 4.5 acres would be eliminated, and phytoplankton productivity would also be affected severely. Construction activities would cause turbidity, and the consequent loss of available light would limit phytoplankton productivity beyond the 4.5 acres immediately involved. The figure for production loss presented in Table 4.6-3 is a conservative one. Wildlife would emigrate as a result of construction noise and activity and loss of habitat, but they would repopulate the area when construction is completed and marsh grasses are reestablished.

4.6.5.2 Operations Impacts

Displacement/Leaching Water System Impacts

Two types of impacts are related to the operational phase of the displacement/leachwater system: 1) effects related to the intake stations, such as entrainment and entrapment of plankton, and 2) effects related to the permanent 50-foot right-of-way pipeline corridor, including net loss of productivity and wildlife disturbance.

Proposed Intake Structure. The intake structure, dredged from the north shore of the ICW, would entrain organisms such as phytoplankters, zooplankters, larval fish, and benthic organisms. Virtually all entrained organisms would be killed. The loss of these organisms would unavoidably affect the aquatic food webs to which they belong, but effects would be localized and of minor severity in the vicinity of the intake structure.

It is doubtful that any severe impingement of organisms would occur because the 0.5-inch mesh screen apparatus and the 0.5 foot per second velocity would not impinge large organisms nor trap them in a strong current. Also, frequent cleaning would minimize clogging which might distort flow.

Table 4.6-3 Annual Loss of Primary Productivity - Big Hill Oil Distribution Pipelines

Route	Vetetation Type	Miles	Construction Right-of-Way	Operation Right-of-Way	Acres Construction	Acres Operation	Net Primary Productivity Kcal/m^3/yr	Net Primary Productivity Total Kcal/yr
#1	farm and prairieland	23.5	75 feet		23.5 prairie		2,500[1]	2.4×10^{8}
					21.3 pasture		2,500[1]	2.2×10^{8}
					47.0 rice		2,300[1]	4.3×10^{8}
					2.1 soy		2,400[1]	2.0×10^{7}
					2.1 hay		1,680[2]	1.4×10^{7}
				50 feet		15.7 prairie		1.6×10^{8}
						14.2 pasture		1.5×10^{8}
						31.3 rice		3.1×10^{7}
						1.4 soy		1.4×10^{7}
						1.4 hay		9.3×10^{6}
	fluvial woodland	2.25	75 feet		20.5		6,296[3]	5.2×10^{8}
				50 feet		13.6		3.5×10^{8}
	swamp	0.25	150 feet		4.5		4,560[3]	8.3×10^{7}
				50 feet		1.5		2.8×10^{7}
#4	farm and prairieland	22	75 feet		21.4 prairie			2.2×10^{8}
					19.4 pasture			2.0×10^{8}
					42.7 rice			3.9×10^{8}
					1.9 soy			1.8×10^{7}
					1.9 hay			1.3×10^{7}
				50 feet		14.3 prairie		1.5×10^{8}
						12.9 pasture		1.4×10^{8}
						28.5 rice		2.8×10^{7}
						1.3 soy		1.3×10^{7}
						1.3 hay		8.5×10^{6}
	fresh marsh	1.25	150 feet		22.7		6,072[4]	5.6×10^{8}
				50 feet		7.6		1.9×10^{8}
	swamp	0.25	150 feet		4.5		4,560[4]	8.3×10^{7}
				50 feet		1.5		2.8×10^{7}

(1) Odum (1971)
(2) Odum (1959)
(3) Day (Unpublished)
(4) Day (1973)

Finally, periodic inspection of pipeline routes and dome facilities would occasionally disturb wildlife. Waterfowl and mammals would probably avoid the area surrounding the pumping stations because of operation noise.

Alternative Intake Structure. The only difference between the alternative displacement/leachwater system and the proposed displacement/leachwater system would be in the areas affected by the present 50-foot pipeline right-of-way. The alternative pipeline right-of-way would temporarily impact 34 acres of dry land and 8 acres of marshlands.

Brine Disposal System Impacts

Pumping brine through the pipeline to the Gulf of Mexico would have two kinds of effects: 1) those related to the permanent 50-foot pipeline right-of-way, and 2) those related to the actual relase of brine into the Gulf.

Increased temperature and salinity of the brine would affect its actual disposal into the Gulf. Brine flowing from the cavities might reach 100° to 150°F. It would then cool in the brine surge pond and during its passage through the pipeline. The temperature increment of the overlying sediment would cause little, if any, additional stress on biota in the marshwater or benthic organisms in the sediment. The actual disposal of brine into the ocean would also have only minimal effects on non-benthic organisms. All available data indicates that mobile organisms which prefer lower salinity levels would avoid the brine discharge area with no apparent difficulty.

The biota of the Big Hill site is generally typical of the coastal waters of the northern Gulf of Mexico at the 30-foot contour interval. This is particularly true of the phytoplankton, zooplankton and demersal nekton communities whose species compositons are readily comparable to those found along the Louisiana-Texas coastline. Standing crops for these communities are also roughly comparable to those elsewhere in this region. The benthic community on the other hand is dominated by a limited number of species most of which are typical of degraded conditions such as associated with oil spillage. A significant finding is that standing crop for the benthic community is low.

The phytoplanktonic community is dominated by a mixture estuarine and marine diatoms. This probably reflects the mixing of estuarine waters from Sabine Pass with offshore marine waters. Species composition varies dramatically from month to month but <u>Skeletonema</u>, <u>Coscinodiscus centralis</u>, <u>Biddulphia</u> spp. <u>Rhizosolenia imbricata</u>, <u>R. robusta</u>, <u>Chaeotoceros</u>

currisetum, and C. decipiens are typical dominants. Interestingly September and December were wholly dominated by just one or two species (particularly Skeletonema) while October and November showed a diverse, equitably distributed species composition. Dinoflagellate numbers, as expected, were low for this time of year.

The dominant species at Big Hill were all copepods except one. This situation is similar to that of the other proposed disposal locations. Average combined zooplankton densities at Big Hill were of a similar order of magnitude distributed similarly over time compared to the same kinds of densities at the other proposed disposal sites. As with the West Hackberry and Black Bayou proposed disposal areas, Big Hill has a fairly well-developed, productive zooplankton community. It appears somewhat less rich than the others in terms of dominants.

The species composition of the nekton community is fairly constant from month to month, and is typical of Louisiana-Texas coastal waters. Standing crop varies markedly from month to month, but these fluctuations appear to be driven by random variation in the populations of the top dominant species, Acetes americanus, a sergestid shrimp, and Anchoa mitchilli, the Bay Anchovy. An influx of species during November probably reflects the fall offshore migration of estuarine summering forms. The sea bob, Xiphopenaeus krogeri, also showed high population densities. This is a locally important commercial shrimp species, whose distribution is restricted to locations just westward (downstream) of major estuarine passes.

The benthic community is almost wholly dominated by either the marine worm (polychaete) Magelona sp. (October, November, December) or the clam Mullinia lateralis (September). In both cases the second ranked species was only about half as abundant as the top dominant. Such a community structure is typical of environmentally degraded conditions. This is supported by the remarkably low standing crop in the benthic community. It should be noted that the depressed standing crop at Big Hill is in part due to the presence of extensive clay outcrops (Beaumont formation). On the other hand, both Mullinia and Magelona are known to be indicator species for degraded environments so that there is little doubt that the benthic environment is in fact degraded.

Disposal of brine at Big Hill would have its greatest impact on the benthic community. Components of this community are generally sedentary and would be unable to avoid exposure to the high density brine as it sinks towards the bottom. The most severely impacted region would be that nearest the diffuser port where highest salinities overages would be encountered. Based on MIT transient plume model, utilizing limited real world current observations for the Big Hill site under typical current regimes, up to 52 acres would be enclosed by the 3 ppt excess salinity isohaline. If total mortality within this region is assumed, about $.49 \times 10^6$ benthic individuals/acre would be eliminated. In the context of the broadly distributed nearshore benthic community, this is not a significant impact. Beyond the 3 ppt isohaline brine impacts on the benthic community would be expected to be minimal. Inasmuch as the planktonic and demersal organisms are either quickly carried through the diffuser site, or can otherwise avoid this region, impacts on these communities should be slight.

Impacts at the Storage Site

Only minimal effects from operation of storage site facilities are anticipated. Mowing the 230-acre fenced area would temporarily disturb small animals and ground-nesting birds. Noise levels from pumps would have little or no effect on surrounding marsh and agricultural lands.

Oil Distribution System Impacts

Operation of the oil distribution pipeline system would have minimal effect on the marshland system, which would revegetate after construction. The 50-foot right-of-way in woodlands would be mowed periodically to prevent regrowth of trees and shrubs. Stream and lake crossings would remain undisturbed, and affected marine organisms would reestablish themselves when turbidity subsides.

Ecological Impacts of Oil Spills

An oil spill on dry land would eliminate soil invertebrates in the immediate area. A 1,000 barrel spill could possibly contaminate up to 3 acres. Section C.5.2.5.4 of Appendix C describes the effect of oil spills on aquatic environments.

4.6.6 Natural and Scenic Resources

4.6.6.1 Construction Impacts

Natural and scenic resources would undergo only temporary and minimal effects from the proposed construction of pipelines.

4.6.6.2 Operations Impacts

No adverse effects are anticipated during normal operation and maintenance of facilities at Big Hill. A break in the pipeline during operation, however, would eliminate vegetation in the affected area and encourage rapid emigration of animals and birds.

4.6.7 Archaeological, Historical, and Cultural Resources

4.6.7.1 Construction Impacts

No archaeological sites were identified on Big Hill dome or near the associated pipeline routes. If the Big Hill site were chosen as an SPR facility, a more intensive survey would be initiated, which would satisfy the requirements of the National Preservation Act of 1966 and Executive Order 11593.

4.6.7.2 Operations Impacts

Operation and maintenance of the Big Hill dome and pipelines would have no adverse effects on known archaeological and historical sites in its vicinity.

4.6.8 Socioeconomic Impacts

4.6.8.1 Construction Impacts

Employment

Construction of oil storage facilities at Big Hill and the related pipelines would employ several hundred workers for a short time, but only about 60 workers would be continuously employed for the full 42-month construction period. At its peak, 165 workers would be at the site. Construction tasks off the site, such as laying pipelines, assembling pump stations and building transmission lines would employ an additional 360 workers in the third month, raising the peak manpower level to over 520. See Figure 4.6-2 for requirements over the full term of construction.

During the first 6 months, the surface facilities at the salt dome would be completed. Drilling of wells (2 rigs, 23 workers apiece) and leaching (45 workers) would both be done in shifts. Therefore, the number of workers on-site during the day would be about 135 in the third month, when employment is at a peak, and about 50 from the sixth month through the nineteenth month, when most of the drilling is being done.

At least two pipeline crews would be required by the project. One crew would lay the brine disposal pipeline and diffuser offshore in the Gulf of Mexico, while another crew would lay

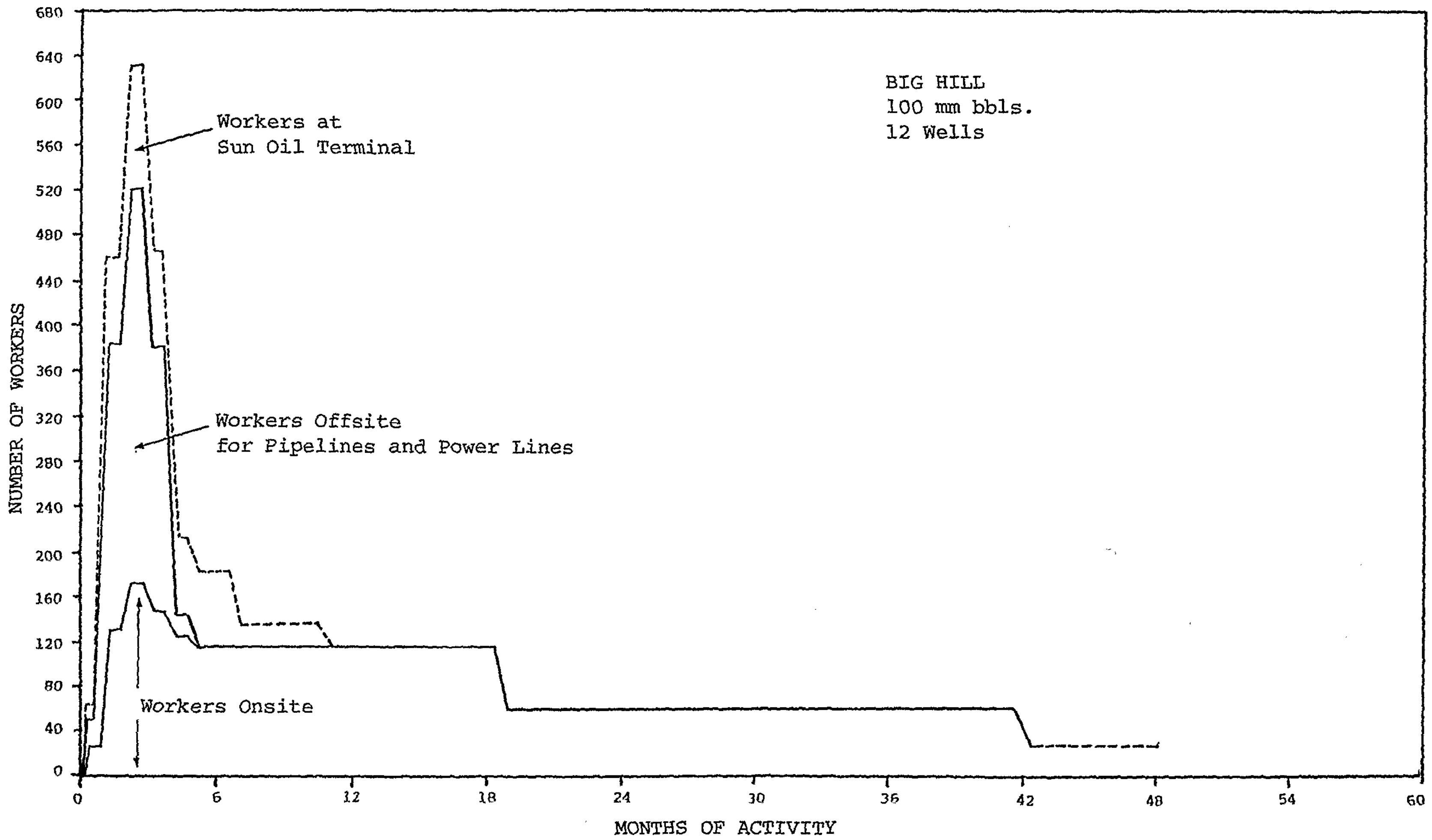

Figure 4.6-2 Labor Requirements at the Big Hill Site

the pipeline on land, both operations taking about 2½ months. The two pipeline crews would engage a combined labor force of 300 workers, which accounts for the major portion of the labor requirements in the third month of construction.

Since the Big Hill salt dome is located in Jefferson County, most of the workers would be drawn from that county's labor pool with some labor drawn from nearby Chambers and Orange Counties. As a result of construction activities associated with the Big Hill SPR site, the following counties would experience a consequent reduction in unemployment: Jefferson County by 0.4 percent, Chambers County by 0.5 percent, and Orange County by 0.5 percent.

Land Use

The land at Big Hill is used for cattle-raising. Also, productive oil wells appear around the periphery of the dome, and liquefied petroleum gas (LPG) is stored in two salt solution cavities by Pure Oil. One ranch (a residence and utility building) is located here, and would not be affected by construction of oil storage facilities except in terms of increased traffic and obstructed view. No zoning restrictions apply to the site, since it lies outside the city. Land use maps indicate that the site is an agricultural area, but use of the area for oil storage would not constitute a significant change from impacts related to its current use for oil production.

Construction of various pipelines would extend beyond site boundaries. The proposed raw water intake pipeline to the ICW and the pipeline laid in the same right-of-way and continuing into the Gulf would cross 1.5 miles of prairie used for grazing, 4 miles to the ICW and 3.5 miles through coastal marshes.

The oil distribution pipeline from the dome to the Sun Terminal would be 27 miles long and would cross more varied terrain, including several major highways. The Texas Highway Department would be consulted regarding these crossings. The pipeline route crosses two sparsely settled residential areas as well as areas used for rice production. Rice-growing activities would be interrupted only during construction. Most of the pipeline route would be through rural areas to its junction with the Sun Terminal.

Traffic

Construction of the facilities would change local traffic patterns. Roadway traffic would increase with transport of workers and material equipment. Coastal traffic would be slowed during installation of the pipeline, and waterway traffic would increase with tankers bringing oil to the Nederland docks.

During peak time, slightly more than 400 workers would be traveling to the site. The traffic pattern and load is difficult to predict, however, because of the variety of alternative routes the workers will use, as well as the use of car pools. If, for the purposes of analysis, it is assumed that 3/4 as many workers came from the Port Arthur area as from the Beaumont area, the configuration indicates approximately 185 cars and trucks moving to the site from Beaumont and another 140 moving there from Port Arthur.

After the initial 12 months of construction at Big Hill, the number of vehicles using the roads would begin to decline. The fact that many of the people on-site would be working in shifts would also decrease traffic. During the two years following the nineteenth month, only 55 workers would be traveling to the site, with a negligible effect on highway traffic and a 66 percent increase on access road traffic at Big Hill.

As the oil distribution pipelines are laid under main highways and the ICW, normal traffic would be slowed. Where possible, detours would reroute traffic around construction areas. The oil pipeline would also cross the Southern Pacific Railroad and the Kansas City Southern Railroad.

The brine pipeline would cross a less inhabited and less traveled section of the country. No parallel roads are available as potential detour routes. Highway 87 must be kept passable during construction activities. The brine pipeline would also cross the ICW, which averages 53 vessels per day.

Tanker travel on the Sabine-Neches Waterway would increase when oil is brought in to fill the storage caverns. Yearly increase in tanker traffic during the initial fill period would be as follows:

	Additional Tanker Trips	Sabine Pass Port Arthur Increase	Neches River Increase
10th - 28th month	157	8%	15%
28th - 42nd month	91	6%	11%

Housing and Public Services

Enough skilled laborers live in Jefferson County to meet the labor force requirements of the project. However, up to

15 percent (nearly 100 workers) might migrate into the area. These workers would probably seek housing in the following areas: 30 in Port Arthur, up to 10 in Nederland, and 20 in the Winnie-Stowell area. The effect of this would change the availability of housing in Beaumont and Port Arthur by less than one percent. Because Nederland is much smaller than its two neighboring cities, the effect would be more noticeable. There, the vacancy rate among rental units could drop by slightly over one percent. The longest impact would be found in the Winnie-Stowell area. There the expected 5 percent increase in the communities population is expected to result in a significant lack of housing units.

Economy

Since the labor supply for the project would be drawn primarily from surrounding areas, worker's earnings would circulate there. Also, because of the site's proximity to the Houston-Galveston area, materials and supplies would probably be shipped from these locations.

Payroll would be at its highest level in the first 6 months of construction and would then stabilize at a lower level while the caverns are being leached and filled. Payroll levels for oil storage facilities would be as follows:

1st - 6th month:	$520,500 per month
7th - 12th month:	218,000 per month
13th - 18th month:	218,000 per month
19th - 42nd month:	114,500 per month

Added to these amounts would be the payroll for expansion of the Sun Oil Terminal facilities. Average payroll for terminal expansion activity is as follows:

1st - 6th month:	$142,700 per month
7th - 12th month:	60,000 per month

(Payroll levels are based on an assumed average wage of $2,000 per month.)

Total cost of facilities planned for construction at Big Hill would be approximately $129,900,000, which includes payrolls, materials, equipment, and related costs. Of this amount, almost 90 percent ($114,500,000) will be spent within the region, which represents a direct increase in local earnings attributable to the project.

This direct increase in local earnings would generate profit in other local businesses as they purchase goods to maintain inventories in order to respond to the increased demand for materials and supplies. The full amount of local profit that the project would contribute would be about $235,900,000. Some of the income might be diffused into the Houston-Galveston area because of its proximity, but most of the profit would remain within the local region. The project-generated earnings would raise anticipated earnings by 11 percent in the 7 counties in this BEA area, and by 13 percent in the standard metropolital statistical area. The increase in income produced by the project compared to anticipated growth from 1980-1985 shows a 58 percent gain for the entire BEA region, and a 64 percent gain within the Beaumont-Port Arthur-Orange metropolitan area.

Government Revenues

If Big Hill were chosen as the oil storage site, some of the land that is now the Pipkin ranch would be purchased by the Federal government. Apart from loss of property taxes, no other reduction in county revenues is anticipated. Instead, local revenues would increase as a result of worker earnings generated by the project. Big Hill construction could yield approximately $166,600 in the first year, $75,000 in the second year, $57,600 in the third year, and $25,800 in the last 6 months of construction. Most of this revenue would go to Jefferson and Orange Counties.

4.6.8.2 Operations Impacts

Employment

Operation of the storage facility would require 15-20 skilled laborers, who would staff the facility on a 24-hour basis.

Land Use

Operation of the storage facility would not significantly affect present use of the land for cattle-raising and oil production. Further, it is unlikely that urban expansion from Beaumont and Port Arthur, the large urban centers closest to the site, would envelop the site during the lifetime of the project.

Traffic

Workers, service trucks, and occasional delivery trucks would cause traffic to increase slightly during the operational standby phase of the project over the 1973 traffic volume levels. Traffic on Route 73 would increase by 1 percent while the Big Hill access road traffic would increase by 25 percent. No appreciable increase would be felt on Highway 10. When oil is withdrawn from the storage sites, tanker traffic along the Sabine Pass and Port Arthur would increase by 8 percent while along the Neches River it would increase by 15 percent.

Housing and Public Services

The operational phase of the project would have less effect on housing than that experienced during construction because part of the staff would be employed permanently. Long-term effects on public services would be very small because of fire control and security systems which would be installed as part of plant facilities.

Economy

Operation of the Big Hill storage project would have very little effect on the economies of Beaumont, Port Arthur, and Orange. The 20 permanent employees on the site would generate a payroll of $45,000 per month, and total operation of the facility would come to about $93,000 per month. Smaller, rural communities such as Winnie, Stowell, and Hamshire, however, would experience a rather substantial economic stimulation.

Government Revenues

Federal ownership of a portion of the land at Big Hill would exempt it from property taxation for the duration of the project. Oil storage would increase local government revenues through the economic activity it stimulates by means of workers' wages.

4.6.9 Impacts Due to Termination

After termination of the SPR program, if the facility were not to be used for any other government purpose, it would be disposed of in accordance with applicable laws and regulations.

4.6.10 Relationship of Proposed Action to Land Use Plans, Policies, and Controls

The Big Hill site and all its related pipelines would lie in Jefferson County. The county requires a permit for use of county road rights-of-way, including crossing these roads. Pipelines that cross drainage ditches would require coordination with the local drainage district. Where pipelines cross state highways, the Texas Department of Highways and Public Transportation would be consulted for procedures to maintain normal traffic flow.

Other state agencies would be involved in the process as well. The Texas Railroad Commission would hold hearings on the advisability of the use of the Big Hill site for oil storage. The Texas General Land Office and the Texas School Land Board require tests to assure quality of the pipeline and its welds, as well as specific measures to insure protection of the environment. These measures have been incorporated into the specifications for the construction of the pipeline. The Corps of Engineers also has jurisdiction over construction in the wetlands.

Land use plans for this area have been prepared by the Southeast Texas Regional Planning Commission. These plans indicate a growth of the urban areas north and east of the site, but no change from current agricultural land use at the site.

4.6.11 Summary of Adverse and Beneficial Impacts

See Table 5.2-2 in Chapter 5 for a detailed summary of the adverse and beneficial effects associated with site preparation and construction at the Big Hill site. The effects for West Hackberry are summarized in Section 4.3.5, so that only major differences are mentioned here. The most important difference is that at Big Hill, a new crude oil pipeline would be required from Big Hill to Sun Terminal. West Hackberry, Black Bayou, and Vinton would use the pipeline which will be constructed as part of the West Hackberry ESR program. Also, effects of brine disposal at Big Hill would be less than at West Hackberry because brine would be discharged at only two-thirds the rate. Last, because the Texas site would draw from a different labor pool for construction and support, governmental revenues would be increased primarily in Texas rather than in Louisiana.

4.7 DISTRIBUTION TERMINAL

4.7.1 Land Features

4.7.1.1 Construction Impacts

Construction of a new tanker dock at Sun Terminal would require the dredging and removal of 600,000 cubic yards of spoil. This would result in an increase in the water depth at the dredge site and modify landforms at the spoil disposal area. Because of the limited subsurface construction, the impacts to stratigraphy or geologic structure are considered to be minimal.

4.7.1.2 Operations Impacts

Maintenance dredging would be required at the docks, which will maintain the altered bathymetry at this location. During the periodic dredging, the disposal of the spoil material would result in a minor geomorphic impact in the disposal area. Routine operation and maintenance, however, is not expected to result in any impacts to soil characteristics at the site.

4.7.2 Water

4.7.2.1 Construction Impacts

The construction of an additional docking facility at the Sun Oil Terminal and the laying of pipelines for the transport of oil and brine would require a significant amount of dredging in the Neches River. Approximately 130 acres of disturbed wetlands habitat, previously used for dredge disposal, would be newly buried by spoil from the construction of the new tanker slips at Sun Terminal. This would constitute a redisturbance of this area, and destroy any vegetation which has been established.

Dissolved oxygen decrease, nutrient level increase and release of toxic materials such as heavy metals and pesticides would depend on sediment contamination at the site. These impacts will be significant at the Neches River, due to the contamination of the sediment in this location.

4.7.2.2 Operations Impacts

Each tanker prior to receiving oil at the tanker dock would discharge a volume of ballast water amounting to 20 percent of its total capacity. Ballast water is normally pumped into a tanker while at sea and therefore would be saline (30 ppt). Texas water quality standards require that no visible film of oil be produced on the water surface during the discharge. The concentration of oil necessary to produce such a film is not precisely established, but available experimental data (Hornstein, 1973) indicates that such a film becomes visible when the oil concentration is approximately 7.5 ppm.*

It is expected that the ballast water resulting from SPR tanker loading would be discharged into the Neches River after treatment in an existing ballast water treatment facility at a rate of 10.92 ft^3/sec or 168,000 bpd.** Upon release, the ballast water would enter the Neches River via a small ditch on the southern bank of the river. The river depth varies from 5 feet near the shore to 40 feet in the navigation channel. The behavior of the resulting plume of the treated ballast waters was modeled by means of a computer program utilizing the general solution of the diffusion equation for a finite moving medium (Hinze, 1959). Figures 4.7-1 and 4.7-2 present this data on the contours for oil concentrations on the river bottom and river surface after discharge, while Figures 4.7-3 and 4.7-4 present the corresponding plots of isohalines (lines of constant salinity).

On the river bottom, as indicated in Figure 4.7-1, oil concentration values of 7.5 ppm would occur as far as 950 feet downstream of the ditch. The oil concentration is expected to exceed 1 ppm for a distance of approximately 7600 feet downstream.

On the surface of the river, oil concentrations of 7.5 ppm, as shown in Figure 4.7-2, would be encountered as far as 960 feet downstream. Likewise concentrations in excess of 1 ppm would occur as far as 7900 feet downstream. On both the river bottom and surface no concentration greater than 1 ppm would occur beyond roughly 40 feet from the southern bank of the river.

The isohalines shown in Figure 4.7-3 for the river bottom indicate that salinites of 30 ppt would persist as far as 950 feet downstream. Salinities greater than 4 ppt would be encountered for a distance of 7600 feet downstream.

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* This concentration includes both dissolved and emulsified oils.

**This rate of discharge is based on the assumption that 60 percent of the oil removed from the storage facility would be transported by tanker from the Sun Oil Dock.

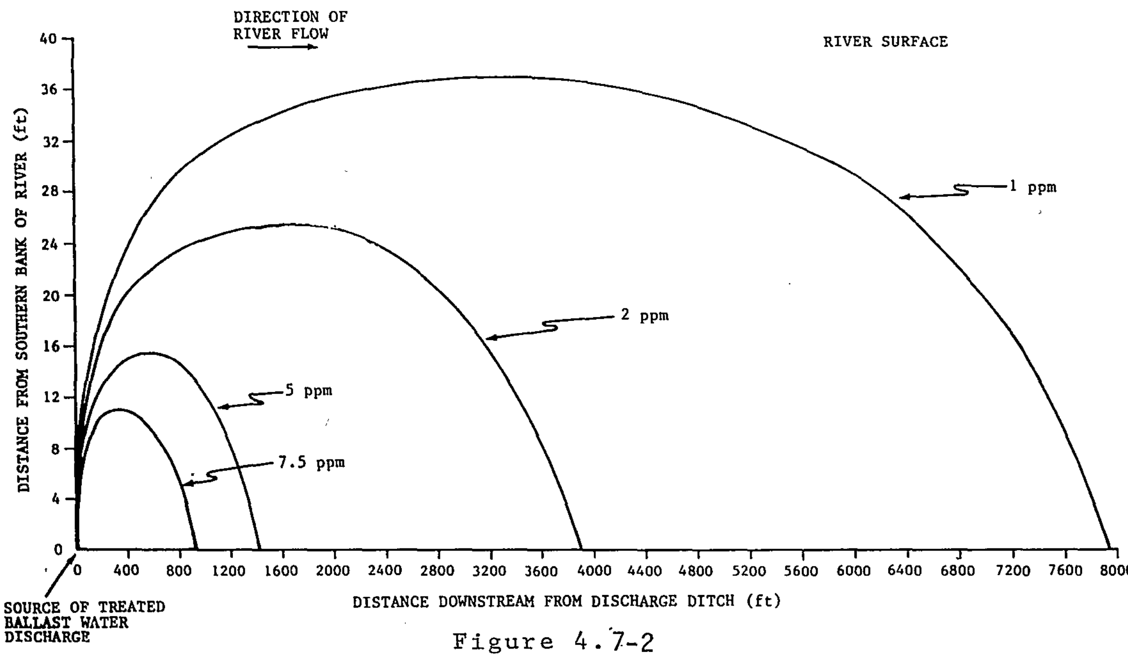

Figure 4.7-2

Computed Oil Concentration on Surface of Neches River

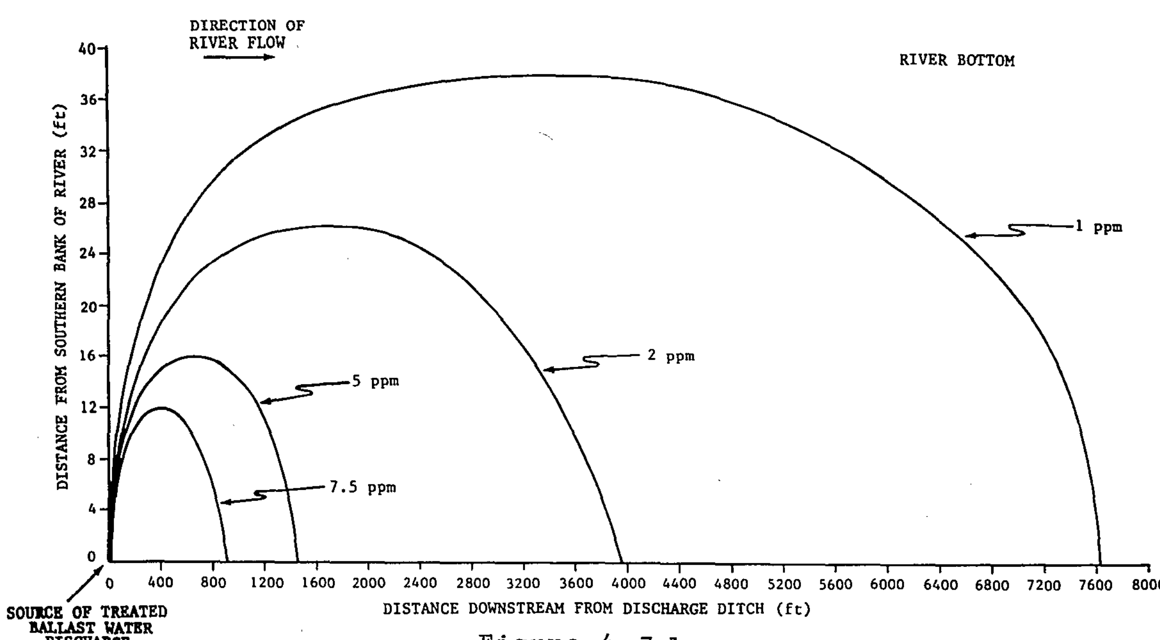

Figure 4.7-1

Computed Oil Concentration along Bottom of Neches River

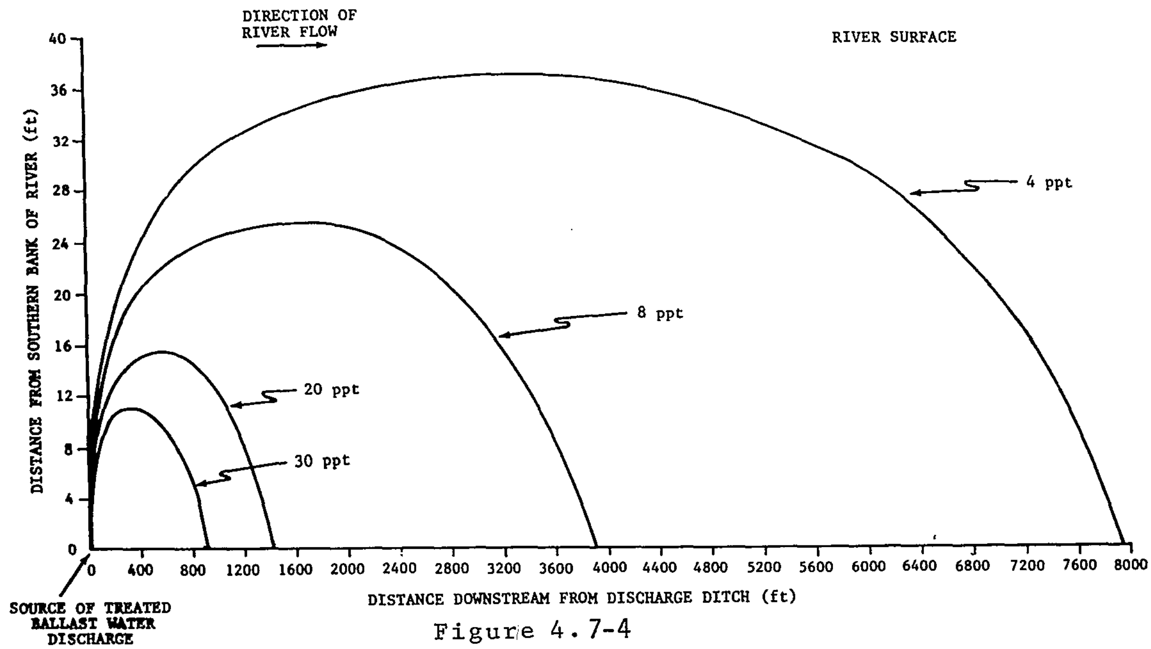

Figure 4.7-4

Computed Salinity on Surface of Neches River

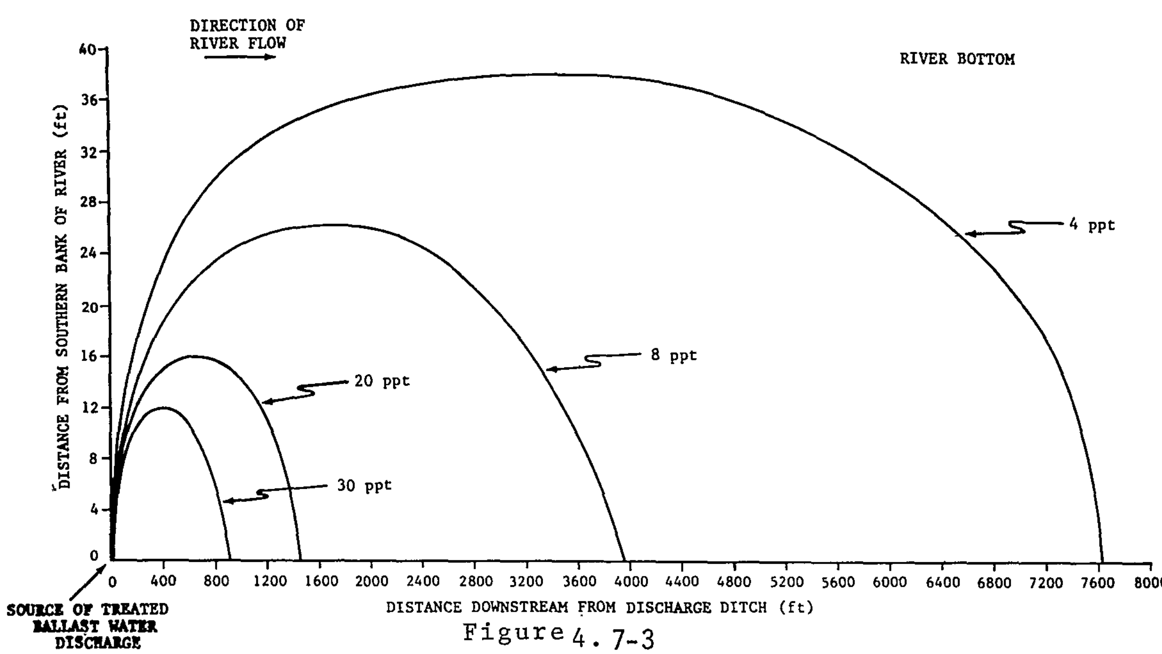

Figure 4.7-3

Computed Salinity on Bottom of Neches River

On the surface of the river, as shown in Figure 4.7-4, the 30 ppt isohaline would extend downstream 960 feet. Salinities in excess of 4 ppt would occur as far as 7900 downstream.

The total area exposed to a given concentration of oil is presented as a function of oil concentration in Figures 4.7-5 and 4.7-6 for the river bottom and surface, respectively. Figures 4.7-7 and 4.7-8 provide similar data for the total area* exposed to a given level of salinity. In each case, an area of approximately 8000 square feet or less is exposed to the maximum levels of oil and salinity.

The cross sectional area** of the portion of the river affected by the discharge of treated ballast water would be less than 0.1 percent of the total cross sectional area of the river. A mixing region of this size would be well within Texas State Water Standards. Thus, the discharge of treated ballast water into the Neches River would be considered to have a minor impact on the river.

4.7.3 Air Quality

4.7.3.1 Construction Impacts

The construction of the proposed oil storage facility at West Hackberry would result in combustion and fugitive emissions at the terminal. Airborne particulates would result from (1) the use of unpaved roads, (2) the operation of machinery and (3) the preparing (grinding) of tanks prior to painting. Expected ground level particulate concentrations are shown in Figure 4.7-9. Where applicable, a water spraying program would be initiated to reduce particulate emissions to prescribed air quality standards.

During the painting of the storage tanks, the 3-hour NMHC standard would be violated for a downwind distance of 4 Km (see Figure 4.7-10). The maximum frequency of violation would be 1 percent of the time annually and the violation would occur to the west of the terminal. Actual painting would take less than a month.

In general, the construction of SPR related facilities at the Sun Terminal site would not result in significant offsite violations of the applicable ambient air quality standards.

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* In the horizontal plane.
**In the vertical plane.

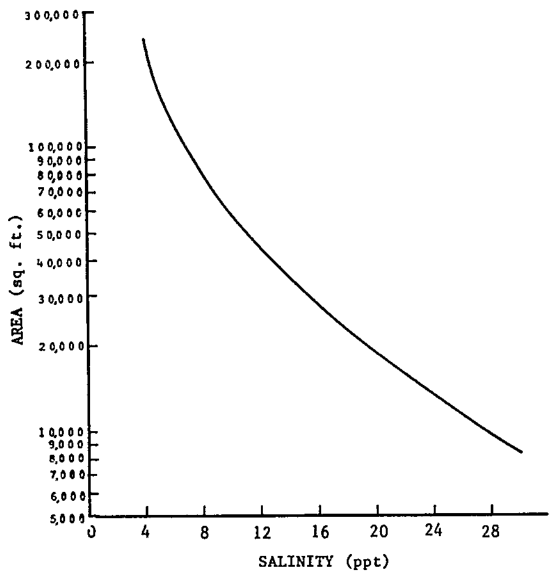

Figure 4.7-7 Variation of Exposed Area with Salinity Concentration Along Bottom of Neches River.

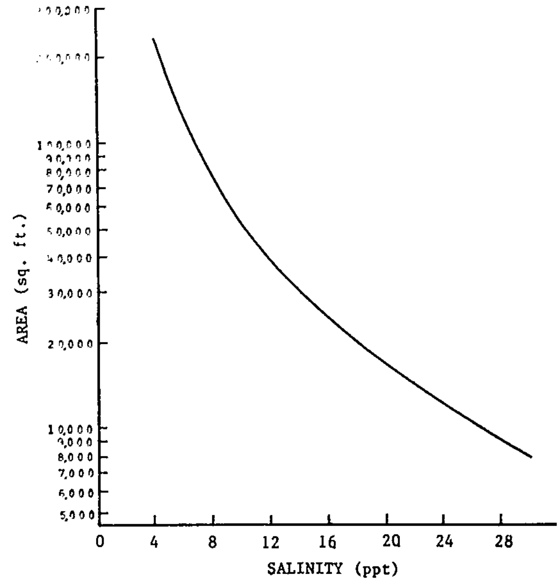

Figure 4.7-8 Variation of Exposed Area with Salinity Concentration on Surface of Neches River.

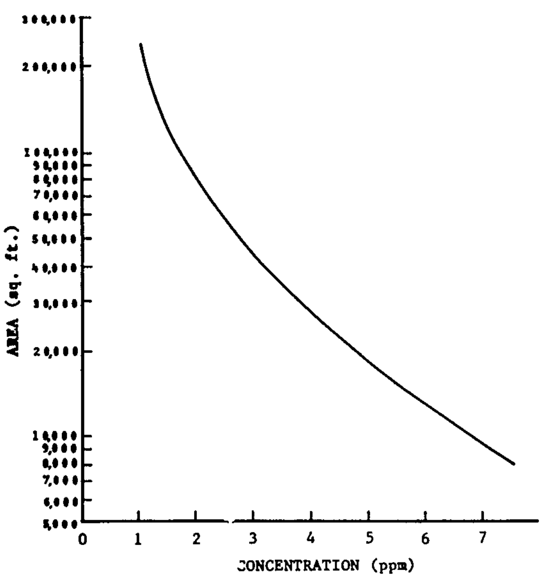

Figure 4.7-5 Variation of Exposed Area with Oil Concentration Along Bottom of Neches River.

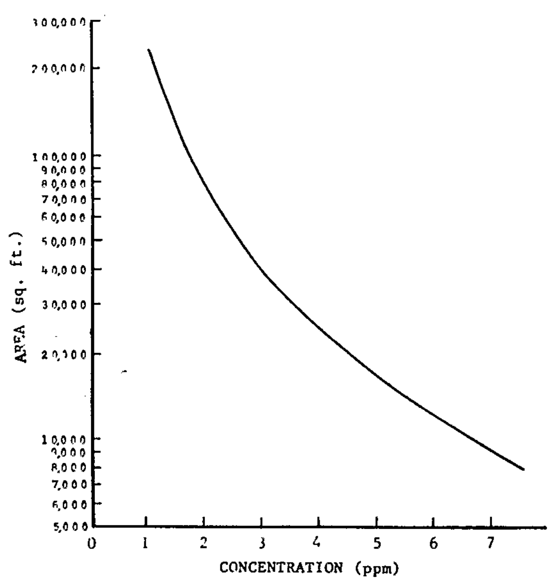

Figure 4.7-6 Variation of Exposed Area with Oil Concentration on Surface of Neches River

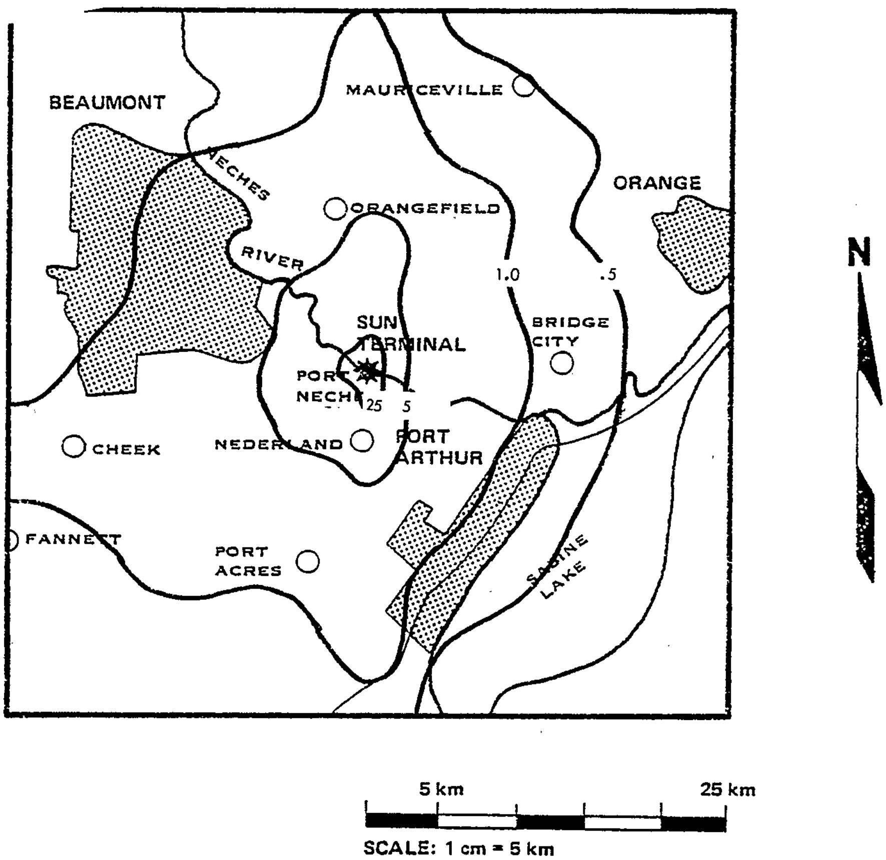

Figure 4.7-9 Annual Average Particulate Ground Level Concentrations (μg/m^3) for the Sun Terminal for all Texoma Sites During the Construction Phase

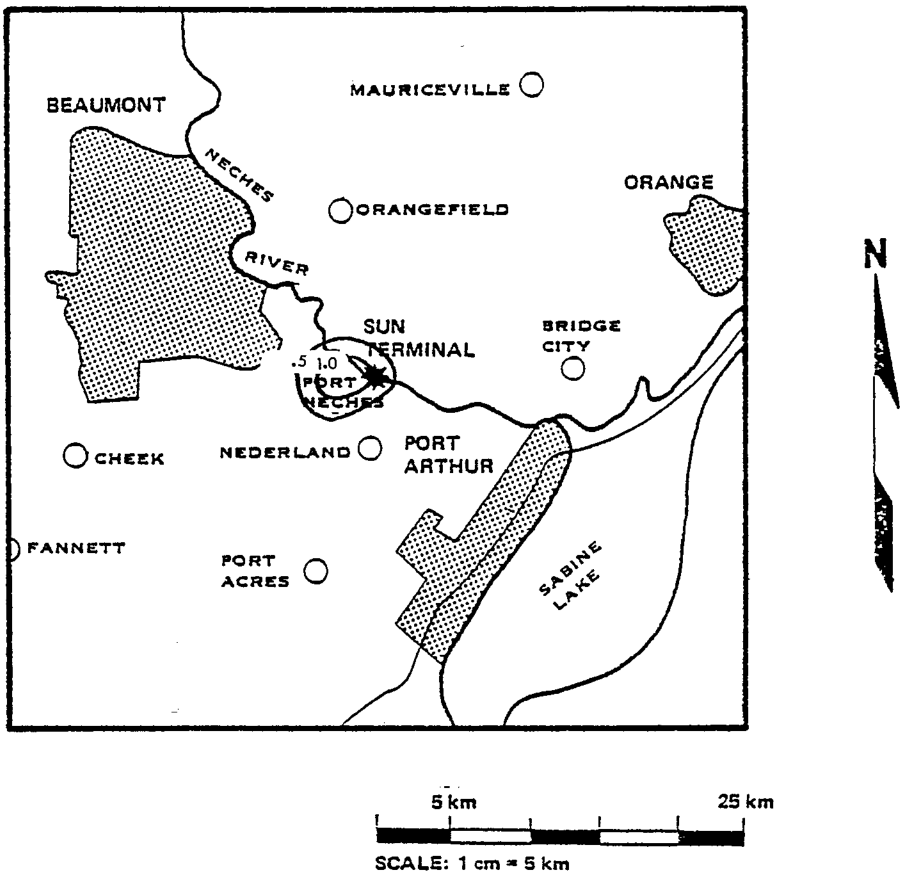

Figure 4.7-10 Annual Frequency of Occurrence (%) of Violations of the 3-hour NMHC Standard for Tank Painting at the Sun Terminal for all Texoma Sites During the Construction Phase*

4.7.3.2 Operations Impacts

The emission sources from operational activities for the terminal include the offloading of crude oil from tankers during fill, and the loading of the oil onto tankers during withdrawal. These emissions would be the result of evaporative losses of gaseous hydrocarbons from exposed liquid surfaces of crude oil.

The operational phase of the program would consist of three types of activity: (1) initial fill, (2) drawdown, and (3) refill. All crude oil would be delivered to the Sun Terminal by tankers during the initial fill and refill phases. During the 150-day drawdown, it is assumed that 60 percent of the oil would be distributed by tanker, while the remainder would be distributed by overland pipelines. Evaporative losses of hydrocarbons would emanate from exposed surfaces of crude oil during each project phase. The largest volume of hydrocarbon emissions would be associated with the handling of crude oil during loading and unloading of the ships. In addition, there would be evaporative hydrocarbon losses from the terminal tank facilities and the terminal pump house. Combustion contaminants could also be expected at the terminal due to boiler emissions from the dockside tankers and from tug engines during tanker assistance. Annual tonnage emission rates for these sources are contained in Table 4.7-1, which provides the emissions for each site alternative.

Short-term modeling calculations have been performed for project hydrocarbon emissions at the terminal site. The calculations are based upon concomitant emissions from all sources including tankers, tanks and pump houses. In addition, two separate scenarios were modeled at the Sun Terminal to handle both ship loading and unloading phases. The results of the modeling analyses are contained in Figures 4.7-11 and 4.7-12. During tanker loading and unloading operations at the Sun Terminal, the NMHC standard would be violated. Figure 4.7-11 indicates that during tanker loading during the distribution phase, the 3-hour NMHC standard would be violated 1 percent or more of the time annually out to downwind distances in excess of 25 kilometers. The maximum impact would occur to the west of the terminal, where violations of the standard would occur 5 or more percent of the time annually out to a downwind distance of approximately 10 kilometers. During ship ballasting operations after the completion of tanker unloading, Figure 4.7-12 indicates that the applicable standard would be violated out to a downwind distance of approximately 20 kilometers with the maximum impact occurring west of the facility where the frequency of violation is in excess of

Table 4.7-1 Annual Tonnage Emission Rates at Sun Terminal During Fill and Drawdown

Source or Activity	Annual Emissions (Tons)				
	HC	Particulate	SO_X	NO_X	CO
West Hackberry					
Fill Phase	144	38	448	149	6
Withdrawal Phase	1092	18	171	58	4
Black Bayou					
Fill Phase	144	38	448	149	6
Withdrawal Phase	1092	18	171	58	4
Vinton					
Fill Phase	56	12	149	50	2
Withdrawal Phase	374	6	57	20	1
Big Hill					
Fill Phase	100	25	298	99	4
Withdrawal Phase	732	12	115	39	3

Data from Tables C.3-11, C.4-3, C.5-4, and C.6-4

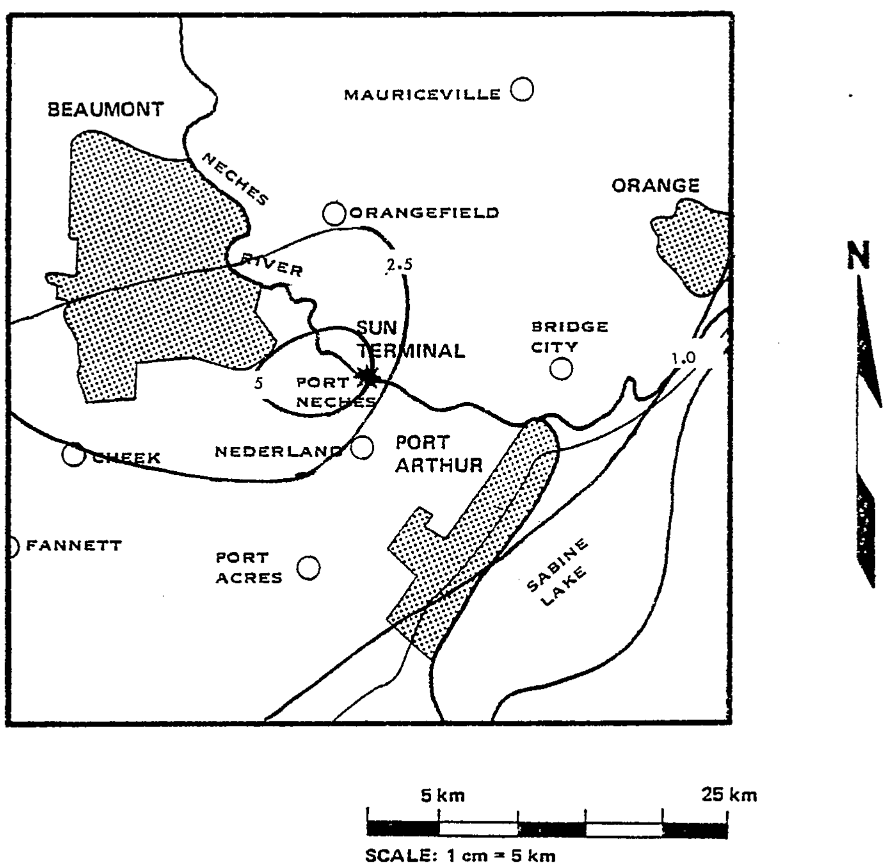

Figure 4.7-11 Annual Estimated Frequency of occurrence (%) of Violations of the 3-hour NMHC Standard at the Sun Terminal for Tanker Loading During the Operational Phase for the West Hackberry site.

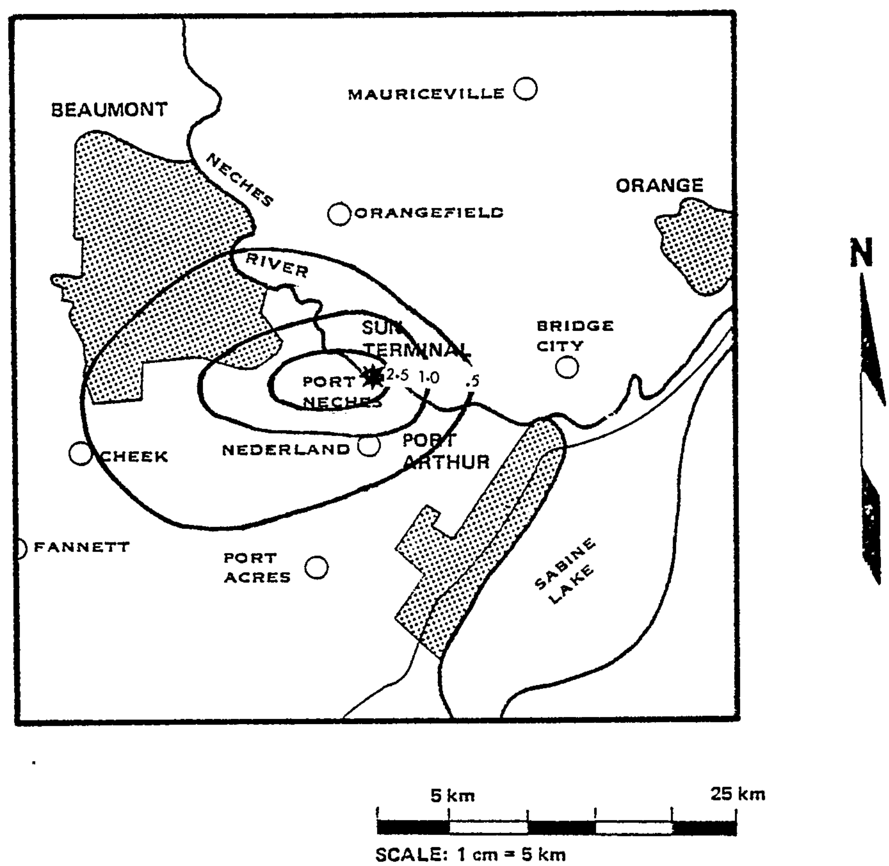

Figure 4.7-12 Annual Estimated Frequency of Occurence (%) of Violations of the 3-hour NMHC Standard at the Sun Terminal for Tanker Ballasting During the Operational Phase for the West Hackberry site.

2.5 percent of the time annually. The calculations are conservative in that they do not include the minor additional dilution attributable to structural wake effect. The approach also assumes that the 3-hour standard for NMHC would be violated during the applicable 6 to 9 a.m. period with a frequency equal to that during the annual period.

Annual NMHC ground level concentrations have also been calculated for the terminal site. Figure 4.7-13 provides the results of this analysis. This calculation is based upon the conservative (worst case) assumption that both the fill and drawdown phases would occur, at least in part, during the same annual period. The results indicate that annual ground level concentration would generally be less than 5 $\mu g/m^3$.

The possible impact of the hydrocarbon emissions emanating from the SPR facilities on local oxidant levels are estimated to exceed 160 $\mu g/m^3$ over a fairly large geographical area. It is probable that maximum daily 1-hour average Ox ground level concentrations in excess of the Federal Primary Standard might occur at stations where violations of the 3-hour NMHC standard are predicted in Figures 4.7-11 and 4.7-12. However, such a prediction would probably be an overestimate as local oxidant levels reflect regional emission trends, and are not presently felt to be related to local sources (HEW 1970).

In summary, Sun Terminal facility would be a significant source of NMHC, and to a lesser extent, combustion contaminants. The calculations on the violation of the 3-hour standard for NMHC are based upon modified emissions data (shown in Table C.3-9) and do not incorporate abatement technology for the control of evaporative losses of hydrocarbon vapors due to shipboard handling of crude oil. Tanker loading and ballasting emissions dominate the terminal site emission levels and it is unlikely that the other sources would independently violate the NMHC standard outside the terminal boundaries. The level of hydrocarbon emissions at the terminal would probably be insufficient to have an important impact on regional levels of photochemical oxidant. The actual magnitude of this impact remains difficult to quantify. The annual tonnage emission rate for the West Hackberry expansion is relatively small in comparison to regional hydrocarbon emission levels in this region of heavy petrochemical activity. This fact, coupled with the presently accepted rationale that local oxidant levels are not directly related to emission strengths from local, isolated sources, indicates that it

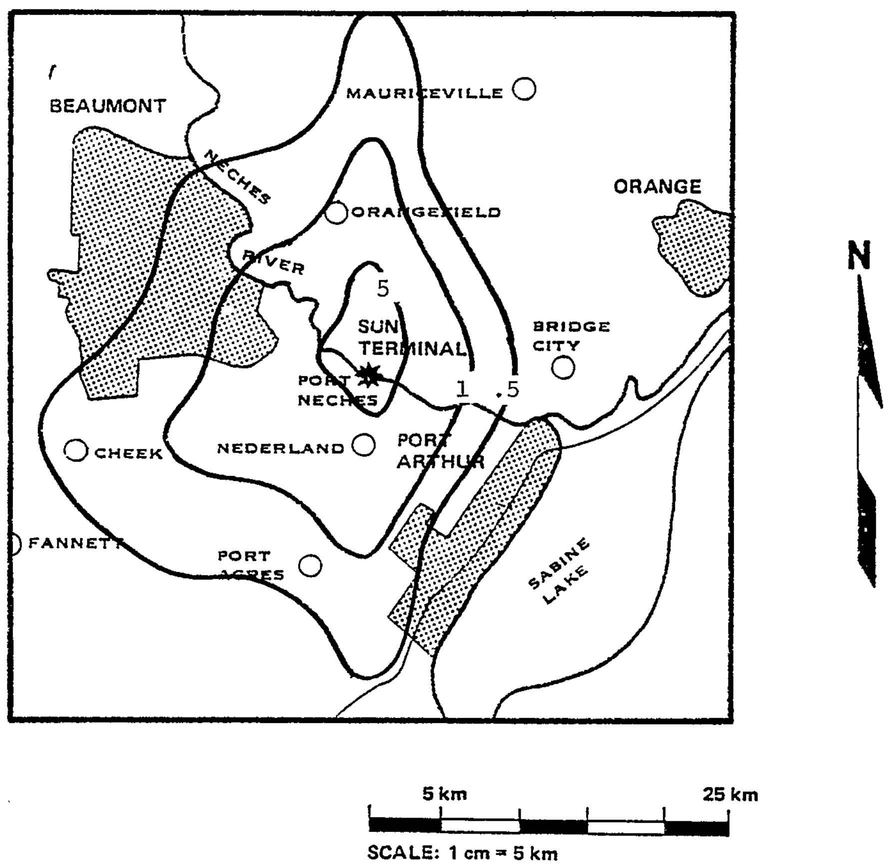

Figure 4.7-13 Annual Average NMHC Ground Level Concentrations (μg/m³) at the Sun Terminal During the Operational Phase for the West Hackberry site.

is unlikely that the proposed use of existing and new facilities at the Sun Terminal would have a significant impact on observed levels of photochemical oxidant. No violations of standards for other contaminants would occur.

Emission Control Technologies

The major emissions from the SPR program sources are hydrocarbons from loading and ballasting operations at the marine terminal. Other hydrocarbon emissions include evaporate losses from surge-storage tanks; leaks from pumps and valves; and vapors from pressure release devices.

Vapor collection and vapor control systems are discussed in detail in Appendix C, Section C.3.1.3.2. Vapor control systems that could be applied to terminal operation include flame oxidation, absorption, and compression-refrigeration-condensation. This technology is relatively new to the industry, and presents a unique set of safety and design problems involving considerable design modification and engineering effort in terms of retrofitting the existing available systems. In addition, operational control strategies (Appendix C) can also be employed to reduce emissions.

4.7.4 Noise

4.7.4.1 Construction Impacts

The construction of additional docks and terminal facilities would contribute to the general noise of unloading operations at the existing terminal on the Neches River. The predominant construction noises are expected to be from pile driving and diesel engine operations. Table F-2 in Appendix F shows sound levels typical of this equipment. It is estimated that noise from construction would contribute 64 dB at approximately 1800 feet from the dock construction site.

4.7.4.2 Operations Impacts

During fill and/or discharge operations, there would be noise generated from the continuous operation of pumps at the terminal. The noise is expected to be continuous both day and night during these operations. However, since the pumps would be placed in some noise dampening enclosure, it is anticipated that there would be a negligible impact on existing ambient levels of sound.

4.7.5 Species and Ecosystems

4.7.5.1 Construction Impacts

Approximately 5.7 acres of grassland would be permanently covered by the 3 surge tanks at Sun Terminal. Typical dry land species of soil organisms (insects, mites, and worms) would be permanently excluded from the upper few centimeters of the soil. Grass and shrubs would also be permanently excluded as would rabbits, birds, and other wildlife that presently use the area for feeding and nesting.

The most signficant impact of construction at the terminal would be the dredging and removal of 600,000 cubic yards of spoil for the new dock facilities. Impacts on biota associated with the dredging have been discussed in the West Hackberry Environmental Impact Statement Supplement, FES 76/77-4 (FEA, 1977b). Dredging would increase the amount of solids suspended in the water column at and downstream from the dredge point. Visually oriented fish would temporarily vacate the area and benthic organisms (insect larvae, mollusks) would suffer increased mortality due to siltation. Bottom foraging fish (catfish, carp and suckers) would be affected the most from the loss of benthic organisms. Plantonic growth, however, would be stimulated due to the upheaval of nutrients in the sediment, but the effects would be relatively short-lived. In general, because of the relatively poor aquatic environment in this section of the Neches River, the proposed additional dredging will not significantly affect the biota in the area.

4.7.5.2 Operations Impacts

Oil related risks associated with the use of Sun Terminal would involve accidental releases from tankers, accidental spills and ballast water discharges into the Neches River. Oil spills in the river would impact various species depending upon the particular location and the specific behavior of the spilled oil. General effects of oil on biota and particular species likely to be impacted are discussed in Appendix H and are not repeated here.

Tankers, prior to receiving oil at the Sun Terminal tanker dock, would discharge a volume of dirty ballast water into ballast treatment facilities onsite. After treatment the existing ballast would be discharged into the Neches River. This discharge would temporarily increase oil and salinity concentrations in the receiving waters. As a result of this discharge, the aquatic environment near the release point would probably be biologically degraded, but the expected contamination (a maximum increase of 7.5 ppm for an area of 8000 square feet or less) is not expected to significantly alter the quality of this part of the river. A worst case discharge would significantly affect phytoplankton and eliminate this area as a fish-breeding ground.

4.7.6 Natural and Scenic Resources

4.7.6.1 Construction Impacts

The area around the dock and terminal is presently utilized for petroleum industry and shipping activities. It is anticipated that the dredging planned for Sun Terminal would be very similar to the routine dredging that periodically takes place at this location. Because of the nature of the general area and the anticipated construction, no degradation of the natural and scenic environment is expected.

4.7.6.2 Operations Impacts

Normal operation of Sun Terminal for SPR-related activities would not degrade the existing natural and scenic environment of the area.

4.7.7 Archaelogical, Historical, and Cultural Resources

4.7.7.1 Construction Impacts

Extensive archaeological surveys of the West Hackberry dome and the oil pipeline route have been completed. The results of these surveys will be used for compliance with the National Historical Preservation Act of 1966 and Executive Order 11593.

4.7.7.2 Operations Impacts

Known archaeological and historical sites in the vicinity of Sun Terminal would receive no adverse impact from the operation of this facility.

4.7.8 Socioeconomic Impacts

4.7.8.1 Construction Impacts

The impacts of project construction on local river traffic would be an increase in the number of tankers bringing oil to the docks at Nederland.

The following table shows the annual increase in tanker traffic on three sections of the Sabine-Neches Waterway. It is assumed that each tanker holds 410,000 barrels of oil.

	Additional Tanker Trips	Sabine Pass Port Arthur Increase	Neches River Increase
7th-16th month	130	12%	23%
18th-36th month	234	12%	23%
36th-50th month	136	9%	17%

4.7.8.2 Operations Impacts

In the event that it became necessary to withdraw the oil, 23 additional workers would be needed at Sun Terminal. Since the withdrawal would occur only when oil imports were suspended, it is expected that workers normally employed in offloading the foreign oil shipments would be used at the docks to load oil and at the Texoma pipeline terminal to monitor the flow of oil from storage to inland refineries.

During cavern refilling, 10 to 15 workers would be needed at the terminal to offload oil from tankers into the pipelines leading to the storage facility at West Hackberry. The workers detailed to the oil storage program would be full-time employees of the Sun Oil Terminal, so the personnel required at the docks during oil withdrawal and cavern refilling would not represent new positions created by the project.

Traffic

During a period when oil is removed from storage because of an interruption in foreign oil supplies, tanker traffic in the Sabine-Neches Waterway would not be significantly increased since most of the normal tanker traffic results from the importation of crude oil.

During a 40-month refill period, tanker trips, in addition to normal traffic on the waterway, would increase 12 percent along Sabine Pass and Port Arthur, and 23 percent in the Neches River.

Housing and Public Services

Workers would be needed at the docks in Nederland when the oil is removed from storage and when it is replaced, but work would not create additional jobs or increase demand for public services.

4.7.9 Impact due to Termination

After termination of the SPR program, DOE would presumably cease its leasing operation at Sun Terminal. The facility would continue to function as a privately-owned depot for shipments of foreign and domestic petroleum products to inland refineries.

4.7.10 Relationship of the Proposed Action to Land-Use Plans, Policies and Controls

The proposed construction at Sun Terminal and the operation of the facilities at the dock would be in compliance with local, state and federal regulations. Where dredging and spoil deposition would be required, the Corps of Engineers would be contacted to obtain the necessary permits.

4.7.11 Summary of Adverse and Beneficial Impacts

The removal of approximately 600,000 cubic yards of material from the Neches River to create new dock sites would alter the depth of that section of the river. Dredging would also release light metals into the water column; while heavier metals would become absorbed by suspended solids which would be stirred up by the construction activities but would settle rapidly. Water quality would therefore be temporarily effected although the impact would not be significant.

The release of treated ballast water from SPR related tankers at the dock is expected to affect the water quality of several acres of the Neches River with excess salinity and oil discharges. Due to the large mixing area in the river, this discharge is considered to have a minor effect.

During construction, there would be minor impacts to air quality from the use of unpaved roads, the operation of machinery and the preparing (grinding) of tanks prior to painting. When tankers load and offload oil, the hydrocarbon emissions are expected to violate the 3-hour NMHC Standard 1 percent of the time annually. This would occur at downwind distances in excess of 25 kilometers.

Noise emissions would be evident mainly during the construction phase from pile driving and diesel engine operations. These activities would contribute 64 dB to the ambient level approximately 1800 feet from the construction site.

Dredging and the subsequent siltation during the construction of new docks will temporarily impact benthic organisms and bottom-foraging fish. The greatest impact to both animal and plant species in the area would come as a result of an accidental oil spill. The probability of a major spill, however, is considered remote.

No natural or scenic resources would be affected by terminal construction or operation.

Activities at the terminal are not considered to have a significant socioeconomic impact on the area. An increase in the work force at the docks would be needed at a time when oil imports were suspended. Therefore workers normally employed in offloading foreign shipments would be used at the docks and at the Texoma pipeline to handle the transfer of oil from storage to the inland refineries.

4.8 CONSIDERATIONS OFFSETTING ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIVITY

The United States has become increasingly dependent upon petroleum imports. These imports constituted approximately 48 percent of the nation's oil consumption in the first ten months of 1977. During this same period, overall oil requirements increased 7.7 percent and total imports increased 24.1 percent. The increase in total imports between 1972 and 1977 was 86 percent.

In the past 25 years, the United States has experienced four sudden denials of oil imports 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.

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 (Holcombe, 1974; Bennet, 1974). 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. 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. 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.

The concern voiced by the National Petroleum Council (1975), the Ford Foundation (1974), and the Energy Laboratory at the Massachusetts Institute of Technology (1974) as well as the public, in addition to the nation's formal commitments to the International Energy Program (IEP), provided strong impetus for passage of the Energy Policy and Conservation Act of 1975 (P. L. 94-163), which provided for the creation of the Strategic Petroleum Reserve. The expansion of the Texoma storage facility group from 60 million barrels (MMB) to 210 MMB would provide an additional 150 MMB of the SPR requirement.

4.9 SUMMARY

Impacts are summarized in Chapter 5.0 and major differences between each of the alternate sites and the proposed site have been discussed in Sections 4.4.11, 4.5.11, and 4.6.11. Differences in facility designs are summarized in Table 2. 8-1 in Chapter 2.0. Detailed analysis of specific impacts is provided in Appendix C.

Land use impacts would be relatively minor at the proposed and alternate sites. Construction of canals for wellhead access at Black Bayou and Vinton would alter drainage patterns. This would probably result in permanent damage to marshland, which in the vicinity of Black Bayou is prime habitat for waterfowl, alligators, and other marsh life.

Brine disposal would be into the Gulf of Mexico for all sites except Vinton. There, brine would be injected into subsurface aquifers which must have approximately 36 square miles (times 100 feet thick) capacity. Aquifer capacity has not been determined and the ability to use the Vinton site will remain in question until this is determined or until an alternative means of brine disposal is found.

The brine pipeline for Black Bayou would cross the interior of Sabine National Wildlife Refuge while at West Hackberry the brine pipeline would cross the West Cove portion of Calcasieu Lake. The brine pipelines for Big Hill would also cross sensitive marsh areas, temporarily damaging those areas.

Site access would be relatively difficult at Black Bayou because workers must cross the ICW via the Gum Cove Ferry.

Big Hill would require a new crude pipeline system which would be significantly longer than the connector lines to the West Hackberry ESR pipeline. Substantial construction activities would be associated with the Big Hill crude oil pipeline.

The capacities of the alternate sites would mean that Black Bayou would be a direct substitution for expansion of West Hackberry. Both Big Hill and Vinton would be required to fulfill a total 150 million barrels of crude oil storage.

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5.0 MITIGATION MEASURES AND UNAVOIDABLE ADVERSE IMPACTS

5.1 INTRODUCTION

This section identifies the impacts described in Chapter 4 of the report. It also describes available mitigation measures, control technology, and a statement of the unavoidable adverse impacts.

5.2 SUMMARY

In the tables that follow, the primary impacts, the available mitigation measures, the control technology, and the unavoidable impacts of construction and operation of each site are presented as follows:

- Table 5.2.1 Proposed Site - West Hackberry Expansion
- Table 5.2.2 Alternate Site - Black Bayou
- Table 5.2.3 Alternate Site - Vinton
- Table 5.2.4 Alternate Site - Big Hill

TABLE 5.2-1 PROPOSED SITE - WEST HACKBERRY EXPANSION
SITE CONSTRUCTION AND OPERATION

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
A. LAND FEATURES/GEOLOGY			
Spoil Disposal			
Neches River (Tanker Dock)	Loss of about 670 acres	None	Same as primary impact
Brine Pipeline Construction	Alteration of land form to allow flatter route of pipeline	Burial of pipeline after its completion	Artificially imposed morphology
	Vertical mixing of soil in trenches	Utilize double-trenching to maintain original soil profile layers	None
Road Construction and Site Preparation	Loss of 200 acres of pasture vegetation	Partial re-establishment after construction in areas adjacent to roads	Net loss on site, plus affecting of adjacent vegetation by traffic
B. WATER QUALITY IMPACTS			
Dredging for Dock at Nederland			
Neches River	Increased turbidity in Neches River	Restrict time over which dredging occurs	Locally increased turbidity
		Close supervision of dredging operators and disposal machines	Slight, temporary increase in turbidity down-stream.
	Release pollution from channel beds into stream	None	Same as primary impact
	Increase COD	None	Same as primary impact
	Increase nutrient(s) concentration	None	Same as primary impact
	Increase in sulfides from petroleum pollutants	Decreased by combining with heavy metal ions	Decreased augmentation of sulfides

Table 5.2-1 WEST HACKBERRY EXPANSION (CONTINUED)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Dredging for Brine Pipeline Placement			
West Cove of Calcasieu Lake	Localized turbidity	None	Same as primary impact
Disposal of Dredged Materials, Sun Terminal			
Neches River	Mixture of water with dredged material greatly increases turbidity	Proper design of overflow systems for spoil containment areas	Only localized turbidity increase
	Potential increase in algal growth by release of nutrients	None	Same as primary impact
	Decrease in dissolved oxygen by mixing-in of oxygen consuming materials	Disposal in a confined area	Increase in algal growth in disposal area
	Further increase in sulfides from already existing heavy hydrocarbon pollution	None	Same as primary impact
	Increase chromium and nickel concentrations	None	Same as primary impact
	Toxic hydrocarbons released by stirring of water	None	Same as primary impact
Discharge of Treated Ships' Ballast Water	Oil concentrations on river bottom of 7.5 ppm or more up to 950 feet from discharge point	Use of segregated ballast tankers	None
Grading, Excavation and Filling	Increased turbidity in adjacent water bodies	None	Same as primary impact
	Increased sedimentation	Sow grass or replant natural vegetation	Reduced sedimentation

Table 5.2-1 WEST HACKBERRY EXPANSION (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Withdrawal of Water for Displacement and Leaching	Altered flow velocities would reach a maximum of .03 ft/sec in the ICW	None	Induced flows are negligible
	Maximum salinity increase in the vicinity of the withdrawal point would be less than .20 ppt	None	Same as primary impact
	Maximum salinity increase in the ICW would be less than 1 ppt	None	Same as primary impact
Disposal of Brine in Gulf of Mexico	During both leaching and refill processes bottom areas of up to 207 acres around the diffuser have salinities in excess of 3 ppt above ambient	None	Same as primary impact
	Leaks would cause damage to biota in vicinity	None	Same as primary impact
Brine Pipeline Construction	Increased sediment load in adjacent waterways from erosion	None	Same as primary impact
C. AIR QUALITY			
Construction Activities at Storage Facility	Annual pollutant emission rate of particulates = 1124.8 tons/yr	Employ most advanced dust suppression techniques	Reduced particulate emissions
Painting of Tanks	Annual pollutant emission rate of HC = 5.3 tons/yr	None	Same as primary impact
Tanker Loading at Sun Terminal	Annual pollutant emission rate of HC =1040 tons/yr	Use of vapor control technology with shipboard activities	Reduced HC emissions

Table 5.2-1 WEST HACKBERRY EXPANSION (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Tanker Loading from VLCC	Annual pollutant emission rate of HC = 738 tons/yr	Loading takes place far offshore	Slight to insignificant increase of air quality HC level onshore
Tanker Ballasting	Annual pollutant emission of HC = 112 tons/yr	Use of segregated ballast tankers	Reduced primary impact
Brine Placement in Surface Holding Ponds	Annual pollution emission rate of HC = 210 tons/yr (fill phase only)	None	Same as primary impact
D. NOISE IMPACT			
Pipeline Construction	Noise levels increased by 55 dB at 500 feet from right-of-way for short periods	None	Same as primary impact
Construction of Dock at Terminal	Additional noise on Neches River near existing docking facilities	None	Same as primary impact
Petroleum Transfer Operations	Increased noise from pumping machinery (localized), tanker engines, and electrical generation equipment	None	Same as primary impact
Well Drilling at Storage Site	Noise levels increased to no more than 55 dB at 2,000 feet from the drilling site	None	Same as primary impact
E. BIOLOGICAL IMPACT			
Road Construction	Decreased production of beef cattle dependent on pasture forage	Partially regained after re-establishment of pastureage in construction areas	Net decrease in production locally
Brine Pipeline Construction	Temporary loss of agricultural production by loss of land use	None	Same as primary impact
	Permanent loss of woodland as wildlife habitat and timbering source	None	Same as primary impact

Table 5.2-1 WEST HACKBERRY EXPANSION (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Withdrawal of Water for Leaching and Displacement	Entrainment of planktonic organisms	Reduce velocity and alter intake structure design to reduce entrainment	Small, less mobile organisms entrained
Brine Pipeline Construction	Destruction of immobile organisms in path of pipelines	Revegetation after about one growing season would occur	Species diversity would probably decrease
	Interference with life cycles of and mortality to shellfish and fin fish by increased sediment load	None	Same as primary impact
	Loss of productivity by increased light attenuation in water column due to turbidity	Reduce turbidity by using best available technology	Some increase in later productivity due to increased nutrient concentration
	Destruction of benthic organisms by settling of sediments	None	Temporary decrease in benthic populations
Petroleum Handling Operations	Spills can be directly toxic to flora and fauna and render soils unable to support vegetation	Rapid containment and cleanup of spilled oil	Reduced toxic effect
	Spills at the site could enter Black Lake causing serious damage and toxic effects to resident flora and fauna	Provision of permanent large volume dikes around wellheads for containment	Greatly reduced impa[illegible] to Black Lake ecolog[illegible]
F. SOCIOECONOMIC IMPACTS			
Construction Activities	Decreased availability of housing by influx of workers on construction phase	Provision for alternate housing - mobile homes, etc.	Reduced housing shortage problem
	Short term disruption of traffic from construction of brine pipeline	None	Same as primary impact

Table 5.2-1 WEST HACKBERRY EXPANSION (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
	Pipeline construction would mar aesthetic value of Highway 27 and Holly Beach until pipeline right-of-way is restored	None	Same as primary impact
	Crowding of school and hospital	Building of additional classrooms transportation to larger hospital	None
	Traffic congestion would require extra police services	Provide additional police	None

TABLE 5.2-2 ALTERNATE SITE - BLACK BAYOU
SITE CONSTRUCTION AND OPERATION

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
A. LAND FEATURES/GEOLOGY			
Brine Pipeline Construction	Spoil from pipeline would alter surface drainage patterns adjacent to pipeline	Backfill pipeline trench	Substantial reduction in time drainage patterns altered
		Leave gaps in spoil mounds	Reduced surface drainage pattern disruption
	Vertical mixing and disruption of internal soil structure	None	Same as primary impact
Oil Pipeline Construction	Loss of woodlands	None	Same as primary impact
	Loss of wildlife habitat ~4.61 acres	None	Same as primary impact
Filling Operation	9-10 acres filled to height of 8 feet in marsh area	None	Same as primary impact
B. WATER QUALITY			
Filling, Grading and Excavation	Introduction of sediment would increase the average level of suspended solids by .99 ppm. for 5 months	None	Same as primary impact
Displacement/Leaching Water System Pipe-	Destruction of marsh organisms	Organisms re-establish in two years	No long term impact
	Excavating would increase suspended sediments	None	Same as primary impact
	Increase turbidity	None	Same as primary impact
	Spoil run-off in disposal area	None	Same as primary impact
	Pollutant release from sediment	None	Same as primary impact

Table 5.2-2 BLACK BAYOU (Continued

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Dredging in Black Bayou	Turbidity increase would release some pollutants from sediment. Increase of COD, toxic sulfides, pesticides, toxic metals	Minimize turbidity - employ most recent technological advances	Reduced primary impact
Dredging in Marshes	Turbidity increase would increase some pollutants from sediment in immediate area of dredging	Minimize turbidity - employ most recent technological advances	Reduced primary impact
	Damage to floating vegetation in immediate area	Restore area disturbed	No permanent impact
Disposal of Dredged Material	Increase in turbidity and release of aquatic nutrients	Employ most recent dredging technology	Minor increase in turbidity and nutrients
	Depression of DO levels	Employ most recent dredging technology	Minor decrease in DO
	Release of toxic pollutants from sediment	Employ most recent dredging technology	Minor increase in toxic pollutants
	Loss of 62 acres of wetland habitat	Build spoil area higher	Less than 62 acres lost

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Construction at Central Plant Area	459.7 acres would be impacted by increased suspended solid levels due to sources distributed throughout site	None	Same as primary impact
Operation at Storage Location	Waste materials and chemicals in pest control could be source of water pollutants	None	Same as primary impact
Discharge of Treated Ballast Water	Oil concentration of 7.5 ppm on river bottom 950 feet downstream	Use of segregated ballast tankers	None
	Oil concentration of 7.5 ppm on river surface 960 feet downstream	Use of segregated ballast tankers	None
	Salinities of 30 ppt persist 950 feet downstream	None	Minor impact on Neches River
Brine Disposal Leaching	During leaching process salinities greater than 3 ppt above ambient would cover 104 acres under typical conditions in the Gulf	None	Same as primary impact
Construction of Displacement/ Leaching Water System	Construction of intake sump and intake structure pilings destroys benthic organisms, spoil disposal destroys marsh organisms	None	Same as primary impact
Withdrawal of Leaching and Displacement Water	Lateral displacement impacts to connected water bodies	None	Same as primary impact

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
	Induced salinity increases in Black Bayou	None	Same as primary impact
	Pollutants in Intra-coastal Waterway would be introduced into Black Bayou	None	Same as primary impact
Maintenance Activities	Spillage of oil and fuels during equipment operations	Training of operators	Slight danger of spillage
	Improper use of agri-cultural and indus-trial chemicals, i.e., excessive use, improper waste disposal of materials etc., pollutes ecosystem	Training of operators	Small incidence of pollution
	Biological pollutants entering water system (bacteria, fungi, worms, viruses, etc.)	Employ proper sanitary practices	Reduced amounts of pollutant entering water system
C. AIR QUALITY IMPACT			
Construction Activities at Storage Facility	Annual pollutant emission rate of particulates = 5249 tons/yr	Employ most advanced dust supression techniques	Reduced air quality due to high particulate level
Painting of Tanks	Annual pollutant emission rate of HC = 5.3 tons/yr	None	Same as primary impact
Tanker Loading at Sun Terminal	Annual pollutant emission rate of HC = 1040 tons/yr	Use of vapor control technology with ship-board activities	Reduced primary impact
Tanker Loading from VLCC	Annual pollutant emission rate of HC = 738 tons/yr	Loading takes place far offshore	Slight to insignificant increase of HC level onshore

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Tanker Ballasting	Annual pollutant emission of HC = 112 tons/yr	Use of segregated ballast tankers	Reduced primary impact
Brine Placement in Surfact Holding Pond	Annual pollutant emission of HC = 210 tons/yr (fill phase only)	None	Same as primary impact
D. NOISE IMPACTS			
Construction at Oil Storage Site	At 2,000 feet from center at site sound levels of L_{eq} <55 dB, L_{dn} <55dB	None	Same as primary impact
Pipeline Construction	At 500 feet from center of site noise levels of L_{eq} <55 dB, L_{dn} dB	None	Same as primary impact
Terminal and Dock	At 2,000 feet from the dock site noise level of 64 dB	None	Same as primary impact
E. BIOLOGICAL IMPACTS			
Brine Disposal Pipeline Construction	351 acres of marshland and 3.6 acres inland water disturbed	Organism reestablish in two years	Temporary habitat disruption
	Destruction of biota in pipeline path	None	Same as primary impact
	Disturb and displace protected and rare wildlife	Constant during non-breeding and post-nesting period	Reduced impact on breeding and/or nesting success
	Affect area biota by increasing erosion and sedimentation	None	Same as primary impact
	42.5 acres offshore in Gulf disturbed	None	Same as primary impact
	Biota in beach and shore Gulf of Mexico would be destroyed	Restore area	Organism reestablish in two years

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
	Beach wildlife would be disturbed and displaced, some nests, resting places, and less mobile invertebrates would be destroyed	None	Same as primary impact
Oil Pipeline Construction	Destruction of organisms in pipeline path	Restore area	Same as primary impact Recovery in two years
	Loss of benthic fauna	None	Same as primary impact
	Increased turbidity affecting fish, benthos, and plankton	None	Same as primary impact
Construction at Central Plant Area	Disturb and displace waterfowl, mammals, and reptiles	None	Same as primary impact
	Destroy non and slightly mobile marsh organisms in 10 acre area	None	Same as primary impact
Construction of Equipment Barge Dock, Dredging of Access Canals, and Barge Slip	Organisms in direct path of canal would be destroyed	None	Same as primary impact
	Increased suspended solids, tubidity	None	Same as primary impact
	Non and slightly mobile organisms in 7.35 acres of marsh destroyed by creating access canals, same organisms destroyed in 10 acres given to spoil disposal	None	Same as primary impact
	Biota on .5 acre of canal bottom destroyed due to barge slip construction, and biota on .5 acre of dry land used for spoil disposal	None	Same as primary impact

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Petroleum Handling Operations	Spills can be directly toxic to flora and fauna and render soils unable to support vegetation	Rapid containment and cleanup of spilled oil	Reduced toxic effects
	Spills at the site could enter local water bodies causing serious damage and toxic effects to resident flora and fauna	Provision of permanent large volume dikes around wellheads for containment	Greatly reduced impact to local ecology
Brine Spill	Accidental brine spill would render soil incapable of supporting vegetation	Addition of chemical to spill area	Recovery time reduced to estimated 5 to 10 years
Dredged Spoil Disposal From Canals in Marsh	Spoil deposition on wetlands would affect ecology of immediate area	None	Same as primary impact
Oil Pipeline Spill	Wildlife habitat temporarily degraded	Use proper cleanup procedures	Reduced primary impact. Vegetation recovery would begin after 1 month and result in wildlife habitat restored in 1 to 2 years
Water Withdrawal	Entrainment of organisms and nutrients in water, could result in reduction in fish and shellfish in area	None	Same as primary impact
F. SOCIOECONOMIC IMPACTS			
Use of Public Services	Potential serious injuries of workers laying pipeline	Helicopter ambulance service	None
	Traffic congestion would require extra police services	Provide additional police	None

Table 5.2-2 BLACK BAYOU (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Pipeline Construction	Short-term disruption of beach esthetics due to brine disposal pipeline construction	None	Same as primary impact
Traffic Due to Work Force	Ferry crossing Intra-coastal Waterway can't service work force	Bus transport from ferry crossing	Reduced traffic bottleneck
		Build bridge	None
	Short-term disruption of traffic due to pipeline construction	None	Same as primary impact

Table 5.2-3 ALTERNATE SITE - VINTON SITE
CONSTRUCTION AND OPERATION

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
A. LAND FEATURES/GEOLOGY			
Pipeline Construction	Mixing of surface and subsurface soils - confined to pipeline path	None	Same as primary impact
Dredging for Brine Line and Servicing Canal	241,000 cubic yards of material removed would require 35 acres of marsh for disposal	None	Loss of marshland acreage
Construction Activities at Storage Location	60 acres used for recreation rendered unusable	None	Same as primary impact
	60 acres of pastureland unusable	Cattle and horses could graze on periphery outside construction site	Reduced primary impact
	Ged Lake would receive 630 tons of soil as a result of run-off from erosion from earth moving activities	Excess soil removed after construction to regain depth and volume of lake	None
Injection of Brine Into Deep Aquifer During Cavern Leaching	Possible change in rate of production and increased lifetime of oil and gas wells near disposal site	None	Same as primary impact
B. WATER QUALITY IMPACTS			
Grading, Excavation and Filling	30 acres of land would be disturbed over 5 months resulting in an average increase in suspended solids of 7.6 ppm above normal for Ged Lake	Follow most recent technological advances	Reduced primary impact
Dredging in Marshes	Turbidity increase would release some pollutants from sediment, impact would be temporary	None	Same as primary impact

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Creation of Inlet for Intake Structure	Removal of 8,060 cubic yards of material resulting in a temporary turbidity lasting 3 to 4 weeks after construction	Follow most recent technological advances	Reduced primary impact
Water Withdrawal for Displacement or Leaching	Replenishment source for Vinton Canal is Intracoastal Waterway, pollutants in the waterway will enter Vinton Canal	None	Same as primary impact
	Increased salinity of Vinton Canal	None	Same as primary impact
Water Withdrawal Leaching/Displacement	Entrainment of organisms and nutrients in water, could result in reduction in fish and shellfish in area	None	Same as primary impact
	Lateral displacement impacts connected water bodies	None	Same as primary impact
	Salinity changes	None	Same as primary impact
	Pollutants in Intracoastal Waterway would be introduced in Vinton Canal	None	Same as primary impact
Injection of Brine into Deep Aquifers During Leaching and Refill	Contamination of fresh ground water or surface water due to aquifer fracture	Minimize pressure buildup, need sands (100 feet or thicker) within aquifer to extent at least 36 square miles	None
	Aquifer leakage	Abandoned wells in 3.5 mile radius of disposal site should have records examined and be replugged if necessary	None

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Discharge of Treated Ballast Water	Oil concentration of 7.5 ppm on river bottom 950 feet downstream	Use of segregated ballast tankers	None
	Oil concentration of 7.5 ppm on river surface 960 feet downstream	Use of segregated ballast tankers	None
	Salinities of 30 ppt persist 950 feet downstream	None	Same as primary impact
	Accidental release during discharge could result in higher oil concentration in water system	Use of proper clean-up procedures	Reduced primary impact
Maintenance Activities	Spillage of oil and fuels during equipment operations into ecosystem	Training of operators	Reduced primary impact
	Improper use of agricultural and industrial chemicals, i.e., excessive use, improper waste disposal of materials, etc., pollutes ecosystem	Training of operators	Reduced primary impact
	Biological pollutants entering water system (bacteria, fungi, worms, viruses, etc.)	Proper sanitary conditions	None

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
C. AIR QUALITY IMPACT			
Construction Activities at Storage Facility	Annual pollutant emission rate of particulates = 3730 tons/yr	Employ most advanced dust suppression techniques	Reduced particulate emissions
Painting of Tanks	Annual pollutant emission rate of HC = 5.3 tons/yr	None	Same as primary impact
Tanker Loading at Sun Terminal	Annual pollutant emission rate of HC = 346 tons/yr	Use of vapor control technology with shipboard activities	Reduced HC emissions
Tanker Loading from VLCC	Annual pollutant emission rate of HC = 246 tons/yr	Loading takes place far offshore	Slight to insignificant increase of HC level onshore
Tanker Ballasting	Annual pollutant emission rate of HC = 38 tons/yr	Use of segregated ballast tankers	Reduced primary impact
Brine Placement in Surface Holding Ponds	Annual pollutant emission of HC = 70 tons/yr (fill phase only)	None	Same as primary impact
D. NOISE IMPACTS			
Construction of Oil Storage Site Area	At 2,000 feet from center of site noise levels no more than L_{eq} = 55 db L_{dn} = 55 dB	None	Same as primary impact
Pipeline Constructions	At 500 feet from center of construction noise levels no more than L_{dn} = 55 dB	None	Same as primary impact
Drilling Equipment	At 50 feet from equipment noise level of 95 dBA	None	Same as primary impact
Construction of Brine Disposal Wells	At 1,800 feet from drilling sites noise level greater than L_{dn} = 55 dB	None	Same as primary impact

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Terminal and Dock Construction	At 2,000 feet from dock site noise level of 64 dB	None	Same as primary impact
E. BIOLOGICAL IMPACT			
Raw Water System Pipeline Construction	Removal of vegetation from 20 acres of surface land, 4.4 acres is pastureland, 9.8 acres has native grasses and shrubs, 5.8 acres is forested	Pastureland would rapidly revegetate	Temporary production loss
Brine Pipeline Construction	Increase turbidity and add nutrients to aquatic environment thereby increase phytoplankton, periphyton, and macrophyte production	Follow most recent technologic advances	Reduced primary impact
	Benthic invertebrates affected to a varying degree	Follow most recent technologic advances	Reduced primary impact
	Snails and bivalve mollusks would experience gill abrasion	Follow most recent technologic advances	Reduced primary impact
Oil Pipeline Construction	9.1 acres of pastureland removed for one year	None	Same as primary impact
	41.9 acres of grassland shrub habitat, removal of vegetation will have detrimental effect on songbirds and small mammals	None	Same as primary impact
	At Grays Canal, temporary siltation and turbidity of water would destroy benthic fauna in immediate area	Follow most recent technolgic advances	Reduced primary impact

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
	39 acres of marsh would be affected resulting in increased turbidity and release of pollutants from sediment and permanent damage to floating vegetation in immediate area	Follow most recent technologic advances	Reduced primary impact
Oil Pipeline Operation-Maintenance	34 acres of dry land would be mowed periodically rendering it unusable to most wildlife	None	Same as primary impact
?etroleum Iandling)perations	Spills can be directly toxic to flora and fauna and render soils unable to support vegetation	Rapid containment and cleanup of spilled oil	Reduced toxic effects
	Spills at the site could enter Ged Lake or Vinton Drainage Canal causing serious damage and toxic effects to resident flora and fauna	Provision of permanent large volume dikes around wellheads for containment	Greatly reduced impact to Ged Lake or Vinton Drainage Canal
Operation and Maintenance Brine Spill	Accidental brine spill would render soil incapable of supporting vegetation	Remove soil and revegetate	No long term impact
Brine Disposal Leak	Harm to biota immediate vicinity of leak	Monitors can detect large leak and then stop pumping	Reduced danger of impact

Table 5.2-3 VINTON (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
F. SOCIOECONOMIC IMPACTS			
Construction	Construction activities would detract from historic Post Office	None	Same as primary impac
Pipelines Construction	Pipeline construction would temporarily mar wilderness aspect of marshes	None	Same as primary impac
Traffic, Due to Construction	Construction workers would take Ged Road, annual traffic increase of 367 percent	None	Same as primary impac
Public Services	Traffic congestion would require extra police services	None	Same as primary impa
Housing	Limit available housing units	Commute from larger cities Mobile homes	None

Table 5.2-4 ALTERNATE SITE - BIG HILL SITE
CONSTRUCTION AND OEPRATION

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Socioeconomic Impacts			
A. LAND FEATURES/GEOLOGY			
Disposal of Dredged Material	Loss of wetland habitat as follows: .5 acres at South Fork Taylor Bayou .4 acre at North Fork Taylor Bayou 1.0 acre at Lovell Lake	Follow most recent technological advances	Reduced primary impact
	2.6 acres at Hillebrandt Bayou 2.6 acres at Taylor Bayou 6.2 - 7.0 acres at Intracoastal Waterway 2.1 acres at Salt Bayou 2.1 acres at Spindletop Ditch		
Pipeline Construction	Disturbance of several soil types would alter drainage characteristics	None	Same as primary impact
Pipeline construction for Displacement/ Leaching Water System	Temporary disturbance of 9 acres of prairie grassland and 75 acres of marshland would require ~1 year for prairies grassland to recover and in marshland temporary loss of production, habitat, and emigration of mobile wildlife	Bury pipeline and return pasture to usage	No long term impact
	Alternative pipeline would impact 61 acres of prairies grassland and 26 acres of marshland	Bury pipeline and return pasture to usage	No long term impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Brine Disposal Pipeline	Temporary disturbance of 15 acres of prairie grassland and 133 acres of marshland	Bury pipeline and return pasture to usage	No long term impact
	Alternative pipeline would impact 61 acres of prairie grassland and 26 acres of marsh-land	Bury pipeline and return pasture to usage	No long term impact
Oil Distribution Pipeline	Removal of 213.6 acres of prairies - farmland community	None	Same as primary impact
	Removal of 20.5 acres of fluvial woodland and 4.5 acres of swamps	Revegetation techniques	Change in vegetation composition
	Loss of 2.75 acres of stream and lake bottom	None	Same as primary impact
	Alternate route #4 would be similar to primary route except no loss of fluvial woodland and loss of 4.5 acres of freshwater marsh	None	Same as primary impact
Water Withdrawal Pipeline	Disturb 6 acres of dryland and 25 acres of marshland	None	Same as primary impact
	Alternative pipeline would impact 34 acres of dryland and 8 acres of marshland	None	Same as primary impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
B. WATER QUALITY IMPACTS			
Grading, Excavation, and Filling	~1400 cubic yards of sediment washed into surface water system by erosion during 5 months of activity will increase suspended solids in Spindletop Marsh, Salt Bayou Marsh, Willow Slough, and Mayhaw Bayou	None	Same as primary impact
Miscellaneous Construction Activities	Spillage of oil and fuels during equipment operations	Training of operators	Reduced primary impact
	Improper use of herbicides, pesticides, and fertilizers, i.e., excessive use, improper waste disposal of materials, etc.	Training of operators	Reduced primary impact
	Biological pollutants entering water system (bacteria, fungi, worms, viruses, etc.)	Proper sanitary conditions	None
Dredging in South Fork Taylor Bayou	Removal of 5,000 cubic yards of dredged material has short term effects of depress DO levels and release nutrient materials into water column	Follow most recent technological advances	Reduced primary impact
	Increased turbidity	Follow most recent technological advances	Reduced primary impact
	Release of toxic pesticides or industrial chemicals from dredged material some degree of PCB accumulation in food chain	None	Same as primary impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Dredging in North Fork Taylor Bayou	Removal of 3,200 cubic yards of material with impacts similar to South Fork	Follow most recent technological advances	Reduced primary impact
Dredging in Lovell Lake	Removal of 10,000 cubic yards of dredged material with impacts similar to Taylor Bayou but less currents intensify impact for more localized area	Follow most recent technological advances	Reduced primary impact
Dredging in Hillebrandt Bayou	Removal of 25,000 cubic yards of dredged material with impacts similar to Taylor Bayou	Follow most recent technological advances	Reduced primary impact
Dredging in Taylor Bayou	Removal of 25,000 cubic yards of dredged material with impacts similar to South Fork Taylor Bayou	Follow most recent technological advances	Reduced primary impact
Dredging in the Intracoastal Waterway	Removal of 52,500-60,000 cubic yards of dredged material with impacts similar to Taylor Bayou	Follow most recent technological advances	Reduced primary impact
Dredging in Salt Bayou	Removal of 20,000 cubic yards of dredged material with impacts similar to Taylor Bayou	Follow most recent technological advances	Reduced primary impact
Dredging in Spindletop Ditch	Removal of 20,000 cubic yards of dredged material with impacts similar to Taylor Bayou	Follow most recent technological advances	Reduced primary impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Dredging in Marshes	Removal of 850,000-1,000,000 cubic yards of dredged material with push-ditch dredging dredged material used as back fill, short term localized impacts of increases in turbidity and nutrient levels and decrease in DO level	Follow most recent technological advances	Reducted primary impact
Disposal of Dredged Material	Increase in turbidity	Employ most recent dredging technology	Minor increase in turbidity
	Release of aquatic nutrients	Employ most recent dredging technology	Minor increase in nutrients
	Decrease of DO levels	Employ most recent dredging technology	Minor decrease in DO
	Release of toxic pollutants from sediments	Employ most recent dredging technology	Minor increase in toxic pollutants
Brine Disposal Pipeline Construction	In the Gulf an area of 50 feet wide and 10.2 miles long would be temporarily disturbed and suffer some destruction of some benthic forms	Bury pipeline	No long term impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
Dredging for Intake Station on Intra-Coastal Waterway	Dredging of 8,060 cubic yards	Follow most recent technological advances	Reduced primary impact
	Increase turbidity	Follow most recent technological advances	Reduced primary impact
	Temporarily eliminate benthic forms	Follow most recent technological advances	Reduced primary impact
	Loss of 1.8 acres of wetlands due to spoil disposal	None	Same as primary impact
	Temporary evacuation of mobile wildlife	None	Same as primary impact
Brine Disposal Leaching	During leaching process salinities greater than 3 ppt above ambient would cover 52 acres under typical conditions in the Gulf	None	Same as primary impact
Brine Disposal Refill	Salinity of 3 ppt above ambient would cover 52 acres under typical conditions in the Gulf	None	Same as primary impact
Maintenance Activities	Spillage of oil and fuels during equipment operations	Training of operators	Reduced primary impact
	Improper use of agricultural and industrial chemicals, i.e., excessive use, improper waste disposal of materials, etc.	Training of operators	Reduced primary impact
	Biological pollutants entering water system (bacteria, fungi, worms, viruses, etc.)	Proper sanitary conditions	None

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
C. AIR QUALITY IMPACT			
Construction Activities at Storage Facility	Annual pollutant emission rate of particulates = 12,571 tons/yr	Employ most advanced dust suppression techniques	Reduced particulate emissions
Painting of Tanks	Annual pollutant emission rate of HC = 5.3 tons/yr	None	Same as primary impact
Tanker Loading at Sun Terminal	Annual pollutant emission rate of HC = 693 tons/yr	Use of vapor control technology with shipboard activities	Reduced HC emissions
Tanker Loading from VLCC	Annual pollutant emission rate of HC = 488 tons/yr	Loading takes place far offshore	Slight to insignificant increase of HC level onshore
Tanker Ballasting	Annual pollutant emission rate of HC = 75 tons/yr	Use of segregated ballast tankers	Reduced primary impact
Brine Placement in Surface Holding Ponds	Annual emission pollutant rate of HC = 140 tons/yr (fill phase only)	None	Same as primary impact
D. NOISE IMPACTS			
Construction at Site	At 2,000 feet from center of site noise levels of L_{eq}<55dB, and L_{dn}<55dB	None	Same as primary impact
Pipeline Construction	At 500 feet from center of construction noise level of L_{eq}<55dB	None	Same as primary impact
Terminal and Dock	At 2,000 feet from dock site noise level of 64dB	None	Same as primary impact

Table 5.2-4 BIG HILL (Continued)

ACTION	PRIMARY IMPACT	MITIGATION OR OFFSETTING BENEFIT	UNAVOIDABLE IMPACT
E. BIOLOGICAL IMPACTS			
Water Withdrawal Pipeline	Periodic inspection and maintenance would result in waterfowl and small mammals avoiding area	None	Same as primary impact
Water Withdrawal	Impingement/entrainment of organisms and nutrients in water	Minimize inflow velocity	Reduced primary impact
Brine Spill	Accidental brine spill would render soil incapable of supporting vegetation	Clean up and replant	Vegetation would be restored in 1 to 2 years
Petroleum Handling Operations	Spills can be directly toxic to flora and fauna and render soils unable to support vegetation	Rapid containment and cleanup of spilled oil	Reduced toxic effects
	Spills at the site could enter local water bodies causing serious damage and toxic effects to resident flora and fauna	Provision of permanent large volume dikes around wellheads for containment	Greatly reduced impac to local ecology
F. SOCIOECONOMIC IMPACTS			
Construction Surface Facilities	Construction of surface facilities would impact a residence with noise and traffic plus westward view would be dominated by oil surge tank	None	Same as primary impact
Construction of Pipeline	Short-term disruption of grazing due to pipeline construction	None	Same as primary impact
Traffic Due to Construction	Short-term disruption of traffic due to construction	None	Same as primary impact
Use of Public Services	Potential injuries of workers laying pipelines	Helicopter ambulance service	None

6.0 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

6.1 INTRODUCTION

In this chapter the relationship between local short-term use of the environment and maintenance and enhancement of long-term productivity is analyzed and tradeoffs are discussed. Specifically, the effects on national and regional economic activity are assessed and the adverse impacts on environmental productivity for the proposed and alternate sites are summarized.

6.2 EFFECT ON NATIONAL AND REGIONAL ECONOMIC PRODUCTIVITY*

The location of an SPR facility in the Texoma region would help offset the impacts of an oil supply interruption on both the regional and national economies. Since the reserve facility would be located in a region containing a large number of crude oil pipelines, refineries, and product pipelines, the oil would be immediately available to those sectors most severely impacted from the interruption and would prevent immediate production halts at both the regional and national level. This particular situation of having available oil supplies would put the proper authorities in a more advantageous position when trying to develop alternatives to remedy the supply interruption.

The construction and operation of a Strategic Petroleum Reserve facility *per se* in the Texoma area would most likely not have any impacts, either detrimental or beneficial, on the long term economic productivity of the regional or national economy. This is due to the fact that the increased regional demand for goods and services resulting from the SPR facility would be only short-term, making it highly unlikely suppliers would alter productive capabilities to meet this temporary demand. Regional economic productivity would be altered if the following conditions hold: Firms in the region are trying to expand plant and equipment; factor suppliers are operating at or near capacity rates of production; supplies needed at the SPR facility have to be purchased in the region. Under

*Economic productivity is defined as the ability of the economy to produce goods and services.

these circumstances, the purchases of factors needed for construction and operation of the facility would bid-away resources demanded for expansion by other firms in the region.

6.3 ADVERSE IMPACTS ON ENVIRONMENTAL PRODUCTIVITY

6.3.1 Impacts on Land

6.3.1.1 West Hackberry

During construction at the site, activities causing impacts on the land include road construction, well drilling and preparation, and general construction activities associated with the various facilities located on site. The impacts from these activities would include soil erosion and changes in the topography, mainly retention dikes being built around the ponds. There would be no impacts to the stratigraphy or geologic structure in the area. Evidence indicates that any changes which occur in local production of oil and gas will be minor. While the facility is in operation there would be no impacts on the topography or drainage patterns in the area and only minor impacts on the soil caused by soil erosion.

The construction of the brine pipeline and formation of spoil banks along either the proposed or alternative route would result in only minor, temporary changes in the topography. Since the pipeline would be buried beneath the various water bodies, there would be no permanent alteration of drainage patterns. These conclusions also apply to the raw water pipeline.

At the Nederland terminal the only impact to existing land forms would result from spoil disposal associated with the construction of a new tanker dock. This would be a minor topographic impact.

In summary, the long term impacts to land arising from facility expansion at the West Hackberry site would be minor soil erosion and topographic changes (dikes) at the site and minor topographic changes caused by spoil disposal and oil pipeline burial. While the facility is in operation the land used at the site for various facilities will be removed from current use, indicating a small loss in environmental productivity for the area.

6.3.1.2 Black Bayou

The Black Bayou site for an SPR facility is located in a marshy area. Since nine or ten acres would have to be filled to a height of about eight feet, the most obvious impact would be on the topography of the region. This fill would represent a permanent alteration of the natural habitat with the associated biological impacts on various species and vegetation in the area. To improve access to the site, barge canals would be constructed resulting in localized but permanent changes in drainage patterns, permanent topographic changes from spoil banks created with the dredge material, and changes in the natural habitat in the immediate vicinity of the canal. After construction at the site, maintenance dredging at the barge docks would continue to cause environmental impacts including occasional turbidity of canal waters and minor siltation within the canal. Evidence indicates that any changes which occur in local production of oil and gas will be minor.

The oil distribution system for Black Bayou would consist of a 14,000 foot pipeline linking this storage facility to the pipeline from West Hackberry ESR to Sun Terminal. Topographic alterations would occur during construction resulting from the creation of spoil banks from the dredge material; however, these alterations would only be temporary since the spoil material would be used for backfill. The same situation would prevail with the raw water pipeline. In both cases, the dredging of the trench, even though backfilled, could alter surface drainage patterns. Construction of both the raw water and oil pipelines would result in vertical mixing of the soil caused by the original soil removal and replacement.

Impacts to land caused by the brine disposal system would be similar to those resulting from the oil distribution system as discussed above; specifically, temporary topographic changes from the spoil disposal prior to backfilling the trench and a possibility of permanent alteration of the drainage patterns in areas adjacent to the pipeline trench.

At the Nederland terminal the only impact to existing land forms would result from spoil disposal associated with the construction of a new tanker dock. This would be a minor topographic impact.

In summary, the long-term impacts to land arising from locating a storage facility at Black Bayou include changes in topography from spoil banks and fill operations at the site, and changes in drainage patterns adjacent to barge canals and pipeline routes. The topographic changes at the site would have adverse impacts on environmental productivity. The land would be effectively isolated from its surrounding marshy habitat. Adverse impacts on the environmental productivity of the land would also result from changes in drainage patterns if these changes caused alterations in surface water configurations.

6.3.1.3 Vinton

The proposed storage site at Vinton has been designed for 50 million bbls capacity compared to 150 million bbls of expanded capacity at West Hackberry. Nevertheless, the types of impacts are essentially the same. The conclusion concerning adverse impacts on environmental productivity is that any long term impacts would be minor at the site - arising from changes in the topography from retention dikes and possible soil erosion from roads - and there would be no impacts along the various pipeline routes or at Sun Terminal other than that discussed in Section 6.3.1.1.

6.3.1.4 Big Hill

The discussion presented in Section 6.3.1.3 applies to Big Hill except for two items: (1) a new 26 mile oil pipeline would be required and (2) the proposed capacity is 100 million bbls. The new pipeline would be expensive compared to the relatively short connector lines for the other two site alternates, but the pipeline would not impact particularly sensitive areas or pose any unusual environmental problems. It should be noted that in order to provide the same capacity as the proposed West Hackberry expansion - 150 mbbls, Big Hill and another site or sites would be required.

6.3.2 Impacts on Water

6.3.2.1 West Hackberry

Resource use and depletion involved with the withdrawal of water for the West Hackberry and Sulphur Mines SPR sites would have negligible adverse impacts on environmental productivity associated with water bodies in the areas in and around the ICW. The reason for this low level of impact is that during the maximum withdrawal rate the induced currents and altered salinities are too small to produce noticeable effects on aquatic biota. Likewise, pollutant concentrations in the ICW would not be substantially altered through migration of these substances from other areas during water withdrawal. This is because the waterway already has one of the highest pollutant concentrations in the area and the migration rate into the area during withdrawal would be minimal.

A minor factor affecting the environmental productivity of Black Lake would be the increased silt along the bottom of the lake resulting from soil erosion at the facility site. This silt build up would be unfavorable to benthic organisms in the southeast corner of the lake. This, in turn, would cause higher organisms such as fish to migrate from the area for extended periods.

Construction activities associated with the brine and raw water pipelines would result in temporary increases in turbidity and siltation in water bodies traversed. These impacts would continue for only a short length of time after construction.

After the facility ceased operations at the site, the ICW would tend to recover its original characteristics; however, the degree of recovery possible will depend upon the changes wrought on the surrounding environment.

6.3.2.2 Black Bayou

As a result of the extensive filling operations required at the Black Bayou site erosion into the surrounding water areas would be expected to be a continual impact. Other adverse impacts on environmental productivity resulting from the short term use of the enviornment are difficult to identify at the Black Bayou site due to the lack of water quality data for Black Bayou. The replenishment sources in this case would be the ICW and the Sabine River.

6.3.2.3 Vinton

The lack of reliable water quality data for the Vinton Canal prevents an accurate assessment of the adverse impacts on water which would alter the environmental productivity of the region. An examination of the fish catch in the canal does indicate relatively fresh water which, if true, would indicate an increase in salinity if the ICW served as the primary replenishment source.

General activities associated with site preparation and construction activities would result in soil erosion, most of which would be deposited in Ged Lake. This would have the same effect on benthic organisms as mentioned in Section 6.3.2.1.

No long term adverse impacts would result from the underground brine disposal except in the case of unforeseen circumstances such as aquifer fracture or leaking, or earthquakes.

6.3.2.4 Big Hill

Impacts on water at the Big Hill site appear to be minor over the long term. It does not appear there would be any adverse impacts on environmental productivity in the region.

6.3.3 Impacts on Air

As noted in the various sections on air quality, the adverse impacts on air as related to environmental productivity are minor in the short term, above recommended standards onsite only for short periods and always below recommended standards offsite, and negligible over the long term. This includes the effect of deposition of particulates on surrounding land areas.

7.0 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES*

7.1 INTRODUCTION

During the developmental and operational phases of a Strategic Petroleum Reserve facility in the Texoma region, a number of resources would be committed to the project. Resource commitments which would be irreversible or irretrievable are identified in this chapter.

7.2 LAND

During construction and operation of the facilities, irretrievable loss of production would be sustained from a maximum number of acres for each site as follows:

		Pipeline Routes (Permanent Right-of-Way in Acres)			
	On-Site	Oil	Brine	Raw Water	Total
West Hackberry Expansion	160	0	150	25.6	310
Black Bayou	230	16	121	0	367
Vinton	60	46	27	13.5	146.5
Big Hill	230	144	55	33	462
Sulphur Mines Intake System				120	

Biological and agricultural production losses would be short term, generally lasting less than two years. Permanent production losses would occur in the plant sites where buildings, tanks, and other permanent structures would be erected. Spoil banks and other "filled" areas created in marsh habitats would result in a permanent alteration of the habitat; biological productivity would be temporarily reduced and different life forms would contribute to the lands productivity.

Along the pipeline routes, the land would be returned to former uses following construction. Also, a large portion of the acreage on site would not be disturbed beyond the construction period, except for routes through woodland regions where the right-of-way would be maintained.

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*Data are based on a projected 150 million barrel expansion at the West Hackberry site which does not include the 60 million barrel ESR.

7.3 AIR

During both construction and operation of the SPR facility, there would be "commitments" of air resources to the project, in that emissions would temporarily contaminate the air and lower air quality. These commitments would, by no means, be irreversible or irretrievable. Any reduction in air quality would occur only during an operation of the facility and would cease when the project was terminated. Various emissions include fugitive dust losses from site preparation activities and the use of paved and unpaved roads; hydrocarbon emissions from the use of heavy duty diesel-powered construction equipment, light duty vehicles, drill rigs, painting operations, crude oil transfers, and ship ballasting.

7.4 WATER

During the leaching and displacement operations the following amount of water would be used at each site:

Water Use (millions of barrels)

Site	Leaching	Displacement	Source
West Hackberry Expansion	6726	1259	ICW
Black Bayou	6726	899	Black Bayou
Vinton	2238	300	Vinton Canal
Big Hill	4482	600	ICW
Sulphur Mines	0	151	ICW

After the water is drawn from the original source and used for either leaching or displacement, it would be transported to the Gulf of Mexico for disposal or, in the case of Vinton, would be injected into underground aquifers. Since water cycles in the environment it is never truly lost from the system. Thus disposal of water saturated with brine in the Gulf of Mexico would not constitute either an irreversible or irretrievable commitment of resources. The water would simply be unavailable for other purposes for a short time. For all practical purposes water injected into underground aquifers would constitute an irretrievable and essentially irreversible commitment of water resources.

7.5 SPECIES AND ECOSYSTEMS

During construction of the storage facility at any one of the sites, there would be a temporary loss of productivity at the site and along pipeline routes. Irretrievable and irreversible commitments of resources would include organisms killed during construction. Some examples of these organisms would be mites, insect larvae, and small mobile animals such as frogs on land and benthic organisms in water. Also, both marsh and terrestrial vegetation would be killed during construction. The same conclusions would hold during the operation phase of any one of the facilities. Estimates of permanent habitat losses would be equivalent to those provided in Section 7.2, although these numbers would be worst case since only those pipeline rights-of-way through woodland areas would be permanently maintained.

7.6 MATERIAL

The following presents estimates of the amount of steel and concrete to be used at each potential SPR site. Materials are considered irretrievable since no estimate of salvage value is available.

Site	Steel (tons)	Concrete (ft^3)
West Hackberry Expansion	3.96×10^4	88,500
Black Bayou	3.74×10^4	60,000
Vinton	1.09×10^4	60,000
Big Hill	4.67×10^4	60,000

7.7 ENERGY

The estimates of energy consumption are given below for each potential site. The commitments of these energy resources are irretrievable.

West Hackberry Expansion

Leaching	8.07×10^8 kwhr
Fill/withdrawal (5 cycles)	2.99×10^9 kwhr
Concrete	1.56×10^7 kwhr
Steel	4.64×10^8 kwhr
Total	4.25×10^9 kwhr

Energy content of oil = 1.21×10^{12} kwhr.
Ratio of energy used to energy content of oil = 3.5×10^{-3}

Black Bayou

Leaching	8.07×10^8 kwhr
Fill/withdrawal (5 cycles)	2.99×10^9 kwhr
Concrete	1.06×10^7 kwhr
Steel	4.38×10^8 kwhr
Total	4.25×10^9 kwhr

Energy content of oil = 1.21×10^{12} kwhr.
Ratio of energy used to energy content of oil = 3.5×10^{-3}

Vinton

Leaching	4.98×10^8 kwhr
Fill/withdrawal (5 cycles)	1.42×10^9 kwhr
Concrete	1.06×10^7 kwhr
Steel	1.28×10^8 kwhr
Total	2.06×10^9 kwhr

Energy content of oil = 4.03×10^{11} kwhr.
Ratio of energy used to energy content of oil = 5.1×10^{-3}

Big Hill

Leaching	4.51×10^8 kwhr
Fill/withdrawal	8.60×10^8 kwhr
Concrete	1.06×10^7 kwhr
Steel	5.47×10^8 kwhr
Total	1.87×10^9 kwhr

Energy content of oil = 8.06×10^{11} kwhr.
Ratio of energy used to energy content of oil = 2.3×10^{-3}

The energy consumption figures presented do not include th energy utilized in transporting the oil to or from the sit

7.8 LABOR

To construct and operate any one of the facilities for twenty years would require the following amounts of labor, measured in man-years of effort:

Site	Total	Construction	Operation*
West Hackberry Expansion	1207	482	725
Black Bayou	1176	451	725
Vinton	683	275	408
Big Hill	969	415	554

The use of this labor represents an irretrievable resource commitment since the labor services consumed would not be available for other activity.

*Assumes 30 month fill and 5 month withdrawal times with five complete cycles over the twenty year time period for facility operation.

7.9 CAPITAL

The cost of construction and operation for each of the alternative sites in the Texoma region is as follows (millions of 1976 dollars):

Site	Construction	Operation (range/year)
West Hackberry Expansion	185	1.8 - 7.5
Black Bayou	181	1.8 - 7.5
Vinton	90	1.0 - 4.2
Big Hill	130	1.2 - 6.3

These figures do not include the value of stored oil, the transportation costs associated with transporting the oil from place of purchase to Sun Terminal, or the cost of land. These capital costs are irretrievable since material costs are considered, as a worst case, irretrievable due to the lack of reliable salvage value estimates, while energy and labor service costs are irretrievable.

7.10 SUMMARY

Irreversible or irretrievable commitments of resources resulting from the construction and operation of an SPR facility include the loss of environmental productivity along pipeline rights-of-way and at the site; the destruction or organisms and marsh and terrestrial vegetation; the commitment of steel and concrete which have limited secondary use potential; the consumption of energy and labor services; and the use of capital resources.

8.0 SUMMARY OF PROPOSED AND ALTERNATIVE ACTIVITIES

8.1 INTRODUCTION AND SUMMARY

In the Texoma region, four salt domes are being considered as potential SPR storage sites: a proposed site, West Hackberry expansion, with three alternatives. Alternative sites are the Black Bayou dome, the Vinton dome, and the Big Hill dome. The Sulphur Mines salt dome which is also in the Texoma region is being developed as an ESR site. It is being developed in addition to the 210 million barrels of oil storage proposed for these four sites. This chapter presents a summary of the proposed and alternative activities at each of the four sites. For each site, a description of each proposed major system is followed by a description of any alternative system which has been considered and would serve the same function. For a more detailed description of all proposed systems, refer to Chapter 2. A summary map is provided for each site detailing the proposed facility design.

8.2 SUMMARY OF PROPOSED SITE ACTIVITIES: WEST HACKBERRY EXPANSION

Site Layout

Proposed: Fifteen additional wells to be drilled for the expansion of the SPR facility would be spaced at a minimum of 600 feet apart and would all be located on dry land. Approximately 1.8 miles of new roadways would be needed for access to the wells, all roadways would be located on land requiring a minimum of clearing and grading. Pipelines connecting the wells and the central plant would be laid beside the access roadways. The various onsite pipeline connectors would be buried.

Alternative: None

Central Plant Facilities

Proposed: The plant would be located on a 40 acre tract adjacent to the ESR site. The central plant facilities would serve both the ESR plant and the SPR expansion site. Buildings would be required to house the main office, all electrical control equipment, a repair shop, and a chemical lab.

Alternative: None

Raw Water System

Proposed: The raw water intake for the West Hackberry site would be located on the south bank of the ICW, approximately 4.36 miles north of the site. The intake/pumping station would be located in a dredged slip. Water would be transferred to the site through a 48-inch diameter pipe (13,000 feet of prestressed concrete pipe for marshlands and 10,000 feet of steel pipe for the portion underneath Black Lake). Submarine cables paralleling the pipeline from the site to the intake/pumping station would provide the electric power for the pumps.

Alternative: An alternative water system for both the ESR and SPR expansion would be located on Black Lake. This would require one of the following design alternatives (1) dredging a sump from the lake bottom near the shore, (2) dredging a 2800-foot long open channel from the shore into Black Lake, or (3) constructing a rectangular box intake in Black Lake which is connected to the onshore pumping station by a 3300-foot long 66-inch diameter pipe. The intake structure would consist of a platform supported on pilings with multiple screens for minimizing impingement of trash and organisms. Water would be transferred to the storage site through a 36" diameter pipeline by a total of 4 pumps located at the intake station.

Another alternative source of water supply would be the Calcasieu Ship Channel, 4 miles east of the site. A pump station (requiring 3 or 4 acres) would be constructed adjacent to the channel on land built up from former spoil areas. Power supply from local utilities would be available at the site.

Since it is planned to construct a brine disposal line to the Gulf of Mexico, the option of building a parallel water supply line was examined. A remote pumping station on an offshore platform, a remote power supply for offshore pumps, and extensive multiple screening to minimize entrainment of organisms would be required.

An alternative method of providing electric power to the pumps on the ICW would be to string overhead transmission lines from the site. The utility poles would be located in the marshes on the western side of Black Lake.

Brine Disposal

Proposed: The brine disposal system planned entails the construction of a pipeline to the Gulf of Mexico for direct disposal into the sea.

Initially the brine leaving the caverns would be placed in a 175,000 barrel brine settling and surge pond at the central plant area. From here, the brine would be transferred through a pipeline which would parallel Calcasieu Ship Channel. After leaving the coast, the pipeline would extend to the diffuser location, 7.0 miles offshore.

Alternative: An alternative route for the brine disposal pipeline would be west of and parallel to Highway 27. For most of its route along Highway 27 the pipeline would be placed in the Stark's Canal. As the brine line leaves the coast at Holly Beach, it would extend to the same diffuser location as planned for the proposed route.

Oil Distribution System

Proposed: The distribution pipeline to the Sun Terminal at Nederland, which is planned for construction under the ESR development, would also be used for the SPR development.

Alternative: None

Land Requirements

Proposed: About 220 acres of the onsite facilities at West Hackberry are being developed in the Early Storage Reserve Program. The central plant area would be located on this tract.

Another 160 acres would be required for the SPR expansion site and would include only the additional storage wells, roadways, and pipeline connections. The oil pipeline would serve both the ESR and the SPR expansion facilities. The proposed brine disposal pipeline to the Gulf of Mexico would require a permanent right-of-way totaling 176 acres. The pipeline construction right-of-way would require 389 acres. Thus, a total of 549 acres would be temporarily or permanently committed for the development of the West Hackberry expansion.

Alternative: None

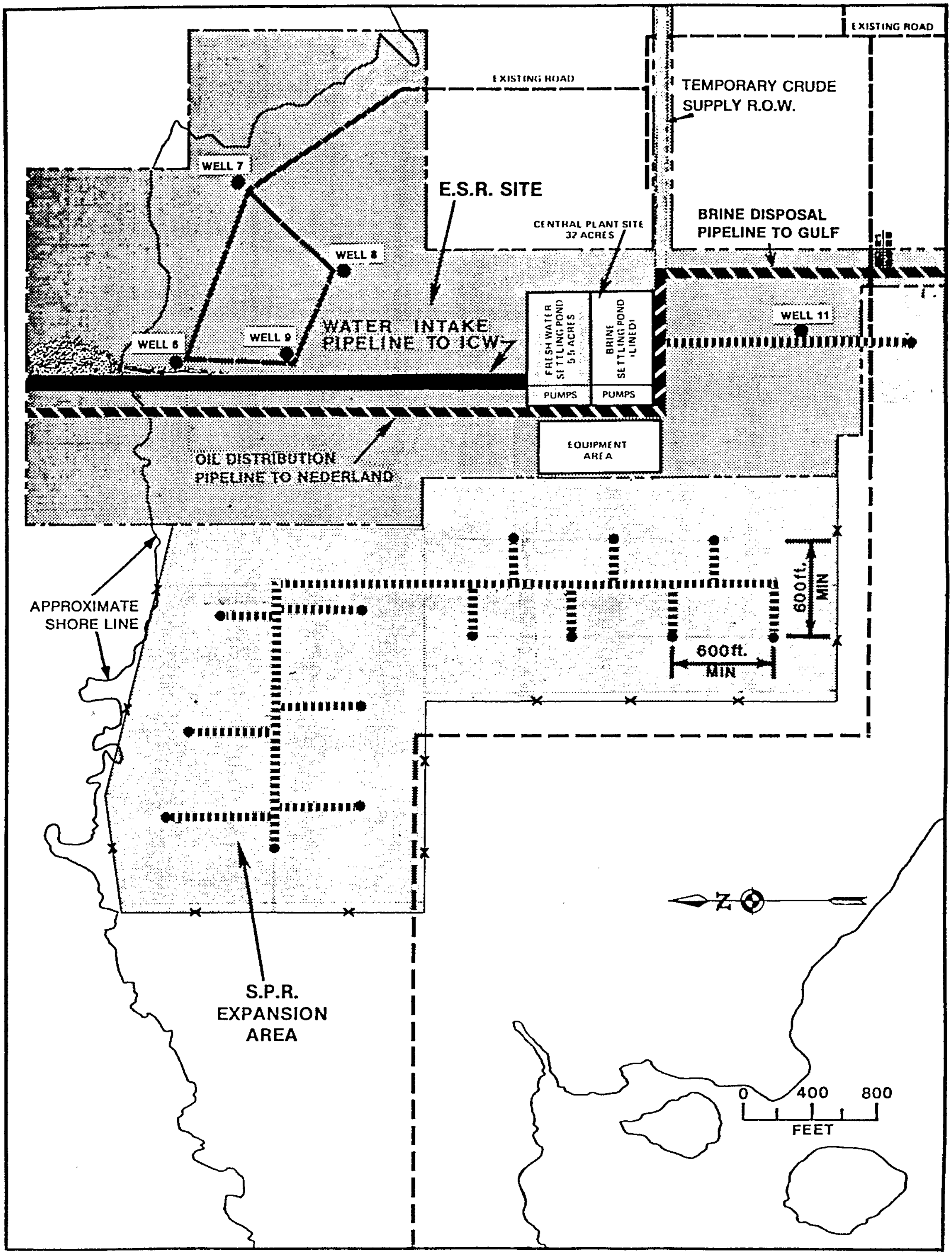

Figure 8.2-1 West Hackberry Facility Layout

8.3 SUMMARY OF ALTERNATIVE SITE ACTIVITIES

8.3.1 Black Bayou

Site Layout

Proposed: The 15 storage wells would be located on elevated platforms spaced roughly on 600 feet centers over the marsh on the eastern half of the salt dome. A few new access canals would be required to construct and maintain all 15 wells. Approximately 106,000 cubic yards of new canal cuts would be dredged. A dredge spoil area of approximately 10 acres would be needed. Because wellheads must be accessed by barge, for construction and workover, a small equipment barge would be included in the equipment design. A timber dock with mooring piles would be constructed on the canal just south and across the road from the central plant area. A barge slip would be required parallel to the canal. The dredge spoil would be deposited on dry land adjacent to the barge slip. No new roadways would be required. Pipelines connecting the wells and the central plant would be buried in the marsh along the access canals.

Alternative: None

Central Plant Facilities

Proposed: The central plant would include all pumps, pump buildings, control buildings, office, surge ponds, surface tankage, metering systems, and transformers. The plant site, about 10 acres, would be constructed upon landfill. All buildings and permanent structures would be supported on concrete pilings for stability. Adjacent to the central plant would be an equipment yard of several acres. Buildings would be required to house the main pumps, the main office, all electrical control equipment, a repair shop, and a chemical lab. An estimated 91,000 cubic yards of fill material would be required to raise the low lying marsh land (0 to 5 feet) to a suitable height (6 to 8 feet).

Alternative: None

Raw Water System

Proposed: A water intake station would be constructed on the eastern side of the Black Bayou channel. The intake structure would consist of a platform (10' x 10') supported on pilings with multiple screens for minimizing impingement of organisms. A sump would be dredged from the side of the channel to minimize inflow restrictions and sand entrainment. Approximately 60 cubic yards would be dredged and then deposited in the designated disposal area. A 36" pipeline connection of about 3,500 feet long would be laid parallel to other onsite piping to the central plant and into the 175,000 barrel raw water surge pond. A 3,000 barrel water tank located onsite would be used for start-up operations.

Alternative: Two possible alternatives were considered. Since it is planned to build a brine disposal line to the Gulf, the option of building a parallel water supply line was suggested. This would require a remote pumping station on an offshore platform. In addition, a remote power supply would be needed for the pumps at the offshore site.

The other possible source for water supply would be the ICW about 2 miles north of the site. This alternative would require a longer water supply pipeline and the construction of an offsite pumping station on the bank of the ICW. The required pipeline would follow the same route 2.7 miles along the Black Bayou Cutoff channel as proposed for the oil distribution connection. The pumping station would include a dredged sump of about the same size as proposed for Black Bayou. It would also require a separate transformer area to provide power for the pumps.

Brine Disposal

Proposed: The proposed system calls for a 27 mile, 36" pipeline into the Gulf of Mexico. The pipeline route presently being considered would pass through marsh for the entire distance but would follow an existing Transcontinental Gas Pipeline Company right-of-way for 90 percent of the distance. The brine leaving the caverns would empty into a 175,000 barrel settling and surge pond at the central plant area.

Alternative: An alternative to the brine pipeline to the Gulf of Mexico is a deep well injection system.

Oil Distribution System

Proposed: The ESR pipeline planned between West Hackberry and the Sun Terminal at Nederland, Texas, would pass within 2.7 miles of the Black Bayou storage site. A 2.7 mile connection along Black Bayou Cutoff to the West Hackberry pipeline on the ICW (plus the required pumps and tanks) is the only development necessary to complete the distribution system for Black Bayou. According to present plans, the 42" pipeline connector would be laid along one side of the Black Bayou Cutoff channel bottom. A minimum of 5 feet of cover would be required to maintain site clearance for barge traffic. The total pipeline length from Black Bayou to Nederland is about 28 miles.

Alternative: None

Land Requirements

Proposed: About 230 acres would be needed at Black Bayou to develop the onsite facilities. This area would include 10 to 12 acres for the central plant and 10 acres for dredge disposal, in addition to the required storage wells, access canals, and water intake station.

The brine disposal pipeline to the Gulf of Mexico would require a permanent right-of-way totaling 163.7 acres. A larger area (248 acres) would be affected during the pipeline construction.

The oil distribution pipeline connection would require a permanent right-of-way totaling 16 acres. About 26 acres would be affected during its construction. Thus, a total of 410 acres would be permanently committed for the development of the Black Bayou site.

Alternative: None

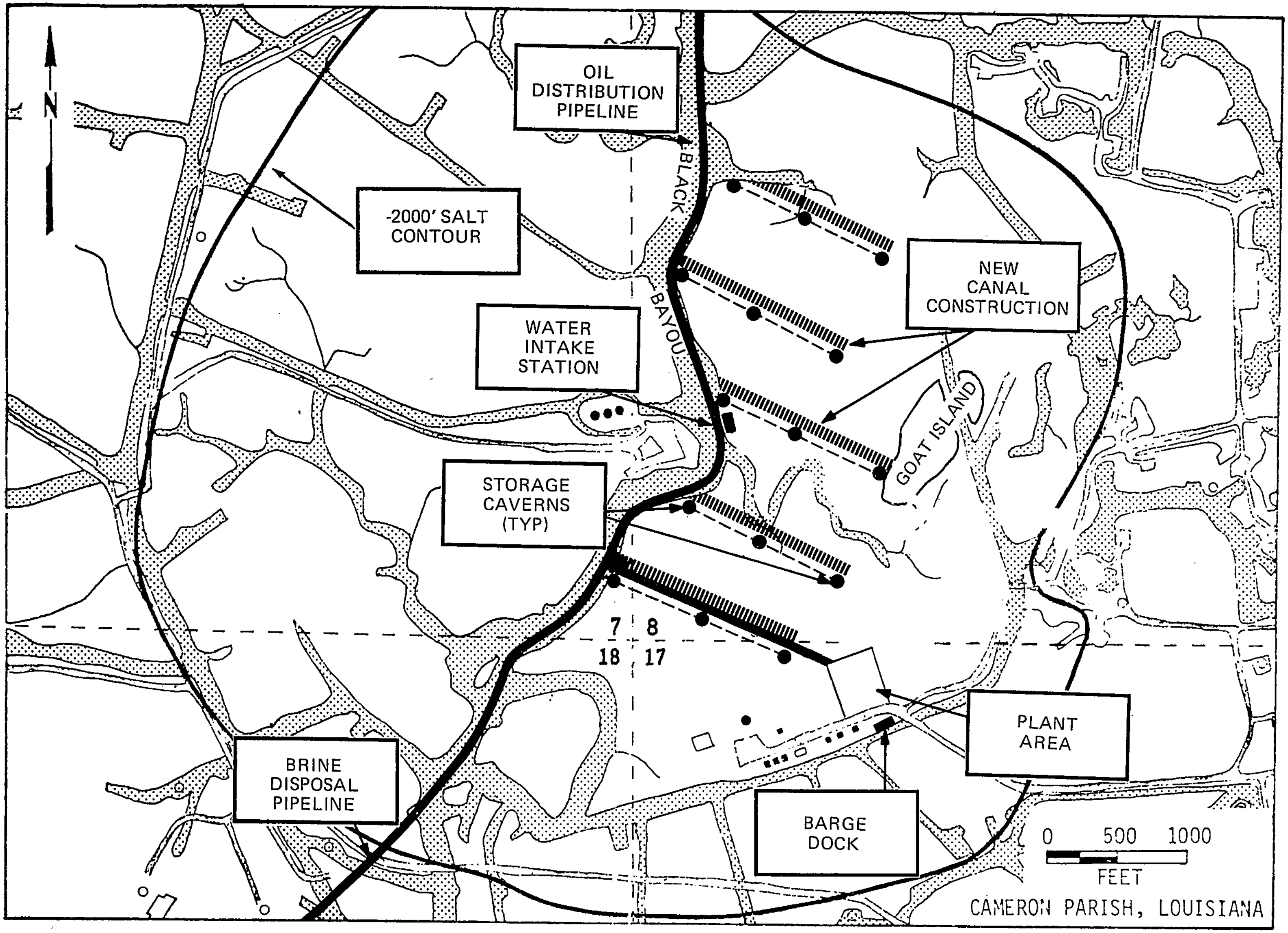

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Figure 8.3-1 Black Bayou Summary Map

8.3.2 Vinton Salt Dome

Site Layout

Proposed: The 6 storage wells at the Vinton dome facility would be spaced 800 feet apart and would all be located on dry land. New roadways would be required for access to the wells and central plant facilities. Approximately 1.0 mile of new road construction would be needed. All roadways would be located on dry land, requiring a minimum of clearing and grading. The one well located on the far north side of the lake would be connected by pipelines supported by pilings across the lake. All other onsite lines would be buried.

Alternative: None

Central Plant Facilities

Proposed: Preliminary designs indicate that oil injection pumps, brine injection pumps, and raw water injection pumps would be housed in a central pump building located in the central plant area. Current designs also specify electric pumps and equipment with power being supplied by local utilities. No onsite backup generation is planned.

Oil pumps are used for injection and withdrawal operations. Pipeline transfer pumps (located at Sun Terminal) are used for pumping oil to the site. Fill operations require oil transfer, oil injection, and brine disposal pumps. Withdrawal operations require oil displacement, water supply pumps, and oil injection pumps used for transfer to the dock.

Another building would be required to house the main office, all electrical control equipment, a repair shop, and a chemical laboratory. Buildings required for housing pumps, control equipment, laboratory, and repair shop would be built upon concrete slabs. In cases of insufficient soil bearing strength, reinforced concrete pilings would support beams upon which the floor would be laid.

The plant area would be an estimated 6 acres and would require a minimum of clearing and grading. Adjacent to the plant area would be an equipment yard of roughly 4 acres. A security fence would enclose both the plant area and equipment yard.

Alternative: None

Raw Water System

Proposed: For the leaching of new caverns and for the displacement of stored oil, raw water would be supplied from the Vinton drainage canal located about 1.5 miles east of the dome. This waterway is about 100 feet wide by 15 feet deep and is connected to the ICW 5.5 miles to the south.

The pipeline to this area would be a 36" line proceeding from the central plant area due south across the dome for 0.4 miles. Then it would turn east for about 0.6 miles (prairie) and northeast along a light duty road for 1.25 miles until it intersects with the canal. The final leg includes 0.9 miles of prairie and 0.35 miles across wooded area ending at the western spoil bank of the canal. Total pipeline would be 2.5 miles in length. The intake station would be built on an inlet dredged off the Vinton drainage canal, so as to avoid any interruption of water supply due to ship traffic.

The intake structure design would follow standard engineering procedure and be in compliance with the Hydraulic Institute Standards. It would consist of can type pumps submerged to a minimum depth of 3 or 4 feet. The intake cans would be located in the dredged inlet as mentioned above, and would be sized to create an intake velocity of 0.5 feet per second or less. This would result in less bio-fouling of the intake screening structures.

The raw water holding pond would be designed to accomodate the largest volume of water pumped during any four hour period (a flow rate of 343,000 B/D). The water would be held for this amount of time for settling purposes. Therefore, the pond would be designed to hold 60,000 barrels. This is a volume of 12,500 cubic yards resulting in average dimensions of about 150 x 225 x 10 feet deep. The walls of the pond would be sloped at 45 degrees for structural integrity. The material removed during construction would be used for earthen dikes at the site and for the construction of roads and building foundations.

Alternative: Three possible alternatives were considered in lieu of the proposed use of Vinton drainage canal for raw water supply. Since it is proposed to construct an oil pipeline to the ICW, the option of laying a parallel water supply line was suggested.

Ged Lake, which lies directly adjacent to the site, was considered as a possible raw water source.

Subsurface aquifers were also considered as possible sources of leaching water. These aquifers consist of massively bedded sands which extend from near the surface to deeper than -1,000 feet throughout the area.

Brine Disposal System

Proposed: The current design specifies brine disposal into subsurface saline aquifers. The brine would flow through a 24" epoxy lined steel pipe to the disposal wells and injected into the ground. The wells are located approximately 2 miles south of the site and consist of 10 wells in a linear array with 1000 foot intervals. Approximately eight of the ten wells would be in a marsh with access by a new barge canal. These wellheads would be constructed on 30 x 30 foot elevated platforms and therefore, no land fill would be required. The new barge canal, which would be 2.2 miles long by 80 feet wide by 7 feet deep, traverses both marsh and dry land so that the drill rig barges would have easy access to all the well sites. The total amount of material removed during the dredging of this canal would be about 241,000 cubic yards. The disposal of this dredged material along the banks of these canals would require approximately 35 acres of marsh.

The pipeline leading to the disposal wells would be a total of 2.75 miles in length. Beginning at the central plant area it would head south across prairie for 0.5 miles crossing a small road in the process. The route would turn east for 0.75 miles following the same route as the proposed water supply pipeline, and then south for 1.5 miles, all across prairie. At this point, it would intersect with the well connecting pipelines at approximately midpoint of the disposal field.

Other components of the brine disposal system are a brine surge pond and a bank of pumps. The pond, which would be a 60,000 barrel lined open structure, was designed to be capable of a four hour holding time during the highest brine flow rate experienced. The brine would be held to allow for settling before it is pumped to the disposal field and injected into deep wells. The pond would also serve as a surge point in the event of an injection well back-up or system rupture. The dimensions of this pond would be approximately 150 x 225 x 10 feet deep with the walls slanted at 45 degrees for structural integrity. About 12,500 cubic yards of earth would be removed during construction of this pond that would be used for dikes, roads, or building foundations on the site.

Alternative: The only environmentally acceptable alternative to deep well brine injection would be disposal into the Gulf of Mexico.

Oil Distribution System

Proposed: Crude oil would be pumped between the Vinton site and Sun Terminal in Nederland, Texas, via a proposed 31 mile long pipeline. A new 7.5 mile x 42" pipeline would connect with the proposed oil pipeline from the West Hackberry ESR site to the Sun Terminal. Thus, the 31 miles from the Vinton site to Sun Terminal would include part of the original ESR pipeline

Both oil supplies for storage and then distribution of the stored oil would be handled at Sun Terminal.

A 20,000 barrel oil tank would be located onsite for surge purposes. The dike surrounding the tank would be designed to contain the total volume of the tank in the event of a major leak. Also inside this dike area would be a 3000 barrel blanket oil tank. The blanket oil is required during leaching operations to maintain a high pressure oil layer above the brine.

The distribution pipeline would be connected to the manifold side of the oil injection pumps. These pumps would serve to inject oil during fill and oil transfer to the terminal during withdrawal.

Alternative: None

Land Requirements

Proposed: The central plant area would require 6 acres of land including ponds and tanks. An additional 4 acres would be required adjacent to the central plant for the storage of equipment such as parts and machinery. Total land area at the site, including central plant, wellheads, and access roads, would amount to approximately 60 acres directly north and west of Ged Lake.

A 50 foot permanent right-of-way is required for maintenance of the pipeline. During construction, however, a temporary 75 foot right-of-way is needed on dry land and 150 feet on wet land.

The intake station on Vinton drainage canal would require 1 acre, including a dredged inlet. Total permanent land requirements for all proposed pipeline routes and physical facilities associated with this site would be approximately 150 acres.

Alternative: None

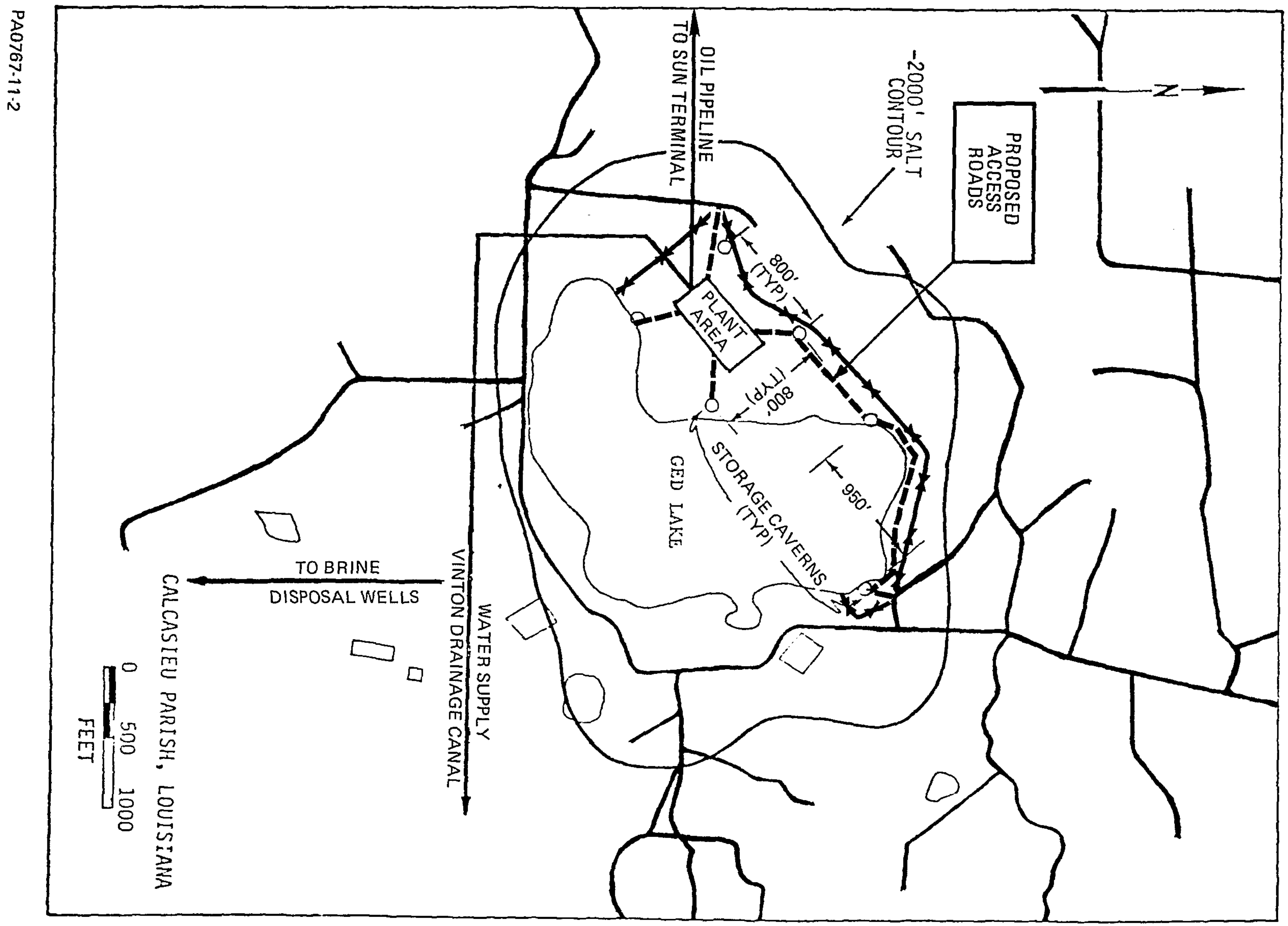

Figure 8.3-2 Vinton Summary Map

8.3.3 Big Hill Salt Dome

Site Layout

Proposed: The twelve proposed caverns would be arranged in a 3 x 4 linear array. They are positioned in the center of the dome to avoid any conflicts with existing production around the rim of the dome.

On solid dry ground, such as exists at the Big Hill site, the wellheads at the storage wells would not require special structures (e.g., platforms). Some land has been cultivated on the high portions of hill over the dome, indicating that farming is being conducted in the area. The onsite pipeline connectors would be buried to minimize the impact to grazing land at the site.

All the roadways onsite for access to wellheads would be on dry land, requiring a minimum of clearing and grading. About 1.5 miles of new roadways would be needed.

Alternative: None

Central Plant Facilities

Proposed: Preliminary designs indicate that all oil injection pumps, brine injection pumps, and raw water injection pumps would be housed in a central pump building, or other appropriate sound attenuating structure, located in the plant area (see Figure 2.7-5). A manifold system in the plant area would be used to direct the flow and would not be housed in a building.

Another building would be required to house the main office, all electrical control equipment, a repair shop, and a chemical lab. At this lab, brine samples would be analyzed to calculate the rate of new leaching. Also, tests would be conducted on crude oil samples to determine their compatibility with other stored oils.

Buildings required for housing pumps, control equipment, laboratory, and repair shops would be built upon concrete slabs. In cases of insufficient soil bearing strength, reinforced concrete piles would support beams upon which the floor would be laid.

The plant area would be an estimated 10 acres, including an equipment yard, and would require a minimum of clearing and grading. A security fence would enclose both the plant area and equipment yard.

Alternative: None

Brine Disposal System

Proposed: The brine displaced during leaching and crude oil fill operations would be pumped through a 36-inch diameter epoxy-lined steel pipe for direct disposal into the Gulf.

The pipeline route for brine disposal would extend in a southeasterly direction from the dome, following an existing pipeline right-of-way for 5.5 miles until it intersects with the ICW. This leg includes 1.5 miles of prairie, which is adjacent to the dome, and 4 miles of marsh and is the same route as proposed for the raw water supply pipeline. It crosses Salt Bayou and a dirt road in the process. The route would then cross the ICW (perpendicularly), and proceed 0.5 miles across marsh in the same direction. At this point, it would cross a branch of Star Lake and continue through marsh for about 3 miles to the Gulf Coast, crossing a dirt road along the way. At the coast, the pipeline would cross State Road 87 and coastal beach totaling 0.7 miles. The entire route to the Gulf Coast would be about 9.2 miles. The brine diffusor ports would be located about 3.5 miles offshore at this point (perpendicular), in a water depth of 30 feet. The total brine pipeline would be 13.2 miles.

Other components of the brine disposal system are a brine surge pond and a bank of pumps (Figure 2.7-5). The pond would be a 120,000 barrel lined, open structure and is designed for a four-hour holding time during the highest brine flow rate experienced. This pond serves as a source for detecting and removing any oil that may be mixed with the brine, as well as a surge point in the event of a system malfunction. The dimensions of this pond would be approximately 250 x 175 x 10 feet deep with walls sloped 45 degrees for structural integrity. About 25,000 cubic yards of earth would be removed during its construction and go into dikes, roads or building foundations on the site.

Alternative: An alternative pipeline route for the brine disposal system was considered. The alternative route is 3.3 miles longer than the proposed route, but traverse much less marshland. The total length of this line would be 16.5 miles, or about 11.5 miles to the Gulf coast.

Raw Water System

Proposed: For the leaching of new caverns and for the displacement of stored oil, raw water would be supplied from the ICW located 5.5 miles south of the dome. A 36-inch diameter pipe is planned to follow the same route as the brine disposal line. When the line intersects the ICW an inlet would be dredged for the intake structure. By positioning the intake ports off of the waterway any interruptions of a constant water supply due to ship traffic would be avoided.

The intake structure design would follow standard engineering procedure and be in compliance with the Hydraulic Institute Standards. The intake velocity would be at 0.5 feet per second or less, thus minimizing the bio-fouling of the intake screens due to entrainment of marine organisms.

Other components of this system include a raw water tank, pond, and pumps. Water taken from the ICW would be pumped at 150 psi to the site by four 700 hp units located at the intake station.

The raw water pond would be designed to accommodate the largest volume of water during any four hour period. The pond would therefore be 120,000 barrels in volume, with dimensions 250 x 275 x 10 feet deep. The walls of the pond would be sloped at 45 degrees for structural integrity. The material removed during construction of this pond, 25,000 cubic yards, would be used for earthen dikes at the site and for the construction of roads and building foundations.

Alternative: The alternative pipeline for this system is identical to the alternative brine route described above, but terminates at the ICW. This route would be 7.5 miles in length, and although it is two miles longer than the proposed route, it traverses much less marsh.

Oil Distribution System

Proposed: Crude oil would be transported between the Big Hill site and Sun Terminal in Nederland, Texas via a new proposed 27 mile x 42 inch pipeline. Sun Distribution Terminal is the initiating point of the Texoma pipeline which would be used for inland distribution of oil stored at Big Hill. Supply would be from tankers exclusively and distribution operations would utilize both tankers and inland oil pipelines.

A 20,000 barrel oil tank would be located on-site for surge purposes. This tank would be a cylindrical steel structure approximately 40 feet high and 50 feet in diameter. The dike surrounding the tank would be designed to contain the total volume of the tank in the event of a major leak. Also, inside this dike area would be a 3000 barrel blanket oil tank. The blanket oil is required during leaching operations to maintain a high pressure oil layer above the brine (as described in Appendix A). The approximate dimensions of this tank would be 20 feet high with a 32 foot diameter.

The proposed distribution pipeline proceeds in a northerly direction away from the site and would proceed for approximately 3.5 miles along Big Hill road. From this point, the pipeline would proceed in a northeasterly direction to Sun Terminal.

The distribution pipeline would be connected to the manifold side of the oil injection pumps. These pumps would serve to inject oil during fill and to transfer oil to the terminal during withdrawal.

Alternative: The alternative pipeline route for this system is about one mile shorter than the proposed route. This route would run north to Highway 73, following this road for five miles. Then the route turns northeast until it reaches the Neches River, then southeast to Sun Terminal.

Land Requirements

Proposed: The central plant area at this site would require about 10 acres of land including ponds, tanks and other structures. The total land encompassed by the plant area and the twelve wellheads would be approximately 230 acres.

The land requirements for the proposed pipeline routes are given in Table 2.7-3. As noted, a 50 foot permanent right-of-way is required for maintenance of the pipeline. During construction, however, a temporary 75 foot right-of-way is needed on dry land and 150 feet is needed over wet land.

Intake station on the ICW would require about an acre of spoil bank. This includes the dredged inlet and intake structures.

Total permanent land requirements for all proposed routes as well as physical facilities would be approximately 715 acres.

Alternative: None

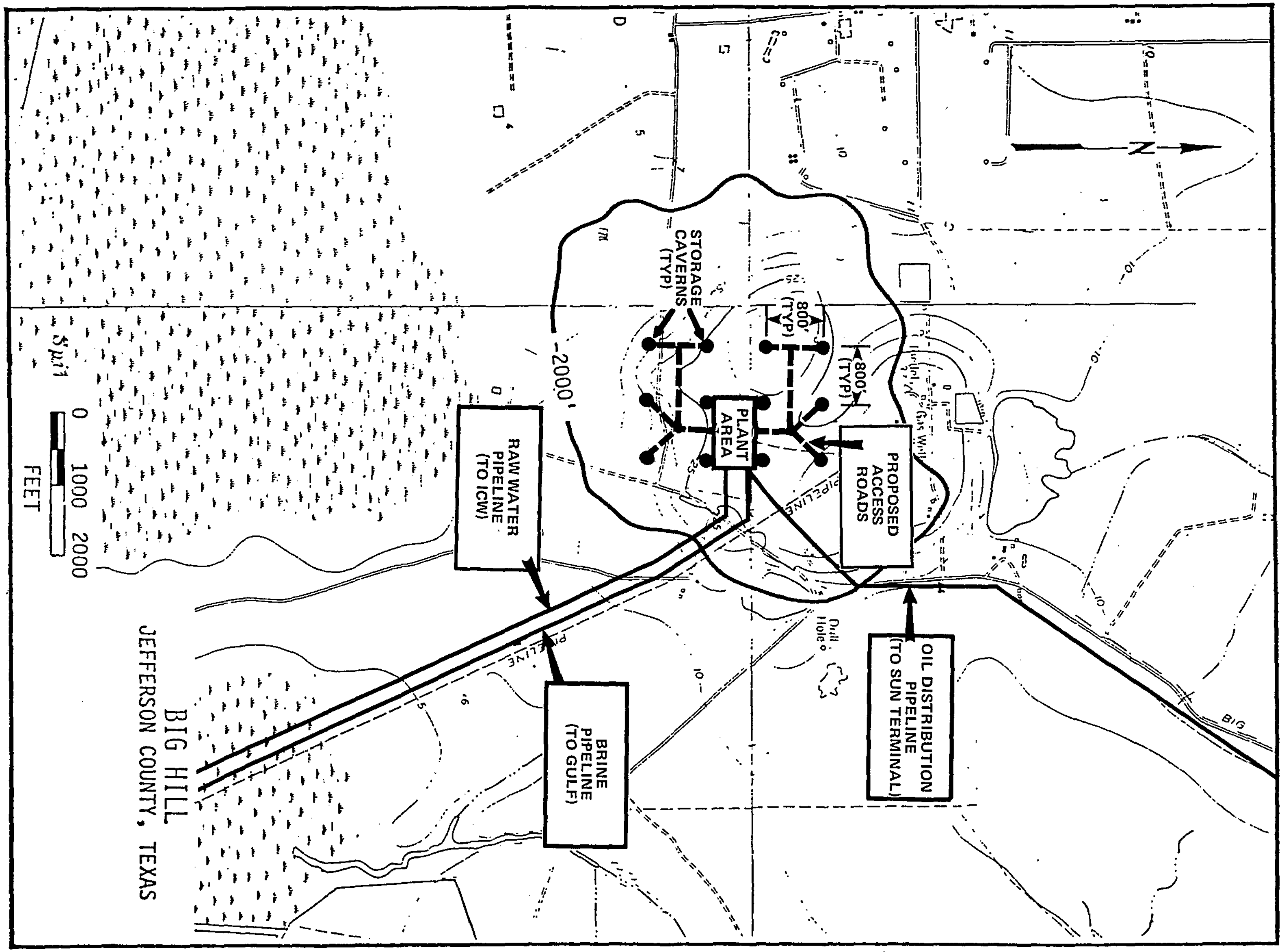

Figure 8.3-3 Big Hill Summary Map

8.3.4 No-Action Alternative

A description of the no-action alternative and its impacts, as it applies to the entire program, is provided in the Final Programmatic SPR EIS (FES-76-2). The no-action alternative within the Texoma group of alternative expansion sites could take one of the two forms: (1) in fulfillment of the requirements in the Energy Policy and Conservation Act the Department of Energy may be obligated to increase the development within one of the other proposed regions or within an entirely new region; or (2) the petroleum storage capacity developed throughout the country may prove adequate without additional storage in the Texoma area. In either case, the impacts associated with the SPR described in Section 4 would not occur and the existing environment, with an ESR facility, in the Texoma region as described in Section 3 would be maintained. However, if the first alternative listed above followed a decision not to develop an SPR storage facility in the Texoma area, other impacts would result: those associated with any alternate site or group of sites. Since many of the candidate SPR sites are also located in the Gulf Coast Region, it is likely that many of the impacts resulting from the development of the replacement storage capacity would be substantially the same as those for the Texoma group. However, the detailed impacts of any particular facility are site specific and would be discussed in the EIS for that site. If the second alternative listed above followed a no-development decision in the Texoma region, the only new impact would result from the fact that the oil which was to be stored in Texoma salt dome(s) would not be available in that region.

9.0 CONSULTATION AND COORDINATION WITH OTHERS

In preparation of the Draft Environmental Impact Statement numerous agencies, governmental units, other groups, and individuals were consulted for information and technical expertise. A complete list of these groups is found in this chapter.

9.1 COORDINATION AND CONTACTS WITH OTHERS

Federal Agencies

United States Army Corps of Engineers
Vicksburg, Mississippi
Galveston, Texas
New Orleans, Louisiana

National Oceanographic and Atmospheric Administration
Washington, D.C.

Environmental Protection Agency
Research Triangle, North Carolina

Department of Transportation: Office of Pipeline Safety

U. S. Coast Guard

Department of Commerce: Bureau of the Census

Department of Interior: Bureau of Mines

U. S. Fisheries and Wildlife Service: Ecological Service
Galveston, Texas,
Advisory Council on Historic Preservation

State Agencies

Louisiana Wildlife and Fisheries Commission
Lake Charles, Louisiana

Louisiana Air Control Commission

Louisiana State Department of Highways
Louisiana Archaeological Survey and Antiquities Commission

Texas Water Development Board
Austin, Texas

Texas Water Quality Board
Austin, Texas

Water Pollution Control Board
Austin, Texas

State Agencies (continued)

Southeast Texas Regional Planning Commission
Nederland, Texas

Texas Employment Commission
Austin, Texas

Texas State Department of Highways

Texas Department of Community Affairs

Texas Department of Health Resources

Texas Air Control Board

Texas Parks and Wildlife Commission
Port Arthur, Texas
Texas Historical Commission

Local Agencies

Vinton Waterworks
Vinton, Louisiana

Chamber of Commerce
Nederland, Texas
Port Arthur, Texas
Beaumont, Texas
Orange, Texas
Winnie, Texas
Vinton, Louisiana

Other

Calcasieu Pilot Association
Lake Charles, Louisiana

Coastal Environments, Inc.
Baton Rouge, Louisiana

Henley Environmental Services
Austin, Texas

Lamar University
Beaumont, Texas

Coastal Studies Institute: Louisiana State University
Baton Rouge, Louisiana

McNeese State University
Lake Charles, Louisiana

Sabine Waterfowl Refuge
Lake Charles, Louisiana

Texas A & M University: Moody College of Marine Sciences
Galveston, Texas

University of Southwest Louisiana
Lake Charles, Louisiana

Western Oil and Gas Association

Sun Oil Company
Nederland Distribution Terminal

Sabine Pilots

Texas Sportman's Association
Port Arthur, Texas

Amoco Production
Lake Charles, Louisiana

Calcasieu Parish Policy Jury
Lake Charles, Louisiana

9.2 ENVIRONMENTALLY ORIENTED PERMITS AND LICENCES

A number of Federal regulations which must be complied with are listed in Table 9.1. Also included in the list are state and local regulations which are relevant to the program. DOE will consult with the agencies in charge of implementing these regulations pursuant to the Intergovernmental Coordination Act of 1968.

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

	AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
	FEDERAL			
1.	U.S. Army Corps of Engineers, Galveston, District Engineer	General Regulatory Policies	33 CFR 320	
		A. Permit required for all structures or work including excavation, dredging, and disposal activities in navigable waters	33 CFR 322.3	
		B. Permits required for all activities that alter or modify the course, condition, location, or capacity of a navigable water	33 CFR 322	
		C. Permit required for construction of fixed structures on the outer continental shelf	33 CFR 322.3(b)	
		D. Permit required for all discharges of dredged or fill material into national waters	33 CFR 323	
		E. Structures under or over a navigable water are considered to affect the navigable capacity of the waterbody	33 CFR 322.3 (a)(1)	
		F. Staff gages, tide gages, water recording devices, water quality testing devices and similar scientific structures, and survey activities do not require separate permits provided there is no interference with navigation	33 CFR 322.4(e)(f)	
		G. No permit will be granted to work in wetlands unless the benefits of the proposed alteration outweigh the damage to the wetlands and the proposed alteration is necessary to realize those benefits	33 CFR 320.4(b)(4)	
		H. Evaluation of permit applications will take into consideration the impacts of the proposed project on wildlife resources, water quality, and historic, scenic, and recreational sites.	33 CFR 320.4 (c)(d)(e)	

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
	I. Federal agency applicants for permits are responsible for assuring that their activities directly affecting the coastal zone are consistent with approved State coastal zone management programs	33 CFR 320.4(h)	
2. U.S. Coast Guard, District Commander of 8th Coast Guard District (New Orleans) (No Permit Required)	<u>Coast Guard Regulations on Oil Spills</u>	33 CFR 154	
	A. Letter of intent to operate oil transfer facility	33 CFR 154.110	Letter of intent must be submitted and approved 60 days prior to date the operation is intended to begin.
	B. Notice of Discharge of Oil	33 CFR 153	Notice for oil spilled and delegation of responsibility for cleanup.
	C. Facilities and Vessels for Transporting and Handling Petroleum	33 CFR 151.154	
	D. Large Oil Transfer Facilities	33 CFR 154	Provides equipment requirements and criteria for operations monies.
	E. Oil Transfer Operation	33 CFR 156	Regulated oil transfer.
3. U.S. Environmental Protection Agency, Region VI	<u>Regulations on Policies and Procedures for the National Pollutant Discharge Elimination System (NPDES)</u>	40 CFR 125	
	1. These Regulations proscribe the policy and procedures to be followed by the Administrator of the U.S.E.P.A. pursuant to Sections 402 and 403 of the Federal Water Pollution Control Act.	33 USC 1251 nt	

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
	2. Requires permit. . . for any industrial discharge into navigable waters including the "contiguous zone" territorial sea. Such a permit would probably be necessary for discharge of effluents from the off-shore and on-shore terminal waste treatment facilities. In addition, should the NPDES permit system requirements not apply to a particular operation, certification is still required 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.		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.
	<u>Regulations on Oil Pollution Prevention</u>	40 CFR 112	
	A Spill Prevention, Control, and Countermeasures Plan (SPCC) must be prepared for each oil handling facility, within six months of the commencement of facility operations. An acceptable plan must be implemented at each facility within 1 year after operations commence.	40 CFR 112.3	
	<u>Regulations on Transportation for Dumping, and Dumping of Materials into Ocean Waters</u>	40 CFR 220	
	Permit for ocean dumping required for brine disposal.	40 CFR 220-229	
	<u>Regulations for Underground Injection Control</u>		
	Solution mining, subsurface hydrocarbon storage, and subsurface brine disposal, must be carried out in conformance with the Safe Drinking Water Act (PL 93-523)	42 USC 300 f et. seq.	
	Draft Regulations and EPA Administrator's Decision Statement #5 are the present EPA guidelines for determining compliance with the above Act.	41 CFR 170 39 CFR 69	

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
	<u>Air Pollution Control</u>	40 CFR 60	New Source performance testing must be provided
4. Department of Interior Fish and Wildlife Service	<u>Protection of Wildlife</u>	16 USC 661-666 16 USC 1531-1540	Fish and Wildlife Coordination Act Endangered Species Act
5. Department of Commerce National Marine Fishery Service	<u>Wildlife Preservation</u>	16 USC 661-666 16 USC 1531-1540	
6. Department of Transporation, Office of Pipeline Safety	<u>Sets Standards for Pipeline Carrying Petroleum or Hazardous Materials</u>	49 CFR 195	
<u>STATE</u>			
7. 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 water. (b) State must approve applications for NPDES permits before submission to U.S. Environmental Protection Agency (c) Permit for waste disposal.	Louisiana Regulation Requiring Submission of Reports for the Discharge of Industrial Waste . . . 40 CFR 123 Subpart A, Section 123.3.	Certificate of Approval required 3 to 12 weeks before beginning discharges.
8. Louisiana Air Control Commission (enforcement agency) is the Louisiana Division of Air Control and Occupational Health	(a) Certificate of Approval for construction of sources of air pollution emissions. Applies to onshore turbines, barge loading and unloading facilities, surge tanks, pumps, and related facilities.	Louisiana Air Control Regulations Section 6.1.	At present, no permit is required if only crude oil is handled

Table 9.1 Regulatory Bodies and Their Jurisdiction Concerns

AGENCY	REFERENCE JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
	(b) 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 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.	Louisiana Air Control Commission Regulations Section 11.0.	
9. Louisiana Archaeological Survey and Antiquities Commission	<u>Preservation of Archaeological and Historical Resources</u>	Louisiana Rev. Stat; Sect. 41.1601-1613	Requires a Survey in the impacted area before construction commences.
10. Louisiana State Art, Historical and Cultural Preservation Agency	<u>State Historic Preservation Officer</u>	16 USC 469-	
11. Louisiana State Division of Health Bureau of Environmental Services	(a) Permit for installation of sewage treatment facilities and for disposal of solid and oily wastes. (b) Plans and specifications must be approved before construction of a water supply system is commenced.	Chapter 10. Sanitary Codes, Sections 10.50 and 10.56.4, State of Louisiana	
12. Louisiana State Department of Conservation	(a) Well drilling for brine production. (b) Injection wells for salt water or waste disposal. (c) Permit required for storage of hydrocarbons.	La. Rev. Stat. Sects. 30-1, et. seq; Statewide Order 29-B	

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
13. Louisiana State Department of Highways	Right-of-way for pipelines and power lines passing under or over highways.		
14. Louisiana State Land Office	(a) Right-of-way for pipeline crossing state-owned lands and navigable waterways. (b) Surface lease for storage and transportation of oil and gas.	La. Rev. Stat. Sects. 41:1173-1174	
15. State of Louisiana Department of Public Works	(a) Levee Integrity - for pipeline crossing, construction of ramps for access to the pipeline; construction of a dock. (b) Permit to lay pipelines under or across navigable waterways or across stream. (c) Letters of objection or no objection concerning construction of barge facilities and tanker facilities.	La. Rev. Stat. Sect. 38.1 et. seq.	
16. Louisiana State Fire Marshal	(a) Approval of plans and specifications for all barge facilities, tanker facilities, and pipeline construction.	La. Rev. Stat. Sects. 40:1561-1563 41:1262-1269	
17. Not Established	Compliance with Coastal Zone Management Plan, when adopted.		
18. Louisiana Wildlife and Fisheries Commission	Commission will submit letter of objection or no objection to Corps, consultation and coordination with Commission required.	La. Rev. Code Title 56	
19. Texas Air Control Board	Permit required for constructing and operating surge tanks, dock facilities used to load vessels, and other air contaminant sources at the new tanker facility at Nederland, Texas	Texas Clear Air Act (Article 4477-5) Section 3.27 Texas Regulation VI, Rule 601	

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

	AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
20.	Texas General Land Office	Easements required to use state-owned lands for construction of pipeline and new tanker facility at Nederland, Texas.		Office will submit letter of objection or no objection to Corps.
21.	Texas Parks and Wildlife Department	Dredging permit may be required for construction of pipeline and new tanker facility at Nederland, Texas.		Department will submit letter of objection or no objection to Corps.
22.	Texas Department of Water Resources	(a) Permit for discharge of waste into public waters.	Texas Water Quality Act, Chapter 21, Vernon's Texas Water Code, Section 21.079	Board will submit letter of objection or no objection to Corps.
		(b) Permit required prior to construction of a treatment facility.		
		(c) A waste discharge from any industrial, public or private project or development which constitutes a new source of pollution is required to have the highest and best degree of treatment available under existing technology.	Texas Water Quality Rule 635.6	If treatment facilities are built in a flood area, the design report shall describe precautions taken to prevent waste from entering floodwaters.
		(d) Notification must be given within 24 hours of any spill or accidental discharge.	Texas Water Quality Rule 635.4	
		(e) Activities which are inherently capable of causing spillage or accidental discharge of polluting substances are subject to regulations or preventive measures adopted by the Board.	Texas Water Quality Rule 635.6	
		(f) Certification of NPDES permit	Texas Water Quality Rules, Section 645.	
		(g) Permits required for storm water runoff.		Board will submit letter of objection or no objection

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

	AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
23.	Texas Department of Water Resources	Certification that well casings are sufficiently sealed and that use of wells will not contaminate fresh water supplies.	Texas Water Conservation Rules and Regulations (Rules 8 and 13)	
24.	Texas Department of Water Resources	(a) Appropriate permit required for use of surface waters and leaching and displacement.	Texas Water Code Chapter 5 and 6.	Annual Report of water taken from streams and reservoirs may be requested.
		(b) Appropriation permit required for use of surface waters for water supply system for human use.		
25.	Texas Air Control Board	(a) Construction permit required for any facility that may emit air contaminants.	Texas Clean Air Act (Article 4477-5) Section 2.37; Texas Regulations VI, Rule 601	Plans and specifications are to be submitted for determining compliance with air control standards.
		(b) Operating permits are issued for any facility that emits air contaminants.	Texas Clean Air Act (Article 447-5), Section 3.28.	Application must be made within 60 days after operation commences; monitoring date may be required.
26.	Texas Railroad Commission	(a) Notification of drilling operations relating to oil activities.	Texas Railroad Commission Rules and Regulations	
		(b) Permit for oil pipelines	Rule 70	
		(c) Submission of monthly storage reports and annual pipeline operation reports.		

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
27 Texas General Land Office	Right-of-way for pipelines crossing public lands.		Office will submit letter of objection or no objection to Corps.
28. Texas State Department of Highways	Right-of-way for pipelines crossing highways.		
29. Texas Historical Commission	(a) Notification of findings of survey conducted to determine whether National Register of Historic Places property would be affected by the project.	16 USC 470 (f) "National Historical Preservation Act of 1966.	
	(b) Notification of findings of survey conducted to determine whether properties which would be eligible for nomination to the National Register of Historic Places would be affected by the project.	Executive Order #11593 "Protection and Enhacement of the Cultural Environment," May 1971.	
30. Texas Parks and Wildlife Department	(a) No permit required if all dredged spoil will be used to backfill pipeline trench, and stream banks will be returned to original condition after pipeline construction.	Texas Parks and Wildlife Department Rules 127.30.01.001 - 127.30.07.001	Office will submit letter of objection or no objection to Corps.
	(b) As above, and, if beaches will be returned to original condition after use of Gulf water for leaching and displacement.		
31. Texas Department of Health Resources	(a) Approval of plans and specifications required before construction of water supply system, for human use, is commenced.		
	(b) Permit required for collection, handling, storage, and disposal of municipal or industrial solid waste.		

Table 9.1 Regulatory Bodies and Their Jurisdictional Concerns

AGENCY	REGULATORY JURISDICTIONAL CONCERNS	REFERENCE	REMARKS
LOCAL			
32. Cameron Parish Policy Jury	(a) Permits required for construction of docks, pipelines, and buildings to existing dock and new tanker facilities. (b) Approval required for crossing roads, ditches, canals, and waterways during pipeline construction.		
33. Jefferson County Commissioners Court	Permit required for crossings of county roads and and other county property due to construction of pipeline to tanker facility.		
34. Jefferson County Drainage District 7	Permits for pipeline laid across drainage ditches.		
35. Orange County Commissioners Court	Permit required for crossings of county roads and any other county property due to construction of pipeline to tanker facility.		
36. Orange County Drainage District	Permit required for crossing drainage ditches due to construction of pipeline to tanker facility.		

9.3 Parties from which comments were requested

Federal

Department of Agriculture
Department of the Army
Department of Commerce
Department of Defense
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of the Interior
Department of Labor
Department of State
Department of Transportation
Department of the Treasury
Advisory Council on Historic Preservation
Appalachian Regional Commission
Council on Environmental Quality
Energy Research and Development Administration
Environmental Protection Agency
Federal Energy Administration (10 Regional Offices)
Federal Power Commission
Interstate Commerce Commission
National Science Foundation
Nuclear Regulatory Commission
Tennessee Valley Authority
Water Resources Council
National Oceanic and Atmospheric Administration
U.S. Fish & Wildlife Service

State (Louisiana)

Louisiana State Clearinghouse
Louisiana Department of Justice
Louisiana Air Control Commission
Louisiana Wildlife & Fisheries Commission
Louisiana Offshore Terminal Authority
Louisiana Department of Conservation
Louisiana Stream Control Commission

State (Texas)

Texas State Clearinghouse
Texas Soil and Water Conservation Board
Texas Railroad Commission
Texas Parks and Wildlife Department
Texas Water Rights Commission
Texas Water Development Board
Texas Water Quality Board
Texas Department of Agriculture
Texas Industrial Commission
Texas Air Control Board

State Department of Highways and Public Transportation
Bureau of Economic Geology
General Land Office
Texas Forest Service
Texas Department of Health Resources
Texas Coastal and Marine Council
Texas Historical Commission
Division of Natural Resources and the Environment
Office of State-Federal Relations

Local

Cameron Parish Police Jury (LA)
Calcasieu Parish Police Jury (LA)
Iberville Parish Police Jury (LA)
Iberia Parish Police Jury (LA)
Jefferson County (TX)
Orange County (TX)

Other

Acadiana Planning and Development District
American Petroleum Institute
Center for Law and Social Policy
Electric Power Research Institute
Environmental Defense Fund, Inc.
Environmental Policy Center
Friends of the Earth
Fund for Animals, Inc.
Institute of Gas Technology
Interstate Natural Gas Association
Izaak Walton League of America
Energy Conservation Committee-Keys to Education for Environmental Protection
National Association of Counties
National Audubon Society
National Parks and Conservation Association
National League of Cities
National Resource Defense Council, Inc.
National Wildlife Federation
New York State-Office of Energy Analysis
U.S. Conference of Mayors
American Littoral Society
Edison Electric Institute
New Orleans Audubon Society
South Central Planning and Development Commission
Kaiser Engineers
Florida Aubudon Society
Louisiana Wildlife Federation
Olin Chemicals
Louisiana Environmental Professional Association
Baton Rouge Audubon Society
Council on the Environment

The States-Item
Orleans Audubon Society
Calcasieu Rod & Gun Club
Ecology Center of Louisiana
Sierra Club, Delta Chapter
Sierra Club, N.O. Group
League of Women Voters
Louisiana Power & Light
The Fund for Animals
The Times-Picayune
The Courier
Canoe & Trail Shop, Inc.
RESTORE, Inc.
National Audubon Society
Sierra Club-Gulf Coast Regional Conservation Committee
Sierra Club-Southern Plains Regional Conservation Committee
LOOP, Inc.
Seadock, Inc.
Allied Chemical
Gulf States Marine Fisheries Commission

9.4 PARTIES FROM WHOM COMMENTS WERE RECEIVED

The comments on the Draft Environmental Impact Statement addressed herein are those received by the Department of Energy within the allotted comment period. Copies of those letters of comment are contained in Appendix V.

Comments received by DOE after the expiration of the time period also have been considered in the preparation of this Final Environmental Impact Statement to the degree practicable within such time limits, but are not addressed individually within Chapter 9.

9.4.1 DEPARTMENT OF THE ARMY, NEW ORLEANS DISTRICT, CORPS OF ENGINEERS

COMMENT a

"There are numerous misspelled and/or misused genera and species in the text, and several biological references are misquoted."

RESPONSE

The draft environmental statement was reviewed by qualified professional biologists for correct usage of biological nomenclature and accuracy of the ecological and biological sections. We regret any errors and have corrected those detected. The nomenclature used was the most current accepted form and, in many cases, the new scientific names have not reached the general literature.

COMMENT b

"The statements on pages 3.2-21 and B.2-57 which describe Choupique Island as being created by filling with dredged material are incorrect. The island is the result of a dredged cutoff associated with the construction of the Calcasieu Ship Channel."

RESPONSE

The statements in question have been reworded. Choupique Island was formed as indicated in the comment. However, much of the cutoff area has apparently been built up with fill.

COMMENT c

"The sections which describe the environmental setting of each proposed project site should include discussions of the vector problems and potentials that exist at each site. The impact sections also should discuss the impacts of the proposed projects of the vector problems and potentials."

RESPONSE

No vector problems and potentials have been identified. The Texas Department of Health has commented that no adverse public or environmental health effects should be expected if the Big Hill Site is developed. The state entomologist for Louisiana (Paul Scheppf) related that, in general, vectors transmitting serious human diseases are not present in the Cameron and Calcasieu Parish area. The only knowledge of potential problems in recent years has been the detection, by the Calcasieu Parish surveillance program, of St. Louis encephalitis in birds. A mosquito control program is operated in both Cameron and Calcasieu Parishes.

COMMENTS d

"Review of the adverse impacts which would be caused by construction of the Big Hill, Vinton, and Black Bayou facilities indicates that these environmental impacts would be severe and unnecessary since adequate capacity would be afforded by expansion of the West Hackberry site."

RESPONSE

Other sites besides West Hackberry are considered as alternatives to the development of the required storage capacity at West Hackberry. The action proposed in the EIS is to store the oil in the West Hackberry salt dome.

COMMENT e

"The brine disposal line diffuser for the West Hackberry site must be located at a sufficient distance offshore in the Gulf and west of the Calcasieu Ship Channel so as to preclude introduction of waters of higher salinities to the Ship Channel and Calcasieu Lake. The brine disposal system, including the settling ponds, must be properly constructed and monitored to insure that only the lower salinity levels projected in the draft EIS would enter the surrounding marshlands and the Gulf."

RESPONSE

The results of the analysis by NOAA, utilizing the MIT Transient Plume model, indicate that for the proposed diffuser site the maximum excess salinities occurring in the vicinity of the Calcasieu Ship Channel would be on the order of 0.1 ppt. Such an excess would occur roughly every four days and would persist for less than 24 hours. Because the MIT model did not take into account variations in the water depth, the results noted should be considered as an order-of-magnitude estimate only. Physical assumptions made for modeling purposes are being checked by an ongoing field monitoring program.

The brine disposal system, including lined settling ponds, will be constructed and monitored to preclude the inadvertent release of high salinity brine to the surrounding marshlands.

COMMENT f

"The entire study area is subject to hurricane tidal flooding to some extent, and the Black Bayou site and pipeline terminal site in particular appear to be subject to flooding from the 1 percent chance hurricane tidal surge."

"The impact statement does not appear to address (except in one or two brief references) the flood potential of the sites, the susceptibility of the sites or offsite facilities to flood damage, the possible environmental impacts of such flood damage, or the flood protection measures planned if required."

RESPONSE

All of the facilities at all sites would be designed to withstand the effects of hurricane tidal flooding. Any facility systems which could cause ignition of a fire or explosion would be located above the flood level in a structure designed to withstand flood and storm effects, as would any equipment for monitoring system conditions.

A plan for shutdown would be created which in several stages, depending on the distance or time to landfall for a given tropical storm, would shut down operation of the facility. This plan would allow safe shutdown, tie-down, or removal of objects which could be blown or washed against facility structures causing severe physical damage. The plan would also allow for emptying brine ponds to as low a level as possible during the warning period, prior to landfall of the storm.

COMMENT g

"On pages 9.2-2 and 9.2-3, references to Corps of Engineers regulations should be changed to agree with the current regulations. On 19 July 1977, Title 33, CFR, Parts 209. 120 and 209. 131 were rescinded and superseded by regulations contained in Title 33, CFR, Parts 320 through 329."

RESPONSE

The document has been revised to show the revised Corps of Engineers regulations of July 19, 1977, Title 33, CFR, Parts 320 through 329.

COMMENT h

"Appendix O, paragraph 5, page O-40 should specify the wave heights at the facilities."

RESPONSE

The wave height data appearing in Appendix O pertain to the Gulf of Mexico. No historical wave height data were available for any of the water bodies immediately adjacent to the four storage facilities.

COMMENT i

"Personnel of the Federal Energy Administration and the Corps of Engineers have been maintaining close liaison concerning the required Corps regulatory permits."

NO RESPONSE

9.4.2 DEPARTMENT OF COMMERCE, NOAA, NMFS, ST. PETERSBURG,

COMMENT a

"The five brine disposal sites in the Gulf of Mexico are located in water depths of either 30 or 44 feet. The proposed sites are located within the limits of Grid Nos. 17 and 18 identified by the NMFS for the purpose of computing Gulf of Mexico shrimp fishery statistics. During 1975, 70% of the shrimp harvested within Grid No. 17, or more than 3.7 million pounds of shrimp valued at more than $5.4 million, were caught in water depths of 60 feet or less. (Anon. 1976, Gulf coast shrimp data, annual summary 1975. Current Fishery Statistics No. 6925, U. S. Dept. of Commerce, NOAA-NMFS, 26). Also during 1975, 45% of the shrimp harvested within Grid No. 18, or about 2.8 million pounds of shrimp valued at about $5.4 million, were caught in water depths of 60 feet or less. Because of the importance of this area to marine fisheries the sections of the FEIS containing discussions concerning proposed brine disposal in the Gulf should provide the rationale for selecting the brine discharge sites and discuss alternatives including discharging in waters deeper than 60 feet."

RESPONSE

The proposed and alternative sites discussed in the draft EIS included only three potential brine diffuser locations, all of which are located at approximately the 30-foot depth contour.

As indicated in the comment, the bulk of the shrimp (as well as menhaden) fisheries' catches are within the 60-foot depth contour. It is noted, however, that in the coastal ocean of the region covered by the draft EIS, the 60-foot depth contour is approximately 40 miles from the shore. Further, as discussed in Appendix Q, and indicated in Tables Q-5 and Q-21 and Figures Q-13 and Q-18, the transshelf distribution is non-uniform for adult and larval stages of shrimp and menhaden, as well as the five most common fish species. Generally, the commercially important species occur in minimum densities in waters shallower than 30 feet, in maximum densities in waters between 36 and 150 feet, with declining densities with increasing depth beyond 150 feet. Additionally, the data presented in Appendix Q show that in deeper waters (120 feet) shrimp larvae were concentrated near the bottom where impacts from a bottom diffuser would be most severe.

Therefore, from the analysis of data of the National Marine Fisheries Service and other sources, it was concluded that the least potential for significant biologic and economic impacts resulting from brine diffusion would be realized by locating the structure in the relatively unproductive nearshore zone at a depth of less than 36 feet. Other factors considered in determining the proposed diffuser locations included avoidance of impingement of the salinity plume on the beach and at inlets and avoidance of navigational freeways and anchorages. This rationale for determining the proposed locations was corroborated through consultation with local experts and representatives of Louisiana state agencies and universities. In view of the circumstances peculiar to the coastal waters between Calcasieu Pass and Galveston Bay which would result in significantly increasing the potential impact of diffusing brine at greater depths, it is inappropriate to consider alternate diffuser locations at depths greater than those presently under consideration.

COMMENT b

"The anticipated impacts (of brine disposal) on marine life and their habitats should be compared, especially with regard to migration routes and spawning areas of major components of the fishery."

RESPONSE

A monitoring program has been implemented at the proposed and alternative Gulf disposal sites to verify that no important biota will be jeopardized.

COMMENT c

"The FEIS, or a supplement thereto, should include results of laboratory studies on larval stages of several species of marine fishes and crustaceans endemic to the proposed disposal sites, including white shrimp. These bioassays should, for each dome, test the tolerance of those selected species to the brine, at discharge temperatures, that have been put into solution with water from each proposed intake location. The need for such tolerance studies prior to brine disposal at a nearby site has been discussed by NMFS participants in a Strategic Petroleum Reserve workshop on environmental considerations of brine disposal near Freeport, Texas, held in Houston, Texas, on February 17 and 18, 1977. These discussions are included in the proceedings of the workshop."

RESPONSE

Bioassays designed to determine effects of the brine discharge have been carried out, as was recommended at the workshop. The results are discussed fully in the report "Analysis of Brine Disposal in the Gulf of Mexico: Bioassay Results" published in March 1978. These results are discussed in relation to the Big Hill and West Hackberry sites in Chapter 4, Volume I of the FEIS.

COMMENT d

"The FEIS should also discuss the feasibility of, as well as environmental impacts associated with, alternative methods of brine disposal for the enlargement or creation of those possible storage areas for which FEA is presently considering disposal in the Gulf."

RESPONSE

Of the three feasible methods of disposing of brine discussed in the Final EIS, Strategic Petroleum Reserve (FEA/FES 76-2) the large volumes of brine which must be disposed during leaching of 150 million barrels of new storage space render underground injection and use as a chemical feedstock impractical where the candidate storage site is near the coast.

While injection into deep saline aquifers may be technically feasible at some of the sites for which the proposal is offshore diffusion, the uncertaintly regarding reservoir capacity of the receiving aquifers, the extremely high costs, the schedule delays and the low system reliability render the alternative of deep well injection impractical where the alternative of Gulf disposal exists. The alternative of disposing of these large volumes of brine by providing it to industry for use as chemical feedstock is logistically impractical since the requirements for feedstock do not correspond to the DOE brine disposal requirements.

COMMENT e

"From the DEIS review, it appears that the alternative least damaging to freshwater commercial and marine fishery resources and their habitats would be storage at the Vinton and Big Hill salt domes, especially if that enabled all the brine to be disposed by injection wells."

RESPONSE

Brine disposal at Vinton would not appreciably influence fisheries, but ocean disposal of brine from the other sites is not expected to have a significant impact. Vinton is the only site where injection wells are the proposed method of brine disposal.

COMMENT f

"Page 3.2-25, paragraph 2. The FEIS should note that two Louisiana Department of Wildlife and Fisheries marine biologists reported that the decline in shrimp harvests from Sabine Lake since 1968 could be directly attributed to the operational procedures of Toledo Bend Dam. (White, C. J. and W. S. Perret. 1974. Short term effects of the Toledo Bend Project on Sabine Lake, Louisiana. Proc. 27th S. E. Assoc. Game and Fish Comm. pp. 710-721)."

RESPONSE

The conclusions of White and Perret's study with respect to shrimp harvests have been added to the FEIS in the indicated paragraph.

COMMENT g

"Page 4.3-42, paragraph 1. The proposed water intake location in Black Lake is relatively near the mouth of Black Lake Bayou, a migration route for marine organisms to the Lake. The FEIS should discuss whether operation of the structure at the proposed location would result in minimal entrainment of organisms in Black Lake. If not, the FEIS should determine the location which would result in the least amount of entrainment. The FEIS should also include drawings showing water circulation patterns in the Lake under various wind and tidal conditions."

RESPONSE

The proposed water intake system for the West Hackberry storage site has been relocated to the Intracoastal Waterway (ICW). This move was prompted by several factors including the comments received on the DES and the extensive discussions DOE has had with numerous federal and state agencies. Prior to this decision to move the intake, two additional locations in Black Lake and two types of intake structures (open channel and pipeline) were considered. In addition, a bathymetric survey and drogue study (to determine surface currents) were performed for a section of Black Lake. The decision to move the intake to the ICW was prompted more by (1) the consensus of opinion that this location was preferable and (2) a sampling program demonstrating the depauparate nature of the ICW, than by any demonstrable long-term harm potentially produced by a Black Lake intake location. In addition, moving the water intake to the ICW would allow the potential for DOE to use this same intake for the Sulphur Mines site.

COMMENT h

"Page 4.4-2, paragraph 3. The present salinity regime of Black Bayou and Right Prong should be discussed since those salinities would be increased by the withdrawal of leaching water."

RESPONSE

Data collected by the Sabine National Wildlife Refuge and obtained during conversation with members of the refuge staff indicate a mean salinity of about 3.2 ppt for Right Prong. At present, no salinity data have been located for Black Bayou for use in the technical discussion of salinity regimes.

The text has been modified to indicate the 3.2 ppt salinity for Right Prong.

COMMENT i

"Page 4.4-10, Impacts at the Storage Location. The FEIS should discuss measures to reduce wetland impacts resulting from construction of the 10 acre fill for the central plant. These measures include (1) using any previously altered areas for the plant site and (2) using spoil from existing and new disposal areas rater than dredging addi-tional wetlands for fill."

RESPONSE

The central plant location was strategically selected with respect to road and canal access as well as proximity to existing filled areas and storage caverns. There are no suitable previously altered areas which have satisfactory access. Such access would have to be constructed if another area were used. This would increase the size of the area that would be affected.

The land-fill materials used in constructing the central plant would be brought in from outside and would not be obtained from wetlands. Therefore, obtaining the fill would not have an additional effect on wetlands.

COMMENT j

"Page 4.4-12, Displacement/Leaching Water System Impacts. The FEIS should discuss the impacts associated with water withdrawal from the Gulf Intracoastal Waterway (GIWW) instead of Black Bayou. The salinities in Black Bayou and Right Prong would probably not be increased as much, and there would probably be less entrainment of marine organisms since the structure would be further from Sabine Lake."

RESPONSE

As suggested, withdrawal of water from the ICW should reduce any impact from induced salinity increases in Black Bayou and Right Prong. It is also reasonable that fewer organisms may be entrained by withdrawal from the ICW.

Existing information does not indicate that induced salinity increases in Black Bayou or Right Prong due to withdrawal from Black Bayou would cause any disruption of the populations of marine organisms in these water bodies.

COMMENT k

"Page 4.5-7, Brine Disposal System Impacts. The FEIS should discuss the alternative of locating all ten of the proposed injection wells in areas other than tidal marshes. This should eliminate the wetland destruction resulting from the dredging of a 2.2 mile-long access canal with its associated spoil disposal (35 acres). For the presently proposed system, the FEIS should evaluate and compare the impacts of using land-based drilling rigs and constructing board roads for access with the impacts of using barge-mounted drilling rigs and draglines, the latter for excavation."

RESPONSE

Because of the unique environmental setting which wetlands represent, special attention would be given to avoiding locating wells in such areas to the extent this is practicable, within the limitations of program constraints. Furthermore, all reasonalbe mitigative measures will be taken to minimize the effects of any wells constructed in wetlands.

COMMENT l

"Page 4.6-8, Displacement/Leaching Water Systems Impacts. The FEIS should explain why the less environmentally damaging displacement/leaching water pipeline route and brine disposal pipeline route are considered only as alternatives to the proposed routes, not the proposed routes."

RESPONSE

Certain errors on this page may have contributed to a mistaken impression. In the first paragraph, the figure of $68K/acre for beef production losses should be $680 for the total loss of beef production. In the second paragraph the $75,000 figure given as the monetary value of marsh production losses should have been $7,500. Although the temporary productivity losses in marshland would be greater with the proposed leaching/displacement water and the proposed brine disposal pipeline, the total estimated direct monetary losses which would result from construction of the alternative pipelines would be higher than for the proposed pipelines.

The losses mentioned above have been corrected in the text. In addition, statements have been added which compare the total losses which would result with the construction of proposed and alternative pipelines.

COMMENT m

"Page 4.6-15, Brine Disposal System Impacts. The impacts of brine disposal from the Big Hill storage site should be discussed in at least the detail as the West Hackberry site."

RESPONSE

The physical and chemical modeling assumptions and conclusions are nearly the same for the Big Hill storage site as for the West Hackberry site. It would be unduly repetitious to present essentially the same discussion of these considerations for each site.

COMMENT n

"Page 5.0-2, Table 5.2-1. Proposed Site-West Hackberry Expansion Site Construction and Operation. The Draft EIS, in discussing impacts resulting from water withdrawal from Black Lake, indicates that salinities in the Black Lake area should decrease slightly and that the habitats of commercially important species would not be changed irreversibly. Because of the fragile condition of the Black Lake estuarine system, the FEA should develop a contingency plan for water withdrawal that could be put into effect should the withdrawal result in increased salinity in Black Lake rather than a decrease as predicted. In such a plan, water could be withdrawn from the GIWW, west of the Alkali Ditch, which should reduce the amount of entrainment of marine organisms as well as reduce any salinity increase in Black Lake."

RESPONSE

The proposed water intake location has been changed to a point on the ICW west of Alkali Ditch.

COMMENT o

"8.0 Summary of Proposed and Alternative Activities. The FEIS should discuss the various alternatives suggested in these comments."

RESPONSE

Both the proposed and alternative actions are discussed in Appendix A. The discussion on page 8.1-1 has been changed to reference this section.

COMMENT p

Page A.4-27. "Another possible alternative water source that should be considered in the FEIS is the GIWW west of the Alkali Ditch. This alternative would be less damaging to marine fishery resources in that there would probably be less entrainment of marine organisms at a water intake structure in the fresher waters of the GIWW."

RESPONSE

The decision has been made to relocate the proposed water intake facility on the ICW (GIWW).

COMMENT q

Page A.4-29. "The FEIS should consider, as an alternative to the proposed brine disposal pipeline which parallels the Calcasieu Ship Channel, another pipeline alignment also paralleling the Ship Channel which would maximize the use of existing spoil disposal areas and other non-wetland areas. This alignment was suggested by the Environmental Assessment Branch Area Supervisor of NMFS in Galveston, Texas, in an August 19, 1977, response to a request from the New Orleans District, Corps of Engineers' Regulatory Functions Chief, for a preliminary evaluation of the permit application by FEA prior to issuance of the public notice. This alignment would impact much less wetlands and oyster beds than the proposed alignment and would cause much less disturbance to marine life migration than the alignment in Starks Canal."

RESPONSE

While the Corps of Engineers normally allows pipeline construction no closer than 300 feet from active spoil banks, DOE and the Corps have been working closely in an attempt to assure that the alignment of the brine pipeline creates the least possible disturbance of wetlands and oyster beds. The Corps has expressed a willingness to allow alignment of the pipeline in the spoil bank between the Calcasieu Ship Channel and Calcasieu Lake if the design of the line is sufficient to prevent damage resulting from unstable spoil and future spoil deposition. The DOE is therefore giving active consideration to this alignment.

9.4.3 DEPARTMENT OF COMMERCE, MARITIME ADMINISTRATION

COMMENT a

"It is stated that on page 4.2-8 that: Because of the high degree of similarity between lightering and offloading at terminals, the spill frequency for the former was assumed to be the same as for the latter."

"Although there are many similarities between transferring cargo at a dock and ship-to-ship transfers, there are also several major differences. Lightering may be the more accident prone operation because of the at sea mooring vessel exposure to wave and wind action of the sea. This statement also appears in Appendix C (page C.2-21)."

RESPONSE

This assumption is explained on pages C.2-20 and 21. Some assumption, with respect to the possible occurrence of spills, is made necessary because of the paucity of any data and the requirement for reporting spills. Lightering is becoming an increasingly common operation in the oil transport industry and presently over 20 percent of all imported oil arriving at Gulf Coast ports has been transferred from transoceanic carriers (VLCC/ULCC) to smaller tankers which can negotiate the 40 foot channel depth of those ports (U.S. Army Corps of Engineers, 1977). As of the end of 1976, there had been no reported accidents or polluting incidents in connection with lightering operations (U.S. Coast Guard, 1976). Industry statements regarding lightering operations indicate the risk of polluting causing incidents is extremely low. These statements are corroborated by the absence of reports of such incidents in Lloyds List (Lloyds of London, 1969-1977) or the U.S. Coast Guard Commercial Vessel Casualty Data (U.S. Dept. of Transportation, 1977). At the invitation of the companies involved, the Coast Guard does overfly lightering operations in the Gulf of Mexico once or twice a day. Also, a Coast Guard observer may be placed aboard the ship to be lightered. The impressions gained from these activities are that the current lightering operations are well planned and executed. In light of the facts, it is believed that the referenced assumption creates a conservative worst case for analysis purposes.

COMMENT b

"It is stated on page 4.3-14 that: Each tanker prior to receiving oil at the tanker dock would discharge a volume of ballast water amounting to 20 percent of its total capacity."

"An estimate for ballast of 20 percent of vessel deadweight tonnage may not be sufficiently high. A tanker designed without segregated ballast tanks will take sufficient sea water aboard in cargo tanks after discharging cargo to ensure proper propeller immersion and to provide safe handling and sea-keeping characteristics. The amount of ballast taken aboard and the tanks into which it is loaded depend on: (a) the anticipated weather conditions, (b) the distance and route of the ballast voyage, (c) the size, configuration and handling characteristics of the vessels, (d) the ultimate case of disposition of dirty ballast, and (e) the nature of the cargo carried in tanks prior to ballasting. A tanker would normally ballast 35 percent or more of its total deadweight tonnage. Unless some of this ballast is clean or segregated, it is recommended that the estimate for dirty ballast be 40 percent of vessel deadweight tonnage. This statement also appears in Appendix C (page C.3-92)."

RESPONSE

Conversations have been held with (1) the Captain of the Port, U. S. Coast Guard, Port Arthur, Texas; (2) the Saline Pilot Association, Port Arthur, Texas; and (3) the Manager of the Maritime Department, Sun Oil Company Terminal, Nederland, Texas. These local authorities generally agree that a 50,000 DWT tanker, which is considered representative of the size of the U. S. flag tankers to be used in transporting oil from the Nederland terminal, would normally take on salt water ballast ranging from 0 to 20% of the tanker capacity. The 20% figure used in the text represents the upper limit of such a range and thus appears justifiable.

9.4.4 DEPARTMENT OF COMMERCE, NOAA, ROCKVILLE, MARYLAND

COMMENT a

"Appendix D.25 - The MIT Transient Plume Analysis - The modeling approach used to characterize the dispersion of brine into surrounding waters may suffer from assumptive mathematical simplifications. The assumptions of constant depth and vertically constant current would appear to be weaknesses in the MIT model."

The simplification of a vertically homogeneous water column, which includes constant depth, no vertical shear, and no stratification, is essential to make tractable the problem of predicting brine dispersion. For the case of a negatively buoyant plume jetted upwards from the bottom, this simplification is entirely appropriate and is not a significant weakness in the model.

The MIT Transient Plume Model addresses the far field, i.e., the region beyond the point where plumes from individual nozzles have merged and where the rate of vertical collapse (sinking due to density) is offset by the rate of vertical diffusion upwards. In this region, the significant core of the plume, i.e., the region with salinity greater than 0.5 ppt above ambient, is within five feet of the bottom. At the diffuser, the jet will rise 15-20 feet above the nozzle for the given diffuser performance criteria. Thus, depth <u>per se</u> is not a factor for depth greater than 30 feet. Bottom irregularity, such as ridges and troughs, would serve to deflect the far-field plume locally but would not directly affect diffusion; thus, its consideration in the model is inappropriate.

Similarly, vertical shear should not be a significant factor. It's only region of influence would be at the diffuser, and its effect would be trivial in view of the probable vector gradients as compared to the great turbulent energy of the jet and brief residence time of the plume (on the order of seconds) in the upper water column before falling back to the bottom. Thus, vertical shear is sufficiently accounted for in the vertical eddy viscosity term of the model.

<u>COMMENT b</u>

"Appendix G - Oil Spill Risk and Oil Pollution. The present state-of-the-art for oil spill analysis includes models which provide lines of probabilistic impact and probabilistic time to impact in this area. This information, missing in the subject DEIS, would improve the plan for containment and removal of spilled oil."

RESPONSE

Such models require detailed statistics on winds and currents, and have been applied successfully to certain ocean areas. The models could be helpful for the preparation of SPCC and Spill Contigency plans. However, for the purposes of assessing potential environmental impacts in the Gulf Coast area, the methods utilized in Appendix C.2 are adequate and account for the average effects of winds and currents.

9.4.5 ENVIRONMENTAL PROTECTION AGENCY

COMMENT a

"The draft statement indicates that for unloading purposes, displacement water for the salt domes will be withdrawn from Black Bayou, Sabine Lake, Intercoastal Waterway,or Vinton Canal. This procedure will necessitate the construction of a water intake structure in either one of these water supplies. The Final would be strengthened if it included more information addressing the intake structure and design. This information should include working drawings of proposed intake facilities and should address intake flow velocity and the screening design that will be used."

RESPONSE

As stated, a water intake would be required to obtain water from any of the proposed sources. A limit for intake flow velocity (0.5 fps) and the intake locations are indicated in the draft statement. Intake characteristics have been under study with the objective of minimizing biological losses. Additional intake information has been supplied in the final EIS.

COMMENT b

"According to the statement, construction of numerous pipeline systems for both brine disposal or raw water supply could necessitate the utilization of wetland habitat. We would like to point out that the policy of the Environmental Protection Agency, as published in the Federal Register (40 CFR 230, September 5, 1975) requires that particular cognizance and consideration be given any proposal that has potential to damage or destroy wetlands by dredging activity. The applicant should provide, where any dredging operations in wetlands are concerned, substantive evaluation of the proposed project and alternative actions. In conclusion, the selected project action should be the most practicable of all alternatives and provide possible mitigative measures to minimize harm to the wetland environment. In the selection of any right-of-ways, efforts should be made to avoid wetlands. Adequate discussion on this matter should be provided in the Final EIS."

RESPONSE

Wetlands are recognized as sensitive systems in the EIS, and impacts to them have been assessed with as fine a resolution as practicable using present knowledge. Pipeline construction is not expected to result in any substantive long-term deterioration of the wetlands environment.

A number of considerations are included in determining the acceptability and desirability of federal projects. In the present case, the proposed actions are part of the most practical plan for implementing the development of a Strategic Petroleum Reserve since they allow storage of oil in salt domes at a very low relative cost and place a minimal demand on material resources of the nation while at the same time connecting the oil storage locations to water and pipeline oil distribution pathways relatively easily.

COMMENT c

"The proposed Texoma Group Strategic Petroleum Reserve projects involve hydrocarbon storage by emplacement of crude oil into salt domes, solution mining of the salt to create or enlarge existing storage capacity, and, in some cases, disposal of the produced or displaced brines by deep well injection. All these types of operations will be regulated under the Underground Injection Control (UIC) program of the Safe Drinking Water Act (Public Law 93-523), as per Draft regulations, August 31, 1976. Therefore, the data presented in the Draft EIS needs to be strengthened to support an effective evaluation of the environmental impacts of these operations. The applicant should provide sufficient data to EPA from the testing and analysis program, before initiating any of the emplacement, mining, or disposal operations. When the State of Louisiana assumes primary enforcement authority of the Underground Injection Control Program, the data and analyses provided should be consistent both with those requirements proposed in EPA Administrator's Decision Statement #5 (39 CFR:69), or those required under the superceding UIC regulations, when they become applicable, and those required for permit applicaton under Statewide Order 29-B of the Louisiana Department of Conservation, Oil and Gas Division. In addition, close coordination should be afforded EPA and

Louisiana Department of Conservation in all phases of data requirements, collection and presentation. Also, selected technical data should be provided to the public in the form of a "by request" appendix to the Final EIS. We are requesting that the intentions of the applicant to comply with the above recommendations be adequately addressed in the Final EIS."

RESPONSE

If the storage capacity of the West Hackberry site is expanded, SPR will supply all data required in applying for a permit for underground injection of brine. This information will be presented to the Louisiana Department of Conservation at a public hearing, as was done for both the West Hackberry ESR site, and the Bayou Chocktaw site, subsequent to their selection for SPR use. Furthermore, DOE will continue to maintain communications with the Department of Conservation during the development of all SPR facilities.

COMMENT d

"In addressing the ambient air quality standards, Table C. 3-8 on page C. 3-56 of the draft statement discusses standards for the Prevention of Significant Deterioration (PSD) in a Class II area for only Sulfur Dioxide (SO_2) and Total Suspended Particulate (TSP) criteria pollutants. The statement needs to recognize that the Clean Air Act amendment, signed August 7, 1977, has changed past PSD standards by requiring new PSD standards to include all criteria pollutants (i.e., SO_2, TSP, non-methane hydrocarbons (NMHC), nitrious oxides (NO_x), carbon monoxide (CO), and photochemical oxidants (O_3). These standards should be addressed in the Final EIS."

RESPONSE

The text concerning ambient air quality standards, page C3-53, has been changed to explain EPA requirements under the August, 1977, amendment to the Clean Air Act. While as stated, new standards for pollutants not covered formerly would have to be met, the regulations to obtain this end have not been promulgated yet.

COMMENT e

"The draft EIS failed to adequately address the "emission offset" policy. Increased hydrocarbon emissions from fill and withdrawal operations may cause non-methane hydrocarbons and photochemical oxidants to be exceeded for temporary periods within the immediate storage facility areas. Although no long-term adverse impacts on air quality are expected, the "emission offset" policy should be addressed in the final statement."

RESPONSE

An expanded discussion of the "emission offset" policy has been added to the text on page C.3-52. This discussion reflects a prior EPA determination that the offset policy does not apply to SPR facilities due to the temporary and intermittent nature of the emissions. DOE is aware that the EPA policy regarding emission offsets, and its applicability to the SPR program, is currently undergiong review, and that a clarification will be issued in the near future. DOE will take any steps necessary as a result of this clarification.

COMMENT f

"The levels of environmental noise tabulated on page F-15, Volume IV, of the Draft EIS have been labelled as established guidelines from EPA. This phrase established guidelines is incorrect. Rather, this table reflects identified levels which are requisite to protect public health and welfare with an adequate margin of safety for both activity interference and hearing loss. Furthermore, the noise levels cited in this table do not constitute a regulation, specification, or standard. This discrepancy should be corrected in the Final EIS."

RESPONSE

The wording of the sentence on page F-15 with the incorrect phrase has been changed. The new version properly identifies the character of the presented noise levels.

COMMENT g

"No sewage discharges are discussed for any of the Texoma Group sites. If such discharges exist, discharge points, treatment, and possible impacts to receiving streams should be discussed. In addition, National Pollutant Discharge Elimination System (NPDES) permit application for such discharges should be addressed. This subject should be addressed in the Final EIS."

RESPONSE

Sanitary wastes generated during construction at the proposed storage site or along the rights-of-way would be handled through the existing septic system or portable facilities consistent with Occupational Health and Safety Administration and Federal and State pollution control regulations. Wastewater handling procedures during the operational phases of the SPR would be designed to assure that the waste stream would meet all appropriate and applicable Federal, State, and local disposal standards. These procedures would be finalized during the detailed project design. The NPDES permit application would include those discharges which would occur.

COMMENT h

"The draft statement did not adequately address the Spill Prevention Control and Countermeasure (SPCC) Plan. The Final EIS should contain a statement that a SPCC Plan will be prepared within six months after the facilities begin operation and shall be fully implemented no later than one year after operations begin, and will meet the requirements of Code of Federal Regulations 40 CFR 112."

RESPONSE

The requirement to prepare a Spill Prevention, Control, and Countermeasures Plan within six months of the commencement of facility operations is presented on page 9.2-4. Information on implementation of the plan has been added.

COMMENT i

"The displacement water intake located in Black Lake for the West Hackberry site could have a major impact on the extensive crab and shrimp fishery in the Black Lake area. With the projected oil withdrawal rate of 1.47 million barrels per day, the entire volume of Black Lake (8,768 acre-feet) will be pumped into the domes in 46 days, or three entire lake volumes during the five months required to empty the domes. This magnitude of withdrawal could adversely impact the crab and shrimp fishery by destroying the postlarval population in the lake. EPA recommends that the alternate intake location on the Intercoastal Waterway be strongly considered. The applicant's intention on this matter should be included in the Final EIS."

RESPONSE

The proposed intake location has been changed to the ICW.

COMMENT j

"These comments classify your Draft Environmental Impact Statement as ER-2. Specifically, based on the information contained in the draft statement, we have environmental reservations concerning the loss of valuable wetland habitat, the possible long-term cumulative impacts to groundwater aquifers, and the possible adverse impacts to groundwater aquifers, and the possible adverse impacts to the crab and shrimp fishery in the Black Lake area. We are requesting additional information regarding air, noise, waste water treatment, and other areas as addressed in the above comments. 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."

RESPONSE

EPA's comments and requests have been addressed in this final impact statement as presented in the responses to comments above.

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