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Strategic Petroleum Reserve

Supplement to
Final Environmental
Impact Statement for

Bayou Choctaw Salt Dome
FES 76-5

May 1977

Federal Energy Administration
Strategic Petroleum Reserve Office

FEA/S-77/129

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SUMMARY

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

PREPARED BY: The Strategic Petroleum Reserve Office, Federal Energy Administration, Washington, D.C. 20461

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

2. Brief Description of the Proposed Action:

The Federal Energy Administration proposes to implement the Strategic Petroleum Reserve (SPR), Title I, Part B of the Energy Policy and Conservation Act of 1975 (P.L. 94-163) through the development of a 94 million barrel crude oil storage facility at the Bayou Choctaw salt dome. The purpose of the SPR is to mitigate the economic impacts of any future interruptions of petroleum imports. Under the initial phase of the SPR, one hundred fifty million barrels of oil will be stored by 1978. Of the different types of storage facilities, existing solution-mined salt dome cavities are among the most attractive for petroleum storage because of the relative low cost of bulk storage and the extreme geological stability of rock salt masses. The Bayou Choctaw site, a salt dome with existing cavities located in Iberville Parish, Louisiana, has been identified as a candidate site for early storage because it offers the advantage of large storage capacity, easy access to the distribution network, and a relatively short preparation period.

The oil transportation system proposed in the Final EIS (FES 76-5) has been revised to provide direct connection by pipeline to the existing oil distribution system at St. James, Louisiana. This Supplement is concerned with the construction and operation of this revised oil distribution system.

3. Summary of Environmental Impacts and Adverse Environmental Effects:

This site-specific EIS Supplement analyzes the environmental impacts caused by site preparation and operation of the proposed St. James oil distribution system and compares these impacts with those associated with the Addis distribution system considered in the Final EIS. Construction of the pipeline system, tanker dock, and terminal would use wetland habitat directly and degrade water quality by releasing

suspended particulates and toxic substances to surface waters. Marine operations (loading, unloading and transporting crude oil) create the risk of oil spills which have the potential to disrupt fish and shellfish production, destroy non-mobile aquatic organisms and birds, and damage marsh vegetation. Loading and unloading operations would also cause evaporative hydrocarbon concentrations which would temporarily exceed the Federal standards.

Surface water drawdown for oil displacement and injection of brine during cavern fill would not be affected by the proposed facilities.

Beneficial impacts include the economic gains associated with additional employment and income in the Gulf region, as well as protection from economic losses that result from petroleum supply interruptions.

4. Alternatives Considered:

Alternative Terminal Sites
Alternative Transportation Modes
Alternative Pipeline Routes

5. Comments on the Supplement have been requested from the following:

Federal Agencies

Appalachian Regional Commission
Council on Environmental Quality
Department of Agriculture
Department of the Army, U. S. Corps of Engineers
Department of Commerce
Department of Defense
Department of Health, Education, and Welfare
Department of Housing and Urban Development
Department of Interior
Department of Labor
Department of State
Department of Transportation
Department of Treasury
Energy Research and Development Administration
Environmental Protection Agency
Federal Power Commission
Interstate Commerce Commission
Nuclear Regulatory Commission
Tennessee Valley Authority
Water Resources Council

State Agencies

Texas and Louisiana State Clearinghouses
New York State, Office of Environmental Analysis

Regional and Local Agencies

Ascension Parish Police Jury
Assumption Parish Police Jury
Gulf States Marine Fisheries Commission
Iberville Parish Police Jury
Louisiana Offshore Terminal Authority
South Central Planning and Development Commission
St. James Parish Police Jury

Other Organizations

Acadiana Planning and Development District
Allied Chemicals
Allied Chemical Corporation
American Fisheries Society
American Littoral Society
American Petroleum Institute
Baton Rouge Audubon Society
Calcasieu Rod & Gun Club
Canoe & Trail Shop, Inc.
Center for Law and Social Policy
Council on the Environment
Ecology Center of Louisiana, Inc.
Edison Electric Institute
Electric Power Research Institute
Environmental Defense Fund, Inc.
Environmental Policy Center
Environmental Resources and Energy Group
Florida Audubon Society
Friends of the Earth
Funds for Animals, Inc.
Gulf States Marine Fisheries Commission
Institute of Gas Technology
Interstate Natural Gas Association
Izaak Walton League of America
League of Women Voters
LOOP, Inc.
Louisiana Offshore Terminal Authority
Louisiana Power and Light
Louisiana Wildlife Federation
Louisiana Department of Justice
National Association of Counties
National Audubon Society

National League of Cities
National Parks and Conservation Association
National Resource Defense Council, Inc.
National Science Foundation
National Wildlife Federation
New Orleans Audubon Society
RESTORE, Inc.
Seadock, Inc.
Sierra Club-Delta Chapter
Sierra Club-Gulf Coastal Regional Conservation Committee
Sierra Club-New Orleans Group
Sierra Club-Southern Plains Regional Conservation Committee
The Courier
The States - Item
The Times - Picayune
U. S. Conference of Mayors
U. S. Louisiana Department of Justice

6. <u>Date Made available to CEQ and the Public</u>:

The Final Environmental Impact Statement was made available to the Council on Environmental Quality and to the Public December 17, 1976.

This supplement was made available to the Council on Environmental Quality and the public in May 1977.

SECTION 1.0

DESCRIPTION OF PROJECT

1.1 BACKGROUND

This document is a Supplement to a site specific Final Environmental Impact Statement (FES) prepared for the proposed storage of crude oil at the Bayou Choctaw salt dome (FES 76-5). This salt dome is located in Iberville Parish, Louisiana. This project is part of the Strategic Petroleum Reserve (SPR) program currently being planned by the Federal Energy Administration (FEA). Creation of the SPR was mandated by Congress in Title I, Part B of the Energy Policy and Conservation Act of 1975, P.L. 94-163 (the Act) for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any future oil supply interruption. The Act requires that within seven years the SPR contain a reserve equal to the volume of crude oil imports during the three consecutive highest import months in the 24 months preceding December 22, 1975 (approximately 500 million barrels). The Act further requires the creation of a 150 million barrel reserve within three years of December 22, 1975 as the initial phase of the SPR to provide early protection from near-term disruptions in the supply of petroleum products.

The Bayou Choctaw Final Environmental Impact Statement (FES 76-5), which addresses the effects of developing 94 million barrels of existing storage capacity for the initial phase of the SPR program, was filed with the Council on Environmental Quality and made available to the public on December 17, 1976. This statement considers environmental effects which could result from the full range of activities required to develop and utilize storage capacity at Bayou Choctaw. These effects included construction of surface facilities such as pipelines, surge tanks, and tanker docks; transport of oil to and from storage; drawdown of surface water for oil displacement; and deep well injection of saturated brine during cavern filling.

Subsequent to the filing of the Bayou Choctaw EIS, it has been determined that a more desirable location for the Mississippi River tanker facility would be the location of this facility adjacent to the existing Capline Terminal at St. James, rather than the previously proposed site which was located southwest of Addis, Louisiana (Figure 1.1). There are several advantages to relocating the tanker facility at the St. James location. One important advantage is the flexibility gained in the oil distribution system which would be provided by direct connection of the Bayou Choctaw oil storage site to the 40-inch Capline crude oil pipeline. This pipeline delivers oil to refineries located in the Midwest. If the tanker facility were located at Addis, oil must first be transported by barge or tanker down the Mississippi before the oil could be injected into Capline for distribution in the system during an oil supply interruption. With the tanker facility and pipeline terminals at St. James, oil could be injected directly into the Capline. Furthermore, if the LOOP project is constructed, oil could be offloaded from very large crude carriers (VLCCs) in the Gulf and delivered to Bayou Choctaw entirely by pipeline.

Additional advantages are: (1) only one tanker dock would be constructed at St. James in lieu of two at Addis. This is possible since during withdrawal oil could be supplied directly to Capline pipeline. In addition, during an oil supply interruption existing Capline docks would be free for offloading oil to tankers; (2) a smaller terminal is required since St. James tankage could be partially used during withdrawal; and (3) a significantly larger amount of oil during the initial fill would be moved via tanker and pipeline in lieu of barges to Bull Bay.

In addition, a significant disadvantage to the Addis terminal location is the increased potential danger of collisions between oil-laden barges or tankers and other river traffic. Vessels proceeding south from Baton Rouge and other ports to the north must negotiate a sharp bend in the river toward the east at Addis (Figure 1.1). Many vessels, particularly multiple barge tows, pass very close to the west bank of the river which could create a dangerous traffic pattern with potential for collision with SPR oil tankers and/or tanker docks.

The purpose of the Supplement is to consider the incremental effects on the environment which would result from constructing terminal facilities at St. James together with the pipeline which would connect St. James to the Bayou Choctaw storage site. The principal differences between the originally proposed and the revised oil distribution systems are: (1) a longer crude oil pipeline (39 miles versus 5 miles), (2) relocation of terminal construction activities, (3) greater use of pipelines for oil transportation, and (4) construction of one less tanker dock and a smaller tanker terminal.

In order to retain the perspective of impacts associated with development of the entire project, summaries of other project impacts are provided in this Supplement. Liberal reference is made to FES 76-5 for detailed information on the environment and for analysis methodologies. For ease in cross-referencing this material the format and contents of the major sections and subsections in this Supplement parallel those described in FES 76-5.

In addition to the Bayou Choctaw salt dome, four other alternative candidate sites are able to provide early storage capacity to supply the Gulf Coast, East Coast, and Caribbean oil market areas. These salt domes are located at West Hackberry, Cameron Parish, Louisiana (FES 76-4), Bryan Mound, Brazoria County, Texas (FES 76-6), Cote Blanche Island, St. Mary Parish, Louisiana (FES 76/77-7), and Weeks Island, Iberia Parish, Louisiana (FES 76/77-8).

1.2 PROPOSED FACILITIES

The proposed development of storage capacity at Bayou Choctaw consists of the following facilities (Figure 1.2): conversion of existing brine and product storage capacity to bulk crude storage; construction of associated surface facilities, a pipeline to the Mississippi River, and a new permanent tanker dock on the Mississippi; oil supply and withdrawal via existing barge docks at Bull Bay, the Mississippi River terminal facilities, and connecting pipelines.

Operation of the storage facility would require that oil would be pumped into the caverns to displace brine to the surface; a maximum of 28 deep subsurface injection wells located on the southern flank of the dome would be used to pump the waste brine into deep saline aquifers. To withdraw the stored oil, fresh surface water would be taken from the onsite lake (which is connected to the Intracoastal Waterway (ICW) via adjacent canals and bayous) and injected into the storage cavities. Oil would be displaced from the caverns at a pressure sufficient to provide positive suction to the oil injection pumps which would serve dual purpose as pipeline pumps during withdrawal. For further details on the proposed storage concepts and systems, refer to Section 1.2 of FES 76-5.

1.3 SITE DEVELOPMENT AND CONSTRUCTION

A description of the proposed new oil distribution facilities to be used for cavern fill and withdrawal, which are the subject of this Supplement to the Bayou Choctaw EIS, is provided in this section. A general description of facilities required to provide storage capacity at Bayou Choctaw is given in Section 1.2. Detailed descriptions of complete site development and construction plans are provided in FES 76-5 (Section 1.3).

1.3.1 Physical Facilities

The proposed revision to planned oil distribution facilities at Bayou Choctaw consists of a new tanker dock and terminal facility adjacent to the Capline Terminal at St. James, a 39-mile 36-inch pipeline between St. James and Bayou Choctaw, and a small oil surge tank at Bayou Choctaw. The facilities would replace two similar tanker docks and a larger terminal near Addis, a 5-mile long, twin 30-inch pipeline (oil and ballast water) between Bayou Choctaw and the Addis terminal, and expansion of barge dock facilities at Bull Bay.

1.3.1.1 Storage Site Layout

Oil would be displaced from the storage caverns into the 39-mile pipeline to St. James by raw water taken from a 12-acre lake on the Bayou Choctaw site. No separate mainline pumps are needed to move the oil to St. James since the oil injection pumps would be used in this dual purpose. However, there would be an additional 20,000 barrel oil surge tank and 2-125 HP lift pumps at the site. The tank would be enclosed in a diked area of less than one acre as a standard method of compliance with SPCC regulations.*

1.3.1.2 Pipeline System

A 36-inch diameter, 38-mile long reversible pipeline would be constructed between Bayou Choctaw salt dome and the Capline Terminal at St. James (St. James Terminal) for oil fill and withdrawal (no intermediate pump stations would be required). The pipeline would in general parallel the Mississippi River levee (west bank), passing within 0.5

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*Spill prevention Control and Countermeasure Plan as called for in 40 CFR 112.7.

miles of the towns of Plaquemine, White Castle, Annadale, and Freetown (Figure 1.3). Approximately 26.8 miles of the pipeline right-of-way (ROW) would pass through agricultural land (primarily sugar cane); 10.2 miles of ROW would pass through fresh water swamp lands; and 0.8 miles would pass through urban (residential) lands. More than 95 percent of the ROW would parallel existing pipeline rights-of-way (generally within 0.25 miles). In addition, a 1-mile pipeline would be constructed through agricultural land between the St. James Terminal site (Section 1.3.1.3) and the tanker dock on the Mississippi River. Thus, total length of pipeline installation would be about 39 miles. Pipeline installation would meet all applicable Department of Transportation standards.

The oil pipeline from Bayou Choctaw to St. James Terminal would replace the originally proposed 5-mile pipeline connecting the storage site to a tanker terminal near Addis on the Mississippi River (Figure 1.2). This 5-mile pipeline ROW would cross about 2.5 miles of agricultural land (sugar cane) and 2.5 miles of swamp forest (75 percent of the swamp crossing would parallel an existing ROW). Thus, the revised pipeline route to St. James would cross an additional 7.7 miles of swamp forest, 25.5 miles of agricultural land, and 0.8 miles of urban land.

1.3.1.3 St. James Terminal

New facilities which would be constructed at St. James Terminal include a tanker dock and a small tank farm facility needed to handle the oil to be used for SPR storage and distribution (Figure 1.4). The tanker dock would provide mooring for one tanker and would require dredging of an estimated 30,000 cubic yards of material. About 10,000 cubic yards of this total would be removed from the river bed and deposited in the river channel at water depths of more than 50 feet. Material excavated from above the waterline would be hauled from the site and deposited in non-wetland areas above the mean high water elevation. (This material may be suitable for use in constructing dike enclosures at the terminal.) Other facilities associated with the tanker dock would include dolphins, a pipe bridge, and walkways.

SPR oil handling and metering facilities would be constructed by FEA or by private industry within a 30-acre terminal site located either just south of the existing Capline tank farm or on Koch Oil Company property just north of Capline (Figure 1.4). Contained within the terminal site would be two 400,000 barrel floating roof oil surge tanks, mainline pumps (650 HP), tanker loading pumps, flow meters, and a meter prover.

Electric utility power would be the prime source of energy for the terminal. A 10,000 KVA transformer and substation would be required. A powerhouse building containing all terminal motor starting switchgear and control equipment would be located at the terminal. The tanker loading/unloading control equipment would be housed in a control building adjacent to the substation.

The oil surge tankage would be contained within adequately sized containment dikes as a standard method of compliance with SPCC regulations. The tanks would conform to American Petroleum Institute (API) and American Society of Mechanical Engineers (ASME) construction codes and be protected by adequate fire prevention and control systems.

The proposed SPR facilities would be manifolded to connect with the existing St. James Terminal facilities, thus allowing oil to be supplied to existing tankage at St. James for transfer to Capline pipeline or for offloading across St. James docks during the critical cavern withdrawal phase of the program.

The proposed tanker terminal at St. James would replace a somewhat larger terminal which was proposed near Addis (FES 76-5). The Addis terminal would have included six 200,000 barrel oil surge tanks and docks sufficient to provide mooring for two tankers. The total area developed at Addis would have been approximately 40 acres. In addition, an estimated 1.5 million cubic yards of material would have been dredged for the docks and the spoil deposited in the Mississippi River channel.

The St. James Terminal site as proposed in this Supplement would avoid the need to expand existing barge dock capabilities at Bull Bay which would have included construction of an additional barge slip (3 acres), a diked terminal containing three 150,000 barrel oil surge tanks (6.5 acres), and disposal of an estimated 86,000 cubic yards of excavated spoil.

1.3.2 Land Requirements

Acreage required for construction of the oil distribution system to St. James area would be as follows. The 20,000 barrel oil surge tank and lift pumps would be contained within an area of less than 1 acre at the Bayou Choctaw storage site. The 39-mile oil pipeline to the tanker dock at St. James would require a 75-foot construction ROW, or approximately 355 acres of land. Expanded facilities at St. James Terminal would occupy 30 acres.

In total, an estimated 386 acres of land would be needed for the revised Bayou Choctaw oil distribution system. Similar facilities needed for distribution of oil through the Addis proposal would require approximately 125 acres.

1.3.3 Road Construction and Other Grading

Most of the excavation and earth movement would be associated with construction of the 39-mile oil pipeline and the 30-acre terminal at St. James. Minor excavation and grading would be required to construct the oil surge tank at Bayou Choctaw and a 0.8-mile access road south of the terminal at St. James. The pipeline described in this Supplement follows existing rights-of-way for almost its entire length; therefore, no new access roads should be required.

Pipeline installation through the swamp forest and agricultural land is estimated to require approximately 5640 cubic yards of soil excavation per mile. This estimate is based on a trench width of 48-54 inches and a minimum of 3 feet of cover over the pipe. Thus a total of approximately 220,000 cubic yards would be excavated along the entire proposed route. The containment dikes that surround the oil surge tanks at St. James would require roughly 54,000 cubic yards of earth movement.

The terminal facilities originally proposed at Addis would be somewhat larger than those proposed at St. James, therefore a greater volume of earth movement would be required for the containment dikes at Addis, estimated at about 83,000 cubic yards. Expansion of dock facilities at Bull Bay would require dredging of an additional 86,000 cubic yards of earth. However, pipeline installation for the Addis proposal would involve excavation of only about 28,000 cubic yards of earth. No new access roads would be required for the Addis oil distribution system.

1.3.4 Pipeline Construction Techniques

Two basic methods of construction may be used during installation of the oil distribution pipeline: (1) push ditch method, and (2) conventional dry land method. A third method, using flotation canals, is required in marsh terrain which cannot support heavy construction equipment, but this type of terrain would not be encountered along the proposed St. James ROW. Descriptions of construction techniques are provided in FES 76-5 (Section 1.4). It is estimated that approximately 29 miles of the proposed pipeline to St. James would be constructed using conventional dry land methods; 10 miles would utilize the push-ditch technique.

It is expected that the St. James pipeline would be hydrostatically tested in approximately 15-mile segments. Backfilling would proceed continuously, however. Immediately after construction is completed in a given area, work would begin to restore the area to a stable condition as close as practicable to its original, pre-construction condition. The length of time between excavation and backfilling would normally be about six to seven days. Approximately three miles of trench would be open at any given time. Hydrostatic pressure tests would be made on segments between block valves after backfilling. The amount of work required for restoration would vary with the terrain and the amount of disturbance. All disturbed land would be reseeded with native vegetation immediately after backfilling to promote growth of ground cover. Topsoil would be replaced in agricultural land to promote growth of crops. Where major streams or channels are crossed in wetland areas, bulkheads would be constructed across the pipeline ditch at either bank to prevent erosion and flow diversion.

1.3.5 Development Timetable

The planned timetable for development of existing capacity at Bayou Choctaw is given in Table 1.1. Oil deliveries would begin via barges at the existing Bull Bay terminal on July 1, 1977. Construction of the new oil pipeline and terminal facilities would begin on September 1, 1977 and would be completed by April 1, 1978. Tanker dock construction would occur during the months of October 1977 through June 1978. On April 1, 1978 oil deliveries would begin by tanker, utilizing the Koch Oil Company dock presently under construction north of Capline, at a maximum rate of 240,000 BPD. Upon completion of the new FEA dock south of Capline, oil fill operations would occur via the facilities of the Koch Oil Company dock as required to maintain the rate of 240,000 BPD. The remainder of the oil deliveries would be made through the new tanker terminal and pipeline, allowing time for development of new caverns to replace existing product storage capacity which is to be displaced by the SPR program.

According to the schedule (Table 1.1), approximately 74 million barrels of oil could be in storage by December 22, 1978 (at maximum delivery rates). The remaining 19.5 million barrels cannot be placed in storage until suitable storage caverns are developed for product storage at the dome. This delay is not affected by choice of oil distribution system.

Development of Bayou Choctaw facilities as described in FES 76-5 involves expansion of the Bull Bay barge facilities as well as construction of the oil pipeline and tanker terminal at Addis. The Bull Bay expansion would be required to provide greater transport capacity during withdrawal. More oil would be delivered via inland waterway barges during initial fill (75 million barrels compared to 7.2 million barres) with this development scheme than with the St. James terminal alternative.

1.3.6 Construction Cost

Preliminary engineering feasibility estimates for constructing the alternative oil distribution system to St. James indicate that the facility would cost approximately 20 percent less than the alternative of constructing the Addis-Bull Bay Terminal facilities and pipeline as originally proposed.

1.4 OPERATION AND MAINTENANCE

1.4.1 Operating Procedures

1.4.1.1 Storage Phase

One goal of the SPR program is to complete the first 150 million barrels of oil storage within three years from December 22, 1975 while the facilities for the remainder of the Strategic Petroleum Reserve are under construction. Development of existing storage capacity at Bayou Choctaw is presently planned for completion 44 months after construction begins; however, the majority of the facilities would be completed in 12 months except two caverns which currently store product. Approximately 74 million barrels of oil could be in storage by December 1978 (see Table 1.1). There is expected to be an interim period after the initial fill until the need arises for emergency distribution of the stored oil. During this interim period and during standby storage following future oil fills, the only activities required at the site would be security and maintenance activities (see Section 1.4, FES 76-5).

1.4.1.2 Extraction Phase

The SPR program calls for an emergency delivery of stored oil over a 5-month period (150 days). This plan requires delivery rates of 627,000 BPD for the 94 million barrel Bayou Choctaw facility.

The new St. James pipeline/terminal would be the primary distribution point for the Bayou Choctaw facility. The Koch Oil Company dock or other existing tanker docks may be used, if necessary, in addition to the new FEA dock. During emergency withdrawal, as much as 50,000 BPD may be transported by barge across the Bull Bay docks and up the ICW to Baton Rouge refineries. The remainder would be pumped to St. James for distribution up the Capline to midwest refineries or by tanker to New Orleans, the Caribbean, or East Coast refineries.

1.4.1.3 Refill Phase

After an oil supply interruption has ended, and provided that supplies are stabilized and new imports are sufficient for developing additional storage reserves, refill of the Bayou Choctaw storage facility is planned. The rate of fill would depend on the availability of surplus imports.

Refill would occur at a maximum rate of 240,000 BPD via the St. James tanker terminal (1.07 year refill period). Under conditions of business-as-usual, it is assumed that the tanker size most likely available would be 45,000 dead weight tons (DWT). Five fill and withdrawal cycles are planned for the SPR system over a time period ending approximately in the year 2000.

1.4.1.4 Comparison of Operation Procedures

Use of the alternative oil distribution system at St. James Terminal would produce several changes in the operating procedures compared to the original Addis proposal, primarily involving the movement of oil. Pipeline transportation of oil in the St. James alternative between Bayou Choctaw and St. James would substantially replace tanker or barge transport on the Mississippi River between Addis (river mile 222) and St. James (river mile 160). Except for initial fill, oil movement rates and destination for both alternatives would be the same. However, since the Capline pipeline could be supplied directly by the new St. James pipeline, there would be a significant reduction in the tanker movements during withdrawal. There would also be a significant reduction in the amount of oil transported by barge using the Bull Bay docks with the St. James alternative, especially during the initial fill.

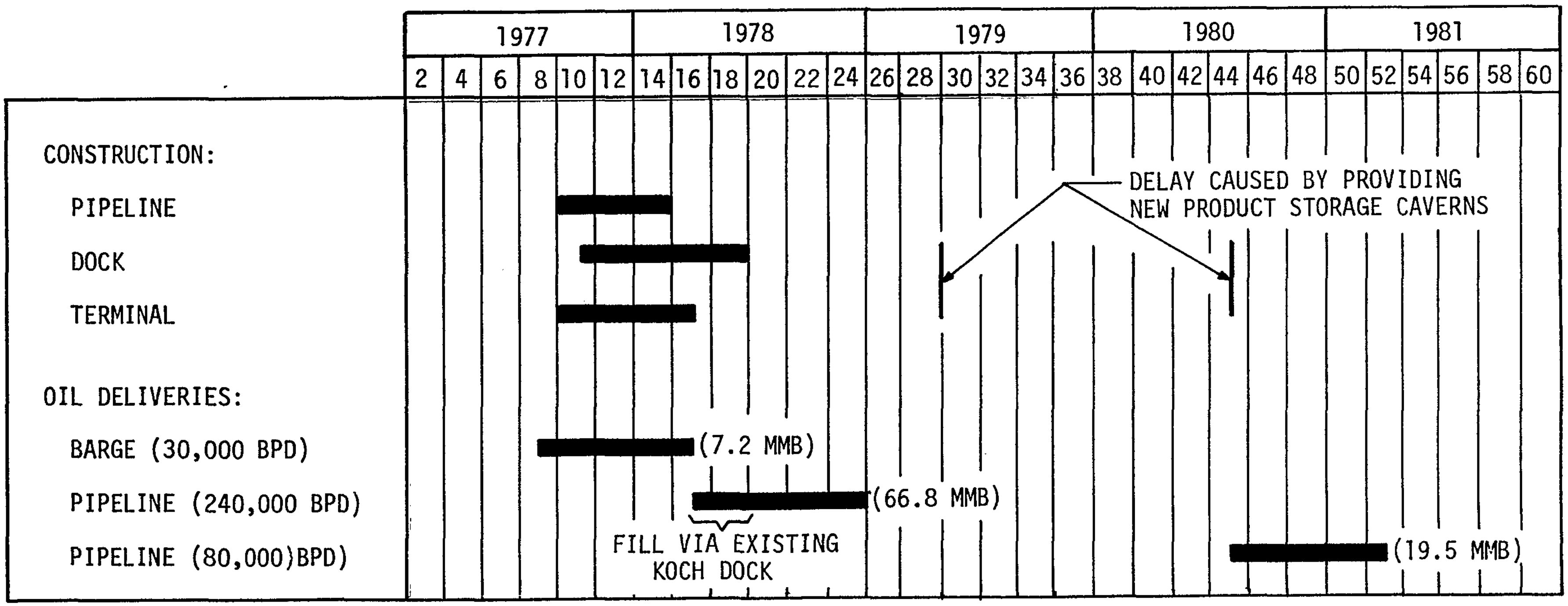
1.4.2 Safety Procedures

A description of normal safety and engineering practices applicable to the proposed oil handling facilities is provided in FES 76-5.

1.5 TERMINATION AND ABANDONMENT

Facilities constructed as part of the St. James oil distribution system alternative include the 20,000-barrel oil surge tank at the storage site, a 39-mile pipeline to St. James, a 30-acre oil terminal adjacent to the existing St. James Terminal, and a new tanker dock on the Mississippi River. Depending on the date of project termination, these facilities, or major subsystems and components, may have up to 10 or more years of useful life remaining. If needed for movement of oil, arrangements could be made for full utilization as appropriate. If no longer considered useful, all aboveground facilities would be dismantled and disposed of properly. Below-ground pipelines would be flushed with water, capped, and left in place, unless they present a hazard or obstruction to other intended land uses.

TABLE 1.1 Development Schedule, Bayou Choctaw Oil Distribution System to St. James



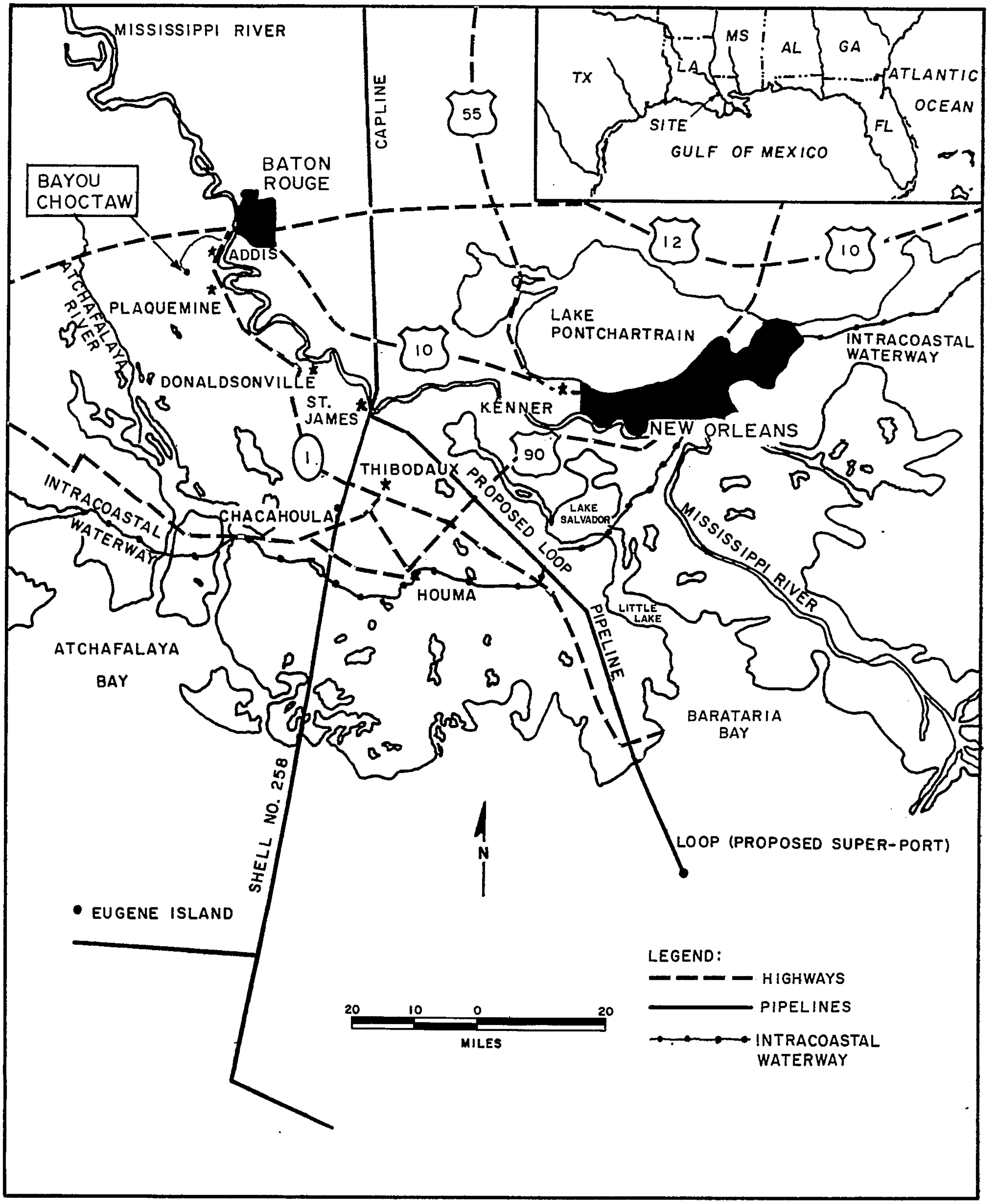


Figure 1.1 Bayou Choctaw Location Map

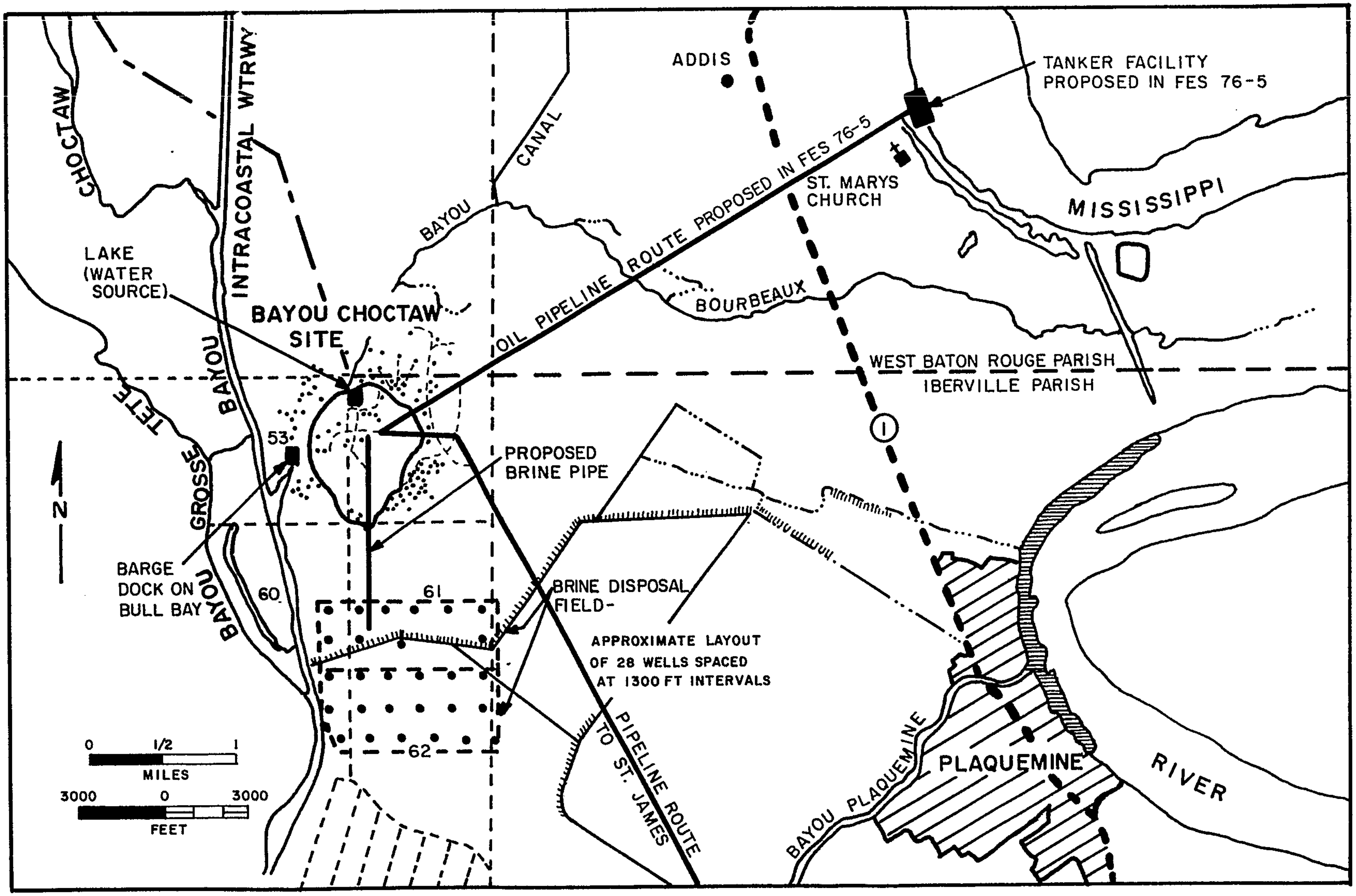


Figure 1.2 General Facilities (proposed)

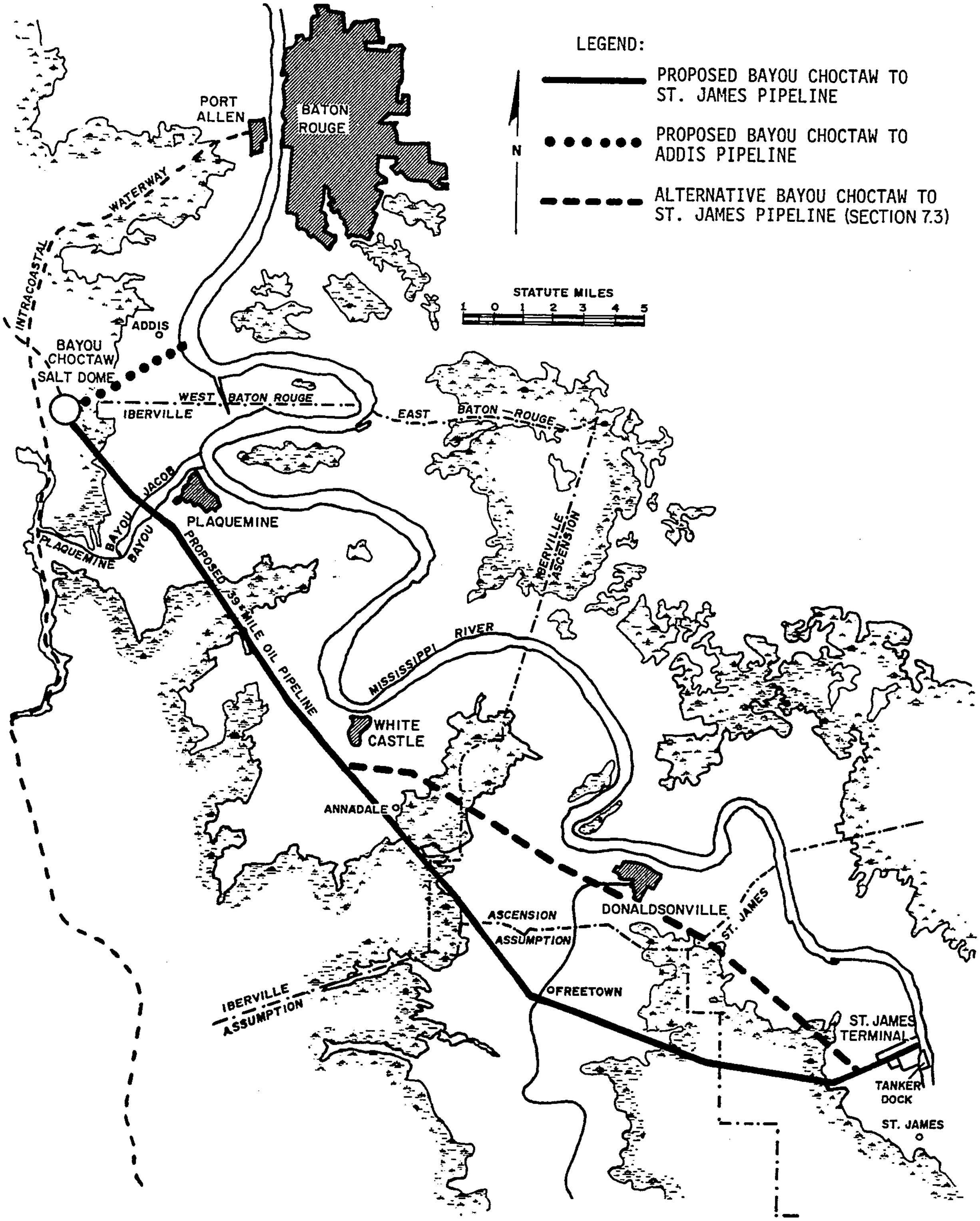


Figure 1.3 Bayou Choctaw - St. James Pipeline Route

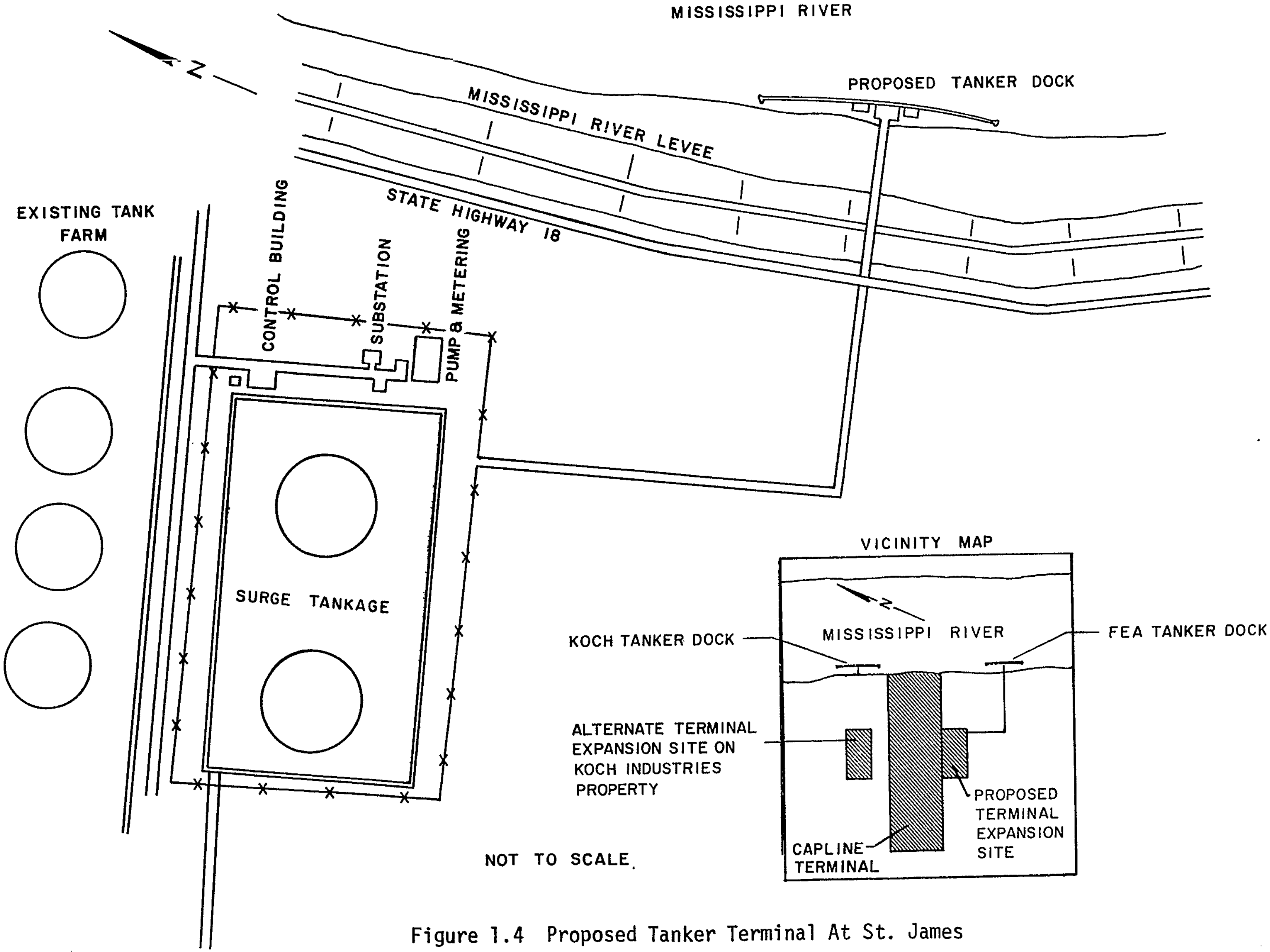


Figure 1.4 Proposed Tanker Terminal At St. James

SECTION 2.0

DESCRIPTION OF THE ENVIRONMENT

The construction of the major facilities in the proposed alternative oil distribution system (i.e., the 39-mile pipeline right-of-way (ROW) and the terminal and dock facilities) between Bayou Choctaw and St. James would affect principally the croplands and swamp forest which are the main environmental features located along the ROW. This section describes the environs along the proposed new pipeline ROW and at the St. James Terminal. The regional features and the area around the Bayou Choctaw salt dome are also summarily described. Detailed information describing the Bayou Choctaw salt dome environment is contained in Section 2 of the previously published Bayou Choctaw EIS (FES 76-5).

2.1 LAND FEATURES AND USES

2.1.1 Physiography and Geology

The Bayou Choctaw salt dome is one of nearly 450 salt domes in the Gulf Coast region of the United States and Mexico. The Bayou Choctaw dome is located on the eastern margin of the Atchafalaya Basin, just west of the natural levee of the Mississippi River (Figure 1.1). Although the physical presence of many domes along the relatively flat Gulf Coast is evident by their upraised topography at the surface, the only evidence of the Bayou Choctaw dome is the presence of a system of man-made canals and levees and a small lake which was caused by collapse of caprock and sediment over one of the mined salt caverns (this lake is the intended source of raw water for oil displacement). Generally, the surface area over the dome is a swamp which has an elevation of approximately 6 to 7 feet above sea level.

The Bayou Choctaw salt dome lies within the east-west trending Gulf Coast Geosyncline. This geosyncline is characterized by consolidated and unconsolidated sediments which are more than 40,000 feet thick. Near the dome there is more than 9000 feet of unconsolidated to poorly consolidated Miocene and younger sediments which are composed principally of sands and shales. The saturated brine which would be displaced from the caverns by oil during filling of the caverns would be injected into sand beds deep within these Miocene deposits.

Seismic activity within the Gulf Coast region is very low. The National Oceanic and Atmospheric Administration (NOAA) has classified the United States into four zones with differing degrees of expected seismic risk. The Bayou Choctaw project area, including the pipeline ROW and St. James Terminal, lies within the boundary area described as an area of seismic risk Zone 1. Within this zone only minor damage would be expected. Since the mid-1800's only one earthquake has been recorded in the area. This quake occurred on October 19, 1930 and had an epicenter located approximately 4 miles southeast of Donaldsonville (Figure 1.3). The earthquake had a recorded intensity on the modified Mercalli scale of VI*.

Detailed descriptions of the Bayou Choctaw salt dome are given in Section 2.1 of FES 76-5. In general, the dome is circular, shallow, and steep sided. Caprock reaches as close as 237 feet to the surface. Radial faulting (believed to be inactive) occurs in sediments around the dome as a result of salt piercement. Salt occurs at a depth below sea level of from 500 to 1200 feet. The surface area within the 2000 foot salt contour is about 330 acres.

2.1.2 Soil Characteristics

Between Bayou Choctaw and St. James the pipeline ROW will cross several different soil associations. Three of these associations occur over most of the length and are described on the parish Soil Conservation Service maps as follows:

> Commerce-Convent Association - Nearly level loamy soils.
>
> This is an area of nearly level, somewhat poorly drained, alkaline loamy soils on the natural levees of the Mississippi River and its distributaries. These soils are used mostly for cropland, urban and industrial uses. The Commerce soils at the lower elevations make up about 70 percent of the association. They have a dark grayish-brown silt loam or silty clay loam surface and a grayish-brown stratified silt loam and silty clay loam subsoil. The Convent soils at the higher elevations make up about 15 percent of the association. They have a dark grayish-brown silt loam surface and a grayish-brown stratified silt loam, very fine sandy loam subsoil. Vacherie, Tunica and Sharkey soils make up most of the remaining 15 percent of this association.

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*At VI on the Mercalli scale, windows and glassware may be broken, knicknacks may fall off shelves, and furniture is moved or overturned.

Sharkey-Swamp Association - Unprotected clayey soils.

This is an area of level to depressed clayey soils on [and] adjacent to the natural levees of the Mississippi River that occur at low elevations and are frequently flooded. These soils are used mostly for woodland and wildlife habitat. The poorly drained frequently flooded Sharkey soils make up about 75 percent of the association. They have a dark gray clay surface and a gray clay subsoil. The very poorly drained and ponded swamp land, that is almost continually flooded, make up about 15 percent of the association. They generally consist of a thin organic layer over gray clays and mucky clays. Tunica, Vacherie and Commerce soils make up most of the remaining 10 percent of the association.

Sharkey-Tunica Association - Level to nearly level clayey soils.

This is an area of poorly drained level to nearly level alkaline clayey soils in depressions on natural levees and also on broad flats at the base of natural levees of the Mississippi River and its distributaries. These soils are used mostly for cropland and pasture. The Sharkey soils make up about 70 percent of the association. They have a very dark grayish-brown or dark gray clay surface and a gray clay subsoil. The Tunica soils make up about 20 percent of the association. They have a very dark grayish-brown clay surface, a gray clay upper subsoil and a gray silt loam or silty clay loam lower subsoil. Vacherie and Commerce soils make up most of the remaining 10 percent of the association.

The pipeline route crosses nearly equal amounts of all three associations.

In the St. James Parish the soils are similar, but the associations are slightly different (Cockerham and others, 1973).

Convent-Silty alluvial land association - Frequently flooded, loamy soils.

This association consists of loamy soils that formed in sediments recently deposited by the Mississippi River. It occurs as a narrow band on both sides of the river, between the river and the levee. Scouring and deposition caused by frequent flooding have resulted in a gently undulating series of narrow ridges and swales.

Commerce-Sharkey Association - Nearly level, loamy and clayey soils.

This association consists of loamy and clayey soils on the broad, natural levees of the Mississippi River and its distributaries. It occupies a broad band adjacent to the river and extends across the central part of the survey area. The slope is graded from about 20 feet above sea level near the river to about 10 feet near the swamps, and the gradient is less than 1 percent.

Sharkey Association - Clayey soils

This association consists of clayey soils in a broad band between the natural levees and the low back swamps. The soils are level or depressional and are at elevations of 5 to 10 feet above sea level.

Barbary-Sharkey Association - Frequently flooded, clayey soils

> This association consists of frequently flooded to nearly continuously flooded clayey soils. These soils occur in the very broad basins on both sides of the Mississippi River. Elevation ranges from about 1 to 5 feet above sea level.

Along the proposed pipeline route, the Barbary-Sharkey association predominates.

In the dome area the soil associations are of the Sharkey-Tunica and the Sharkey-Swamp associations.

2.1.3 Land Uses

2.1.3.1 Mineral and Fossil Fuel Extraction

Numerous gas and oil fields are located throughout the Atchafalaya Basin. Since discovery of the Bayou Choctaw dome in 1931, the oil fields at Bayou Choctaw have been in continuous production. Another significant oil production area is located along the pipeline ROW in the Burton gas field. This field is located north of the proposed pipeline route in a swamp forest area of St. James Parish.

Brine has been mined from the Bayou Choctaw dome by Allied Chemical since 1934. This solution mining has resulted in development of several large caverns within the salt dome, some of which have subsequently been used for hydrocarbon product storage under lease arrangements with Allied.

2.1.3.2 Agriculture

The Bayou Choctaw salt dome is located entirely within a fresh backwater swamp area to the west of the natural levee of the Mississippi River. No farming activity occurs on the site; however, about one mile to the east of the site and along 28 miles of the proposed pipeline ROW (toward St. James), farming occurs on and adjacent to the natural levees. The primary crops raised on these levees are sugar cane and pasture grass, but in some areas cotton, soybeans, and truck crops are also planted. Where the proposed pipeline will cross natural levee lands, the agricultural development extends in an area up to 8 miles wide. Logging may be periodically undertaken in hardwood forests where mature stands exist, but accurate information on this activity is not readily available. Observations of aerial photographs indicate that logging of the area has not occurred recently.

2.1.3.3 Residential/Industrial Development

Except for the industrial development in the area by Allied Chemical, no other operative developments were identified on the Bayou Choctaw salt dome. Farmhouses and residences occur intermittently throughout the agricultural lands crossed by the pipeline ROW but fewer than a dozen residences are within 1000 feet of the proposed route. None of these houses would be displaced. Most of the residences and urban developments are confined to the region along the natural levees (Figure 1.3).

For purposes of this report, "urban area" is defined as an area where scattered houses are located in greater density than in rural or agricultural areas and where some houses are within 1000 feet of the ROW.

Principal developed areas which would be crossed by the pipeline ROW include the outskirts of Plaquemine along Plaquemine Bayou (perhaps 25 houses within 1000 feet of the pipeline), White Castle (40 houses within 1000 feet), Annadale (30 houses within 1000 feet), and Freetown on Bayou Lafourche (50 houses within 1000 feet). No heavily developed urban areas are crossed by the pipeline. Only 0.8 miles of "urban" (actually scattered residential) lands are crossed by the pipeline.

2.1.3.4 Historic, Recreation, and Wildlife Resources

The recreation and wildlife resources of the Bayou Choctaw area are both numerous and vast. However, most of the land involved in developing the Bayou Choctaw salt dome has already been disturbed; about 95 percent of the pipeline route follows an existing ROW. Only a few designated historical or recreational areas exist in the immediate vicinity of the project and these areas wouldnot be affected by the project. The "Inventory of Basic Environmental Data, South Louisiana" identifies many of these resources (U.S. Army Corps of Engineers, 1973) and their relative proximity to the salt dome.

The only designated recreational and wildlife areas that would be impacted by the project are located many miles downstream of the bayous crossed by the pipeline; these areas would only be affected in the case of accidental oil spill.

2.1.4 Potential Development of the Site and Adjacent Areas

Potential development of the area either in the immediate vicinity or adjacent to the Bayou Choctaw salt dome or in backswamp areas along the pipeline ROW would be restricted to activities involved in mineral or fuel extraction and/or storage, because the physical environment in these areas, such as backwater swamp, places severe constraints on the land use. Recent studies indicating the impacts of swamp and marsh development have shown that in the long run these so-called "land reclamation projects" are for the most part failures (Gagliano, 1973) and the history of the delta region of Louisiana abounds with records of land reclamation failures. The reasons for these failures and the low potential for development results from the undesirable engineering properties of the soils in these flood basin deposits.

The soils in these areas do not provide a stable foundation, therefore the types of structures that can be built in these unstable areas are expensive. After construction, the land surface often subsides below the surrounding water table, making it difficult to maintain drainage. With the reduction of the natural vegetation, erosion is increased and, as a result, canals become clogged. Side wall slumping into canals also increases the cost of maintenance.

It is therefore unlikely that much of this land would be developed for purposes other than those relating to oil, gas, and salt extraction, storage of petroleum products, and scattered timber harvesting.

The agricultural and residential areas along the pipeline ROW would be temporarily disturbed by construction of the proposed project. No permanent structures could be erected on the ROW, but after pipeline installation, normal farming practices could continue; no houses would be removed along the ROW. Disturbance in residential areas would be of very short duration since the work would proceed at a rate of from 1/2 to 1 mile per day.

2.2 WATER ENVIRONMENT

The Bayou Choctaw salt dome and the pipeline route to the north and west of Bayou Lafourche are located in the Terrebonne-Verret Drainage Area of the Mississippi and Atchafalaya River basins. The pipeline route south and east of Bayou Lafourche is located in the Barrataria-Salvador-Des Allemands Drainage Area. Along the levees to the north the land is predominantly dry; flooded swamp forest occurs intermittently in areas to the south and in some of the areas adjacent to levees; near the coast, the area is predominantly a flooded marshland. Surface water in the project area is fresh water with a salinity of less than 0.25 parts per thousand (ppt). The annual rate of precipitation at Bayou Choctaw is about 56 to 60 inches.

2.2.1 Surface Water System

The surface water system in the project area is complex and consists of a network of rivers, bayous, manmade canals and waterways, and small lakes (Figure 2.1). During periods of high water due to floods or storms, there is also considerable sheet flow outside of the well-defined channels. Surface waters which could be affected by construction of the proposed oil distribution system for Bayou Choctaw include: the Mississippi River (oil tanker movements and dock construction), and the bayous and canals crossed by the pipeline ROW (which include Wilbert Canal, Plaquemine Bayou, Bayou Jacob, Bayou Goula, Rocky Canal, Bayou Lafourche, Baker Canal East, Bayou Verret, and St. James Canal). Many small drainage ditches are also crossed; these ditches are located mostly in the agricultural lands.

2.2.1.1 Hydrology

The average flow in the Mississippi River in the vicinity of the project was 925,000 cubic feet per second (cfs) during 1973-74. Over the 98-year period of record the highest recorded flow was 1,473,000 cfs; the minimum flow was 73,700 cfs. The stream cross section at the site is approximately 130,000 square feet and has an average width of 2600 feet and average depth of 50 feet.

No data is available on flow rates for the numerous bayous and canals crossed by the pipeline. Because of the low gradients found in these areas, water flow is typically sluggish and intermittent. Factors controlling water quantity in the bayous include seasonal variations in precipitation, seasonal variations in flow of the Mississippi and Atchafalaya Rivers, and the regulated flow in the Port Allen Canal.

Drainage from the land area crossed by the pipeline is generally to the west, toward the Port Allen Canal; however, the direction of flow varies since the water levels and direction of flow in the major water bodies (including tidal action of the Gulf) control the flow in the smaller streams. Therefore, under certain conditions, backflow will occur up the bayous and canals from the west. The wetlands along the bayous and canals thus function as a giant but shallow reservoir during periods of upland or coastal flooding.

Plaquemine Bayou and Bayou Jacob are two navigable streams which flow parallel to each other to the southwest from the Mississippi River at Plaquemine toward the Port Allen Canal. However, neither of these bayous is currently maintained for commercial navigation and traffic at the point of pipeline crossing. Bayou Jacob is heavily forested with a very narrow open water channel. Traffic on Plaquemine Bayou is generally limited to pleasure craft in the vicinity of the ROW crossing; some shell barge traffic utilizes the route from Mile 2 to the ICW.

At the point of pipeline crossing, Plaquemine Bayou is approximately 200 feet wide with a well defined channel; Bayou Jacob is 100 feet wide and heavily forested. The depth of water is less than 4 feet in Plaquemine Bayou and less than two feet in Bayou Jacob. The principal water source for these streams is local runoff since the bayous were cut off from the Mississippi River at Plaquemine in 1961. Water flow data for these bayous are not available.

Another major waterway crossed by the pipeline at Freetown is Bayou Lafourche. This crossing is approximately five miles southwest of Donaldsonville. Water is pumped into Bayou Lafourche from the Mississippi River at Donaldsonville and this is the major source of water in the bayou. Average flow during the 18 years prior to 1975 was 254 cfs and is primarily due to pumping. Extreme high flows were recorded in April, 1975 at 600 cfs; no flow has been recorded in the bayou several times since 1959. Approximate channel width at the point of crossing is 150 feet. Bayou Lafourche is an important navigable waterway to the south, serving Thibodaux and other towns in Lafourche Parish, but it is not maintained for commercial traffic above Thibodaux, Louisiana.

2.2.1.2 Water and Sediment Quality

Water use designations and numerical limits for selected water quality parameters have been established by the State of Louisiana for several of the major water bodies in the area (U. S. Corps of Engineers, 1973). The Mississippi River and Bayou Lafourche have been designated for use as domestic water supplies. The Mississippi River, Plaquemine Bayou and the Intracoastal Waterway (Port Allen Canal) are designated as suitable for secondary contact recreation (e.g., fishing and boating) and for the propagation of fish and wildlife. Bayou Lafourche (above Larose) and Bayou Verret are designated as suitable for primary contact recreation (e.g., swimming).

Water and sediment quality data are presented in Section 2.2.1.2 of FES 76-5 for the Mississippi River, Bayou Plaquemine, and the Intracoastal Waterway. Additional data are available for water quality in the Mississippi River at Union, Louisiana, 10 miles above St. James, and in Bayou Lafourche at Larose, more than 60 miles below the pipeline crossing (USGS, 1975). Water quality at these locations conforms to State of Louisiana numerical standards. Concentrations of phenols, diazinon, cyanide, and DDD exceed U. S. Environmental Protection Agency guideline criteria for water supply, but are within the limits recommended for aquatic biota. Most of the industrial and municipal wastes in the area are discharged into the Mississippi River or into wetlands rather than directly into small open water bodies.

Due to extensive use of river water and development along the river banks, concentrations of total Kjehdahl nitrogen, COD and oil and grease approach the upper limit established by EPA guidelines. Sediment data from Bayou Plaquemine show high levels of heavy metals (e.g., 122 mg/kg lead, 80 mg/kg mercury, 153 mg/kg zinc).

2.2.1.3 Elutriate Tests

Sediment in the Mississippi River generally consists of fine sand (100 to 250 micrometers). Standard elutriate tests have been performed on the sediments taken from the Mississippi River in the vicinity of Addis. The data from these tests are presented in FES 76-5. The volume of dredged material expected to be discharged in the Mississippi River from construction of the tanker dock at St. James will be less than 10,000 cubic yards. Results of the elutriate tests for similar types of dredged spoil show that no appreciable oxygen demanding materials, nutrients, or heavy metals are expected to be released from this material.

2.2.1.4 Water Usage

The surface waters of the Mississippi River serve as a water supply for industrial and agricultural activities. Bayou Lafourche as far south as Larose is used as a source for domestic water supply. Most municipal and rural water supplies for the area are taken from the groundwater.

In 1970 in the Baton Rouge area (extending to Donaldsonville), industrial water usage averaged approximately 440 million gallons a day; municipal usage averaged 39 million gallons per day; and rural domestic water use averaged 0.3 million gallons per day (Lower Mississippi Regional Comprehensive Study, 1974). Recent analyses of present and future water requirements for industrial, municipal, rural, and electric power production in the East Baton Rouge area concluded that freshwater in the area was plentiful.

2.2.2 Subsurface Water Systems

Both shallow (up to 1,000 feet deep) and deep (greater than 1,000 feet deep) aquifers are present in the study area. Currently these aquifers serve as a municipal water supply but some groundwater is also used for industrial operations.

2.2.2.1 Shallow Aquifers

The Plaquemine aquifer, the major shallow subsurface aquifer in the Bayou Choctaw salt dome region is comprised of deltaic and alluvial deposits of sand and gravel which are covered by a clay and silt surface layer approximately 100 feet thick. In the vicinity of Bayou Choctaw, fresh water (less than 250 mg chloride/liter) occurs to a maximum depth of 500 feet. Along the pipeline route the depth of the aquifer decreases to less than 300 feet toward St. James (Whiteman, 1972). In Iberville Parish about 2.2 million gallons per day (mgd) are withdrawn from the aquifer for municipal water supply (1.65 mgd for the town of Plaquemine).

The Bayou Choctaw salt dome is located mostly within the Mississippi Alluvial Plain section of the Coastal Plain physiographic province. In the vicinity of the dome, the alluvial plain is approximately 50 miles wide. The dominant feature in this plain is the Mississippi River which directly influences both the quantity and the quality of water in the Plaquemine aquifer. The maximum channel depth of the River ranges from 50 to more than 130 feet below mean sea level. The channel intersects the Plaquemine aquifer (100 feet deep), and is believed to be hydraulically connected to the aquifer. During periods of high water the shallow ground water flows from the river channel to the aquifer and at low river stage from the aquifer toward the river. The physical movement of the water flow is slow (about one foot per day). Approximately one percent of the water in the aquifer is affected by this slow exchange and therefore the aquifer is not depleted during periods of low river levels (Whiteman, 1972).

2.2.2.2. Deep Aquifers

Detailed information on the characteristics of deep aquifers in the Bayou Choctaw environs is provided in FES 76-5. The Miocene deposits are located at depths of from 3000 feet to 9000 feet below MSL in the area proposed for deep well brine injection. Since the structures in the proposed oil distribution system will not affect the deep aquifers, no further data on these aquifers are presented in this Supplement to FES 76-5.

2.3 METEOROLOGICAL CONDITIONS

Regional meteorological and air quality conditions for the vicinity of Bayou Choctaw are presented in Section 2.3 of FES 76-5. No site specific data for Bayou Choctaw or St. James are available, therefore data is described for the nearest monitoring stations, usually Baton Rouge, Louisiana.

2.3.1 Climatic Conditions

The climate of the Bayou Choctaw area is characterized as a humid-subtropical area which is strongly influenced by the offshore marine environment. Seasonal fluctuations in temperature are moderate. In winter the days vary from cool and clear to overcast. In summer the days are generally warm, humid, and affected by afternoon rain showers.

The average annual rainfall is approximately 53 inches at Baton Rouge; peak periods of rainfall occur in winter and summer and the minimum usually occurs in the fall. Annual lake evaporation totals about 48 inches. Winds occur most frequently from northerly, easterly, and southerly directions; annual mean wind speed is 8.3 miles per hour (mph). Extreme winds in excess of 100 mph are usually associated with hurricanes or an infrequent tornado.

Atmospheric stagnation periods are minimal due to the proximity of the Gulf of Mexico and the level terrain. The total number of forecast days of high meteorological potential for air pollution in a 5-year period is approximately 10 days (Holzworth, 1972).

The seasonal inversion* frequency as a percent of total hours is reported to be approximately 35 percent in the winter, 25 percent in the spring, 30 percent in the summer, and 35 percent in the fall. The annual inversion frequency is 30 percent (Hasler, 1961).

2.3.2 Existing Air Quality

In compliance with the Federal Clean Air Act (1970), the State of Louisiana has adopted an Implementation Plan which provides for the implementation, maintenance, and enforcement of the Federal Air Quality

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* A reversal in the normal atmospheric temperature gradient such that temperature increases with altitude (within 300 to 600 feet), results in an atmospheric inversion. Vertical diffusion of ground-level emissions is thereby restricted.

Standards promulgated by the Environmental Protection Agency (EPA) on 25 November 1971 (36 FR 22384). The Louisiana Air Control Law requires any person intending to initiate new construction or modify an existing facility which may increase air contaminants to file the appropriate applications and reports with the Louisiana Air Control Commission (LACC) stating plans, specifications, anticipated emissions and quantities, and plans for the abatement of emissions for the proposed construction or modification. Exemptions to this law apply to certain volatile organics, of which crude oil is included.

Tables 2.1 and 2.2 list the Federal Ambient Air Quality Standards and the Louisiana Ambient Air Quality Standards. Louisiana's primary emphasis has been directed to monitoring air quality and controlling emissions in highly industrialized areas of the State. The monitoring stations nearest to the site are located along the Mississippi River in the highly developed industrial corridor found between Baton Rouge and New Orleans. Because these stations have had many equipment failures, the data are useful only for suspended particulates. For the Baton Rouge and New Orleans stations, ozone concentration data have also been compiled.

The air quality monitoring stations nearest to Bayou Choctaw are located at Addis (2-1/2 miles northeast of the site), Baton Rouge (15 miles northeast of the site), Carville (19 miles southeast of the site), and Donaldsonville (23 miles southeast of the site). Data for these stations are presented in FES 76-5 and in FES 76/77-8. An analysis of these data shows that the late fall and winter are the periods when the highest levels of particulates are encountered. With the exception of Donaldsonville, ambient particulate levels in the area are below the annual standard (75 $\mu g/m^3$).

Neither the EPA nor the State of Louisiana monitor for hydrocarbon concentrations in southern Louisiana. However, these data have been reported as a result of a short-term ambient air quality study performed in Lafourche Parish (Kem-Tech, 1975). In this study air quality was monitored continuously during two weekly periods in September and December in non-urban areas of coastal Louisiana. One of the monitoring sites was located in a fresh marsh area of Lafourche Parish, 45 miles southeast of St. James; the other site was located within five miles of the Gulf of Mexico, 75 miles southeast of St. James. Analysis of the data taken at these stations indicate that the national ambient air quality standard (NAAQS) for non-methane hydrocarbons (160 $\mu g/m^3$ during a 3-hour period) was exceeded 39 percent of the time in September and 16 percent of the time in December. These non-methane concentrations ranged from a maximum of 812 $\mu g/m^3$ to a low of 83 $\mu g/m^3$; average hourly concentrations ranged from a high of 518 $\mu g/m^3$ to a low of 71 $\mu g/m^3$. The report concluded that, although based on limited data, the NAAQS for non-methane hydrocarbons is probably exceeded quite frequently in southern Louisiana. However, these hydrocarbons were generally felt to be of the non-reactive type, and thus not precursors of ozone formation.

Table 2.3 lists the photochemical oxidant levels for 1975 at New Orleans, Baton Rouge, and Lake Charles. These are the three closest stations for which the most recent photochemical oxidant levels were available. The data indicate that all three stations exceeded the state 1 hour standard of 0.08 ppm more than once during 1975, whereas all sites were below the state and national annual standard of 0.03 ppm. In this regard it can be assumed that the background photochemical oxidant levels would generally be lower in rural areas, such as at the proposed oil storage site, because of the lower background levels of hydrocarbons which could react with sunlight and other product emissions to form the photochemical oxidants.

Along the Baton Rouge-New Orleans industrial corridor, pollutant concentrations can typically be expected to be considerably higher than those concentrations measured in areas like Bayou Choctaw. The proposed pipeline route parallels the generally southeasterly direction of the river and is always within 10 miles of the west bank. Therefore, northerly and easterly winds could frequently transport concentrations of pollutants in excess of what would otherwise be characteristic of rural, undeveloped areas. Furthermore, the St. James Terminal is a focal point for extensive crude oil distribution and movement and thus is an important source for hydrocarbon emissions in the region. This aspect is also true to a lesser degree for the oil and gas production and LPG storage at Bayou Choctaw. Thus, it is likely that the area traversed by the proposed oil distribution system is exposed, at least on occasion, to atmospheric pollutant conditions and concentrations nearly equal to the highest measured in southern Louisiana.

Emissions data by parish for various pollutants are summarized in the Louisiana Air Control Commission Implementation Plan. Major parish pollutants are: St. James Parish - SO_x and particulates; East Baton Rouge - SO_x, particulates, and hydrocarbons; Iberville - hydrocarbons; and Ascension - particulates.

The general region of southern Louisiana is considered to have a significant need to reduce SO_2 and hydrocarbon emissions in the near future. Because of excessive levels of photochemical oxidants and particulates, the EPA is requesting the state to prepare a revised control strategy which will likely affect future hydrocarbon emissions. The substance of this strategy is unknown at this time.

2.3.3 Noise

Ambient sound levels at the Bayou Choctaw site and along the proposed pipeline route to St. James are typical of levels expected for a secluded, essentially flat, moderately forested area. The sounds in the area are dominated by the wind in the trees, insects, crickets, birds, and other wildlife. Noise levels measured at undeveloped areas on Weeks Island in the coastal area of Louisiana indicate that day-night weighted sound levels are slightly above 50 decibels (dB) (FES 76/77-8). It is expected that a similar sound level (53 dB) should apply to the undeveloped areas located along the proposed pipeline route between Bayou Choctaw and St. James.

Noise levels near small communities and at highway crossings (based on measurements made at similar land uses near Weeks Island, FES 76/77-8) indicate that daytime and nighttime sound levels would be 58 dB and 39 dB, respectively. Day-night sound levels are estimated at 56 dB.

At the Bayou Choctaw site, the ambient sound levels may occasionally be significantly higher than along other areas of the pipeline route due to ongoing industrial activity. Using ambient measurements made at similar locations, local day-night weighted sound levels may be as high as 70 dB. Ambient sound levels at the St. James Terminal area are mainly contributed by highway traffic, and the day-night weighted sound level is estimated to be 65 dB.

2.4 SPECIES AND ECOSYSTEMS

2.4.1 Natural Environment of the Area

The environmental setting for the proposed oil distribution system encompasses Iberville, Ascension, Assumption, and St. James parishes in southeast Louisiana. The principal physical features of this area are the Mississippi River and its natural levee to the northeast and the Atchafalaya Basin floodplain to the southwest. Except for the levees along the Mississippi and, to a lesser extent, Bayou Lafourche, most of the area is periodically flooded and consists mainly of swampland and small bodies of open water. Away from the levees most forms of land development are possible only after extensive land drainage with varying degrees of cost and success. To the west of Bayou Lafourche, the fresh waters of the area drain towards the Atchafalaya Bay complex and the marshes of Terrebonne Parish; east of Bayou Lafourche, these waters drain through a complex marsh system to Lake Salvador, Little Lake, and Barataria Bay (Figure 1.1).

The natural vegetation within this region is highly influenced by the heavy rainfall and a generally low gradient (relief) which retards drainage. Much of the land that is not excessively inundated (principally on and adjacent to levees) is used for agriculture, primarily sugar cane production.

2.4.1.1 Ecosystems

There are three major ecosystem types in the area: cleared lands, woodlands, and fresh waters. The characteristic flora and fauna of these systems are described in the Inventory of Basic Environmental Data - South Louisiana published by the U. S. Army Corps of Engineers (1973) and in FES 76-5.

Cleared lands in the four parishes amount to about 349,750 acres of the total 975,522 acre land area and consist of crop and pasture land (either on or adjacent to natural levee lands) and urban and suburban lands (principally on the natural levee along the Mississippi River). Because they have been disturbed, cleared lands do not support as diverse a fauna and flora as the nearby wetlands. The levee lands, however, do provide habitat diversity for the region. Predominant crops are sugar cane and soybeans; signal grass and goatweed are the dominant pasture grasses. Blackbirds, sparrows, field birds, cottontail rabbits, skunks, rats, and mice are typical of the wildlife found in these areas.

The most widely occurring vegetation type in the project area is the woodlands, consisting of 593,650 acres and composed primarily of deciduous swamp and bottom land forests. The deciduous swamp consists mainly of an oak-gum-cypress tree community and the bottomland is made up of an elm-ash-cottonwood tree community. The soils in these areas are poorly drained, and consist of fine grained organic matter. Wooded swamps along rivers and streams comprise the bulk of this habitat type. These wooded swamps often occur in association with shrub swamps but these swamps are limited in extent to small areas along the streams and at the heads of embayments or impoundments. Water from 1 to 3 feet deep generally covers the surface area of these swamps. Water-tolerant bald cypress and tupelo gum occupy the perpetually swampy sloughs and the low-lying areas. Other dominant tree species of this vegetation type include sweetgum, eastern cottonwood, overcup oak, water oak, nuttall oak, black willow, sycamore, ash, red maple, box elder, cherrybark oak, hackberry, bitter pecan, and swamp tupelo.

The bottomland forest provides excellent habitat for a variety of terrestrial, avian, and aquatic wildlife. Common species include frogs, poisonous and non-poisonous snakes, small rodents, fur bearing mammals, and a variety of wading birds, hawks, owls, and song birds.

Open water bodies compose a relatively minor portion (17,840 acres) of the four parish area. The predominant bodies of open water within the region are the Mississippi River, the Atchafalaya River, Bayou Choctaw, Bayou Jacob, Bayou Lafourche, and Plaquemine Bayou. In addition, there are numerous small bayous, canals, ponds, and lakes. The heavy vegetation and low land gradients combine to provide excellent habitat for aquatic life in these areas.

Vegetation in the open water bodies includes vascular plants or macrophytes and algae growing within the water column, on macrophytes, and on the bottom. In some cases duckweed or water hyacinth cover the water surface. Aquatic animal life includes zooplankton, benthic invertebrates such as crayfish and shell fish, and fish (common species are catfish, bowfin, freshwater drum, largemouth bass and other sunfish, gar and minnows). Very high fish productivity can be sustained in these waters.

In addition to the abundant aquatic life, several important species of wildlife inhabit the various water bodies, including a variety of waterfowl, nutria, muskrat, mink, and otter, as well as many species of turtles, water snakes, and frogs.

2.4.1.2 Rare or Endangered Species of the Study Area

Wildlife species in the region considered to be rare or endangered include the Southern Bald Eagle, Arctic Peregrine Falcon, and American alligator. The Southern Bald Eagle typically nests in tall trees located near large water bodies. There are no large water bodies located along the pipeline ROW. The alligator occurs throughout the project area. The Peregrine Falcon is most likely to inhabit the coastal marshes of Louisiana rather than inland swamps. No aquatic species listed as rare or endangered by the U. S. Fish and Wildlife Service occur in the project area (U. S. Department of Interior, 1976).

2.4.1.3 Important Commercial Species of the Study Area

Commercially important vegetation utilized in the project area includes agricultural crops and trees harvested for timber. The principal crops are sugar cane, soybeans, and field corn; the principal trees harvested are cottonwood, cypress, willow, oak, ash, and gum (FES 76-5).

Louisiana leads the nation in fur production. The raccoon and mink are the most abundant furbearers found in the swamplands. Other furbearing animals which inhabit the bottomlands include the oppossum, nutria, and bobcat. Muskrats, which reach their highest levels of abundance in the brackish marshes, are also likely inhabitants.

The waters in the Atchafalaya Basin support large populations of crayfish, frogs, and freshwater fish. Commercial harvest of crayfish from the wetlands adjacent to the Mississippi River levee is negligible. However, the freshwater swamps crossed by the pipeline route support large populations which are available for individual harvest. Catfish, buffalo drum, and carp are the important commercial fishery species.

2.4.2 Environmental Setting of the Bayou Choctaw Site

Less than one acre of additional land would be developed at the salt dome as a result of the proposed pipeline to St. James. Therefore, the following section presents only a summary of the storage site description discussed at length in FES 76-5.

Land elevation at the Bayou Choctaw salt dome ranges from 0 to 10 feet above mean sea level. The northern half of the site is relatively dry and has elevations of 5 to 10 feet; the southern half of the site is covered by the woodlands ecosystem (Section 2.4.1.1). A network of canals and bayous on the site connect directly to the Intracoastal Waterway via Choctaw Bayou and Bull Bay. Much of the site area has been cleared, dredged, and filled for industrial development of salt leaching and hydrocarbon storage facilities. A network of improved gravel roads services these developed areas.

The dominant vegetation in the swamp on the site are bald cypress and tupelo gum trees. Wildlife species include deer, swamp rabbit, gray squirrel, wading birds, woodpeckers, ducks, frogs, snakes, raccoon, mink, and alligator. The site also provides a potential nesting habitat for the endangered Southern Bald Eagle though no observations have been recorded.

2.4.3 Environmental Setting of the Pipeline Right-of-Way

The 38-mile pipeline between Bayou Choctaw and St. James Terminal and the 1-mile pipeline between the terminal and the new tanker dock would utilize a total of 355 acres of land, assuming a 75-foot wide construction ROW (Table 2.4). The ROW follows the Mississippi River levee at the northeastern edge of the Terrebonne-Verret Drainage Area, then crosses Bayou Lafourche into the northwestern corner of the Des Allemands-Salvador-Barataria Drainage Area. Nearly 70 percent of the lands crossed by the ROW are already cleared for agriculture or pasture land; 26 percent is swamp forest. Only seven acres of the ROW are within residential areas but most of this land is also open field and pastureland.

Virtually the entire ROW parallels existing pipeline corridors. Sixty percent of the swamp forest crossed occurs along a 6-mile segment between St. James Terminal and Bayou Lafourche. Most of the remainder of the swamplands crossed occur as wetlands very close to the cleared agricultural land. Most of the cleared land is planted in sugar cane and is extensively ditched for drainage.

The pipeline would cross a total of 15 highways (excluding local roads), three railroads, nine large bayous and canals (plus many small streams and ditches), and several existing pipelines.

2.4.4 Environmental Setting of the Dock and Terminal Facilities

The proposed Mississippi River dock and terminal facilities at St. James would utilize about 30 acres of cropland adjacent to the existing Capline tank farm. One potential location is just south of the Capline tank farm, west of the proposed new tanker dock. The other possible location is just north of Capline on Koch Oil Company property. The tanker dock would be located along the west bank of the Mississippi River out to a channel depth of approximately 40 feet.

The Mississippi River near St. James is both wide and deep and has a steep shoreline. The steep banks together with the fluctuating water levels, prevent the establishment of large, permanent aquatic macrophyte beds. The high turbidity levels and shifting sediments in the river also prevent the establishment of a productive benthic algal community. Phytoplankton populations in the river are generally small due to the high turbidity and are replenished from the upstream backwaters usually as displaced periphyton.

The aquatic biological community of the lower Mississippi River, which includes the study area, consists mostly of organisms typically associated with large, sluggish streams. Fishes dominate the fauna of the lower Mississippi River in the study area. Common species found in this part of the river are mostly "rough" or nongame fish such as paddlefish, gizzard shad, buffalo, drum, gar, and carp. Other species found in the area include the skipjack, shovelnose sturgeon, several catfish, and sunfish.

It is doubtful that a true zooplankton community exists in this part of the river. Samples collected in the middle of the Mississippi River indicated that zooplankters were never abundant, and contained only species of zooplankton found in the adjacent backwater bodies of water (Frey, 1966). Rotifers are often the most abundant group in these situations, although some cladocerans, nematodes, and copepods are found.

Benthic invertebrates commonly found in slow moving, turbid streams with silt or mud bottoms such as those in the site area are usually dominated by bloodworms (Chironomidae) and oligochaetes (Tubificidae) which can live in the silty substrate and withstand low dissolved oxygen concentrations. May fly larvae may be found in mud bottoms of lakelike backwater areas. In areas of high siltation, mollusks and many aquatic insect larvae are usually uncommon or completely absent.

2.5 SOCIOECONOMIC CHARACTERISTICS

2.5.1 Population

2.5.1.1 Population Density

Communities that would be affected by construction of the proposed oil distribution system are located in Iberville, Ascension, Assumption, and St. James Parishes. Project operation would also affect East Baton Rouge and West Baton Rouge Parishes to the north. The population densities and the extent of urban and rural development of these parishes is presented in Table 2.5. The area immediately adjacent to the project may be classified as rural. Many of the people live along the highways which connect the towns or at major intersections. The majority of these people do not farm the surrounding land, but commute to jobs in the nearby towns.

Principal population centers and transportation arteries in the project area are shown in Figures 1.1 and 1.3.

2.5.1.2 Towns and Urban Areas

Major towns and their population in the area include: Plaquemine (7,881*); Port Allen (5,867); Donaldsonville (7,478); Gramercy (2,591); Lutcher (3,911); Maringouin (1,365); Napoleonville (1,008); White Castle (2,206). Most of the commercial and retail businesses servicing the area are located in Baton Rouge (pop. 165,964). Figure 1.3 shows the location of some of these centers of population relative to the site and proposed pipeline. Other major urban areas which may provide services and laborers for the project include Thibodaux in Lafourche Parish (pop. 14,992) and Houma in Terrebonne Parish (pop. 30,864). A number of unincorporated communities having a population of less than 1,000 lie along the main highways on both sides of the Mississippi River.

2.5.1.3 Historical Growth and Trends

The proposed project lies within an area that until 20 years ago was economically underdeveloped with the population tending to migrate into the cities. In 1956 Dow Chemical built a plant near Plaquemine,

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* This is the population within the corporate limits, an additional 1,224 people live in unincorporated Plaquemine Southwest. All population figures given in this section are taken from the 1970 census.

which now employs more than 1,000 people. Since 1965, additional industrialization of the area has brought a substantial increase in tax revenues available to the local communities and also stimulated employment opportunities, but this industrialization has not produced a marked increase in the population of Iberville Parish. Many of the workers employed by these industries live in the neighboring West and East Baton Rouge Parishes and Ascension Parish, and therefore commute to their jobs in Iberville.

The area southeast of Baton Rouge experienced substantial growth during the 1960-1970 decade. Rates of population expansion for each of the six parishes during this period were:

Iberville	2.7%
St. James	7.4%
Assumption	9.2%
West Baton Rouge	14.0%
East Baton Rouge	24.0%
Ascension	32.8%

The project area (except for Assumption Parish) lies within the New Orleans-Baton Rouge Corridor (NOBAR). This is one of three growth corridors in southeastern Louisiana. Factors influencing this growth are the proximity to the major industrial and trade centers of New Orleans and Baton Rouge; excellent river, highway, railroad, and air transportation facilities; and existence of developable land along the Mississippi River levees. By 1980, the NOBAR area population is projected to increase 25.4 percent over the 1970 population of 619,000; a 23.1 percent increase is anticipated between 1980 and 1990, which would be substantially more than the growth rate of the state.

2.5.2 Cultural Patterns

The communities which would be affected by the project consist basically of two cultural types. One type is representative of a way of life that has existed in the area for decades, and is based on the aspects of agriculture and local commerce. In these towns families that have been established for generations own substantial portions of the land and exert a conservative influence on community growth and civic affairs. The majority of these citizens are of French heritage. Their ethnic consciousness combined with the stability and small size of the communities tends to accentuate the cultural differences between the residents who have been raised there and the people who have recently moved into the community. This pattern can be found to some extent in many small towns and neighborhoods throughout Southern Louisiana. Thibodaux, Napoleonville, and many of the villages close to the project area are representative of this type of cultural pattern.

The other type of cultural community is similar to the first type, but one in which the community has grown rapidly since about 1950. This expansion has been largely due to the development of the oil and gas industry in the area. A relatively higher proportion of this population has migrated into towns from other states, and these people are generally more inclined to move in and out of different neighborhoods. The transient nature of this group has resulted in a declining ethnic awareness in the community and a greater acceptance of further growth with its concomitant changes in the appearance of the town itself and in the characteristics of social life and civic affairs. The City of Baton Rouge and its nearby suburbs represent this type of community.

2.5.3 Community Services

Near the project area the availability of housing for sale or rent is severely limited especially in the area west of the Mississippi River. Table 2.6 shows the status of housing units in the six parishes near the proposed project. East of the Mississippi River there is a greater availability of housing units in the various communities.

Data on school systems, hospitals and police and fire protection are provided in FES 76-5.

The SPR terminal and tanker facilities at St. James would require a minor increase in security and fire protection services over those provided at the existing Capline Terminal. The principal fire protection services are supplied by onsite Capline personnel and equipment.

The only publicly supported recreation facilities in the project area are several boat ramps with access to the major bayous and the

Mississippi River. Hunting and fishing are major forms of recreation in the six parish area. The bayous, swamps, marshes, open fields, and abundant fish and wildlife populations provide the necessary resources.

2.5.4 Economic Characteristics

2.5.4.1 The Basic Economy of the Area

The principal income-producing industries of the six-parish area are petroleum, manufacturing, construction, shipping, and agriculture. Commercial fishing is a leading activity in the coastal parishes located to the south; lumber is an important product in Iberville Parish.

Manufacturing

The greatest number of jobs in the six-parish area are found in manufacturing (Table 2.7). In the project area chemical plants and the manufacture of goods related to construction activities predominate. Baton Rouge and its suburbs has more than 125 manufacturing plants.

The project area is particularly well suited for manufacturing due to: (1) an abundance of fresh water provided by the Mississippi River; (2) convenient shipping facilities via the port at Baton Rouge and the confluence of four railroad systems; and (3) close proximity to mineral resources that provide raw materials for the production of organic and inorganic chemical compounds.

Shipping

Over the past decade the volume of cargo handled at the Port of Baton Rouge has steadily increased. In 1974 the port handled an estimated 53.5 million tons and about 800 vessels used the public port facilities. A large proportion of this cargo was grain which was transferred by barge from other regions of the country that border the Mississippi River or its tributaries. Baton Rouge is the second largest grain port in Louisiana and has a grain elevator with 7.5 million bushel capacity and a 340 foot grain wharf.

The port also has an 11 million gallon tank terminal for the transfer of liquid products. A large bulk handling terminal provides for the shipping of ores and concentrates. The port's Public Commodity Warehouse offers 75,000 square feet of covered storage area, and an additional 200 acres are available for open storage.

Mineral Production

A number of minerals commercially extracted in the area include salt, sand and gravel, lime, cement, and natural clays. The most important minerals are petroleum, natural gas, and natural gas liquids. This latter industry is particularly important to Iberville Parish where in 1971 the value of its mineral production exceeded $67 million. Values of mineral production in other parishes within the region for 1971 were: Ascension, $46.4 million; Assumption, $29.8 million; East Baton Rouge, $21.6 million; St. James, $11.1 million. Mineral values for West Baton Rouge are unavailable, but they are estimated to be relatively small.

Agriculture and Forestry

The arable land in the project area is limited and is used either as pasture land for grazing cattle or raising a limited variety of cash crops. The major crops in terms of acreage harvested in the area are sugar cane and, to a lesser extent, soybeans and corn.

Lumbering is an important industry in Iberville Parish where there are about 279,300 acres of commercial forest. Several lumber companies and wood product industries are also located in this parish.

2.5.4.2 Employment Distribution

The employment status in the project area is given in FES 76-5. The relatively high rate of unemployment in Iberville Parish (9 percent) may be accounted for by the effects of a seasonal and unsteady job market in some of the plants and also a lack of skills among a sizable proportion of the available labor force. (This situation may improve in the future because of a vocational school being built in Plaquemine.)

Although East Baton Rouge Parish had a low unemployment rate (4.5%), the pool of available workers is larger there. Recent unemployment data is not available.

Leading potential sources of employment are in the categories of manufacturing, construction, retail trade, and services.

The greatest number of workers required for the proposed project construction would be: (1) craftsmen, foremen and kindred; (2) equipment and vehicle operators and kindred; and (3) laborers.

The number and proportion of workers who commute out of their home parishes to their jobs is high (see FES 76-5). For example, 59 percent of workers living in West Baton Rouge Parish work outside the parish. Comparable percentages listed for Iberville, East Baton Rouge, and Ascension are 39 percent, 21 percent, and 37 percent, respectively. This generally indicates a widespread pattern of cross-commuting, reflecting the concentration of jobs in the City of Baton Rouge, the growth of manufacturing plants along the Mississippi north and south of that city, and developing areas in Iberville and Ascension Parishes.

2.5.4.3 Income Distribution Patterns

The 1969 median family income in Iberville and Assumption parishes was lower than the other four parishes, well below the national and state medians (Table 2.8). The highest incomes in the six-parish area were in the East Baton Rouge and St. James parishes, both of which exceeded that of the state as a whole. The pattern of distribution of families below "low income," or poverty, level is consistent with the pattern of median income level. A large part of the indigenous population derives its income from public assistance programs. Higher paying jobs in Iberville Parish are generally filled by more highly skilled people living outside the parish. The slow rate of housing development has hindered inmigration of workers and their families.

2.6 UNIQUE FEATURES

2.6.1 Archaeological and Historical Sites

The Mississippi delta was an attractive habitat for primitive man due to the abundance of resources in the delta available to sustain aboriginal economies. Thus, archaeological sites are numerous throughout the delta. The locations of these known sites are prescribed in FES 76-5 and in the Inventory of Basic Environmental Data, South Louisiana (Corps of Engineers, 1973). No known archaeological sites are located either on the Bayou Choctaw salt dome or within the pipeline ROW or at the St. James Terminal site.

Historic sites, particularly of state interest, are abundant in the many towns and communities located along the natural river levees. The locations of these sites are also provided in the references sited above. No known sites of historic interest would be affected by the proposed project.

2.6.2 Parks, Wildlife Refuges and Scenic Areas

No parks, refuges, or recreation areas are in the area of expected impact. No widely recognized scenic areas would be affected, although portions of the swamp forest crossed by the pipeline would be of aesthetic and recreational importance to local hunters, fishermen, bird watchers, and other outdoorsmen.

2.6.3 Biologically Sensitive Areas

As discussed above, the region's primary physiographic features are the natural levees, formed from alluvial deposits of the Mississippi River and its distributaries, together with the associated inter-levee basins. The three major biological habitats in the project area are the cleared lands, woodlands, and freshwater ecosystems.

The cleared lands comprise a relatively large portion of the area which could be affected by the proposed oil distribution system and would not be considered as ecologically sensitive habitat.

Within the project area the woodlands ecosystem is composed entirely of deciduous swamp and a bottomland forest vegetation type. The wooded swamps along rivers and streams comprise the bulk of this habitat type. This ecosystem would be particularly sensitive to changes in ground and surface water levels and salinity concentrations.

Except for a six-mile segment of swamp forest crossed by the pipeline ROW in St. James and Assumption parishes, the woodlands affected by the pipeline are relatively small in extent. All of the wetlands crossed are located at the upper end of drainage areas adjacent to the levees. Thus, only relatively small regions of the swamp forest would be subject to being isolated from the regional hydrologic patterns of the swamp ecosystem. Several canals and pipeline corridors already cut through these areas. Since water drains from the ROW crossings into the Atchafalaya and Des Allemands basins, any major alteration in quantity or quality of water flow to the south and west could potentially affect large areas of wetlands.

Prominent bodies of water comprising the fresh water ecosystem are the Mississippi River, Bayou Grosse Tete, Bayou Choctaw, the Atchafalaya River (a minor portion of which borders Iberville Parish on the west), Plaquemine Bayou, Bayou Jacob, Bayou Lafourche, and numerous minor canals and bayous which traverse the area. This ecosystem is very sensitive to changes in salinity and water levels. Except for the potential for oil spill risk, it is not expected that the construction or operation of the proposed pipeline would significantly affect the presence of any threatened or endangered wildlife species that could be present in the project area (see Section 2.4.1.2).

TABLE 2.1 National Ambient Air Quality Standards (NAAQS).

Pollutant	Primary Standard	Secondary Standard
Particulates:		
Annual Geometric Mean	75 $\mu g/m^3$	60 $\mu g/m^3$
24-hour Maximum	260 $\mu g/m^3$	150 $\mu g/m^3$
Sulfur Oxides:		
Annual Arithmetic Mean	80 $\mu g/m^3$ (0.03 ppm)	-
24-hour Maximum	365 $\mu g/m^3$ (0.14 ppm)	-
3-hour Maximum	-	1300 $\mu g/m^3$ (0.5 ppm)
Carbon Monoxide:		
8-hour Maximum	10 mg/m^3 (9 ppm)	Same as Primary
1-hour Maximum	40 mg/m^3 (35 ppm)	
Photochemical Oxidants:		
1-hour Maximum	160 $\mu g/m^3$ (0.08 ppm)	Same as Primary
Hydrocarbons (Non-methane):		
3-hour Maximum	160 $\mu g/m^3$ (0.24 ppm)	Same as Primary
Nitrogen Dioxide (NO_2):		
Annual Arithmetic Mean	100 $\mu g/m^3$ (0.05 ppm)	Same as Primary

$\mu g/m^3$ = Micrograms per Cubic Meter

mg/m^3 = Milligrams per Cubic Meter

TABLE 2.2 Louisiana Ambient Air Quality Standards*

Pollutant	Primary Standard	Secondary Standard
Suspended Particulates:		
Annual Geometric Mean	75 μg/m^3	60 μg/m^3
Maximum 24-hour Mean	260 μg/m^3	150 μg/m^3
Dust Fall	20 tons/mi^2/month	---
Coefficient of Haze:		
Annual Geometric Mean	0.6 COH/1000 lin. ft.	---
Annual Arithmetic Mean	0.75 COH/1000 lin. ft.	---
Maximum 24-hour Mean	1.50 COH/1000 lin. ft.	---
Sulfur Dioxide (SO_2)		
Annual Mean	80 μg/m^3 (0.03 ppm)	60 μg/m^3 (0.02 ppm)
Maximum 24-hour Mean	365 μg/m^3 (0.14 ppm)	260 μg/m^3 (0.02 ppm)
Maximum 3-hour Mean	---	1300 μg/m^3 (0.5 ppm)
Sulfur Acid Mist: (Sulfur Trioxide or any Combination thereof)		
Maximum Annual Mean	4 μg/m^3 } not to be exceeded more than 1% of the time	---
24-hour Mean	12 μg/m^3 } not to be exceeded more than 1% of the time	---
1-hour Mean	30 μg/m^3 } not to be exceeded more than 1% of the time	---
Carbon Monoxide (CO):		
8-hour Maximum	10 mg/m^3 (9 ppm)	Same as Primary
1-hour Maximum	40 mg/m^3 (35 ppm)	Same as Primary
Hydrocarbons (Non-Methane):		
3-hour Maximum between 6:00 & 9:00 a.m.	160 μg/m^3 (0.24 ppm)	Same as Primary
Total Oxidants:		
Annual Arithmetic Mean	58.8 μg/m^3 (0.03 ppm)	Same as Primary
4-hour Maximum	98.0 μg/m^3 (0.05 ppm)	Same as Primary
1-hour Maximum	160.0 μg/m^3 (0.08 ppm)	Same as Primary
Nitrogen Dioxide (NO_2):		
Annual Arithmetic Mean	100 μg/m^3 (0.05 ppm)	Same as Primary

*Maximum permissible concentrations. Standards other than annual are not to be exceeded more than once per year.

μg/m^3: Micrograms per Cubic Meter

mg/m^3: Milligrams per Cubic Meter

TABLE 2.3 Photochemical Oxidants - 1975 Data[a] (in parts per million).

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

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

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

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

TABLE 2.4 Acreages Affected in Various Land Use Types by Construction of the Proposed Bayou Choctaw Oil Distribution System.

Facility	Cleared Lands		Woodlands	Total
	Croplands/ Pasturelands	Urban/ Residential	Deciduous Swamp & Bottomland Forest	
Dome Site	0	1	0	1
Pipeline (75 foot right-of-way)	255	7	93	355
St. James Terminal	30	0	0	30
Total	285	8	93	386

TABLE 2.5 Population Density of Surrounding Parishes

	IBERVILLE	WEST BATON ROUGE	EAST BATON ROUGE	ASCENSION	ASSUMPTION	ST. JAMES
Population						
Total	30,746	16,864	285,167	37,086	19,654	19,733
Per square mile	49.0	83.1	621.3	123.2	55.2	78.0
Rural Population[a]						
Farm	1,535	479	2,960	1,087	2,996	628
Non-farm	18,824	9,685	34,649	24,000	16,658	12,603
Urban/Rural Population Distribution[b]						
Rural	66.7	61.1	13.1	68.0	100.0	67.2
Urban	33.3	38.9	86.9	32.0	-0-	32.8

[a]Non-farm and farm totals based on sampling only; may not add to total rural population.

[b]This table uses the U.S. Census Bureau definition of urban and rural residence in which urban population is defined as persons living in places of 2500 or more inhabitants.

Source: 1970 Census Data

TABLE 2.6 Housing Availability, by Parish

	HOUSING UNITS AND OCCUPANCY BY PARISH					
	IBERVILLE	WEST BATON ROUGE	EAST BATON ROUGE	ASCENSION	ASSUMPTION	ST. JAMES
Year-Round Housing Units	9,096	4,803	88,936	11,214	5,290	4,796
Owner-Occupied	5,202	2,906	54,049	7,394	3,384	3,369
Renter-Occupied	2,942	1,497	27,411	2,636	1,581	1,255
Vacant for Sale or Rent	328	133	5,537	730	151	59
% Vacant for Sale or Rent	3.6%	2.8%	6.8%	7.3%	2.9%	1.2%
Median Value of Owner-Occupied Units	$10,300	$12,400	$17,800	$12,600	$8,900	$11,900

Source: 1970 Census of Housing

TABLE 2.7 Employment in Major Occupational Groups by Parish

Occupational Groups	IBERVILLE		WEST BATON ROUGE		EAST BATON ROUGE		ASCENSION	
	Employees	Percent	Employees	Percent	Employees	Percent	Employees	Percent
Total Reported	5,979	100.0%	1,719	100.0%	88,653	100.0%	6,551	100.0%
Agriculture, Forestry, Fisheries	(D)	(D)	(D)	(D)	410	0.5%	(D)	(D)
Mining	262	4.4%	(D)	(D)	637	0.7%	(D)	(D)
Contract Construction	1,252	20.9%	108	6.3%	15,217	17.2%	642	9.8%
Manufacturing	2,131	35.6%	(D)	(D)	16,902	19.1%	2,697	41.2%
Transportation and Public Utilities	282	4.7%	566	32.9%	5,733	6.5%	525	8.0%
Wholesale Trade	112	1.9%	53	3.1%	7,113	8.0%	314	4.8%
Retail Trade	938	15.7%	329	19.1%	17,840	20.1%	1,531	23.4%
Finance, Insurance, Real Estate	175	2.9%	72	4.2%	7,344	8.2%	254	3.9%
Personal, Medical, Legal & Educational Services	674	11.3%	108	6.3%	16,865	19.0%	492	7.5%
Unclassified	(D)	(D)	42	2.4%	592	0.7%	(D)	(D)

"D" denotes figures withheld to avoid disclosure of operations by individual reporting units

Source: County Business Patterns 1973, compiled by the U.S. Bureau of Census.

TABLE 2.8 Family Income Distribution in the Six Parish Project Area for 1969

	Median Family Income	Percent of Families Below Low Income Level
Iberville	$6,251	30.6%
West Baton Rouge	6,909	27.3%
East Baton Rouge	9,617	13.6%
Ascension	7,894	22.3%
Assumption	6,135	30.4%
St. James	8,048	21.5%
State of Louisiana	7,527	21.6%
United States	9,957	10.7%

Source: U.S. Department of Commerce, Bureau of the Census, County and City Data Book.

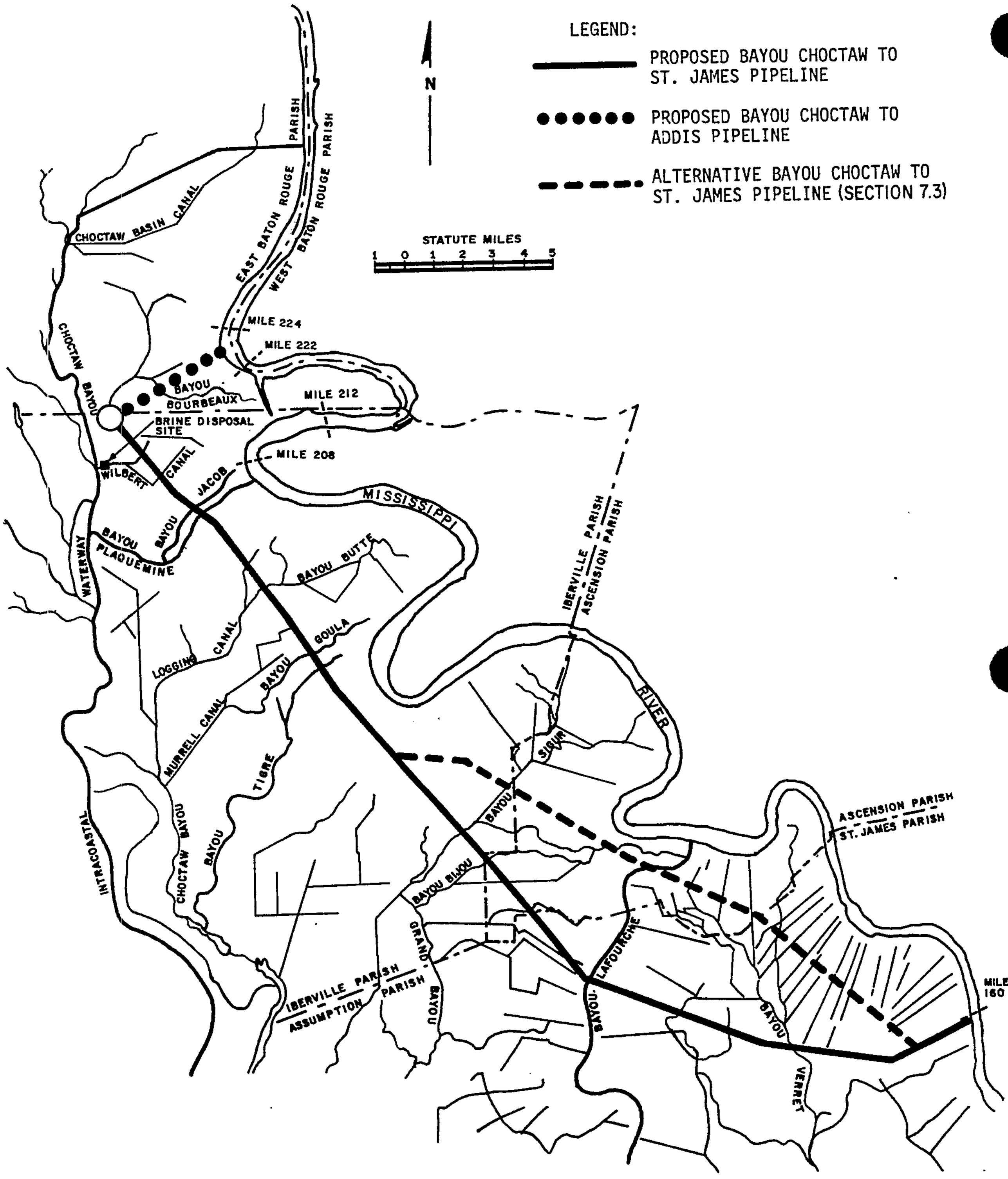

Figure 2.1 Surface Water System in the Vicinity of Bayou Choctaw Site

SECTION 3.0

ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

3.1 IMPACT OF SITE PREPARATION, CONSTRUCTION AND OPERATION

3.1.1 Land Features and Uses

Impacts of the proposed project on land features and uses would occur almost exclusively during site preparation and the construction of facilities. These impacts would result primarily from building the dock, laying the pipeline, and construction of the required levees around the SPR terminal at St. James. Soil erosion would occur due to the exposure of the soil during construction activities and the tendency of the soil to break loose during heavy rainfall in the area. This impact would be of a temporary nature, however. After construction most of the land disturbed during construction would revert back to its former use.

3.1.1.1 Geologic Impacts

Construction

Geologic impacts associated with construction of the proposed pipeline to St. James would be associated with soil and substrate disturbance during excavation of the pipeline trench, grading and filling the terminal site, and dredging of the Mississippi River at the tanker terminal. Estimates for the volume of earth to be moved during excavation are provided in Section 1.3.

At the tanker dock, 20,000 cubic yards of earth would be excavated from the river bank; 10,000 cubic yards would be taken from below the water line. The effect of this excavation on water quality and the cross section of the river channel would be minor. The material excavated from above the water line is expected to be used in building the dikes (levee) around the 30-acre terminal site. If this material is unsuitable for diking, there are ample locations along the levee, away from wetlands, which could be used for spoil disposal without significant impact on the environment.

Grading, filling, and dike construction at the St. James Terminal would involve an estimated additional 54,000 cubic yards of earth movement. Sources and disposal sites for this material are available nearby along the natural levee. The quantity of earth to be moved at the terminal does not constitute a significant alteration in surface topography.

Excavation and laying of the pipeline to the St. James Terminal would result in a temporary open ditch approximately 3 miles in length. Backfilling would be conducted continuously and should result in the trench remaining open for 6 to 7 days at any one location. Alignment selection and laying of the entire 39-mile pipeline would take a total of 6 months. However, most construction activity would be completed within three months.

Excavation along the entire pipeline ROW would temporarily displace an estimated 220,000 cubic yards of material during the three-month period. The soils would be backfilled into the trench within one week of excavation. During the one week period of exposure some erosion and lateral loss of material can be expected to occur, especially in the wet, swampy terrain or during periods of heavy rainfall. Thus, some segments of the pipeline ROW may contain a shallow depression resulting from subsidence and minor displacement of surface soils. Except where a definite drainage channel is created, these depressions in the swampland should gradually fill in with sediments and organic material because of the slow but continuous water flows in the swamp.

Movement of pipe-laying and material transportation equipment through wetlands would cause some compaction of soils within the pipeline ROW. This compaction would further reinforce the tendency to lower the surface soil elevation slightly along the ROW and create small depressions in the land. Use of swamp buggy equipment and push ditch installation methods, which is standard practice in this type of terrain, would minimize the extent of these impacts.

Summary Comparison of Construction Impact

Construction of the proposed oil pipeline system connecting St. James Terminal with Bayou Choctaw would avoid several significant impacts compared to the impacts which would accompany construction of the Addis Terminal. For example, since the Bull Bay barge docks would not be expanded for the St. James pipeline ROW, excavation of a new barge slip and disposal of an estimated 86,000 cubic yards of material would not occur. Also, the 83,000 cubic yards of grading and fill required for the Addis Terminal and 1.5 million cubic yards of dredged materials from the tanker dock vicinity (which would be disposed of in the Mississippi River channel) would not be necessary. However, temporary excavation of an additional 190,000 cubic yards of soil would be required along the 34 additional miles of pipeline for the St. James ROW.

Other geologic effects associated with leaching, oil storage, and brine disposal for the Bayou Choctaw system, as discussed in FES 76-5, would not be affected by development of the alternative St. James oil distribution system.

Operation

Construction of the proposed oil distribution system to St. James would also eliminate expansion of the Bull Bay barge docks. The existing docks would be used to fill the site at a rate of 30,000 BPD until the St. James pipeline is completed and for moving up to 50,000 BPD of oil from the site during withdrawal. Increased barge traffic along Bull Bay could cause some additional erosion of the channel bottom and shoreline but since no new construction is required, the existing natural vegetation along the route should help to reduce the erosion potential.

Summary Comparison of Operation Impacts

Use of the St. James facilities would reduce oil movements through Bull Bay to 50,000 BPD during withdrawal compared to the approximately 150,000 BPD needed with the Addis Terminal. During initial fill, oil movement by barge would be reduced from a maximum of 170,000 BPD with the Addis alternative to 30,000 BPD. The associated bank and channel erosion should also be reduced.

3.1.1.2 Land Use Impacts

Construction

Construction of the newly proposed distribution system would affect land usage at the Bayou Choctaw salt dome, along the pipeline route, and at the St. James Terminal. Less than one acre would be required for the surge tank and retaining dike at Bayou Choctaw. This land is adjacent to previously developed industrial land and would not represent a basic change in land use.

The new terminal at St. James would be located on 30 acres of cropland which is adjacent to existing industrial facilities or on Koch Oil Co. property. The 39-mile pipeline would require a 75-foot wide construction ROW. Land use impacts are estimated to affect 255 acres of crop and pasture lands, 7 acres of urban/residential land, and 93 acres of swamp land (Table 2.4).

Major crossings along the pipeline route are listed below:

Highways: 14 developed roads, including State highways 77, 75, 69, 1, and 18.

Railroads: 3 crossings (Texas and Pacific)

Bayous or Canals: 9 principal waterways, including Bayou Jacob, Plaquemine Bayou, and Bayou Lafourche.

Construction impacts in agricultural areas would be temporary. The work would proceed at a rate of from 1/2 to 1 mile a day. Depending upon the growth stage of the sugar cane crop with regard to the growing season at the time of excavation, a possible loss of one crop on the land within the ROW could occur. The landowners would be compensated for such losses by FEA. After construction, agricultural use of the ROW may be resumed. In areas used as pasture (about 20 percent of the total agricultural acreage, or 50 acres), the impact from excavation would be very small.

The impact of pipeline construction at road and railroad crossings would be negligible because the pipeline trench would be bored under the roadbed and therefore no traffic would be disrupted. Some increase in highway traffic may be expected as a result of commuting trips by the construction crews. This increase is not expected to be significant since the 125-man pipeline crew would be working a 10-hour shift and consequently would not be travelling on the local roads during peak commuting hours.

Waterway crossings are not anticipated to create a major adverse impact; any disruption would be of less than one week duration. Although there is no commercial traffic on Bayou Jacob or Bayou Lafourche, it is possible that some pleasure boating and fishing would be disrupted for a few days. Plaquemine Bayou, which carries occasional shell barge traffic near the point of pipeline crossing, may be expected to experience some traffic delay, but because of the short duration, this disruption is not considered to be significant.

The land use impact in areas where houses are located within 1000 feet of pipeline construction would not be significant because the land for the ROW is already cleared.

Excavation or other alterations within the swamp forest ROW would have significant local impacts (see Section 3.2 and 3.5) which would continue past the construction phase of the project because the pipeline ROW must remain cleared for inspection or maintenance purposes.

Operation

Operation of the SPR facilities would require permanent utilization of 30 acres at St. James, 1 acre at Bayou Choctaw and a 50-foot wide corridor along the pipeline ROW (237 acres). Agricultural lands within this pipeline corridor (170 acres) could be replanted and should be no more or less productive and valuable as a result of pipeline construction. No permanent structures could be erected over the ROW and no structures could be erected on the 5 acres adjacent to residential lands; none now exist on this land.

Within the ROW through the swamp land (62 acres), all woody vegetation would be periodically cleared to facilitate access in case of an emergency. Thus, the 50-foot corridor would not function as highly productive swamp forest land during the project lifetime. The potential impact is not significant in terms of lumber production or recreation.

There are few indirect effects of facility operation on land use. Residential, industrial and agricultural uses will be unaffected, except in the case where a parcel of land has been traversed in a manner which prevents full development. However, as the pipeline parallels existing pipeline rights-of-way for 95 percent of its length, this impact should not occur frequently.

Summary Comparison of Land Use Impacts

Construction of the oil distribution facilities to St. James would impact 235 acres of crop and pasture land, 8 acres of urban/residential land, and 93 acres of swamp forest, for a total direct impact on 386 acres. Construction of the Addis oil distribution facilities would directly impact a total of 125 acres which includes 47 acres of swamp forest and marsh, and 78 acres of cleared industrial and crop land. Major transportation crossings between Bayou Choctaw and Addis would be limited to State Highway No. 1 and to the Texas and Pacific Railroad ROW.

Lands permanently removed from other uses at Bayou Choctaw, Bull Bay, and Addis Terminal would total approximately 50 acres for the Addis alternative compared to 31 acres at Bayou Choctaw and St. James for the St. James pipeline facility. Along the pipeline route, 45 acres would be within the permanent ROW to Addis compared to 206 for the ROW to St. James. The potential for indirect impact is relatively small for both pipeline routes since existing rights-of-way are followed to the fullest extent possible.

3.2 WATER QUALITY

Potential water quality impacts due to the St. James oil distribution system are limited primarily to excavation and dredging for installation of the pipeline and tanker dock and the effects of oil spills (see Section 3.7) during operation. Dredging would be required only at the Mississippi River tanker dock site and at the major stream crossings along the pipeline route. Impacts of this dredging would be due mainly to increased turbidity and a reduction of the dissolved oxygen levels in the water.

3.2.1 Impact of Dredging and Pipeline Installation

Pipeline construction would affect water quality in bayous, canals and flooded wetlands crossed by the ROW. Approximately 57,500 cubic yards of material would be excavated from the pipeline trench in wetland areas. The material removed from the pipeline trench would be piled alongside the trench for periods of up to one week prior to backfilling. During this time, rainfall and surface water drainage would wash some of the material from the spoil pile and into surface waters.

Effects on adjacent surface waters may include lowered oxygen levels due to release of organic materials into the water column, lowered pH due to release of sulfides, increased heavy metal and pesticide concentrations, release of nutrients stimulating possible eutrophic conditions, and high turbidity. The silts and clays which predominate along the pipeline ROW would not drain well by gravity forces alone. Also, the gradients along the project route are very gradual. In the swamp forest habitat, impacts should be confined to the immediate vicinity of the pipeline route, except in areas where streams are crossed, and the impacts should last for no more than six months following excavation. These wetlands are relatively insensitive to the discharge of small quantities of pollutants since these systems have been observed to purify the waters and to store material in the sediments.

Where the pipeline must cross streams, bayous, and canals, there will be greater disturbance to area water quality because the currents in these streams will suspend and redistribute the spoil over a larger area compared to the swamp forest habitats.

Quantitative assessment of the impact of dredging operations and the disposal of dredged material on the open water environment is currently not feasible because of the paucity of information in the literature with regard to tested and accepted methods for such assessment. In many cases the extrapolation or correlation of impact assessment for areas with different ecological characteristics is not valid. Various research programs currently underway as part of the Dredged Material Research Program, carried out by the U. S. Army Corps of Engineers Waterways Experiment Station, Environment Effects Laboratory, may ultimately produce the necessary prediction techniques. At the present time only a qualitative description of such impact, based on past observations under similar conditions, is possible.

Assessments of impacts for the pipeline crossings at Plaquemine Bayou and Bayou Jacob will be used as examples of the impacts to be expected in waterways for the Bayou Choctaw ROW. Sediment samples taken in Plaquemine Bayou near the Port Allen Canal (3 to 4 miles downstream of the proposed ROW crossing) were approximately half sand and half clay and silt. Chemical analysis of these sediments indicated that they contained high concentrations of heavy metals, pesticides, total Kjeldahl nitrogen, ammonia, and oil and grease (FES 76-5). Both of these bayous are cut off from the Mississippi River and thus act as a sink or trap for nutrients and pollutants in the water. The major water source in the bayous is the local rainfall and surface drainage. The drainage flows principally from urban, residential and agricultural lands.

Currents in these bayous are generally very slow; reverse flow often occurs in response to changes in the water level in the Port Allen Canal. Thus, there is not likely to be significant scouring or physical displacement of spoil except in the case of a local flood. Because of these slow rates of flow sediments and chemicals suspended in the water column by pipeline trench dredging and backfilling should be confined to the water column within a few hundred feet of the crossing.

Elutriate tests conducted on sediments taken nearby from Plaquemine Bayou and the Intracoastal Waterway (ICW) show that concentrations of certain heavy metals and pesticides may exceed EPA recommended water quality criteria for aquatic life (Table 3-1) within the affected zone. Heavy metals seem to be adsorbed on the sediment particles so that dredging may actually decrease water column concentrations.

The effects of dredging on the water column should be temporary and last only a few days after installation and backfilling of the pipeline.

In addition to affecting water quality, construction of the pipeline could also alter surface drainage patterns and rates. For example, after trench excavation, and before back filling, an open trench of 6 to 7 feet deep would extend along the pipeline ROW. This trench could promote drainage of adjacent soils and, more significantly, could provide a channel to carry surface water away from the area during the six to seven days prior to backfilling at any particular location. Since the pipeline ROW is generally perpendicular to the regional flow of surface water, this alignment of the ROW may temporarily alter local flow rates by depleting water levels in some areas and increasing them in others.

The ROW crosses the upper reaches of the Verret-Terrebonne and Des Allemands-Salvador-Barataria Drainage Areas and thus should not materially affect water flow in the highly productive marsh-estuarine system nearer the coast.

Standard construction practices attempt to promote and retain natural drainage patterns across a pipeline trench by providing breaks in the spoil piles every few hundred feet and by constructing bulkheads to interrupt the flow of water along the trench. Thus, at high water levels, the normal regional drainage patterns would not be altered. After backfilling the trench, within one week after excavation, surface drainage should not be altered on a regional scale. Locally, shallow depressions left along the ROW may divert water to a degree, creating flows and water levels which are higher than normal in some areas and lower than normal in others. The amount of acreage affected by this change should be of only local significance.

At crossings of major water bodies, care would be taken to prevent significant flow of water into the pipeline trench on either bank.

Where there is a significant potential for such flow, such as at Plaquemine Bayou and Bayou Lafourche, the trench would be partially backfilled or a bulkhead would be installed on either side of the water body immediately after excavation. After backfilling, appropriate measures would be taken to prevent erosion of the banks at the pipeline crossing so that water flows remain within the channel.

An estimated 10,000 cubic yards of substrate would be dredged from the bed of the Mississippi River at the new tanker dock location. This material would be discharged into the Mississippi River channel in water depths of 50 feet or greater. Primary concerns are increased turbidity, nutrients and toxic substances.

Based on maintenance dredging studies conducted in Alabama, suspended solids are expected to be less than 100 mg/l at distances greater than 400 feet from the source. This is comparable to average suspended solids levels in the Mississippi (Appendix D.3, FES 76-5).

Elutriate test data taken from samples of Mississippi River sediment are reported in FES 76-5. There is expected to be little impact on nutrient levels or heavy metals. Concentration of phenols and DDT may increase locally, but should be rapidly diluted by the large river flow. The total quantity of dredged material to be disposed of in the channel from the dock construction (10,000 cubic yards) is an insignificant fraction of a single day's sediment load carried by the river (on the order of 2 percent).

The proposed construction should have negligible impact upon the ground-water regime of the area. The major shallow freshwater aquifer in the Bayou Choctaw salt dome region is the Plaquemine Aquifer. This aquifer is overlain by about 100 feet of clays and silt which serve as a confining bed which would isolate the aquifer from the effects of construction.

3.2.2 Impact of Earth Excavation and Fill

Site preparation and construction activity would involve less than 75,000 cubic yards of earth movement, principally at one of the two 30-acre terminal sites on cleared land at St. James. Assuming that the surface soils are exposed for approximately six months, an estimated 2750 cubic yards of sediment might be eroded and carried into the surface water system by rainfall (based on Appendix F, FES 76-5). This estimate is highly conservative because lands adjacent to the terminal sites are level and there is no water body nearby to receive this sediment. Therefore, discharge into surface waters would likely occur over a very long period of time and should not measurably degrade water quality.

3.2.3 Chemical and Biological Pollutants

Numerous solid and liquid products used in construction practices are a source of water pollution. For example, minor amounts of petroleum products are likely to be released through leaks, spills, and miscellaneous sources. Fertilizers and herbicides may affect water quality locally if improperly used. After the field hydrostatic pressure test, filtered water from a local bayou or canal used in these tests would be discharged to surface waters after mud, rust particles, and mill scale is allowed to settle in a tank or pond. Some deposition in the soil may result from the coal tar epoxy pipeline coating and the graphite anodes. None of these sources are expected to be significant either to the project region or local area.

3.2.4 Withdrawal of Surface Water

The impacts of surface water withdrawal for oil displacement are described in FES 76-5. The proposed oil distribution system to St. James would not affect the maximum rate of oil withdrawal and therefore the system would not further affect surface water withdrawal impacts.

3.2.5 Brine Disposal

Impacts of brine disposal into deep saline aquifers are described in FES 76-5. The proposed oil distribution system to St. James would not significantly affect the maximum rate of oil delivery or the subsequent requirement of brine disposal. With the St. James oil distribution system, a maximum oil fill rate of 30,000 BPD across the existing Bull Bay dock for 9 months and a rate of 240,000 BPD via pipeline for 9 months (initial fill) is planned compared to the proposed rate of 170,000 BPD (pumped over a longer period of time) from the new Bull Bay dock system with the Addis alternative.

3.2.6 Summary Comparison of Water Quality Impacts

In the one case, the construction of the St. James oil distribution facility would avoid a substantial amount of dredging activity (estimated to amount to 86,000 cubic yards at Bull Bay and 1.5 million cubic yards in the Mississippi River) which would be associated with the Addis alternative. Spoil would be deposited on the eastern bank of the Port Allen Canal from Bull Bay and in the Mississippi River channel from the Addis terminal construction. This disposal would cause a widespread, though temporary, degradation of water quality in both the canal and the river. In addition, maintenance dredging would be required at the new Bull Bay barge slip and in the Mississippi River near the Addis tanker dock. Earth excavation and filling associated with the Addis alternative is estimated to amount to 263,000 cubic yards which would result in an estimated 7000 cubic yards of sediment that would be washed into surface waters. This amount is more than two times the maximum volume estimated for the St. James alternative.

On the other hand, the pipeline ROW to Addis is 34 miles shorter than to St. James and would require approximately 192,000 cubic yards less excavation during construction of the pipeline. The potential for adversely affecting local surface waters prior to backfilling would thus be substantially smaller. In addition, the Addis ROW would not cross wetlands perpendicular to the normal drainage flow. Hydrologic effects on both water quality and quantity would thus be negligible.

The Addis pipeline would not cross any major water bodies and therefore would likely have only negligible, indirect effects on the quality of nearby open waters.

3.3 AIR QUALITY

In this section, the air quality impacts associated with implementing the revised oil distribution system (St. James alternative) are assessed and are compared with the impacts of the Addis alternative. Major differences between these two alternatives which affect air quality impacts include the use of an extended 39-mile pipeline to St. James, relocated terminal activities, and the greater dependence on pipelines for oil transportation. This greater use of pipelines (compared to the use of barges or tankers for the Addis alternative) results in a markedly reduced hydrocarbon vapor loss in transport and transfer of the crude oil.

Before the impacts associated with the St. James alternative could be compared to the impacts of the Addis distribution system, it was necessary, for several reasons, to recalculate the expected emissions of hydrocarbons presented in FES 76-5. The most important reason was that significant new data on emission factors for petroleum loading/unloading from vessels has become available since FES 76-5 was published. The revised emission factors are presented in Appendix A of this Supplement The physical and chemical bases for these rates are given in Appendix C. Additional reasons for recalculation of the expected emissions included a reduction in total capacity from 99 million barrels to 94 million barrels, inclusion of transit emissions, revised assumptions on crude oil vapor pressure and the assumption that crude oil would remain in the pipeline and surge tanks during standby storage (i.e., continuous exposure).

The basic mode of oil transport assumed for the calculation of the St. James alternative hydrocarbon emissions (and oil spill risks treated in Section 3.7) is as follows. During fill, oil would be transferred to 45 MDWT (45 thousand dead weight ton) tankers (typical size assumed available) in the Gulf south of the Mississippi River, transported by tanker up the Mississippi River, offloaded to surge tanks at St. James, and pumped through the 36-inch pipeline to storage at Bayou Choctaw. During the initial fill, some of the oil (7.2 million barrels (MMB)) would be transferred to barges at a terminal on the Mississippi River and barged to the Bull Bay docks. For the purpose of establishing a worst case air quality analysis, Port Allen, Louisiana is used as the terminal location. For the worst case oil spill analysis Venice, Louisiana is used as the transfer point because of the greater risk of oil spill over the longer distance..

For the Addis alternative, the above fill transit mode is altered by the location of the tanker dock at Addis and the use of barges to transport approximately 80 percent of the initial fill and 20 percent of the subsequent fills to Bull Bay.

For the purposes of this Supplement, it was necessary to estimate the portion of oil stored in Bayou Choctaw which would be shipped to the Gulf and the portion delivered to the Capline pipeline during withdrawal. From the Strategic Petroleum Reserve Plan (1976), estimated crude oil imports in 1980 will be 6.0 million barrels per day (MMBD), of which 1.18 MMBD (19.7 percent) will be carried by the Capline to the midwest. Should an oil supply interruption occur while only 150 MMB is in storage, an equitable portion for delivery to Capline would be 19.7 percent of 150 MMB, or 29.6 MMB. Over a 150-day withdrawal period, this would be 197,000 BPD. Another 50,000 BPD is assumed to be delivered to refineries in the vicinity of Baton Rouge and the remaining 380,000 BPD would be transported to the Gulf by tanker (or to refineries along the Mississippi River). Although subject to change depending on details of oil movement analyses such as matching crude oil types with refinery capabilities, this assumption provides a reasonable basis for estimated oil spill risks and hydrocarbon emissions. Upon completion of the entire SPR program, a greater portion of the oil may be distributed from Bayou Choctaw to Capline; this would reduce the air quality and oil spill impact potential below that analyzed in this Supplement.

During oil withdrawal, more than 90 percent of the oil would be pumped to St. James by pipeline. Based on the approximate oil delivery plan described above, over 60 percent would be transferred to 80 MDWT tankers (typical) for transit to the Gulf; the rest of the oil delivered to St. James would be pumped into Capline. Approximately 50,000 BPD would be transported by barge from Bull Bay to refineries in the Baton Rouge area.

For the Addis alternative, just under 80 percent of the oil would be pumped to Addis where almost 80 percent of this amount would be transported by tankers to the Gulf and the rest by tanker to St. James for injection into Capline. Of the 140,000 BPD transported by barge, two-thirds would be delivered to St. James for Capline and the remainder delivered to Baton Rouge area refineries.

3.3.1 Storage Site Construction and Operation

Air quality emission effects associated with construction and operation of the Bayou Choctaw storage facility (excluding oil distribution facilities) would be caused principally by drill rigs, construction vehicles, spray painting, and oil leakage. These effects are described in Section 3.3.1 of FES 76-5. The impacts from these effects are concluded to be minor.

3.3.1.1 Construction

The proposed alternative oil distribution system connecting the site with St. James would require an additional 20,000 barrel oil surge tank at Bayou Choctaw. Using the same assumptions given in Section 3.3.1 of FES 76-5, spray painting this tank would result in an additional 190 pounds of reactive hydrocarbon emissions over a 3 day period; this would have no measurable effect on air quality.

3.3.1.2 Operation

During storage and withdrawal phases, the 20,000 barrel crude oil surge tank would release an estimated 26 pounds per day of hydrocarbons (94 tons total emissions by the year 2000). This estimate is based upon an empirical equation developed by the American Petroleum Institute (1962) and assuming that the surge tank will be 25 feet high, 76 feet in diameter, and have a crude oil true vapor pressure of 2.8 pounds per square inch (psi) (Reid vapor pressure of 4 psi at 75^{o}F) and a crude oil density of 300 pounds per barrel. During worst case conditions (crude oil true vapor pressure of 3.7 psi, corresponding to a Reid vapor pressure of 5 psi), hydrocarbon emissions would be 33 pounds per day. This amount would have minimal impact on air quality.

3.3.2 Construction and Operation of the Tanker Dock Facilities and Pipeline

Air quality effects associated with the entire oil transport system from the very large crude carrier (VLCC) transfer point in the Gulf of Mexico to the site are considered in this section. With the proposed alternative oil distribution system to St. James, expansion of the Bull Bay docks would not be required.

3.3.2.1 Construction

Since expansion of the Bull Bay barge docks would not be required if a pipeline is built to connect with St. James, emissions would occur only along the pipeline ROW and at St. James due to terminal and tanker dock construction. Emissions from construction equipment at the tanker dock and terminal site would be similar to those given in Section 3.3.2 of FES 76-5 except that these emissions would be smaller and would occur at St. James instead of at Addis. It was concluded in FES 76-5 that the air quality impact resulting from both Bull Bay expansion and tanker terminal construction would be minimal. Since the Bull Bay expansion would no longer be required, the air quality impact due to construction effects would be even smaller if the St. James alternative were constructed.

3.3.2.2 Operation

The largest potential effects on air quality associated with the operation of the proposed Bayou Choctaw system would result from hydrocarbon emissions during fill and drawdown cycles. Hydrogen sulfide losses are expected to be minimal since most of the crude oil to be stored at Bayou Choctaw would have weathered sufficiently during overseas transit to eliminate the H_2S component.

Hydrocarbon emissions to the atmosphere due to the project would occur mainly with transfer of the oil during barge and tanker loading or unloading operations and during barge and tanker transit to various oil transfer locations. Standing storage hydrocarbon losses from the floating roof storage tanks would contribute a smaller local, but continuous, source. Storage tank losses at Bayou Choctaw and St. James are assumed to continue throughout the project lifetime since the tanks and oil pipelines would be kept partially filled at all times. Losses from tanks at the Port Allen tanker-barge transfer terminal would occur only during the initial eight months of the first cavern fill as these facilities would be leased by FEA.

The estimated hydrocarbon emissions resulting from operation of the Bayou Choctaw facility are presented in Table 3.2 for both the St. James and Addis distribution systems. These data represent the total emissions expected over the entire period of project operation (5 fills and 5 withdrawals) based on average crude oil properties (Reid vapor pressure of 4 psi and a density of 300 lbs/bbl). The minimal losses from ship's boilers and the small leakage that may occur from the system of pipes, manifolds and valves at the site have been neglected in these estimates.

Hydrocarbon emissions in Table 3.2 are based upon the following activities: 1) transfer of oil between VLCC and 45 MDWT tankers 12 miles offshore (emission factor of 0.72 lb/1000 gal); 2) "breathing" losses during transit by barge and tanker between Gulf of Mexico and transfer points on the Mississippi River (emission factor of 0.0119 lb/hr/1000 gal); 3) transfer from 45 MDWT tankers to 20,000 barrel barges (assumed to take place at Port Allen for estimating worst case impacts, emission factor of 1.96 lb/1000 gal); 4) offloading 45 MDWT tankers at St. James (emission factor of 0.42 lb/1000 gal); 5) loading of barges at Bull Bay (emission factor of 1.54 lb/1000 gal); and 6) loading 80 MDWT tankers at St. James (emission factor of 0.55 lb/1000 gal). Emission factor for offloading barges at Bull Bay was assumed to be zero. Derivation of the emission factors given above is provided in Appendices A and C.

Standing storage vapor losses from floating roof crude oil storage tanks were estimated using the empirical equation developed in API publication 2517 (1962). The tanks were assumed to be welded tanks with a pan roof, single seal and painted white. The crude oil was assumed to have a true vapor pressure of 2.8 psi (Reid of 4 psi) at an annual average storage temperature of 75^{o}F and a density of 300 lb/bbl. The tanks were assumed to be 32 feet high with diameters proportional to their capacity. The emissions in Table 3.2 for Bayou Choctaw and St. James tanks are calculated on the basis of a constant emissions rate during the period from 1979 to 2000. Emissions at Port Allen occur only during the initial fill. Comparison with emission rates calculated on the basis of a recently derived equation for storage tank vapor losses (EPA, 1976a) indicates the emissions in Table 3.2 may be conservatively high by 10 to 15 percent. Recent studies performed by Chicago Bridge & Iron (1976) indicate that API 2517 overestimates standing storage losses for crude oil by a factor of 2 to 3 or greater. However, the results of the Chicago Bridge & Iron study are considered too preliminary for use at this time.

For the proposed oil distribution system at St. James, the standing storage loss is about 52 tons/year. The much smaller losses from pipeline pumping operations and the short-term construction emissions are distributed over a large area and should not add significantly to the total at St. James. Hydrocarbon emissions from the Addis storage tanks would be approximately 110 tons/year (Table 3.2); this estimate assumes that all 6 tanks are partially filled with crude oil at all times.

Since the total expected hydrocarbon emissions from operation of the Bayou Choctaw storage site using a St. James Terminal are approximately 60 percent of those for the Addis distribution system, it is apparent that the use of a longer pipeline greatly reduces the vapor losses. This is particularly evident in the reduced transit losses on the Mississippi River and the reduced losses from transfer operations, particularly at Port Allen and Bull Bay. It can also be seen that cavern fill losses are much higher than withdrawal losses. This difference is due to the fact that oil would not be transferred to VLCCs during withdrawal operations.

Estimated annual average hydrocarbon emissions (St. James alternative) at St. James, Port Allen, and Bull Bay during peak fill/withdrawal operations were compared to recent parish totals (EPA, 1976[b]). This comparison shows that the atmospheric hydrocarbon increases in each parish would be minimal as indicated below:

Location	Peak Annual Emissions From St. James System (tons/yr)	Emission Inventory Parish	Emission Inventory Total (tons)	Percent Increase
St. James	881	St. James:	22,870	3.9
Bull Bay	243	Iberville:	11,167	2.2
Port Allen	320	East Baton Rouge:	162,619	0.21

Because the national ambient air quality standard (guideline) for non-methane hydrocarbons is a 3-hour value (160 $\mu g/m^3$; 6-9 a.m.), it is necessary to look at worst case emissions instead of averages at each location. Worst case emissions in pounds per day at each major source location and the downwind distances over which the hydrocarbon standard would be exceeded are presented in Table 3.3 for both the St. James oil distribution system and the Addis system.

Worst case emissions due to oil transfer were estimated assuming maximum loading and unloading rates of vessels as follows: 1) VLCC transfer to two tankers in Gulf simultaneously at a rate of 100,000 barrels per hour (B/H) (emission factor of 1.49 lb/1000 gal); 2) 45 MDWT tanker transfer to two barges at Port Allen simultaneously at a rate of 12,000 B/H (emission factor of 2.25 lb/1000 gal); 3) loading two barges simultaneously at Bull Bay at a rate of 12,000 B/H (emission factor of 1.59 lb/1000 gal); 4) loading 80 MDWT tanker at St. James rate of 27,600 B/H (emission factor of 0.83 lb/1000 gal); and 5) offloading 80 MDWT tanker at St. James at a rate of 27,600 B/H. Emission factors were calculated assuming uncleaned tankers and barges, and using a conservative worst case Reid vapor pressure of 5 psi instead of 4 psi. Transit emissions were not included since they are non-point sources and occur over a large area. Likewise, standing crude oil storage tank losses are treated as area sources and are considered separately.

Downwind centerline ground-level concentrations estimates were made using the model described in Appendix A. Estimates were made for atmospheric conditions corresponding to worst case conditions ("D" stability and a wind speed of 1 meter per second (mps) onshore and 2 mps in the Gulf of Mexico). Background hydrocarbon concentrations were assumed to be zero. It was conservatively assumed that the loading and unloading emissions at each location are point source releases at ground-level.

A comparison of these estimates shows that the results are similar for both the St. James and Addis oil distribution systems. The maximum downwind distance with concentrations exceeding 160 $\mu g/m^3$ would be 34 kilometers (21 miles) from the VLCC transfer in the Gulf of Mexico, much of which is over water. Onshore, the maximum distance would be 16 kilometers (10 miles) at Port Allen. As discussed in Section 2.3.2 of FES 76-5, southern Louisiana is considered to have a need to reduce hydrocarbon emissions.

Worst case standing storage tank losses were calculated using the previous assumptions for average conditions, but using a conservative Reid vapor pressure of 5 psi. Estimated maximum daily hydrocarbon emissions and 3-hour average concentrations at 2, 5, and 10 kilometers downwind are as follows:

Location	Maximum Daily Emissions (lbs)	Downwind Concentrations ($\mu g/m^3$) 2 Km	5 Km	10 Km
St. James	367	36	10	4
Bull Bay	338	36	10	4
Port Allen	259	27	8	3

In comparison the Addis alternative would have had maximum daily emissions of 778 lbs and 3-hour average concentrations at 2 km of 75 ug/m^3, at 5 Km of 22 ug/m^3 and at 10 km of 8 ug/m^3. These values are quite small when compared to the 3-hour standard of 160 ug/m^3. However, the Addis and Port Allen emissions occur in close proximity to Baton Rouge, which is in a non-attainment area for photochemical oxidants and therefore may be sensitive to additional hydrocarbon releases.

The only expected detrimental effect upon ambient air quality associated with the Bayou Choctaw facility would be the temporary elevation of total hydrocarbon concentrations at the marine terminal (St. James, Louisiana) during loading and unloading operations. These emissions are presently exempt from Louisiana air quality regulations. However, the USEPA has proposed changing control strategies regarding hydrocarbon reactivity. The key proposals which would impact the SPR project are the subjecting of crude oil emissions to the requirement for SPR project vapor regulation, and control of at least 85 percent efficiency for ship and barge loading and unloading. However, the ship and barge proposal is intended only for gasoline transferring as previously described in the Louisiana SIP plan. Nevertheless, the exemption for crude oil could also soon be eliminated. The policy of eliminating fractional hydrocarbon reactivity factors will result in reduced projected hydrocarbon emissions. It is anticipated that all new sources will be required to apply best available control technology.

3.3.3 Noise Impacts

Construction activity associated with the conversion of existing storage capacity at Bayou Choctaw and ancillary facilities may cause some noise impacts for residential, recreational, farming, and other land uses in the general project vicinity. Construction of the oil distribution system is planned to take place over a period of approximately 9 months.

3.3.3.1 Storage Site Area

Construction noise sources at the storage site area during site preparation would be air compressors, trucks, diesel engines, pumps, drilling rigs, impact equipment, concrete mixers, and general construction related equipment. Noise levels typical of this equipment are given in Table 3.4. Diesel engines would provide the most consistent source of noise. Impact and drilling equipment would create the peak sound levels. Construction of the additional 20,000 barrel oil surge tank associated with the St. James oil distribution system would have no measurable effect on overall sound levels created by other activities. The areas adjacent to the storage site are predominantly industrial land and marshlands. The nearest agricultural land is at least one mile away and the nearest residential area is at least two miles distant. No noise sensitive activities are known to occur adjacent to the storage site area.

During operations at the storage facility, the primary noise generation would be from pumps associated with fill and discharge operations and barges on the Intracoastal Waterway. The operation of the pumps will not contribute to the ambient sound. The utilization of the St. James pipeline would reduce the number of barges required during withdrawal by approximately a factor of three (during initial fill the reduction would be a factor of 10). The peak sound level during a barge passby is measured to be 63dB at 150 feet (FES 76/77-8). The limited use of barges would reduce noise contribution due to barge traffic. The equivalent sound level during a barge passby is estimated to be 53dB at 150 feet for a duration of 5 minutes (FES 76/77-8). Other operational activities, including traffic from commuting workers would be unchanged.

3.3.3.2 Pipeline Corridor

A 39-mile pipeline would be built for movement of oil between Bayou Choctaw and St. James. The pipeline construction consists of (1) excavation, (2) laying of pipe, (3) welding, and (4) finishing operations. The proposed pipeline route passes within 500 to 1000 feet of perhaps 150 houses located at highway crossings near Plaquemine, White Castle, Annadale, and Freetown (Figure 1.3). The equivalent sound level (L_{eq})* at 500 feet from pipeline construction is estimated to be 68 dB (FES 76/77-8). The ambient sound level for residents along the pipeline route is estimated to be between 62 and 68 dB during pipeline construction. Due to the short duration (maximum of 2 to 3 days) of exposure to construction activity by any particular resident, and the fact that nighttime construction is not anticipated, this temporary increase in sound level would not cause significant adverse impact.

3.3.3.3 Terminal and Dock

Major noise sources from the terminal and dock construction are expected to be pile driving for the dock construction and diesel engine noise in the terminal area construction. Trucks, concrete mixers, compressors, and general construction equipment would all contribute to increased ambient levels. For construction activity at the dock and terminal site the daytime L_{eq} during the period of construction is estimated to be 70 dB 500 feet from the center of the site. There are several residences and small businesses along Highway 18 within 500 feet of the Koch Oil Company terminal site. Due to the current industrial nature of the area, the temporary noise impact should not be particularly disturbing.

When tanker unloading and loading occur, the major noise associated with the operations would be from tanker pumps discharging crude oil, tanker loading pumps, and pipe transfer pumps. The pumps for both tanker loading and pipeline transfer to the storage area would be electrically powered and would be contained in a pump house on the terminal site. Noise from the diesel engines powering the tankers and tanker discharge pumps would contribute negligibly to daytime ambient levels.

3.3.3.4 Summary Comparison of Noise Impacts

Construction

Construction at the storage site, terminal and dock areas requires the use of heavy construction equipment. The operation of this construction equipment would increase ambient sound levels at the perimeter of

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*L_{eq} is a steady noise level containing the same noise energy as a varying level measured over the same period of time.

the sites. However, due to the present industrial nature of the sites, the actual increase in ambient sound levels at noise sensitive land use areas is estimated to be minimal. Therefore, the impact is expected to be minimal and similar for both the St. James and Addis alternatives.

Construction of the St. James pipeline will increase the ambient sound levels at nearby residences from an estimated daytime L_{eq} of 53 dB to between 62 and 68 dB during construction activity. This increase in ambient levels would cause some annoyance to the inhabitants. However, since the maximum exposure of any resident to the construction noise is only 2 to 3 days, the impact will be brief and is not expected to be significant. On the other hand, significantly more residents would be affected by construction of the St. James pipeline than by a pipeline to Addis because of the longer pipeline length for the St. James route.

Operation

Operation noise of the storage site, terminal and dock would be mainly due to increased use of pumps. The operation of pumps partially enclosed by pump housing would contribute little to the ambient sound levels at the perimeter of the sites. Thus, no impact is expected for either oil distribution system alternative.

The operation of the pipeline is not a noise source. There would not be a pumping station located on the pipeline route. The utilization of the St. James pipeline reduces the use of barges for oil transportation. Therefore, noise impact due to barge traffic along the Intracoastal Waterway would be reduced by development of the St. James oil distribution system in place of the Addis system.

3.4 SPECIES AND ECOSYSTEMS

3.4.1 Impacts on Bayou Choctaw Area

Construction of the 20,000 barrel oil surge tank at Bayou Choctaw would disturb less than 1 acre of previously cleared land at the salt dome site (Section 1.3). This impact would occur simultaneously with the impacts associated with the conversion of existing caverns for oil storage, construction of control facilities and pump houses, a 500,000 barrel brine pit, raw water delivery pipes, brine disposal pipes, a 28-well brine injection field and extensive roads and dikes throughout the area. These construction activities would directly affect 198 acres; indirect effects of lesser degree would occur over another 2050 acres (FES 76-5). Thus, compared to the overall project construction, the incremental effects of the St. James pipeline alternative at Bayou Choctaw are small.

A significant reduction in environmental impact with regard to the development of the St. James pipeline alternative would be due to the elimination of the expansion of the barge dock facilities at Bull Bay. This elimination would avoid a direct impact to approximately 10 acres of land and also avoid severe temporary stress to aquatic life in Bull Bay (FES 76-5).

Operation of the storage site would not be affected by the St. James pipeline alternative.

3.4.2 Impact on Displacement Water Source

The St. James pipeline alternative would not alter the source or quantities of water required for oil displacement. Environmental impacts of this system are described in Section 3.4.2 of FES 76-5.

3.4.3 Impacts of the Brine Disposal System

The St. James pipeline alternative would not alter the brine disposal method or the quantities of brine to be displaced from the caverns by filling the caverns with oil. Environmental impacts of this system are described in Section 3.4.3 of FES 76-5.

3.4.4 Impact from Pipelines

Development of the St. James oil distribution system would require construction of a 39-mile long, 36-inch diameter pipeline along the route shown in Figure 1.3. The construction of the pipeline would require a ROW 75 feet wide and would result in direct impacts to an estimated 255 acres of cleared agricultural land, 7 acres of sparsely populated residential land, and 93 acres of swamp forest (Table 2.4). The pipeline would also cross three large bayous (Plaquemine Bayou, Bayou Jacob, and Bayou Lafourche) plus a number of smaller bayous and canals. Descriptions of the environmental setting and habitat types traversed by the pipeline are provided in Section 2.4.

Approximately 95 percent of the SPR alternative pipeline ROW would closely parallel existing pipeline corridors. For purposes of analysis, it has been assumed that the rights-of-way would not overlap at any point so that the analysis would yield a conservative estimate of maximum impact. However, the indirect effects on the biota and habitat quality would be considerably lower than those that would be expected if the route were taken through previously undeveloped terrain.

The pipeline construction will have several possible effects on biota. Primarily the excavation can directly destroy vegetation and sessile organisms along the ROW. This destruction in turn would reduce the available habitat and therefore displace animal life which can increase the stress on neighboring animal populations. However, since the pipeline ROW is relatively long (39 miles) but narrow (75 feet) the local disruptive effects of construction would be isolated to small segments of the ROW.

Spoil banks can also disrupt normal migration patterns for aquatic life. Spoil runoff and sedimentation may lower water quality, smother benthos, and stress populations in adjoining areas. Construction noise and the physical presence of construction crews can disturb wildlife. Greatly altered physical conditions can prevent regeneration of productive habitats after construction is complete. The extent and significance of these impacts depends on the type of habitat crossed and the success of restoration measures in mitigating potentially lasting construction effects.

Construction through cleared agricultural land would primarily affect the crop and income generating productivity of the land. After backfilling and grading, most normal agricultural activities could be resumed without further impact. Pipeline construction normally results in temporary displacement of the resident biota. Some wildlife such as rabbits, rodents, and song birds (Section 2.4.1.1), which utilize agricultural and residential lands on and adjacent to levees would therefore be displaced. Long term effects of the displacement would be negligible since most native grasses or crops can return within a year. In the short term, lands adjacent to the pipeline ROW are generally available for temporary use without overstressing existing populations. Short term effects will vary in significance depending upon the suitability of adjacent habitats.

Construction impacts on the ecology of the swamplands are more serious and potentially long lasting. Vegetative and animal productivity in these swamps depend to a great degree on hydroperiod, adequate circulation, and the water quality in the swamp. Pipeline canals and spoil banks can create stagnant water conditions, excessive drainage, or heavy sedimentation, any of which can affect biological productivity and habitat quality not only within the immediate ROW but in adjacent wetlands as well. The duration of these impacts is usually dependent on the success of re-establishment of the original hydrologic flow patterns after backfilling of the pipeline ditch.

Pipeline construction across bayous and canals disturbs the bottom sediment and also suspends material in the water column (Section 3.2). Benthic organisms are generally destroyed within the ROW because they are removed with the excavated material or they may be affected several hundred feet downstream by increased turbidity or suspension of toxic materials in the water column. These effects are usually of short duration, however, and recolonization of the impacted area should occur within several months. Mobile organisms can usually avoid the affected area. Plankton organisms may be reduced by high turbidities or increased levels of toxic materials but the percentage of the total plankton population affected by the excavation would be negligible.

Data on carrying capacities of typical habitats found in Louisiana have been used to provide an estimate of potential direct displacement effects on wildlife due to the pipeline. Using the acreage to be impacted (Table 2.4) and estimates of faunal carrying capacity given in the Corps of Engineers Environmental Inventory (1973), an estimate of the number of individuals which could be displaced from the pipeline ROW has been made.

Table 3.5 summarizes this estimated potential short-term and long-term impact on selected species due to direct habitat disruption. A worst case effect would occur if animal populations in the area to be impacted were at optimum levels and if adjacent habitats were already at their full carrying capacity such that further increases in population could not be sustained. This case would result in the death of the individuals or species least able to compete for food and shelter in numbers approximately equal to those displaced from the pipeline ROW. It has been assumed that agricultural and residential lands can fully recover in 1 to 2 years. Swamp forest areas have been assumed to recover new growth and productivity in about 10 years (although complete regrowth may take 30 years or longer) within the portion of the ROW which is allowed to revert to natural conditions with woody vegetation (25 feet). The remaining 50-foot permanent ROW through these swamp lands has been assumed to be kept cleared and essentially unproductive for the life of the project to allow maintenance and inspection of the pipeline. The estimates in Table 3.5 are necessarily based on average carrying capacities, since site specific baseline inventories have not been made for the proposed pipeline route.

As indicated previously, nearly the entire ROW parallels an existing, and cleared, pipeline corridor. The most ecologically productive habitat along the ROW is the 6-mile segment of swamp located to the west of St. James at the upper end of the Des Allemands-Salvador-Barataria Drainage Area. All other segments of swamp crossings are short discontinuous reaches adjacent to cleared and drained agricultural lands. In addition, some degradation in habitat quality can be expected as a result of indirect effects on water quality and surface water flow patterns. These effects should be primarily short term (less than six months) and may involve partial loss of productivity over an additional 100 to 200 acres.

Estimates of impacts on aquatic life at the pipeline crossings are necessarily approximate because of differences in substrate and/or flow characteristics at the crossings, as well as standing crop of biota at these locations. Losses would be limited primarily to benthos, plankton and macrophytes, though the reduction in food web biomass may have some small effect on fish life for a period of several months. The total length of bayou and canal crossings along the pipeline route is less than 0.25 miles. Assuming that all of the benthos and plankton at each crossing were destroyed by siltation or excavation for 0.25 miles of stream length at each crossing (considered conservatively high), the total affected area would be 40 acres. Using data established for benthos populations in several freshwater lakes in southcentral Louisiana (Lantz, 1974), and data on plankton net productivity for southern Louisiana (Day, et al., 1973), the total impact estimated would then be 1.1×10^8 benthic organisms and 2.8×10^6 gm dry weight of phytoplankton (assuming 1 week of highly turbid waters at each crossing).

Comparatively, none of these local impacts are considered significant to the project region. However, each pipeline ROW constructed through the Louisiana swampland adds to the cumulative loss of productive wetlands in the region. Therefore, by planning the ROW for the pipeline to follow an existing ROW to St. James, previously undisturbed swamp land will not be directly affected. However, most sections of the route have only one pipeline ROW, possibly with a shallow depression that does not greatly affect natural surface drainage. Widening these right-of-way or laying a parallel pipeline trench increases the risk of surface water flow disruption and creates a pipeline corridor likely to be used again in the future.

Potential impacts resulting from oil spills which could occur during fill or withdrawal operations for the St. James alternative are treated in Section 3.7.

3.4.5 Impacts from Dock and Terminal Facilities

Less than 10 percent of the initial crude oil fill operations would be conducted from existing barge facilities located at Bull Bay adjacent to the site. No expansion of these facilities is planned with the development of the St. James pipeline alternative. Subsequent fill operations and most (more than 90 percent) of the oil withdrawal would utilize the pipeline to the St. James Terminal.

For the tanker dock which would be constructed on the Mississippi River near the St. James Terminal (40 miles southeast of Bayou Choctaw) up to 20,000 cubic yards of earth would be excavated from the river bank (above the normal water level) and deposited on the levee. Another 10,000 cubic yards of material would be dredged from the river bed and subsequently deposited in the river channel in water depths greater than 50 feet. This procedure is standard practice for channel maintenance dredging. The resulting increased turbidity in the river would be evident for several hundred yards downstream. Adverse impacts would be local and negligibly low. Plankton populations in this part of the river are generally expected to be low. Plankton are carried along with the river currents and therefore the plankton found in the river near the terminal have been displaced from upstream backwater areas (Day, et al., 1973). Fish would avoid the extremely turbid areas in the main channel, but the large riverine forms found in the Mississippi River are well adapted to high turbidities usually present in the water columns. Fish production in the river would not be reduced.

Aquatic macrophytes do not form an established bank community on the Mississippi River because of fluctuating water levels and steep banks; therefore, impact on the aquatic macrophytes would be minor.

During dredging activities, pesticides and heavy metals in the sediments would be widely dispersed in the water column and in large measure would be readsorbed on sediments downstream. Background levels of these pollutants are high in the lower Mississippi. Construction of the dock would result in a redeposition rather than an increase of these pollutants.

Bank degradation above the water level in the river would affect the biotic populations living in or on the bank. There is some shrub and tree vegetation which provides wildlife habitat adjacent to the planned dock site. The soil excavated from the bank would be used as fill during construction of the containment levee around the storage terminal.

The terminal facility at St. James would be constructed on approximately 30 acres of cleared land located west of the new dock or on Koch Oil Company land further north (Figure 1.4). The existing terrestrial flora and fauna are species which can tolerate disturbed soil conditions. After construction is complete, most displaced birds and small mammals would move back into the area.

Biological impacts could also result from the operation of the terminal facility due to oil spills from tanker transfer and transport operations. An analysis of the risk of spills and the associated impacts to the aquatic environment is provided in Section 3.7.

3.4.6 Summary Comparison of Biological Impacts

Construction of all components of the Bayou Choctaw SPR project, as originally proposed in FES 76-5, would have an impact on 1350 acres. Construction of the St. James oil distribution system would avoid the impact of 10 acres of dredging and fill at Bull Bay, 75 acres of pipeline ROW construction between Bayou Choctaw and Addis, 30 to 40 acres involved in terminal construction, and 1.5 million cubic yards of dredged material and channel disposal of spoil in the Mississippi River.

Use of the St. James alternative would result in a total impact area of 1611 acres for the Bayou Choctaw project. Additional acreage effects include construction of a surge tank and dike on 1 acre at Bayou Choctaw, disruption of 355 acres of land along the 39-mile pipeline ROW, 30 acres at the St. James Terminal and approximately 30,000 cubic yards of excavation for the tanker docks, most of which would be used for fill at the terminal site. The net effect of this alternative is substitution of a 39-mile long pipeline corridor with its associated local impacts on hydrology and habitat quality for a similar 5-mile pipeline corridor and elimination of most intensive, short-term impacts on local water quality through dredging and spoil disposal.

It is very unlikely that any threatened or endangered terrestrial or aquatic species would be significantly affected by either alternative except for the risk due to a major oil spill. Displacement or minor loss of some commercially or recreationally significant species may occur locally, but this impact would not be regionally significant. Threatened and endangered plants and aquatic organisms are not known to inhabit the project area.

3.5 WASTE DISPOSAL

The volumes and types of wastes generated by the originally proposed Bayou Choctaw development would not be greatly affected by development of the St. James alternative. Several additional push ditch sites and pipeline construction access sites would be required along the 39-mile St. James pipeline route. The pipeline construction contractor would be required to leave all of these sites clear of wastes. The waste volumes attributable to the pipeline would not be large enough to overload the capacity of nearby sanitary land fills and some of this material would be available for recycling.

Disposal of the wastes generated by the storage facility, such as brine and waste oil, would be unaffected by the St. James oil distribution system alternative.

3.6 SOCIOECONOMIC EFFECTS

3.6.1 Manpower Requirements

3.6.1.1 On-Site Construction and Drilling

Manpower required to construct the oil storage, raw water supply, and brine disposal facilities at the Bayou Choctaw dome site would be unaffected by the proposed St. James pipeline alternative. The number of workers required onsite is not expected to exceed 70 men at a maximum and, for much of the construction period, would not exceed 50 men (FES 76-5, Section 3.6.1).

3.6.1.2 Construction of Oil Pipeline to St. James

The proposed 39-mile pipeline between Bayou Choctaw and St. James is planned to be constructed in a period of 6 months (Table 1.1). The work is expected to be accomplished by a single crew with a peak size of 125 men and a total labor requirement of 475 man-months. Most of these men would be skilled laborers. Construction of the 5-mile pipeline to Addis is estimated to require 100 men in one crew for a period of up to one month.

3.6.1.3 Construction of Tanker Dock and Terminal at St. James

Construction of the tanker dock at St. James is estimated to take about 9 months; the terminal would require 7 months. Average manpower requirements for these facilities are expected to be 33 men for the dock and 50 men for the terminal. The total manpower would therefore amount to 650 man-months of labor. Because of the larger terminal facilities and two tanker docks which would be required at Addis, the manpower needed for that alternative is estimated at 1000 man-months. About half of the workers on the job would be unskilled laborers.

3.6.1.4 Summary Comparison of Construction Manpower Requirements

Construction of the St. James pipeline system is estimated to require a total of 1125 man-months of labor over a nine month period. Assuming a maximum construction crew size of 70 men for the Bayou Choctaw storage site facilities (FES 76-5), the maximum number of construction workers would total approximately 275 people for the first 3 to 5 month period. Thereafter, no more than 150 men would be required at any one time. For the Addis distribution system, labor requirements would be approximately 1100 man-months. The peak number of workers required would be approximately 250.

3.6.1.5 Facility Operation

During facility standby operation, approximately 10 workers would be required for maintenance and operation. During periods of oil fill and withdrawal, a total of 20 to 30 skilled laborers would be needed to carry out the oil transfer activities. These manpower requirements would not be affected greatly by development of the St. James alternative.

3.6.2 Sources of Labor and Supplies

Construction is a major industry in the Baton Rouge area, and it is anticipated that experienced contractors would be available. In East Baton Rouge Parish alone there are about 700 construction contractors, employing over 15,000 workers (U.S. Bureau of Census, 1973). Work similar to that required for the proposed project has been performed by local firms involved in the development of oil fields and the construction of facilities for large petrochemical plants.

The work requires primarily skilled craftsmen and operators who in most cases are permanent employees of the contractors, and live in the Baton Rouge area. These workers would commute to their jobs at the Bayou Choctaw site, or to the other construction sites along the pipeline route, and at the terminal and dock facilities on the Mississippi River.

Many of the supplies could be purchased from local firms in Baton Rouge. Specialized equipment, pipe, and wellheads may be brought in from regional suppliers in New Orleans, Morgan City, and Lafayette.

3.6.3 Community Effects

No significant migration of workers to the area is anticipated to result from the project. The major impact on the communities would be increased traffic on State Highway No. 1 leading from Baton Rouge to Donaldsonville, and on the parish roads leading to the storage site, the pipeline route, and the dock area. However, project workers would be working a 10-hour shift and, their commuting hours would not be expected to coincide with normal commuting traffic.

Sufficient rental housing units are available in Baton Rouge to accommodate the 25 to 50 workers and families that might be drawn from outside of the region during peak periods of construction.

Construction activities for the pipeline route should not have a significant effect on the normal community activities. At busy highway and railroad crossings the pipeline would be bored underground; at lightly travelled intersections some minor delay may be necessary. Waterway crossings at Bayou Jacob, Bayou Lafourche, and Plaquemine Bayou would cause some inconvenience primarily to pleasure craft. The bayous would be passable at all times, however, and total construction time should be no more than a week at any single crossing site.

Except for the temporary period during construction activity, there should be no adverse impact on aesthetics in the vicinity of area residences or highway crossings. The areas to be utilized for surface facilities at Bayou Choctaw and St. James are either in or adjacent to industrial activity centers. Within the swamp forest, the construction and maintenance of a cleared pipeline ROW is a definite adverse impact on aesthetics. The persons affected would be hunters, trappers, fishermen and other recreationers. Nearly the entire 10.2-mile corridor through swamp forest parallels an existing pipeline ROW. However, the overall impact is judged to be of significance to those persons utilizing the swamp.

The operation of the storage facility would, by itself, contribute very little to the overall growth of the predominantly rural area of the four parishes. If the dock facilities built on the Mississippi River are permitted to be used by private industry when they are not needed by the Federal government, this could encourage incidental growth at St. James.

Operation of the project would not produce a need for additional housing in the region. Almost all workers would be hired from Baton

Rouge and surrounding towns, and would commute to their jobs. The additional activity in the area and installation of equipment can be expected to contribute to the demand for expansion of police and fire protection services. Continued use of the site might require expenditures to be made by the parishes to upgrade access roads to the area.

School systems are not expected to be affected by the project since it would not draw significant numbers of new families with school-age children to the area.

Security guards would be stationed at the storage facility site and at the dock to prevent theft of equipment and materials. The guards would cooperate in their activities with the sheriff's department of Iberville and St. James Parishes, which have jurisdiction over these areas. Fire-fighting equipment would be on hand at the site and the dock. Auxiliary aid in containing fires is available from local fire departments.

Medical facilities in Plaquemine, White Castle, Donaldsonville, and Baton Rouge would be used to provide emergency care to workers at the site and at the dock. Since workers and their families would primarily be established residents of the Baton Rouge metropolitan area, no additional growth pressure on health services is expected to result from the project.

3.6.4 Economic Impact

3.6.4.1 Employment and Payroll

The major local benefit of the project would be the direct employment and payroll. It is anticipated that a number of local contractors would be hired for various phases of construction. The payroll during site preparation and construction of the St. James oil distribution system would be approximately as follows.*

Month	1	2	3	4	5	6	7	8	9	10
No. Workers	83	116	208	208	208	116	83	33	33	33
Total Wages (in thousands of dollars)	145	203	364	364	364	203	145	58	58	58

*Based on an average wage rate of $1750 per month and Table 1.1.

This payroll amounts to a total of $1,962,000 and is approximately $44,000 more than would accompany the construction of an oil pipeline system to Addis. Total payroll for construction of the entire storage facility is estimated to be approximately $4,000,000 over a 2.5 year period.

Using either oil distribution system alternative, payroll for the staff of 10 persons required for maintenance of the site would amount to about $18,000 per month for the life of the project. During periods of oil withdrawal and refill of the cavities, the payroll would rise to $43,750 per month. Income received by workers would tend to circulate in the Baton Rouge area.

The only potential adverse economic impact which might be associated with the St. James oil distribution system would be the loss of agricultural crops along the pipeline ROW. FEA would reimburse the land owner for any crop losses caused by facility construction.

3.6.4.2 Local Business and Industry

The construction phase of the project would benefit the following local businesses: building contractors, construction material suppliers, pump and pipe manufacturers and distributors, metal fabricators and suppliers, and drilling companies. There are also a number of firms in the area that specialize in the repair of the kinds of equipment that would be used. It is expected that these local contractors would be used as much as possible. The business generated by the project would not create a significant number of permanent new jobs, but would be an important source of income for these industries.

3.6.4.3 Tax Benefits

The three main sources of tax revenue for Louisiana and the parishes are: (1) severance taxes (and royalties) from the extraction of oil and gas, (2) property taxes, and (3) sales tax (3% State tax plus 3% city and parish tax on general goods and services). Severance tax would not be affected by the SPR program. If the site, rights-of-way, materials and equipment are federally owned, then these items would be exempt from property and sales taxes now received from private owners. There is a possibility that the dock and terminal at St. James would be constructed and operated by private industry and leased to FEA. This arrangement would add to the local tax base. No existing valuable industrial property would be affected by the proposed oil distribution facilities.

3.6.4.4 Community Costs

Costs to the community would be primarily those paid for public services: for example, trash collection, police and fire protection, and the added costs of road maintenance in the vicinity of the project.

The present and projected growth rate of general construction, heavy industry and the petrochemical industry in the area indicates that replacement jobs at the end of the project's construction period would probably be available.

3.6.4.5 Archaeological and Historical Impacts

No known cultural resources would be affected by construction or operation of the proposed oil distribution system (Section 2.6). In recognition of the potential existence of undiscovered sites, a cultural survey would be conducted prior to finalizing and constructing the pipeline route alignment. Based on this survey, appropriate measures would be taken to avoid destruction of important cultural sites. The State Historic Preservation Officer would be contacted for approval prior to, and after completion of, the field survey.

3.6.5 Summary Comparison of Socioeconomic Impacts

Construction of the alternative St. James oil distribution system would require an estimated 1125 man-months of labor, which is nearly the same as would be required for the Addis system. Peak manpower requirements are 275 for St. James and 250 for Addis. Total payroll would be approximately $44,000 larger for the St. James alternative.

Effects on community services and amenities should not be significantly different for the two alternatives. The longer pipeline to St. James would require more crossings of transportation corridors and aesthetic impacts to swamp forests would be much more extensive. Also more land would be removed from public tax rolls. For both alternatives, manpower and contractors would come predominantly from the local area.

Operation manpower requirements are essentially unaffected by the choice of oil distribution system alternative.

3.7 EFFECTS OF ACCIDENTS AND NATURAL DISASTERS

Spill expectations were previously estimated in FES 76-5 for a storage capacity at Bayou Choctaw of 99 million barrels of petroleum. The principal oil transport mode was by tanker via a terminal at Addis. In order to compare this action with the alternative of utilizing a terminal at St. James, the oil risks have been recalculated for both alternatives based on 94 MMB storage capacity at Bayou Choctaw and using the oil transport system as described in Section 3.3 of this Supplement.

The methodology used in these calculations is summarized in Appendix B. The projections in this Supplement differ from the prior estimates in FES 76-5 in that a number of smaller spills are attributed to oil transfer operations and vessel operations. Spills due to bilge valve opening, loss of oily coolants, and so forth, are included as vessel casualty rather than transfer spills. The projected spill size averages are thus lower in the Supplement than in FES 76-5.

The spill expectations compared in Tables 3.6, 3.7, and 3.8 show that differences are most pronounced between the two alternatives for oil withdrawal. These differences are largely due to handling spills involved in utilization of barges and the larger number of handling steps required to deliver petroleum to the Capline pipeline for the Addis alternative. The chance of a spill greater than 10,000 barrels in size is approximately the same for both alternatives.

The assumed average cargo is estimated to be 20,000 barrels for barges, 300,000 barrels for lighters, and 448,000 barrels for interport tankers. These estimates represent, respectively, cargo averages for barges of 2750 - 3000 DWT, tankers of 45-55 MDWT, and tankers of 65-105 MDWT operating under ballast and draught restrictions.

3.7.1 Pipeline Accidents

Because of the significantly longer pipeline length, the St. James alternative involves a greater expectation of pipeline spills than the Addis alternative. The higher spill expectation for St. James during initial fill is due to more oil being moved by pipeline and less by tanker and barge. The overall probability of a pipeline spill, including the standby period, during project lifetime (assumed to be 22 years, 1979-2000) is 45 percent, with a total spillage expectation of 475 barrels (Tables 3.6, 3.7, and 3.8).

For the Addis alternative, the spill probability for the pipeline is 7 percent, with a total expected volume of 77 barrels.

3.7.2 Risk of Oil Spills During Marine Transportation

3.7.2.1 Vessel Casualties

For both of the Bayou Choctaw alternatives considered, vessels provide the major exposure for a large spill. During the life of the project, the total inland waterway spill expectation for the St. James alternative is 2056 barrels in 4.8 spills, compared to 2578 barrels in 6.0 spills for the Addis alternative. The spill expectation in Gulf of Mexico waters within 12 miles of Southwest Pass is 75 barrels (.067 spills).

The chance of a vessel spill with a volume greater than 10,000 barrels during the life of the project is 2.42 percent for the St. James system and 3.0 percent for the Addis system. Thus, there is no significant overall difference in exposure to major spills between these two alternatives.

The above estimation is based upon a maximum credible spill size of 60,000 barrels. A larger statistical size limit could be assigned to the 80,000 DWT class tankers which are assumed to be used in the withdrawal cycles and this limit could have the mathematical effect of increasing the large spill expectation. For example, using a maximum spill size of 100,000 barrels for the larger tankers would increase the expected occurrence of spills larger than 10,000 barrels by 2 to 3 percent (e.g., from 2.42 percent to 2.47 percent). The increase would be nearly equal for either alternative and does not substantially affect the results.

3.7.2.2 Transfer Spills

The Addis alternative involves a considerably larger number of vessel transfers, and is thus projected to have a correspondingly smaller average spill size than the St. James alternative. For example, in a single withdrawal, the Addis distribution system would require 1050 barge loadings and 675 barge unloadings, 181 tanker loadings and 53 tanker unloadings, compared to 375 barge loadings and 128 tanker loadings required for the St. James system. Transfer spills are thus more likely with the Addis alternative (3458 barrels total) than with the St. James alternative (2547 barrels, Tables 3.6, 3.7, and 3.8).

The methodology used in these estimates results in a projection of an average spill which is dependent upon transfer size. Since pump rates onboard and dockside tend to be sized by vessel capacity, this outcome would be expected and implies that the common factor in transfer spills is related to the time required to diagnose a leak and to take corrective action.

3.7.2.3 Marine Terminals

The average size of a terminal spill (spill from surface facilities) in the United States during the 1969-73 period of the data base was about 1100 barrels. The proposed Bayou Choctaw terminals (surface facilities) are atypically small compared to normal petroleum facilities; therefore an assumed average of 500 barrels has been selected for these smaller terminals (the large underground storage at Bayou Choctaw is considered separately, see FES 76-5). However the tie-in to a large complex such as that found at St. James poses additional exposure; therefore a normal average spill size was adopted (1100 barrels) for this terminal.

The total oil spillage projected during the project lifetime from terminal operations with the St. James alternative is 734 barrels, compared to 535 barrels with the Addis alternative. The greater total spillage for the St. James alternative is a result of the larger average spill size assigned to terminal operations at St. James and the more frequent use of a terminal at Port Allen for transfer between tankers and barges.

It should also be noted that terminal spills usually have no external environmental impact because diking at the terminals prevents oil discharges from reaching the offsite environment or damaging the ecology except under unusual circumstances.

3.7.2.4 Ecological Impact from Oil Spills

General Oil Movements

Oil releases from the Bayou Choctaw storage system due to operation of the St. James oil distribution system may originate from barges, tankers, transfer operations, terminal facilities or pipelines. The most likely areas impacted by these releases would be the Mississippi River, Gulf of Mexico, ICW, or lands crossed by the pipeline between Bayou Choctaw and St. James. The amounts which could be expected in these releases are listed in Tables 3.6, 3.7, and 3.8, but these are statistical expectations and therefore it is possible that a large spill could occur at any of these locations.

Oil which reaches waterways or flooded wetlands can spread rapidly and widely to other areas. Where dilution and mixing are great, as in the Mississippi River or Gulf of Mexico, biological effects are usually difficult to measure. Where water is shallow and currents weak, as in surface waters or swamps along the pipeline route, near Bayou Choctaw, or in some coastal estuaries along the delta, oil can spread throughout the water column and toxic quantities can be deposited on the substrate. It has been assumed in the following estimates that 6 barrels of oil per acre would produce 100 percent destruction of immobile life forms in these shallow waters.

Oil spilled on dry land, or reaching thick stands of marsh grass would be adsorbed onto the soil and vegetation. Although relatively small areas would be affected, the impacts would often be intense. An oil coating of 25 barrels/acre, based on studies by Mackin (1950), is assumed to produce total destruction of immobile life forms (except possibly the root systems of some plants) in dry land and marsh areas.

Oil released from a buried pipeline would tend to migrate along the pipeline within the trench. Since the water table is near the surface of the ground along most of the pipeline route the oil would tend to collect in the low areas where the trench intersects the water table. The primary constituents of oil tend to float on water so that there is little danger of an oil spill penetrating the saturated silts and clays overlying the Plaquemine aquifer under normal conditions. However, some of the more soluble components of the oil, particularly the aromatic hydrocarbons, could migrate within the cones of influence of pumping wells and downward along the casings of improperly completed walls. This migration would result in an unpleasant taste and aroma in the water effected. However, since most wells in the area penetrate the Plaquemine aquifer, which is overlain by 100 feet of silts and clays, it is unlikely that any major domestic water supplies would be affected by a spill.

Biological Impacts

Impacts of oil spills on aquatic and terrestrial organisms are described in FES 76-5. Average spills from vessels are estimated to be about 430 barrels (except 1111 barrels in the Gulf); average spills from pipelines are estimated at 1100 barrels. Corresponding maximum credible spills are taken to be 60,000 barrels and 5000 barrels, respectively. In shallow waters along the pipeline route, a single worst case spill could have lethal effects over 830 acres (5000 acres/6 bbl/acre); if a major tanker spill should reach shallow coastal waters, up to 10,000 acres could be affected (60,000/6). Impacts to wetlands could occur on 200 acres (5000/25) and 2400 acres (60,000/25) for pipeline and tanker spills, respectively. Expected spill impacts, based on annual releases given in Tables 3.6, 3.7, and 3.8, would be much lower (between 2 and 25 acres per year over the project lifetime).

Biological impacts attributable to the Addis or St. James alternative would be similar for both oil distribution systems, although approximately 14 percent more oil spillage is expected with the Addis alternative. There is a greater chance that wetlands southwest of the Mississippi River levee would be affected by the St. James alternative because of the greater length and location of the pipeline. Pipeline accidents are statistically less likely to occur than tanker or barge accidents, however. Because of the great amount of oil transported by tanker and barge, the Mississippi River, Port Allen canal, and Bull Bay are likely to receive more oil spillage if the Addis alternative is developed.

3.7.3 Fires and Explosions

The intrinsic risks from fire and explosion are related to vessel casualties and terminal accidents. Pipeline risks from these hazards are very low.

The exposure to fire and explosion can be evaluated implicitly as 15 percent of vessel casualty and 20 percent of terminal spills. The chance of fire and explosion would rate comparatively as 0.96 events for the Addis route and 0.83 for the St. James route; thus, the alternatives show no significant difference for the life of the project. This evaluation is implicit in that it does not attempt to evaluate the relative damage potential; this potential is high at St. James and for tankers and low for the other terminals and for barges. The inclusion of damage potential would attribute a greater risk to the St. James alternative.

3.7.4 Accident and Injury

The potential for accident and injury can be projected from the industrial rates for petroleum and marine transport categories (National Safety Council, 1975). Incidents per million man-hours (1973 basis) are:

	Petroleum	Marine Transport
Time-lost injury	6.56	10.86
Serious injury	.09	.16
Fatality	.08	.03

The marine transport casualty rate is above the national average of 10.2 incidents per million man-hours, but petroleum casualty rates are well below average. From operational manpower estimates over the 22-year life of the project, the following casualty incidence is projected:

	St. James		Addis	
	Terminals	Transport	Terminals	Transport
Million man-hours	1.52	5.95	1.51	12.90
Time-lost injury	9.97	64.6	9.91	140.1
Serious injury	.14	1.0	.14	2.1
Fatality	.12	0.2	.12	0.4

Casualty exposures to the public at river ferry crossings have not been computed, but would be higher for the Addis alternative, due to more river traffic generated. The increased exposure, however, is due to barges, not tankers.

3.7.5 Natural Disasters

Natural disasters that may affect the oil distribution system include seismic events, hurricanes, tornadoes, high winds, lightning, and floods. However, these phenomena are not expected to pose a severe threat to the project, nor to cause the project to seriously degrade the environment. The effect of natural disasters on pipelines and tankers has already been factored into the statistical estimates used in Section 3.7.1 and 3.7.2. Other potential effects of disasters such as seismic risk, severe weather, and lightning are examined in this section. The St. James and Addis facility alternatives are considered to have similar risks due to these natural disasters.

3.7.5.1 Seismic Events

The risk of seismic events for southeastern Louisiana is described in FES 76-5. There is estimated to be a 50 percent probability of an earthquake occurring in the area during the life of the project. Ground movements should be small since the maximum seismic intensity recorded in the area was VI on the modified Mercalli scale. Consequent effects on pipelines should be negligible.

The greatest potential for seismic damage would be the two 400,000 barrel storage tanks to be located at the terminal area near St. James. Although the likelihood of a catastrophic rupture of a storage tank is small, the dikes surrounding the tank would be designed to contain the entire volume of oil in each tank.

Seismic risks are concluded to be minor for both the St. James and Addis alternatives.

3.7.5.2 Severe Weather and Floods

A major hurricane passes through the Bayou Choctaw area about every four years (Simpson, et al., 1971). Heavy rainfall, local and regional flooding, and tornadoes often accompany hurricanes. The storage integrity of the facility would not be threatened by a hurricane. Sufficient hurricane warning systems are available so that oil transfer would be stopped and the surge tanks emptied. The oil pipelines would be buried over much of their length and would not be affected. The St. James Terminal is located behind the Mississippi River levee on the natural river levee; this location is well above potential flood waters.

Tornadoes not associated with hurricanes could be a more hazardous risk to the oil tanks because of the lack of a long range warning system. It is possible that a tornado could strike one of the large oil surge tanks near the dock and cause a major oil loss. The annual tornado frequency in this area is about three tornadoes for each 3600 square miles. The oil surge tanks would be designed to withstand very strong winds and should remain intact under most tornado conditions. Should a break occur, most oil would be trapped within the diked area.

3.7.5.3 Lightning

Although lightning may interrupt operations and cause fires if certain system components are hit, there is a low probability that fires would occur. In the event that a fire did occur, it would cause only slight environmental degradation in the form of air pollution. There is no risk of explosion from such fires in the Bayou Choctaw system.

TABLE 3.1 Elutriate Test Data for Plaquemine Bayou and Intracoastal Waterway

PARAMETER	EPA Recommended Quality Criteria for Aquatic Life (μg/l[a])	Test Results Bayou Plaquemine (μg/l)	Test Results Intracoastal Waterway (μg/l)
Cadium	4/30[b]	1.1	1.8
Chromium	50.0	0.5	0.5
Copper	1/10LC50	15.0	16.0
Lead	30.0	1.0	1.0
Mercury	0.2	3.0	0.2
Nickel	1/50LC50	21.0	21.0
Zinc	5/1000LC50	6.5	11.0
COD	-	221,000.0	658,000.0
TKN	-	2,480.0	1,240.0
Oil and Grease	-	-	-
Sulfide	-	-	-
Suspended Solids	80000	-	-
Phenols	100	-	-
Cyanides	5	-	-
PCB	0.002	-	-
Aldrin	0.01	.001	.001
DDT	0.002	.003	.012
DDD	0.006	.0015	.0015
DDE	-	.012	.003
Dieldrin	0.005	.010	.002
Chlordane	0.04	.010	.01
Endrin	0.002	.003	.003
Heptachlor	0.01	.001	.001
Lindane	0.02	.027	.001
Taxaphene	0.01	.05	.05
Diazinon	0.009	-	-
Malathion.	0.008	-	-
Parathion	0.001	-	-
Arsenic	-	-	-

[a] μg/l : Micrograms per Liter

[b] 4μg/l when hardness <100mg/l; 30mg/l when hardness >100mg/l.

Source: FES 76-5

TABLE 3.2 Estimated Hydrocarbon Emissions (Tons) Accompanying Transport of Oil[a]

A: St. James Distribution System Alternative

Location	Initial Fill	Refills(4)	Withdrawals	Storage Tanks[b]	Total[c,d]
Gulf of Mexico (Transfer to 45 MDWT tankers)	1,421	5,685	0	0	7,106(9,574)
Mississippi River[e] (Tanker/barge transit)	777	3,005	2,375	0	6,157(6,157)
Port Allen (Barges/tanker transfers)	296	0	0	24	320(240)
Bull Bay (Load 20,000 bbl barges)	0	0	1,213	0	1,213(795)
St. James (Load 80 MDWT tankers Offload 45 MDWT tankers)	766	3,316	3,292	1,146	8,520(8,520)
Total	3,260	12,006	6,880	1,170	23,316(25,286)

B: Addis Distribution System Alternative

Location	Initial Fill	Refills(4)	Withdrawals	Storage Tanks[b]	Total[c,d]
Gulf of Mexico (Transfer to 45 MDWT tankers)	1,421	5,685	0	0	7,106(9,574)
Mississippi River[e] (Tanker/barge transit)	1,087	4,114	3,598	0	8,799(8,799)
Port Allen (Barges/tanker transfers)	3,233	3,457	0	184	6,874(5,066)
Bull Bay (Load 20,000 bbl barges)	0	0	3,396	1,054	4,450(3,281)
Addis (Transfer to 80 MDWT tankers Offload 45 MDWT tankers)	136	2,575	4,216	2,429	9,356(9,356)
St. James (Offload 80 MDWT tankers)	0	0	710	0	710(710)
Total	5,877	15,831	11,920	3,667	37,295(36,786)

[a]Average conditions assuming Reid vapor pressure of 4 psi and density of 7.14 lbs./gallon.

[b]Estimated to occur continuously for a 22-year period, except at Port Allen where tanks would be leased during cavern fill.

[c]Entries in table calculated on basis of most likely arrival conditions of vessels (cleaned, uncleaned, or average) using factors derived in Appendix C. These are: VLCC to 45 MDWT tanker, cleaned; tanker to barge, uncleaned; fill barge, uncleaned; fill 80 MDWT tanker, average (i.e., indeterminate). During cavern fill, tankers draw ballast water. During cavern withdrawal, tankers carry ballast water to Gulf.

[d]Totals in parenthesis are for 50 percent tankers cleaned, 50 percent uncleaned, or average emission factors derived in Appendix C.

[e]All transit emissions are assumed to occur along the Mississippi River, although a small percentage occur in Gulf.

TABLE 3.3 Estimated Maximum Daily Hydrocarbon Emissions Accompanying Transport of Oil and Distances to Which Air Quality Standards Would Be Exceeded

A. St. James Distribution System Alternative

Location	Maximum Daily[a] Emissions (lbs.)	Maximum Downwind Distance[b] Concentration Exceeds Standard (Kilometers)
Gulf of Mexico (12 miles offshore)	150,192	34
Port Allen	27,216	16
Bull Bay	19,224	12.5
St. James	23,088	14

B. Addis Distribution System Alternative

Location	Maximum Daily[a] Emissions (lbs.)	Maximum Downwind Distance[b] Concentration Exceeds Standard (Kilometers)
Gulf of Mexico (12 miles offshore)	150,192	34
Port Allen	27,216	16
Bull Bay	19,224	12.5
Addis	23,088	14
St. James	18,360	12

[a]Calculated on the basis of maximum emission factors (uncleaned tanks) and Reid vapor pressure of 5 psi (Appendix C).

[b]Hydrocarbon standard is 160 $\mu g/m^3$, 3-hour average, 6 to 9 a.m.

TABLE 3.4 Construction Equipment Noise Levels

Equipment	A-Weighted sound level at 50 feet (dB)
Air Compressor	81
Backhoe	85
Concrete Mixer	85
Crane Mobile	83
Dozer	87
Generator	78
Grader	85
Pile Driver	101
Pump	76
Rock Drill	98
Truck	88

Source: "Noise Emission Standards for Construction Equipment Background Document for Portable Air Compressors." U.S. Environmental Protection Agency, EPA 550/9 - 76 - 004.

TABLE 3.5 Loss of Faunal Carrying Capacity (individuals or pounds) in Swamp Forest and Cleared Land Habitats Due to Construction of St. James Pipeline Route

	Swamp Forest		
	Short-Term [a]	Long-Term [b]	Cleared Lands [c]
Deer	1 to 2	2 to 4	-
Rabbit	15	30	24 to 87
Squirrel	40	80	5
Wood Duck	Less than 1	Less than 1	-
Bobcat	Less than 1	Less than 1	-
Migrant Waterfowl	3	6	218
Raccoon	3	6	-
Fox	Less than 1	Less than 1	Less than 1
Fish (lbs.)	12,400 to 18,600	24,800 to 37,200	-
Mink	3	6	-
Alligator	1	2	-
Otter	1	2	-
Woodcock	-	-	12 to 37
Dove	-	-	19 to 262
Quail	-	-	33 to 66
Song Birds	-	-	-

[a] Short-term swamp forest impacts occur within 25 feet of ROW, based on 31 acres cleared initially (Table 2.4). Productivity assumed to recover after 10 years.

[b] Long-term swamp forest impacts based on 62 acres (50 foot ROW) maintained clear of woody vegetation for at least the project lifetime.

[c] Impacts of construction through agricultural and residential lands assumed temporary. Full productivity recovered after 1 to 2 years.

TABLE 3.6 Expected Crude Oil Spills - Initial Fill

	St. James Distribution System Alternative			Addis Distribution System Alternative			
	No. of Spills	Average Spill Size	Total Spillage Expectation	No. of Spills	Average Spill Size	Total Spillage Expectation	Maximum Credible Spill (bbl)
Gulf - Transfers	17.4	16.2	282	17.4	16.2	282	1,000
- Vessel Casualty	0.01	1111	11	0.01	1111	11	60,000
Lower Mississippi[a]							
- Vessel Casualty[b]	0.32	428	137	0.245	428	105	60,000
Upper Mississippi							
- Port Allen Transfers	4.3	5.1	22	46.5	5.5	236	500
- Bull Bay Transfers	4.0	1.8	7	43.6	1.8	79	500
- St. James and Addis Transfers	3.2	27	87	0.6	26	15	500
- Vessel Casualty[b]	0.23	428	96	0.395	428	169	60,000
Pipelines	0.028	1100	31	$2.5X10^{-4}$	1100	0.3	5,000
Mississippi River Terminals[c]	0.048	500/1100	50	0.047	500	24	5,000
Bayou Choctaw Terminal	0.047	500	24	0.05	500	24	3,000
Total	29.6	25.3 bbl	747 bbl	108.8	8.7 bbl	945 bbl	

[a]Upper River - Baton Rouge to New Orleans
Lower River - Below New Orleans

[b]Bunker spills from tankers included. Diesel spills from tugs not included.

[c]Average spill size at Port Allen and Addis Terminals is taken to be 500 barrels; average size at St. James is taken to be 1100 barrels because of greater complexity and exposure.

TABLE 3.7 Expected Crude Oil Spills - Refill

	St. James Distribution System Alternative			Addis Distribution System Alternative			
	No. of Spills	Average Spill Size	Total Spillage Expectation	No. of Spills	Average Spill Size	Total Spillage Expectation	Maximum Credible Spill (bbl)
Gulf - Transfers	17.4	16.2	282	17.4	16.2	282	1,000
- Vessel Casualty	0.01	1111	11	0.01	1111	11	60,000
Lower Mississippi[a]							
- Vessel Casualty[b]	0.28	428	119	0.245	428	105	60,000
Upper Mississippi							
- Port Allen Transfers	-	-	-	12.4	5.1	63	500
- Bull Bay Transfers	-	-	-	11.7	1.8	21	500
- St. James and Addis Transfers	3.5	27	94	2.7	27	73	500
- Vessel Casualty	0.28	428	119	0.377	428	161	60,000
Pipelines	0.02	1100	18	0.0025	1100	3	5,000
Mississippi River Terminals[c]	0.05	1100	52	0.05	500	24	5,000
Bayou Choctaw Terminal	0.05	500	23	0.05	500	24	3,000
Total	21.6	33.3 bbl	718 bbl	44.9	17.1 bbl	767 bbl	
Total, 4 refills	86.4	33.3 bbl	2872 bbl	180	17.1 bbl	3068 bbl	

[a]Upper River - Baton Rouge to New Orleans
Lower River - Below New Orleans

[b]Bunker spills from tankers included. Diesel spills from tugs not included.

[c]Average spill size at Port Allen and Addis terminals is taken to be 500 barrels; average size at St. James is 1100 barrels because of greater complexity and exposure.

TABLE 3.8 Expected Crude Oil Spills - Withdrawal

	St. James Distribution System Alternative			Addis Distribution System Alternative			
	No. of Spills	Average Spill Size	Total Spillage Expectation	No. of Spills	Average Spill Size	Total Spillage Expectation	Maximum Credible Spill (bbl)
Gulf - Casualty	0.0034	1111	4	0.0034	1111	4	60,000
Lower Mississippi[a] - Casualty	0.20	428	86	0.20	428	86	60,000
Upper Mississippi							
- Bull Bay Transfers	4.2	3.6	15	11.7	3.6	42	500
- Mississippi River Transfers[b]	1.4	81	114	26.7	6.7	176	500
- Vessel Casualty[c]	0.205	428	88	0.38	428	162	60,000
Pipelines	0.008	1100	9	0.001	1100	1	5,000
Mississippi River Terminal[b]	0.043	1100	48	0.064	547	35	5,000
Bayou Choctaw Terminal	0.047	500	24	0.047	500	24	3,000
Total	6.0	64.4 bbl	388 bbl	39.1	13.6 bbl	530 bbl	
Total, 5 withdrawals	30.1	64.4 bbl	1938 bbl	195.0	13.6 bbl	2650 bbl	
Projected Total, 5 Cycles	146.1	38.0 bbl	5557 bbl	484.0	13.8 bbl	6663 bbl	
Projected Total with Oil Stored in Pipelines	146.4	40.2 bbl	5557 bbl	484.0	13.9 bbl	6723 bbl	

[a]Upper River - Baton Rouge to New Orleans
Lower River - Below New Orleans

[b]17% at St. James, 83% at Addis for Addis alternative. Tanker loading spill components equal for both alternatives.

[c]Bunker spills from tankers included. Diesel spills from tugs not included.

SECTION 4.0

PROBABLE ADVERSE ENVIRONMENTAL IMPACTS WHICH CANNOT BE AVOIDED

The anticipated significant environmental impacts of construction and operation of the proposed oil distribution system connecting Bayou Choctaw with St. James Terminal are summarized in Table 4.1. Also presented in this table are possible mitigating measures to reduce these impacts and a list of unavoidable impacts which would occur if the St. James alternative were constructed. A summary comparison of impacts which would accompany development and use of the Addis alternative (see Section 4.0, FES 76-5 for more detail) are also provided in the table.

The principal differences in impacts between the two alternative oil distribution systems are the following: (1) greater potential for disruption to the wetland environment would occur with the St. James alternative due to the longer pipeline route required to the St. James Terminal; (2) a reduced temporary impact on water quality and aquatic life in Bull Bay and the Mississippi River for the St. James alternative due to smaller dredging requirements; (3) reduced emissions of hydrocarbons (by 37 percent) with the St. James system because of the fewer barge/tanker transfers required; (4) a reduced potential of total oil spill risk (by 14 percent) occurring with the St. James alternative because of greater use of pipeline oil transport.

TABLE 4.1 Summary of primary environmental impacts, mitigative procedures, and unavoidable environmental effects.

ACTION	PRIMARY IMPACT	MITIGATION	UNAVOIDABLE IMPACT
Dredging and Spoil Disposal			
Bull Bay	None. Reduction from 9-10 acres disturbed with Addis alternative.	-	None
Mississippi River	10,000 cubic yards of dredged spoil removed from river bed and deposited in channel.	-	-
	Some minor increase in turbidity, TKN, COD. Short-term stress on aquatic life and loss of benthic invertebrates over 1-2 acre area.	Follow most recent advances in dredging technology.	Less than primary impact.
	Reduction from 1.5 million cubic yards dredged from river bed and deposited in channel with Addis alternative.	-	-
Enclosure of the Storage Site	About 31 acres of altered surface drainage, destruction of vegetation, commitment to industrial land use.	None	Same as primary impact
	About 40 acres altered in similar manner with Addis alternative.	-	-

TABLE 4.1 (Continued)

ACTION	PRIMARY IMPACT	MITIGATION	UNAVOIDABLE IMPACT
Construction of oil distribution pipeline	62 acres of swamp land converted to permanent right-of-way; 31 acres of swamp cleared for construction; 262 acres of agricultural and residential land temporarily disturbed for construction.	None	Same as primary impact
	Potential for additional impacts to natural drainage, water quality and habitat quality along pipeline route.	Return topography to previous conditions to preserve drainage patterns. Backfill pipeline trench as soon as possible and reseed land.	Less potential for degrading habitat quality.
	Temporary loss of benthic organisms and degradation of water quality at waterway crossings.	None	Same as primary
	For Addis alternative: About 15 acres of swamp forest converted to permanent right-of-way; 7.5 acres of swamp cleared for construction; 22.5 acres of agricultural land disturbed for construction. Potential for degradation of wetlands and water quality correspondingly lower.	-	-

TABLE 4.1 (Continued)

ACTION	PRIMARY IMPACT	MITIGATION	UNAVOIDABLE IMPACT
Barge and Tankship Traffic	Bank erosion and bottom scour.	Seed and plant banks with native vegetation.	Reduced soil erosion.
Air Quality			
Construction	Construction emissions are approximately the same for both alternatives. Minor degradation in air quality due to engine emissions, dust and spray painting.	Maintain engines in good mechanical condition, use gravel on areas crossed by heavy equipment and sprinkle with water when necessary; use high density primers and paints.	Less than primary
Vessel Transfers and Transport	23,300 tons of hydrocarbons emitted during 5 fill/withdrawal cycles; maximum rate of 75 tons per day in Gulf and 21.1 tons/day inshore.	Use of a vapor recovery system at dock.	Total transfer emissions reduced by less than 20 percent.
	Worst case hydrocarbon concentrations exceed standard 34 km downwind in Gulf and 16 km downwind inshore.	Use of a vapor recovery system at dock.	Distance over which standards exceeded reduced at St. James.
	For Addis alternative: total emissions would be 37,000 tons; maximum rate 75 tons/day in Gulf and 30.4 tons/day onshore; Standard exceeded up to 34 km in Gulf and up to 16 km inshore.	Use of a vapor recovery system at dock.	Similar emissions reduction possible for Addis alternative (20 percent).

TABLE 4.1 (Continued)

ACTION	PRIMARY IMPACT	MITIGATION	UNAVOIDABLE IMPACT
Terminal Operation	1170 tons total hydrocarbons emissions during project lifetime (approximately 52 tons/year) from storage tanks at St. James.	Use of a vapor recovery system on tank.	Reduced hydrocarbon emissions
	No significant emissions at Addis.	-	-
	For Addis alternative: hydrocarbon emissions total 2429 tons (110 tons/year) at Addis and 1054 tons (48 tons/year) at Bull Bay.	Use of a vapor recovery system	Reduced hydrocarbon emissions
Oil Spill Risks			
Expected Spill Volumes	Total spillage volume of 5900 bbl expected during project lifetime: 25% in Gulf, 55% in Mississippi River, 12% at terminals, and 8% from the pipeline.	Rapid deployment of oil containment and recovery equipment.	Much reduced amount of oil remaining to degrade environment
Risk of Major Spill (>10,000 bbls)	Estimated to be 2.4% during project lifetime; potential for widespread destruction of biological resources.	None	Same as primary impact.
Biological Effects	Contamination of sediment; loss of plankton, waterfowl, vegetation, taste effects on fish.	Rapid cleanup	Reduced exposure of environment

TABLE 4.1 (Continued)

ACTION	PRIMARY IMPACT	MITIGATION	UNAVOIDABLE IMPACT
Effects on Ground Water	Shallow aquifer contamination (<100 feet)	Remove oil-saturated soil; establish shallow well point system to recover oily water.	Reduced volume of oil reaching water table.
	Addis alternative would result in an expectation of 6723 bbl spilled; a 3.0% chance of a spill over 10,000 bbl; nearly 70% of the expected spillage would be in the Mississippi River; potential impact to onshore wetlands and aquifers would be somewhat lower.	Rapid deployment of spill containment and cleanup equipment.	Reduced exposure of environment.
Project Work Force	Increased local traffic and demand for services (same as Addis alternative).	None	Same as primary
Operation of SPR Facility	Responsibility to assure security and response to accidents (same as Addis alternative).	Dedicated security and fire fighting capabilities.	Minimal local responsibilities.

SECTION 5.0

RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND MAINTENANCE AND ENHANCEMENT OF LONG-TERM PRODUCTIVITY

This section describes the relatively short-term uses of the local environment that are implicit in the construction and operation of the proposed alternative for the oil distribution system between Bayou Choctaw and St. James and the expected effects on maintenance and enhancement of long-term productivity. Based on the analysis in the previous sections of this Supplement to FES 76-5, it is concluded that the proposed use of the pipeline ROW and the St. James Terminal and their environs would not significantly degrade the long-term productivity of the environment in these areas.

The principal short-term use of the St. James alternative would be the efficient transport of crude oil for use during a period of national emergency. This oil movement would contribute to the short-term availability of petroleum resources should the nation's foreign supplies be reduced, thus providing an element of stability and security to our economy and to our national well-being. Development of either the Addis or St. James facility would place about 75 million barrels of oil in storage by December 22, 1978.

Development of the St. James alternative would produce short-term adverse effects on the vegetation and wildlife at the terminal and along the pipeline ROW (described in detail in Section 3.4). due to the construction of these facilities. It is expected that wildlife would reestablish themselves within one year after construction is completed in these areas but only after some alteration in species balance resulting from clearing and disturbance to the vegetation. Hunting and fishing resources would be reduced temporarily but these resources should not suffer long-term impairment if care is taken to avoid permanent alterations in surface water hydrology patterns. Although the proposed pipeline ROW follows existing pipeline corridors, there is a greater potential for such alteration with the St. James alternative than with the Addis alternative because of the greater length and the fact that the ROW alignment crosses the general flow of surface drainage.

Construction and operation of the St. James oil distribution system would dedicate 31 acres of cleared land to industrial purposes, greatly reducing natural productivity of this land, and it is unlikely that this land would be available for agricultural activities in the future. Also, the natural productivity would be greatly reduced on 62 acres of swamp forest within the ROW during the life of the project. For the Addis alternative, approximately 50 acres would be permanently transformed into industrial uses and about 15 acres of swamp forest would be lost for natural productivity during the project lifetime.

Construction and operation of the St. James facility should not degrade water quality to any significant degree. On the other hand, short-term adverse impacts would be locally significant in Bull Bay and in the Mississippi River for the Addis alternative.

Operation of the project with uncontrolled release of hydrocarbon vapors from barges and tankers during oil transfer and transportation for both the St. James alternative and the Addis facility would produce a significant increase in atmospheric hydrocarbon loading, at least in the vicinity of the primary transfer terminals (Section 3.3). For the period of operation this increase could affect the development of future industrial sites in areas which experience noticeably increased hydrocarbon or ozone concentrations as a result of the project. This impact should be of greatest significance within 5 to 10 miles of the transfer terminals. Air quality impacts which would accompany use of the Addis alternative would be substantially more severe, however (Section 3.3).

Chronic or high-level pollution from possible accidental oil spills could have adverse impacts in certain areas. It is difficult to quantify these impacts or to estimate the short- or long-term effects of a major oil spill, since these effects would depend upon various factors such as size of the spill, season of the year, and the location and fate of the spill. Data provided on expected average spill rates and on maximum credible spill impact (Section 3.7) indicate that significant environmental damage should be localized and not affect regional resource values. Development of the Addis facility would be accompanied by slightly greater risks of oil spill due to the greater reliance on barge and tanker transportation for the oil distribution system.

SECTION 6.0

IRREVERSIBLE OR IRRETRIEVABLE COMMITMENTS OF RESOURCES

Of the resources committed to the development and operational phase of the proposed St. James oil distribution system facilities, only a few of these commitments are irreversible or irretrievable. These committed resources are:

Energy

The energy required for crude transportation for five fill/withdrawal cycles amounts to about 17.9×10^{12} BTU for the Addis transport alternative and about 17.2×10^{12} BTU for the St. James transport alternative. In terms of crude oil equivalence content (5.5 million BTU/barrel), the potential oil resource utilization for the proposed five cycle SPR program at Bayou Choctaw is about 3.25 million barrels for Addis and 3.13 million barrels for St. James. Since approximately 470 million barrels of crude can be provided by the site during the storage cycles, the energy resource utilization amounts to less than 0.7 percent of the potential energy storage capacity.

In addition, the energy content of materials required to construct the St. James oil distribution facilities is approximately 125,000 barrels of oil. Because of the much shorter pipeline required, energy requirements for constructing the Addis facility is only 26,000 barrels of oil.

Land Area, Vegetation, and Wildlife

Two resources that are irretrievably committed for the life of the project are the natural vegetation and wildlife that would be lost along the pipeline route and at the terminals. For the St. James alternative, a maximum of 268 acres of land would remain cleared of obstructive vegetation during the project lifetime. This commitment would alter the associated wildlife habitats in these areas for the duration of the project. During construction, there would be a temporary loss of vegetative productivity on an additional 118 acres of land adjacent to the pipeline.

Land committed to construction for the life of the Addis facility would be 95 acres. An additional 30 acres of vegetative productivity would be lost for a short period of time.

Construction Materials

Most of the concrete, steel, and other materials used in construction are also considered as an irretrievable commitment of resources since no estimate of salvage can be made at this point. Approximately 17,000 tons of steel would be required for pipe, tanks, and other components needed for the St. James oil distribution system. This is 13,500 more tons than for the Addis alternative.

Labor

To construct and operate the facility for twenty years, approximately 440 man years of effort are required. This involves approximately 140 man years of construction effort and approximately 300 man years of operational effort. There is little difference between the manpower required for development of either the Addis or the St. James alternative.

Investment

The total cost of construction for the project at Bayou Choctaw is estimated to be approximately 10 percent lower using the St. James alternative than using the Addis alternative. Operating costs would be approximately the same for either oil distribution system.

Oil losses due to spills are 5900 barrels from the St. James facilities and 6720 barrels with the Addis facility. (Recovery of spilled oil would be in the same proportion for both systems.) Differences in oil losses due to hydrocarbon emissions are more substantial, an equivalent volume of 163,200 barrels for the St. James alternative and 261,065 barrels for the Addis alternative (based on 7 barrels/ton).

SECTION 7.0

ALTERNATIVES TO THE PROPOSED ACTION

Alternatives to the proposed St. James oil distribution system include alternative modes of transportation, alternative terminal locations, and alternative pipeline routes.

No-action is not considered to be an alternative to the proposed St. James system; no-action is an alternative to the development of the entire Bayou Choctaw oil storage system and is discussed in FES 76-5.

7.1 ALTERNATIVE MODES OF OIL TRANSPORTATION

Various modes of transportation may be considered as alternatives to the St. James pipeline distribution system. For example, oil could be transported to and from the Bayou Choctaw storage site by means of tank truck, railroad tank car or exclusively by barge. These modes of transportation would avoid the need to build a pipeline to the Mississippi River. However, none of these transportation modes by themselves can be considered as feasible alternatives. For example, transportation of the oil by truck would require the installation of new roads to and from the site. Assuming that the normal tank truck would carry 130 barrels of oil per trip, filling the Bayou Choctaw storage cavern would require about 723,000 one way truck trips; a similar number of trips would be required for the withdrawal of the oil. The handling of oil in these small quantities would greatly extend the length of time both to fill and withdraw the oil from the cavern. In addition, because of the great increase in the number of transfer actions, the increase in hydrocarbon emissions from both truck engines and oil transfers would be very high. The risk of oil spills would be greatly increased because of the large number of trips and the increased handling in oil transfer, though the size of each spill would be relatively small.

Special railroad tank cars called "unit trains" could be used to carry the oil between the storage site and St. James. These trains are primarily used for long overland routes compared to the 40-mile distance between Bayou Choctaw and the terminal. To handle this traffic new railroad sidings and facilities would have to be constructed specifically for this purpose. Each unit train could carry about 50,000 barrels of oil (450 barrels per tank car); therefore at least 12 unit trains would be required each day to meet the required fill and withdrawal schedule.

Land requirements, capital costs, energy use and manpower needs for tank truck and tank car transportation would be high. Unit trains or tank trucks are not generally considered competitive with pipeline deliveries for distances of less than several hundred miles when large volumes of oil such as those required in the SPR program are considered.

At rates of more than 600,000 barrels per day (BPD), more than 30 barges would have to be loaded each day at Bull Bay or other facilities. Extensive dredging and filling would be required to construct the necessary barge docks. Barge traffic levels on the ICW and Mississippi River would be very high, and the risk of oil spills and atmospheric hydrocarbon emissions would be significantly increased, compared to distribution of oil by the St. James pipeline alternative.

7.2 ALTERNATIVE TERMINAL LOCATIONS

The closest available location for a tanker terminal on the Mississippi River to the Bayou Choctaw site is near Addis, Louisiana. A comparison of environmental effects associated with developing this site is provided in Section 3.0. Although a location may be found which is acceptable from the standpoint of collision risk between vessels on the river, it would still be necessary to transport oil by barge or tanker to St. James for delivery to the Capline pipeline system and subsequent distribution to refineries located in the midwestern states. A summary comparison of environmental impacts for the St. James and Addis oil distribution system is presented in Section 4.0. A summary comparison is also presented in Table 7.1.

A terminal location other than Addis would require a longer pipeline and would still present the problem of oil transportation by river to St. James and the Capline system. If the Addis location is not acceptable, St. James is the most logical alternative for the location of the oil distribution terminal. No other nearby terminal can provide the flexibility of facilities and delivery to an existing major inland crude oil pipeline.

7.3 ALTERNATIVE PIPELINE ROUTE

An alternative pipeline route could be followed in place of the proposed Bayou Choctaw-St. James route described in Section 1 of this Supplement. This alternative pipeline route would follow the Texas and Pacific Railroad ROW for most of the distance between White Castle and St. James (Figure 1.3). This route would avoid 70 percent of the wetlands crossed by the proposed St. James route. The lands crossed by the Texas and Pacific route are primarily agricultural or urban. Total pipeline length between Bayou Choctaw and the St. James Terminal would be reduced from 39 miles to approximately 36 miles if the Texas and Pacific route were followed.

As shown in Figure 1.3, this alternative route (Texas and Pacific) would follow the same St. James ROW from the Bayou Choctaw storage site to the vicinity of White Castle, Louisiana and would include the same crossings at Plaquemine Bayou and Bayou Jacob as required for the primary alternative. At White Castle the Texas and Pacific alternative ROW diverts from the St. James ROW to the east and follows the railroad ROW and State Highway No. 1 to Donaldsonville. At Donaldsonville, the pipeline could either continue along the railroad ROW through town, or skirt the town to the southwest and subsequently return to the railroad alignment for the remainder of the distance to the St. James Terminal.

The principal environmental advantage of the Texas and Pacific alternative pipeline route would be a reduction in the potential for impact on the natural drainage patterns along the ROW and on productivity and the quality of habitat in the swamp forest which is located along the primary St. James ROW. The Texas and Pacific pipeline ROW would cross less than 5 miles of swamp forest compared to 10.2 miles for the St. James ROW. In particular, the six-mile segment of swamp crossing west of St. James would be avoided.

Although the proposed 39-mile St. James pipeline ROW parallels an existing pipeline ROW for most of its length, it is considered unlikely that natural drainage patterns along the ROW are severly altered. Placement of a second pipeline in the same area increases the potential for this type of alteration and also increases the probability that the same corridor would be used for future pipelines.

Use of the Texas and Pacific Railroad ROW is consistent with the concept of utilizing levee lands for transportation corridors in coastal Louisiana. The only waterways crossed are linear drainage canals which are not highly productive natural habitats.

Another advantage to the use of the railroad ROW is the likelihood that an oil spill would be more easily confined and recovered if it occured on dry land than would be possible if the spill occurred in a flooded swamp forest. Oil spill impacts along the railroad alignment would be more localized and identifiable. Wetland productivity would not be affected unless a spill occurred within a waterway and the spill was not detected for several hours.

One of the several disadvantages to the use of the railroad ROW is that negotiation for ROW purchase or use would be considerably more complicated because more land owners would be involved; land costs could also be higher. Use of the railroad alignment would cause more disturbance to agricultural, residential and other developed land uses. Where the railroad ROW goes through urban areas it may be necessary to deviate from the railroad, particularly at Donaldsonville, if sufficient land is unavailable or sensitive land uses (e.g., hospitals) are adjacent to the ROW. Transit through the towns may also be undesirable because of the potential hazard, due to fire, of the oil. Another undesirable feature of the railroad alignment may be that vibration caused by trains could have some potential to affect or loosen the pipeline joints and thus increase the risk of oil spills (such risks are included in the spill data base used in Section 3.9).

There are a number of construction problems associated with the Texas and Pacific alignment: (1) the railroad roadbed was constructed by trenching on the sides which does not leave an area suitable for dry land pipeline construction; (2) due to industrialization along the pipeline ROW, significantly more roads would be crossed; (3) the drainage system of the roadbed would require special construction features; and (4) some utility lines located near the railroad may require relocation.

The basic tradeoff between these two pipeline routes appears to be between a greater potential for larger adverse impacts to wetlands with the proposed primary St. James route compared to the greater potential for short-term socioeconomic impacts with the alternate route along the Texas and Pacific railroad ROW. It is not expected that capital and operating costs would be substantially different for either of the two pipeline routes.

TABLE 7.1 SUMMARY COMPARISON OF ENVIRONMENTAL IMPACTS FOR THE ST. JAMES TERMINAL AND THE ADDIS TERMINAL

CONSTRUCTION IMPACTS SUMMARY

	GEOLOGY & SOILS	LAND USE	WATER QUALITY	AIR QUALITY	ECOLOGY
1. Barge dock					
a. original proposal: expansion of existing Bull Bay dock	86 x 10^3 yd^3 of material excavated and disposed	9-10 acres distributed	Widespread temporary degradation of water quality in Port Allen Canal	Insignificant paint solvent emissions; HC from construction activities	Temporary elimination of bottom species, and reduction of plankton productivity from dredging temporary disruption of wildlife and vegetation from dredge disposal
b. New proposal: no expansion	The new proposal deletes the impacts of expansion of the Bull Bay Barge dock.				
2. Tanker Terminal					
a. Original proposal: new facilities on Mississippi River near Addis, LA	86 x 10^3 yd^3 material excavated and disposed; 1.5 x 10^6 yd^3 dredged material from Mississippi River (for dock)	30 acres of shore property	Widespread temporary degradation of water quality in Miss. River; 7000 yd^3 sediment washed into surface waters	Paint solvent emissions	Temporary elimination of bottom species and reduction of plankton productivity from dredging, temporary disruption of wildlife and vegetation from dredge disposal
b. New proposal: new terminal facilities located either on Koch property or on property south of Capline Terminal, new dock constructed south of Capline Terminal	75 x 10^3 yd^3 earth moved 1.0 x 10^4 yd^3 material dredged from Miss. for dock	30 acres cropland permanently used	2750 yd^3 sediment into surface water	Paint solvent emissions	Temporary elimination of bottom species and reduction of plankton productivity from dredging, temporary disruption of wildlife and vegetation from dredge disposal

	GEOLOGY & SOILS	LAND USE	WATER QUALITY	AIR QUALITY	ECOLOGY
3. Pipeline to Tanker Terminal a. Original proposal: 5-mile pipeline	Minor movement of earth (approximately) 5.0×10^4 yd^3)	15 acres swamp forest converted to permanent ROW; 7.5 acres swamp cleared for construction; 22.5 acres of agricultural land	Localized degradation from increased turbidity, toxic sulfides, heavy metals, and other pullutants and accompanying decrease in dissolved oxygen	Temporary degradation from fugitive dust and vehicle emissions	Temporary disturbance of marsh species, wildlife and waterfowl. Disturbance should cease upon completion of pipeline construction
b. 39-mile pipeline	19×10^4 yd^3 earth moved 57.5×10^3 yd^3 material excavated in wetland areas	62 acre swamp land converted to permanent ROW; 31 acres swamp cleared for construction; 262 acres agricultural/residential land temporarily disturbed	Localized degradation from increased turbidity, toxic sulfides, heavy metals, and other pollutants and accompanying decrease in dissolved oxygen	Temporary degradation from fugitive dust and vehicle emissions	Temporary disturbance of marsh species, wildlife and waterfowl. Disturbance should cease upon completion of pipeline construction

SECTION 8.0

RELATIONSHIP OF THE PROPOSED ACTION TO LAND USE PLANS

Much of the general area in the vicinity of the project consists of deciduous swampland and bottomland forests and has been designated by the Louisiana State Planning office as wetlands. The area which includes the proposed storage site and most of the pipeline ROW is not planned for urban or suburban build-up. Of the adjacent parishes, only West Baton Rouge is vested with authority to enforce parish-wide zoning ordinances.

Land along the Mississippi River is developed for agriculture and heavy industry. The development of the proposed terminal at St. James is compatible with present land use patterns there. Land use plans and zoning restrictions have been proposed for both Iberville and West Baton Rouge Parishes, but none of these restrictions have been adopted.

The population of the six nearby parishes is expected to increase substantially between 1970 and 1980 as they are located along the New Orleans-Baton Rouge development corridor. Lands to be developed will consist predominantly of elevated areas along the Mississippi River and Bayou Lafourche natural levees. A generalized projection of land use for a large section of Louisiana, including the Bayou Choctaw project area, indicates that the storage site would be in an area designated as open space. The proposed pipeline would cross through agricultural land and swamp forest; the dock and terminal sites would be located in an industrial area. The projection further indicates that in the corridor affected by this project, some agricultural land may be converted to industrial usage, but only very short segments of the pipeline ROW would infringe upon areas designated for non-industrial urban usage.

SECTION 9.0

CONSULTATION AND RELATED PERMITS

A list of local, state, and Federal agencies, as well as industry and public organizations, contacted during the preparation of the Bayou Choctaw EIS is given in FES 76-5. Several of these same sources were contacted during the course of preparing this Supplement, notably the Department of Interior (Fish and Wildlife Service), Corps of Engineers, Environmental Protection Agency, Louisiana Air Control Commission, and Louisiana Wildlife and Fisheries Commission.

A list of permits and licenses, pertaining to the environment, which may be required is given in Section 9.2 of FES 76-5.

SECTION 10.0

REFERENCES

Section 1.0 References

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APPENDIX A

ESTIMATES OF EMISSIONS FROM TANKER AND BARGE TRANSFERS AND MODEL USED TO CALCULATE DOWNWIND GROUND-LEVEL CONCENTRATIONS

APPENDIX A

ESTIMATES OF EMISSIONS FROM TANKER AND BARGE TRANSFERS AND MODEL USED TO CALCULATE DOWNWIND GROUND-LEVEL CONCENTRATIONS

A.1 EMISSIONS FROM BARGE AND TANKER TRANSFERS

Emission factors for petroleum loading/unloading used in the Bayou Choctaw Supplement were based upon American Petroleum Institute (API) publication 2514-A(1976) and Appendix C. Factors used were as follows:

		Emission Factors (lb/1000 gal transferred)	
		Average Oil Properties	Worst Case Oil Properties
Ship Loading:	Cleaned	0.30	0.33
	Uncleaned	0.79	0.83
	Average	0.55	0.58
Barge Loading:	Cleaned	0.48	0.52
	Uncleaned	1.54	1.59
	Average	1.01	1.06
Ship Ballasting:	Cleaned	0.17	0.17
	Uncleaned	0.66	0.66
	Average	0.42	0.42

Average oil properties were assumed to be a Reid vapor pressure (RVP) of 4 psi and a temperature of 70^{o}F, while worst-case oil properties were based on an RVP of 5 psi. The specific emission factors used for the transfer operations in Section 3.3.2.2 (Table 3.2) are as follows (lb/1000 gal):

1) Transfer of oil between VLCC and 45 MDWT tankers 12 miles offshore: 0.30 (loading) + 0.42 (ballasting) = 0.72
2) Transfer from 45 MDWT tankers to 20,000 barrel barges at Port Allen: 1.54 (loading) + 0.42 (ballasting) = 1.96
3) Offloading 45 MDWT tankers at St. James and Addis: 0 + 0.42 (ballasting) = 0.42
4) Loading barges at Bull Bay: 1.54 (loading) + 0 = 1.54
5) Loading 80 MDWT tankers at St. James and Addis: 0.55 (loading) + 0 = 0.55

An average value of 0.42 lb/1000 gal was used for all ballasting emissions. Total emissions based on an average between cleaned and uncleaned tanks are also shown in Table 3.2.

Worst case emission factors used in Section 3.3.2.2 were based upon uncleaned tankers and barges. These factors are as follows (lb/1000 gal):

1) VLCC transfer in the Gulf: 0.83 + 0.66 = 1.49
2) 45 MDWT transfer to 20,000 barrel barges at Port Allen: 1.59 + 0.66 = 2.25
3) Loading barges at Bull Bay docks: 1.59 + 0 = 1.59
4) Loading 80 MDWT tankers at St. James and Addis: 0.83 + 0 = 0.83
5) Offloading 80 MDWT tankers at St. James: 0 + 0.66 = 0.66

A description of the physical and chemical basis for these emission factors is provided in Appendix C.

A.2 LOSSES IN TRANSIT

Transit losses are estimated at 0.01 percent per psi true vapor pressure (TVP) per week in transit (American Petroleum Institute, 1976). Transit times for the Bayou Choctaw oil distribution are as follows:

45 MDWT Tanker transit from 12 miles offshore to Port Allen	44 hours
Barge transit from Port Allen to Bull Bay	2 hours
45 MDWT Tanker transit from 12 miles offshore to St. James	32 hours
Barge transit from Bull Bay to Baton Rouge	3 hours
80 MDWT Tanker transit from St. James to 12 miles offshore	33 hours
45 MDWT Tanker transit from 12 miles offshore to Addis	43 hours
Barge transit from Bull Bay to St. James	13 hours
80 MDWT Tanker transit from Addis to St. James	11 hours
80 MDWT Tanker transit from Addis to 12 miles offshore	44 hours

A.3 MODEL USED TO CALCULATE DOWNWIND GROUND-LEVEL CONCENTRATIONS

Downwind concentrations of hydrocarbons from crude oil transfer and storage were calculated using methods recommended by the U.S. Environmental Protection Agency (Turner, 1969).

The equation used is:

$$\chi = \frac{Q \times 10^6}{\pi\sigma_y\sigma_z u} \exp\left[-\frac{1}{2}\left(\frac{H}{\sigma_z}\right)^2\right] \qquad (1)$$

where:

χ = downwind concentration ($\mu g/m^3$)

Q = effluent source term (g/sec)

σ_y = horizontal dispersion coefficient (m)

σ_z = vertical dispersion coefficient (m)

u = wind speed (m/sec)

H = stack height (m)

Except for storage tank calculations, effluents were assumed to be continuous point source emissions released at ground level (H = 0). In addition, the model is based upon the following assumptions: the effluents are normally distributed along the plume centerline; there is no removal of pollutants from the plume; and there is complete reflection at the ground. Worst-case assumptions were for stability class "D" and a wind speed of one meter per second (mps) except two mps offshore. These conditions occur very infrequently at the site, particularly for durations longer than about one hour.

Values calculated by Equation 1 are peak concentrations assumed to be 10-minute averages. Extrapolation of the peak concentrations to various averaging periods up to 24 hours are determined by a power law correction (Turner, 1969). The equation used is:

$$\chi(t) = \chi(10\text{-minute}) \times \left(\frac{t}{10}\right)^{-0.17} \qquad (2)$$

where t is the averaging interval in minutes.

Equation 2 is applicable only when the average wind direction is constant. Therefore, extrapolation confidence is much less for 24 hours than for 1 hour.

Downwind concentration calculations from storage tanks were made assuming an elevated release with no plume rise. Since the storage tanks are multiple point sources, an area source correction was applied.

To allow for an area source, a virtual distance X_1 is found that approximates the distance required for a point source to disperse into an area equivalent to that of the area source. The total distance $(X + X_1)$ is then used to determine revised dispersion coefficients (σ_y and σ_z) for use in Equation 1. For worst-case calculations, the wind was assumed to blow parallel to the longer axis of the tanks.

APPENDIX B

OIL SPILL RISK ANALYSIS METHODOLOGY

APPENDIX B

OIL SPILL RISK ANALYSIS METHODOLOGY

B.1 PIPELINES

The basis for calculating pipeline spills in this Supplement to the Bayou Choctaw oil distribution system is the spill rate frequency, namely, 50 spills annually per 100,000 miles of pipeline. This estimate was derived in the LOOP Environmental Analysis (1975) for new crude lines. The mean spill size was considered in the Supplement to be 1100 barrels for the large (36-inch) lines involved (DOT Office of Pipeline Safety annual summaries, 1969-73).

B.2 VESSEL TRANSFERS

The bases for calculating spills for vessel transfers are selected frequency records and gross spillage rates for transfer operations as follows:

Frequency	-	1 spill per 90 operations at docks and inland waters.
	-	1 spill per 18 operations between vessels offshore.
Spillage	-	3×10^{-6} of cargo transferred, vessel to vessel
		2×10^{-6} of cargo transferred, dock to vessel
		1×10^{-6} of cargo transferred, vessel to dock

The frequency rate for offshore transfers is based upon a worldwide survey of transfer operations for the period between 1966-70 (J. J. Henry, 1973). This survey included single point mooring systems (SPM), lightering and 7-point mooring facilities. The frequency rate for onshore transfers is a median of several recorded U. S. facilities experiencing a spill every 60 to 133 transfers. Spillage rates recorded in U. S. facilities range from 0.5 to 3×10^{-6}, while foreign ports have experienced much higher rates. The given rates were selected on the basis of U. S. experience and are consistent with other published projections.

B.3 TERMINALS

Sufficient data has not been analyzed to determine whether throughput, capacity, or a combination thereof, is the best parameter for estimating terminal spillage. The basis selected for this Supplement is throughput, which is the most conservative estimate for terminals with minimal storage exposures such as those proposed for the storage program. The assumed basis for terminal exposure is as follows:

Frequency	-	1 spill per 2 billion barrels throughput
Spill Size	-	1100 barrels at the St. James terminal
	-	500 barrels at the Addis, Bayou Choctaw, and Port Allen terminals.

The frequency is estimated on the basis of spill data for all U. S. terminals during the period 1969-70; average spill size, from 1969-73 data.

B.4 VESSEL CASUALTY

The vessel casualty rates used in this Supplement are based on estimates selected from various casualty records to provide a spillage model dependent upon the route length. In this regard, spillage in inland waters is based upon a ton-mile cargo exposure; in offshore waters, spillage is based upon a time exposure. Very large crude carriers (VLCC) casualty exposure offshore was not included in the analysis, nor were spills from the diesel fuel tanks of the barge tugs on their empty return legs.

Frequency	-	1 spill per 7 billion ton-miles in inland waters.
	-	travel in ballast weighted 50% in inland waters (1 spill per 14 billion ton-miles)
	-	1 spill per 12.8 vessel years in offshore waters.
Mean Spill Size	-	428 barrels in inland waters.
	-	1111 barrels in coastal waters.

Offshore spillage rates are based upon tankships' casualty rates in worldwide coastal waters. It may be reasonable to use lower rates such as might apply to a dedicated fleet for lightering operations, but the rates used in this Supplement are more conservative (yield higher spill estimates). The spill frequency in inland waters is based upon the composite for all U. S. waters for barges and tankships during the period of 1968-70 (AEC, 1972). The average spill size, however, is based upon tankships for the years 1969 to 1973, since the average size of the barge fleet proposed is larger than that of the barge fleet in the data base.

B.5 MAXIMUM CREDIBLE SPILL

The assumptions used in this Supplement differ philosophically from those used in FES 76-5 for the estimates of maximum credible spill size.

The maximum credible spill used here refers to the largest practical size spill to be treated statistically. This spill represents a truncated statistical limit selected for the distribution which estimates the frequency of occurrence for different size spills. The limit chosen for the maximum credible spill from vessels in this Supplement is 60,000 barrels; 400,000 barrels was used in FES 76-5 for the Addis alternative.

Spills greater than the maximum credible spill (60,000 barrels) are virtually absent from U. S. data bases. Worldwide, these spills are so rare that it is uncertain how accurately extrapolation of the log normal to these very large spill sizes may predict future expectations. The use of a maximum credible spill as the practical limit of consideration is not intended to imply the impossibility of larger spills - but rather that extrapolation beyond this maximum credible spill size is beyond the limits of statistical confidence and reason.

An additional difference in the philosophy used in this Supplement compared to that used in FES 76-5 is the use of a statistical base which includes small discharges in the estimates of vessel casualties. These small discharges from both vessel operations and transfer operations are more frequent than large spills.

The result of these differences between the two computational approaches is that many small spills, which have a lower average size per event, are projected in this Supplement compared to FES 76-5. In addition, the total spillage expectation, including offshore losses, is estimated to be slightly higher in this Supplement than was estimated in FES 76-5. The average spillage projected in this Supplement for transport of 94 million barrels of oil is 556 barrels by means of the St. James alternative, and 666 barrels of oil by means of the Addis transport system. The offshore spillage component estimated in this Supplement for both alternatives is 148 barrels of oil. For comparison, 536 barrels of oil spillage was estimated for inland waters for the Addis alternative in FES 76-5. The inland oil spillage expectation estimated in this Supplement is 408 barrels for St. James and 518 barrels for Addis.

APPENDIX C

EMISSIONS FROM MARINE VESSEL TRANSFERRING OF CRUDE OIL

C.1 Introduction

Ships and barges will be used to deliver crude oil to and from the marine terminals for the Strategic Petroleum Reserve (SPR) facility. Hydrocarbon emissions are generated at marine terminals when volatile hydrocarbon liquids are either loaded onto or unloaded from ships and barges.

The magnitude of crude oil transfer emissions are dependent on many factors. Industry testing programs have been conducted recently to evaluate the interrelationship of these and other important factors in developing up-to-date emission factors for ship and barge loading and ballasting emissions. Most of those studies completed have developed emission factors for gasoline. Crude oil transferring operations are under study by the Western Oil and Gas Association (WOGA) (Ref 1).

This appendix evaluates the existing emission data and proposes an analytical procedure for estimating the probable crude oil emission factors for the SPR facility.

Section 2 presents the general nature and characteristics of marine transfer emissions. Sources testing data compiled by many industry sources concerning marine transfer emissions are presented in Section 3. Description of a proposed procedure and assumption required to estimate emission factors for crude oil are presented in Section 4. The final section concludes the emission factor analysis and presents a summary of emission factors proposed to be used for the SPR facility.

C.2 Emission Sources and Characteristics

C.2.1 Loading Emissions

Loading emissions are attributable to the displacement to the atmosphere of hydrocarbon vapors residing in empty vessel tanks by volatile hydrocarbon liquids being loaded into the vessel tanks. Loading emissions can be separated into (1) the arrival component and (2) the generated component. The arrival component of loading emissions consists of hydrocarbon vapors left in the empty vessel tanks from previous cargos. The generated component of loading emissions consists of hydrocarbon vapors evaporated in the vessel tanks as hydrocarbon liquids are being loaded.

The arrival component of loading emissions is directly dependent on the true vapor pressure of the previous cargo, the unloading rate of the previous cargo, and the cruise history of the cargo tank on the return voyage. The cruise history of a cargo tank may include heel washing, ballasting, butterworthing, vapor freeing, or no action at all.

The generated component of loading emissions is produced by the evaporation of hydrocarbon liquid being loaded into the vessel tank. The quantity of hydrocarbons evaporated is dependent on both the true vapor pressure of the hydrocarbons and the loading and unloading practices. The loading practice which has the greatest impact on the generated component is the loading and unloading rate.

A typical profile of gasoline concentration in a ship tank during loading is presented in Figure 1 (Ref 2). As indicated in the figure, the hydrocarbons present throughout most of the vessel tank vapor space are contributed to by

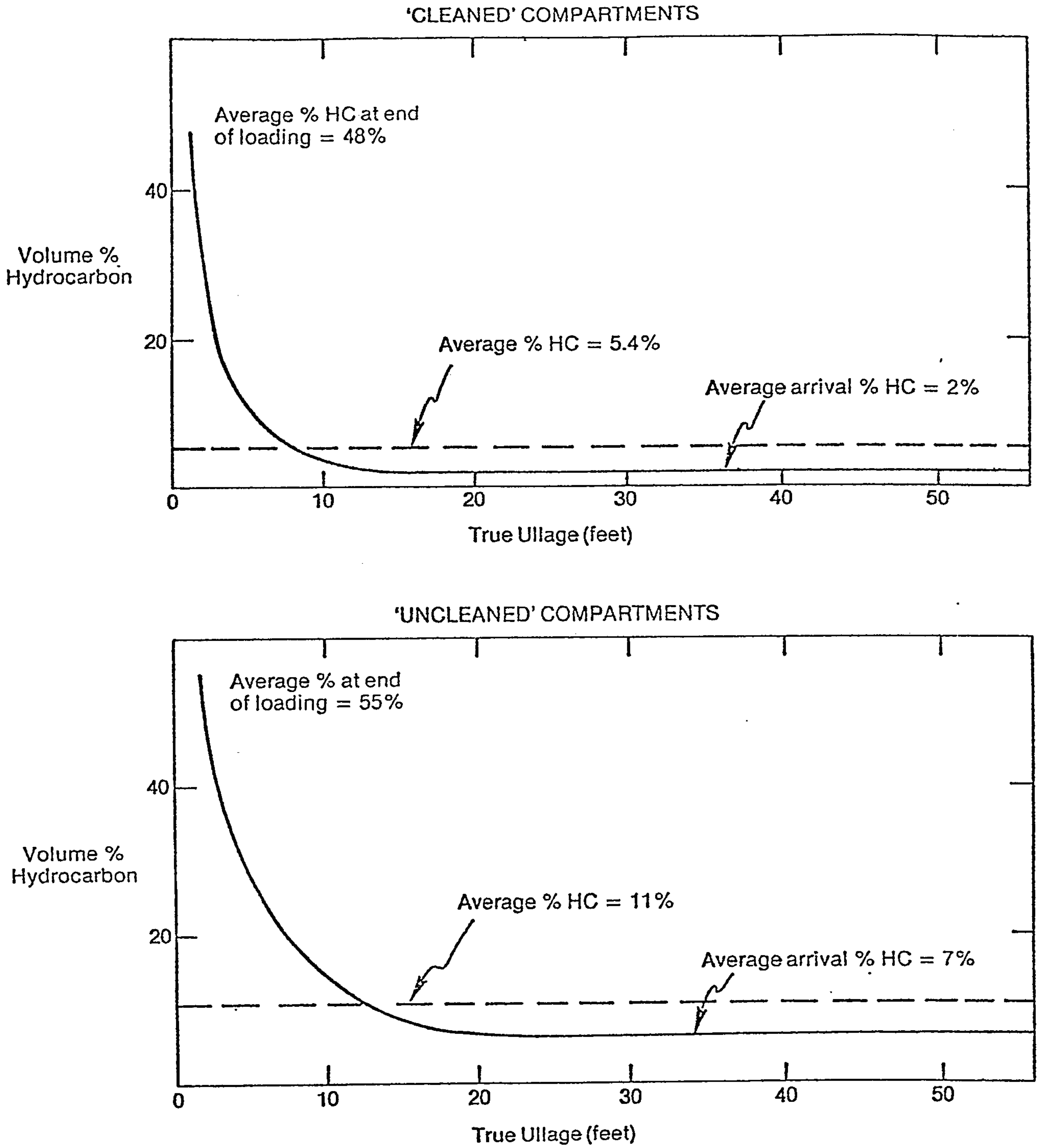

Figure 1 Typical Ship Emission Profiles

the arrival vapor component and the concentration is almost uniform. There is a sharp rise in hydrocarbon vapor concentration just above the liquid surface. This is the generated component. The generated component, also called a "vapor blanket," is attributable to evaporation of the hydrocarbon liquid.

From Figure 1 it is apparent that for large vessels with 55 foot ullages, the average hydrocarbon concentration of vapors vented during loading operations is primarily dependent on the arrival component. For smaller vessels such as barges with 12 foot ullages, the average hydrocarbon concentration in the vented loading vapors is dependent on both the generated component and the arrival component.

C.2.2 Unloading Emissions

Unloading emissions are hydrocarbon emissions displaced during ballasting operations at the unloading dock subsequent to unloading a volatile hydrocarbon liquid such as gasoline or crude oil. During the unloading of a volatile hydrocarbon liquid, air drawn into the emptying tank absorbs hydrocarbons evaporating from the liquid surface. The greater part of the hydrocarbon vapors normally lies along the liquid surface in a vapor blanket. However, throughout the unloading operation, hydrocarbon liquid clinging to the vessel walls will continue to evaporate and to contribute to the hydrocarbon concentration in the upper levels of the emptying vessel tank.

Before sailing, an empty marine vessel must take on ballast water to maintain trim and stability. Normally, on vessels that are not fitted with segregated ballast tanks, this water is pumped into the empty vessel tanks. As ballast water enters tanks, it displaces the residual hydrocarbon vapors to the atmosphere generating the so termed "unloading emissions."

C.2.3 Parameters Affecting Emissions

Emission testing results indicate that many factors affect the magnitude of crude oil loading and unloading emissions. Due to the interrelated nature of these parameters, it is difficult to quantify the emission impacts. This section qualitatively presents the effects of the following parameters on marine loading and unloading emissions:

- loading and unloading rate
- true vapor pressure
- cruise history
- previous cargo
- chemical and physical properties

C.2.3.1 Loading and Unloading Rate

During the loading operation, the initial loading and unloading rate has a significant effect on hydrocarbon emissions due to the splashing and turbulence caused by higher initial loading or withdrawing rates. This splashing and turbulence results in rapid hydrocarbon evaporation and the formation of a vapor blanket. By reducing the initial velocity of entering or withdrawing rates, it is possible to reduce the turbulence and consequently, to reduce the size and concentration of the vapor blanket. Slow final loading rate can also lower the quantity of emissions. This is because when the hydrocarbon level in a marine vessel tank approaches the tank roof, the action of vapors flowing towards the ullage cap vent begins to disrupt the quiescent vapor blanket. Disruption of the vapor blanket results in noticeably higher hydrocarbon concentrations in the vented vapor (Ref 3).

C.2.3.2 True Vapor Pressure

The true vapor pressure (TVP) of a hydrocarbon liquid has a marked impact on the hydrocarbon content of its loading and unloading emissions. TVP is an indicator of a liquid's volatility and is a function of the liquid's Reid Vapor Pressure (RVP) and temperature. Compounds with high TVP exhibit high evaporation rates and consequently, contain high hydrocarbon concentrations in their loading and ballasting vapors. The monographs presented in Figures 2 and 3 correlate the TVP for crude oil and gasoline. The RVP of gasoline loaded in the Houston-Galveston area range from 9.5 to 13.6 psia in the winter season, while the RVP of crude oils unloaded normally range from 2 to 7 psia. For the purpose of assessing a SPR facility, the crude oil is assumed to have a maximum RVP of 5 psia and an average RVP of 4 psia at a temperature of 70° F.

C.2.3.3 Cruise History

The cruise history of a marine vessel includes all of the activities which a cargo tank experiences during the voyage prior to a loading or unloading operation. Examples of significant cruise history activities are ballasting, heel washing, butterworthing, and gas freeing. Cruise history impacts marine transfer emissions by directly affecting the arrival vapor component. Barges normally do not have significant cruise histories because they rarely take on ballast and do not usually have the manpower to clean cargo tanks.

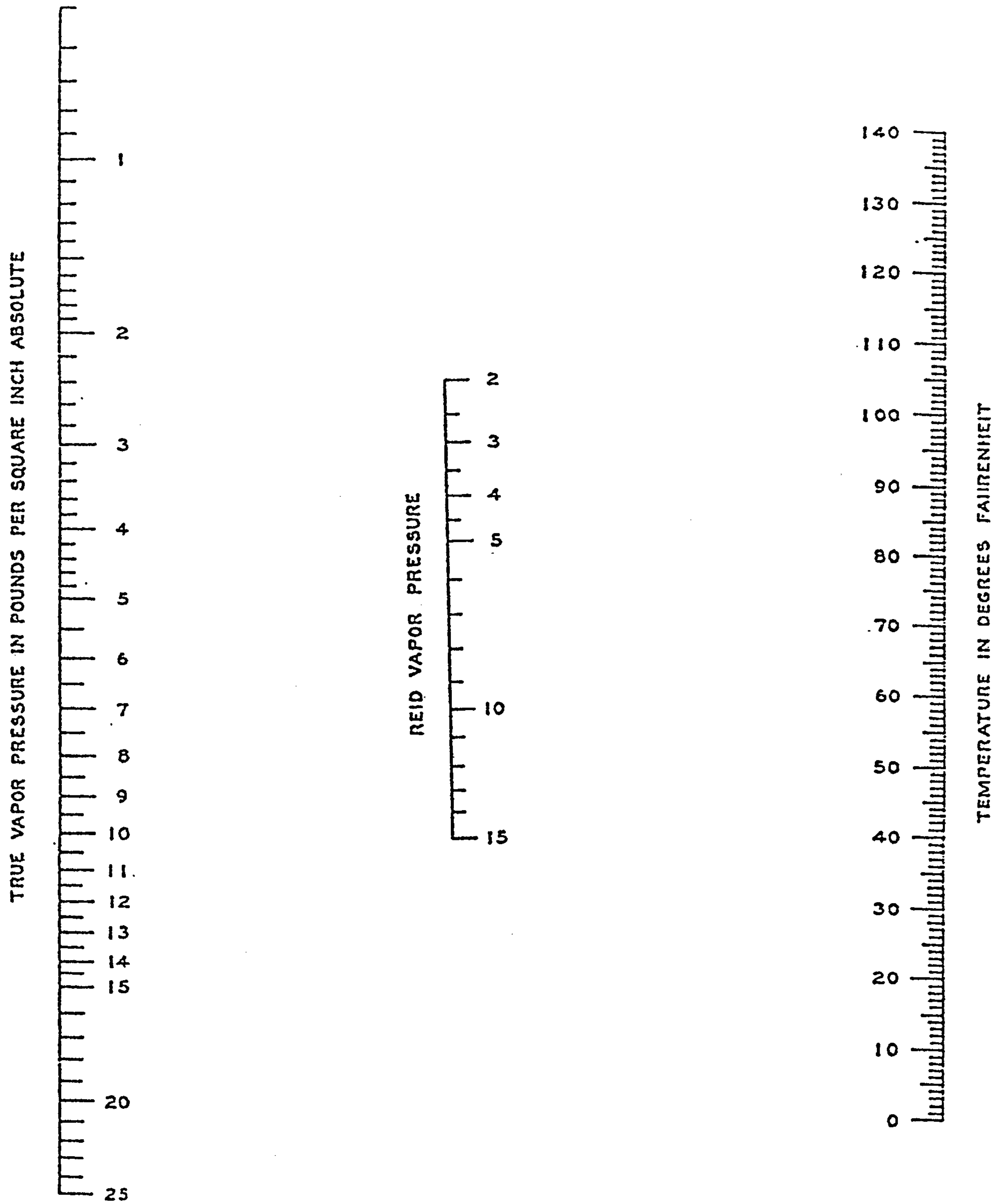

Figure 2 Vapor Pressures of Crude Oil

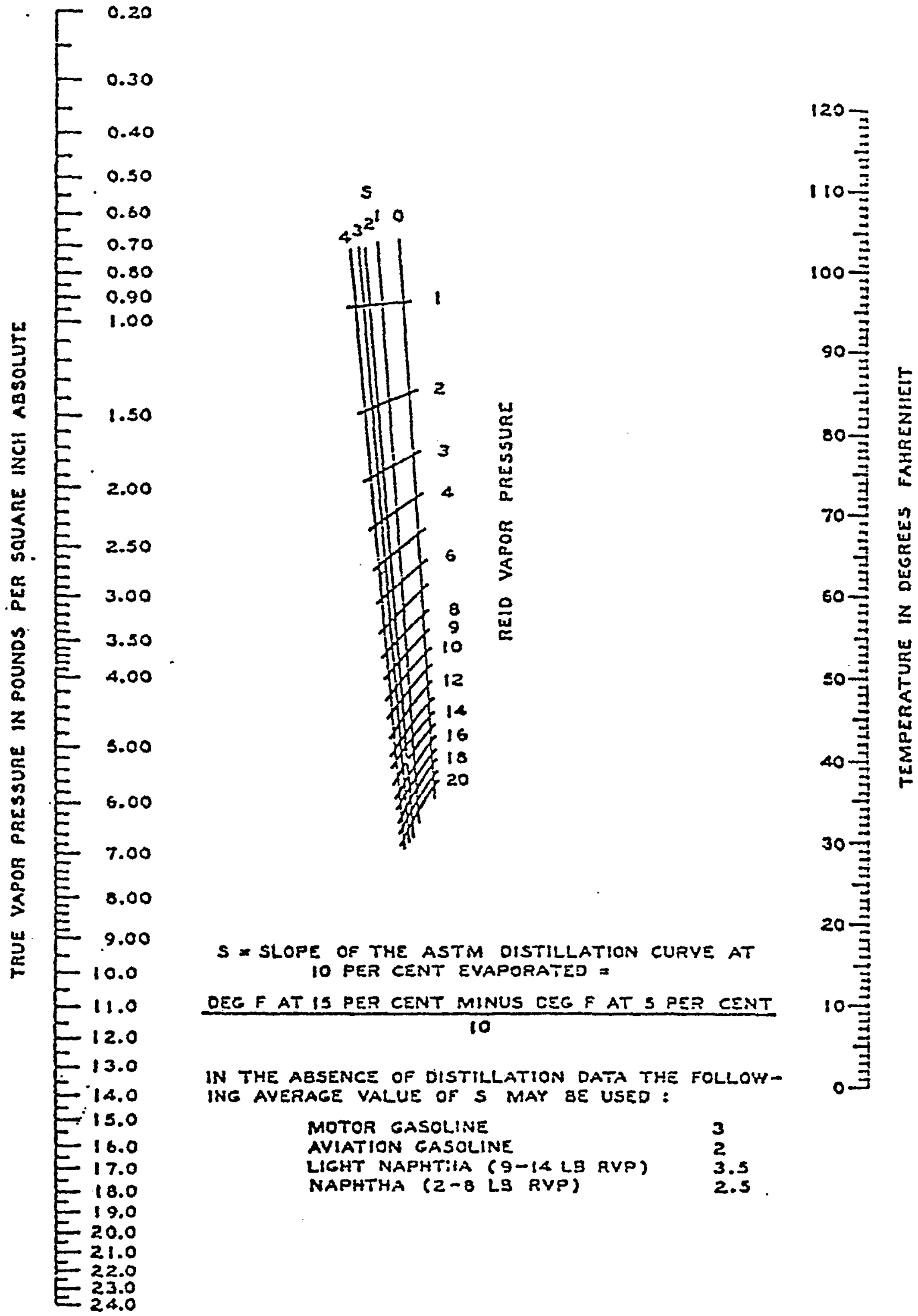

Figure 3 Vapor Pressures of Gasolines and Finished Petroleum Products

Ballasting is the act of partially filling empty cargo tanks with water to maintain a ship's stability and trim. Recent testing results indicate that prior to ballasting, empty cargo tanks normally contain an almost homogeneous concentration of residual hydrocarbon vapors. When ballast water is taken into the empty tank, hydrocarbon vapors are vented, but the remaining vapors not displaced retain their original hydrocarbon concentration. Upon arrival at a loading dock, a ship discharges its ballast water and draws fresh air into the tank. The fresh air dilutes the arrival vapor concentration and lowers the effective arrival vapor concentration by an amount proportional to the volume of ballast used.

Although ballasting practices vary from vessel to vessel, the average vessel is ballasted approximately 40%. The heel of a tank is the residual puddles of hydrocarbon liquids remaining in tanks after emptying. These residual liquids will eventually evaporate and contribute to the arrival component of subsequent vessel-filling vapors. By washing out this heel with water, AMOCO Oil Company found that they were able to reduce the hydrocarbon emissions from subsequent filling operations from 5.7 volume percent to 2.7 volume percent hydrocarbons (Ref 3). Butterworthing is the washing down of tank walls in addition to washing out tank heels. Butterworthing also reduces loading emissions by reducing the arrival component concentration. The hydrocarbon liquids washed from the tanks are stored in a slops tank for disposal onshore (Ref 3).

In addition to heel washing and butterworthing, marine vessels can purge the hydrocarbon vapors from empty and ballasted tanks during the voyage by several gas freeing techniques which include air blowing and removal of ullage dome covers. A combination of tank washing and gas freeing will effectively remove the arrival component of loading emissions (Ref 3).

C.2.3.4 Previous Cargo

The previous cargo conveyed by a tanker also has a direct impact on the arrival component of loading emissions. Cargo ships which carried nonvolatile liquids on the previous voyage normally return with low arrival vapor concentration. EXXON Oil Company tests conducted in Baytown indicated that the arrival component of empty uncleaned cargo tanks which had previously conveyed fuel oil ranged from 0 volume percent to 1 volume percent hydrocarbons. Cargo tanks with the same cruise history which had previously conveyed gasoline, exhibited hydrocarbon concentrations in the arrival vapors which ranged from 4 volume percent to 30 volume percent and averaged 7 volume percent (Ref 3).

C.2.3.5 Chemical and Physical Properties

The chemical compositions and molecular weight of crude oil vapors will vary over a wide range. The typical vapor consists predominantly of C_4 and C_5 compounds. The molecular weight ranges from 45 to 100 pound per pound mole with an average of approximately 70.

C.3 Industry Emission Testing Results

The petroleum industry has been involved in test programs to quantify the hydrocarbon emissions from gasoline and crude oil transfer operations at marine terminals. Table 1 summarizes the test programs which have been conducted by the petroleum industry. The industry programs have included motor gasoline, aviation gasoline, and crude oil loading onto tankers, barges, and ocean barges. Well over 200 vessel tanks were sampled in these programs. The petroleum industry tests were primarily conducted between 1974 and 1975 in the Houston-Galveston area. Tests have also been conducted on the California Coast and in the Great Lakes area (Ref 3).

Table 1 Summary of Petroleum Industry Testing Programs on Marine Loading Emissions

Company	Types of Marine Testing	Location	Date	Extent of Testing	Emission Factors
WOGA	tanker loading and ballasting emissions for crude oil and natural gasoline	Ventura County Union Oil Terminal Getty Oil Terminal California	May 1976 (tests are ongoing)	6 tests to date	preliminary data indicates that emissions from loading a nonvolatile crude into ballasted tanks which previously carried more volatile crude and not gasoline are 0.9 to 1.0 lb/1000 gallons
EXXON	primarily gasoline loading, but also averages and crude loading	Exxon Terminal Baytown Texas Karg Island, Iran	winter 1974-1975 summer 1975	100 ship tests 30 barge tests	Gasoline Loading tanker - gas free 3.24 vol % tanker - ballasted 6.96 vol % tanker - uncleaned 10.26 vol % average Exxon tanker 6.41 vol % (1.47 lb/mgal) ocean barge -gas free 5.69 vol % ocean barge -ballasted 9.08 vol % ocean barge -uncleaned 14.40 vol % avg. EXXON ocean barge 11.71 vol % (2.66 lb/mgal) barge 18.35 vol % (4.14 lb/mgal) Aviation Gasoline Loading tanker - gas free 1.63 vol % tanker - unclean (av. gas prev.) 6. 65 vol % tanker - unclean (no gas prev.) 10.64 vol % average EXXON tanker 5.35 vol % (1.47 lb/mgal) average military tanker 4.13 vol % (1.13 lb/mgal) barge 18.35 vol % (4.25 lb/mgal) Weighted Average Dock 1.8 lb/mgal Also have a TVP dependent correlation (see text)
American Petroleum Institute	motor gasoline loading	predominantly in Houston-Galveston area	1974-1976		clean tankers 1.3 lb/mgal clean barges 1.2 lb/mgal uncleaned tankers 2.5 lb/mgal uncleaned barges 3.8 lb/mgal
Arco	motor gasoline loading of tankers	Houston Refinery	Nov. 1974, Feb. and April 1975	11 tests	Gasoline Loading on Tanker fast load, low TVP, clean 2.1 vol % (0.4 lb/mgal) fast load, med TVP, clean 2.6 vol % (0.5 lb/mgal) slow load, high TVP, clean 4.2 vol % (0.9 lb/mgal) slow load, high TVP, part clean part lean 6.9 vol % (1.5 lb/mgal) avg. ARCO tanker 3.9 vol % (0.84 lb/mgal)
AMOCO	primarily motor gasoline loading	Whiting, Ill	2/26/74-7/22/75	40-50 tests	none developed
	crude barge unloading	Texas City, Texas	5/29/74-8/5/75	9 tests	none developed AMOCO did state that average emissions for AMOCO ship less than 10.2 vol %
Shell	gasoline loading on tanker	Deer Park, Texas	Oct. 1974	5-10 tests	none developed
British Petroleum	crude oil loading on tanker	Middle East	1973	Unknown	none developed

C.4 Proposed Emission Factor Calculating Procedures

The emission factor calculation procedure, suggested in API publication 2514A for loading operations are used. In this method, the total mass emission factor (lb/1000 gal) is derived from the average HC volume concentration. The hydrocarbon volume concentration is then converted into a total hydrocarbon mass by multiplying an average vapor molecular weight and a correction factor accounting for vapor generation factor. These are:

$$H_f = \left(\frac{Xv}{100}\right) \left(\frac{K.W_m}{V_k}\right) \left(\frac{100+F}{100}\right) \qquad (1)$$

and

$$F = \left[\frac{(1-X_T)\left(\frac{U_i}{U_i-U_f}\right) - (1-X_r)\left(\frac{U_f}{U_i-U_f}\right)}{(1-X_v)}\right]^{-1} \qquad (2)$$

where:

H_f = hydrocarbon emission factors, lb/1,000 gal

X_v = volumetric average of HC concentration of vented vapor, percent

K = constant, 133.7 ft^3/1,000 gal

W_m = molecular weight of HC vapor, lb/lb-mole

V_k = molar volume of perfect gas, 379.44 ft^3/lb mole at STP conditions

F = vapor generation factor, See Equation (3)

X_T = volumetric average HC concentration of arrival vapor, percent

X_v = volumetric average HC concentration of remaining vapor, percent

U_i = total tank depth, ft

U_f = final ullage, ft

According to API calculation, a maximum volume increase (vapor generation factor F) of 6 percent for both ships and barge was determined. Thus, if we combine the constants K and V_K with a conservative value of F equivalent to 6 percent, equation (1) can be simplified to:

$$H_f = 0.3735 \cdot (X_v) \cdot (W_m) \qquad (3)$$

The total volume of HC concentration vented at loading conditions (X_v) is equal to the sum of arrival HC concentration (X_a) and the generation HC vapor concentration (X_g). Thus

$$X_v = X_a + X_g \qquad (4)$$

Based on the above relation, EXXON has further derived the following loading emission correlation:

$$X_v = \left(\frac{E}{V}\right) = \left[\frac{C}{100}\right] + \left[\frac{P \cdot (G - U) \cdot A}{V}\right] \qquad (5)$$

where:

E = total volume of HC emitted at the loading condition, CF
C = arrival HC concentration, percent
V = HC liquid loaded, ft^3
P = true vapor pressure of the HC liquid, psia
A = surface area of the HC liquid, ft^2
G = HC generation coefficient value of 0.36 ft^3/ft^2- psia)
U = final true ullage correction in $ft^3/(ft^2 \cdot psia)$ from Figure 4

Assuming $V = A\ (U_i - U_f)$, Equation (5) becomes

$$X_v = \left[\frac{C}{100}\right] + \left[\frac{P \cdot (G - U)}{(U_i - U_f)}\right] \qquad (6)$$

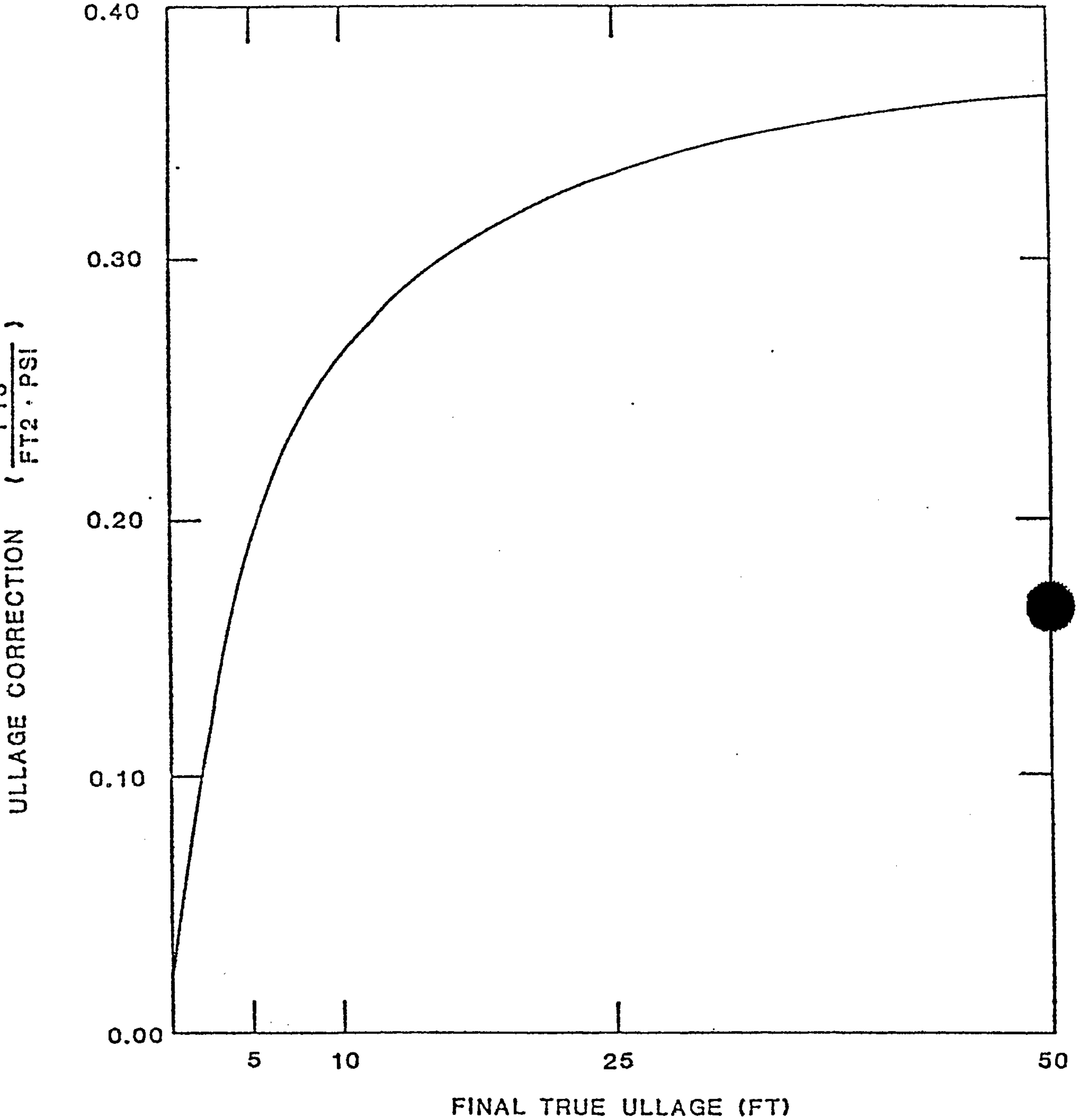

Figure 4 Hydrocarbon Generation Coefficient, Final Ullage Correction to the EXXON Corporation

The EXXON correlation of equation (6) is based principally upon gasoline loading data (Ref 3). For the loading of crude oil, SAI has proposed to adjust the first and second terms by multiplying correction factors α_1 and α_2, respectively. Thus, for crude oil loading operation:

$$X_v = \alpha_1 \left[\frac{C}{100}\right] + \alpha_2 \left[\frac{P \cdot (G - U)}{(U_i - U_f)}\right] \qquad (7)$$

In the above correlation, α_1 is principally affected by the characteristics of the previous cargo, whereas the value of α_2 is independent to the conditions of previous cargo.

For the purpose of SPR facility analysis, it is further assumed

- o $\alpha_1 = 1$, when previous cargo is gasoline
- o $\alpha_1 = \alpha_2$, when previous cargo is crude oil.

The correction factor α_2 can be interpretated as the ratios of evaporation mass transfer coefficients between crude oil and gasoline. Mackay and Matsuger (Ref 6) have correlated the mass transfer coefficient (K) based on wind tunnel studies of evaporative hydrocarbon liquids. They found that the mass transfer coefficient is inversely proportional to the vapor phase Schmidt number (S_c) as follows:

$$K = f(U.A) \cdot (S_c)^{-0.67}$$

where U is wind speed, and A is the oil surface area.

The α_2 thus can be determined by

$$\alpha_2 = \frac{K_c}{K_g} = \frac{\left(S_c^{-0.67}\right) \text{crude oil}}{\left(S_c^{-0.67}\right) \text{gasoline}}$$

Since the Schmidt number (S_c) is defined by the mass transport properties $\mu/\rho D_{AB}$ (Ref 7)

α_2 can then be calculated by the following equations:

$$\alpha_2 = \frac{(\mu/\rho D_{AB})^{-0.67} \text{ crude oil}}{(\mu/\rho D_{AB})^{-0.67} \text{ gasoline}} \tag{8}$$

and

$$D_{AB} = 0.0018583 \frac{\sqrt{T^3 \left(\frac{1}{M_A} + \frac{1}{M_B}\right)}}{P\sigma_{AB}^2 \, \Omega_{D,AB}} \tag{9}$$

$$\mu = 2.6693\text{x}10^{-5} \frac{\sqrt{MT}}{\sigma^2 \Omega_{\mu_{AB}}} \tag{10}$$

μ = viscosity of vapor

ρ = density of vapor

D_{AB} = binary diffusivity for system A (air) and B (hydrocarbon)

M_A, M_B = molecular weight of A, B, respectively

P = fluid pressure, atmosphere

σ_{AB} = collision diameter, A

$\Omega_{D,AB}$ = collision integral for mass diffusivity

$\Omega_{\mu,AB}$ = collision integral for viscosity

The pertinent intermolecular properties and functions for prediction of transport properties of hydrocarbon gases at low densities are presented in Table 2 and Table 3, respectively.

Table 2 Intermclecular Parameters of Hydrocarbons

Substance	Molecular Weight M	Lennard-Jones Parameters[a]	
		σ (Å)	ϵ/κ (° K)
CH_4	16.04	3.822	137.
C_2H_2	26.04	4.221	185.
C_2H_4	28.05	4.232	205.
C_2H_6	30.07	4.418	230.
C_3H_6	42.08	—	—
C_3H_8	44.09	5.061	254.
n-C_4H_{10}	58.12	—	—
i-C_4H_{10}	58.12	5.341	313.
n-C_5H_{12}	72.15	5.769	345.
n-C_6H_{14}	86.17	5.909	413.
n-C_7H_{16}	100.20	—	—
n-C_8H_{18}	114.22	7.451	320.
n-C_9H_{20}	128.25	—	—
Cyclohexane	84.16	6.093	324.
C_6H_6	78.11	5.270	440.
Other organic compounds:			
CH_4	16.04	3.822	137.
CH_3Cl	50.49	3.375	855.
CH_2Cl_2	84.94	4.759	406.
$CHCl_3$	119.39	5.430	327.
CCl_4	153.84	5.881	327.
C_2N_2	52.04	4.38	339.
COS	60.08	4.13	335.
CS_2	76.14	4.438	488.

Source: (Ref 7)

Table 3 Functions for Prediction of Transport Properties of Gases at Low Densities[a]

$\kappa T/\epsilon$ or $\kappa T/\epsilon_{AB}$	$\Omega_\mu = \Omega_k$ (For viscosity and thermal conductivity)	$\Omega_{\mathcal{D},AB}$ (For mass diffusivity)	$\kappa T/\epsilon$ or $\kappa T/\epsilon_{AB}$	$\Omega_\mu = \Omega_k$ (For viscosity and thermal conductivity)	$\Omega_{\mathcal{D},AB}$ (For mass diffusivity)
			2.50	1.093	0.9996
0.30	2.785	2.662	2.60	1.081	0.9878
0.35	2.628	2.476	2.70	1.069	0.9770
0.40	2.492	2.318	2.80	1.058	0.9672
0.45	2.368	2.184	2.90	1.048	0.9576
0.50	2.257	2.066	3.00	1.039	0.9490
0.55	2.156	1.966	3.10	1.030	0.9406
0.60	2.065	1.877	3.20	1.022	0.9328
0.65	1.982	1.798	3.30	1.014	0.9256
0.70	1.908	1.729	3.40	1.007	0.9186
0.75	1.841	1.667	3.50	0.9999	0.9120
0.80	1.780	1.612	3.60	0.9932	0.9058
0.85	1.725	1.562	3.70	0.9870	0.8998
0.90	1.675	1.517	3.80	0.9811	0.8942
0.95	1.629	1.476	3.90	0.9755	0.8888
1.00	1.587	1.439	4.00	0.9700	0.8836
1.05	1.549	1.406	4.10	0.9649	0.8788
1.10	1.514	1.375	4.20	0.9600	0.8740
1.15	1.482	1.346	4.30	0.9553	0.8694
1.20	1.452	1.320	4.40	0.9507	0.8652
1.25	1.424	1.296	4.50	0.9464	0.8610
1.30	1.399	1.273	4.60	0.9422	0.8568
1.35	1.375	1.253	4.70	0.9382	0.8530
1.40	1.353	1.233	4.80	0.9343	0.8492
1.45	1.333	1.215	4.90	0.9305	0.8456
1.50	1.314	1.198	5.0	0.9269	0.8422
1.55	1.296	1.182	6.0	0.8963	0.8124
1.60	1.279	1.167	7.0	0.8727	0.7896
1.65	1.264	1.153	8.0	0.8538	0.7712
1.70	1.248	1.140	9.0	0.8379	0.7556
1.75	1.234	1.128	10.0	0.8242	0.7424
1.80	1.221	1.116	20.0	0.7432	0.6640
1.85	1.209	1.105	30.0	0.7005	0.6232
1.90	1.197	1.094	40.0	0.6718	0.5960
1.95	1.186	1.084	50.0	0.6504	0.5756
2.00	1.175	1.075	60.0	0.6335	0.5596
2.10	1.156	1.057	70.0	0.6194	0.5464
2.20	1.138	1.041	80.0	0.6076	0.5352
2.30	1.122	1.026	90.0	0.5973	0.5256
2.40	1.107	1.012	100.0	0.5882	0.5170

[a] Taken from J. O. Hirschfelder, R. B. Bird, and E. L. Spotz, *Chem. Revs.*, 44, 205 (1949).

Table 4 presents the comparative analysis of hydrocarbon vapor emitted by loading gasoline and crude oil. As can be seen, due to the difference in chemical compositions between gasoline and crude oil, the gasoline generally exhibits higher transport properties and thus results in a higher evaporation mass diffusivity coefficient (i.e., 1.345 for gasoline versus 0.513 for crude oil). Based on this analysis, the value of α_2 can be determined as 0.381.

The appropriate arrival HC hydrocarbon concentration, (C), can be calculated based on API gasoline emission factors as follows:

Vessels	Arrival Conditions	Emission Factors (lb/1000 gal)	Generation Vapor $\frac{P \cdot (G - U)}{(U_i - U_f)}$, %	Calculated Arrival Vapor (C), %
Ships	Cleaned	1.3	$\frac{7.5\ (0.36-0.010)}{(55-1.5)} = 3.64$	1.71 (2.50)
	Uncleaned	2.5	3.64	6.65 (8.00)
Barges	Cleaned	1.2	$\frac{7.5\ (0.36-0.27)}{(55-12)} = 1.57$	3.37
	Uncleaned	3.8	1.57	14.1

The calculated arrival HC vapor concentration for ships using API emission factor seems to be in close agreement with the EXXON reported value (value in parenthesis).

By substituting the appropriate values of C, α_2, and P, Equation (7) also compares well with the latest available WOGA test data. The WOGA test on September 5, 1976 estimated the overall crude oil emission factor to be 0.62 lb/1000 gallons which falls in the middle of the calculated emission factors. The calculated emission factors using Equation (7) are 0.35 lb/1000 gallons and 0.85 lb/1000 gallons for cleaned and uncleaned ships, respectively.

Table 4. Comparison of Chemical Compositions and Mass Transport Properties Between Gasoline and Crude Oil

Chemical Composition, Volume % of Loading Vapors	Gasoline[a]	Crude Oil[b]
$C_1 + C_2$	0.02	0.12
C_3	0.02	0.15
C_4	2.36	1.33
C_5	1.07	2.05
C_6	0.19	0.63
C_7	0.19	0.32
C_8	0.15	0.03
C_9	---	0.02
C_{10}	---	0.01
C_{11}	---	0.01
Air	96.0	95.35
$\Sigma\,\epsilon/K$	302.1	331.6
$\Sigma\,KT/\epsilon$	1.039	1.055
$\Omega_{D,AB}$	1.42	1.40
$\Omega_{\mu,AB}$	1.56	1.54
σ_A (Air)	3.681	3.681
σ_B	5.28	5.21
σ_{AB}	4.48	4.45
M_B	67	77
μ	6.919×10^{-4}	7.516×10^{-4}
D_{AB}	0.36	0.081
ρ	2.99×10^{-3}	3.43×10^{-3}
$(\mu/\rho D_{AB})^{-0.67}$	1.345	0.513

[a] Shell Oil Company, Ship Valley Forge, test date 10/19/74
[b] Avila Terminal, Lion of California, test data 5/8/76

Source: (Ref 3)

Simarily, the emission from ship ballasting operation can be correlated based on arrival vapor concentrations during loading operations. Since the ballasting potentially dilutes tank arrival concentration by approximately the same percentage as that of ballasting volume, for a ship with 40 percent ballasting volume the emission factor can be calculated by dividing the arrival HC concentration (C) by 0.4.

C.5 Conclusion

A modified analytical procedure based on API and EXXON gasoline data enables quantative determination of hydrocarbon emission factors from crude oil transferring operations under various arrival conditions. The procedure employs correction factors to both arrival and generation components of the hydrocarbon vapors concentration previously derived from gasoline data. An emission reduction factor of 0.38 is derived for crude oil when comparing the evaporation mass diffusivity of crude oil with gasoline. The final hydrocarbon emission factors for crude oil loading operations are summarized in Table 5. As can be seen, the average emission factors from ship loading operations range from 0.55 to 0.58 lb/1000 gallons. Similar hydrocarbon emission factors range from 1.01 to 1.06 lb/1000 gallons for barge crude oil loading operations. The ballasting emission factors are calculated to range from 0.17 to 0.66 lb/1000 gallons.

Table 5. Summary of Maximum and Average Hydrocarbon Emission Factsors for Crude Oil Transport Operation

essels	Arrival Conditions[a]	Maximum Emission Factor[b]		Average Emission Factor[c]	
		Previous Cargo		Previous Cargo	
		Gasoline	Crude Oil	Gasoline	Crude Oil
Ship Loading					
	Cleaned	--	0.33	--	0.30
	Uncleaned	1.90	0.83	1.86	0.79
	Average	--	0.58	--	0.55
Barge Loading					
	Cleaned	--	0.52	--	0.48
	Uncleaned	3.87	1.59	3.83	1.54
	Average	--	1.06	--	1.01
Ship Ballasting					
	Cleaned	--	0.17	--	0.17
	Uncleaned	--	0.66	--	0.66

[a] Average condition lies between cleaned and uncleaned conditions. The cleaned is defined as the arrival conditions where vessels had been subjected to any cleaning process prior to loading, as well as compartments which had previously contained a nonvolatile hydrocarbon.

[b] Based on RVP = 5.0 and temperature of 70° F.

[c] Based on RVP = 4.0 and temperature of 70° F.

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