Strategic Petroleum Reserve

Supplement to Final Environmental Impact Statements for Weeks Island/Cote Blanche Mines

FEA/7677-7 and FES 76/77-8

August 1977

Federal Energy Administration

Strategic Petroleum Reserve Office

FEA/S-77/228

SUMMARY

STATEMENT TYPE: ( ) Draft ( ) Final Environmental Statement
(X) Supplement to Final Environmental Statements

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. 95-163) through the development of an 89 million barrel crude oil storage facility at the Weeks Island Mine and a 27 million barrel crude oil storage facility at the Cote Blanche Island Mine. 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 conventionally-mined salt dome caverns 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 Weeks Island and Cote Blanche Island sites, salt domes with existing caverns located, respectively, in Iberia and St. Mary Parishes, Louisiana, have been identified as candidate sites for early storage because they offer the advantage of large storage capacity, potential access to the existing oil distribution network, and a relatively short preparation period.

The oil transportation systems proposed in the Final Environmental Impact Statements (FES 76/77-7 and FES 76/77-8) have 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 barge distribution system considered in the Final EISs. Construction of the pipeline system, tanker dock, and terminal would use wetland habitat directly and would degrade water quality by releasing suspended particulates and toxic substances to surface waters. Marine operation (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 air quality standards.

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. <u>Alternatives Considered</u>:

Alternative Transportation Modes
Alternative Terminal Sites
Alternative Pipeline Routes
Alternative Pipeline Construction Methods

5. <u>Comments on the supplement have been requested from the following</u>:

<u>Federal Agencies</u>

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

Regional and Local Agencies

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

Other Organizations

Acadiana Planning and Development District
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
Domtar Chemicals, Inc.
Ecology Center of Louisiana, Inc.
Edison Electric Institute
Electric Power Research Institute
Environmental Defense Fund, Inc.
Environmental Policy Center
Enviornmental Resources and Energy Group
Florida Audubon Society
Friends of the Earth
Funds for Animals, Inc.
Institute of Gas Technology
Interstate Natural Gas Association
Izaak Walton League of America
League of Women Voters
LOOP, Inc.
Louisiana Power and Light
Louisiana Wildlife Federation
Louisiana Department of Justice
Morton Salt Company
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. Date made available to CEQ and the Public:

The Final Environmental Impact Statements were made available to the Council on Environmental Quality and to the Public in January 1977.

This supplement was made available to the Council on Environmental Quality and the Public in August 1977.

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SECTION 1.0

DESCRIPTION OF PROJECT

1.1 BACKGROUND

This document is a supplement to site specific final environmental impact statements (EISs) prepared for the proposed storage of crude oil at the Cote Blanche Island salt mine in St. Mary Parish, Louisiana (FES 76/77-7) and the Weeks Island salt mine in Iberia Parish, Louisiana (FES 76/77-8). These projects are part of the Strategic Petroleum Reserve (SPR) Program currently being planned by the Federal Energy Administration (FEA). Creation of the SPR was mandated by Congress in Title I, Part B of the Energy Policy and Conservation Act of 1975, P.L. 94-163 (the Act) for the purpose of providing the United States with sufficient petroleum reserves to minimize the effects of any future oil supply interruption. The Act requires that within seven years the SPR contain a reserve equal to the volume of crude oil imports during the three consecutive highest import months in the 24 months preceding December 22, 1975 (approximately 500 million barrels). The Act further requires the creation within three years of a 150 million barrel early storage reserve as the initial phase of the SPR to provide early protection from near-term disruptions in the supply of petroleum products. In addition, the President proposed to the Congress in the National Energy Plan on April 29, 1977 that the SPR be expanded to a total volume of 1 billion barrels.

The Weeks Island Mine final environmental impact statement, addressing the effects of developing 89 million barrels (MMB) 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 in January, 1977. The Cote Blanche Island Mine final EIS, addressing the effects of developing 27 million barrels of existing capacity, was also made available in January, 1977. These statements consider environmental effects which could result from the full range of activities required to develop and utilize existing caverns for oil storage. These effects include construction of surface facilities at the site, such as pipelines, pump stations and barge docks; transport of oil to and from storage by barge and tanker; conversion of the existing mines to oil storage facilities; development of new mines for use by

Domtar Chemicals (Cote Blanche Island) and by Morton Salt Company (Weeks Island) and possible short term displacement of mine workers due to temporary mine shutdown.

The method of oil transportation proposed in FES 76/77-7 and 76/77-8 was by barge via the Mississippi River and the Intracoastal Waterway (ICW). Because of the uncertainty of obtaining sufficient barges during business-as-usual conditions, however, each cavern fill for Weeks Island was projected to require 2.3 years (105,000 barrels per day (BPD) and 22 barges). Withdrawal of oil from Weeks Island could be accomplished in 260 days (at 342,000 BPD) if 70 barges could be obtained and dock capacity at the site were expanded. Because of the smaller storage volume at Cote Blanche Island, less time would be required to fill and withdraw the oil. However, if both sites were developed to the full 116 MMB capacity, a correspondingly longer time would be required for fill and withdrawal. Construction of a pipeline connecting Cote Blanche Island and Weeks Island with the terminal facilities at St. James, Louisiana was considered as an alternative (Section 8.2.4.2, FES 76/77-7 and 76/77-8).

The Weeks Island site has been selected for use in the SPR Program. The Cote Blanche Island site remains a candidate site and may be selected at a later date. The purpose of this supplement is to propose and assess the impacts of a pipeline between St. James and the mine sites to transport the crude oil to and from storage. No expansion of barge dock capacity would be required as all withdrawals and refills would be made by pipeline.

This method of oil transport would achieve the flexibility of direct connection with both the 40-inch Capline crude oil pipeline for inland oil distribution and with existing tanker docks for delivery of oil to Gulf of Mexico, Caribbean, and East Coast refinery centers. Furthermore, if the LOOP project is constructed, oil could be offloaded from VLCCs in the Gulf and delivered to both sites entirely by pipeline.

A significant operational disadvantage to the use of barges for oil distribution is the very large number of vessels required (4640 barge trips for each oil fill and withdrawal, assuming use of 25,000 barrel barges for 116 MMB total capacity). During cavern withdrawal, there would be approximately 30 barges leaving the two sites each day. Logistical problems associated with unloading these barges and the unavoidable quantities of oil spills and hydrocarbon emissions associated with barge transit and oil transfer pose significant environmental impact potential.

The purpose of this supplement, therefore, is to consider the incremental effects on the environment which would result from constructing and operating a crude oil pipeline between St. James, Louisiana and the Cote Blanche Island and Weeks Island salt domes. The principal differences between the oil distribution systems originally proposed in FES 76/77-7 and 76/77-8 and the pipeline alternative are: (1) construction of a 67-mile 36-inch crude oil pipeline; (2) no expansion of barge dock capacity at Cote Blanche Island and Weeks Island; (3) construction of a new tanker dock and 4-200,000 barrel oil surge tanks at St. James; and (4) possible construction of microwave towers at the storage sites. This supplement compares the impacts associated with development and use of the barge oil distribution systems described in FES 76/77-7 and 76/77-8 with impacts associated with a pipeline distribution system serving both storage sites.

In order to retain the perspective of impacts associated with all phases of development of the existing storage capacity at Cote Blanche and Weeks Islands, summaries or references to other project impacts are provided in this supplement. Liberal reference is made to FES 76/77-7 and 76/77-8 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 76/77-7 and 76/77-8.

SECTION 2.0

DESCRIPTION OF THE PROPOSED ACTION

2.1 INTRODUCTION

Weeks Island: The Morton salt mine is located on Weeks Island in Iberia Parish, southcentral Louisiana. Weeks Island is a coastal "island" about 95 miles southwest of New Orleans and on the east shore of Weeks and Vermilion Bays (Figure 2.1-1). The "island" is surrounded on all sides by brackish and intermediate marsh; the Intracoastal Waterway (ICW) passes just to the west (Figure 2.1-2). Weeks Island is approximately circular, with a diameter of about 2 miles. The highest point on the island has an elevation of about 170 feet above sea level. Weeks Island is the topographic expression of one of a series of salt domes on the Louisiana coast known as the Five Islands.

Morton Salt Company operates a conventional mine in the southwestern portion of the dome adjacent to the ICW. FEA proposes to convert the existing mine into an oil storage facility containing approximately 89 MMB of crude oil. Development of a replacement mine would be at the option of Morton Salt Company. Once the new mine is developed, there should be no interference between the simultaneous use of the salt dome for oil storage and for salt mining and processing.

Cote Blanche Island: Cote Blanche Island is another of the Five Islands in southcentral Louisiana. Cote Blanche is located approximately five miles southeast of Weeks Island in St. Mary Parish (Figure 2.1-1). It is surrounded on three sides by brackish marsh and, on the north, by the ICW (Figure 2.1-2). Cote Blanche Island is approximately circular, with a diameter of about 1.5 miles. The highest point on the island has an elevation of about 100 feet above mean sea level.

Domtar Chemicals, Inc. operates a conventional salt mine in the southwestern portion of the dome adjacent to a canal which connects to the ICW. FEA proposes to convert the existing mine into an oil storage facility containing approximately 27 MMB of crude oil. Development of a replacement mine would be at the option of Domtar Chemicals. As with the Morton mine, operation of the planned SPR facility should not interfere with normal salt mining and processing, once the new mine has been developed.

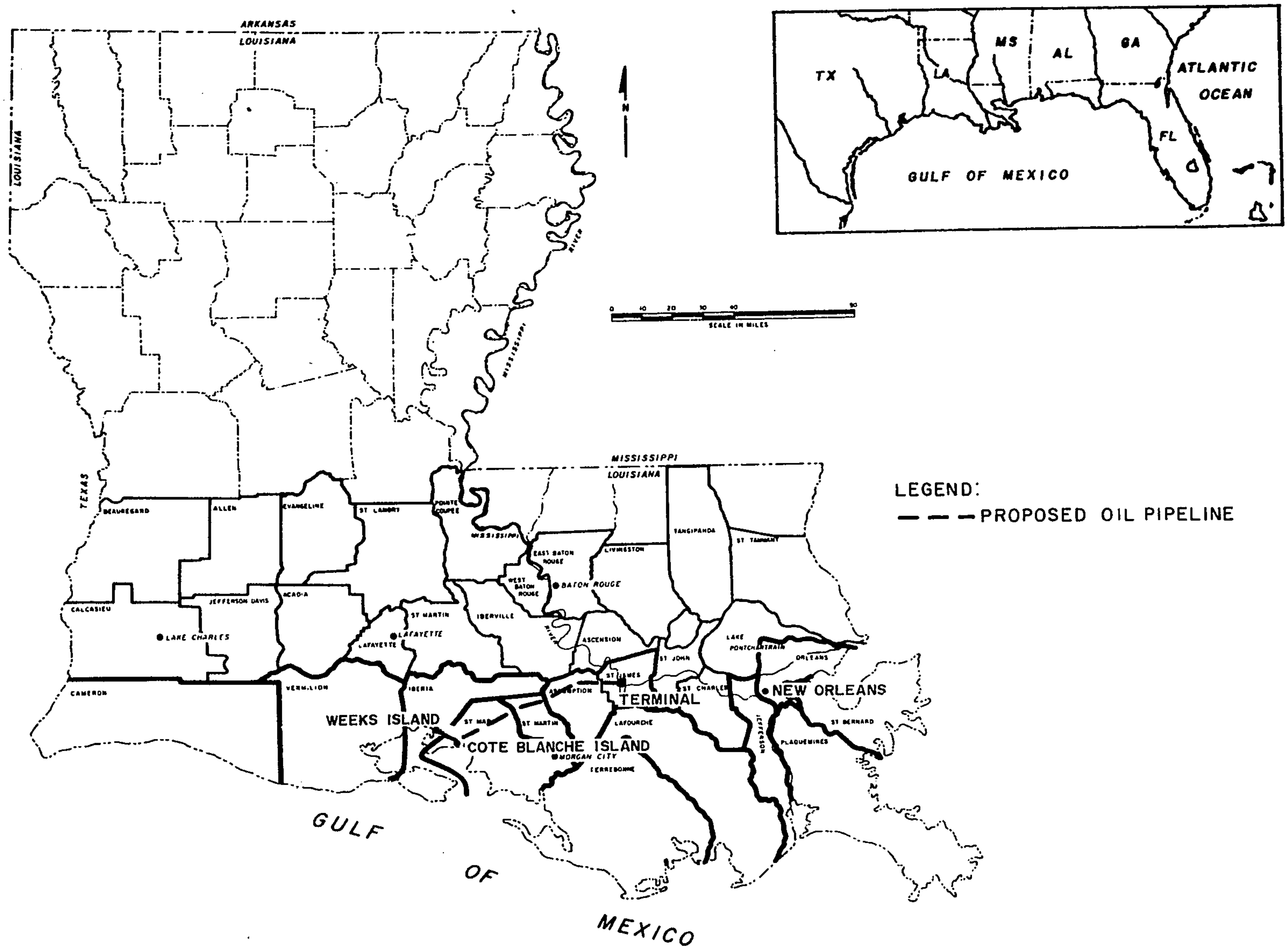


Figure 2.1-1. Map of Louisiana Highlighting the general Study Area

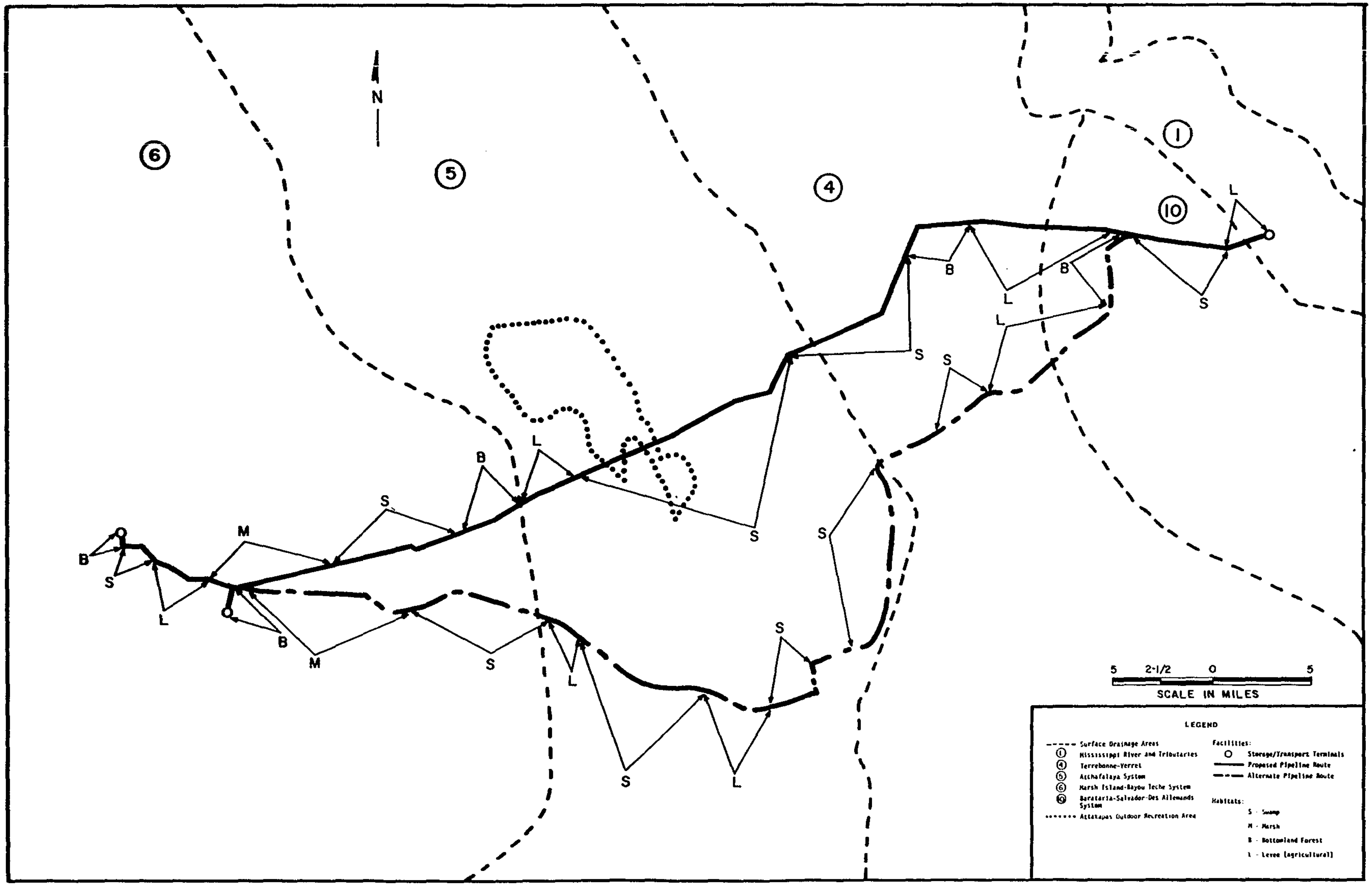


Figure 2.1-2 Proposed and Alternate Weeks Island/Cote Blanche Island Crude Oil Pipeline System.

2.2 EXISTING MINE FACILITIES

Salt is mined underground at Weeks Island and Cote Blanche Island by the room and pillar (dry) method at depths of approximately 700 feet and 1300 feet, respectively, below mean sea level (MSL). (An upper mine level, elevation -536 MSL, is abandoned at Weeks Island). Crushed and screened rock salt is hoisted to the surface by means of skips through large diameter production shafts, transported by conveyor to a mill and processing plant, then taken to dock facilities and loaded onto barges for transportation to the market area (generally, chemical plants in southeastern Louisiana). At Weeks Island, a portion of the salt is used in the adjacent Morton Chemical Company plant where it is processed into HCl, $NaSO_4$, and activated clay. Both mine facilities and shaft entrances are located more than 35 feet above MSL. The Weeks Island mine has been in operation since 1903; current production is from 1 to 1.5 million tons of rock salt per year. Cote Blanche Mine has been in operation since 1965 and has an annual production of about 1 million tons. A small amount of salt is solution-mined at Weeks Island from two brine wells 0.5 miles north of the mine. A settling lake and an evaporation pond are used to separate the salt. The water supply and effluent disposal site is the Intracoastal Waterway.

As the proposed crude oil pipeline would not affect the operation of the mines no further description of existing facilities is provided in this supplement (see Section 2.2 of FES 76/77-7 and FES 76/77-8).

2.3 MINE CONVERSION

2.3.1 Underground Conversion

Underground activities required to adapt the existing salt caverns to oil storage consist primarily of grading for efficient drainage, equipment and waste salt removal, and conversion of one of the existing mine shafts into a pump shaft. Oil is to be pumped into and out of the caverns directly; water would not be used for oil displacement. There would be no leaching of additional storage capacity at the existing mines.

A more detailed description of underground mine conversion activities is provided in Section 2.3.1 of FES 76/77-7 and FES 76/77-8.

2.3.2 Aboveground Conversion

Weeks Island: A new pump station would be built on approximately 4 acres of land adjacent to the pump shaft (Figure 2.3-1). The station would include an electrical substation, powerhouse, manifolding, meter proving loop, and metering system as described in FES 76/77-8, Section 2.3.2. No surge tanks would be required at the site. These facilities would not differ significantly from those required for barge transportation of oil.

Because barges would not be used for movement of oil to or from the mine, the expanded barge dock facilities planned in FES 76/77-8 would not be required. This would avoid approximately 250,000 cubic yards of dredging and disposal and 19 acres of construction impact along the ICW near the existing Morton barge docks.

The 36-inch diameter pipeline to St. James would cross approximately 1.7 miles of island terrain adjacent to the Southern Pacific railroad, as shown in Figure 2.3-1. All movements of oil to and from storage would occur through this pipeline.

A 150-foot microwave tower may be constructed at the site adjacent to the pump station in the western portion of the island (Figure 2.3-1).

Cote Blanche Island: Aboveground conversion at Cote Blanche Island would be similar to that at Weeks Island. A schematic layout of the planned terminal is shown in Figure 2.3-2.

As at Weeks Island, construction of the proposed pipeline to St. James would eliminate the use of barges for oil transportation. Thus the planned 19-acre dock construction, barge slip expansion, and connecting pipelines requiring excavation and disposal of 250,000 cubic yards of material, would not be required.

The 20-inch oil pipeline would be constructed across the ICW west of the ferry crossing, then parallel to approximately 1.1 miles of cleared transmission line right-of-way on the island to the storage site (Figure 2.3-2). A 150-foot microwave tower may be constructed at the storage site adjacent to the pump station for communication.

2.3.3 Pipeline Construction

The principal component of the proposed new oil distribution system would be a 36-inch diameter pipeline constructed between Weeks Island/ Cote Blanche Island and the SPR terminal facilities adjacent to Capline Terminal near St. James, Louisiana. The pipeline must cross the Atchafalaya River Basin Floodway. Two possible routes have been selected for assessment, as shown in Figure 2.1-2.

The northern route, which crosses the Atchafalaya Basin along existing pipeline corridors (principally the 20-inch Chico Corporation Pipeline and the 8-inch Union Carbide (UCAR) pipeline), has been selected as the proposed alignment. The southern route, which follows the levee along Bayou Teche to Morgan City then turns north along the East Protection Levee of the Atchafalaya Basin Floodway, is analyzed as an alternative alignment (Section 8.0).

For the originally proposed alternative of barge transportation, pipelines would have only been constructed between the storage sites and the barge docks adjacent to the sites. These would no longer be needed under the proposal assessed herein.

2.3.3.1 Pipeline Corridor Description

A brief description of the pipeline corridor is provided in this section. Further details on hydrology, ecology, and other environmentally sensitive aspects of the route are contained in appropriate portions of Sections 3 and 4.

The proposed pipeline route between the Weeks and Cote Blanche storage sites and St. James Terminal is termed the Atchafalaya Basin route. The route crosses a 13-mile wide section of the Atchafalaya Floodway between Oaklawn and Lake Verret (Figure 2.1-2). The route parallels existing pipeline rights-of-way (ROW) for nearly its entire 67-mile length.

From the pump station on Weeks Island, the pipeline route follows the Southern Pacific Railroad south and then east along the flank of the salt dome to State Highway 83 (Figure 2.3-1). From this point, the ROW parallels the Southern Pacific Railroad across agricultural land north of the small community of Cypremort (Figure 2.1-2). Near Cote Blanche Island, the ROW crosses the Ivanhoe canal and enters intermediate marsh. Just east of the Cote Blanche road the ROW joins the 20-inch Chico pipeline (Sugar Bowl Line) through the marsh, crosses Hog Bayou near Freetown, then enters swamp forest, crosses Bayou Choupique, the Charenton Drainage Canal and finally reaches the natural levee ridge of Bayou Teche just west of Franklin. Paralleling the Chico and UCAR pipelines (generally within 75 feet), the ROW follows Bayou Yokely northwest of Franklin through bottomland forest and agricultural land, crosses Bayou Teche between Oaklawn and Irish Bend, and enters the Atchafalaya Basin Floodway by crossing the West Protection Levee.

Within the Floodway, the ROW crosses the Atchafalaya River and Grand Lake, paralleling (on the north) the same two existing pipelines (Chico and UCAR) through cottonwood-willow and swamp forests and open water. East of Grand Lake, the ROW passes through a broad expanse of cypress-tupelo swamp forest adjacent to the Chico pipeline canal, crosses Little Bayou Long, parallels the Southern Natural Gas Pipeline ROW, then crosses the ICW and the East Protection Levee to leave the Atachafalaya Basin Floodway.

East of the Floodway, the ROW continues to follow the Chico and UCAR pipelines across Old River and Goddel Bayou and crosses Highway 70 south of Pierre Part. Just west of Lake Verret the proposed ROW turns to the northeast parallel to the Wanda Petroleum pipeline across the upper end of the lake, then again follows the Chico ROW just west and north of Grand Bayou onto the natural levee ridge of Bayou Lafourche. The ROW crosses Bayou Lafourche and extensive agricultural lands just north of Klotzville. At Baker Canal North, the ROW follows the proposed 36-inch pipeline ROW from Bayou Choctaw to St. James through extensive cypress-tupelo swamp forest in the Barataria-Salvador-Des Allemands Basin, finally reaching the Capline Terminal on the Mississippi River.

Lengths of various types of terrain crossed by the ROW are approximately:

Cleared Levee (Agricultural)	17.4 miles
Intermediate Marsh	4.2 miles
Open Water	2.6 miles
Swamp Forest	33.4 miles
Bottomland Forest	8.7 miles
Manmade Levee	0.3 miles
Industrial Land (Weeks and Cote Blanche Islands)	0.6 miles
Total	67.2 miles

There are 19 major waterway crossings (bayous, canals, lakes, and rivers), 8 railroad crossings and 11 highway crossings (excluding local roads). The route passes within 2 miles of 22 small communities (Section 3.9), the largest of which is Franklin on Bayou Teche. The route passes through Iberia, St. Mary, St. Martin, Assumption, and St. James parishes.

2.3.3.2 Pipeline Construction Methods

Three basic modes of construction have been selected for installation of the pipeline system. Terrain differences, pipe size (large diameter pipe), and schedules for construction necessary to meet in-service dates are the controlling factors in the selection. The three modes are:

1. Conventional Land Lay (Dry Land)
2. Conventional Push Ditch
3. Flotation Canal

These three basic modes would provide reliable construction methods to insure completion by the in-service dates.

A fourth mode of pipeline construction, termed the "modified push ditch" or "modified flotation canal," may be applicable in certain wetland terrain having constant or predictable water levels. This method, although described in this Section, is not considered practical for the proposed pipeline system.

The methods of construction proposed for the pipeline are shown by segment on the map in Figure 2.3-3; approximate lengths of habitat crossed using each method are given in Table 2.3-1. Basically, the dry land method is proposed on the Lafourche, Teche, and Cypremort levee ridges and on the elevated storage site terrain (a total of 28.4 miles); the conventional push ditch is proposed in swamp forests and marsh lands outside the Atchafalaya Basin (a total of 25.7 miles); and the flotation canal (either widening an existing canal or cutting a new one) is recommended between the East and West Protection Levees of the Atchafalaya Basin (a total of 13.1 miles). Summary descriptions of each method and the rationale for selection on particular segments of the pipeline follow.

Conventional Land Lay (Dry Land) Construction

This method is a mobile sequential operation, generally applicable to ground capable of supporting heavy equipment, wherein pipe is installed in ditches excavated by ditching machines and backhoes. The pipeline is assembled and lowered into the ditch by large sideboom tractors and other ancillary equipment. Backfill and cleanup is then accomplished by bulldozers and other earthmoving equipment. This method is applicable to higher ground elevations where water is generally not an impediment.

Typical cross sections showing conditions immediately after pipe installation and several months after backfilling are shown in Figure 2.3-4. Average volume of excavation is 8200 cubic yards per mile. A

75-foot wide construction ROW and a 50-foot permanent access ROW are typical. Backfilling returns the terrain to the original contour and normal vegetation (crops, grasses, or trees) will return. Surveillance of the pipeline ROW typically consists of monthly aerial overflights and quarterly ground inspection. Operation and maintenance procedures would conform to Title 49 Part 195, Transportation of Liquids by Pipeline.

The levee ridges along Bayou Lafourche, Bayou Teche, and Bayou Cypremort are generally suitable for this method of pipeline installation. Also, the land adjacent to the Southern Pacific Railroad southeast of Weeks Island is considered to be capable of supporting the necessary equipment. As this method requires the least amount of excavation, terrain alterations are generally insignificant after backfilling and environmental effects are minimal. It is possible that during wet periods some of the lower elevations specified for dry land construction could not support the necessary equipment, in which case conventional push ditch would be utilized.

Conventional Push Ditch Construction

This method is utilized in swampy areas where water depths are reasonably stable and predictable. Clearing of the rights-of-way is generally accomplished by hand (chain saws), with timber being stacked by heavy equipment working on timber mats. Heavy equipment (such as backhoes) are utilized working from timber mats (to provide support) to excavate a ditch of sufficient depth to provide enough water for pipeline installation. Once the push ditch has been excavated a stationary push site is established. This site may be on high ground, if available, or may be constructed by the use of temporary board-road type material, or may be a barge stationed in an accessible location. The push site must be accessible in order to facilitate movement of pipe and personnel to the site.

The pipeline is assembled at the push site in sequential fashion by a number of operations including welding, inspection, and pipe coating. The welded pipe is then pushed off the barge and floated into place in sections up to several miles in length (limited by water depth, obstructions, or bends).

Floats are required so that the pipe may be pushed into position through the water. Once the pipe is in place, the floats are removed allowing the concrete-coated pipe to sink to the bottom of the ditch. Backfill and cleanup can be accomplished utilizing large equipment working from mats for support.

Typical cross sections showing conditions immediately after pipe installation and several years after backfilling are shown in Figure 2.3-5. Average volume of excavation is about 15,000 to 20,000 cubic yards per mile (though it may vary from 8000 to 40,000, depending on soil conditions). A 75-foot construction ROW and a 15 to 50-foot permanent access ROW are typical. Backfilling is dependent upon the consistency and type of material excavated. At best, restoration to near the original contour can be accomplished. At worst, spoil material having a liquid consistency may provide almost no backfill at all. Vegetation which reestablishes itself across the ROW is dependent upon the succes of backfilling. Surveillance of the ROW consists of monthly aerial overflights and quarterly ground reconnaissance by boat or swamp buggy.

The swamp forest east of Lafourche ridge and north of Lake Verret and the intermediate marsh and swamp forest west of Teche ridge are considered to have the proper combination of stable water levels and sufficient soil bearing capacity to allow this method of construction. Terrain alteration depends on the ditch slope (and therefore top width) which will remain stable and on the success of backfilling. Frequently, enough suitable spoil volume is either lost or is not available, thus creating shallow depressions along the ROW after backfilling.

Flotation Canal Construction

This method employs the excavation of a canal sufficient in size and depth so that barges and floating equipment can be accommodated for pipeline installation. Excavation equipment generally requires a minimum of 6 to 8 feet of assured water depth. Barges used to excavate are normally 40 to 50 feet wide and from 150 to 200 feet in length with 6 to 8 yard deck-mounted clam bucket excavators (dredges). Crew quarters are provided so that they may be operated 24 hours a day. Tugboats are required for supplying these barges. The width of the excavation for the flotation canal is approximately 80 to 100 feet so as to accommodate movement in and around the dredge. Spoil from the canal must be deposited alongside the canal.

Clearing is generally accomplished by hand; the dredges which excavate the flotation canal lay the timber aside, placing the spoil from the flotation canal on top. Gaps at regular intervals in the spoil bank (and at existing waterway crossings) are generally left in order to provide and maintain normal surface drainage patterns.

The pipe is installed by the mobile lay-barge method, utilizing the flotation canal that has been excavated. This is a sequential assembly operation performed on the deck of a lay barge approximately 40 feet wide and up to 400 feet long. The flotation canal is not backfilled. Water flow and access to the flotation canal is controlled by the selective installation of plugs (to prevent waterflow) and barriers (e.g., fence) which remain intact until future maintenance is required.

Typical cross sections showing conditions immediately after pipe installation and several months after bank stabilization are shown in Figure 2.3-6. The average volume of excavation is about 130,000 to 165,000 cubic yards per mile. A 120 to 140-foot construction ROW and a 15 to 50-foot permanent access ROW are typical. Terrestrial vegetation is excluded from the pipeline canal; spoil banks support grasses, shrubs, cottonwoods, and willows. Surveillance of the ROW typically consists of monthly aerial overflights and quarterly ground reconnaissance by boat.

Where there is an existing pipeline canal with space available along one bank, it is often possible to widen the canal instead of excavating a separate parallel canal. In this case, typically a 100 to 120-foot construction ROW and a 50-foot canal extension are sufficient (Figure 2.3-7). Excavation volume may be 75,000 cubic yards per mile, deposited on the near bank.

Within the Atchafalaya Basin, water levels fluctuate significantly in response to flow in the Mississippi River and local rainfall. Conditions are too variable both across the Basin and at any given location, to assure that pipeline installation and maintenance can be accomplished within necessary time constraints using any method other than flotation canal. Along the selected route, 9 miles of existing canal can be widened, and 4 miles of separate canal (parallel to another canal) must be excavated (Figure 2.3-3 and Table 2.3-1).

Modified Push Ditch Construction

This method employs shallow draft barges to excavate a canal which can be used to float the pipe into place. A larger push barge is then used to assemble the pipe and to push it into the canal, using flotation buoys to position the line before sinking. Under proper conditions, backfilling can be accomplished from the excavation barge.

Large diameter, concrete-coated pipelines, such as required for this project, must be pushed in relatively straight sections. The minimum bend radius may be 4000 feet; thus any bends requiring a smaller radius, and many crossings of other pipelines, would require installation of prefabricated bends. For such installation, barge access and new push sites must be provided.

Typical cross sections showing conditions immediately after pipe installation and several months after backfilling (where this is feasible) are shown in Figure 2.3-8. Average volume of excavation is 30,000 cubic yards per mile. A 120-foot construction ROW and a 15 to 50-foot permanent access ROW are typical. Backfilling would minimize terrain alteration but a shallow canal normally results because of spoil compaction and erosion. Revegetation depends on final topography. Pipeline surveillance would be the same as for flotation canals.

The modified push ditch method is most applicable to areas which have relatively constant, or predictable, water levels, such as coastal marshes. Possible advantages in some terrain may include reduced ROW width, reduced excavation volume, and less potential for drainage pattern alteration. Factors which make the method impractical for the proposed Weeks Island/ Cote Blanche Island pipeline within the Atchafalaya Basin include: (1) unpredictable and highly variable water levels could leave barges or pipelines stranded for weeks or months at a time; (2) the very liquid consistency of the silty substrate would prevent effective backfilling so that terrain would be altered in a manner similar to a flotation canal; (3) the logistics of supplying concrete-coated 36" pipe to the push barge would be difficult and costly; (4) the timetable for initial fill of the Weeks Island and Cote Blanche Island storage sites does not allow for indeterminate delays caused by weather or other unpredictable events; (5) the cost of mobilizing a second contractor to continue pipelaying in the event of a loss of water level is extreme. (Should this occur, a flotation canal would have to be constructed in the troublesome locations); (6) where the existing canal ROW cannot be followed, a second, parallel canal would be erected in the swamp; and (7) the shallow depth of the canal would create the danger of grounding if boat traffic is allowed access.

In summary, the modified push ditch is not considered to be a practical and technically feasible way of installing the pipeline across the Basin within a prescribed time period.

Pipeline Construction at Crossings

Highway and railroad crossings would be bored under the roadbed to avoid interruption of traffic. Local roads would be crossed either by boring or via an open trench. In the case of the latter, only half the road would be trenched at one time and traffic would be routed to the other half where possible. In settled areas, provision would be made to avoid interference with the flow of pedestrian and vehicular traffic. Excavated material which cannot be piled along the ditch would be hauled away and, where necessary, the ditch would be bridged with steel plates or other material to maintain traffic flow while pipe-laying proceeds. The length of open ditch would be limited to that necessary for efficient construction.

Special measures would be taken at stream and river crossings to control potential environmental impacts during construction. In general, river crossings involve the excavation or dredging of a trench in which the assembled pipe would be located. Small stream crossings require construction techniques which depend on the volume of flow and streambed conditions. The streams may be temporarily diverted, or passed across the pipeline trench by means of a flume or conduit. The objective is to minimize interruption of the stream flow and turbidity. Backfill in these streams would be the original parent material.

At major stream crossings (greater than 100 feet wide), installation would normally be open trenching using dragline dredges operated from the banks or excavating equipment operated from barges. Excess excavated materials would be deposited in an approved spoil area, usually on the stream bank. It is estimated that a total area of 170 acres would be required for temporary spoil storage and for equipment access and pipe storage along the banks of the major stream and canal crossings. Streams with silt or clay bottoms would not be excavated until immediately prior to the pipe-laying activity. Once the ditch has been dredged, the concrete-coated pipe, already prepared in adequate length on one bank, is pulled into the trench by cable from the opposite bank until it spans the stream. The ends of the pipeline are plugged during this operation to prevent water from entering. In unstable channels, or where channel widening is planned, the horizontal run of pipe under the channel is extended well into the banks on both sides. The pipe would have a minimum cover of 5 feet below the maximum depth of the river bottom/scour, or as required by governmental regulations.

All equipment crossings of soft-bottom streams are typically done via causeways constructed of the most suitable locally available materials and at an elevation equal to, or slightly higher than, the normal water level. Where normal stream flow volume tends to erode the causeway, proper methods are used to reduce erosion.

Construction of access roads should not be required as the ROW follows existing pipeline alignments for its entire length. Existing canals would be used for equipment access within the Atchafalaya Basin Floodway.

It is expected that the St. James pipeline would be laid and tested in segments up to 15 miles or more in length. Immediately after construction is completed in a given area (possibly before hydrostatic pressure testing) 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 one to three weeks. The amount of work required for restoration would vary with the terrain and the amount of disturbance. All disturbed land could be reseeded with native vegetation immediately after backfilling to promote growth of ground cover. In agricultural land the original topsoil could be replaced to promote immediate crop production. Where major streams or channels are crossed in wetland areas, bulkheads could be constructed across the pipeline ditch at either bank to prevent erosion and flow diversion; riprap could be used in other locations.

2.3.4 St. James Terminal

New facilities which would be constructed at St. James Terminal include a tanker dock and four 200,000 barrel storage tanks needed to handle the oil to be used for SPR storage and distribution (Figure 2.3-9). The tanker dock and connecting pipelines would be located on 3 acres of land just south of another FEA dock on the Mississippi River. The dock would provide mooring for one tanker and would require dredging of up to 200,000 cubic yards of material to be 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.

The four 200,000 barrel oil storage tanks would be constructed by FEA or by private industry on approximately 25 acres of land adjacent to a 30-acre terminal site planned to handle crude oil for the early phase of the Bayou Choctaw storage site (supplement to Bayou Choctaw EIS [FES 76-5, 1977]); the site would be located either just south of the existing Capline tank farm or on Koch Oil Company property just north of Capline (Figure 2.3-9). The tanks would be manifolded to connect with the four 200,000 barrel floating roof oil surge tanks, mainline pumps, tanker loading pumps, flow meters, and meter prover which are planned for the 30-acre Bayou Choctaw terminal facility (and could be used for either storage site).

In addition, FEA is considering creation of additional storage capacity at five candidate salt domes which would serve the St. James Terminal. This expansion would require up to a total of four additional 200,000 barrel storage tanks on approximately 50 acres of land at St. James to accommodate distribution of the increased amount of oil. The construction and use of these tanks is being addressed in an EIS now in preparation for this group of five sites.

Electric utility power would be the prime source of energy for the terminal. A 10,000 KVA transformer and substation located on the 30-acre terminal site would be utilized. A powerhouse building containing all terminal motor starting switchgear and control equipment would be located at the site. 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 API and 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 Capline 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 Capline Terminal site as proposed in this supplement would avoid the need to expand existing barge dock capabilities at Weeks Island and Cote Blanche Island, which includes construction of additional barge slips (13 acres total) and adjacent pumps, dock facilities, and pipelines (25 acres total) and dredging and disposal of an estimated 500,000 cubic yards of excavated spoil.

2.3.5 Operation

Oil would be transported to and from storage at Weeks Island and Cote Blanche Island entirely by pipeline. For analysis purposes, withdrawal of oil is assumed to occur 5 times between 1980 and approximately 2000 in response to oil supply interruptions. The planned average fill rate is 190,000 barrels per day (BPD). Oil would be delivered to Weeks Island first (requiring 15.4 months to fill completely) and then to Cote Blanche Island (requiring 4.7 months to fill completely). Oil would probably be offloaded from VLCCs in the Gulf to small tankers (45 MDWT typical), which would transport the oil to the FEA dock at St. James.

From St. James, oil would be pumped through the 67-mile pipeline to the storage sites.

Oil withdrawal is planned to be accomplished in 150 days. This requires an average withdrawal rate of 773,000 BPD to empty both Weeks Island and Cote Blanche Island within the required time. At St. James, a portion of the oil would be delivered to the Capline pipeline for distribution to Midwest refineries; the remainder would be loaded onto tankers (80 MDWT typical) for delivery down the Mississippi River to other ports in the Gulf of Mexico, Caribbean, or East Coast.

Oil movements planned for the SPR facilities originally proposed for Cote Blanche Island (FES 76/77-7) and Weeks Island (FES 76/77-8) involve barge transportation between the storage sites and the Mississippi River, transfer between barges and small tankers in the Mississippi and tanker transport to and from the Gulf of Mexico. During cavern fill operations, the availability of barges is expected to limit fill rates to 105,000 BPD at Weeks Island and 85,000 BPD at Cote Blanche Island. These combined rates are the same as the planned pipeline fill rate.

During withdrawal the maximum rate of 342,000 BPD (70 barges committed) associated with the alternative barge distribution system would require 11 months to withdraw the entire 116 MMB of combined storage at the sites. This would require loading of nearly 14 barges each day from the sites during this period.

2.3.6 Development Schedule

The planned timetable for construction of the oil distribution system and initial oil delivery to Weeks Island and Cote Blanche Island is given in Table 2.3-2. The development schedules for mine conversion are given in FES 76/77-7 and 76/77-8. Table 2.3-2 gives the earliest feasible development schedule for the distribution system. Presently Morton plans to develop shallow salt production facilities which would avoid shutdown of the mine during conversion. Expanded mining operations would be developed through this new mine. These plans would not delay the oil storage development schedule or construction of the oil distribution system.

According to the schedule in Table 2.3-1, construction of the new tanker dock at St. James would begin in the tenth month of the project and be completed nine months later. Construction of the pipeline and terminal facilities at St. James would occur from the eleventh month through the seventeenth month.

Immediately thereafter, oil deliveries would begin by tanker and pipeline at an average rate of 190,000 BPD (maximum of 240,000 BPD). Approximately 27 MMB of oil are expected to be in storage at Weeks Island by December 22, 1978. Weeks Island would be filled to capacity (89 MMB) by the end of 1979 and Cote Blanche Island would be filled (27 MMB) by the spring of 1980.

Development of the Weeks Island and Cote Blanche Island facilities as described in FES 76/77-7 and 76/77-8 would not involve construction of a pipeline or of facilities at St. James. However, conversion of the present mine to an oil storage facility and expansion of the barge docks would not allow oil deliveries to begin any earlier than planned for the proposed oil pipeline system. At a combined rate of 190,000 BPD, oil fill by barge could be accomplished in 20 months or approximately the same time period as planned for the St. James pipeline system.

2.3.7 Termination and Abandonment

The oil distribution system may be of use for transport of oil across southern Louisiana after the SPR program has been terminated. If so, arrangements would be made with private industry to provide for such use. If no longer considered useful, all aboveground facilities would be dismantled and disposed of properly. Below ground pipelines may be flushed with water, capped, and left in place, unless they present a hazard or obstruction to other potential land uses.

2.3.8 Costs

Preliminary engineering feasibility estimates for construction and operation of the proposed and alternative oil distribution systems indicate the capital costs would be more than twice as great with the pipeline to St. James as with barge transportation. During oil fill and withdrawal, however, costs would be considerably reduced with the proposed system because barges would not have to be leased to transport oil to and from the sites. An accurate projection of facility development and utilization costs is not available at this time. However, it is expected that for three or more oil supply interruptions the proposed pipeline system would be less costly.

TABLE 2.3-1 Lengths of pipeline ROW habitat crossings (miles)[a]

Habitat	Dry Land	Push Ditch	Construction Method[b] Flotation Canal[d]	Flotation Canal[e]	Total ROW Construction by Habitat
Deciduous Swamp Forest	1.2	20.5	9.1	2.6	33.4
Bottomland Forest	8.7	-	-	-	8.7
Intermediate Marsh	-	4.2	-	-	4.2
Agricultural Land	17.4	-	-	-	17.4
Industrial Land	0.6	-	-	-	0.6
Levee Land	0.3	-	-	-	0.3
Open Water[c]	0.2	1.0	0.1	1.3	2.6
Total ROW Construction by Method	28.3	25.7	9.2	3.9	67.2

[a]Based on aerial photographs of proposed pipeline alignment.

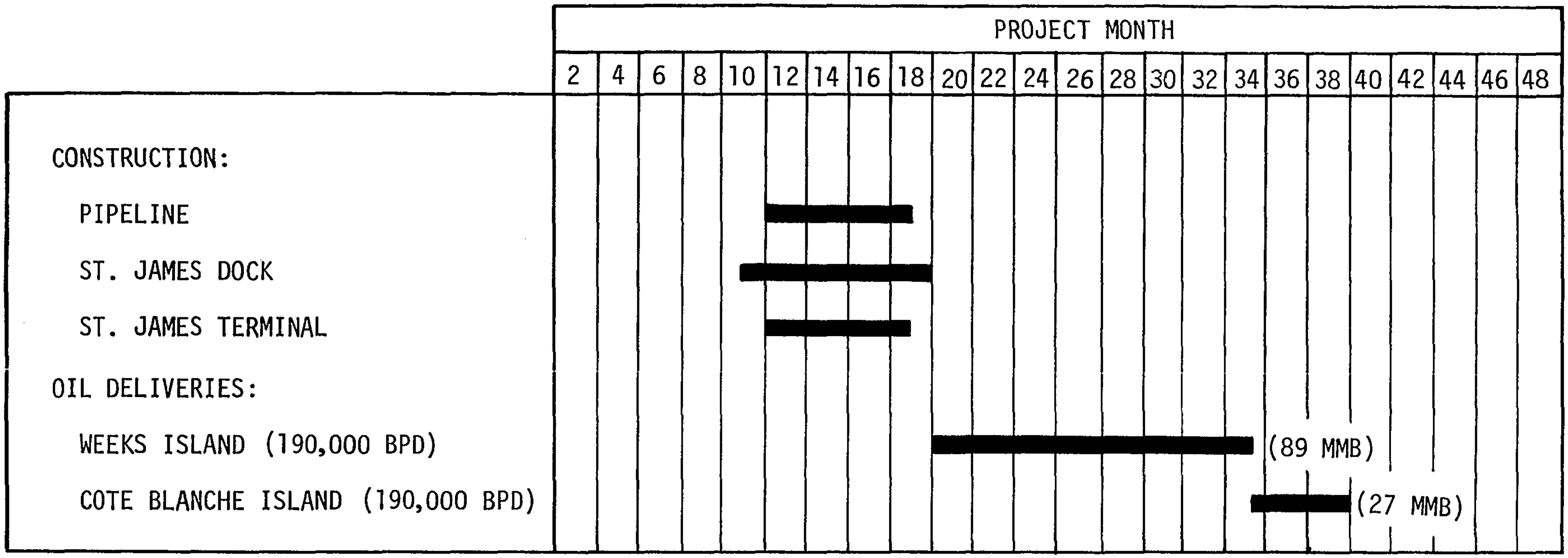
[b]See Figure 2.3-3 for identification of construction methods by segment along the proposed route.

[c]Crossings at major water bodies such as Lake Verret and Grand Lake would utilize conventional water crossings with backfill; pipe would be laid from a barge.

[d]Widen existing canal.

[e]Separate FEA canal.

Table 2.3-2. Development Schedule, Weeks Island and Cote Blanche Island Oil Distribution Systems to St. James



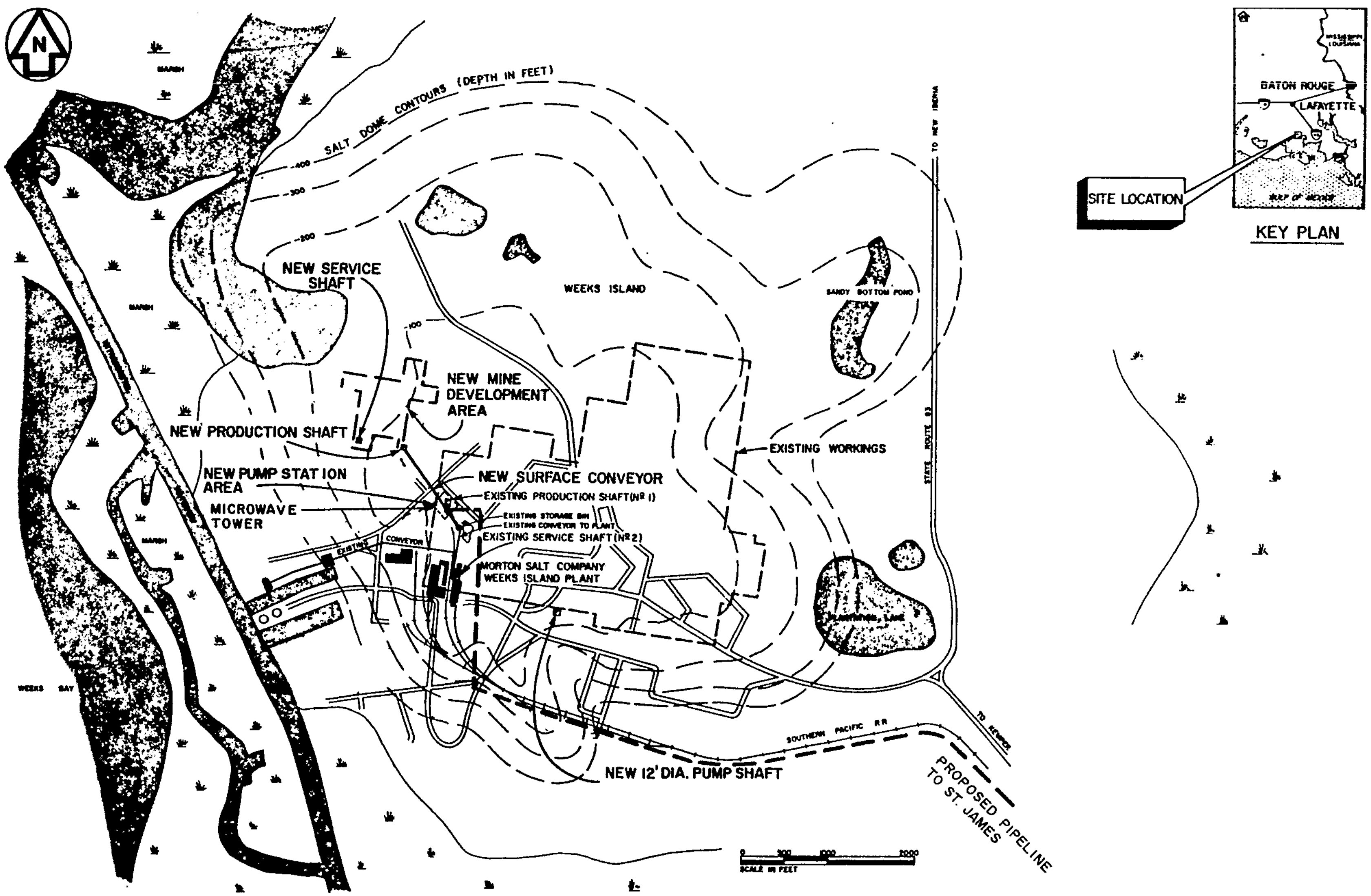


Figure 2.3-1 Weeks Island Mine Surface Facilities

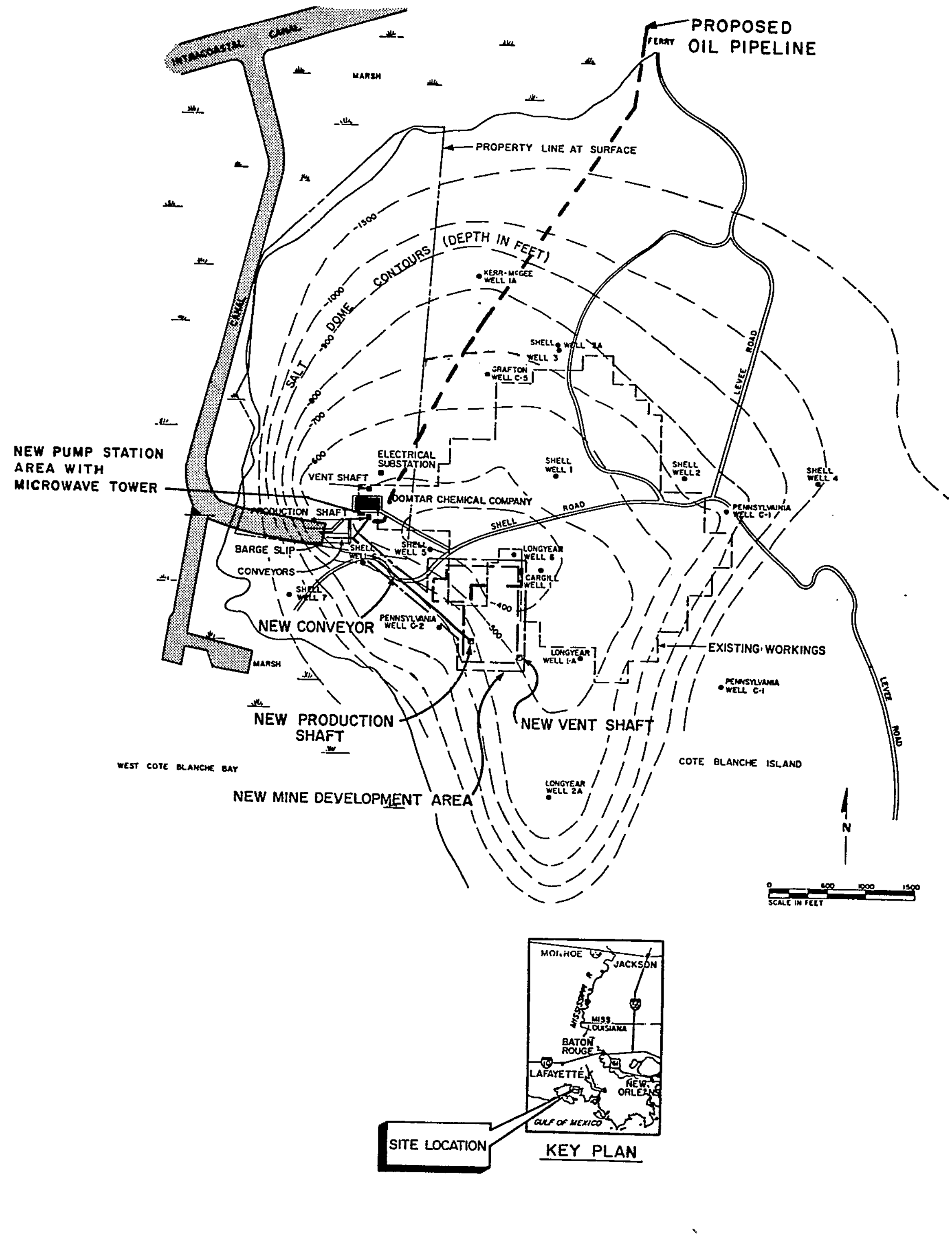


Figure 2.3-2. Cote Blanche Mine Surface Facilities

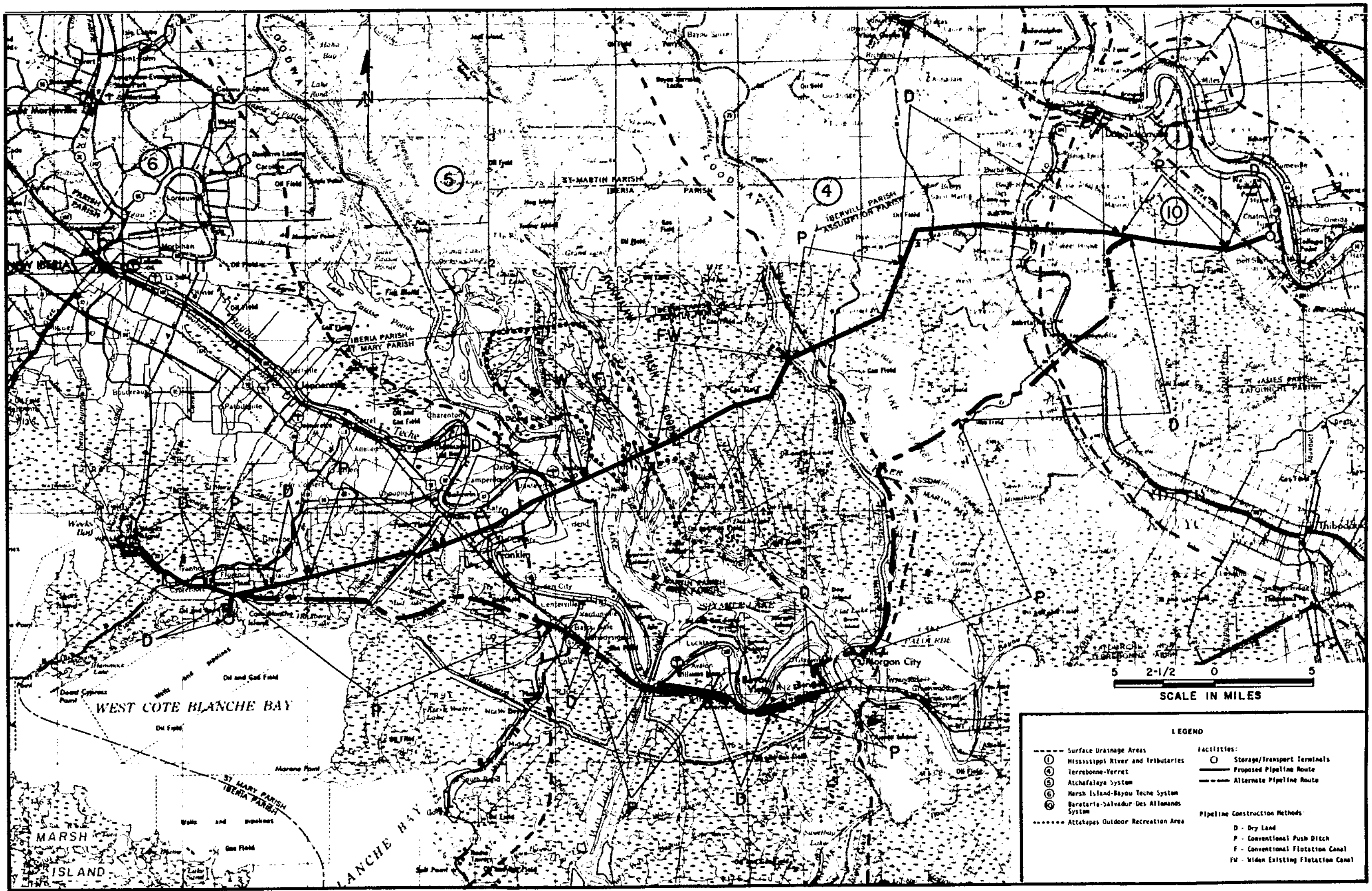
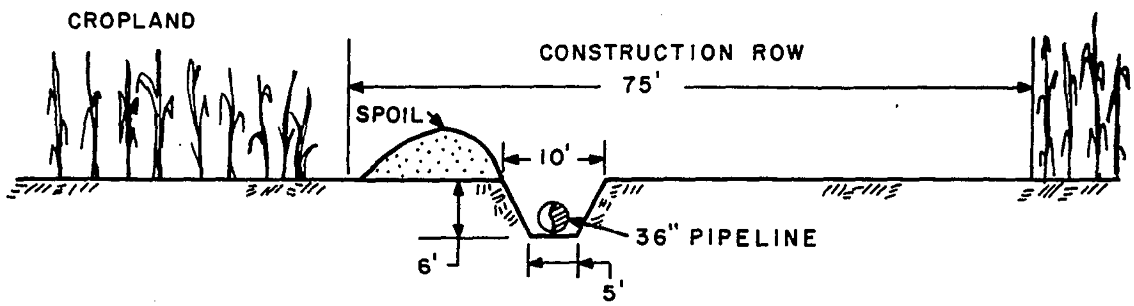


Figure 2.3-3. Proposed Methods of Pipeline Construction.

A. CONVENTIONAL DRY LAND DITCH AFTER EXCAVATION



B. CONVENTIONAL DRY LAND DITCH AFTER BACKFILLING

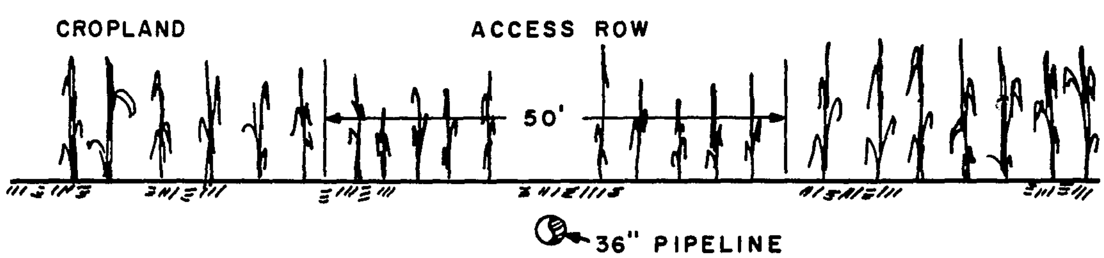
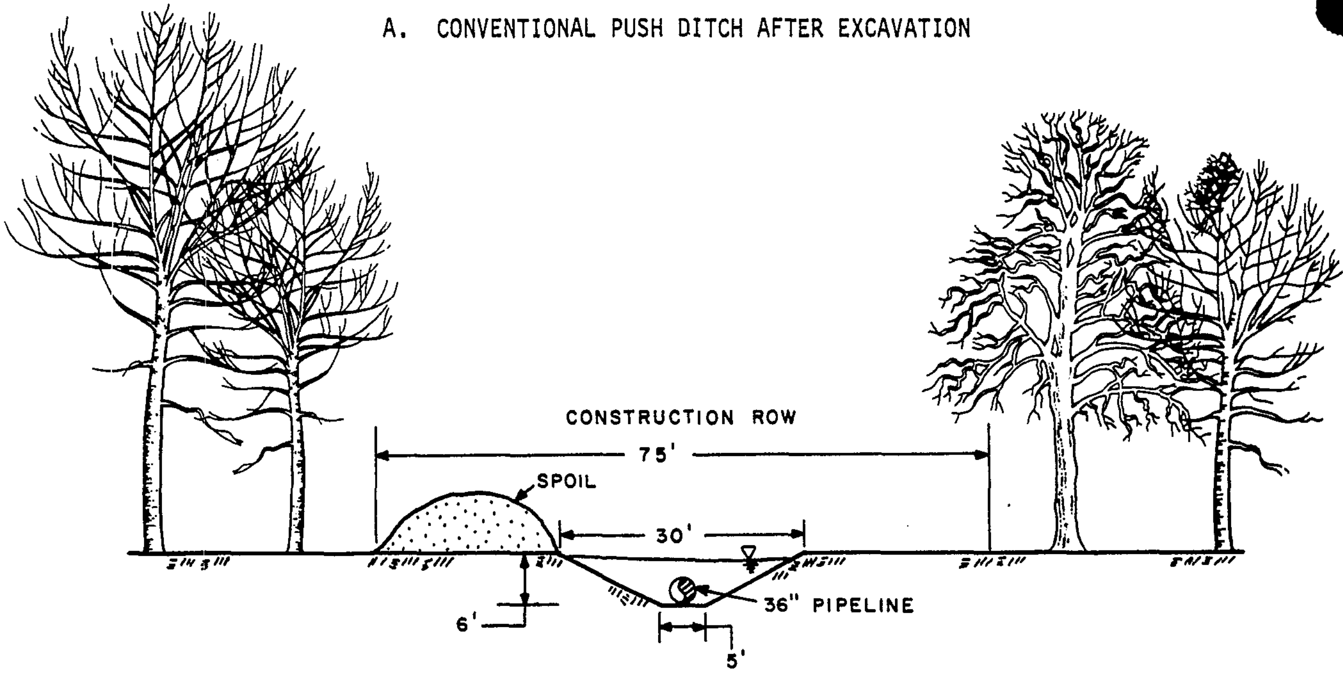


Figure 2.3-4. Typical Cross-Section of Conventional Dry Land Pipeline Construction After Excavation and Several Months after Backfilling.

A. CONVENTIONAL PUSH DITCH AFTER EXCAVATION



B. CONVENTIONAL PUSH DITCH SEVERAL YEARS AFTER BACKFILLING

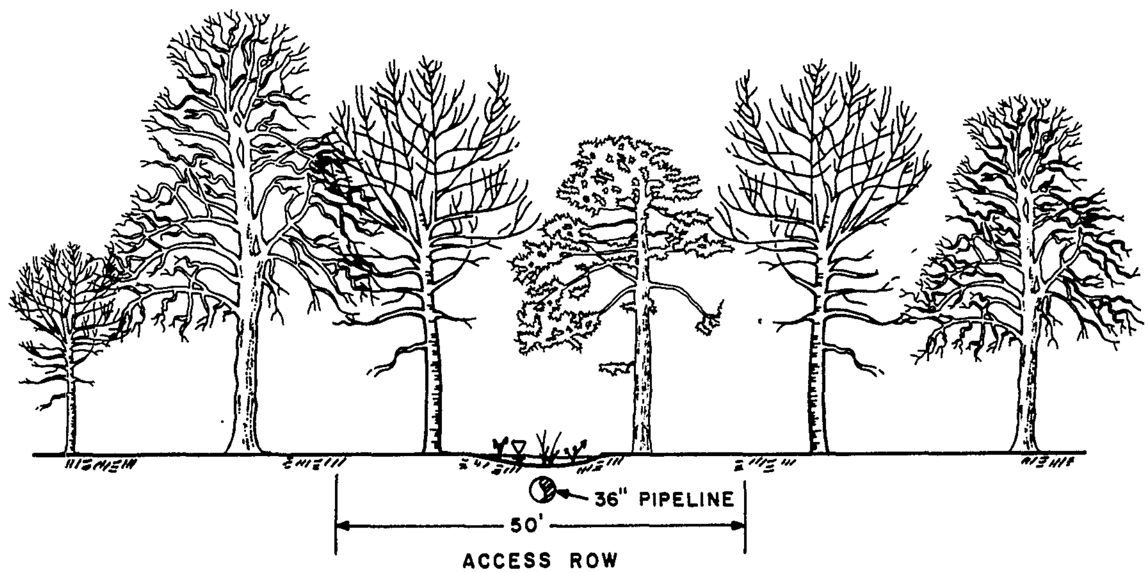


Figure 2.3-5. Typical Cross-Section of Conventional Push Ditch Pipeline Construction After Excavation and Several Years After Backfilling.

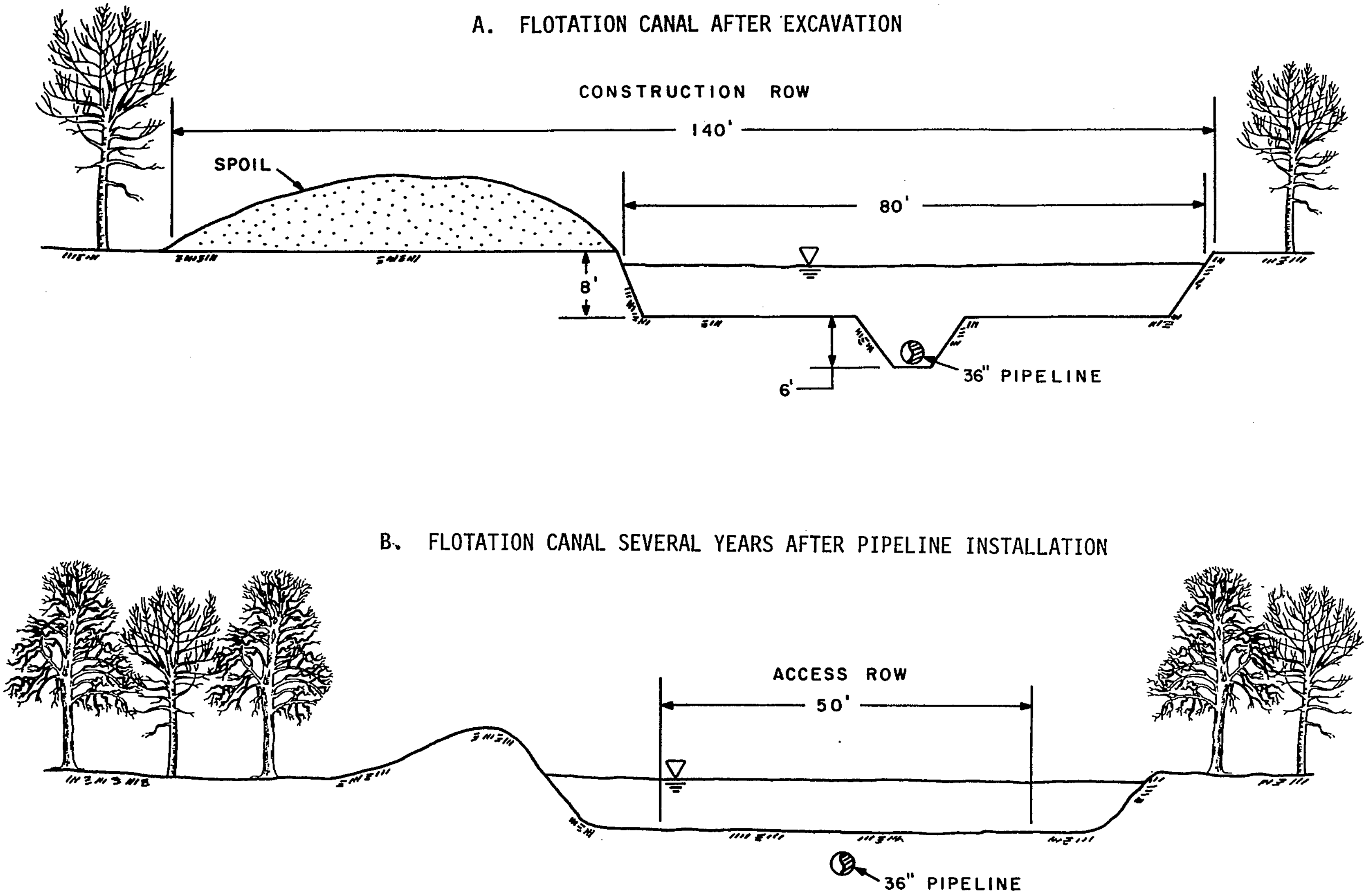


Figure 2.3-6. Typical Cross-Section of Conventional Flotation Canal Construction After Excavation and Several Years After Pipeline Installation.

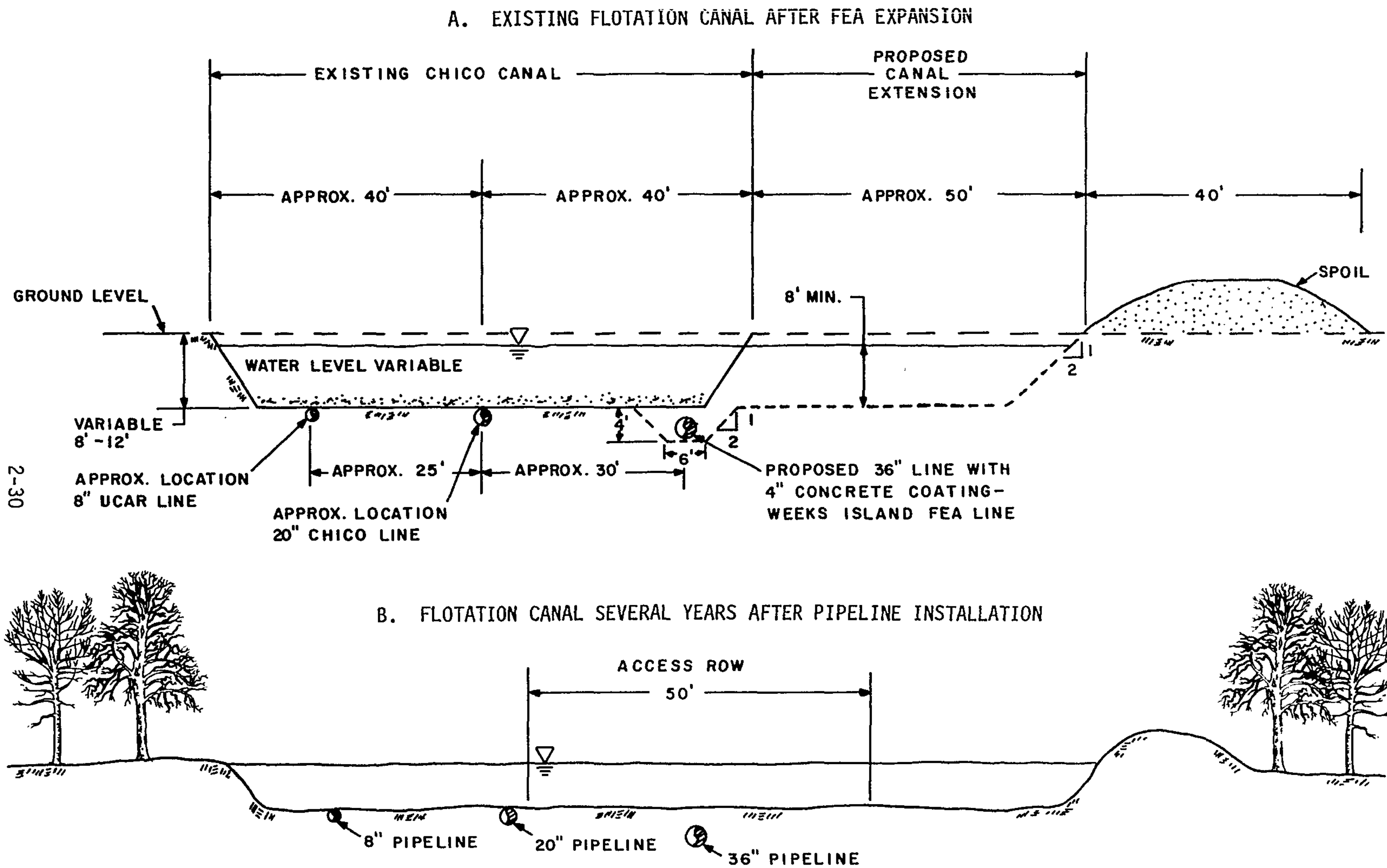
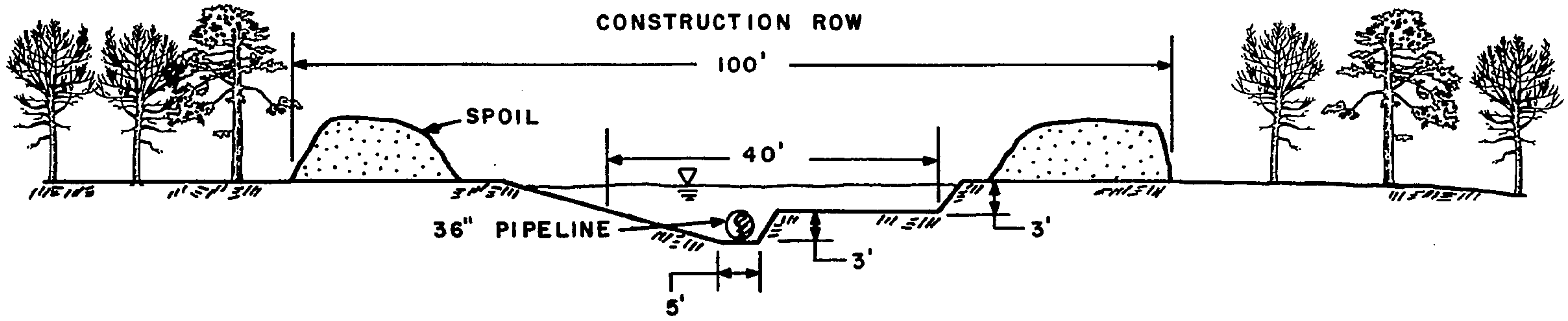


Figure 2.3-7. Typical Cross-Section of Conventional Flotation Canal Expansion of Existing Canal After Excavation and Several Years After Pipeline Installation.

A. MODIFIED PUSH DITCH AFTER EXCAVATION



B. MODIFIED PUSH DITCH SEVERAL YEARS AFTER BACKFILLING

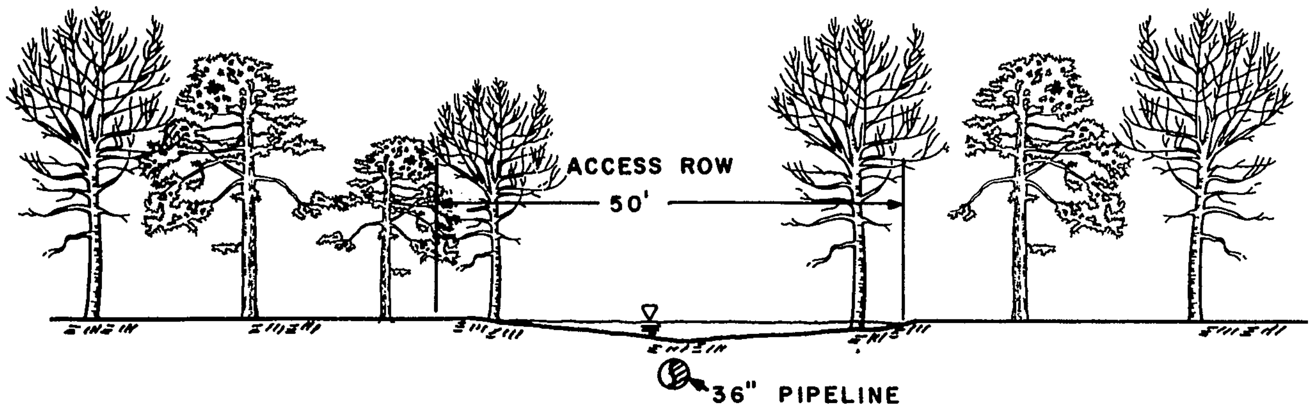


Figure 2.3-8. Typical Cross-Section of Modified Push Ditch Pipeline Construction After Excavation and Several Years After Backfilling.

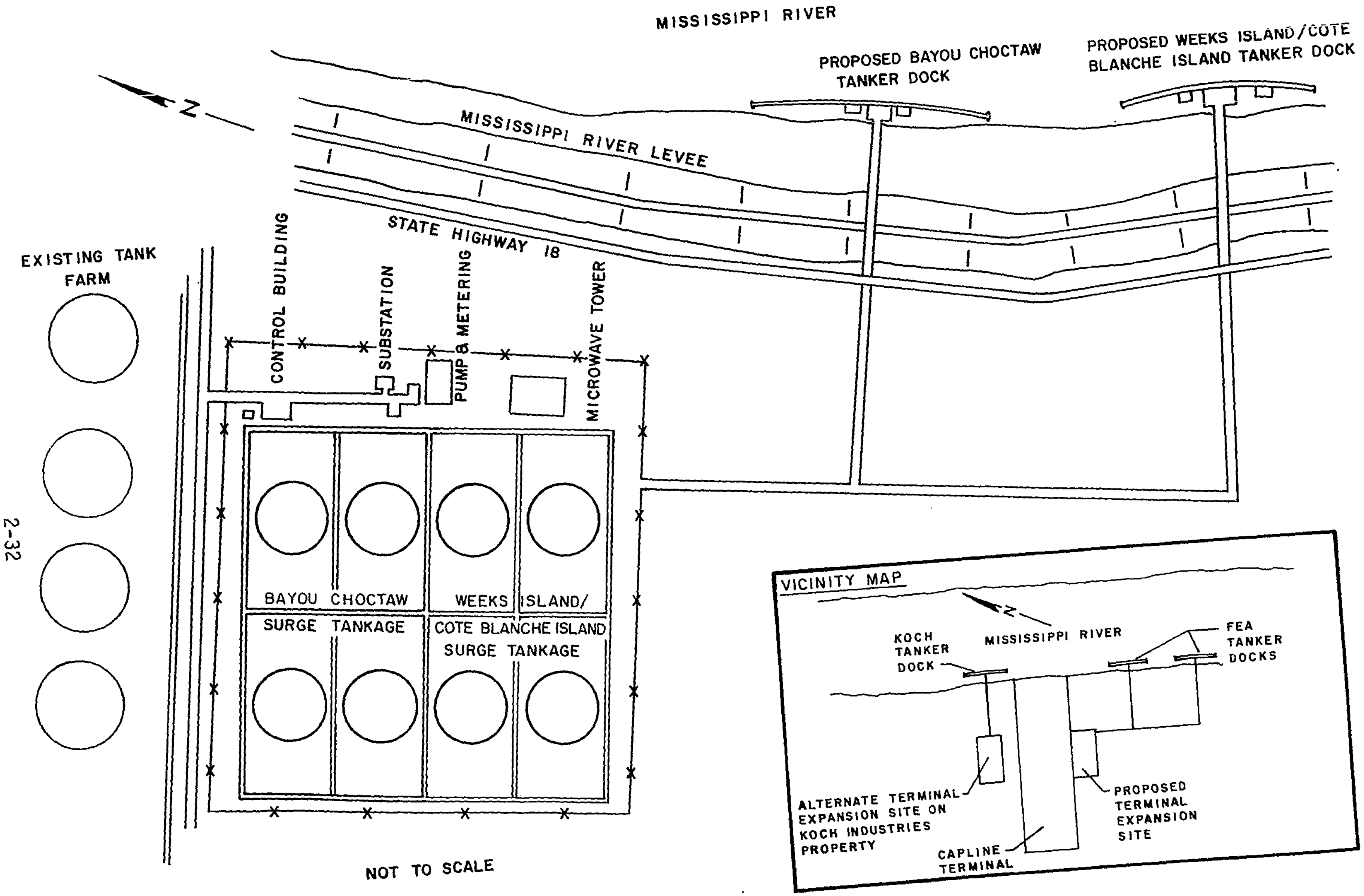


Figure 2.3-9. Proposed Tanker Terminal at St. James

2.4 NEW MINE DEVELOPMENT

Construction and operation of a pipeline between Weeks Island, Cote Blanche Island, and St. James would have no effect on plans to develop new salt mines on the islands. The decision to develop a new mine is up to the mine owner. Possible development plans are described in Section 2.4 of FES 76/77-7 and 76/77-8.

SECTION 3.0

DESCRIPTION OF THE EXISTING ENVIRONMENT

3.1 INTRODUCTION AND SUMMARY

The Weeks Island and Cote Blanche Island salt mines have been proposed as potential sites for crude oil storage as part of the National Strategic Petroleum Reserve Program. This section briefly summarizes the existing physical, biological and human environment surrounding the mine sites and along the proposed pipeline route to St. James, Louisiana. Detailed information regarding the storage sites is provided in Sections 3.2 through 3.9 of FES 76/77-7 and 76/77-8. The environment along the pipeline route is described in Sections 3.2 through 3.9 of this Supplement.

Weeks Island and Cote Blanche Island are located in the coastal region of Iberia and St. Mary Parishes, respectively. The islands were created as a result of salt dome formation deep in the earth followed by piercement of the salt to within several hundred feet of sea level. Portions of the domes are mined by dry, room and pillar techniques.

Both Weeks Island and Cote Blanche Island are located on the northern edge of the extensive Atchafalaya-Vermilion Bay estuarine complex in coastal Louisiana (Figure 2.1-1). The bays are generally shallow and are rimmed by brackish, intermediate, and fresh marshes on the north and by predominantly brackish marsh on the south.

On the salt domes, the proposed pipeline routes follow existing development corridors - the Southern Pacific Railroad on Weeks Island and a transmission line on Cote Blanche Island. To the east of the storage sites, the ROW crosses fresh and intermediate marsh, with some swamp forest, as far as the natural levee ridge along Bayou Teche. This ridge is the location of most urban/residential/agricultural development in this part of Louisiana. The Atchafalaya Basin route crosses the levee south of Oaklawn and parallels existing pipeline canals across Grand Lake and the extensive swamp lands of the Atchafalaya Basin Floodway (Figure 2.1-2). East of the Protection Levee, the ROW crosses swamp forest and shallow water north across Napoleonville Salt Dome to the Bayou Lafourche natural levee ridge. East of the Lafourche ridge, the ROW follows the Bayou Choctaw pipeline ROW to St. James (Bayou Choctaw EIS Supplement, 1977). Total length of the Atchafalaya Basin pipeline would be about 67 miles.

Most development in the region is confined to the banks of manmade and natural levees because of the periodic flooding and high water tables in the marsh and swampland. Extensive sugar cane fields are the principal land use on the ridges and along the eastern edge of Weeks Island. Urban development is almost exclusively confined to the wide levee banks of Bayou Teche and Bayou Lafourche. Towns along the levees are of moderate size and generally have populations less than 10,000.

The marshes, swamps, and waterways are developed extensively for oil and gas production and for coastal barge and ship traffic. Extensive oil and gas fields lie just north and south of Weeks Island in the marsh, in Vermilion and West Cote Blanche Bays, and throughout the Atchafalaya Basin. The Intracoastal Waterway (ICW) is adjacent to both islands. The east-west branch passes through Morgan City to Algiers Lock at New Orleans. The Port Allen Branch generally parallels the East Protection Levee between Morgan City and Baton Rouge on the Mississippi River.

Future development in coastal Louisiana will occur primarily along the elevated natural levee ridges of Bayou Teche, Bayou Lafourche, and the Mississippi River. Coastal marshes and interior swamps are not suited to residential, agricultural, or urban development. Oil and gas production in these areas will probably decline because present reserves are not large and limited exploration is taking place.

Two development corridors have been identified by the U. S. Corps of Engineers (1973) in the vicinity of the proposed project: New Orleans-Baton Rouge corridor along the Mississippi River within which the St. James Terminal facilities would be located, and the New Orleans-Lafayette corridor which follows Bayou Teche between Morgan City and Lafayette. Other than scattered construction of mineral or petroleum production and transportation facilities and some agricultural development, the remainder of the project region should not change appreciably in the next 20 to 30 years.

3.2 GEOLOGY AND SOILS

Two dominant physical features of southern Louisiana are the Gulf Coast Geosyncline and the occurrence of salt domes which have formed in response to the general subsidence and sedimentation in the region. Oil, gas, sulfur, and salt deposits are present in economically recoverable quantities throughout the region.

Southern Louisiana has experienced very minor earthquake activity during recorded history. The largest recorded event was a Modified Mercali intensity VI at Donaldsonville on the Mississippi River 12 miles northwest of St. James. Minor damage to chimneys and windows occurred at Napoleonville which is adjacent to the alternative Bayou Teche Route and 6 miles south of the proposed Atchafalaya Basin Route.

The pipeline route crosses soils assigned to several associations in the parishes of Iberia, St. Mary, St. Martin, Assumption, and St. James. In Iberia Parish the pipeline ROW crosses silty soils on the steep slopes of Weeks Island and organic swamp soils east of the island.

Soils in St. Mary Parish are the most diversified. On Cote Blanche Island, the ROW crosses silty soils similar to those on Weeks Island. Much of the route crosses organic swamp and clay soils (marshland); the next most prevalent types are the silts and loams of the river and bayou terraces (ridges). A short portion of the route crosses the bottomlands underlain by swamp, clay, and mucky clay soils (swamp forest).

In St. Martin and Assumption Parishes the primary soils crossed are clayey bottomlands assigned to the Sharkey-Swamp Association. Small sections of alluvial loams and clays, natural levee loams and silty clays (Commerce-Convent Association), and level clayey soils (Sharkey-Tunisa Association) are at the base of the levees.

In St. James Parish the soil associations are similar, consisting of frequently flooded, clayey soils of the Barbary-Sharkey Association; clayey Sharkey soils; and nearly level loamy and clayey soils of the Commerce-Sharkey Association.

Further information on area geology is provided in FES 76/77-8.

3.3 HYDROLOGY AND SEDIMENTOLOGY

3.3.1 Regional Surface Water Characteristics

3.3.1.1 Waterways

Weeks Island and Cote Blanche Island are located in the Marsh Island-Bayou Teche Drainage Area (FES 76/77-7 and 76/77-8). The proposed pipeline route crosses the Atchafalaya, the Terrebonne-Verret, and the Barataria-Salvador-Des Allemands drainage areas between the storage sites and St. James (Figure 2.1-2). Waterways provide the primary mode of bulk commercial transportation in southern Louisiana. Important navigable waterways include the ICW, Atchafalaya River, Bayou Teche, Wax Lake Outlet, Bayou Sale, New Iberia Drainage Canal, and the Charenton Canal. Further east, Bayou Lafourche is an important navigable waterway below Thibodaux and, of course, the Mississippi River is the most important waterway in the East.

A list of major water bodies crossed by the pipeline ROW, together with available information on maximum depth and normal width near the crossings, is provided in Table 3.3-1. The total width of all open waters to be crossed by the pipelines is less than 3 miles for the Atchafalaya Basin Route.

Descriptions of the Vermilion Bay-Atchafalaya Bay Complex, the Atchafalaya River, the ICW, and the Gulf coastal region are presented in FES 76/77-7 and FES 76/77-8. Other regional water bodies likely to be affected by the proposed facilities include the Mississippi River, Bayou Lafourche, and Bayou Teche. A general description of these water bodies is presented in the following paragraphs.

Mississippi River

The Mississippi River is the major fresh-water body in the region. At the most downstream gaging station for which long-term records have been regularly published (Mississippi River at Vicksburg, Miss., Station Number 07289000), the mean daily flow for the 45-year record ending in 1973 was 562,400 cubic feet per second (cfs); maximum recorded discharge was 2,080,000 cfs on February 17, 1973; minimum discharge was 99,400 cfs on November 1, 1939.

The reach of interest within the region is bounded by Baton Rouge (River Mile 230) and St. James (River Mile 156). Generally, streamflow is relatively constant over this 74-mile reach. The stream cross-section is approximately 130,000 square feet (average river width of 2,600 feet with an average depth of 50 feet). River velocities vary from 1.3 feet per second to 8.3 feet per second primarily as a function of changes in streamflow. Discharges in the study region are lower than those at Vicksburg because of the numerous distributary streams and overflow points. The largest flow rate observed over the 98 years of record was 1,473,000 cfs; the minimum observed flow was 73,700 cfs. The average flow for the 1973-1974 time period was 925,000 cfs. In a typical year, high flow conditions occur during January, and low flow conditions occur in September through October.

Bayou Lafourche

This bayou came into existence around 1300 A.D. when the Mississippi River changed course at what is now Donaldsonville, La. Presently this outlet of the Mississippi is blocked off from the river by a levee. The Bayou is currently fed by a pumping station located at Donaldsonville which extracts water from the Mississippi. This pumpage provides the total flow of Bayou Lafourche except for small amounts of local drainage during rain storms. Average daily discharge is recorded at 252 cfs at Donaldsonville (19-year record), with extremes in flow from 0 to 600 cfs. The Bayou discharges into the Gulf of Mexico. A large number of communities rely on the Bayou for domestic and industrial water supply.

Bayou Teche

This waterway is one of the important fresh water bodies in the western side of the region. Streamflow records at the St. Martinville gage show that the average discharge of Bayou Teche during the 17-year period 1959-1976 was 492 cfs; maximum discharge was 3970 cfs and minimum discharge was zero flow, experienced on several occasions. Water for irrigation is diverted from Bayou Teche through the Ruth Canal into the Vermilion River above St. Martinville. This irrigation diversion has averaged 135 cfs during the same 17-year period of record.

3.3.1.2 Water Quality Criteria

Pertinent information on Louisiana water quality standards is presented in FES 76/77-7 and FES 76/77-8, Section 3.3.1.6. Table 3.3-2 contains specific Louisiana water-quality standards for various surface-water segments in the region. Standards for other water segments in the region are contained in Table 3.3-6 of FES 76/77-7 and 76/77-8. The table includes a description of each segment, water-use designations, and specific criteria for chloride, sulfate, dissolved oxygen, pH, coliform, temperature and total dissolved solids.

In addition to State of Louisiana numerical standards, the EPA has proposed criteria for various water uses (e.g., domestic raw water supply, propagation of aquatic life). These criteria are of general applicability regardless of the particular body of water in question. Guidelines or proposed criteria differ from standards in that they do not have legal standing. In some cases, water use criteria are more stringent than geographical (States) standards for the same pollutant. Also guidelines or criteria recommend different levels of the same pollutants for different use designations. Thus, it is possible for a guideline to be exceeded without violating a standard.

The proposed EPA criteria for public water supply, marine aquatic life, and freshwater aquatic life are presented in Tables 3.3-3 (a) through (c), respectively. By cross-reference between FES 76/77-7 and 76/77-8 and Tables 3.3-2 and 3.3-3 of this Supplement, the EPA criteria can be applied to the various segments of surface water bodies in the region according to designated water-use.

3.3.1.3 Surface Water Quality

Description of existing water-quality conditions is based on the most recent water-quality data measured at major sampling stations in the region and compared with applicable standards for the respective surface water segments at which the stations are located. Major sampling stations are listed in Table 3.3-4 along with their locations and stream segment numbers. These stations are the only ones in the region for which a relatively large number of samples have been tested for a long list of parameters. Therefore, data for these stations are presented here to show existing water-quality conditions. Other stations exist for which very few samples are collected annually or for which a limited number of parameters are measured.

Water-quality data for the ten major water-quality sampling stations applicable to the region are contained in USGS (1976), Water Resources Data for Louisiana. Brief descriptions of the existing water-quality conditions in the major surface-water bodies in the region are provided in the following paragraphs. The water quality of the Atchafalaya River and the Gulf Coastal region were briefly discussed in Section 3.3.3.5 of FES 76/77-7 and FES 76/77-8. The most recent ambient water quality data for these water bodies are also included in the following paragraphs.

Mississippi River

Applicable water-use designations for the entire reach of the Mississippi River likely to be affected by the proposed action or alternatives are secondary contact recreation, propagation of fish and wildlife and domestic raw-water supply. Water-quality stations at Plaquemine (above Donaldsonville) and Union (above St. James) are referenced (Table 3.3-4).

Data collected during water year 1976 (October 1975 to September 1976) indicate that, with a few exceptions, standards and criteria are met at these two stations. Exceptions are as follows: In relation to proposed EPA freshwater aquatic-life criteria maximum suspended solids exceeded the criteria by more than a factor of 4 (332 as compared to 80 mg/l); cyanide exceeded the criteria by a factor of 2; and mercury by a factor of 3. Maximum phenol concentration satisfied the aquatic-life criteria, but was 9 times greater than that allowed under proposed EPA Public Water-Supply Intake guidelines. Also, the Louisiana standard for total coliform bacteria was exceeded by more than a factor of 4 at Union and by a factor of nearly 3 at Plaquemine. It is also noted that no test results were reported for many of the chemicals that appear in the standards at these Mississippi River stations.

Atchafalaya River Basin

Three major water-quality sampling stations exist in the Atchafalaya Basin: Atchafalaya River at Myette Point (just above the proposed pipeline ROW crossing), Lower Atchafalaya River at Morgan City and Wax Lake Outlet at Calumet. The first two are located on segments designated for all four State use classifications. Wax Lake Outlet, considered to be in a tidal area, is designated for secondary contact recreation and aquatic-life uses.

Comparison of reported water-quality at the Atchafalaya River stations during water year 1976 with applicable standards shows the following violations. The State standards for sulfate, chloride, and coliform bacteria were exceeded at both stations for some of the time. In addition, proposed EPA freshwater aquatic-life guidelines for suspended solids, diazinon, endrin and mercury were exceeded at both stations at least part of the time, and for DDT at the Lower Atchafalaya station part of the time. Also, the proposed EPA water-supply guideline for phenol was exceeded at both stations part of the time. All other measured constituents met applicable standards or criteria. One parameter that appears in the standards, total dissolved solids, was not reported.

Water quality for Wax Lake Outlet showed only minor departures from standards. The State standard for coliform was exceeded part of the time. Also, the proposed EPA marine aquatic-life criteria for phosphorus and mercury were exceeded part of the time. All other reported measurements met these standards.

Bayou Lafourche

The only major water-quality sampling station on this waterway is at Larose at the intersection of the ICW. Therefore, this station reflects compliance with standards for both Bayou Lafourche and that segment of the ICW. Both water bodies have identical use classifications - primary and secondary contact recreation, aquatic life, and water supply. However, State numerical criteria for the waterbodies differ for sulfate and chloride - the criteria applicable to the bayou being more stringent. Both standards for both segments were violated part of the time, as was the standard for coliform level; the maximum coliform value recorded was 7500 as compared to a 200 counts per 100 ml criteria. Departures from proposed EPA guidelines included suspended solids, diazinon and mercury, part of the time, for aquatic-life criteria; and phenols and cadmium, part of the time, for municipal water-supply standards. All other measured parameters showed compliance with standards. The only standard-applicable parameter not reported was total dissolved solids.

Bayou Teche

The major water-quality sampling station on Bayou Teche is located at Keystone Lock upstream from New Iberia. Designated use classifications for this bayou include all four types, namely, primary and secondary contact recreation, fish and wildlife, and domestic raw-water supply. Numerical criteria are identical upstream and downstream of Keystone Lock except for chloride, sulfate, and total dissolved solids, which are 43, 32, and 220 mg/l, respectively, for the upstream segment, and 80, 50, and 350 mg/l, respectively, downstream. For samples collected during water year 1976, these criteria were met in every case. The State standards for pH, temperature, dissolved oxygen and total dissolved solids were also met. With respect to proposed EPA freshwater aquatic-life guidelines, only diazinon exceeded the criteria; none of the proposed EPA water-supply criteria were exceeded. However, it should be noted that four of these standard-related parameters were not reported, and, for nineteen of these parameters, only one sample was analyzed during water year 1976.

Intracoastal Waterway (ICW)

Two major water-quality sampling stations are representative of the ICW in the region. One station at Larose on the eastern extremity of the region was described under the Bayou Lafourche discussion. The other station is located on the western extremity of the region at Vermilion Lock (East). This segment of the ICW is designated by the State for secondary-contact recreation and propagation of fish and wildlife uses. Water quality measured during water year 1976 showed that the State numerical criteria were met except for coliform levels which exceeded the limitation part of the time. Since this segment of the ICW is considered to be in a tidal area, measured water-quality may be compared to proposed EPA guidelines for marine aquatic life: all parameters met the EPA criteria except for phosphorus, which exceeded the standard part of the time.

Gulf of Mexico Coastal Area

Two major water-quality sampling stations are located in the coastal area of the region. One is in Vermilion Bay at Cypremort Point; the other is in Atchafalaya Bay at Eugene Island. Both water bodies are designated for secondary-contact recreation and propagation of fish and wildlife uses. Applicable state standards are identical except for dissolved oxygen (DO). Minimum allowable DO in Vermilion Bay is 4 mg/l, while the Atchafalaya Bay minimum is 5 mg/l. Water-quality data collected at these two stations show that, with two exceptions, applicable criteria were met. One exception is the State coliform bacteria standard; both stations failed to comply part of the time. The other is the proposed EPA marine aquatic-life guideline for phosphorus, which was exceeded part of the time at both stations.

3.3.1.4 Surface Water Uses

Surface water availability and uses within the vicinity of the storage sites are presented in Section 3.3.1.4 of FES 76/77-7 and FES 76/77-8. A number of navigable waterways would be crossed by the proposed Atchafalaya Basin pipeline route, as listed in Table 3.3-1. In addition to navigational use, the waterways along the pipeline route have uses which include fishing, wildlife habitat, and domestic and industrial water supply (see Table 3.3-2 for water use classification).

3.3.1.5 Sedimentology

The EPA has proposed sediment quality standards which are compared with chemical analyses of bottom sediments at several sampling stations in the study region in Table 3.3-5. Sediment along the Mississippi River is generally comprised of fine sand (100 to 250 micrometers).

Sediment samples for total Kjeldahl nitrogen, chemical oxygen demand, and oil and grease, approach the upper limit of EPA guidelines. These high concentrations result from heavy use of the navigable waterways, and the agricultural and industrial development of the drainage area.

Available data for Bayou Plaquemine (which is outside the project area but may be representative of worst case conditions) show high levels of heavy metals in the sediment. Concentrations of lead, mercury, and zinc are above recommended levels, as are oil and grease. Sediment concentration of total Kjeldahl nitrogen (TKN) approaches the upper limit of EPA recommended criteria.

The only parameters which exceeded EPA guidelines in Vermilion River and the Port Allen branch of the ICW were zinc for the former, mercury and TKN for the latter.

A discussion of the sediment characteristics of the Gulf Coastal region is presented in FES 76/77-7 and FES 76/77-8.

3.3.1.6 Flooding

Much of coastal Louisiana is subject to flooding from hurricane surges and from continental runoff. The Atchafalaya River is formed by the confluence of the Red River and the Old River 5 miles north of Simmesport (and 100 miles north of the proposed pipeline) in Avoyelles Parish, Louisiana. Flow consists of the Red River, controlled diversions from the Mississippi River at the Old River control structure, operated by the Corps of Engineers, and rainfall runoff from within the drainage basin to the south. Flow rates in the river are extremely variable; floods are controlled by the (manmade) East and West Protection Levees which are roughly 15 miles apart and extend from Simmesport on the north to below Morgan City on the south. As a result, water levels in bayous, canals, and swamps along the proposed pipeline route may vary by several feet from season to season and from year to year, depending on conditions in the interior of the continent, on local rainfall, and on Gulf of Mexico storm tides. For example, the maximum recorded flowrate at Simmesport was 781,000 cfs (cubic feet/second) in May, 1973; the minimum was 75,000 cfs in August, 1974. The entire basin between the Protection Levees is thus subject to periodic inundation. The bays and coastal marshes near the storage sites are subject to tidal surges accompanying storms in the Gulf of Mexico.

3.3.2 Regional Ground Water Characteristics

Ground water in the vicinity of the project is supplied chiefly by the Chicot, Atchafalaya, and Plaquemine aquifers. Throughout much of the coastal area clay and silt beds overly the sand units and serve as aquitards. The aquifers are charged through outcrops located across the state north and west of Baton Rouge (FES 76/77-7 and 76/77-8).

There is abundant ground water throughout much of the area to be affected by the proposed project. Water table aquifers may occur locally within the upper 100 feet of clay and silt strata. However, the principal fresh water aquifers occur below these confining layers; these include the Chicot aquifer in the vicinity of Weeks and Cote Blanche Islands and the equivalent Plaquemine aquifer east of the Atchafalaya Floodway. Fresh water occurs to a depth of about 600 feet in the vicinity of the storage sites and to about 300 feet near St. James. Within the Atchafalaya Floodway there is little fresh water below 100 feet of depth (Whiteman, 1972). Below the fresh water bearing sands, ground water gradually becomes brackish and saline.

3.3.3 Local Hydrology

The hydrology of Cote Blanche Island and Weeks Island is described in detail in Section 3.3.3 of FES 76/77-7 and 76/77-8, respectively. Each island is divided into several watersheds and the runoff characteristics are described. The pump shafts and surface facilities at both sites are located well above potential storm tide or surge levels. Local flooding from rainfall runoff is not a threat to the facilities. Several small freshwater lakes on Weeks Island are used by Morton employees for fishing; some water is drawn for boiler feedwater. Two ponds are used for settling and evaporation of brine water. On Cote Blanche Island the only use made of several small lakes is for watering cattle and for wildlife.

TABLE 3.3-1 Major navigable water bodies crossed by the proposed Atchafalaya Basin pipeline route (West to East)

Water Body	Approximate Normal Water Depth (feet)[a]	Approximate Natural Bank Width (feet)[b]
Bayou Cypremort	1	70
Charenton Drainage and Navigation Canal	30	270
Bayou Teche	12	240
Grand Lake (West Point)	60	4200
Grand Lake (East Point)	9	4900
Little Bayou Long	29	200
ICW (Port Allen Branch)	31	570
Old River	8	910
Goddel Bayou	13	580
Lake Verret	8	3300
Grand Bayou	10	200
Bayou Lafourche	2	100

[a]Source: Corps of Engineers Public Notice of Application for Construction Permit, UCAR Pipeline Incorporated 8 Inch Ethylene Pipeline Crossings, 13 May 1975.

[b]Source: Gulf Interstate Engineering company, 1975. Environmental Study to Accompany Application for a Department of the Army Permit, UCAR Pipeline Incorporated 8 Inch Ethylene Pipeline, Louisiana Segment, April 1, 1975.

TABLE 3.3-2 Specific water quality criteria - State of Louisiana.

SEGMENT		WATER USES				CRITERIA						
Agency I.D. Number*	Description	Primary Contact Recreation	Secondary Contact Recreation	Propogation of Fish and Wildlife	Domestic Raw Water Supply	Chloride (mg/l) not to exceed	Sulfate (mg/l) not to exceed	Dissolved Oxygen (mg/l) not less than	pH range	Coliform	Temperature°C	Total Dissolved Solids (mg/l) not to exceed
010040	Intracoastal Waterway (North-South) - Bayou Sorrel to Morgan City		X	X		150	75	5.0	6.0-8.5	1000	32	500
010070	Atchafalaya Bay (Tidal)		X	X		--	--	5.0	6.5-9.0	70	35	--
010010	Bayou Verret (includes Bayou Chevereuil, Bayou Citamon and Grand Bayou, etc.)	X	X	X		1000	500	5.0	6.5-8.5	200	32	2000
040230	Vermilion Bay (Tidal)		X	X		--	--	4.0	6.5-9.0	70	35	--
040240	West Cote Blanche Bay (Tidal)		X	X		--	--	4.0	6.5-9.0	70	35	--
050020	Mississippi River: From Old River Control Structure to Huey P. Long Bridge above New Orleans		X	X	X	75	120	5.0	6.5-9.0	2000	32	400
110010	Lake Verret	X	X	X		100	75	5.0	6.0-8.5	200	32	350
110020	Lake Palourde	X	X	X	X	100	75	5.0	6.0-8.5	200	32	300
110030	Bayou Boeuf - Lake Palourde to Morgan City	X	X	X	X	100	75	5.0	6.0-8.5	200	32	300
110140	Intracoastal Waterway (North-South) - Port Allen to Bayou Sorrel		X	X		250	75	5.0	6.0-8.5	1000	32	500
110150	Lower Grand River and Bell River - Bayou Sorrel to Lake Palourde (includes Bayou Goula and Grand Bayou)		X	X		250	75	5.0	6.0-8.5	1000	32	500
110280	Bayou Lafourche - Donaldsonville to Larose	X	X	X	X	70	55	5.0	6.0-8.5	200	32	500
-	Gulf of Mexico and other open coastal waters not specifically identified in the tables	X	X	X		--	--	5.0	6.5-9.0	70	32	--

*Drainage basins identified by I.D. Number: 01, Atchafalaya; 02, Barataria; 04, Mermentau-Vermilion-Teche; 05, Mississippi; 11, Terrebonne.

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

TABLE 3.3-3(a) Proposed EPA numerical criteria for water quality, public water supply intake

Parameter	μg/l
Arsenic	50
Cadmium	10
Chromium	50
Copper	1000
Lead	50
Mercury	2
Zinc	5000
Phenols	1.0
Cyanides	200
Aldrin	1
Chlordane	3
DDT	50
Dieldrin	1
Endrin	0.2
Heptachlor Expoxide	0.1
Heptachlor	0.1
Lindane	4
Toxaphene	5

Source: "Proposed Criteria for Water Quality," Vol. 1, U. S. Environmental Protection Agency, 1973.

TABLE 3.3-3(b) Proposed EPA numerical criteria for water quality, marine water constituents (aquatic life)

Parameter	μg/l
Arsenic	50
Cadmium	10
Chromium	100
Copper	50
Lead	50
Mercury	1.0
Nickel	100
Zinc	100
Cyanides	10
Oil and Grease	a. Not detectable as a visible film, sheen, discoloration of the surface, or by odor. b. Does not cause tainting of fish or invertebrates or damage to biota. c. Does not form an oil deposit on the shores or bottom of the receiving body of water.
Aldrin	5.5
DDT	0.6
Dieldrin	5.5
Endrin	0.6
Heptachlor	8
Lindane	5
Toxaphene	0.010
pH	6.5 - 8.5
Ammonia	400
Hydrogen Sulfide	10
Dissolved Oxygen	6.0 mg/l
Phosphorus	0.1

Source: "Proposed Criteria for Water Quality," Vol. 1, U. S. Environmental Protection Agency, 1973.

TABLE 3.3-3(c) Proposed EPA numerical criteria for water quality, freshwater constituents, (aquatic life).

Parameter	μg/l
Cadmium	30 (hardness > 100 mg/l) 4 (hardness < 100 mg/l)
Chromium	50
Copper	1/10 LC50
Lead	30
Mercury	0.2
Nickel	1/50 LC50
Zinc	5/1000 LC50
pH	6 - 9
Ammonia	1/20 LC50 (20 μg/l)
Sulfides	2
Suspended & settleable solids	80 mg/l
Turbidity and light penetration	10% change in compensation pt.
Color	10% change in compensation pt.
Oils	1. None visible on surface 2. 1000 mg/kg Hexane extractable substances in sediments 3. 1/20 LC50
Phenols	1/20 LC50 (0.1 mg/l)
Cyanides	1/20 LC50 (.005 mg/l)
PCB	0.002
Aldrin	0.01
DDT	0.002
Dieldrin	0.005
Chlordane	0.04
Endrin	0.002
Heptachlor	0.01
Lindane	0.02
Toxaphene	0.01
Diazinon	0.009
Malathion	0.008
Parathion	0.001
DO	4.0 mg/l (>31°C)

Source: "Proposed Criteria for Water Quality," Vol. 1, U.S. Environmental Protection Agency, 1973.

TABLE 3.3-4 Major water quality stations in study region.

Station Number*	Stream Segment Agency I.D. No.	Latitude Longitude Deg-Min-Sec	Description (Stream, Location)	Number of Samples Reported Water Year, 1976
81557	010010	29-53-40 91-26-46	Atchafalaya R. at Myette Point	20
81600	010010	29-43 91-12	Lwr. Atchafalaya R. at Morgan City	21
81590	010060	29-42-09 91-22-07	Wax Lake Outlet at Calumet	21
31500	010070	29-22-15 91-23-15	Atchafalaya Bay at Eugene Island	21
85700	040190	30-04-15 91-49-45	Bayou Teche at Keystone Lock	12
33000	040230	29-41-10 91-53-30	Vermilion Bay at Cypremort Point	20
14000	040270	29-47-00 92-11-40	Intracoastal Waterway at Vermilion Lock (East)	20
74120	050020	30-17-00 91-13-21	Mississippi R. at Plaquemine	12
74220	050020	30-05-52 90-54-45	Mississippi R. at Union	12
81230	110280	29-34-20 90-23-02	Bayou Lafourche at Larose	21

*Last 5 digits of the U.S. Geological Survey Station Number

TABLE 3.3-5 Sediment quality in region.

	Parameter						
	Lead (Pb)	Mercury (Hg)	Zinc (Zn)	C.O.D.	TKN	Oil & Grease	Sul-fide
Proposed Upper Limit for Sediment (mg/kg)	50	1	50	50,000	1000	1500	1700
Vermilion River at S.H. 3073[a] 86935	<10	0.1	70	-	-	-	-
Mississippi River at Indicated Mile Point[b]							
212	<10	0	14	3100	370	1000	-
224	<10	0	11	1000	84	1000	-
228.5	30	0.1	44	22,000	730	<1000	-
Bayou Plaquemine[c]	122	80	153	2000	1000	9100	-
Intracoastal Waterway (10 mi. So. of Bayou Plaquemine)	4.6	4.6	34	1300	1300	1000	-

[a]Maximum April 1976

[b]Maximum March/April 1975

[c]Maximum March 1975

3.4 CLIMATOLOGY AND AIR QUALITY

Regional meteorological and air quality conditions for southern Louisiana are presented in Section 3.4 of FES 76/77-7 and FES 76/77-8. No site specific data for Weeks Island or Cote Blanche are available; therefore data are presented for representative monitoring stations.

3.4.1 Regional Climatology

The climate of southern Louisiana is classified as humid-subtropical and is strongly influenced by the offshore marine environment. The climate is characterized by mild, short winters, abundant rainfall, high humidity, a long growing season, freedom from extreme summer heat due to frequent afternoon thundershowers, and excellent spring and fall weather. There are few days when sub-freezing temperatures occur and snowfall is rare. Fogging is most frequent from December to May, particularly along the coast and near rivers and lakes. Severe weather is generally associated with thunderstorms and tropical cyclones.

The average annual rainfall is approximately 55 inches at Lake Charles; the wettest months are December and July, while the lowest mean rainfall occurs in October. Annual lake evaporation totals about 50 inches. On an annual basis, the area receives 60 percent of possible sunshine. Based on Lake Charles data, the prevailing winds are southerly and the annual mean wind speed is 8.8 mph. Extreme winds in excess of 100 mph are usually associated with hurricanes or an infrequent tornado; the fastest mile of wind for a 50-year return period is 95 mph.

3.4.2 Climatological Factors Affecting Dispersion

Atmospheric stagnation periods are minimal due to the proximity of the Gulf of Mexico, high mixing heights and the level terrain. During a 5-year study by Holzworth (1972) there was only one occurrence in the southernmost region of Louisiana of a limited dispersion episode with mixing heights less than 250 meters and wind speed less than 6 meters per second.

The seasonal inversion (stable surface layer) frequency at Port Arthur, Texas from 1967-1971 was approximately 22 percent in winter, 19 percent in spring, 30 percent in summer, 34 percent in the fall, and 26 percent annually (NOAA, 1973). The inversion frequency further inland at Baton Rouge is higher since the modifying effects of the Gulf of Mexico are less pronounced.

3.4.3 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 National Ambient Air Quality Standards (AAQS) promulgated by the Environmental Protection Agency (EPA) on 30 April 1971 (36 FR 8186). Primary and secondary AAQS applicable to this project are listed in Table 3.4-13 of FES 76/77-7 and 76/77-8.

Louisiana's primary emphasis has been directed to monitoring air quality and controlling emissions in highly industrialized areas of the State. Data from Donaldsonville, Lafayette, and Lake Charles were used to estimate air quality for the Weeks Island and Cote Blanche sites. These data are presented in FES 76/77-7 and FES 76/77-8. With the exception of Donaldsonville, ambient particulate levels were less than the 24-hour and annual standards. All sites were well under the primary AAQS for nitrogen dioxide and sulfur dioxide.

Neither the USEPA 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 for several days in September and December in two non-urban areas of coastal Louisiana. Analysis of the data taken at these stations indicate that the state and national AAQS 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. The report concluded that, although based on limited data, the national AAQS 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.

Photochemical oxidant levels for 1975 at New Orleans, Baton Rouge, and Lake Charles are presented in Table 3.4-14 of FES 76/77-7 and 76/77-8. These are the three closest stations for which the most recent photochemical oxidant data were available. These data indicate that all three stations exceeded the state and national 1-hour standard of 0.08 ppm more than once during 1975, whereas all sites were below the Louisiana annual standard of 0.03 ppm. It can be assumed that the background photochemical oxidant levels would generally be lower in rural areas such as at the proposed oil storage sites because of lower background levels of hydrocarbons which could react with sunlight and other product emissions to form the photochemical oxidants.

Along the St. James-New Orleans industrial corridor, pollutant concentrations can typically be expected to be considerably higher than concentrations measured in areas like Weeks Island and Cote Blanche. 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. Thus, it is likely that portions of the area traversed by the proposed oil distribution system (principally the Mississippi River) are exposed, at least on occasion, to atmospheric pollutant levels nearly equal to the highest measured in southern Louisiana.

The general region of southern Louisiana is considered to have a significant need to reduce SO_2 and hydrocarbon emissions in the near future.

The Louisiana State Implementation Plan (SIP), revised in 1972, had exempted from regulation the hydrocarbon emissions from crude oil storage and handling. At that time the SIP had not been developed to detail projected levels of air quality by region but predicted that all primary standards would be met by 1976. However, because of the high 1 hour photochemical oxidant levels which have been tabulated from 1975 data, the EPA disapproved the control strategy for attainment and maintenance of the national primary and secondary air quality standards for photochemical oxidants in the Southern Louisiana-Southeast Texas AQCR.

The State was ordered to prepare and submit by July 1, 1977, a revision containing:

a. All achievable emission limitations that are needed to provide for the attainment of the national standard for photochemical oxidants, and

b. A demonstration of the effect on air quality concentrations of such measures.

If additional control measures such as land use and transportation measures are needed for attainment of the national standard, the State will submit by July 1, 1978:

a. Such measures for attainment of the standard for photochemical oxidants, and

b. A demonstration that the control strategy will attain the standard for photochemical oxidants.

The foregoing revision requirements are currently under review by the Louisiana Air Control Commission; a hearing was to be held in March of 1977 to provide its response to the new requirements. However, an extension has been granted setting December 15, 1977 as the date for submitting the required SIP revision; the hearing is now planned for October or November, 1977. No land use or control measures are expected to be required (Tanner, personal communication).

3.5 BACKGROUND AMBIENT SOUND LEVELS

Ambient sound levels at the storage sites and along much of 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. Ambient sound level surveys were conducted early in 1976 in the vicinity of Weeks Island and Cote Blanche Island. Results are summarized in FES 76/77-7 and FES 76/77-8. Weighted day/night ambient sound levels (L_{dn}) were 74 dBA at the center of existing mining operations; 53 dBA at undeveloped areas on the domes; 61 dBA along the ICW; and 56 dBA in nearby small communities. Ambient L_{dn} sound levels at more heavily used highway crossings along the pipeline route and at St. James Terminal are estimated to be 65 dBA.

3.6 ECOLOGICAL CHARACTERIZATION AND BASELINE BIOLOGY

3.6.1 Introduction and Summary

The proposed oil transport pipeline would connect the Weeks Island and Cote Blanche oil storage facilities with the existing Capline Terminal along the Mississippi River, just north of St. James. The pipeline would cross portions of Iberia, St. Mary, St. Martin, Assumption, and St. James parishes in southeast Louisiana. Among the major geographical features which would be affected by the proposed pipeline are: Bayou Teche, the east and west points of Grand Lake (Atchafalaya River), the ICW, Old River, the Atchafalaya Basin Floodway, Goddel Bayou, and Lake Verret. Numerous other bayous and canals would also be traversed by the pipeline.

Forestland represents the predominant habitat type through which the pipeline would be routed. A significant percentage of the route also passes through agricultural lands located on natural levee ridges in the area. Other habitats crossed include intermediate and brackish marshes, open water, and manmade levees. These habitat types support a variety of aquatic and terrestrial species, including many with commercial or recreational value. Some species considered to be threatened or endangered also may occur within the pipeline corridor.

3.6.2 Regional Ecological Characteristics

The pipeline would have two points of origin: Weeks Island and Cote Blanche Island. The aquatic and terrestrial ecological characteristics of these sites are presented in FES 76/77-7 and FES 76/77-8. Ecological descriptions presented in this supplement will therefore be confined to the remainder of the areas in the pipeline corridor.

Excluding coastal bays included within the boundaries of Iberia and St. Mary Parishes, forestland covers approximately 40 percent of the five parishes through which the pipeline would pass; crop and pasture lands contribute about 28 percent to the total land use in this region. In order of increasing importance, other land uses include resource extraction (mining), urban and residential developments, inland open water, and marshlands (Table 3.6-1).

The dominant topographical features are the raised ridges occurring along waterways which separate lowland areas subject to frequent tidal or rainfall-generated flooding. Forested sectors consist primarily of stands of various lowland hardwood species, with a few upland species on elevated lands such as Cote Blanche and Weeks Islands. Agricultural land in the region is developed on and adjacent to the levees. The principal crop is sugar cane; soybeans, cotton, tobacco, and various truck crops are also raised while pasturelands are usually covered with a mixture of cool and warm season grasses and legumes. Built-up portions of the region occur mainly on the elevated natural levees. Open water areas consist primarily of fresh, intermediate or brackish water lakes, bayous, and canals. Marshes are confined to relatively narrow sections along the coastal areas (Chabreck, 1972).

3.6.3 Area Biology

3.6.3.1 Terrestrial Biology

General Description

As in the study region, forest land is the predominant habitat type in the pipeline corridor (Table 3.6-2). Crop and pasture lands are the second most common habitat crossed by the pipeline. Other habitats in the corridor occur along only a relatively small percentage of the ROW. The entire pipeline ROW passes through or adjacent to previously disturbed lands.

The primary forest types within the pipeline corridor are the deciduous swamp forest and the bottomland forest. Swamp forest occurs primarily in areas like the Atchafalaya Basin Floodway where moisture is abundant and the soil is almost permanently wet. Predominant species in these areas include bald cypress and water tupelo. Other important species which occur primarily in the understory of these forests are silver maple, red maple, pumpkin ash, and swamp tupelo. Various grasses, sedges, and aquatic macrophytes such as cattails and arrowhead form a large part of the lower vegetative stratum in the inner portions of the swamp; such species as maidencane, water hyacinth, and bull tongue are often found in the outer regions.

The swamps in the pipeline area provide important habitat for numerous animals, including swamp rabbits, squirrels, rodents, raccoon, nutria, mink, otter, bobcat, deer, various types of birds, amphibians and reptiles.

The bottomland forests are found in slightly more elevated areas which are drier than those characterized by deciduous swamp vegetation. Important vegetative species include bald cypress, sweet gum, oaks, swamp tupelo, bitter pecan, eastern cottonwood, black willow, sycamore, and ash. Palmetto is a common understory species. Predominant wildlife species found in this habitat type are similar to those listed for the swamp forests.

Intermediate and fresh water marshes are crossed to the north and east of Cote Blanche Island. The pipeline ROW párallels existing canals in these areas. Vegetation and wildlife is described in FES 76/77-7 and 76/77-8. Waterfowl, muskrat, nutria, otter, alligator, raccoon, and mink are important wildlife species found in the marshes.

Crop and pasture lands along the pipeline corridor occur on the natural levees formed by alluvial deposits from the Mississippi River, Bayou Lafourche, and Bayou Teche. Sugar cane, rice, cotton, tobacco, soybeans, and various truck crops are the predominant agricultural products in the area; signal grass and goatweed are common pasture species. Fauna which are common in these cleared areas are rabbits, fox, small rodents, and numerous bird species.

Commercially Important Species

Several vegetative species found in the corridor area are commercially valuable; cypress is among the most important timber species in the region. Among the commercially important mammals which occur in swamp habitats crossed by the pipeline are nutria, raccoon, mink, and otter. Other commercially important species include snapping turtles, bullfrogs, and crawfish; these species are found primarily in swamps and lakes or ponds.

Threatened or Endangered Species

Tick seed, quillwort, and Indian paintbrush are the only plant species ranging into Louisiana which are considered endangered by the

U.S. Fish and Wildlife Service; eight species (bluestar, sarvis holly, skullcap, spice bush, Platanthera leucophaea, beardgrass, parrot pitcher-plant, and gerardia) which range into the state are considered "threatened." Some of these species may occur along the ROW since they occur in hydrophytic or mesophytic habitat.

Wildlife species which may occur in the region of the pipeline corridor and are considered to be threatened or endangered species by the U.S. Fish and Wildlife Service (1976 and 1977) include the eastern cougar (endangered), southern bald eagle (endangered), arctic peregrine falcon (endangered) and American alligator (threatened). Cougars prefer heavily wooded habitat; populations of this species inhabiting Louisiana are thought to be very low (Lowery, 1974). Although the bottomland forests along the corridor route provide suitable habitat for the southern bald eagle, a survey of nest locations conducted by the U.S. Fish and Wildlife Service during the past nesting season has disclosed the presence of only one eagle nest within 10 miles of the pipeline corridor. The closest observed nest is located at the southeastern end of Lake Verret (Joseph E. Burgess, 1977, personal communication). The peregrine falcon is likely to occur only in the coastal marshes through which the pipeline would pass, while the American alligator may be expected in bayous and swamps as well as freshwater marshes.

3.6.3.2 Aquatic Biology

General Description

Open water bodies comprise only a small percentage of the pipeline corridor length (less than three miles, Section 2.3). Among the major waterways which the pipeline would transect are Grand Lake (Atchafalaya River), the northwestern tip of Lake Verret, Old River, Goddel Bayou, and the ICW. Other smaller canals and bayous would also be within the ROW. Coastal bays and estuaries which might be affected by a possible oil spill are described in FES 76/77-7 and 76/77-8.

Vegetation within these waterways consists of both vascular hydrophytes and algal species. Aquatic fauna include zooplankton, benthic organisms such as crawfish and mollusks, and fish. The most common freshwater fish found in the study area are crappie, catfish, various species of sunfish, largemouth bass, gar, gizzard shad, and suckers.

Commercially Important Species

The region around the Atchafalaya River Basin is the center of Louisiana's crayfish production. Although numerous types of crayfish are found in the state, the swamp and river crayfish are the only species of significant commercial value.

The Atchafalaya Basin is also an important commercial freshwater fisheries area. About 70 percent of the catch from this area is composed of catfish, buffalo, and drum. Other species which are commercially fished are bowfin, carp, gar, and paddlefish (U.S. Army Corps of Engineers, 1975(b)).

The freshwater and intermediate marshes crossed by the ROW near the coast are important nursery grounds for many commercially and ecologically important species of fish. See FES 76/77-7 and 76/77-8, Section 3.6.

Threatened or Endangered Species

None of the fish known to inhabit areas along the pipeline corridor are considered to be threatened or endangered by the U. S. Department of Interior (1976) or the State of Louisiana.

TABLE 3.6-1 Existing land use, 1972.

	Urban and Built-up Land	Extractive Land	Agricultural Land	Forest Land	Water	Wetland (Marsh)	Barren Land	Total Acreage
Parish IBERIA								
Acreage	9,633	19,266	122,512	82,251	642,694*	122,759	10,621	1,009,736
% of Total Acreage	1.0	1.9	12.1	8.2	63.6	12.2	1.0	
Parish ASSUMPTION								
Acreage	5,681	16,302	76,076	117,078	13,832	0	0	228,969
% of Total Acreage	2.5	7.1	33.2	51.1	6.0	0	0	
Parish ST. MARTIN								
Acreage	8,892	31,863	135,109	298,129	21,736	21,983	0	517,712
% of Total Acreage	1.7	6.1	26.0	57.6	4.2	4.2	0	
Parish ST. MARY								
Acreage	19,019	54,340	85,709	103,987	578,227*	132,145	12,350	985,777
% of Total Acreage	1.9	5.5	8.7	10.5	58.7	13.4	1.3	
Parish ST. JAMES								
Acreage	5,681	741	55,575	87,685	6,916	0	0	156,598
% of Total Acreage	3.6	0.5	35.5	56.0	4.4	0	0	
Total Acreage	48,906	122,512	474,981	689,130	1,263,405	276,887	22,971	2,898,792
% of Total Acreage	1.7	4.2	16.4	23.8	43.6	9.6	0.8	

*Primarily consists of coastal bays.
Source: Louisiana State Planning Office, Land Use and Data Analysis (LUDA), U. S. Geological Survey, 1972

TABLE 3.6-2 Direct acreage[a] impacts required for proposed oil distribution system

Facility	Deciduous Swamp Forest		Bottomland Forest		Intermediate Marsh		Agricultural Land		Industrial Land		Levee Land		Open Water		Total Facility Impacts	
	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.
Pipeline ROW[b]																
Dry Land[c]	11	7	79	53	-	-	158	105	5	4	3	2	2	1	258	172
Conventional[d] Push Ditch	186	124	-	-	38	25	-	-	-	-	-	-	9	6	233	155
Flotation Canal[e] (widen existing canal)	110	55	-	-	-	-	-	-	-	-	-	-	1	1	111	56
Flotation Canal[f] (separate FEA canal)	44	31	-	-	-	-	-	-	-	-	-	-	22	16	66	47
Open Water[g]	154	0	-	-	-	-	16	0	-	-	-	-	-	-	170	0
Total Acreage Impact by Habitat	(505)	(217)	(79)	(53)	(38)	(25)	(174)	(105)	(5)	(4)	(3)	(2)	(34)	(24)	(838)	(430)
Storage Terminal																
Cote Blanche	-	-	-	-	-	-	-	-	4	4	-	-	-	-	4	4
Weeks Island	-	-	-	-	-	-	-	-	4	4	-	-	-	-	4	4
(Subtotal)									(8)	(8)					(8)	(8)
St. James Terminal																
Storage Tanks	-	-	-	-	-	-	25	25	-	-	-	-	-	-	25	25
Dock/pipeline	-	-	1	1	-	-	-	-	-	-	2	2	-	-	3	3
(Subtotal)			(1)	(1)			(25)	(25)			(2)	(2)			(28)	(28)
Total Land Use Impacts	505	217	80	54	38	25	199	130	13	12	5	4	34	24	874	466

[a] Habitats determined by analysis of aerial photographs, topographic maps, and published vegetation maps. See Figure 2.1-2 for approximate location of habitats nearby project.

[b] See Figure 2.3-3 for identification of construction methods by segment along the proposed route.

[c] Based on 75-foot wide construction ROW. A 50-foot ROW is needed for permanent access but there would be no maintenance (i.e., clearing) required during normal operations.

[d] Based on 75-foot wide construction ROW; a 50-foot ROW is needed for permanent access but there would be no maintenance (i.e., clearing) required during normal operations. However, potential lowering of ground level in a 30-foot corridor may permanently exclude normal swamp forest vegetation from some segments of the ROW, replacing cypress-tupelo stands with open water and aquatic macrophytes.

[e] Based on 100-foot wide expansion of existing pipeline canal corridor for construction, and a 50-foot permanent ROW for access. The 50-foot wide extension of existing canal would not be backfilled and represents a permanent displacement of terrestrial wetlands with open water habitat.

[f] Based on 140-foot wide construction ROW and a 50-foot wide permanent ROW. A 100-foot wide canal would not be backfilled and represents a permanent displacement of terrestrial wetlands with open water habitat.

[g] Open water construction impacts consist of 170 acres of temporary spoil storage and equipment access sites in addition to 34 acres of temporary substrate removal.

3.7 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

3.7.1 Regional Sites of Importance

Within the five parish area crossed by the proposed oil distribution facilities, many sites have been identified as having historical, archaeological, architectural, or cultural importance. The U. S. Army Corps of Engineers (1973) lists the following number of known archaeological sites: 57 in Iberia Parish; 47 in St. Mary Parish; 36 in St. Martin Parish; 19 in Assumption Parish; and 3 in St. James Parish.

Federal historical sites listed in the National Register through December 31, 1976 include 4 sites in Iberia Parish; 3 sites in St. Martin Parish; 1 site in St. Mary Parish; 1 site in Assumption Parish; and 2 sites in St. James Parish. Also, there are many historical sites of state or local interest listed in the Corps of Engineers Environmental Inventory (1973).

3.7.2 Project Vicinity

Cultural resource surveys have been conducted on lands to be used in converting the existing mine to an oil storage facility and in developing new salt mines (FES 76/77-7 and 76/77-8). Although there are several archaeological sites on the islands, including one being nominated to the National Register of Historic Places, the surveys indicated that no cultural resources would be endangered by the proposed project.

No surveys have as yet been conducted on lands proposed for the oil terminal at St. James or within the 67-mile pipeline corridor between the sites and St. James. There are several known archaeological sites shown on the Corps of Engineers maps (1973) which are very close to the proposed ROW. Also, there is a good chance that unknown sites may lie on proposed project lands, especially in elevated areas along water courses. A survey would be conducted to locate and identify the significance of any such sites prior to construction so that a determination may be made as to the need for avoidance or excavation. Any such survey would be coordinated with the State Historic Officer.

3.8 SCENIC AND NATURAL RESOURCES

3.8.1 Scenic Resources

Lands traversed by the proposed oil distribution system contain much that is aesthetically appealing to the casual observer and to the hunter and fisherman. Topographic and physiographic features range from the forested uplands of Weeks Island and Cote Blanche Island to the surrounding marshes and expansive bays. Along Bayou Teche and Bayou Lafourche the ROW passes through level cropland which has no unique natural beauty, but contains many stately old homes surrounded by live oaks and other lush vegetation. Within the Atchafalaya Basin wide expanses of swamp forest interlaced with dark bayous and broad lakes create a very beautiful, though relatively inaccessible, natural environment.

The proposed pipeline ROW does not pass through unaltered portions of the natural landscape. The route has been selected to parallel existing railroad, utility, and pipeline corridors which have been previously cleared and, in some cases, have spoil banks and canals left from prior construction activities.

3.8.2 Cultural Resources

The parishes through which the proposed pipeline ROW would pass, especially in the vicinity of Weeks and Cote Blanche Islands, are the center of the Cajun culture, unique to southern Louisiana. Oil and gas production and transmission facilities are not out of place within this culture, though high density development and population growth would likely be disruptive.

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 are for decades, and is based on an economy consisting 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. Morgan City and its nearby suburbs represent this type of community.

The existence and potential for discovering archaeological, historical, or other cultural sites within project land is discussed in Section 3.7.

3.8.3 Natural Resources

There are several national, state and private wildlife refuges in the coastal wetlands of south Louisiana. None are located within the five parishes crossed by the proposed oil distribution system, though several are located within potential impact distance from possible oil spills at Weeks Island and Cote Blanche Island. A complete listing is provided in FES 76/77-7 and 76/77-8. Marsh Island, Shell Keys and Paul J. Rainey Wildlife Refuges are potentially vulnerable to a major oil spill reaching the coastal waters south of the storage sites.

The Attakapas State Outdoor Recreation Area is traversed by the proposed pipeline ROW in the southeastern portion of the Atchafalaya Basin Floodway near Blue Point (Figure 2.1-2). No other state forests, parks, commemorative areas, or preservation areas lie along the proposed ROW.

Section 3.9.1.2 of FES 76/77-7 and 76/77-8 contain information on existing and potential recreational sites in the vicinity of the proposed storage sites. Much of the land crossed by the pipeline ROW is potentially suitable for hunting and/or fishing. Also, several lakes on Weeks Island are utilized by employees for fishing.

3.9 SOCIOECONOMIC ENVIRONMENT

Descriptions of the social and economic setting of the Acadiana region surrounding Cote Blanche Island and Weeks Island are provided in FES 76/77-7 and 76/77-8 (Section 3.9). Regional and local land use is depicted on Figures 3.6-2 and 3.6-3 of the same references. Iberia, St. Mary and St. Martin Parishes are included in the Acadiana regional data. Socioeconomic data for Assumption and St. James Parishes were provided in the supplement to FES 76-5 for analysis of the impacts of developing the revised Bayou Choctaw oil distribution system. Data from these sources is summarized in the following subsections.

3.9.1 Regional Setting

The five parishes through which the proposed oil distribution system would be constructed are Iberia, St. Mary, St. Martin, Assumption and St. James (Figure 2.1-2), extending from the central Gulf Coast to the Mississippi River 35 miles west of New Orleans.

3.9.1.1 Land Use

The total land area of these parishes is about 2600 square miles, much of it in marsh and swamp forest (an additional 1900 square miles of coastal bays and estuaries are included within the boundaries of Iberia and Assumption Parishes). According to a 1972 land use survey of Louisiana compiled by the Soil Conservation Service, forests cover 41 percent of the land area, crop and pasture land 28 percent, and marsh-land approximately 15 percent. Only 3 percent was developed in urban or residential land uses (see Table 3.6-1).

Most of the urban/residential and agricultural land uses are located on wide natural levee ridges flanking the major natural waterways. Within the project area the principal locations of such development are the levees along the Mississippi River, Bayou Lafourche, and Bayou Teche. In addition, the levee along Bayou Cypremort which runs between the two proposed storage sites supports several small communities and extensive sugar cane fields.

Between the levees and along the immediate coast most of the land is lower in elevation and subject to frequent or continuous flooding, either from tides, local rainfall, or upstream flooding of the Mississippi and Atchafalaya Rivers. These lands are seldom suitable for development due to poor soil conditions and high water table. An extensive system of canals have been built, however, to provide navigable waterways and to allow exploration and production of oil and gas resources.

Because of the extensive acreage of undeveloped forests and marshes, southern Louisiana is a virtual paradise for hunters and fishermen. With a few exceptions, such as urban parks and picnic areas, the only recreational facilities required are boat launching ramps providing access to the waterways and interior wetlands from the levees. Locations of such public recreation sites are provided in FES 76/77-7, 76/77-8, and Corps of Engineers (1973).

There are no existing or proposed local land-use plans for the five parish area. However, work has begun on developing a Coastal Zone Management Plan which may affect future development in the coastal portions of Iberia and St. Mary Parishes (including the proposed oil storage sites).

3.9.1.2 Transportation System

Major transportation systems in southern Louisiana include highways, railroads, waterways, and pipelines (Section 3.9.1.3, FES 76/77-7 and 76/77-8). Highways and railroads are principally limited to natural or manmade levees because of poor foundation conditions, high costs and environmental impacts of wetland crossings. Major highways are U.S. 90 which follows Bayou Teche and connects New Orleans with Lafayette, and several state highways which follow Bayou Lafourche (1 and 308), the Mississippi River (18 and 44), and a few other elevated stretches in the region.

Waterways and pipelines provide alternative methods of transporting commercial products. The extensive system of navigable waterways is described in Section 3.3. Generally, these provide connections with the Gulf of Mexico, the Mississippi River, and the east-west ICW. Pipelines transport crude oil, natural gas, and refined products to and from production fields, refinery centers, and product delivery points. Many pipelines have been constructed through the wetlands within the project area.

3.9.1.3 Population and Housing Characteristics

The total 1970 population in the five parish project area was approximately 190,000 (Table 3.9-1). More than 60 percent of these people resided in Iberia and St. Mary parishes, principally in small towns along Bayou Teche. The other three parishes to the east had lower population densities and higher percentages of rural population. St. Mary, Iberia, and St. Martin Parishes grew substantially during the period from 1960 to 1970 (from 10 to more than 20 percent), while Assumption and St. James parishes grew by less than 10 percent. Major towns and cities in the area (with 1970 population) were: Baton Rouge (East Baton Rouge Parish), 165,963; Lafayette (Lafayette Parish, 68,908); New Iberia (Iberia Parish), 30,147; Houma (Terrebonne Parish), 30,922; Morgan City (St. Mary Parish), 16,586; Thibodaux (Lafourche Parish), 13,832.

The proposed oil distribution system crosses two corridors which have been identified as locations of probable future rapid development. The first is the New Orleans-Lafayette Corridor (NOLAF) which roughly parallels Highway 90 between these two cities (Figure 2.1-2). In the project region this includes the Bayou Teche levee from Morgan City to New Iberia, including St. Mary and Iberia parishes. Growth factors include abundant mineral resources, access to highways and navigable waterways, and existence of developable land on the levee ridge. The second growth corridor is the New Orleans-Baton Rouge Corridor (NOBAR), within which lies the Capline Terminal. Growth factors include excellent transportation, proximity to industrial and trade centers, and developable land. Population growth is projected to be more than 20 percent during the 1970-1980 and 1980-1990 decades for NOBAR and probably somewhat less for NOLAF.

Selected 1970 housing characteristics for Iberia, St. Mary, Assumption and St. James Parishes are provided in Table 3.9-2. There was an evident shortage of available housing in the eastern parishes (slightly more than 2 percent vacant). Iberia and St. Mary parishes had a more flexible housing market, but still had a vacancy rate less than the state average of 8 percent. In addition, a significant portion was not high quality (FES 76/77-7 and 76/77-8).

3.9.1.4 Economy

Principal income-producing industries of the five-parish area include mining, manufacturing, construction, shipping, agriculture, and fisheries. Mining is particularly important to Iberia, St. Mary and St. Martin parishes, which have abundant natural resources, especially oil, gas, and salt. More than 13 percent of all 1972 employment in St. Mary and Iberia parishes was in mining (Acadiana Planning and Development District, 1974). Manufacturing is an important source of employment throughout the 5-parish area. Sugar refining and petrochemical production are two principal examples. Construction is of lesser importance in the rural parishes than in Baton Rouge to the north and New Orleans to the east. Shipping and fishing is locally important to some communities in Iberia and St. Mary parishes (e.g., Morgan City) and shipping is also important in St. James Parish along the Mississippi River. Though sugar cane fields and, to a lesser extent, soybeans, corn, and cattle grazing occupy much of the land area along the levee, the proportion of workers employed directly in agriculture is less than 10 percent for all parishes except Assumption where it accounts for about 14 percent.

Total estimated work force in the five parishes in the project area for 1976 was as follows: Iberia, 24,425 (4.4% unemployed); St. Mary, 25,925 (4.6% unemployed); St. Martin, 14,600 (9.0% unemployed); Assumption, 8,725 (5.4% unemployed); St. James, 6,750 (7.0% unemployed). Income levels in the five parishes in the project area are generally relatively low. For example, 1970 earnings in St. Mary and Iberia Parishes ranged from $2000 per worker in agriculture to $9500 in mining (FES 76-5, 76/77-7 and 76/77-8). Mean family income in Iberia and St. James Parishes was above the state average for the year.

3.9.1.5 Government

Most of the public services provided in the region come from local governmental units--the parishes, municipal governments and special districts. In extreme cases, such as Assumption Parish, where incomes are low and the economy rural, and where there has been little growth, per capita spending and outstanding debt are low. Rapid influx of people would place severe burdens on existing schools and other infrastructure, and financing expanded programs and new facilities would place severe financial burdens on the parish. On the other hand, rapidly growing parishes (such as St. Mary) have comparatively high per capita operating expenditures and debt, due to increased demand for services, schools, highways and other facilities; these parishes would be better able to accommodate a continued rapid influx of people.

The three most important sources of revenue for local governments in Louisiana are intergovernmental transfers, real property (or *ad valorem*) taxes, and sales taxes. The most important local source of taxation to parishes is the *ad valorem* tax. This tax is levied locally based on tax rates and valuations that are established individually by parishes (U.S. Department of Transportation, 1976). Total revenue from property taxes in 1971 ranged from $4.5 million in St. Mary Parish to $1.0 million in Assumption Parish (University of New Orleans, 1974). St. Mary and Iberia Parishes are among the largest sources of severance tax (levied on mineral resources extracted) for the state.

3.9.2 Local Setting

3.9.2.1 Land-Use Patterns

The proposed Weeks Island/Cote Blanche Island oil distribution system would extend across approximately 67 miles of land between the storage site and Capline Terminal on the Mississippi River. Most of the route passes through uninhabited wetlands; relatively few urban/residential or transportation corridors would be affected.

A tabulation of acreages to be utilized by the proposed oil distribution system is provided in Table 3.6-2. The pump station at Weeks Island would require about 4 acres of previously cleared land; similarly, 4 acres would be required at Cote Blanche Island. Construction of the pipeline would initially affect an estimated 838 acres, of which 174 are agricultural lands, some of which are adjacent to urban or residential land. The permanent pipeline ROW required for maintenance access would be slightly more than half the construction acreage (430 acres).

3.9.2.2 Transportation System

In addition to the major waterways listed in Table 3.3-1, the pipeline ROW crosses the following transportation systems: Southern Pacific railroad (4 times); Highway 83 (2 times); Missouri Pacific railroad (2 times); Highway 90; Highway 87; Highway 70 (2 times); Highway 69; Highway 1; Highway 308; Texas and Pacific railroad (2 times); Highway 18. The ROW also crosses a large number of existing oil and gas lines and several local roads.

3.9.2.3 Population and Housing

A list of towns and small communities located along the pipeline route and the approximate distance to the proposed ROW is provided in Table 3.9-3 (also, see Figure 2.1-2). The only large towns near the proposed routes are Franklin and Baldwin on Bayou Teche and Klotzville on Bayou Lafourche.

From recent aerial photographs of the proposed pipeline route, there are approximately 350 structures within 2000 feet of the ROW; of these about 100 are within 1000 feet. Nearly 75 percent of the structures within 1000 feet are located in Klotzville, along Bayou Lafourche. About 75 percent of the structures within 2000 feet are located in Klotzville and in Franklin. Other communities with structures within 2000 feet are Grand Bayou: 25; Pierre Part: 25; Oaklawn: 20; Freetown: 5; and Alice B: 5. Assuming 75 percent of these structures are residences, approximately 900 people may live within 2000 feet of the ROW.

TABLE 3.9-1 Population density of surrounding parishes.

	IBERIA	ST. MARY	ST. MARTIN	ASSUMPTION	ST. JAMES
Population					
Total	57,397	60,752	32,453	19,654	19,733
Per square mile	97.4	97.4	44.1	55.2	78.0
Urban/Rural Population Distribution*					
Rural	36.5	34.8	62.7	100.0	67.2
Urban	63.5	65.2	37.3	-0-	32.8

*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 3.9-2 Housing availability, by parish.

	Housing units and occupancy by parish			
	IBERIA	ST. MARY	ASSUMPTION	ST. JAMES
Year-round housing units	16,595	17,279	5,290	4,796
Owner-occupied	10,388	9,974	3,384	3,369
Renter-occupied	5,230	6,116	1,581	1,255
Vacant for sale or rent	977	1,189	151	59
% Vacant for sale or rent	5.9%	6.9%	2.9%	1.2%
Median value of owner-occupied units	$12,000	$14,900	$8,900	$11,900

Source: 1970 Census of Housing

TABLE 3.9-3 Communities along proposed pipeline right-of-way.

Communities	Distance from pipeline ROW (miles)	Approximate 1970 Population
Iberia Parish		
Delcambre	15	2,000
New Iberia	12	30,000
Jeanerette	8	6,300
Boudreaux	7	<500
St. Mary Parish		
Cypremort	0.4	<100
Freetown	0.4	<100
Alice B.	0.25	<100
Ivanhoe	0.25	<100
Florence	1	<100
Richland	0.9	<100
Freetown	0.25	<100
Kemper	2.1	<500
Franklin	0.25	9,300
Baldwin	2.3	2,100
Katy	1.1	<500
Caffery	0.3	<500
Oaklawn	0.6	<500
Irish Bend	0.6	<500
St. Martin Parish		
Arnaudville	32	1,700
Breaux Bridge	23	4,900
Parks	21	500
St. Martinville	13	7,100
Assumption Parish		
Pierre Part	1	<500
Grand Bayou	0.3	<500
Bayou Corner	0.8	<500
Klotzville	0	<1000
Star	0.6	<500
Magnolia	1.1	<500
Sweet Home	0.5	<500
Paincourtville	1.6	<1000
Plattenville	2	<1000
Napoleonville	4	1000
St. James Parish		
St. James	2.1	<500
Burton Lane	0.5	<500

SECTION 4.0

ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

4.1 INTRODUCTION AND SUMMARY

Expected and potential impacts of construction and operation of the proposed oil distribution system connecting Weeks Island and Cote Blanche Island to an expanded tanker terminal at St. James are described in Section 4.0. In addition, these impacts are compared to those expected to accompany the alternative barge transportation system proposed in FES 76/77-7 and 76/77-8. Potentially significant adverse effects associated with construction of the pipeline and terminal facilities for the revised system greatly exceed construction impacts expected with the barge transportation alternative. However, operation of the pipeline system -- particularly the risk of oil spills and the volume of hydrocarbon vapors released -- would result in reduced adverse impacts compared with barge transport. In addition, the proposed system provides the SPR program with greater flexibility for delivery and withdrawal of oil and would meet the intended goal of delivering all stored oil within a 150-day period during an oil supply interruption.

4.2 SITE PREPARATION AND CONSTRUCTION

Construction of oil storage facilities at Cote Blanche Island and Weeks Island involves conversion of the existing mines for oil storage, developing new mines (at the owners option), and construction of an oil transportation system capable of filling and withdrawing from the caverns within the intended time frame of the SPR program. Only the proposed oil distribution system is affected by the revision proposed in this supplement.

As described in Section 2.0, the principal revisions are: (1) construction of a 67-mile, 36-inch diameter oil pipeline across the Atchafalaya Basin between the Weeks Island/Cote Blanche Island storage sites and the tanker terminal at St. James; (2) no expansion of barge dock capacity at the storage sites; (3) expansion of planned terminal facilities and construction of a tanker dock at St. James; and (4) possible construction of microwave towers at the storage sites.

4.2.1 Geology

Geologic impacts associated with construction of the proposed oil distribution system would be associated with soil and substrate disturbance during installation of the pipeline, grading and filling the terminal sites at St. James, Weeks Island, and Cote Blanche Island, and dredging of the Mississippi River at the tanker dock site. The pipeline distribution system does not affect the geologic or structural integrity of the salt dome or storage caverns.

At the St. James tanker dock, as much as 200,000 cubic yards of substrate would be dredged from the river. The effect of this excavation on water quality and the cross section of the river channel would be minor. Material excavated from above the water line is expected to be used in building the dikes (levee) around the 25-acre terminal expansion. 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 20,000 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.

Detailed surveying, clearing, and laying of the entire 67-mile pipeline would take a total of 7 months. However, most construction activity would be completed within four months. Excavation and laying of most of the pipeline to the St. James Terminal (except within the Atchafalaya Basin) would result in a continuous, temporary open ditch.

As shown in Figure 2.3-3 and Table 2.3-1, approximately 28 miles of pipeline would be constructed using dry land construction techniques. This results in a fairly narrow trench 6 feet deep, 5 feet wide at the bottom, and approximately 9 feet wide at the top. Depending on weather conditions, the trench would be backfilled completely within one to three weeks following pipeline installation (under extreme weather conditions, delay may be as long as 6 weeks). Another 26 miles of pipeline would be constructed using conventional push ditch construction techniques (a conventional water crossing using a barge and backfilling would be used across Lake Verret and other large water bodies, Section 2.3.3.2). This results in a ditch 6 feet deep, 5 feet wide at the bottom, and, depending on bank stability, from 10 to 50 feet wide at the top (a typical width of 30 feet has been used in calculations of excavation volumes and impacts). Backfilling would be initiated as soon as possible but, if high water conditions occur, this may take as much as three months and a considerable loss of spoil (up to 50 percent) may occur.

The remaining 13 miles of ROW lies within the Atchafalaya Basin and would require flotation canal construction techniques for pipeline installation (Section 2.3.3.2). Nine miles of this ROW can be completed by widening the existing Chico Corporation pipeline canal by about 50 feet on the north side. The remaining four miles would require a separate canal approximately 100 feet wide and 8 feet deep. No backfilling of the canal is planned.

Excavation along the entire pipeline ROW would temporarily displace an estimated 1,944,000 cubic yards (cy) of material during a four-month construction period (Table 4.2-1). Along the 28-miles of dry land construction, the spoil would be backfilled into the trench within one to three weeks of excavation (233,000 cubic yards). During the period of exposure some erosion and lateral loss of material can be expected to occur; however, the terrain should be essentially unmodified (except for clearing) after backfilling (Figure 2.3-4).

Along the 26 miles of push-ditch construction ROW, 514,000 cy of soils would be exposed to erosion, compaction and dehydration for periods of up to 3 months. As much as 50 percent of the spoil volume may be lost. Thus, it is unlikely that sufficient backfill would be available to completely fill the ditch, even allowing for the 45,000 to 50,000 cy of space occupied by the coated pipeline. The result would be an alteration in local topography by creation of a shallow depression along portions of the push-ditch ROW (Figure 2.3-5). Most of this construction would occur in swamp forest and marsh terrain.

The 1.2 million cy of material excavated from the flotation canal within the swamp forests of the Atchafalaya Basin would be placed in spoil piles, principally along the northern bank. Breaks would be left in the spoil to facilitate movement of water, but none of the material would be backfilled. Much of the spoil volume (again, perhaps 50 percent) would be eroded, compacted, or dehydrated prior to stabilization by vegetation. There would be a significant alteration in bed topography (Figures 2.3-6 and 2.3-7) due to the additional canal width and creation of spoil banks where none now exist (continuous spoil banks exist along the south bank of the existing canal). Some of the spoil would wash back into the canal and some would be carried into the swamp forest to the north.

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 elevation slightly along the push-ditch ROW and create shallow depressions. Planned 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.

At major waterway crossings, material excavated from the waterway would be temporarily stored along one bank. The material would be removed as soon as possible and returned to the excavated trench.

No pump stations are planned for construction between the storage sites and St. James.

Summary Comparison of Construction Impacts on Geology

Construction of the proposed oil pipeline system connecting St. James Terminal with Weeks Island and Cote Blanche Island would involve the following: (1) temporary excavation of an estimated 1,944,000 cubic yards of soil from the 67-mile long pipeline ROW, 75 percent of which would not be backfilled, leaving an 8-foot deep canal across the Atchafalaya Basin and shallow depressions along portions of the swamp forest and marsh ROW outside the Basin; (2) dredging of 200,000 cubic yards for construction of the tanker dock at St. James; (3) minimal amounts of grading at St. James and at the Weeks Island and Cote Blanche Island storage sites. Total earth movement would be approximately 2,180,000 cubic yards, of which perhaps 15 to 20 percent could be returned to its original location.

By avoiding the need for expanding the existing barge docks at Cote Blanche and Weeks Island, an estimated 500,000 cubic yards of dredging and spoil disposal needed for barge slip expansion would no longer be required.

Other geologic effects associated with mine conversion, new mine construction, and oil storage, as described in FES 76/77-7 and 76/77-8, would be unaffected by development of the pipeline system to St. James.

4.2.2 Hydrology

4.2.2.1 Surface Water

Potential water resource impacts due to construction of the proposed St. James oil distribution system would be caused primarily by excavation and dredging for installation of the pipeline, tanker dock, and terminal facilities. Dredging would be required at the Mississippi

River tanker dock site and at the water body and wetland crossings along the pipeline route. Impacts of this dredging would primarily be increased turbidity, a reduction of the dissolved oxygen levels in the water, and alterations in circulation and drainage patterns.

Impact of Dredging and Pipeline Installation

Pipeline construction would affect water quality in bayous, canals and flooded wetlands crossed by the ROW. Approximately 1.722 million cubic yards of material would be excavated for pipeline installation in open water and swamp forest and marsh wetlands (Table 4.2-1). Approximately 40 percent of this material would be piled alongside the push-ditch (or along the banks of waterways crossed) for periods of up to three months prior to backfilling. During this time, rainfall and surface water drainage would wash some of the material from the spoil pile and into adjacent surface waters.

Within the thirteen mile section of swamp forest and open water in the Atchafalaya Basin requiring pipeline installation by flotation canal, an estimated 1.2 million cubic yards of substrate would be excavated and deposited in temporary spoil piles primarily along the north bank. This material would not be returned to the canal as backfill. Much of it would be washed into adjoining canal and swamp by rainfall or high water. The remainder would be stabilized by vegetation.

Effects on adjacent surface waters due to spoil erosion and runoff 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 drain slowly by gravity force alone. Also, the gradients along the project route are very gradual. In the wetland habitat, water quality impacts should be confined to the immediate vicinity of the pipeline route, except in areas where streams are crossed. The impacts may continue for periods of as much as a year or two following excavation or until the spoil piles are stabilized. Some wetlands (especially those with good water circulation patterns) are relatively insensitive to the discharge of small quantities of pollutants since these systems are known to purify the waters and to store material in the emergent plants and sediments. However, siltation is a potentially serious problem in the Atchafalaya Basin.

Where the pipeline must cross streams, bayous, and canals, there would be greater disturbance to area water quality because the currents in these streams would normally suspend and redistribute the spoil over a larger area compared to the swamp forest and marsh habitats. A list of major water bodies, together with the normal maximum depth and average width, is provided in Table 3.3-1. As indicated in Table 3.6-2, approximately 200 acres may be directly affected by excavation in open water, by bankside spoil disposal and by temporary equipment access and storage sites.

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.

Sediment sample data reported in Section 3.3.1.5 and Table 3.3-5 may be taken as representative of conditions to be found in water bodies to be crossed by the proposed pipeline ROW. Chemical analysis of these sediments indicated that they contained high concentrations of heavy metals, pesticides, total nitrogen (Kjeldahl), ammonia, and oil and grease. Many of the smaller bayous crossed have generally slow currents; reverse flow often occurs in response to changes in the downstream water level due to local rainfall, river flooding, or tidal fluctuations. Thus, under certain conditions, the small bayous and large lakes act as sinks or traps for nutrients and pollutants released into the water. There is not likely to be significant scouring or physical displacement of spoil in these water bodies except in the case of a local flood. Because of these slow rates of flow, adverse effects of sediments and chemicals suspended in the water column by excavation, pipeline installation, and backfilling should be concentrated in the water column and substrate within a few hundred feet of the crossing.

Certain of the major waterways crossed by the ROW have relatively swift currents or are channelized to prevent meandering. Examples are the Charenton Drainage and Navigation Canal, Bayou Teche, Grand Lake (West Point), ICW (Port Allen Branch) and the Mississippi River. Under high upstream water conditions, several of the other larger bayous crossed would also maintain significant currents. Under these conditions, flushing and dispersion of suspended sediments and chemicals released into the water column by dredging or spoil disposal would dilute the effects over a greater volume of water and reduce the intensity of impact.

Elutriate tests conducted on sediments taken from Plaquemine Bayou, Port Allen Branch of the ICW, and the Mississippi River show that there is a possibility for concentrations of certain heavy metals (e.g., copper, mercury, nickel, zinc) and pesticides (dieldrin, endrin, and DDT) to exceed recommended EPA water quality criteria for aquatic life within the affected zone (Table 4.2-2). Concentrations of phenol and mercury may exceed EPA recommendations for public water supply in the Mississippi River near St. James. Heavy metals seem to be adsorbed on the sediment particles so that dredging may actually decrease water column concentrations. There are two St. James Parish water supply intakes approximately 5 to 7 miles downstream of the proposed dredging site. Dock site work must be coordinated with Parish officials to avoid contamination of municipal water supplies. Present dredging of the river has no adverse effect if conducted away from the immediate vicinity of the intake pipes (Simon, personal communication).

The data presented in Table 4.2-2 were taken several miles north of the proposed ROW. Data for Mile 224 and Mile 155 on the Mississippi River should be representative of conditions at the St. James dock site. Data for Plaquemine Bayou should represent worst case conditions for many of the small waterways crossed by the ROW because upstream development is generally greater on Plaquemine Bayou. Data for the ICW south of Plaquemine Bayou should also be representative of worst case conditions in most of the larger waterways crossed by the proposed ROW.

In summary, the direct effects of dredging on the water column should be of fairly local extent, lasting only a few days after installation and backfilling of the pipeline. Erosion of the permanent spoil banks along the flotation canal would continue for several months, however, or until stabilization by vegetation.

In addition to affecting water quality directly, construction of the pipeline would also alter surface drainage patterns and rates and thus indirectly affect water quality and quantity. For example, after push-ditch excavation and before backfilling, an open trench 6 to 7 feet deep would extend along the pipeline ROW in marsh and swamp forest wetlands. 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 period of up to 3 months prior to backfilling (and, in places where significant loss of spoil occurs, perhaps permanently). Since the pipeline ROW is generally perpendicular to the regional flow of surface water (Figure 2.1-2), this alignment of the ROW may temporarily alter local flow rates (especially during low water periods) by depleting water levels in some areas and increasing them in others. Both processes can alter water quality, particularly dissolved oxygen levels. Effects may be either beneficial or adverse depending on present conditions.

Within the 13-mile segment of pipeline ROW in the Atchafalaya Basin, a 50-foot canal expansion or a 100-foot separate barge canal would be excavated to a depth of approximately eight feet. As no backfilling would be conducted, a linear, relatively deep channel would be created in the Basin. Though large scale impoundments of water would be avoided by leaving breaks in the spoil pile every few hundred feet, surface hydrology would be unavoidably altered by this construction.

Within the Atchafalaya Basin, approximately 9 miles of existing pipeline canals are to be widened by approximately 50 feet for installation of the 36-inch FEA pipeline (Figure 2.3-3). Expansion would be made on the north side and the existing canal and spoil would be placed on the north bank, leaving openings every 500 feet for water movement. The south bank of the existing canal presently has a nearly continuous spoil bank which now prevents most north-to-south sheet flow. The discontinuous spoil banks to the north of the FEA canal expansion would not prevent drainage into the canal from the swamp during the spring high water priod, but would probably create many small backwater areas along the ROW during normal water levels which would otherwise drain slowly to the south. The 150-foot wide canal is a much more efficient channel for carrying water out of the swamp than unbroken swamp forest. During low water periods, the canal may provide drainage and dewatering of the adjacent swamps (especially to the north). The areal extent and overall significance of this change of hydroperiod is impossible to assess. In some areas, the increased flow rate of stagnant water may raise dissolved oxygen levels and reduce siltation. However, siltation is not generally a serious problem in the interior swamps east of Grand Lake. In any case, there would be a definite increase in open channel flow and a reduction in sheet flow along the ROW. The use of bulkheads or canal plugs, as may be specified by the Louisiana Wildlife and Fisheries Commission and by other State or Federal agencies, would significantly affect the amount of water flow in the canal through the swamp. Except along bayous crossing the ROW, swamp forest south of the existing spoil bank should not be affected by the proposed action.

In the vicinity of Grand Lake, more than 3 miles of pipeline installation would require substantial ROW separation from the existing pipelines. A separate FEA canal would be required parallel to and north of the existing canal. Approximately 2.6 miles of canal would cross swamp forest and the remainder of the ROW would be in open water. The 100-foot wide canal would cause the same types of disruptions to sheet flow and surface drainage as described previously for the canal expansion. However, flow through the (nominal) 100-foot wide strip of forest between the canals would also be significantly affected and the incremental addition to canal flow area would be about 30 percent greater than in the swamp forest to the east.

The pipeline ROW crosses the following Drainage Areas (Figure 2.1-2): the southeastern edge of the Marsh Island-Teche System; the southern portion of the Atchafalaya System; the central portion of the Terrebonne-Verret System; and the northwestern corner of the Barataria-Salvador-Des Allemands System. The terminal expansion and tanker dock are located in the Mississippi River and Tributaries System. In each drainage area the ROW is perpendicular to the general flow of surface water. The potential for adverse impact is greatest in the Atchafalaya and Terrebonne-Verret Systems. Potential ef fects to the other drainage areas would be smaller. Throughout the project area, however, the proposed ROW parallels existing pipeline corridors, usually having existing canals and cleared terrain. Thus the proposed project would not impose significant new changes to unaltered wetland systems, but would reinforce and expand pre-existing modifications to surface hydrologic patterns.

Standard construction practices attempt to promote and retain natural drainage patterns across a pipeline ROW by providing breaks in the spoil piles every few hundred feet and, in certain locations, by constructing bulkheads to interrupt the flow of water along the ditch. Thus, at high water levels, the normal regional drainage patterns should not be altered. After backfilling a pipeline trench (planned within three weeks 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 and much of the affected ROW should gradually fill in with silt and organic debris.

As described earlier, despite similar precautions taken with flotation canals, regional hydrology may be unavoidably altered; local hydrology certainly would be altered. As the proposed pipeline canal would be adjacent to, or an expansion of, an existing canal for its entire 13-mile length, the extent of additional alteration should be reduced. However, the cumulative effect on regional hydrology cannot be predicted with any certainty.

At crossings of certain major water bodies, care would be taken to prevent significant flow of water into the pipeline canal on either bank. Where there is a significant potential for siltation or disruption of beneficial flow patterns, a bulkhead could be installed on either side of the water body immediately after excavation (usually at the request of cognizant State or Federal agencies). Appropriate measures would be taken to prevent erosion of the banks at the pipeline crossing.

As much as 200,000 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 solid concentrations 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 and in Table 4.2-2. There is expected to be little impact on nutrient levels or heavy metals. Concentration of phenols, dieldrin, endrin, and DDT may increase locally, but should be rapidly diluted by the large river flow. The maximum quantity of dredged material to be disposed of in the channel from the dock construction (200,000 cubic yards) is less than half the daily sediment load normally carried by the river.

Impact of Earth Excavation and Fill

Terminal site preparation and construction activity would involve approximately 40,000 cubic yards (yd^3) of earth movement within a disturbed area of approximately 30 acres: an estimated 20,000 yd^3 on 3 acres from the river bank at the dock site; and 20,000 yd^3 on 25 acres at the St. James Terminal expansion site. Assuming that the surface soils are exposed for approximately six months before being stabilized, an estimated 1000 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; the only available water body nearby to receive this sediment is the Mississippi River at the tanker dock site. Therefore, discharge into surface waters would likely occur over a very long period of time and should not measurably degrade water quality.

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 either directly through a screen or 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.

4.2.2.2 Ground Water

The proposed construction should have negligible impact upon the ground-water regime of the area. The major shallow freshwater aquifers in the project vicinity are the Chicot Aquifer in the vicinity of Weeks and Cote Blanche Islands and the analogous Plaquemine Aquifer in the vicinity of St. James. Both aquifers are overlain by about 100 feet of clays and silt which serve as a confining bed which would isolate the aquifers from the effects of construction.

4.2.2.3 Summary Comparison of Construction Impact on Water Quality

Construction of the 67-mile pipeline between the Weeks Island and Cote Blanche Island storage sites and St. James would avoid a substantial amount of dredging activity at the barge slips adjacent to the storage sites (estimated at 250,000 cubic yards at each) which would have limited adverse impacts on water quality in the ICW and adjacent industrial canals. Construction of the new distribution system would involve approximately 2.2 million cubic yards of excavation on agricultural land, wetlands and water bodies for pipeline installation and terminal construction. Water quality impacts would accompany the dredging and spoil disposal throughout the wetlands, particularly in the Atchafalaya Basin Floodway. Most impacts should be local and temporary, but they would be geographically extensive. Locally adverse water quality impacts would occur in the Mississippi River at St. James due to dock construction.

Terminal construction required for the St. James pipeline system is more extensive than for the barge alternative. Potential impacts on water quality are not expected to be significant in either case, however.

Potentially more significant than effects on water quality are the possible alteration to surface hydrology patterns in wetlands which could accompany pipeline construction. As the ROW follows existing pipeline corridors throughout its length, the likelihood of altering regional flow patterns is reduced. Local alteration, some possibly long-term, would occur unavoidably, however. In particular, expansion of existing canals and construction of new canal segments in the Atchafalaya Basin could significantly alter local and, perhaps, regional surface flow patterns. The alternative method of oil transportation, using barges, would not affect surface flow patterns as no wetland construction would be required.

4.2.3 Air Quality

In this section, the air quality impacts from site preparation and construction associated with the proposed pipeline oil distribution system are assessed and compared with the impacts of the barge transportation alternatives described in FES 76/77-7 and 76/77-8. Major differences in the revised oil distribution system which affect air quality include the construction of a 67-mile pipeline from Weeks Island to St. James, and construction of a tanker dock and four 200,000 barrel oil surge tanks at St. James. With the proposed pipeline oil distribution system, construction of the barge docks at Weeks Island and Cote Blanche would not be required.

4.2.3.1 Storage Site Construction

The quality of air during the construction phase at the storage sites would be affected mainly by general construction vehicles, light duty, general use vehicles, and fugitive dust from excavation and vehicular traffic. These effects are described in Section 4.2.3 of FES 76/77-7 and FES 76/77-8. The impacts from these sources were concluded to be minor.

4.2.3.2 Construction of the Tanker Dock Facilities and Pipeline

Since expansion of the barge docks at Weeks Island and Cote Blanche would not be required if a pipeline were built to connect with St. James, construction emissions would occur only along the pipeline ROW and at St. James due to tanker dock and storage tank construction. Emissions from construction equipment would be similar to those given in Section 4.2.3 of FES 76/77-7 and FES 76/77-8 where the air quality impacts were concluded to be minor.

Additionally, at St. James, there would be paint solvent emissions associated with spray painting the four 200,000 barrel floating roof oil storage tanks to be constructed. These tanks would probably be spray-painted with solvent-based paints composed of relatively volatile, light hydrocarbons. The quantity of paint required depends on several variables. Here it is assumed (for purposes of evaluating a "worst case" impact) that one gallon would cover 100 square feet with 2 coats, that one gallon would weigh 15 pounds, and that half the weight is solvent. The estimated hydrocarbon emission rate based on a painting rate of 6000 square feet per day (60 gallons of paint per day) is 1.32 grams per second (g/s). At this painting rate, these emissions would occur over a period of about 40 days at the St. James terminal.

At 1 kilometer (km) downwind, the 3-hour "worst-case" hydrocarbon concentration due to paint solvent emissions is calculated to be 104 $\mu g/m^3$, well below the 3-hour standard of 160 $\mu g/m^3$. However, since background hydrocarbon levels often exceed the 3-hour standard in the area, infrequent additional exceedances may occur during painting. Worst-case assumptions and modelling techniques used are described in Appendix A.

4.2.3.3. Summary Comparison of Construction Impacts on Air Quality

Neither proposed oil distribution system would have a significant adverse regional impact on air quality. However, the St. James pipeline system involves considerably more construction activity and may result in short-term, locally high concentrations of dust and engine emissions at St. James terminal and at work sites along the pipeline ROW. Also, paint solvent emissions at the St. James terminal would cause moderate emissions of light hydrocarbons which, although maximum expected concentrations would be below primary air quality standards, would contribute to locally high background concentrations for a period of about 40 days.

4.2.4 Noise Level

Activity associated with construction of the surface facilities along the pipeline ROW and for the dock and terminal expansion at St. James 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.

4.2.4.1 Storage Site Area

Construction noise sources at the storage sites during site preparation would be air compressors, trucks, diesel engines, pumps, drilling rigs, impact equipment, concrete mixers, and general construction related equipment. Typical noise levels for this equipment are given in Table 4.2-3. Diesel engines would provide the most consistent source of noise. Impact and drilling equipment would create the peak sound levels. The areas adjacent to the storage sites are predominantly industrial land, upland forest, and marshlands. The nearest agricultural land and residences are at least 1 mile away. No noise sensitive activities are known to occur adjacent to the storage site areas.

On the basis of ambient sound levels reported in Section 3.5 and in FES 7/77-7 and 76/77-8, the following approximate sound levels (day-night weighted average, L_{dn}) are expected to result from the project: center of sites, 80 dB; along ICW, 65 dB; Cote Blanche and Weeks Islands away from sites, 56 dB; nearby noise sensitive areas (nearby towns of Kemper and Boudreaux), 56 dB. These are increases over ambient conditions of 6 dB at the mine sites, 4 dB along the ICW, 3 dB at undeveloped areas on the islands, and no increase at nearby towns.

4.2.4.2 Pipeline Corridor

A 67-mile pipeline would be built for movement of oil between Weeks and Cote Blanche Islands and St. James. The pipeline construction consists of (1) excavation, (2) laying of pipe, (3) welding, and (4) finishing operations. Based on aerial photographs, the proposed pipeline route would pass within 1000 feet of perhaps 100 structures, most of which are located in Klotzville on Bayou Lafourche (Figure 2.1-2). Another 250 structures would be within 1000 to 2000 feet of the ROW, mostly at the towns of Franklin, Klotzville, Grand Bayou, and Pierre Part. The equivalent sound level (L_{eq})* at 500 feet from pipeline construction is estimated to be 68 dBA (FES 76/77-7 and 76/77-8). The equivalent sound level contribution at residences along the pipeline route is estimated to be 68 dBA at 500 feet, 62 dBA at 1000 feet, and 56 dBA at 2000 feet 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.

4.2.4.3 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 potential terminal sites. Due to the current industrial nature of the area, the temporary noise impact should not be particularly disturbing.

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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.

4.2.4.4 Summary Comparison of Construction Impacts on Noise Level

Construction at the storage sites, 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 the sites. Only the storage sites would be affected by the barge transportation alternative, whereas St. James terminal would also be affected by the pipeline system. However, due to the present industrial nature of the sites, the actual increase in ambient sound levels at noise sensitive land use areas is expected to be minimal. Therefore, the overall impact on noise levels is expected to be minimal, though slightly greater for the proposed St. James pipeline system.

Construction of the pipeline to St. James would increase the ambient sound levels at an estimated 250 to 300 nearby residences from an estimated daytime L_{eq} of 56 dBA to as much as 68 dBA during construction activity (a few days). This increase in ambient levels would cause some annoyance to the inhabitants. Only residents located on the ICW or Mississippi River would be affected by the barge transportation alternative.

4.2.5 Biological Impact of Construction

Construction of the pipeline distribution system between Cote Blanche Island/Weeks Island and St. James would involve clearing and excavation on nearly 900 acres of land and would require some long term alteration of habitat type or land use on over 450 acres (Table 3.6-2). Most of the acreage affected would be within the 67-mile pipeline ROW, principally in swamp forest and on agricultural land.

The region through which the proposed facility would be constructed is generally excellent habitat for wildlife. Productivity is high, particularly in the wetlands, due to abundant rainfall, mild climate, a long growing season, and low gradients. As one measure of the direct value of lands to be taken for the project, average carrying capacities for prominent species of wildlife may be assigned based on data summarized in Corps of Engineers (1973). Results are shown in Table 4.2-3 for temporary impacts (construction) and for permanent (life of project) impacts resulting from facility occupation or maintenance clearing.

Data in Table 4.2-4 are for illustrative purposes only. Carrying capacities used apply to "average" conditions as reported in the literature. No site-specific sampling program has been conducted to verify the applicability to project-affected lands. Certain lands crossed, such as those in the southeastern portion of the Atchafalaya Floodway and in the upper Des Allemands-Salvador-Barataria Basin, may be particularly productive and thus support larger numbers of some or all species. In general, however, the lands to be impacted are adjacent to existing industrial facilities or pipeline corridors and thus may be expected to support less than maximum numbers of wildlife. In any case, long term conditions on affected lands would not be greatly altered from those in adjacent ROWs or developed lands.

The numbers of individuals listed in Table 4.2-4 would not necessarily be lost as a result of project construction. Most are mobile and nearby habitats may be capable of absorbing some or all of the displaced individuals (especially within the pipeline ROW where the effects are dispersed along a 67-mile corridor). Worst case impacts would result if nearby habitats were not available or were presently at maximum carrying capacity, resulting in loss of individuals equal to the numbers displaced.

Threatened or endangered species which may occur on project lands are listed in Section 3.6.3. Several threatened or endangered plant species could possibly occur in this region. The cougar could also occur but is very rare and would not likely be dependent on acreage affected by the project. Peregrine falcons may occasionally occur in the marsh to be crossed near Cote Blanche Island. Considering the limited segment of marsh to be affected, there is unlikely to be any significant impact. The southern bald eagle could occur anywhere within the project region. The closest known nesting site is several miles away, however. As indicated in Table 4.2-4, a total of 19 alligators may be displaced by construction, with a permanent carrying capacity loss of 8 individuals. However, the increased open water acreage created by flotation canals in the Atchafalaya Basin may actually increase the amount of alligator habitat in the region.

Commercially important species which would be adversely affected by the project include timber, raccoon, mink, and otter within the swamp forest; muskrat and nutria within the marsh. Fishing impacts may include temporary loss of food for catfish, bullheads, blue crab and crayfish within the Atchafalaya Basin (fishery habitat would be increased by flotation canals in the Atchafalaya Basin) and loss of nursery grounds in the intermediate marsh. None of these impacts appear to be regionally significant.

Recreationally important species displaced from project lands include deer, rabbit, squirrel, waterfowl, dove and quail. The largest number of individuals displaced would be rabbits and squirrel from swamp forest, and waterfowl from agricultural land. Again regional impacts would probably not be significant.

In addition to the direct effects of habitat disturbance, there is the potential for indirect effects associated with ecological interactions. The major potential for the proposed project would seem to be the chance of disrupting surface hydrology and creating stagnant water areas, draining wetlands, or cutting off migration routes. The potential for adverse impact is particularly severe in the Atchafalaya Basin due to alterations in surface hydrology. However, the proposed ROW follows existing pipeline corridors which have already been modified. Additional alteration would affect some new habitats and there may be some reinforcement of existing conditions.

4.2.5.1 Impacts at Storage Sites

Terminal construction at Weeks and Cote Blanche Islands would involve less than ten acres of cleared industrial land. As indicated in FES 76/77-7 and 76/77-8, impacts would not be significant.

4.2.5.2 Impact from Pipeline Construction

Development of the St. James oil distribution system would require construction of a 67-mile long, 36-inch diameter pipeline along the route shown in Figure 2.1-2. The construction of the pipeline would require a right-of-way approximately 100 to 140 feet wide in the Atchafalaya Basin and 75 feet wide outside the Basin. As indicated in Table

3.2-6, direct impacts would occur on an estimated 180 acres of cleared agricultural and industrial land, 38 acres of intermediate marsh, 79 acres of bottomland forest, 34 acres of open water, and 505 acres of swamp forest. The pipeline would also cross several large bayous, canals, and lakes (Table 3.3-1), plus a number of smaller water bodies. Descriptions of the environmental setting and habitat types traversed by the pipeline are provided in Section 3.6.

Virtually the entire 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 (though 9 miles of flotation canal widening are assumed) so that the analysis would yield a conservative estimate of maximum impact (Tables 3.6-2 and 4.2-4). However, the indirect effects on biota and habitat quality should be considerably lower than those that would be expected if a route were selected through previously undeveloped terrain.

Pipeline construction would have several possible effects on biota. The excavation would directly destroy vegetation and sessile organisms along the ROW. This destruction in turn would reduce the available habitat and therefore displace animal life, increasing the stress on neighboring animal populations. However, since the pipeline ROW is relatively long and narrow, the local disruptive effects of construction should be limited to a relatively narrow band along the ROW.

Spoil banks can also disrupt normal migration patterns for aquatic life. Openings would be left to minimize the chances of this occurring. 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. Elevated spoil banks in the Atchafalaya Basin and depressions along the push-ditch ROW would be colonized by different species than normally occur in the cypress-tupelo forest. Altered habitat and increased diversity would result.

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, 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 would vary in significance depending upon the suitability of adjacent habitats.

Indirect construction impacts on the ecology of the swamplands and marsh are potentially significant and are less easily measured. Vegetative and animal productivity in these swamps depend to a great degree on hydroperiod, adequate water circulation, and water quality. Pipeline canals and spoil banks can create stagnant water conditions, excessive drainage, or heavy siltation, any of which can affect biological productivity and habitat quality not only within the immediate right-of-way, but in adjacent wetlands as well. Some existing problems with poor circulation or siltation can be improved by canals. The duration of these impacts is usually dependent on successful re-establishment of the original hydrologic flow patterns after backfilling of the pipeline ditch. In the flotation canal, proper use of flow barriers in the canals and openings in the spoil banks may minimize adverse impacts.

Pipeline construction across bayous and canals disturbs the bottom substrate and also suspends material in the water column (Section 4.2.2). Benthic organisms are generally destroyed within the ROW because they are removed with the excavated material; they may also 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 if heavy siltation does not occur. Mobile organisms (such as fish) can usually avoid the affected area. Plankton populations may be reduced by high turbidities or increased levels of toxic materials but the percentage of the total plankton population affected by the proposed excavation would be negligible.

Forested areas will recover some 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. In dry land areas, the entire ROW should be suitable for regrowth of native vegetation. In swamp lands, regrowth may be limited to areas which are not too deep for germination of cypress and tupelo. As a worst case condition, it is assumed in Table 4.2-4 that a 30-foot wide shallow channel is created along the push-ditch ROW which is unsuitable for woody vegetation growth. Actually, much of this land should return to a closed canopy swamp forest; however, the remainder would support aquatic macrophytes and grasses.

Regrowth of marsh vegetation should be complete 2 to 3 years after backfilling. Again, a 30-foot wide shallow canal is assumed to become open water too deep for productive growth of marsh vegetation.

As indicated previously, nearly the entire ROW parallels an existing, cleared, pipeline corridor. The most ecologically productive habitats along the ROW are the 13-mile Atchafalaya Basin Floodway and 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. 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) outside the Basin and may involve partial loss of productivity over an additional 300 acres. Within the Basin, adverse effects could be long term over 150 to 300 additional acres north of the ROW (based on 1 to 2 acres of adjacent wetlands affected by construction of each acre of flotation canal within the pipeline ROW.)

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 approximately 2.6 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 420 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 1.1×10^9 benthic organisms and 3.0×10^7 gm dry weight of phytoplankton (assuming 1 week of highly turbid waters at each crossing). This is a negligibly small fraction of these organisms existing in the area.

The total effect of these pipeline impacts should not be significant to the project region outside the Atchafalaya Basin. Within the Basin potential effects could become regional, but this is unlikely since existing canals are followed. However, each pipeline ROW constructed through the Louisiana wetlands adds to the cumulative loss of productive wetlands in the region. By following an existing right-of-way, previously undisturbed swamp lands would not be directly affected. Widening this ROW or laying a parallel pipeline trench increases the chance of regional surface water flow disruption and creates a pipeline corridor likely to be used again in the future.

4.2.5.3 Impacts from Dock and Terminal Facilities Construction

The tanker dock which would be constructed on the Mississippi River near the St. James Terminal would require excavation of an estimated 20,000 cubic yards of earth from the river bank (above the normal water level). Up to 200,000 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 should be local and negligibly small. 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 should not be affected measurably.

Aquatic macrophytes do not form an established bank community on the Mississippi River in the project area because of fluctuating water levels and steep banks; therefore, impacts to 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 may be readsorbed on sediments downstream. Background levels of these pollutants are high in the lower Mississippi. Construction of the dock would result in some redeposition downstream and in some increase of these pollutants in suspension downstream.

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 (willow) vegetation which provides wildlife habitat adjacent to the planned dock site. The soil excavated from the bank would probably 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 25 acres of cleared land located west of the new dock or on Koch Oil Company land further north (Figure 2.3-9). 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.

4.2.5.4 Summary Comparison of Construction Impacts on Ecology

Construction of all components of the Weeks Island and Cote Blanche Island oil storage project, as originally proposed in FES 76-5, would have an impact on approximately 80 acres at the storage sites. Construction of the St. James oil distribution system would avoid the impact of 38 acres of dredging and fill at the barge docks since no expansion of these facilities would be necessary.

Construction of the proposed pipeline system would result in a total impact area of about 920 acres for the two projects. Additional acreage affected include disruption of 840 acres of land along the 67-mile pipeline ROW, 8 acres at the storage sites, and 28 acres at the St. James Terminal. The net effect of the proposed system is substitution of a 67-mile long pipeline corridor with its associated potential impacts on hydrology and habitat quality for a relatively minor expansion of barge dock facilities adjacent to the storage sites.

There are essentially no construction impacts on the ecology caused by the barge transportation alternative; there could be potentially significant ecological impacts caused by the proposed pipeline system.

4.2.6 Historic, Archaeological, and Recreational Resources

No known cultural resources would be affected by construction of the proposed oil distribution system (Section 3.7). In recognition of the potential existence of undiscovered sites, a cultural survey would be conducted prior to finalizing 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.

The proposed pipeline ROW passes through the southern part of the Attakapas Outdoor Recreation Area which is managed by the Louisiana Wild Life and Fisheries Commission. The Recreation Area is located in the vicinity of Grand Lake in the Atchafalaya Basin Floodway (Figure 2.1-2). The Attakapas Outdoor Recreation Area would not be affected by the barge transportation alternative. There are no other existing or planned public recreation areas which would be affected by construction of the project.

Because of the greater extent of area impacted by construction, there is a correspondingly greater chance of affecting cultural and recreational resources with the proposed pipeline system. Adequate surveying of the proposed lands should avoid significant cultural resource damage, however.

4.2.7 Impacts on Socioeconomic Environment

Socioeconomic impacts caused by conversion of the Cote Blanche Island and Weeks Island mines to oil storage sites and development of new mines are treated in Section 4.2.7 of FES 76/77-7 and 76/77-8. The decision whether to close the mines temporarily during conversion would not be affected by the choice of oil transportation system. For comparison purposes, however, it is assumed that temporary shutdown would be required in order to meet SPR program schedules.

4.2.7.1 Land Use

Acreages of various land uses to be affected by the proposed transportation system are indicated in Table 3.6-2. Along the pipeline route, much land would be converted from natural wetland habitat to cleared pipeline corridor and canals. Hydrologic and ecologic impacts are treated in Sections 4.2.2 and 4.2.5, respectively. A substantial acreage of agricultural land (sugar cane) would also be within the ROW. Impacts on crop production would only be temporary, however, generally lasting no longer than 1 or 2 growing seasons. The only industrial land affected would be at the mine sites. No residential land would be directly utilized for pipeline construction. However, some of the agricultural land near Franklin and Klotzville is directly adjacent to residential land. Land use restrictions within the permanent ROW would prevent construction on this land.

At St. James, the proposed terminal expansion and dock construction would be an extension of existing facilities and would not constitute a significant alteration in land use.

4.2.7.2 Transportation Impacts

Two types of transportation impacts might result from construction of the pipeline distribution system. The first is direct interference with traffic at major crossings. Approximately 19 major waterways, 8 railroads, 11 highways, and many smaller local roads are crossed by the proposed ROW.

Crossings at railroads and major highways would be made by boring beneath the road bed. There should be no effect on traffic.

At navigable waterways, crossings may require from one to several days. Traffic would be totally disrupted only in the narrower waterways, and then for no longer than 1 to 2 days. In larger waterways, traffic could be diverted around the lay barge or dredging equipment.

At local road crossings, the cut and fill method would be used. Some temporary delay may be experienced for a day or two but traffic would be allowed to pass and the amount of traffic affected would be insignificant.

The second type of traffic disruption would be highway congestion caused by material transportation and commuting of construction workers. An estimate of the number of construction workers required for the pipeline distribution system is provided in Table 4.2-5. Most of the workers would be located at the various construction sites along the pipeline ROW. Also, an estimated 66 workers would be required at the St. James terminal site.

In FES 76/77-7 and 76/77-8 it was estimated that 75 to 100 vehicles may be used to commute to each storage site during the daytime shift. While the western segments of the pipeline are being constructed, perhaps another 150 vehicles may be using local highways during commuting hours. Local traffic would be unavoidably congested during these periods, particularly along Highway 90 in the vicinity of Franklin and Baldwin.

Congestion at other locations of the pipeline construction would be concentrated on roads along Bayou Teche or Bayou Lafourche. Access to several of the construction sites may require transportation by barge from one of the local landings, creating parking and other localized traffic problems.

Commuting levels at St. James terminal should not be great enough to cause significant traffic problems. As with most other roads in the region, Highway 18 is mostly two-lane, but has adequate excess traffic capacity to handle an additional 40 to 50 cars each day.

Transportation of pipe sections and other bulky material would be provided principally by barges. Some increased truck traffic may result from the project but should not significantly affect highway capacity. Barge traffic levels necessary for material transport should be generally insignificant. There could be some disruption or delay in movement of salt by barge from the mine site docks if mining were continued during site construction.

4.2.7.3 Population and Housing Changes

An estimated total of 170 workers from beyond normal commuting distance were estimated to be required at any one time for storage site construction in FES 76/77-7 and 76/77-8. Perhaps half the workers required for construction of the pipeline may come from within commuting distance whereas nearly all workers required at St. James should be available locally (including Baton Rouge area).

Thus, perhaps 150 workers from outside the project region may be required for several months to construct the oil distribution system. Housing shortages could be temporarily severe in Iberia and St. Mary parishes. Temporary quarters may be required onsite or nearby.

Few of the workers which move into the area temporarily would be expected to bring families as the duration of construction is only 7 to 9 months. Therefore, demand for local services, such as schools, would be insignificant.

4.2.7.4 Economic Impacts

From Table 4.2-5, estimated total wages to workers constructing the proposed oil distribution system total $2.4 million over a 9-month period. Approximately half of the workers are expected to reside locally (in the Parish project area and in nearby cities such as Baton Rouge, Thibodeaux, and Houma). Construction wages associated with mine conversion and new mine development were estimated at $10.8 million in FES 76/77-7 and 76/77-8 (perhaps $0.5 million would no longer be realized as a result of the deletion of barge facility expansion). Thus, the oil transportation system represents an estimated 18 percent increase in total construction wages and a 15 percent increase in local construction wages. Secondary development in the local economy would also be stimulated.

4.2.7.5 Government Revenue

It has not been determined as yet whether the SPR facilities would be owned by private industry or by the Federal government. If owned by industry there would be a substantial increase in local property tax revenues. If owned by the Federal government, there would be a minor decrease in local revenues as a result of land being removed from private ownership. State sales tax revenues would be increased in proportion to expenditures for materials and energy and in proportion to increased spending of construction wages.

4.2.7.6 Aesthetic and Sociocultural Impacts

Aesthetic impacts due to construction of the project would result principally from pipeline right-of-way clearing and possible erection of the microwave towers at the storage sites. Terminal expansion and tanker dock construction at St. James would be located adjacent to existing industrial facilities of a similar nature. Though visible in part from Highway 18 and from several residences in the area, aesthetic appearances would not be significantly affected.

Pipeline ROW construction would be most visible at highway crossings. However, most highway crossings are on levees and are flanked by cleared agricultural land. Construction equipment and the pipeline trench would be visible for very brief periods (normally less than 2 weeks). Trees would be cleared from the ROW in several locations adjacent to highways or residences: on Weeks Island, along Bayou Yokely near Franklin, and at Highway 70 south of Pierre Part and near Grand Bayou. At these locations some aesthetic impact would be unavoidable. There are many similar ROW crossings at highways in the area; these may not be considered objectionable and, in some locations, may add diversity to the visual scene. Attempts would be made to maintain a visual barrier of trees between residences and the ROW.

A significant potential effect of the pipeline ROW on aesthetics would occur on Weeks and Cote Blanche Islands and within the swamp forests. Few people have access to these lands, however. Also, in every case the proposed ROW parallels an existing, cleared corridor.

The microwave towers would be constructed to elevations of 150 feet at Weeks Island and at Cote Blanche Island. Although the height above ground level at these locations is such that, in the absence of vegetation or other obstruction nearby, a viewer could see the towers from distances as great as 15 miles (e.g., from Franklin or New Iberia), the towers should not be visually obtrusive beyond a distance of two or three miles because of the small cross section (approximately three feet across).

Construction of project facilities should have no significant impact on social or cultural life styles in the region. Pipelines and oil terminal facilities are commonplace in the region. Mobile construction crews frequently pass through. A possible adverse impact could be caused by high density, temporary housing in one of the local communities which could affect traditional rural Cajun life styles; this is not expected to occur.

4.2.7.7 Summary Comparison of Construction Impact on Socioeconomic Environment

Because facility construction would be much more widespread with the pipeline distribution system than with barge distribution, there is greater potential for both adverse and beneficial impacts. Adverse impacts include changes or restrictions to land use, temporary disruption of transportation, possible localized demand for housing under conditions of shortage, and some degradation of aesthetic appearances. Beneficial impacts include the $1.9 million increase in construction wages and consequent increased tax revenues which would accrue.

TABLE 4.2-1 Pipeline ROW excavation volume (cubic yards displaced)

Construction Method[a]	Deciduous Swamp Forest	Bottomland Forest	Intermediate Marsh	Agricultural Land	Industrial Land	Levee Land	Open[b] Water	Total ROW Excavation by Method
Dry Land[c]	9,840	71,340	-	142,680	4,920	2,460	1,640	232,880
Conventional Push Ditch[d]	410,000	-	84,000	-	-	-	20,000	514,000
Flotation Canal[e] (widen existing canal)	682,500	-	-	-	-	-	7,500	690,000
Flotation Canal[f] (separate FEA canal)	338,000	-	-	-	-	-	169,000	507,000
Total ROW Excavation by Habitat	1,440,340	71,340	84,000	142,680	4,920	2,460	198,140	1,943,880

[a]See Figure 2.3-3 for identification of construction methods by segment along the proposed route.

[b]Excavation quantities in open water dependent on depth and may be considerably less than shown, especially for push ditch and flotation canal methods.

[c]Based on 8200 cubic yards/mile; essentially 100 percent backfilled one to three weeks after excavation.

[d]Based on 20,000 cubic yards/mile, though may vary from 8,000 to 40,000 depending on water level and soil condition; backfilled within 6 months; an estimated 10 to 50 percent lost due to erosion. Compaction and dehydration may reduce volume of remaining spoil by up to 25 percent.

[e]Based on 75,000 cubic yards/mile; no backfilling planned.

[f]Based on 130,000 cubic yards/mile; no backfilling planned.

TABLE 4.2-2 Elutriate Test Data for Plaquemine Bayou and Intracoastal Waterway

	EPA Recommended Quality Criteria		Test Results	Test Results	Test Results		
					Mississippi River		
Parameter	Public Water Supply (μg/l[a])	Aquatic Life (μg/l)	Bayou Plaquemine[b] (μg/l)	Intracoastal Waterway (μg/l)	Mile 224[b] (μg/l)	Mile 155[c] (μg/l) Sample 1	Sample 2
Cadium	10	4/30[d]	1.1	1.8	-	0	1
Chromium	50	50.0	0.5	0.5	0	0	0
Copper	1000	1/10LC50	15.0	16.0	9	8	10
Lead	50	30.0	1.0	1.0	1	5	0
Mercury	2	0.2	3.0	0.2	0	0	0
Nickel	-	1/50LC50	21.0	21.0	1.5	2	0
Zinc	5000	5/1000LC50	6.5	11.0	15	20	20
COD	-	-	221,000	658,000	180,000	17,000	12,000
TKN	-	-	2,480	1,240	820	1,200	800
Oil and Grease	-	-	-	-	-	-	-
Sulfide	-	-	-	-	-	-	-
Suspended Solids	-	80000	-	-	-	-	-
Phenols	1	100	-	-	14	17	26
Cyanides	20	5	-	-	-	0	0
PCB	-	0.002	-	-	-	-	-
Aldrin	1	0.01	0.001	0.001	-	-	-
DDT	50	0.002	0.003	0.012	-	-	-
DDD	-	0.006	0.0015	0.0015	-	-	-
DDE	-	-	0.012	0.003	-	-	-

TABLE 4.2-2 (Continued)

Parameter	EPA Recommended Quality Criteria: Public Water Supply (µg/l[a])	EPA Recommended Quality Criteria: Aquatic Life (µg/l)	Test Results: Bayou Plaquemine[b] (µg/l)	Test Results: Intracoastal Waterway (µg/l)	Test Results: Mississippi River Mile 224[b] (µg/l)	Test Results: Mississippi River Mile 155[c] (µg/l) Sample 1	Test Results: Mississippi River Mile 155[c] (µg/l) Sample 2
Dieldrin	1.0	0.005	.010	.002	-	-	-
Chlordane	3.0	0.04	.010	.01	-	-	-
Endrin	0.2	0.002	.003	.003	-	-	-
Heptachlor	0.1	0.01	.001	.001	-	-	-
Lindane	4.0	0.02	.027	.001	-	-	-
Toxaphene	5.0	0.01	.05	.05	-	-	-
Diazinon	-	0.009	-	-	-	-	-
Malathion	-	0.008	-	-	-	-	-
Parathion	-	0.001	-	-	2	-	-
Arsenic	5.0	-	-	-	-	2	0

[a] µg/l: Micrograms per Liter

[b] Source: FES 76/5

[c] Source: U. S. Army Corps of Engineers, 1976

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

TABLE 4.2-3 Construction equipment noise levels.

Equipment	A-Weighted sound level at 50 feet (dBA)
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 4.2-4 Approximate Carrying Capacities for Selected Wildlife Species in Habitats Affected by Proposed Oil Distribution System[a]

	Bottomland and Swamp Forest		Marsh		Agricultural/Cleared		Total	
	T[b]	P[b]	T	P	T	P	T	P
(Acres)	(585)	(221)	(38)	(15)	(217)	(31)	(840)	(267)
Deer	10	4	1	1	-	-	11	5
Rabbit	292	110	-	-	31	4	323	114
Squirrel[c]	760	287	-	-	5	0	765	287
Wood Duck	6	2	1	1	-	-	7	3
Bobcat	2	1	-	-	-	-	2	1
Turkey[d]	8	3	-	-	-	-	8	3
Migrant Waterfowl	58	22	15	6	181	27	254	55
Raccoon[e]	39	15	-	-	-	-	39	15
Fox	8	3	-	-	1	0	9	3
Black Bear[f]	-	-	-	-	-	-	-	-
Fish (lbs.)[g]	-	-	-	-	-	-	17,000	-
Mink	56	21	1	1	-	-	57	22
Alligator[h]	15	6	2	1	-	-	17	7
Otter	17	7	1	1	-	-	18	8
Woodcock[i]	-	-	-	-	15	2	15	2
Rail	-	-	6	3	-	-	6	3
Snipe	-	-	25	10	-	-	25	10
Coot	-	-	8	3	-	-	8	3
Muskrat[j]	-	-	51	20	-	-	51	20
Nutria[j]	-	-	19	8	-	-	19	8
Doves[k]	-	-	-	-	29	4	29	4
Song Birds[l]	-	-	-	-	Numerous	Few	Numerous	Few
Quail[m]	-	-	-	-	36	4	36	4

[a]See Table 3.6-2 for acreages affected by various project features.

[b]T refers to temporary impacts on all lands required for project construction; P refers to permanent impacts on all habitats altered for the lifetime of the project; this includes a 30 foot ROW for push-ditch pipeline construction, the entire width of flotation canals, and all lands displaced by terminal facilities. No permanent impacts are attributed to pipeline ROW in agricultural or other cleared lands.

Footnotes to Table 4.2-4 (Continued)

[c]Most abundant in drier hardwoods areas.

[d]Introduced near Pierre Part, absent elsewhere.

[e]Also common in marsh.

[f]Introduced into Atchafalaya Floodway; uncommon

[g]Based on 34 acres directly affected (Table 3.2-6).

[h]Threatened species

[i]Seeks daytime refuge in dense woods.

[j]Occurs also in swamps.

[k]Not abundant in sugar cane fields.

[l]Also occurs in marshes and swamps.

[m]Occurs in limited numbers throughout area.

TABLE 4.2-5 Construction Workers and Wages Required for the Pipeline Distribution System

Man Months and Wages by Month[a]

		Construction Month (See Table 2.3-1)									
		9	10	11	12	13	14	15	16	17	18	Total
Man months of Labor	Pipeline			16	233	217	217	163	16			862
	Tanker Dock		33	33	33	33	33	33	33	33	33	297
	St. James Terminal Expansion			33	33	33	33	33	33	33		231
	Total		33	82	299	283	283	229	82	66	33	1390
	Wages[b] ($1000)		57.8	143.5	523.5	495.3	495.3	400.8	143.5	115.5	57.8	2,432.5

[a]See Table 2.3-1

[b]Based on average wage of $1750 per man-month.

4.3 ENVIRONMENTAL IMPACTS OF OPERATION AND OIL STORAGE

4.3.1 Impacts on Geology and Mineral Resources

With proper backfilling and erosion prevention measures, operation of the proposed pipeline distribution system should not significantly affect geology or soil conditions. There would be some local erosion at the terminals and in the pipeline ROW as a result of the reduction in ground cover. In particular, along the flotation canal left in the Atchafalaya Basin, there may be some loss of soil and bankside vegetation due to erosion. Accessibility to boat traffic would have a large impact on probable erosion rates.

Transportation of oil by barge would increase traffic in the ICW and would cause some additional bank erosion.

Neither oil distribution system would have significant environmental impacts on geology or mineral resources as a result of project operation.

4.3.2 Hydrologic Impacts

4.3.2.1 Surface Water

Water Supply

Operation of the oil transportation facility would impose no substantial demand on water supplies. Oil would not be flushed from the pipeline during standby storage and there are no other significant water requirements. Local water supplies are available to meet the sanitary demands created by the few employees required.

Should the additional canals in the Atchafalaya Basin promote drainage of nearby swamp forest, excessive dewatering could occur during extremely dry periods.

Pollutant Discharge

No wastes are expected to be intentionally discharged to surface waters from the oil distribution system (possible oil spill impacts are treated in Section 4.3.8). Minor quantities of domestic sewage would be handled in accordance with local regulations, i.e., septic tank disposal or an approved chemical treatment plant.

Flooding

Floods pose no threat to facilities on Weeks Island, Cote Blanche Island, or the terminal at St. James. Much of the pipeline is exposed to surface flooding, but only the pipeline crossings at major levees and shutoff valves at the ICW would be aboveground. Risks associated with flood hazards are included in the oil spill risk data used in Section 4.3.8.

4.3.2.2 Ground Water

Potential environmental impacts to ground water resources due to project operation are limited to possible oil spills. As described in Section 4.2.2, the major fresh water aquifers in the project region are overlain by 100 feet of sand and clay, effectively isolating them from surface contamination. Some local aquifers, particularly on Weeks and Cote Blanche Islands, may be more vulnerable; however, as oil is lighter than water, very little would penetrate through the shallow water table.

4.3.3 Air Quality

In this section, the air quality impacts associated with operation of the proposed oil distribution system are assessed and compared with the impacts of the barge alternative. Major differences between these two systems which affect air quality include the use of a pipeline to transfer crude oil from St. James to the sites and crude oil storage tanks at St. James. Compared to oil transport by barges, the pipeline system results in a markedly reduced hydrocarbon vapor loss in transport and transfer of the crude oil.

Before the impacts associated with the pipeline system could be compared to the impacts of the barge distribution system, it was necessary, for several reasons, to recalculate the expected emissions of hydrocarbons presented in FES 76/77-7 and FES 76/77-8. The most important reasons were significant new data on emission factors for petroleum loading/unloading from vessels and revised assumptions on crude oil vapor pressure. These new data and revised assumptions are discussed in Appendix A of this supplement. The physical and chemical bases for these rates are given in Appendix B.

The basic mode of oil transport assumed for the calculation of the pipeline system hydrocarbon emissions (and oil spill risks treated in Section 4.8) is as follows. During fill, oil would be transferred to 45 MDWT (45 thousand dead weight ton) tankers 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 Weeks Island and Cote Blanche Island.

For the barge alternative, the above transit mode is altered by the use of barges to transport the crude oil from Venice to the storage sites. Two existing 200,000 barrel surge tanks would be leased at Venice for use during the tanker-barge transfer operations.

During oil withdrawal for the proposed system, the oil would be pumped to St. James by pipeline. Approximately 75 percent of the oil would be transferred to 80 MDWT tankers for transit to the Gulf; the rest of the oil delivered to St. James would be pumped into Capline without further emissions.

For the barge alternative, the oil would be transferred to 25,000 barrel barges at the site, transported by barges through the ICW to Algiers Lock and down the Mississippi River to Venice; there the oil would be transferred through the leased storage tanks to 80 MDWT tankers for transit to the Gulf. There would be no oil delivery to Capline under this alternative.

For the purposes of this supplement, it was necessary to estimate the portion of oil stored at Weeks Island and Cote Blanche Island which would be shipped to the Gulf and the portion delivered to the Capline pipeline via St. James. 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 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. The remaining 576,000 BPD would be transported to the Gulf by tanker. Although subject to change depending on details of oil movement analyses such as matching crude oil types

*This is a worst case assumption for environmental analysis. The lower the quantity of oil transported by Capline, the greater the quantity that must be transshipped by water, with the greatly increased risk of water pollution and greatly increased air emissions attendant to water shipment.

with refinery capabilities, this assumption provides a reasonable basis for estimating oil spill risks and hydrocarbon emissions.

4.3.3.1 Leakage from System Piping and Flaring of Gases Displaced From the Storage Caverns

These impacts would be similar to those discussed in Section 4.3.3.1 of FES 76/77-7 and FES 76/77-8. The small leakage that may occur from the system of pipes, manifolds, and valves would be tightly controlled in accordance with standard practice and thus of little consequence. Flaring would occur only during the filling process and would not be affected by the selection of transportation system.

4.3.3.2 Hydrocarbon Vapors Emitted During Oil Transport

The largest potential effects on air quality associated with the operation of the proposed St. James oil distribution system would result from hydrocarbon emissions during fill and drawdown cycles. Hydrogen sulfide losses are expected to be minimal since the crude oil that is to be stored at Weeks Island and Cote Blanche Island would have weathered sufficiently during overseas transit to essentially 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. Standing storage hydrocarbon losses from the floating roof storage tanks at St. James would contribute a smaller, continuous source. These losses are assumed to be continuous during the project lifetime since the tanks and oil pipelines would probably be kept partially filled at all times.

Estimated hydrocarbon emissions resulting from operation of the Weeks Island and Cote Blanche Island storage sites are presented in Table 4.3-1 for both the pipeline and barge distribution systems. These data represent the total emissions expected over an assumed 22-year period of operation (5 fills and 5 withdrawals) based on average crude oil properties (Reid vapor pressure of 4 psia and a density of 4.5 lbs/gal for fugitive losses). During withdrawal operations, the crude oil is assumed to have an elevated temperature of 100°F (see Appendix D) as a result of salt dome heating. 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.

Tanker and barge hydrocarbon emissions in Table 4.3-1 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 the Gulf of Mexico, St. James, and the storage sites (emission factor of 0.0067 lb/hr/1000 gal during fill and 0.0118 lb/hr/1000 gal during withdrawal); 3) transfer from 45 MDWT tankers to 25,000 barrel barges (assumed to take place at Venice, 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 Weeks Island and Cote Blanche Island (emission factor of 1.65 lb/1000 gal); and 6) loading 80 MDWT tankers at St. James and Venice (emission factor of 0.63 lb/1000 gal). The emission factor for offloading barges at Weeks Island and Cote Blanche Island was assumed to be zero. Derivation of the emission factors given above is provided in Appendix C; a summary of these factors is given in Appendix A.

Standing storage vapor losses from floating roof crude oil storage tanks were estimated using the empirical equation developed in API publication 2517 (1962) and recently revised for EPA (1976(a)). The tanks were assumed to be welded tanks with a pan roof and tight-fitting seals and painted light gray or aluminum. The tanks were assumed to be 32 feet high with diameters proportional to their capacity. The emissions in Table 4.3-1 for the St. James tanks are calculated on the basis of continuous emissions during the period from 1979 to 2000 based on average crude oil properties (Reid vapor pressure of 4 psia and molecular weight of 70 for fugitive losses). Emissions for tanks at Venice are calculated only for the period of oil transport. Recent test programs indicate that API 2517 methodology overestimates standing storage losses from floating roof tanks by as much as 90 percent. Therefore, the vapor losses due to clingage of oil to the tank sides during withdrawal have been neglected.

For the proposed oil storage tanks at St. James, the standing storage loss is about 74 tons/year. During withdrawal, the expected loss would be approximately 90 tons/year due to elevated crude oil temperature. The much smaller losses from pipeline pumping operations are distributed over a large area and should not add significantly to the total at St. James. Emissions from the two-200,000 barrel onshore storage tanks leased at Venice for the barge transportation alternative would range from about 37 tons/year during fill to 40 tons/year during the 340-day withdrawal period.

Since the total expected hydrocarbon emissions from operation of the Weeks Island and Cote Blanche Island storage sites using the proposed pipeline system are only about 38 percent of those for the barge distribution system, it is apparent that the use of a 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. It can also be seen that cavern fill losses are higher than withdrawal losses for both distribution systems. This difference is due to the fact that oil would not be transferred to VLCCs during withdrawal operations.

Estimated annual average hydrocarbon emissions at St. James, Weeks Island, Cote Blanche Island, and Venice during peak fill/withdrawal operations for the proposed oil distribution system were compared to recent parish totals (EPA, 1976b). This comparison shows that the atmospheric hydrocarbon increases in each parish would be minimal for the pipeline system, but up to 60 percent of existing HC emissions for the barge alternative as indicated below:

	Peak Annual Emissions From SPR Oil Transport* (tons/yr)	Existing HC Emissions: Parish	Existing HC Emissions: Total (tons/yr)	Percent of Existing
Proposed Pipeline				
St. James	1,241	St. James:	22,870	4.6
Barge Alternative				
Weeks Island	3,084	Iberia:	5,120	60.2
Cote Blanche Island	936	St. Mary:	9,676	9.7
Venice	2,727	Plaquemine:	9,995	27.3

*See Section 4.5 for additional emissions caused by development of Bayou Choctaw.

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. Again, during withdrawal operations, the crude oil is assumed to have an elevated temperature of 100°F.

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 bbl/1000 gal); 2) 45 MDWT tanker transfer to two barges at Venice simultaneously at a rate of 12,000 B/H (emission factor of 2.25 lb/1000 gal); 3) loading three barges simultaneously at Weeks Island at a rate of 18,000 B/H and two barges at a rate of 12,000 B/H at Cote Blanche (emission factors of 1.71 lb/1000 gal); 4) loading 80 MDWT tanker at St. James at a rate of 27,600 B/H (emission factor of 0.94 lb/1000 gal); 5) transfer to 80 MDWT tankers at Venice from barges at a rate of 24,500 B/H (emission factor of 0.94 lb/1000 gal); and 6) offloading 80 MDWT tanker at St. James at a rate of 27,600 B/H (pipeline system only; emission factor of 0.66 lb/1000 gal). Emission factors were calculated assuming uncleaned tankers and barges, and using a conservative worst case Reid vapor pressure of 5 psia instead of 4 psia.

Maximum transit emissions were not calculated since they are non-point sources and occur over a large area. Worst case standing storage tank losses were calculated using the previously described methodology and tank characteristics, but using a conservative Reid vapor pressure of 5 psia and a crude oil temperature of 100°F.

The environmental impact of the computed emissions is dependent on the ambient air quality and the dispersal characteristics of the atmosphere (Section 3.4). Downwind centerline ground-level concentrations estimates were made using the model described in Appendix A. Estimates were made using maximum emission rates and 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).

Estimated maximum daily emissions from tanker transfer operations at each major source and the downwind distance over which the hydrocarbon standard would be exceeded are set forth in Table 4.3-2 for both the pipeline oil distribution system and the barge system. A comparison of these estimates shows that the results are similar for both systems. The maximum downwind distance with concentrations (3-hour average) exceeding 160 $\mu g/m^3$ would be 34 Km (21 miles) from the VLCC transfer in the Gulf of Mexico for both oil distribution systems, much of which is over water. Onshore, the maximum distance would be 16 Km (10 miles) at Venice, 17.5 Km (11 miles) at Weeks Island, and 13 Km (8 miles) at Cote Blanche Island for the barge alternative or 15.5 Km (10 miles) at St. James for the proposed pipeline system. These values are conservative since the emissions at each location were assumed to be point source releases at ground level. However, since the 3-hour hydrocarbon standard is probably exceeded quite frequently in southern Louisiana (Section 3.4.3), transfer operations would be expected to cause intermittant additional exceedances.

Concentration estimates due to crude oil storage tank emissions were made using an area source correction as described in Appendix A. The release was assumed to be elevated (32 feet) with no plume rise. Estimated "worst case" hydrocarbon concentrations corrected to a 3-hour average (EPA, 1970), at 2, 5, and 10 Km downwind are as follows:

Location	Maximum Emission Rate (g/s)	Downwind Concentrations ($\mu g/m^3$) 2 Km	5 Km	10 Km
St. James	4.28	83	23	9
Venice	2.14	43	12	5

These values are much less than the 3-hour standard of 160 $\mu g/m^3$. However, the St. James emissions occur in close proximity to Baton Rouge, which is a non-attainment area for photochemical oxidants and therefore may be sensitive to additional hydrocarbon emissions.

Presently, the only guideline which relates to hydrocarbon emissions is the Federal and State standard for photochemically reactive hydrocarbons. This standard is intended for the comparison of hydrocarbon emissions from internal combustion equipment because most often these emissions are the precursors to traffic-induced smog, but it is inappropriate as a device to estimate the relative magnitude of the impact on air quality due to elevated levels of hydrocarbons which have chemical properties different from those for which the regulation was developed. To date, emissions from crude oil transfer and storage operations are exempt from Federal and State regulations. Whether this situation would continue over the lifetime of the Strategic Petroleum Reserve program is speculative, particularly since the EPA has required Louisiana to revise its Implementation Plan for compliance with the national standard for photochemical oxidants in this area.

4.3.3.3 Emissions from Tanker Engine Exhaust

Since barges would not be used for the proposed pipeline distribution system, engine exhaust emissions would be much less than for the barge alternative assessed in FES 76/77-7 and FES 76/77-8. There it was concluded that the effects on air quality should be negligible.

4.3.4 Impacts on Noise Levels

During operations at the Weeks Island and Cote Blanche Island storage facilities, the primary noise generation would be from pumps associated with fill and discharge operations. The pumps would not contribute to the ambient sound level.

At St. James, the major noise contribution 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.

There would be no measurable effect of pipeline operations on ambient noise levels.

The utilization of a pipeline for oil transportation eliminates the need for barge traffic along the Intracoastal Waterway. The peak sound level during a barge pass-by was measured to be 63dB at 150 feet (FES 76/77-7 and 76/77-8). The equivalent sound level during a barge pass-by is estimated to be 53 dB at 150 feet for a duration of 6 minutes (FES 76/77-7 and 76/77-8). Tanker traffic on the Mississippi would be increased but the number of pass-bys would be much smaller and the noise level contribution would be less significant. Other operational activities, including traffic from commuting workers, would not be significantly affected by the choice of oil transportation system.

4.3.5 Biological Impacts of Operation

Biological impacts could result from the operation of the oil distribution facility due to possible oil spills from tanker and pipeline transport. An analysis of the expected spill risks and associated impacts is provided in Section 4.3.8.

Most other biological impacts associated with operation of the facilities would be essentially a continuation of construction impacts on land use and habitat as discussed in Section 4.3.5. Total acreage displaced by surface facilities or contained within the pipeline ROW during the lifetime of the project would be 466 acres (Table 3.6-2). Of this total, however, 146 acres are agricultural, industrial, or levee lands which would be unaffected by the ROW maintenance; 24 acres are open water which would not be affected by operations; 54 acres are bottomland forest which would be replanted or allowed to revegetate naturally; and 156 acres are swamp forest and marsh along the push ditch ROW, at least 40 percent of which should revegetate naturally. Numbers of certain prominent types of wildlife displaced from the lands expected to be permanently affected by project operations, maintenance, or initial construction are given in Table 4.2-4.

Much of the normal vegetative productivity, and therefore wildlife food supply, would be lost from the 267 acres of permanently affected lands. These lands are spread over a 67-mile corridor, however, and thus constitute a small portion of available habitat in any one locale; this productivity and habitat loss could be of local significance. The lands would be adjacent to existing terminal facilities, mine sites, or pipeline corridors, and thus perhaps of less habitat value than undisturbed areas.

To the extent that there is a long term adverse effect on hydroperiod and water circulation patterns along the pipeline corridor due to pipeline installation, vegetative productivity and/or habitat quality may be adversely affected on adjacent lands. The potential is particularly significant north of the proposed ROW within the Atchafalaya Basin. It is impossible to assess the importance of such indirect effects, but they may occur to various degrees on as much as several hundred acres of nearby swamp forest.

No attempt has been made to evaluate beneficial effects of the cleared lands. However, the boundary of two very different habitats, such as swamp and cleared pipeline ROW, provides habitat diversity in the form of an ecotone, or edge effect. Many species of birds, rabbits, small rodents, and other wildlife would be expected to utilize this land which may otherwise not inhabit the swamp forest. Also, creation of deep water canal area in the pipeline ROW within the Atchafalaya Basin (and shallow water habitat outside the basin) may significantly increase the available fishery habitat in some areas, particularly during low water periods. Spoil banks along the canals would add some diversity and have some value as refuge during flood periods.

An additional impact which would be a direct result of operating the St. James pipeline distribution system is the loss of birds from collisions with the microwave towers and guy wires which may be constructed at the storage sites. Bird mortality caused by collisions with towers and other man-made structures have been well documented (Stoddard and Norris, 1967; Stout, 1967). The majority of bird mortalities are small songbirds; few studies list waterfowl and shorebirds among the casualties (Graber, 1968), possibly because waterfowl travel by day or night while most passerine birds fly at night.

Bird mortality is particularly high during periods of spring and fall migration. As Louisiana is situated at the base of the Mississippi Flyway a considerable number of migratory birds pass through the project region (Lowery, 1974). Though most migrants fly well above man-made structures, low cloud ceilings and rain may force a reduction in altitude and increase the chance of collision. Studies have shown that mortality is as much as ten times higher during the fall than during the spring (Bremer and Ellis, 1958), possibly because of bird movements caused by southward moving cold fronts.

Isolated cases of bird mortality may be extremely high (e.g., as high as 2500 a year at one television tower in Florida (Stoddard and Norris, 1967). However, most towers associated with high mortality are very tall (900 to 1000 feet) compared to the proposed FEA towers. Even under these conditions, many ornithologists consider bird mortality caused by tower collisions to be "trivial and unimportant" (Stout, 1967; Mayfield, 1967). Visibility of structures, especially guy wires, is very important in minimizing collisions. However, most deaths occur at night when visibility is very poor. Lighting around towers increases mortality rates as birds are attracted to the area and strike the dark guy wire while circling the towers (Graber, 1968).

In summary, it may be expected that the proposed FEA microwave towers would cause a local increase in avifauna mortalities each year, mostly to small, low-flying song birds. The impact to bird populations in general and to any particular species should not be significant. This could easily be verified by occasional monitoring of the grounds around the tower and under the wires for bird count and species identification.

In comparison, the operational effects of the pipeline distribution system on biota should be greater than those of the barge alternative primarily because of the much larger acreage to be cleared and occupied and because of linear canals constructed through highly productive wetlands. Total oil spill expectation is somewhat smaller for the pipeline system and is less concentrated in aquatic or coastal marsh habitats (Section 4.3.8).

4.3.6 Historical/Archaeological Impacts

There would be no foreseeable impact on historical or archaeological resources as a result of project operation utilizing either oil distribution system.

4.3.7 Impacts on Socioeconomic Environment

During facility standby operation, approximately 10 workers would be required for maintenance and operation. During periods of oil fill and withdrawal, a total of 25 to 35 skilled laborers would be needed to carry out the oil transfer activities. For the barge transportation alternative, manpower requirements were estimated at 2 or 3 employees at each storage site during standby operations and 15 at each during fill and withdrawal. Mining operations would be unaffected by the pipeline system, whereas barging could interfere somewhat with transportation of salt from the mines.

4.3.7.1 Land Use

Acreages required for the pipeline distribution system are listed in Table 3.6-2. As indicated in Section 4.2.7, restrictions on land use within the project boundary should have little overall impact, particularly since existing rights-of-way are followed. No structure could be erected within the operational ROW but normal agricultural activities could continue unchanged. It is possible that some land may be eliminated from possible use for construction of residences or other economic purposes, but there is land available elsewhere at each crossing of the levee ridge for such development. Within wetland areas, the project continues the trend toward changing natural areas to developed land uses.

There should be no impact on secondary development due to the project as oil would be allocated by market demand rather than proximity to storage. However, if the dock facilities built at St. James are permitted to be used by private industry during standby storage, some incidental growth could result.

4.3.7.2 Transportation

There would be no significant effect on barge, rail, or highway traffic as a result of the pipeline transportation system. During oil fill and withdrawal, tanker traffic in the Mississippi would be increased by approximately one vessel per day.

Air traffic must be made aware of the existence of the microwave towers, though there are no airports near enough for them to pose a significant problem.

4.3.7.3 Impacts on Population and Housing

Operational employment should total less than 35 at Weeks Island, Cote Blanche Island, and St. James combined. Most would be local residents. No significant increase in population or housing would occur as a result.

4.3.7.4 Economy

The additional 10 permanent employees should have yearly wages of about $150,000. During oil fill and withdrawal (a 2.3-year period for each supply interruption) total wages may be $600,000. These jobs would have a beneficial, but not significant, impact on the local parish economy.

4.3.7.5 Government Revenue

Some tax revenues incidental to the new jobs and population generated by the project would accrue to local and state governments. Lands within the project boundary (Table 3.6-2) would be removed from parish property tax rolls if the Federal government should own and operate the project facilities. If owned by private industry, there could be a substantial increase in property tax revenues.

4.3.7.6 Aesthetic and Cultural Impacts

Operation of the facility should have few effects on aesthetics or cultural resources other than those caused by project construction and continued maintenance (Section 4.2.7). A possible large oil spill would have some temporary adverse effects on aesthetics if it should occur near a major waterway, near residential land, or if substantial acreage of vegetation is destroyed.

As indicated in Section 4.2.7, the microwave towers may be visible from a distance of several miles but should not be prominent enough to degrade aesthetic appearances significantly. There is little possibility for interference with local television reception because of the limited extent of microwave communications planned. Proper system design and wave length selection should avoid any problems.

4.3.7.7 Summary Comparison of Operational Impact on Socioeconomic Environment

Neither the pipeline nor barge distribution system should have a significant impact on socioeconomic conditions due to project operations. There would be more land displaced from other uses during the life of the project as a result of the pipeline system (approximately 495 acres versus 80 acres); transportation impacts should be somewhat greater with barge transportation; population, housing, and wage impacts should be approximately the same for either distribution system.

Loss of property tax revenues would be greater for the pipeline system because of the land required for pipeline ROW. Also, aesthetic impacts would be greater because of maintenance clearing through the swamp forest and near roadway crossings and residences.

4.3.8 Impacts Due to Oil Spill and Related Risks

Oil spill expectations were previously estimated in FES 76/77-7 and 76/77-8 for a combined storage capacity at Weeks Island and Cote Blanche Island of 116 million barrels of petroleum. The principal oil transport mode was by barge via the Mississippi River and ICW. In order to compare this action with the proposed pipeline to St. James, the oil spill risks have been recalculated for both systems using the oil transport system described in Section 4.3.3 of this supplement. The major difference in the barge spill risks presented here (compared to FES 76/77-7 and 76/77-8) is the assumption that oil would not be transferred to VLCCs for distribution during withdrawal. No oil is delivered to Capline for the barge alternative. The methodology used in these calculations is summarized in Appendix B.

The calculated spill expectations in Tables 4.3-3 and 4.3-4 show that differences are most pronounced between the two transportation systems for oil withdrawal. These differences are largely due to greater handling spills involved in utilization of barges compared to pipelines. During fill operation, spill risks are also greater for the barge alternative because of the risks associated with barge-tanker transfers in the Mississippi River.

The chance of a spill greater than 10,000 barrels in size is approximately three times larger for the pipeline system because of the greater use of tankers rather than barges.

The assumed average cargo is estimated to be 25,000 barrels for barges, 300,000 barrels for lighters (used during fill), and 448,000 barrels for interport tankers (used during withdrawal). These estimates represent, respectively, cargo averages for barges of 3500-3750 DWT, tankers of 45-55 MDWT, and tankers of 65-105 MDWT operating under ballast and draught restrictions.

4.3.8.1 Barge Transport

Barges were the primary mode of oil transport considered in FES 76/77-7 and 76/77-8 but would not be utilized with the pipeline system. For the barge alternative, barge spill risks are identical during fill and withdrawal and are calculated at 86 barrels in the lower Mississippi River, and 135 barrels in the ICW for each cycle. The total spill exposure is estimated to be 2210 barrels with 5.2 spills during the life of the project. The chance of a barge spill with a volume greater than 10,000 barrels is 0.5 percent during the life of the project.

Discussions of barge spill parameters and calculation methodology are provided in FES 76/77-7 and 76/77-8 and in Appendix B of this Supplement. The projected spill size probability distribution (given the occurrence of a spill) is also presented in FES 76/77-7 and 76/77-8.

4.3.8.2 Oil Spill Risk from Terminal Operations

Terminal spill risks occur with both oil distribution systems. 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 Weeks Island/Cote Blanche terminals (surface facilities) are atypically small compared to normal petroleum facilities; therefore an assumed average spill size of 500 barrels has been selected for these smaller terminals (the large underground storage at the sites is considered separately, see FES 76/77-7 and 76/77-8). 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 pipeline system is 940 barrels, compared to 600 barrels with the barge alternative. The greater total spillage for the pipeline system is primarily a result of the larger average spill size assigned to terminal operations at St. James. Spill size probability distributions for terminals are given in FES 76/77-7 and 76/77-8.

It should 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.

4.3.8.3 Oil Spill Risks from Tanker Operations

Oil tankers would be used as the mode of oil transport between the Gulf of Mexico and St. James docks for the proposed pipeline system and between the Gulf and Venice for the barge alternative. Because of the considerably longer transport distance required, spill risks would be considerably greater for the pipeline system (2550 barrels versus 540 barrels for the barge alternative). The chance of a tanker spill with a volume greater than 10,000 barrels during the life of the project is 4.35 percent for the pipeline system and 0.8 percent for the barge alternative. (Spill size probability distributions for tanker transport are provided in FES 76/77-7 and 76/77-8.)

4.3.8.4 Pipeline Spill Risks

There are no pipeline spill risks associated with the barge transportation alternative. The total expected spill exposure for the proposed 67-mile pipeline to St. James is 290 barrels for five cavern fills, 70 barrels for five withdrawals, and 415 barrels for 11.6 years of standby storage exposure. The overall probability of a pipeline spill, including the standby period, during project lifetime (assumed to be 22 years, 1979-2000) is 70 percent, with a total spillage expectation of 775 barrels.

4.3.8.5 Oil Spill Risks from Transfer Operations

The largest number and volume of oil spills expected from movement of oil for the SPR program would be caused by transfer operations.

Total spillage estimates for the proposed pipeline system during the project lifetime are 1740 barrels from VLCC-tanker transfers in the Gulf and 1445 barrels from tanker-dock transfers at St. James. For the barge alternative, estimated total oil spillage is 1740 barrels from VLCC-tanker transfers, 3480 barrels from tanker-barge transfers at Venice, and 1740 barrels from barge-dock transfers at Weeks Island and Cote Blanche Island. Avoidance of the large number and volume of spills associated with the barge-tanker transfer operation at Venice (or other location in the Mississippi River) is the major oil spill advantage of the pipeline distribution system.

Transfer spills are projected to have a maximum credible size of 500 barrels (except 1000 barrels in the Gulf) and therefore represent a (relatively) frequently recurring, non-catastrophic spill risk which would be particularly damaging in areas which are not adequately flushed or diluted with unpolluted water.

A more complete description of transfer spill risk parameters is given in FES 76/77-7 and 76/77-8.

4.3.8.6 Summary of Oil Spill Risk from Oil Transport Operations

From Tables 4.3-3 and 4.3-4, it may be seen that the maximum credible spill sizes are associated with tanker transport (60,000 barrels) and barge transport (20,000 barrels). The largest expected average spill sizes are associated with tanker transport in the Gulf (1111 barrels) and with large diameter pipeline spills (1100 barrels). The pipeline system has the greatest risk of very large spills (4.35 percent chance of a spill greater than 10,000 barrels during five fills and withdrawals versus 1.35 percent chance for the barge alternative).

The largest expected total spill volume and most frequent spill incidents are associated with transfer of oil between vessels in the Gulf (1740 barrels for both systems), in the Mississippi River (3480 barrels for the barge alternative), and between vessels and docks (1740 barrels for barge alternative and 1445 barrels for pipeline system). The total number of transfer spills is projected to be 1180 for the barge alternative and 140 for the pipeline system.

Spill risks along the ICW are only incurred with the barge alternative (except for pipeline crossings). A total of 1350 barrels are projected from 3 spills.

Spills which impact marshlands, swamp forests, or agricultural land would occur primarily with the proposed pipeline distribution system. Totals through the year 2000 are estimated to be 775 barrels, based on a 70 percent chanoe of an 1100 barrel spill occurring.

Terminal spill volume is expected to be slightly greater for the pipeline system because of the larger risk exposure at St. James. Any oil spilled should be contained with the diking system, however.

4.3.8.7 Oil Spill Risk from Cavern Storage

The chance of an oil release from the storage caverns at Cote Blanche and Weeks Islands is considered in FES 76/77-7 and 76/77-8. The risk is not affected by selection of oil transport system.

4.3.8.8 Movement and Dispersion of Spilled Oil

Considerable description of oil spill movement and dispersion for specific risk exposures is provided in Section 4.3.8.7 of FES 76/77-7 and 76/77-8. All of this material is relevant to the analysis of the candidate oil transport systems. The proposed St. James pipeline system introduces two additional significant spill exposures: tanker accidents in the upper Mississippi River and pipeline spills between the storage sites and St. James.

In the upper Mississippi, oil spills of up to 60,000 barrels are considered possible (larger spills could occur, but are so unlikely as to be a statistically insignificant risk). A slick of over 20 miles in length could be formed from such a spill but, as most of the river is well confined by steep banks, cleanup could be accomplished quickly and effectively. There would be damage to shoreline, boats, and structures and some risk of fire. Very little of the oil would reach the sensitive marshes near the Gulf.

Pipeline spills of up to 10,000 barrels are considered possible. Block valves at major stream crossings, the very low gradients along most of the ROW, and the sensitive leak detection and shutdown systems to be designed into the facility would generally limit any spills to considerably less than this amount. Spills which occur at major water bodies would normally be carried to the south and eventually to the coastal estuaries if not contained and recovered. The generally slow currents would increase the chances that effective recovery could be accomplished before transport very far downstream. However, the slow currents, meandering channel configuration, and frequent reverse flow which occurs in many of the smaller water bodies would promote maximum lateral dispersion of the oil and intensify water quality and biological impact in locations which could not be reached quickly or effectively by recovery operations.

Spills occurring in marsh or swamp forests would generally be very difficult to recover or to clean up. (An exception would be spills occurring from sections of pipeline within confined canal banks. Fast response could keep most oil from reaching adjacent wetlands.) Biological processes would likely be relied upon to break down and disperse oil which reaches swamp forest or marsh. The areal extent of coverage is dependent on soil wetness. Surface coatings and oil contaminated subsoil could be removed in agricultural areas if economically feasible.

4.3.8.9 Oil Spill Containment and Recovery Plan

Applicable requirements and an outline of a possible Spill Prevention Control and Countermeasure Plan (SPCC) are provided in Section 4.3.8.8 of FES 76/77-7 and 76/77-8. Greater emphasis would be placed on measures applicable to pipeline transport if the proposed system should be selected. Frequent over-flights of the pipeline ROW would be made to check for evidence of small leaks which are not detectable with metering equipment. Considerable technology is available to prevent and contain oil leaks from pipelines.

4.3.8.10 Effects of Oil Spills on Water Quality

A discussion of oil weathering processes which affect oil spilled in water bodies is provided in Section 4.3.8.9 of FES 76/77-7 and 76/77-8, as are typical effects on water quality at the storage sites and major inland and coastal water bodies. The most severe impacts would occur in shallow or slow moving water columns which are not well flushed. Toxic concentrations of hydrocarbons or concentrations sufficient to taint the flesh of fish and shellfish would develop in such locations. Much of the drainage area crossed by the pipeline would be subject to such impacts should a spill occur. In addition, bodies of water which are utilized as water supply sources, such as the Mississippi River, Bayou Lafourche, and Bayou Teche, could be affected. Alternative water sources might be required at some locations following a spill until petroleum concentrations fall within acceptable levels.

4.3.8.11 Biological Impacts of Oil Spills

The extensive description of potential biological impacts of oil spills contained in Section 4.3.8.10 of FES 76/77-7 and 76/77-8 for the Mississippi River, ICW, and coastal estuaries is also generally applicable to the inland waterways and swamp forests crossed by the pipeline ROW. All components of the ecosystem are vulnerable to oil damage, though sensitivity differs by species, time of year, local flushing action, amount and frequency of spill. Mobile organisms can usually avoid oil-contaminated areas, though habitat may be destroyed for several months or even years.

The type of exposure to be expected differs in accordance with the mode of transport and handling (see Tables 4.3-3 and 4.3-4). Tanker and barge casualty spills may be quite large but are relatively infrequent. In the Mississippi River and Gulf of Mexico, effects on aquatic organisms should be generally small. Coating of river banks would have locally adverse impacts but should not be regionally significant. If a large spill reaches the marshes of the Mississippi River delta, impacts could be severe but the chance of such an event is fairly low (for example 3.6 vessel casualty spills are projected to occur in the lower Mississippi or Gulf of Mexico during the project lifetime with the pipeline system; 3.1 spills are projected with the barge alternative). Effects on marsh inhabitants, such as waterfowl and fur animals, in addition to primary productivity, could be severe.

Barge spills in the ICW could also be quite large but a total of only 3 spills is expected during five fill/withdrawal cycles. Within the ICW, biological impacts should be minor. However, if oil reaches a waterway leading to the coastal bays and marshes before recovery, ecological damage could be more serious.

A pipeline spill would likely have the most intensive, localized biological impact. The recurrence interval of a spill, even with oil left in the line during standby storage is 31 years, however.

The small spills accompanying oil transfer operations constitute the vast majority of all spills expected from the SPR program (99 percent of spills for the barge alternative and 95 percent with the pipeline system). These are likely to have long-term, chronic impacts on ecological communities in the near vicinity, likely resulting in species diversity changes rather than direct lethal impacts. With appropriate deployment of booms and other oil recovery equipment, effects should be very localized. There is some potential for long-term contamination of fresh and intermediate marshes south of Venice with the barge alternative, however, as a result of frequent transfer oil spills at Venice. Effects on productivity, waterfowl, and fur bearer populations should not be significant at the oil spill rates expected.

Several scenarios are described in Section 4.3.8.10 of FES 76/77-7 and 76/77-8 to evaluate potential effects of maximum credible spills for various oil spill modes. The bases of selected maximum credible spill sizes are provided in Appendix G of those documents. Assumptions are also given for quantities of oil expected to evaporate or be recovered under the stated conditions. Biological effects are quantified on the basis of acres expected to be severely impacted using 25 barrels per acre of fresh crude causing 100 percent loss of vegetation for a period of at least two years in wetlands. In open water bodies, it has been estimated that, on the basis of a damage threshhold of 10 ppm hydrocarbon, a contamination of 6 barrels per acre could cause total loss of productivity in shallow waters (2 to 4 feet deep) for periods of two weeks to several months, depending on water circulation and species affected (Dames & Moore, 1975). Numbers of wildlife potentially affected are also considered qualitatively and quantitatively (based on typical carrying capacities) in FES 76/77-7 and 76/77-8.

Using the above oil spill damage parameters as indicators, the following impacts may be estimated. For a barge accident of 20,000 barrels (barge alternative), a possible impact on 320 acres of marsh or on 1330 acres of shallow water might result. Avifauna, fur animal and shellfish impacts should be small. However, from the vicinity of the storage sites there is a small possibility of affecting the Marsh Island Wildlife Refuge.

For a tanker accident of 60,000 barrels (both distribution systems), a possible marsh impact on 1680 acres or a shallow water impact on 7000 acres might result. Avifauna, fur animal and shellfish impacts could be severe in the lower Mississippi Delta. The Pass a Loutre Waterfowl Management Area and Delta Wildlife Refuge would be potentially vulnerable.

For an oil transfer accident of 500 barrels (both distribution systems), a possible marsh impact on 14 acres or a shallow water impact on 60 acres might result. Avifauna, fur animal, and shellfish impacts should be small. There is little chance of affecting the Marsh Island, Pass a Loutre, and Delta Management Areas.

For a pipeline spill of 10,000 barrels, assuming 20 percent lost to evaporation and none recovered, a possible wetland impact of 320 acres or a shallow water impact of 1340 acres might result. The Attakapas Outdoor Recreation Area and the southern portion of the Atchafalaya Basin are potentially vulnerable.

To provide a degree of perspective, the likelihood of these maximum credible spill accidents may be estimated based on frequencies given in Tables 4.3-3 and 4.3-4 and spill size probability distributions from FES 76/77-7 and 76/77-8. (1) For a 10,000 to 20,000 barrel barge spill, the recurrence interval for the barge alternative would be 4250 years (1 chance in 193 during project lifetime). (2) For a 50,000 to 60,000 barrel tanker spill, the recurrence interval for the proposed pipeline system would be 63,000 years (1 chance in 2850 during project lifetime); for the barge alternative, the chance would be one in 15,400 during the project lifetime. (3) For a 200 to 500 barrel transfer spill, the recurrence interval for the pipeline system would be 1430 years (1 chance in 65 during project lifetime); for the barge alternative, the chance would be 1 in 8 during the project lifetime. (4) For a pipeline spill of 5000 to 10,000 barrels, the recurrence interval for the pipeline system would be 2380 years (1 chance in 108 during project lifetime).

Thus, for both distribution systems, the chance of having a spill approaching the maximum credible size is extremely remote.

TABLE 4.3-1 Estimated hydrocarbon emissions (tons) accompanying transport of oil[a].

Location	Tankers/Barges Fills(5)	Tankers/Barges Withdrawals(5)	Storage Tanks[b]	Total[c,d]	
A. Proposed St. James Pipeline Distribution System					
Gulf of Mexico (Transfer to 45 MDWT tankers)	8,770	0	0	8,770	(11,816)
Mississippi River[e] (Tanker transit)	2,599	3,553	0	6,152	(6,152)
St. James (Load 80 MDWT tankers Offload 45 MDWT tankers)	5,116	5,756	1,716	12,588	(12,588)
Cote Blanche Island	0	0	0	0	(0)
Weeks Island	0	0	0	0	(0)
Total	16,485	9,309	1,716	27,510	(30,556)
B. Barge Distribution System Alternative					
Gulf of Mexico (Transfer to 45 MDWT tankers)	8,770	0	0	8,770	(11,816)
Mississippi and ICW[e] (Tanker/barge transit)	5,484	6,428	0	11,912	(11,912)
Venice (Barges/tanker transfers)	23,873	7,673	633	32,179	(25,724)
Weeks Island (Load 25,000 bbl barges)	0	15,419	0	15,419	(10,373)
Cote Blanche Island (Load 25,000 bbl barges)	0	4,678	0	4,678	(3,147)
Total	38,127	34,198	633	72,958	(62,972)

TABLE 4.3-1 Footnotes

[a]Average conditions assuming Reid vapor pressure of 4 psi and density of 4.5 lbs/gal for fugitive losses.

[b]Estimated to occur continuously for a 22-year period at St. James but only during tanker/barge transfer operations at Venice.

[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]A small percentage of transit emissions occur in Gulf.

TABLE 4.3-2 Estimated Maximum Daily Hydrocarbon Emissions Accompanying Transport of Oil and Distances to Which Air Quality Standards Would Be Exceeded

A. Proposed St. James Pipeline Distribution System[a]

Location	Maximum Daily[b] Emissions (lbs.)	Maximum Downwind Distance[c] Concentration Exceeds Standard (Kilometers)
Gulf of Mexico (12 miles offshore)	150,192	34
St. James	26,160	15.5

B. Barge Distribution System Alternative

Location	Maximum Daily[b] Emissions (lbs.)	Maximum Downwind Distance[c] Concentration Exceeds Standard (Kilometers)
Gulf of Mexico (12 miles offshore)	150,192	34
Venice	27,216	16
Weeks Island	31,032	17.5
Cote Blanche Island	20,688	13

[a] See Section 4.5 for emissions caused by development of Bayou Choctaw.

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

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

TABLE 4.3-3 Oil Spill Expectation - Weeks Island and Cote Blanche Island Storage Fill

Location	Proposed St. James to Weeks Island/Cote Blanche Island Pipeline Transportation System			Barge Transportation Alternative			Maximum Credible Spill (bbl)
	No. of Spills	Average Spill Size	Total Spillage Expectation	No. of Spills	Average Spill Size	Total Spillage Expectation	
Gulf of Mexico: Subtotal	21.5	17	364	21.5	17	364	
VLCC-Tanker Transfers	21.5	16.2	348	21.5	16.2	348	1,000
Tanker Casualty	0.014	1111	16	0.014	1111	16	60,000
Lower Mississippi River[a]: Subtotal	0.4	428	171	56.2	8.5	476	
Tanker-Barge Transfers	-	-	-	55.9	6.2	348	500
Vessel[b] Casualty	0.4	428	171	0.298	428	128	60,000
Upper Mississippi River[a]: Subtotal	4.55	49.5	225	0	0	0	
St. James Tanker Transfers	4.3	27	116	-	-	-	500
Tanker Casualty	0.25	428	109	-	-	-	60,000
Intracoastal Waterway: Subtotal	0	0	0	52.3	4.8	251	
Cote Blanche/Weeks Island Barge Transfers	-	-	-	52	2.2	116	500
Barge Casualty	-	-	-	0.316	428	135	20,000
Pipeline: Subtotal	0.053	1100	58	0	0	0	10,000
Terminals: Subtotal	0.116	810	94	0.116	500	60	
St. James	0.058	1100	64	-	-	-	5,000
Cote Blanche	0.013	500	7	0.013	500	7	5,000
Weeks Island	0.045	500	23	0.045	500	23	5,000
Venice	-	-	-	0.058	500	30	5,000
Total - Single Fill	26.6	34	912	130.2	8.8	1151	
Total - Five Fills	133	34	4560	651	8.8	5755	

[a]Lower Mississippi refers to section between Algiers Locks and Gulf (115 miles); Upper Mississippi refers to section between St. James Terminal and Algiers Locks (73 miles).

[b]Tankers for pipeline system; tankers and barges for barge alternative

TABLE 4.3-4 Oil Spill Expectation - Weeks Island and Cote Blanche Island Storage Withdrawal

Location	Proposed St. James to Weeks Island/Cote Blanche Island Pipeline Transportation System: No. of Spills	Average Spill Size	Total Spillage Expectation	Barge Transportation Alternative: No. of Spills	Average Spill Size	Total Spillage Expectation	Maximum Credible Spill (bbl)
Gulf of Mexico: Subtotal	0.005	1111	6	0.007	1111	8	
VLCC-Tanker Transfers	-	-	-	-	-	-	1,000
Tanker Casualty	0.005	1111	6	0.007	1111	8	60,000
Lower Mississippi River[a]: Subtotal	0.298	428	127	54.8	8.7	476	
Tanker-Barge Transfers	-	-	-	54.5	6.4	348	500
Vessel[b] Casualty	0.298	428	127	0.298	428	128	60,000
Upper Mississippi River[a]: Subtotal	2.289	111	254	0	0	0	
St. James Tanker Transfers	2.1	82.3	173	-[c]	-[c]	-[c]	500
Tanker Casualty	0.189	428	81	-	-	-	60,000
Intracoastal Waterway: Subtotal	0	0	0	52.3	7	367	
Cote Blanche/Weeks Island Barge Transers	-	-	-	52	4.5	232	500
Barge Casualty	-	-	-	0.316	428	135	20,000
Pipeline: Subtotal	0.013	1100	14	0	0	0	10,000
Terminals: Subtotal	0.116	810	94	0.116	500	60	
St. James	0.058	1100	64	-[c]	-[c]	-[c]	5,000
Cote Blanche	0.013	500	7	0.013	500	7	5,000
Weeks Island	0.045	500	23	0.045	500	23	5,000
Venice	-	-	-	0.058	500	30	5,000
Total - Single Withdrawal	2.7	183	495	107.2	8.5	911	
Total - Five Withdrawals	13.5	183	2475	536	8.5	4555	
Total - Five Fill/Withdrawal Cycles (See Table 4.3-3)	146.5	48.2	7035	1187	8.7	10,310	
Project Total with Oil Stored in Pipelines	146.9	50.7	7450	1187	8.7	10,310	

[a]Lower Mississippi refers to section between Algiers Locks and Gulf (115 miles); Upper Mississippi refers to section between St. James Terminal and Algiers Locks (73 miles).

[b]Tankers for pipeline system; tankers and barges for barge alternative

[c]For barge alternative, oil would not be delivered to Capline pipeline.

4.4 TERMINATION AND ABANDONMENT

Termination and abandonment plans are described in FES 76/77-7 and 76/77-8. The proposed pipeline to St. James would be flushed with inhibited water, capped, and left in place unless a specific hazard or interference with other land uses exists. Storage tanks at St. James would be made available for industrial use.

4.5 THE RELATIONSHIP OF THE PROPOSED ACTION TO LAND-USE PLANS, POLICIES, AND CONTROLS FOR THE AFFECTED AREAS

The only area officially designated for a specific land use which is affected by the proposed pipeline distribution system is the Attakapas Outdoor Recreation Area (Figure 2.1-2). The pipeline ROW crosses approximately 1.3 miles of the southern portion of this area adjacent to an existing pipeline canal. There would be unavoidable direct loss of habitat on approximately 22 acres due to pipeline construction of which approximately 16 acres would be permanently converted to canal and spoil banks.

The pipeline ROW and other project facilities are to be constructed adjacent to existing land uses of a similar nature. Though there would be substantial loss of wetlands, no previously undisturbed areas would be utilized. The utilization of an existing pipeline corridor is expected to be consistent with concepts likely to be included in a future Coastal Zone Management Plan.

Interaction between the Weeks Island and Cote Blanche Island storage sites for both distribution systems are included in the analysis of impacts contained in this supplement. Interactions for the barge alternative are further described in Section 4.5 of FES 76/77-7 and 76/77-8. In summary, storage site interaction for oil spills, air emissions, and barge traffic are eliminated with the proposed pipeline system. Interactions are shifted away from Venice and the storage sites to the St. James terminal and the Mississippi River. There should be much less potential for program oil transport capacity limitations with the pipeline distribution system.

Since the proposed SPR program development now utilizes a common terminal location near St. James on the Mississippi River for fill and withdrawal of the Cote Blanche Island, Weeks Island, and Bayou Choctaw oil storage sites, cumulative and interactive effects of construction and operation of these facilities must be considered. Environmental impacts of constructing and operating the pipelines which would connect these storage sites to St. James (i.e., clearing, excavation, habitat loss, changes in surface flow patterns, noise generation, and socioeconomic conditions) may be obtained from the present supplement and from the supplement to the Final EIS, Bayou Choctaw Salt Dome (FES 76-5, 1977). These effects do not interact in any significant manner.

At St. James and along the Mississippi River south to the Gulf of Mexiso, environmental effects of the proposed facilities which may have cumulative or interactive effects include construction activities at St. James and oil spills and hydrocarbon emissions associated with oil transportation and handling.

Construction of the 8-200,000 barrel oil surge tanks, as many as two tanker docks, and associated pipelines and control facilities could occur simultaneously at St. James. This would double the amount of activity occurring at the site, including numbers of workers, release of dust, noise, engine emissions, and quantities of earth movement. A 60-acre oil storage and tanker docking facility would be built adjacent to existing facilities of similar nature covering over 400 acres (Capline Terminal). The environmental effect of constructing both FEA facilities at St. James should not be significantly worse than constructing either one individually.

If salt dome storage at Bayou Choctaw is implemented concurrently with the Weeks Island/Cote Blanche Island storage sites, significant air quality interaction would occur, particularly at St. James. There would be little or no interaction at the dome sites due to the remoteness of their locations. The combined hydrocarbon emissions over a 22-year period of operation would be almost 23,000 tons at St. James for the proposed pipeline oil distribution system. Total combined emissions, including transit losses along the Mississippi River, tanker transfer in the Gulf of Mexico, and the smaller emissions at Port Allen and Bull Bay, would be approximately 52,000 tons. Comparatively, the combined emissions during a 22-year period of operation for the Addis alternative (Bayou Choctaw salt dome) and the barge alternative (Weeks Island and Cote Blanche Island) would be almost 112,000 tons. However, the only significant point source common to the three storage sites would be the Gulf of Mexico tanker transfer location.

Estimated maximum hydrocarbon emissions from tanker transfer operations at St. James, the only location where significant interaction would occur with the proposed system, are estimated to be 27.7 tons/day (291 g/s) based on the combined (Bayou Choctaw plus Weeks Island/Cote Blanche Island) emissions during withdrawal operations. Estimated maximum daily emissions in the Gulf remain unchanged; maximum transit emissions were not calculated since they are non-point sources and occur over a large area. Maximum storage tank losses, based on 8-200,000 barrel tanks, would be just over 1 ton/day (10.7 g/s).

The estimated maximum downwind distance over which the 3-hour hydrocarbon standard would be exceeded at St. James during withdrawal of all three proposed storage sites would be 27 Km (17 miles), compared to around 16 Km (9 miles) for the individual systems. This value is quite conservative since the combined tanker emissions were assumed to be point source releases at ground-level. (For this reason, the relatively small additional emissions from the storage tanks were not included in this estimate.) Nevertheless, since the 3-hour hydrocarbon standard is probably exceeded quite frequently in southern Louisiana (Section 3.4.3), transfer operations would be expected to cause intermittent additional exceedances over a relatively large area in the vicinity of St. James.

Tanker traffic and oil spill risks would be concentrated in the Mississippi River, and particularly at St. James, if the proposed storage facilities and pipeline distribution systems were constructed. Total oil spill risks may be estimated for different geographical areas by summing the predictions given in Table 4.3-3 and 4.3-4 of this supplement and Tables 3.6, 3.7, and 3.8 of FES 76-5 (1977). Total expected spill losses during project lifetime from the proposed pipeline systems are 13,000 barrels compared to 17,000 barrels for the alternative systems. Along the Mississippi River corridor, however, total spillage is nearly as great for the pipeline distribution system (11,800 barrels) as for the alternative facilities (13,500 barrels). At the St. James tanker docks, nearly 2500 barrels of oil are expected to be spilled during 5 fill/withdrawal cycles if the Bayou Choctaw, Weeks Island and Cote Blance Island sites are serviced by pipeline. During this period, total spillage at the onshore terminal (expected to occur within containment levees) would be about 1150 barrels.

Thus, development of pipeline distribution systems connecting all three storage sites with St. James would present generally somewhat less risk of water quality and biotic resources along the Mississippi River corridor than development of the alternative oil distribution systems for each site. Expected quantities of oil spilled at the St. James docks have significant potential for local contamination of the water column, substrate, and river bank during oil movement operations.

Comparing the spill impact potential occurring from development of all three storage facilities with that from development of one or two, it should be noted that marine spill risks are a function of throughput. Thus, development of Bayou Choctaw alone would represent 45 percent of total oil spills; Weeks Island would be 42 percent of total spills; and Cote Blanche Island would be 13 percent of total oil spills. The increased risk of multiple site development is a result of increased frequency of expected oil spills. Recovery of biological systems from oil spill damage is generally less complete when repeated spills occur, which indicates that the biological effect of several small spills in the same location may be greater than that of a single spill of the same total volume. Thus, biological damage from oil spills attributable to tanker operations as a result of multiple site development through a common oil terminal at St. James may increase more rapidly than the spill volume. There is no data base to quantify this potentially synergistic effect. However, assuming all three sites would be developed by one means or another, this adverse effect would appear to be more than offset due to the total elimination of the spill risk associated with the barging component of that alternative.

In summary, development of oil distribution facilities at St. James to handle oil for Weeks Island, Cote Blanche Island, and Bayou Choctaw oil storage sites would have interactive environmental impacts in the form of expanded air quality degradation at the St. James area. However, there would be an accompanying reduction in the initially projected air quality degradation in the Weeks Island/Cote Blanche Island area (due to elimination of barge operations), and in the vicinity of Venice.

4.6 SUMMARY OF ADVERSE AND BENEFICIAL PROJECT IMPACTS

Table 4.6-1 summarizes the findings of the present analysis of environmental impacts which would be caused by development of the pipeline oil distribution system. A summary comparison with impacts associated with development of the barge system alternative, considered in FES 76/77-7 and 76/77-8, is also presented.

The significantly greater amount of construction required to install a 67-mile pipeline from the storage site to St. James and to expand terminal facilities at the Mississippi River results in substantially greater potential for adverse construction impacts. Land requirements, disruption of wildlife habitat, water quality and drainage alteration, air quality, aesthetics and some other socioeconomic impacts are distributed in a narrow corridor across a broad geographical area in southern Louisiana. Many of these effects are minimized by the selection of a pipeline right-of-way which is adjacent to existing corridors throughout its length. Thus the types of impacts are not unique to the immediate area though there would be some reinforcement of existing conditions. Many of the construction impacts should be relatively short-term though, in wetlands, a 30 to 100-foot wide corridor would remain cleared of woody vegetation or converted to aquatic habitat, and restricted from many uses for at least the life of the project.

Operational impacts accompanying the barge transportation alternative would be significantly greater than with the pipeline system: oil spillage is expected to be 38 percent higher (though it would be confined principally to the ICW and lower Mississippi River, rather than having potential for spills in difficult-to-reach interior swamp forests); hydrocarbon emissions would be 165 percent higher and located principally at the storage sites, lower Mississippi River, and Gulf of Mexico, rather than at St. James and the Gulf for pipeline distribution; traffic congestion in the ICW and barge availability would be a potential delaying factor during an emergency oil withdrawal; and there would be potential interference with salt mine operation at the storage sites.

Essentially, the choice is between a capital-intensive, fairly high construction-impact system with excellent operational characteristics (the proposed pipeline distribution system) and a low-capital (but high operational) cost, minimal construction-impact system with potentially very poor operational characteristics (the barge system alternative). The choice between systems depends on the number of oil supply interruptions expected. Few interruptions may favor reliance on the existing barge and navigable waterway transportation system. Frequent interruptions, such as the five postulated for the present analysis, may favor the more efficient pipeline system.

Should future plans develop for storing even larger quantities of oil at either Weeks Island or Cote Blanche Island, barge transportation would be even less feasible and the cost per barrel of stored oil more favorable for pipeline transportation.

TABLE 4.6-1 Summary of environmental impacts associated with the proposed pipeline distribution system and comparison with the barge distribution alternative.

Subject Areas and Environmental Impact	Pipeline System Impact Evaluation	Comparison with Barge Alternative
Geology		
Construction:		
Dredging, excavation, grading.	Significant alteration of topography (1,944,000 yd^3); significant permanent alteration (1,450,000 yd^3).	Temporary and permanent impact greater than barge alternative (500,000 yd^3).
Operation:		
Erosion	Potential for significant surface and bank erosion, especially along flotation canal.	Probably less significant than bank erosion in ICW.
Hydrology		
Construction:		
1. Water quality	Significant temporary impacts on turbidity and possibly pesticides due to excavation in wetlands and dredging in water bodies; potentially significant long-term impacts depending on drainage impact.	Much greater potential than barge alternative; essentially no barge system impacts.
2. Surface drainage	Potentially significant impacts along pipeline ROW; some long-term local alteration of drainage patterns, particularly in Atchafalaya Basin.	Much greater potential; essentially no barge system impacts.
3. Ground water	No impact.	Neither system should affect ground water.
Operation:		
1. Oil spills	Some risk of oil spills affecting water quality, including water supplies in Bayou Teche, Bayou Lafourche, Mississippi River.	Less oil spillage expected; also, barge alternative effects no water supply sources.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Pipeline System Impact Evaluation	Comparison with Barge Alternative
2. Ground water	Minimal impact risk due to oil spills.	Both systems present minimal risk.
Air Quality		
Construction:	Some local, short-term impacts due to dust, engine exhaust, and paint solvents at St. James and along pipeline ROW.	Greater than barge alternative.
Operation:	Significant levels of hydrocarbon emissions in Gulf, along Mississippi River, and at St. James during oil transport; significant emissions from storage tanks at St. James during standby storage. Concentration of hydrocarbons would exceed 3-hour primary standards as far as 34 miles from VLCC transfer point in Gulf and 10 miles from St. James docks (17 miles if the Bayou Choctaw facility were also developed).	Much lower total hydrocarbon emissions (less than 40 percent of barge alternative), particularly in lower Mississippi River and at storage sites. Significantly greater impact at St. James.
Noise		
Construction:	Significant, short-term (2-3 days) impacts to as many as 250 residences along pipeline ROW. Some minor impact at St. James.	Greater than barge system alternative.
Operation:	Negligible.	Less than noise associated with barge transportation on ICW.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Pipeline System Impact Evaluation	Comparison with Barge Alternative
Terrestrial Ecology		
Construction:		
1. Habitat and productivity loss	Locally significant loss of 874 acres of habitat during construction (66% in wetlands) and 267 acres for long-term (65% in wetlands). Greatest impact to swamp forest inhabitants such as squirrels and rabbits. Some displacement of alligators.	Much greater than the 40 acres of predominantly industrial land required for barge system alternative.
2. Drainage alteration	Locally significant potential outside Atchafalaya Basin; possibly regional impact within Basin.	No barge system impact.
Operation:		
1. Microwave towers	Loss of relatively small number of birds each year due to collision with towers and guy wires; not considered significant to any resident or migrant species.	No impact with barge alternative.
2. Oil spills	Some risk to avifauna and wildlife inhabiting marsh and swamp forest along pipeline ROW.	Greater risk to swamp forest biota but less risk to marsh inhabitants than barge alternative.
Aquatic Ecology		
Construction:		
1. Habitat loss	Temporary destruction of 34 acres of substrate; possible loss of aquatic biota not regionally significant.	Approximately twice as large habitat impact as with barge alternative; habitat more productive than barge slips at storage sites.
2. Water quality	Estimated maximum temporary loss of 420 acres of productivity in water column and substrate.	Considerably greater than barge system alternative.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Pipeline System Impact Evaluation	Comparison with Barge Alternative
Operation:		
1. Oil spills	Some risk to fish and shellfish in inland and coastal water bodies.	Considerably less risk to fish and shellfish than barge system alternative.
2. Habitat	Regionally significant increase in open water habitat within Atchafalaya Basin.	No barge alternative impact.
Cultural Resources		
Construction:	Some potential for destroying unknown archaeological sites. Survey would add to knowledge of area resources.	Little to no potential for barge system impacts.
Operation:	No impact.	No impact difference.
Socioeconomic Environment		
Construction:		
1. Land Use	Significant land requirements for pipeline ROW, including 199 acres of temporary impact on agricultural land and long-term exclusion of structures from ROW. Attakapas Recreation Area crossed by pipeline.	Greater than barge system alternative which only affects industrial land at storage site.
2. Transportation	Some potential for temporary delay of highway and waterway traffic along pipeline ROW; some localized traffic congestion.	Minor barge system impact.
3. Population and Housing	Some local increase in population and demand not expected to be significant.	Greater than barge system alternanative.
4. Economy	Significant increase in local wages, estimated at $2.4 million - Beneficial impact.	Increase of approximately $2 million over barge system alternative.
5. Government Revenue	Increase proportional to increased spending of wages.	Greater than barge system alternative.

TABLE 4.6-1 Continued

Subject Areas and Environmental Impact	Pipeline System Impact Evaluation	Comparison with Barge Alternative
6. Aesthetic and Socio-cultural Resources	Some degradation to aesthetics along pipeline ROW (particularly within Atchafalaya Basin) and at storage sites due to microwave towers. Little sociocultural impact expected.	Much greater aesthetic impact than barge system alternative.
Operation:		
1. Land Use	Continued restrictions in use of land within pipeline ROW (466 acres).	No barge system impact.
2. Transportation	Insignificant increase in tanker traffic in Mississippi River.	Much smaller impact than increased barge traffic in ICW and lower Mississippi River.
3. Population, Housing, Economy	Negligible impact.	No impact difference.
4. Government Revenue	Significant loss of property tax revenue to local parishes if all project lands government owned and operated.	Substantially greater revenue loss than would occur for barge alternative.
5. Aesthetics	Some potential for impacts due to oil spills. (Also see Construction impacts)	More spills could occur over land and near populated areas than with barge alternative, less in coastal waters and marshes.

4.7 CONSIDERATIONS OFFSETTING ADVERSE ENVIRONMENTAL EFFECTS OF THE PROPOSED ACTIVITY

Effective delivery of stored crude oil to refinery and demand centers during a future oil supply interruption would greatly reduce the potential loss of national economic productivity (estimated at $35-45 billion for the 1973-74 interruption). Should barge availability or the transportation problems associated with that alternative cause a substantial delay in oil delivery, the value of the SPR facility at Weeks and Cote Blanche Islands could be substantially reduced. If a frequent, urgent need for the oil stored at these sites were to arise, the pipeline system construction costs and environmental impacts may be offset by the anticipated advantages of operational flexibility and efficiency.

SECTION 5.0

MITIGATIVE MEASURES AND UNAVOIDABLE ADVERSE IMPACTS

An extensive list of possible mitigative measures for site preparation, construction, design and operations are provided in Section 5.2 of FES 76/77-7 and 76/77-8. Impacts which are considered to be unavoidable despite mitigation efforts are also described. For the present supplement, Table 5-1 summarizes mitigative measures applicable to both the proposed pipeline distribution system and the barge alternative, as well as the unavoidable impacts which would be expected. The table is set up in a format similar to Table 4.6-1 so that the reader may cross-reference with impacts expected in the absence of mitigation measures. Details are provided in the text of Section 4.

A review of Table 5-1 indicates that most mitigative measures apply primarily to the proposed pipeline distribution system. Significant examples include revegetation for erosion control, wildlife habitat, and aesthetics; extra measures to avoid continuous spoil piles and to completely backfill flotation canals; and measures to allow local parishes to collect property taxes from the pipeline and terminal facilities. Examples of mitigating measures which could have significant effects for both alternatives are use of the most advanced dredging technology to reduce water quality impacts; providing bus transportation for construction workers where traffic congestion may be troublesome; installation of vapor recovery systems during oil transfer and water storage in oil surge tanks during standby storage for hydrocarbon emissions reduction. Furthermore, FEA is actively pursuing the possibility of using double seal floating roof tanks at the St. James terminal facility, rather than the single seal tanks required as Best Available Control Technology by the Louisiana State Implementation Plan. Recent preliminary studies performed by Chicago Bridge & Iron (1976) indicate that such tanks reduce the standby-storage loss by 75 to 90 percent of emissions from standard single-seal tanks (Chicago Bridge & Iron, 1976).

TABLE 5-1 Summary of mitigative measures and unavoidable environmental impacts (see Table 4.6-1 for primary impact)

Subject Areas and Environmental Impact	Mitigation	Unavoidable Impact
Geology		
Construction:		
Dredging, excavation, grading	Import backfill where significant depressions are left in swamp forest or marsh.	Pipeline System: Less than primary impact.
Operation:		
Erosion	Revegetation and seeding	Pipeline System: Substantially less than primary in short-term Long-term impact unaffected.
Hydrology		
Construction:		
1. Water quality	Follow most recent advances in dredging technology.	Both Systems: Some reduction from primary.
2. Surface drainage	Pile spoil on one bank only and alternate sides.	Pipeline System: Reduced temprary drainage impact
	Bring in suitable substrate to backfill canal completely; revegetate.	Pipeline System: Avoid loss of 86 acres of swamp to deep canal in Atchafalaya Basin.
	Remove existing spoil piles and backfill existing canals or provide openings in existing spoil banks south of existing canal.	Pipeline System: Improve drainage over present conditions.
3. Ground water	None	Both Systems: Same as primary
Operation:		
1. Oil Spills	Increase number of block valves; provide for suction on pipelines in case of rupture.	Pipeline System: Slightly reduced exposure to pipeline spills.
2. Ground water	None	Both Systems: Same as primary

TABLE 5-1 Continued

Subject Areas and Environmental Impact	Mitigation	Unavoidable Impact
Air Quality		
Construction:	Maintain engines; spread gravel and sprinkle roadways; use high density primers and paints	Both Systems: Somewhat less than primary impact.
Operation:	Use of a vapor recovery system at docks and at Venice transfer location.	Both Systems: Reduce transfer losses by 60 to 90 percent.
	Displace oil in tanks with water during standby storage.	Pipeline System: Eliminate St. James tank emissions during standby storage.
	Use double-seal floating roof tanks for oil storage at St. James.	Pipeline System: Reduce hydrocarbon emissions from storage tanks by 75 to 90 percent of estimates.
Noise:		
Construction:	None	Both Systems: Same as primary
Operation:	None	Both Systems: Same as primary
Terrestrial Ecology		
Construction: 1. Habitat loss	Backfill imported material to prevent creation of deep canal; seed with native vegetation.	Pipeline System: Avoid 86-acre canal in Atchafalaya Basin; reduced erosion and improved habitat recovery.
2. Drainage alteration	Remove existing spoil banks and backfill existing canals; provide breaks in existing spoil banks.	Pipeline System: Improve existing wetland habitat to the south.

TABLE 5-1 Continued

Subject Areas and Environmental Impact	Mitigation	Unavoidable Impact
Operation:		
1. Microwave towers	Improve visibility of guy wires. (Note: lighting attracts birds and increases mortality)	Pipeline System: Reduce daytime collisions only; predominant nighttime collisions unaffected.
2. Oil spills	Increase number of block valves	Pipeline System: Slight reduction in oil spill risk to wildlif
3. Ground surveillance	Avoid swamp buggy surveillance in swamp forest and marsh.	Pipeline System: Avoid continuing destruction of wetland vegetation in pipeline ROW.
Aquatic Ecology		
Construction:		
1. Habitat loss	None	Both Systems: Same as primary
2. Water quality	Follow most recent advances in dredging technology	Both Systems: Some reduction from primary impacts.
Operation:		
Oil Spills	None	Both Systems: Same as primary.
Cultural Resources		
Construction:	None	Both Systems: Same as primary.
Operation:	None	None
Socioeconomic Environment		
Construction:		
1. Land Use	None	Both Systems: Same as primary.
2. Transportation	Contractors provide bus or other transportation of construction workers.	Both Systems: Reduced traffic congestion.
3. Population and Housing	Maximum effort to hire local workers; provide portable housing.	Both Systems: Reduced housing demand.

TABLE 5-1 Continued

Subject Areas and Environmental Impact	Mitigation	Unavoidable Impact
4. Economy and Government Revenue	Maximum effort to hire local workers.	Both Systems: Increased local economic stimulus.
5. Aesthetic and Sociocultural Resources	Maximum possible retention of existing vegetation in populated areas; revegetation and landscaping in sensitive, high visibility areas.	Pipeline System: Greatly reduced aesthetic impact.
Operation:		
1. Land use, transportation, population and housing	None	Both Systems: Same as primary.
2. Government Revenue	Provide for industry ownership of facilities	Both Systems (especially pipeline): Increase local property tax revenues.
3. Aesthetics	None	Both Systems: Same as primary.

SECTION 6.0

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

6.1 BENEFICIAL ASPECTS OF SHORT-TERM USE OF THE ENVIRONMENT

Both oil transportation systems have as their purpose the effective movement of crude oil to and from storage in mined salt caverns at Weeks Island and Cote Blanche Island as part of the Strategic Petroleum Reserve Program. The most critical period of the transport operation is the delivery of oil to existing distribution systems for use during a national emergency caused by a foreign oil supply interruption. Oil stored in the Weeks and Cote Blanche Island caverns is planned to be withdrawn over a period of 150 days to meet expected national demand for petroleum products.

The pipeline distribution system provides a direct link to the Capline pipeline, which delivers oil to refineries in the Midwest, and to a terminal on the Mississippi River, which can load oil tankers for delivery to Gulf Coast or other U.S. ports. The pipeline system is designed to handle the 773,000 BPD flow rates required to deliver the entire 116 MMB planned storage capacity to St. James in 150 days. Filling of the storage sites could be accomplished at rates limited only by available supply. This system thus has the capacity and flexibility to meet the purposes of the Program.

The barge distribution alternative has an inherent limitation to its oil movement capacity because of the limited availability of barges and the very high traffic levels at barge transfer points. Barge availability fluctuates with local and national economic conditions and material demands. Under conditions of a national oil supply emergency, many more barges could probably be used to transport oil than would be available under business-as-usual conditions. At present, it appears that a reasonable maximum availability of the equivalent of 70-25,000 barrel barges could be put in use during withdrawal. Using a tanker-barge transfer location at Venice in the lower Mississippi River, it is estimated that 341,000 BPD could be transported from the sites; total oil withdrawal could not be accomplished at this rate in less than 11 months, or twice the Program delivery period. It may be possible to identify a suitable terminal for tanker-barge transfers closer to Algiers Lock; this would reduce the round-trip time for barging to the storage sites, but would require more than 15 barges being loaded and unloaded at the storage sites each day (31 barges for a 150-day withdrawal rate).

Thus, unless the 150-day withdrawal period is extended for the Weeks Island and Cote Blanche Island sites, the barge transportation alternative does not meet project goals as effectively as the proposed pipeline system.

6.2 ADVERSE IMPACTS ON LONG-TERM PRODUCTIVITY OF THE ENVIRONMENT

6.2.1 Geology

There are no significant geologic impacts on long-term productivity with either oil distribution system.

6.2.2 Hydrology

The only long-term hydrologic impacts on productivity expected to result from the oil distribution system would be impacts caused by permanent alteration of surface drainage or by accidental oil releases. Construction of the pipeline would reinforce existing disturbances in natural circulation within the wetlands and may cause a general decrease in primary productivity and habitat quality. As the pipeline ROW follows existing pipeline corridors for its entire length, very little new disturbances should be caused. The most likely location for reinforcing existing problems would be in the swamp forest of the Atchafalaya Basin where the flotation canal construction method would leave a relatively deep canal. There should be no long-term impact due to construction outside the wetlands for the pipeline system or due to construction of the barge alternative.

Long-term oil pollution impacts could result from chronic oil releases in a specific location or from a massive oil spill, either of which could contaminate soil and substrate and create a continual pollution source. Water quality effects should not last beyond a few years after the last major oil release, however.

6.2.3 Air Quality

The only possible long-term effect on productivity due to air quality impacts would be possible future exclusion of new industries or industrial expansion in the vicinity of the project because of non-attainment of air quality standards. As the only continuous source of emissions would be tanks at St. James, the areal extent of such a restriction would likely be very small.

Air quality degradation caused by the SPR project is not expected to affect biological productivity in the area.

6.2.4 Ecology

Long-term biological impacts would result from the loss of over 250 acres of habitat for at least the life of the project with the pipeline system and alteration of circulation patterns on adjacent land. The pipeline ROW would support some species diversity as an ecotone between swamp forest and cleared lands, however, so habitat losses would not be total. After the project is terminated, revegetation of native species would be allowed as long as the pipeline is not used for other purposes. The 86 acres of ROW within the swamp forest of the Atchafalaya Basin is expected to remain an open canal permanently; this represents a locally significant loss in primary productivity.

The barge alternative involves construction of dock facilities on approximately 20 acres of land adjacent to the ICW at the storage sites. This land is currently very low quality habitat; its use does not represent a significant loss in productivity.

Long-term impacts on aquatic productivity could result from water quality effects described in Section 6.2.2. Poor circulation or altered drainage patterns could cut off nursery grounds or reduce food supplies. Oil coating of vegetation, shellfish beds, and mud flats could reduce fish populations locally, but again this condition should not continue indefinitely.

6.2.5 Socioeconomic Environment

There is no foreseeable long-term adverse impact on socioeconomic conditions as a result of either the proposed oil distribution system or the barge system alternative as long as no serious loss in natural resources occurs.

SECTION 7.0

IRREVERSIBLE AND IRRETRIEVABLE COMMITMENT OF RESOURCES

Table 7-1 presents a summary of irreversible and irretrievable committments of resources considered to be associated with development of the barge and pipeline oil distribution systems. Material and natural resource commitments are listed for the categories of land, water, air, material, energy, labor, and biological resources.

Alterations to land use which are likely to be permanent and (economically) irretrievable would affect approximately 122 acres of land for the pipeline system compared to about 23 acres for the barge alternative. No irreversible or irretrievable air or water resource commitments are expected. A significant commitment of steel for underground pipelines and surface tanks is required for the pipeline system. Both distribution systems would utilize large quantities of energy, primarily for oil transport and handling, but the total requirements for either system would be less than 1 percent of the total potential energy storage capacity. A great deal more manpower is required to construct the pipeline transport system.

Biological resource commitments are, in part, proportional to land impacts and, in part, proportional to oil spill volume expectation. Assuming that adjacent lands are at full carrying capacity (worst case impacts), biotic populations displaced from the facility lands would be lost. Table 4.2-3 provides an estimate of the wildlife lost with the pipeline system temporarily (a few weeks in cleared lands to a few years in wetlands) and for the project lifetime (20 to 25 years). In addition, lands which are irretrievably committed (Table 7-1) would lose their value as wildlife habitat for the foreseeable future.

In summary, the major difference in resource commitments for the two oil distribution systems is the additional land required for construction of the pipeline distribution system. This commitment does not appear to be significant in view of the large regional land resource base.

TABLE 7-1 Irreversible and irretrievable commitment of resources.

Resource Type	Resource Commitment: Pipeline System	Resource Commitment: Barge Alternative
Land	St. James tanker terminal: 25 acres agricultural St. James tanker dock: 1 acre bottomland forest, 2 acres river levee. Storage site pump stations: 8 acres industrial. Flotation canal: 86 acres swamp forest	Barge slips: 15 acres Storage site pump stations: 8 acres industrial
Water	None	None
Air	None	None
Material		
Steel	32,000 tons	0
Concrete	400 tons	200 tons
Energy	Oil Transport and Handling: 4,088,000 bbl Construction: 233,000 bbl Atmospheric Emissions: 183,400 bbl Oil Spills: 7,500 bbl 4,511,900 bbl (0.78% of total potential storage capacity)	4,265,500 bbl 1,200 bbl 496,200 bbl 10,300 bbl 4,773,200 bbl (0.82% of total potential storage capacity)
Construction Labor	1390 man-months	300 man-months
Biota	Table 4.2-4 indicates losses from direct construction impacts for periods of up to several years on 840 acres, and up to 25 years on 267 acres. Permanent losses would be incurred on the 122 acres of irretrievable land commitments listed above. Locally high potential for habitat and biotic losses in case of persistent or large oil spills.	Negligible loss from construction; 23 acres of disturbed canal bank and industrial land. Locally high potential for habitat and biotic losses in case of persistent or large oil spills.

SECTION 8.0

ALTERNATIVES TO THE PROPOSED ACTION

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

No-action is not considered to be an alternative to the proposed distribution system; no-action is an alternative to the development of the entire Weeks Island or Cote Blanche Island oil storage system and is discussed in FES 76/77-7 and 76/77-8.

8.1 ALTERNATIVE MODES OF 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 Weeks Island and Cote Blanche Island storage sites by means of barges, tank trucks, railroad tank cars, or a pipeline connecting the sites with an offshore tanker terminal (monobuoy system). These modes of transportation would avoid the need to build a pipeline to the Mississippi River.

8.1.1 Tank Trucks and Unit Trains

Several of the alternative transportation modes cannot be considered feasible alternatives by themselves. 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 Weeks Island and Cote Blanche Island storage caverns would require about 892,000 one way truck trips; a similar number of trips would be required for each withdrawal of 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 sites and St. James. These trains are primarily used for routes much longer than the 67-mile distance between Weeks and Cote Blanche Islands 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 15 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 pipelines for distances of less than several hundred miles when large volumes of oil such as those required in the SPR program are considered.

8.1.2 Barges

Barge transportation, using 20,000 to 30,000 barrel capacity inland waterway barges, was the proposed method of oil transportation considered in FES 76/77-7 and 76/77-8. Impacts associated with this alternative have been summarized and compared to those of the proposed pipeline system in Sections 1 through 7 of this supplement.

Other barge transportation modes could be used to supplement the proposed system. Sea-going barges could transport oil between the storage sites and tankers in the Gulf of Mexico via the lower Atchafalaya River. As these barges have a greater draft than inland waterway barges, a special barge slip would have to be excavated adjacent to the ICW north of Cote Blanche Island and a pipeline would be installed across the island to connect with the storage facility. There are not many sea-going barges available for use in oil transport. Assuming ten 25,000 barrel capacity barges could be made available, approximately 80,000 BPD could be withdrawn from storage by this method. For further details, see Section 8.2.4.1 of FES 76/77-7 and 76/77-8.

Small (10,000 barrel capacity) inland waterway barges could be used to increase the total barge transportation capacity during oil withdrawal. However, the very great traffic levels which would result would create delays which may offset the higher potential transport capacity. Use of small barges is expected to have only limited applicability for SPR oil movement from Weeks and Cote Blanche Islands.

8.2 ALTERNATIVE TERMINAL LOCATIONS

Alternative storage site locations are described in Section 8.2 of FES 76/77-7 and 76/77-8. Alternative locations also exist for the St. James pipeline/tanker terminal and the Venice barge/tanker transfer terminal.

8.2.1 Alternative Oil Distribution Terminal on Mississippi River

The proposed terminal location at St. James provides the flexibility of oil delivery to Capline or to sea-going tankers and allows the use of existing terminal facilities during emergency oil withdrawal as a potential supplement to FES-constructed facilities. St. James is also one of the closest locations on the Mississippi River to the storage sites. Selection of any other terminal location on the Mississippi River would thus either eliminate the direct tie-in with Capline or require tanker or barge transport to St. James to achieve such a tie-in. It would also probably require a longer pipeline and would not afford the flexibility of utilizing existing, large volume oil terminal facilities in case of a national emergency.

8.2.2 Offshore Terminal and Pipeline System

Another possibility would be to construct a pipeline to connect with an offshore monobuoy facility in the Gulf of Mexico (Section 8.2.4.3, FES 76/77-7 and 76/77-8). If this facility were used for oil withdrawal only, no pumping platform would be required and construction costs would be principally those of a 60 to 65-mile pipeline out to a water depth of 60 feet or more. Barge transport could be used for oil fill. If oil fill were also made through this terminal, a pumping platform would be required.

Environmental effects of constructing a marine terminal would be primarily of temporary duration. Very little wetland habitat would be affected, though the West Cote Blanche Bay and shallow offshore Gulf would be crossed. Oil spill and hydrocarbon emissions would be considerably lower because the tank and transfer emissions at St. James would be avoided. Oil spill exposures would be to shallow offshore waters, coastal marshes, and deep Gulf waters, rather than inshore wetlands and navigable waterways.

Two disadvantages to use of an offshore terminal would be the loss of flexibility for delivery of oil to Capline and the need to obtain a Federal license for deepwater port construction and operation. Should sufficient oil storage capacity be made available in other locations closer to St. James to supply the anticipated Capline and southeastern Louisiana demand, the first disadvantage would not be important. If the offshore terminal were used only for withdrawal purposes or for withdrawal and refill purposes, the initial fill could be made by barge though greatly expanded barge facilities would be required at the storage site. The offshore terminal and pipeline could probably be licensed and constructed in time for withdrawal as early as 1980 or 1981.

8.2.3 Alternative Tanker-Barge Transfer Terminal Location

A location could be selected closer to New Orleans for the tanker-barge transfer terminal needed for the barge transport alternative. Venice is approximately 87 miles below Algiers Lock; this is considered a worst case location for barge transportation impacts. A terminal location near New Orleans would reduce the average barge round-trip time to the storage sites from about 125 hours to perhaps 85 hours. For this case, assuming terminal facilities and traffic levels do not cause further delays, a 70 barge fleet could withdraw oil at a rate of about 500,000 BPD. Total withdrawal could be accomplished in about 230 days compared to 340 days with a terminal at Venice and 150 days for the SPR program plan. A 500,000 BPD withdrawal rate would require loading 20 barges per day at the two storage sites, offloading 20 barges per day to tankers at the Mississippi River terminal, and having 70 barges continually in transit between these two locations.

8.3 ALTERNATIVE PIPELINE ROUTE TO ST. JAMES

An alternative pipeline route between Weeks Island/Cote Blanche Island and St. James was selected for evaluation of environmental impacts. This route avoids crossing sensitive wetlands to the maximum possible extent (Figure 2.1-2) by paralleling the natural levee along Bayou Teche to Morgan City instead of crossing the Atchafalaya Basin directly. The route parallels existing pipeline, railroad, or highway rights-of-way for virtually the entire 79-mile distance to St. James.

8.3.1 Description of Bayou Teche Alternative Route

The Bayou Teche alternative pipeline route is identical to the proposed Atchafalaya route from the storage sites to a point just north of Cote Blanche Island (Figure 2.1-2). From there the pipeline route crosses intermediate marsh north of and parallel to the ICW, crossing Hog Bayou, Bayou Gregorie, Bayou Chopique, the Charenton Drainage and Navigation Canal, and the southern edge of Mud Lake. The route then follows the Franklin Canal north into swamp forest, crossing several drainage canals to the east and reaching the southern flank of the Teche ridge (levee) just south of Garden City. From there, the ROW parallels the Southern Pacific Railroad (SPRR) on the south through alternating segments of swamp forest and levee ridge agricultural lands, crossing Bayou Sale, Yellow Bayou Drainage Canal, Wax Lake Outlet, Bayou Patterson and Little Bayou Black. Just east of the city of Berwick, the route crosses the SPRR and U.S. Highway 90 to the north onto agricultural land, then turns east to cross the Atchafalaya River and the East and West Atchafalaya Basin Protection Levees. The pipeline then parallels the East Protection Levee and State Highway 70 on the east through swamp forest, across the west edge of Lake Palourde, then north through swamp forest just west of a new community which has developed along Highway 70. The route continues to parallel Highway 70 just east of the toe of the East Protection Levee at the edge of the swamp forest, then turns northeast across Belle River and Lake Verret onto the north flank of a small natural levee ridge formed by Bayou Attakapas, continuing across agricultural land, Highway 268 and the Attakapas Canal onto the Lafourche

Ridge just south of Napoleonville. At Napoleonville, the route crosses Highway 1, Bayou Lafourche, and Highway 308, then continues northeast through agricultural land to the Baker Canal. From this point the route parallels the west bank of the Baker Canal north through drained swamp forest and turns northeast to join the Atchafalaya Route near the La Pice Oil and Gas Field.

Lengths of the various types of terrain crossed by the alternative Bayou Teche pipeline alignment between the storage sites and St. James are approximately:

Cleared Levee (Agriculture)	26.0 miles
Intermediate and Fresh Marsh	12.1 miles
Open Water	4.1 miles
Swamp Forest	24.6 miles
Bottomland Forest	11.6 miles
Industrial Land (Weeks and Cote Blanche Islands)	0.6 miles
TOTAL	79.0 miles

There are 23 major waterway crossings (bayous, canals, lakes, and rivers), 7 railroad crossings, and 7 highway crossings (excluding local roads). The route passes within 2 miles of 26 communities, principally along Bayou Teche and Bayou Lafourche; it crosses Iberia, St. Mary, St. Martin, Assumption, and St. James Parishes, and the same drainage basins as the proposed Atchafalaya Basin route.

Table 8.3-1 indicates the acreages of various habitat types affected by the several components of the oil distribution system using the Bayou Teche ROW. Facilities at Weeks Island, Cote Blanche Island, and St. James would be unaffected by the choice of pipeline ROW. No pump station is anticipated. Construction right-of-ways would be the same as for the proposed alignment: 75 feet construction ROW and 50 feet permanent access ROW. No flotation canal construction is necessary because the Atchafalaya Basin wetlands are avoided.

Because the Atchafalaya Basin Floodway is only crossed at Wax Lake Outlet and at Morgan City, timing of construction to coincide with specific water levels in the swamp would not be as critical as with the proposed alignment. Overall construction time should be affected very little by the slightly longer route, though pipeline costs would be higher by about 20 percent. Land would probably be more difficult to purchase because the route passes along the southern flank of the Teche Ridge, which is the principal locus of development in this part of Louisiana. Access to construction sites would be generally more convenient. The segment of pipeline crossing the Protection Levees at Morgan City may have to be replaced in the near future as the levee is expected to be modified.

Oil movement capacities and operations would be identical for either pipeline route.

8.3.2 <u>Existing Environment Summary</u>

Information provided in FES 76/77-7 and 76/77-8 and in Section 3 of this supplement gives a basic description of the existing environment along the Bayou Teche pipeline route. Basically the route crosses a greater length of intermediate marsh (adjacent to existing canals) along the north shore of West Cote Blanche Bay; parallels a railroad right-of-way along the southern flank of a major development corridor to Morgan City; avoids crossing the biologically productive Atchafalaya Basin Floodway swamp forest (though it does cross Lake Palourde near the west shore and cuts through swamp forest just east of Highway 70); and crosses the middle of Lake Verret and some high quality swamp along the shoreline (following an existing pipeline ROW). The Bayou Teche route does not cross any wildlife refuges or game management areas but does pass very close to Lake End Park and C. R. Brownell Memorial Park just north of Morgan City.

8.3.3 <u>Environmental Impacts of Construction and Operation</u>

A summary of significant environmental impacts expected to accompany construction and operation of the Bayou Teche pipeline alternative is presented in the following subsections. Emphasis is placed on pipeline route construction as the terminals and all operating procedures would be identical to those previously described for the Atchafalaya Basin Route. A summary comparison of impacts for the two proposed routes is provided in Section 8.3.3.10.

8.3.3.1 Geology and Topography

Construction methods employed for pipeline installation would consist of dry land and conventional push ditch techniques (Figure 2.3-3 and Section 2.3.3.2). Excavation for push ditch pipeline installation would involve approximately 477,000 cubic yards (cy) in the swamp forest, 242,000 cy in intermediate marsh, and 76,000 cy in open water (total of 795,000 cy). Excavation for conventional dry land pipeline installation would involve approximately 95,000 cy in bottomland forest, 213,000 cy in agricultural land, and 5,000 cy in industrial land (total of 313,000 cy). Backfilling may take from one to three weeks on dry land and as long as 3 months, depending on weather, in wetlands. As much as 400,000 cy of spoil volume could be lost before backfilling the conventional push ditch, leaving a shallow depression along portions of the ROW.

Operational impacts would be negligible.

8.3.3.2 Hydrology

Water quality impacts associated with dredging and excavation in the wetlands and water bodies would be similar to those described for the Atchafalaya Route outside the Basin (Section 4.2.2). The primary difference would be the lack of need to construct flotation canals. More water bodies and approximately the same mileage of wetlands would be crossed along the Bayou Teche ROW. Adverse impacts due to drainage and circulation changes should be lower because the wetlands crossed are generally of lower quality, no deep canals would be left without backfilling and, as with the proposed route, existing development corridors would be followed throughout most of the ROW.

Operational impacts would be very similar to those with the proposed route. The Bayou Teche route is nearly 20 percent longer, but crosses approximately the same length of aquatic and wetland habitat. Also, Bayou Teche is not crossed and thus its water supplies would not be affected by any possible oil spill.

No significant ground water impacts are anticipated.

8.3.3.3 Air Quality

As the Bayou Teche route is 20 percent longer than the proposed route, air emissions associated with construction activities and transportation of workers would be slightly larger than those of the proposed alignment. Also, more construction activity would take place along existing development corridors; therefore construction emissions would be more noticeable to the local population. This impact is not considered significant, however.

There would be no measurable difference in air emissions during oil transport and storage between the two pipeline alignments.

8.3.3.4 Noise

Noise accompanying construction of the Bayou Teche pipeline would be heard along the Teche Ridge, especially where Highway 90 parallels the SPRR and where the ROW skirts the western and northern edges of the cities of Berwick and Morgan City. Noise levels would also be elevated along Highway 70 and on the Lafourche Ridge, particularly at Napoleonville. Although recent aerial photographs were not available for inspection, it is estimated that at least 1000 residences would be within 500 to 2000 feet of the ROW and thus would experience daytime equivalent sound levels of up to 68 dBA for several days each as construction passes through the area.

There would be no impact on noise levels due to pipeline pumping.

8.3.3.5 Ecology

Construction of the pipeline along the Bayou Teche ROW would disturb 907 acres of land for equipment access and pipeline excavation (Table 8.3-1). Approximately 37 percent of this land would be swamp forest, 12 percent bottomland forest or drained swamp, 17 percent intermediate marsh, 30 percent agricultural land, 4 percent open water, and a few acres of industrial land on the islands. A total of 479 acres would be within the permanent access ROW and thus subject to continuing habitat impacts (350 acres of this total is expected to be suitable for revegetation and thus not subject to significant long-term habitat impacts).

Estimated numbers of selected wildlife which could be displaced by the oil distribution system using the Bayou Teche pipeline ROW are listed in Table 8.3-2 using the same population density estimates as used in Table 4.2-4. Assuming these average population densities apply to both routes, direct short-term swampland and other forest impacts would be 25 percent smaller, short-term agricultural land impacts would be 50 percent greater, and short-term marsh fauna impacts would be three times larger than the Atchafalaya Basin route. Long-term impacts to swamp forest wildlife would be less than half those of the Atchafalaya Route; long-term marsh impacts would be three times larger. Neither route passes closer than 3 miles to known eagle nests or wading bird colonies (Personal communication, Ron Fowler, U.S. Fish and Wildlife Services, 1977).

However, as indicated previously, all habitat is not of equal productivity or of equal utility to wildlife. An advantage of the Bayou Teche route is that the very productive high quality cypress-tupelo swamp land east of Grand Lake within the Atchafalaya Basin Floodway would not be crossed. Generally, swamp along the Bayou Teche route is of lower quality with the possible exception of the area around Lake Verret.

In general it is expected that swamp forest impacts would be significantly less severe with the Bayou Teche route, marsh impacts would be significantly more severe, and short-term disturbances to agricultural lands would also be more severe.

There are more waterbodies, and 60 percent more open water is crossed, along the Bayou Teche ROW. Many of these water bodies are narrow drainage canals which are not high quality aquatic habitat. Also, there is no potential for affecting drainage and circulation patterns in the Atchafalaya Basin Floodway. Aquatic impacts are considered to be slightly more severe for the Bayou Teche route.

Ecological impacts of project operation should be very similar for the two pipeline routes. The longer pipeline length for the Bayou Teche alternative implies a 20 percent greater exposure to oil spills, which is estimated to result in an additional 155 barrels of oil released during the project lifetime.

Terrain crossed by the Bayou Teche ROW would not be significantly different in sensitivity to oil spill damages than that of the Atchafalaya Route. Access to a spill from the Bayou Teche route would be generally better; however, a spill would be more likely to reach coastal bays and marshes.

Differences in oil spill impact damage potential for the two routes are not considered significant.

8.2.3.6 Historic, Archaeological, and Recreation Impacts

The potential for uncovering archaeologically significant sites along the Bayou Teche route is considered to be similar to that along the Atchafalaya route except that the former ROW is 20 percent longer.

No recreational lands would be crossed by the Bayou Teche ROW though it would pass very close to two parks on the shore of Lake Palourde north of Morgan City.

8.3.3.7 Socioeconomic Environment

Land use impacts of the Bayou Teche pipeline route alternative are shown in Table 8.2-1. Comparing with Table 3.6-2, it may be seen that the greatest effect on economically developable land would be a 51 percent increase in temporary impacts to agricultural land and a 41 increase in agricultural acreage on which land use restrictions would prevent construction of any permanent surface structures. Most other lands affected by the project are not likely to be developed for residential, industrial or commercial purposes because of drainage and foundation problems. No land presently used for residences or business purposes (other than farming) would be affected by either route.

As more transportation arteries would be crossed by the Bayou Teche pipeline route, temporary construction impacts should be somewhat more severe. There would also be more traffic congestion generated, particularly along Highway 90 and near the cities of Berwick and Morgan City.

Although perhaps 10 percent more man-months of labor would be required for the Bayou Teche alternative due to greater pipeline length, impacts on local population and housing should be little different from those of the proposed route. Operational employment would be unaffected.

The slightly greater labor requirements of the Bayou Teche route would have a small additional beneficial impact on local wages and government revenues. However, more land, of considerably higher property value, may be removed from the parish tax rolls if the facilities are owned and operated by the Federal government.

Because more of the Bayou Teche ROW is near populated areas, the aesthetic impacts of construction would be more noticeable. However, except for the area around Lake Verret and Lake Palourde, the aesthetic quality of lands crossed by the ROW are generally lower than along the proposed alignment.

8.3.3.8 Oil Spill Potential

As indicated in Section 8.3.3.5, pipeline oil spills would be approximately 20 percent higher for the Bayou Teche route. This would be an increase of only 2 percent in total projected spills for the life of the project (Table 4.3-4). The difference is insignificant. The average and maximum credible spill sizes would be unaffected.

8.3.3.9 Irreversible and Irretrievable Resource Commitments

Land use commitments at St. James, Weeks Island, and Cote Blanche Island would total 36 acres, substantially less than for the proposed route (Table 7-1), because of the lack of flotation canals. Irretrievable losses of intermediate marsh would be 44 acres, which is nearly three times that of the Atchafalaya Basin route.

Water and air resources would not be irreversibly affected by either pipeline route.

An estimated 37,000 tons of steel would be required for facility construction, 16 percent more than for the proposed route. An estimated energy equivalent of 4.675 MMB of oil would be required to build and operate the SPR facility with the Bayou Teche ROW, which is an increase of 4 percent over that with the Atchafalaya alignment.

Labor commitments for construction would be 10 to 15 percent greater for the Bayou Teche route.

Biological resources, measured in numbers of individuals on the basis of average carrying capacities, would be generally lower than the Atchafalaya Basin route, primarily because of reduced swamp forest construction. Impacts to marsh and agricultural land would be increased, however.

8.3.3.10 Summary Comparison of Pipeline Route Impacts

Table 8.3-3 provides a summary comparison of environmental impacts expected to occur with development of the two pipeline alignments shown in Figure 2.1-2. The Atchafalaya Route appears to be preferable from the standpoint of socioeconomic and noise impacts, involves considerably less pipeline construction and capital investment, and ROW access is expected to be more easily obtained. The Bayou Teche Route involves less permanent alteration of terrain, less potential for changing surface water hydrology, and less total direct impact (both short and long-term) on wildlife habitat. There is no significant difference in expected impacts on air quality, oil spills, cultural resources, and irreversible resource commitments. Basically, the comparison is between a greater socioeconomic impact during construction of the Bayou Teche route versus a potential for greater impacts on the hydrology and ecology of high quality swamp forest in the southeastern Atchafalaya Basin Floodway for the proposed route.

TABLE 8.3-1 Direct acreage[a] impacts required for alternative Bayou Teche oil distribution system

Facility	Deciduous Swamp Forest		Bottomland Forest		Intermediate Marsh		Agricultural Land		Industrial Land		Levee Land		Open Water		Total Facility Impacts	
	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.	Const.	Oper.
Pipeline ROW[b]																
Dry Land[c]	12	8	109	70	-	-	236	158	6	4	-	-	5	3	364	243
Push Ditch[d]	212	141	-	-	110	73	-	-	-	-	-	-	33	22	355	236
Open Water[e]	120	0	-	-	40	0	40	0	-	-	-	-	-	-	200	0
(Subtotal)	(332)	(149)	(105)	(70)	(150)	(73)	(276)	(158)	(6)	(4)	(0)	(0)	(38)	(25)	(907)	(479)
Storage Terminal																
Cote Blanche	-	-	-	-	-	-	-	-	4	4	-	-	-	-	4	4
Weeks Island	-	-	-	-	-	-	-	-	4	4	-	-	-	-	4	4
(Subtotal)									(8)	(8)					(8)	(8)
St. James Terminal																
Storage Tanks	-	-	-	-	-	-	25	25	-	-	-	-	-	-	25	25
Dock/pipeline	-	-	1	1	-	-	-	-	-	-	2	2	-	-	3	3
(Subtotal)			(1)	(1)			(25)	(25)			(2)	(2)			(28)	(28)
Total Land Use Impacts	332	149	106	71	150	73	301	183	14	12	2	2	38	25	943	515

[a]Habitats determined by analysis of aerial photographs, topographic maps, and published vegetation maps. See Figure 2.1-2 for habitats encountered along pipeline ROW.

[b]See Figure 2.3-3 for identification of construction methods by segment along the proposed route.

[c]Based on 75-foot wide construction ROW. A 50-foot ROW is needed for permanent access but there would be no maintenance (i.e., clearing) required during normal operation.

[d]Based on 75-foot wide construction ROW; a 50-foot ROW is needed for permanent access, but there would be no maintenance (i.e., clearing) required during normal operations. However, potential lowering of ground level in a 30-foot corridor may permanently exclude normal swamp forest vegetation from some segments of the ROW, replacing cypress-tupelo stands with open water and aquatic macrophytes.

[e]Open water construction impacts consist of 200 acres of temporary spoil storage and site access acreage in addition to 38 acres of temporary substrate removal.

TABLE 8.3-2 Approximate carrying capacities for selected wildife species in habitats affected by Bayou Teche oil distribution system[a]

	Bottomland and Swamp Forest		Marsh		Agricultural/ Cleared		Total	
	T[b]	P[b]	T	P	T	P	T	P
(Acres)	(438)	(85)	(150)	(44)	(317)	(35)	(905)	(164)
Deer	8	2	2	1	-	-	10	3
Rabbit	219	43	-	-	44	5	263	48
Squirrel[c]	569	111	-	-	6	0	575	111
Wood Duck	4	1	2	1	-	-	6	2
Bobcat	1	1	-	-	-	-	1	1
Turkey[d]	6	1	-	-	-	-	6	1
Migrant Waterfowl	44	9	61	18	265	30	370	57
Raccoon[e]	29	6	-	-	-	-	29	6
Fox	6	1	-	-	1	0	7	1
Black Bear[f]	-	-	-	-	-	-	-	-
Fish (lbs.)[g]	-	-	-	-	-	-	19,000	-
Mink	42	8	2	1	-	-	44	9
Alligator[h]	11	2	7	2	-	-	18	4
Otter	13	3	4	1	-	-	17	4
Woodcock[i]	-	-	-	-	23	3	23	3
Rail	-	-	25	8	-	-	25	8
Snipe	-	-	100	29	-	-	100	29
Coot	-	-	30	9	-	-	30	9
Muskrat[j]	-	-	200	59	-	-	200	59
Nutria[j]	-	-	76	22	-	-	76	22
Doves[k]	-	-	-	-	42	5	42	5
Song birds[l]	-	-	-	-	Numerous	Few	Numerous	Few
Quail[m]	-	-	-	-	53	5	53	5

[a]See Table 8.3-1 for acreages affected by various project features.

[b]T refers to temporary impacts on all lands required for project construction; P refers to permanent impacts on all habitats altered for the lifetime of the project.

[c]Most abundant in drier hardwoods areas.

[d]Introduced near Pierre Part, absent elsewhere.

[e]Also common in marsh.

[f]Introduced into Atchafalaya Floodway; uncommon

Footnotes to Table 8.3-2 (Continued)

[g]Based on 38 acres directly affected (Table 8.3-1).
[h]Threatened species.
[i]Seeks daytime refuge in dense woods.
[j]Occurs also in swamps.
[k]Not abundant in sugar cane fields.
[l]Also occurs in marshes and swamps.
[m]Occurs in limited numbers throughout area.

TABLE 8.3-3 Summary comparison of pipeline route impacts.

Impact Area	Atchafalaya Route (Proposed)	Bayou Teche Route (Alternative)	Preferable Route
GEOLOGY	Locally significant to surface topography; some long-term alterations due to flotation canals.	Locally significant to surface topography, predominantly short-term.	Bayou Teche
HYDROLOGY/ WATER QUALITY	Locally significant during construction; possibly long-term in Atchafalaya Basin.	Locally significant during construction; less sensitive areas crossed.	Bayou Teche
AIR QUALITY	Significant at St. James and along Mississippi River to Gulf of Mexico.	Significant at St. James and along Mississippi River to Gulf of Mexico.	No difference
NOISE	Locally significant, short-term.	Locally significant, short-term.	Atchafalaya
ECOLOGY/BIOTIC RESOURCES	Locally significant, particularly in Atchafalaya Basin swamp forest.	Locally significant, particularly in intermediate marsh and in vicinity of Lake Verret.	Bayou Teche
HISTORIC/ARCHAEOLOGIC/ RECREATIONAL RESOURCES	Possible disturbance to cultural sites; crosses Attakapas State Outdoor Recreation Area.	Possible disturbance to cultural sites.	No significant difference.
SOCIOECONOMICS	Some short-term construction effects, both beneficial and adverse; possible loss of property taxes.	Some short-term construction effects, both beneficial and adverse; possible loss of property taxes.	Atchafalaya Route
OIL SPILL RISKS	Primarily in Mississippi River.	Primarily in Mississippi River.	No significant difference.
RESOURCE COMMITMENTS	Land, energy, materials, labor, and biota	Land, energy, materials, labor, and biota	No significant difference.

8.4 ALTERNATIVE METHODS OF PIPELINE CONSTRUCTION ALONG PROPOSED RIGHT-OF-WAY

In Section 2 of this supplement, the pipeline construction techniques proposed for the Atchafalaya Basin Route were described and the rationale used in selecting these methods was explained (Section 2.3.3.2 and Figures 2.3-3 through 2.3-6). Basically, conventional dry land installation is proposed on levees and conventional push ditch installation in wetlands outside the Atchafalaya Basin; within the Basin, the flotation canal method is proposed.

Alternative installation procedures could be used for some segments of the pipeline ROW. Outside the Basin, there are no practical alternatives. Dry land construction is the only feasible method where water levels are too low to float the pipeline. In wetlands, the conventional push ditch is both the least costly and least destructive to the environment. Within the Basin, there are several possible alternatives which are considered in some detail in the following paragraphs. These are: (1) expansion of existing flotation canals along the south bank instead of the north; (2) construction of a conventional push ditch parallel to the existing pipeline canals; and (3) expansion of the existing flotation canals using a modified push ditch technique.

8.4.1 Flotation Canal Construction of Pipeline Along South Bank of Existing Flotation Canal

Along much of the south bank of the existing Chico canal across the Atchafalaya Basin, there is an existing spoil bank which does not have gaps at regular intervals, thus disrupting normal drainage from north to south. There are many sections of swamp forest south of this canal which are deteriorating as a result of the modified flow regime which has generally reduced water levels and circulation. Construction of the pipeline along the south bank would avoid creating additional spoil banks to the north and could potentially improve circulation and swamp forest habitat to the south by breaking up the continuous spoil banks.

The existing pipeline canal along the Atchafalaya ROW is generally 70 to 80 feet wide. The 20-inch Chico pipeline is laid close to the center of the canal, approximately 40 feet from the north bank. The 8-inch UCAR pipeline is laid along the south edge of the canal, approximately 5 to 15 feet from the bank. The Chico pipeline has a 30-foot wide ROW and the UCAR pipeline varies from 20 feet to more than 30 feet. Thus the UCAR pipeline ROW extends up to 10 feet under the south spoil bank (Figure 8.4-1). Excavation required for the FEA flotation canal may not be possible closer than 5 to 10 feet of the UCAR line for safety reasons. Thus, a full 70 to 80 feet of new canal would have to be dredged along the south bank, nearly doubling the existing canal width. In places where the UCAR line is within 5 feet of the south bank, a 5 to 10-foot wide strip of vegetation may be left between the two canals. Eventually most of this strip of land would slough off leaving a canal approximately 180 feet wide (Figure 8.4-1).

By laying the 36-inch pipeline to the north of the Chico line as proposed, much of the existing ROW could be used for barge access. Thus, widening of the north bank could be limited to 50 feet, possibly less in places (Figure 2.3-7).

Comparing the potential environmental impacts to the proposed north bank extension, it is evident that approximately twice as much excavation volume and swamp forest acreage would be required for construction south of the existing canal. The final width of the flotation canal would be approximately 180 feet compared to 140 feet. A more acceptable method of improving surface flow to the south across the existing canal would be to gap the continuous spoil banks while laying the pipeline to the north (This is listed as a potential mitigating measure in Table 5-1).

8.4.2 <u>Conventional Push Ditch Construction Across Atchafalaya Basin</u>

A possible alternative to flotation canal construction across the Atchafalaya Basin is the use of conventional push ditch construction techniques (Section 2.3.3.2). With this method a ditch would be constructed through the swamp forest parallel to the existing pipeline canal using heavy equipment working from timber mats. Because of the liquid consistency of the substrate a 30 to 40-foot wide ditch is expected to be required due to sloughing of the banks. Also, the depth of the canal should be a minimum of 8 feet because of the expected wide fluctuation in water level and the need for 3 feet of pipeline cover. A typical cross-section is shown in Figure 8.4-2.

Because of the 4000-foot minimum bend radius which can be made pushing a concrete-coated 36-inch diameter pipe, there would be some deviation from the existing canal. Where bends are too abrupt to follow, and at some pipeline crossings, pre-fabricated bends must be installed. This would require heavy equipment access (lay barge, typically 40'x350'x8' draft) for bend installation and to set up new push sites. There may be as many as 30, or as few as 5, such locations along the proposed ROW. At each, lay barge access must be provided which, at a minimum, would consist of dredging a 50-foot wide by 500-foot long access canal off the existing canal to establish a work site. In some locations, it may be necessary to dredge lay barge access through natural waterways, through the existing pipeline canal (where siltation prevents access), or 1000 or more feet along the proposed push ditch ROW to establish an unobstructed push site.

After pipeline installation and backfilling, a 30 to 40-foot wide shallow ditch would remain parallel to the existing pipeline canals. Where the strip of vegetated bank is narrow (less than 10 feet), bank erosion and sloughing would eventually produce a nearly continuous open water body 120 to 140 feet wide. Where the push ditch alignment deviates further from the canal (at bends in the ROW), relatively narrow islands of vegetation would be created. The consistency of the spoil is expected to be unsuitable for successful backfilling; more than half of the volume would probably be lost to compaction, dehydration, and erosion, leaving very little to fill the ditch. Also, wherever special bends must be installed, there would be new, permanent access canals, some perpendicular to the existing canals, as well as new spoil banks adjacent to existing waterways which require dredging for access.

As a result, the total additional acreage of permanent open water is likely to be as great as that required for the proposed conventional flotation canal construction. Ideally, straight segments of ROW would require approximately one-third as much excavation volume and thus smaller spoil piles and acreage of filled wetlands. However, at bends, pipeline crossings, and wherever special access must be provided, nearly equal or even greater volume of excavation would be needed.

Push ditch construction would be subject to the same limitations and technical difficulties described for the modified push ditch in Section 2.3.3.2. In addition, the equipment required to remove the very large cypress stumps often encountered in the Basin may not be accessible during much of the wet season. Delays in schedule associated with weather, unpredictable water levels, and the highly variable conditions encountered within the Basin are probable. Cost implications of such delays, especially if a second contractor must be mobilized to continue by flotation canal under high or low water conditions, are great.

In summary, it appears that only marginal, if any, environmental benefits would be obtained by utilizing this method of construction. Schedule delays and increased costs would be almost a certainty.

8.4.3 Modified Push Ditch Expansion of Existing Flotation Canal

A possible alternative to expanding the existing canal using the flotation canal construction technique, as proposed, is to expand the canal using the modified push ditch construction method, as described in Section 2.3.3.2. With this method a shallow draft barge (perhaps 40'x150'x3' draft) would be used to expand the existing canal along the north bank and to prepare a pipeline trench for installation. The coated pipeline would then be pushed into position from a (larger) push barge. The estimated canal expansion dimensions would be 25 feet wide by 4 feet deep (plus the pipeline trench at the bottom) (Figure 8.4-3). Where a separate 100-foot canal was proposed at major water body crossings, a 40 to 50-foot modified push ditch could be used in its place.

As with the conventional push ditch method described in Section 8.4.2, the minimum bend radius would be approximately 4000 feet. Wherever the pipeline could not be pushed into position, or at certain pipeline crossings, prefabricated pipe bends would be installed and new push sites established. This would require push barge access to each such site (estimated at a minimum of 5 and a maximum of 30 depending on water levels, final alignment, and contractor equipment). In some locations, access might be provided by simply dredging additional water depth from the existing canal for short distances from an existing navigable waterway. In others, substantial lengths of the existing canal might have to be dredged to accommodate the push barge.

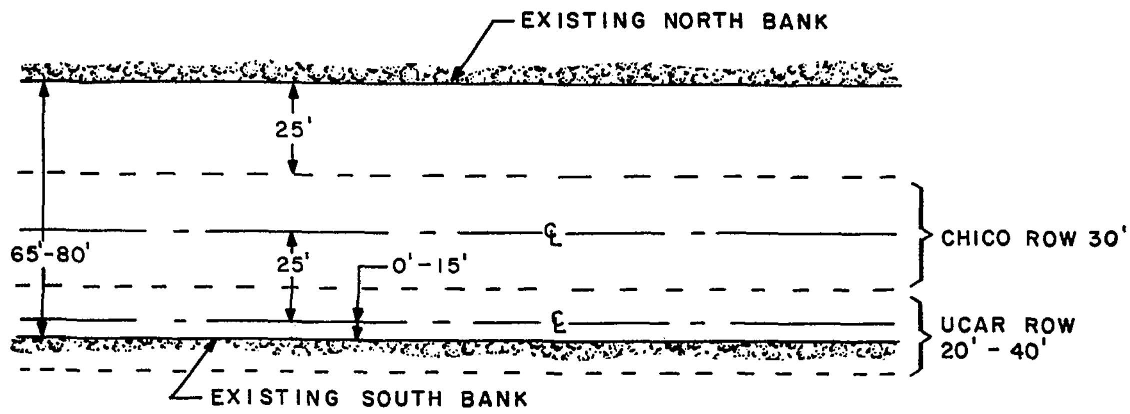
After pipeline installation (and backfilling of the trench), the existing pipeline canal would be widened by approximately 25 feet to a depth of about 4 feet. Backfilling of the canal would not be very effective because of the liquid consistency of the spoil and would not be proposed in order to retain access to the pipeline. Wherever special bends must be installed, part of the existing canal and at least a portion of the expansion must be deepened to provide 8 to 10 feet of draft. Spoil would be piled along the north bank with gaps left for drainage.

The total acreage of additional canal produced by this construction method, if successful, would be about one-half that of the proposed flotation canal method (25 feet versus 50 feet widening). The construction ROW width would be about 60 feet compared to 100 feet. Excavation volume would be about 35,000 cy per mile (plus dredging needed for access to push sites and tie-ins) compared to 75,000 cy/mile for the flotation canal. Direct and potential indirect effects on hydrology and swamp forest habitat should be somewhat smaller as a result, depending on the extent of push barge access required.

Many of the limitations and technical difficulties described in Section 2.3.3.2 apply to canal expansion with a modified push ditch. Receding water levels could strand the dredging barge in shallow water, requiring additional excavation to continue. The pipeline would also be stranded if it cannot be held in place over the excavated pipe ditch. Pipe supply logistics and the vagaries of weather could slow, or halt, construction because there is less flexibility in access and use of equipment. Also, this method of pipeline installation has not been utilized previously in the Atchafalaya Basin and thus is subject to additional delays and costs due to unforeseen problems in the field.

In summary, this method appears to offer some possibility for a reduction in adverse environmental impacts if weather, terrain, and field application do not present unexpected problems. The unconventional nature of the method indicates that there may be uncertainty in schedule completion and total cost and difficulty in retaining a contractor suitably equipped to handle the installation. In the event that a significant number of field tie-ins or pipeline crossings require push barge access, much of the incremental benefit to the environment may be lost.

A. EXISTING CHICO CANAL



B. SOUTH BANK CANAL EXPANSION

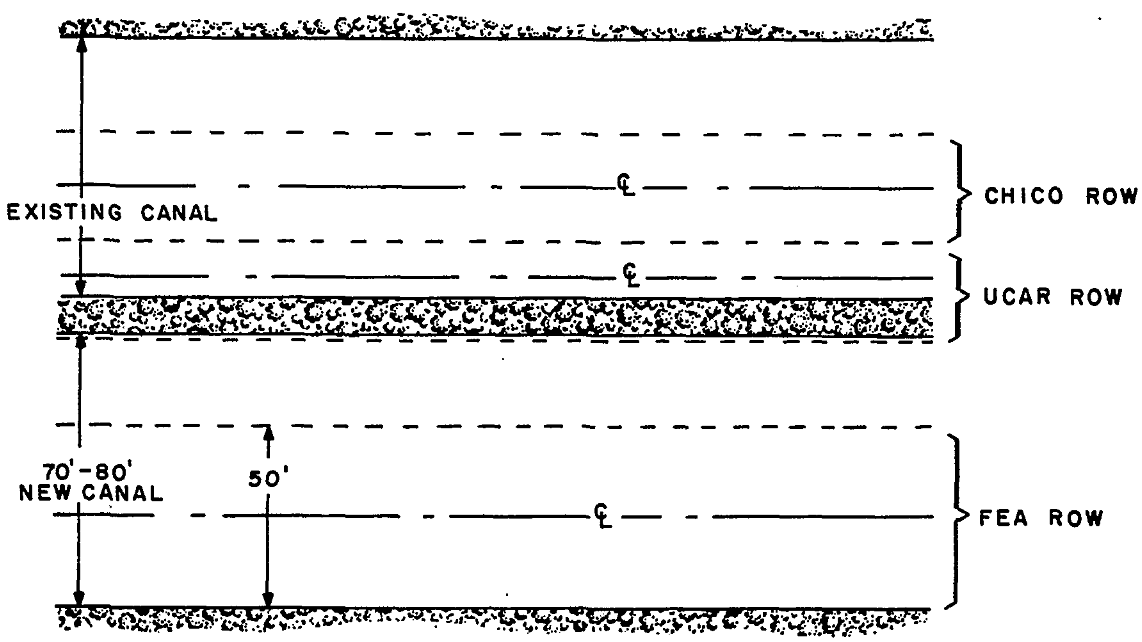


Figure 8.4-1. South Bank Pipeline Construction Alternative.

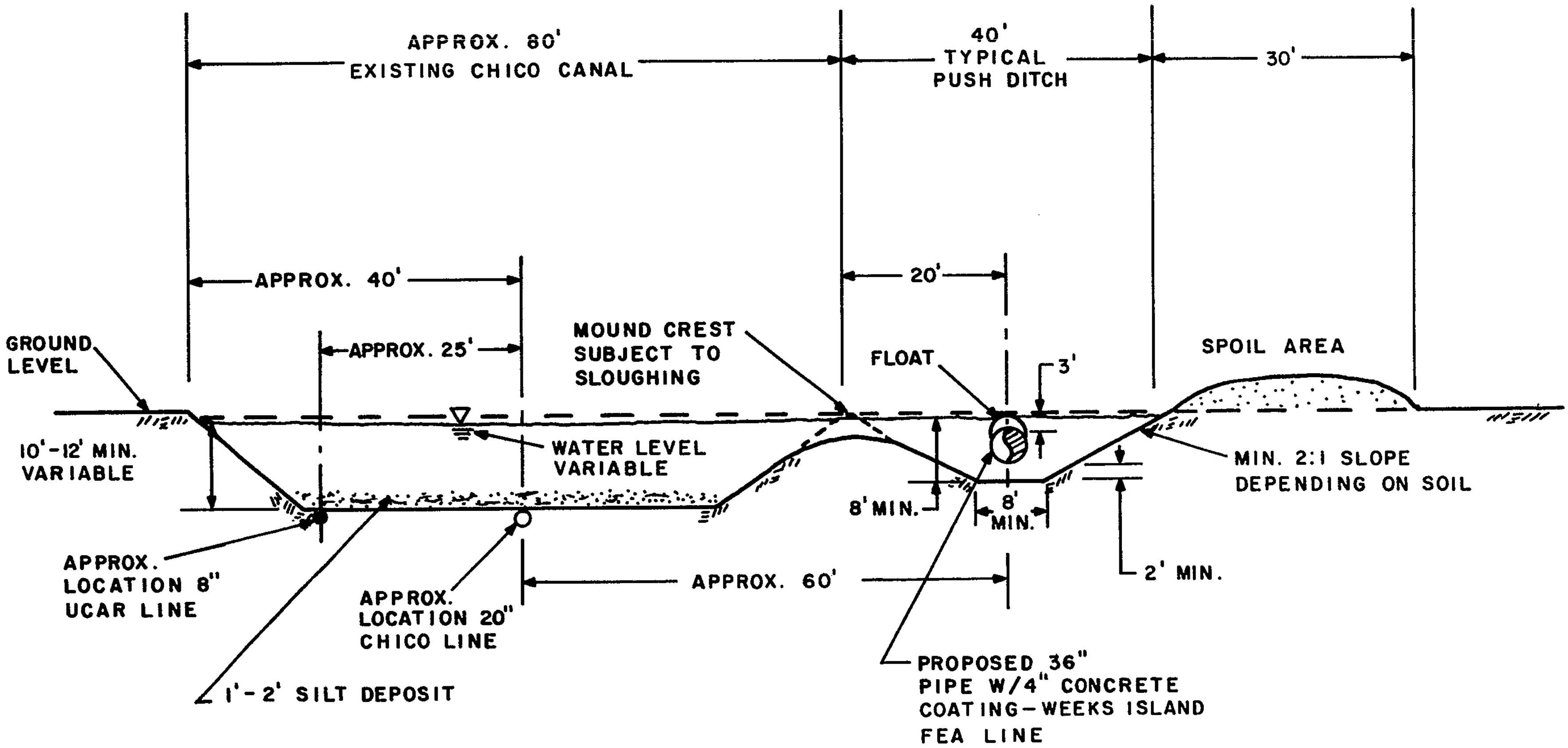


Figure 8.4-2. Push Ditch Construction Alternative Adjacent to Existing Canal.

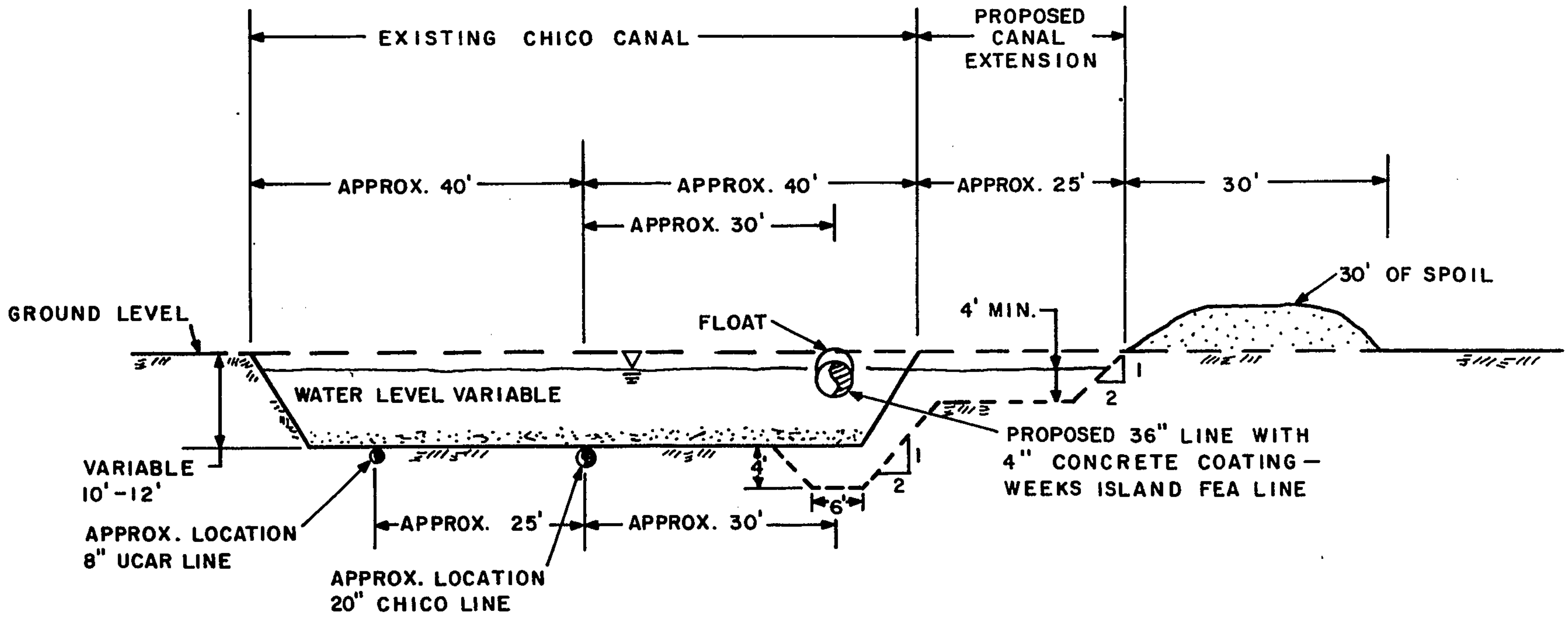


Figure 8.4-3. Modified Push Ditch Construction Alternative by Widening Existing Chico Canal.

SECTION 9.0

CONSULTATION AND COORDINATION WITH OTHERS

A list of local, state, and federal agencies, as well as industry and public organizations, contacted during the preparation of the Weeks Island and Cote Blanche Island EISs is given in FES 76/77-7 and 76/77-8. 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 76/77-7 and 76/77-8.

SECTION 10.0

REFERENCES

Acadiana Planning and Development, 1974. Economic Base Study: Acadiana Planning and Developement District (June).

American Petroleum Institute, 1962. Evaporation loss from Floating Roof Tanks, API Bulletin 2517, New York, February, 1962.

American Petroleum Instutute, 1976. Hydrocarbon Emissions from Marine Vessel Loading of Gasolines. API Bulletin 2514-A, Washington, D.C..

Atomic Energy Commission, 1972. The Probability of Transporation Accidents, AEC 14th Annual Explosion Safety Seminar, New Orleans, Louisiana.

Brewer, R. and J.A. Ellis, 1958. An Analysis of Migrating Birds Killed at a Television Tower in East-Central Illinois, September 1955-May 1957. Auk 75; 400-414.

Burgess, Joseph E., 1977. U.S. Fish and Wildlife Service, Lafayette, Louisiana, Personal Communication.

Chabreck, Robert H. 1972. vegetation, Water and Soil Characteristics of the Louisiana Coastal Region: Louisiana State University Bulletin No. 664, P. 1-72.

Chicago Bridge and Iron Company, 1976. SOHIO/CBI Floating Roof, Emissions Test Program, Final Report, November 18, 1976.

Dames & Moore, 1975. Environmental Analysis: Louisiana Offshore Oil Port, Volume I. October 1975. Prepared by Dames & Moore for LOOP Inc.- New Orleans

Davenport, T.C, and F.J. Conti, 1971. Heat Transfer Problems Encountered in the Handling of Waxy Crude Oils in Large Pipelines. J. Inst. Petrol. 57, 147(1971).

Day, J.W., W.G. Smith, P.R. Wagner, and W.C. Stowe, 1973. Community Structure and Carbon Budgent of a Salt Marsh and Shallow Bay Estuarine System in Louisiana, LSU, Center for Wetland Resources, Publ. No. LSU-SG-72-04.

Federal Clean Air Act, 1970. (42 U.S.C. 1857 et seg.)

Federal Energy Administration, 1976. Final Environmental Impact Statement for Bayou Choctaw Salt Dome, FES 76-5, December 1976.

Federal Energy Administration, 1976. Strategic Petroleum Reserve Plan (public law 94-163, Section 154). Strategic Petroleum Reserve Office, December 15, 1976.

Federal Energy Administration, 1977. Final Environmental Impact Statement for Cote Blanche Island Mine; FES 76/77-7, January 1977.

Federal Energy Administration, 1977. Final Environmental Impact Statement for Weeks Island Mine, FES 76/77-8, January 1977.

Federal Energy Administration, 1977. Supplement to Final Environmental Impact Statement for Bayou Choctaw Salt Dome(FES 76-5), FEA/5-77/129, May, 1977.

Federal Register, 1971. 36 FR 8186 April 30, 1976. U.S. Government Printing Office, Washington, D.C..

Fowler, Ron, 1977. U. S. Fish and Wildlife Services, Lafayette, Louisiana, Personal Communication.

Graber, R. R. 1968. Nocturnal Migration in Illinois-- Different Points of View. Wilson Bulletin 80: 36-71.

Gulf Interstate Engineering Company, 1975. Environmental Study to Accompany Application for a Department of the Army Permit, UCAR Pipeline Incorporated 8 Inch Ethylene Pipeline, Louisiana Segment, April 1, 1975.

J.J. Henry, Inc. 1973. An Analysis of Oil Outflows Due to Tanker Accidents. 1971-72. Report Prepared for U.S. Coast Guard, November 1973.

Holzworth, George C., 1972. Mixing Heights, Wind Speed Potential for Urban Air Pollution Throughout the Contiguous United States, Environmental Protection Agency, Research Triangle Park, North Carolina.

Kem-Tech Laboratories, Inc., 1975. Air Pollution Study of Lower Lafourche Parish, Louisiana. Baton Rouge, Louisiana.

Lantz, K.E. 1974. Natural and Controlled Water Level Fluctuation in a Backwater Lake and Three Louisiana Impoundments, Louisiana Wildlife and Fisheries Commission, Fisheries Bulletin No. 11.

Louisiana State Planning Office, 1972. Land Use and Date Analysis (LUDA) Program: U.S. Geological Survey, 1972.

Lowery, G.H. Jr. 1974. Louisiana Birds. Louisiana State University Press Third Edition 651 pp..

Lowery, G. 1974. THe Mammals of Louisiana and Its Adjacent Waters, Louisiana State University Press, Baton Rouge, Louisiana, 565 pp.

Mayfield, H., 1967. Shed Few Tears. Audubon, May-June, P.61-65.

Perry, H. H., etal, 1963. Chemical Engineers Handbook. 4th Edition, McGraw (1963).

Simon,Larry,1977.St.James Parish Waterworks,St.James,Louisiana.Personal Communication.

Stoddard, H. L., Sr. and Norris, R.H., 1967. Bird Casualties at Leon County, Florida TV Tower: An Eleven-Year Study. Bulletin of Tall Timbers Research Station No. 8.

Stout, I. J., 1967. The Nature and Pattern of Nonhunting Mortality in Fledged North American Waterfowl. M.S. Thesis, UPI & SU, Blacksburg, Virginia, 329 pp. .

Turner, Ora, 1977. Louisiana Air Control Commission,June 28, 1977.Personal Communication

Turner, D.B., 1969. Workbook of Atmospheric Dispersion Estimates, NOAA, U.S. Air Resources Research Office. Also referred to as EPA (1970)

U.S. Army Corps of Engineers, 1973. Inventory of Basic Environmental Data, South Louisiana, Mermentau River Basin to Chandeleur Sound With Special Emphasis on the Atchafalaya Basin, New Orleans, District, September 1973.

U.S. Army Corps of Engineers, 1975a. Public Notice of Application for Construction Permit, UCAR Pipeline Incorporated 8 Inch Ethylene Pipeline Crossings, 13 May 1975.

U.S. Army Corps of Engineers, 1975b. Atchafalaya Basin Usage Study. New Orleans, Louisiana, 85 pp..

U.S. Army Corps of Engineers, 1976. Supplement to Final Environmental Statement Mississippi River, Baton Rouge to the Gulf of Mexico. U. S. Army Engineer District New Orleans. New Orleans, Louisiana, January 1976.

U.S. Bureau of the Census, 1972. County and City Data Book, U.S. Government Printing Office Washington, D.C., 1973.

U.S. Department of Commerce, 1973. NOAA Local Climatological Data, National Climactic Data Center, Asheville, North Carolina, 1973.

U.S. Department of Interior, 1976. Endangered and Threatened Wildlife and Plants, U.S. Federal Register, Vol. 41 (Part IV), No. 208, October 27, 1976.

U.S. Department of Transportation, 1969-74. Summary of Liquid Pipeline Accidents Reported on DOT Form 7000-1. Department of Transportation, Washington, D.C.. Period Covered from January 1, 1965 through December 31, 1973.

U.S. Department of Transportation, 1976. LOOP Deepwater Port License Application. U.S. Department of Transportation, U.S. Coast Guard, Draft Environmental Impact /4(f) Statement. Deepwater Port Project, Office of Marine Environment and Systems, Washington, D.C..

U. S. Environmental Protection Agency, 1973. Proposed Criteria for Water Quality, Volume 1.

U.S. Environmental Protection Agency, 1976a. Noise Emission Standards for Construction Equipment Background Document for Portable Air Compressors EPA 550/9-76-004.

U.S. Environmental Protection Agency, 1976b. Compilation of Air Pollution Emission Factors, Second Edition: Office of Air Quality Planning and Standards, Research Triangle Park, North Carolina, February 1976.

U.S. Environmental Protection Agency, 1976. Revision of Evaporative Hydrocarbon Emission Factors, EPA-450/c-76-039. August 1976.

U.S. Fish and Wildlife Service, October 1976. Endangered and Threatened Wildlife and Plants. Federal Register, Vol. 41 (208).

U.S. Fish and Wildlife Service, January 1977. Endangered and Threatened Wildlife and Plants. Federal Register, Vol. 42 (6).

U.S. Geological Survey, 1975. Water Resources Data for 1975. Date Report LA-75-1.

University of New Orleans, 1974. Statistical Abstract of Louisiana, Division of Business and Economic Research, College of Business Administrations.

Whiteman, C.D., Jr., 1972. Ground Water in the Plaquemine-White Castle Area Iberville Parish, Louisiana. Water Resources Bulletin No. 16, Department of Conservation, Louisiana Geological Survey and Louisiana Department of Public Works, Baton Rouge, Louisiana, 1972.

APPENDIX A

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

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ESTIMATES OF EMISSIONS FROM TANKER AND BARGE TRANSFERS AND MODEL USED TO CALCULATE DOWNWIND GROUNDLEVEL CONCENTRATIONS

A.1 EMISSIONS FROM BARGE AND TANKER TRANSFERS

Hydrocarbon emission factors for petroleum loading/unloading operations used in the Weeks Island/Cote Blanche Island supplement were based upon American Petroleum Institute (API) publication 2514-A (1976) and Appendix C. A summary of average and maximum emission factors are set forth below:

		Emission Factors (lb/1000 gal transferred)			
		Average		Maximum	
		70°F	100°F	70°F	100°F
Ship Loading:	Cleaned	0.30	0.38	0.33	0.45
	Uncleaned	0.79	0.88	0.83	0.94
	Average	0.55	0.63	0.58	0.70
Barge Loading:	Cleaned	0.48	0.57	0.52	0.65
	Uncleaned	1.54	1.65	1.59	1.71
	Average	1.01	1.11	1.06	1.18
Ship Ballasting:	Cleaned	0.17	0.17	0.17	0.17
	Uncleaned	0.66	0.66	0.66	0.66
	Average	0.42	0.42	0.42	0.42

Average emission factors were based on a Reid vapor pressure (RVP) of 4 psia while maximum emission factors were based on a RVP of 5 psia. The crude oil temperature was assumed to be 70°F during fill and 100°F during withdrawal operations. The specific emission factors used for the transfer operations in Section 4.3.3 (Table 4.3-1) 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 25,000 barrel barges at Venice: 1.54 (loading) + 0.42 (ballasting) = 1.96
3) Offloading 45 MDWT tankers at the St. James docks: 0 + 0.42 (ballasting) = 0.42
4) Loading 25,000 barrel barges at Weeks Island and Cote Blanche Island: 1.65 (loading) + 0 = 1.65
5) Loading 80 MDWT tankers at the St. James docks and from barges at Venice: 0.63 (loading) + 0 = 0.63

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 4.3-1.

Emission factors used in Section 4.3.3 for worst case air quality impacts 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 25,000 barrel barges at Venice: 1.59 + 0.66 = 2.25
3) Loading barges at Weeks Island and Cote Blanche Island docks: 1.71 + 0 = 1.71
4) Loading 80 MDWT tankers at the St. James docks and from barges at Venice: 0.94 + 0 = 0.94
5) Offloading 80 MDWT tankers at the St. James docks: 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 (EPA, 1976). Transit emission factors were based on a RVP of 4 psia and are 0.0067 lb/hr/1000 gal at 70°F and 0.118 lb/hr/1000 gal at 100°F. Transit times for the Weeks Island/Cote Blanche Island oil distribution are as follows:

45 MDWT Tanker transit from 12 miles offshore to Venice	4 hours
Barge transit from Venice to Weeks Island/ Cote Blanche Island	64/62 hours
45 MDWT Tanker transit from 12 miles offshore to St. James	32 hours
Barge transit from Weeks Island/ Cote Blanche Island to Venice	41/40 hours
80 MDWT Tanker transit from St. James to 12 miles offshore	33 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

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OIL SPILL RISK ANALYSIS METHODOLOGY

B.1 PIPELINES

The basis for calculating pipeline spills in this supplement to the Weeks Island and Cote Blanche Island oil distribution systems 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 Amendment 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 basis 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 Weeks Island, Cote Blanche Island, and Venice 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 carrier (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 tankship 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 maximum credible spill used in this supplement 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.

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.

Maximum credible spill sizes for other risk hazards are given in Tables 4.3-3 and 4.3-4.

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

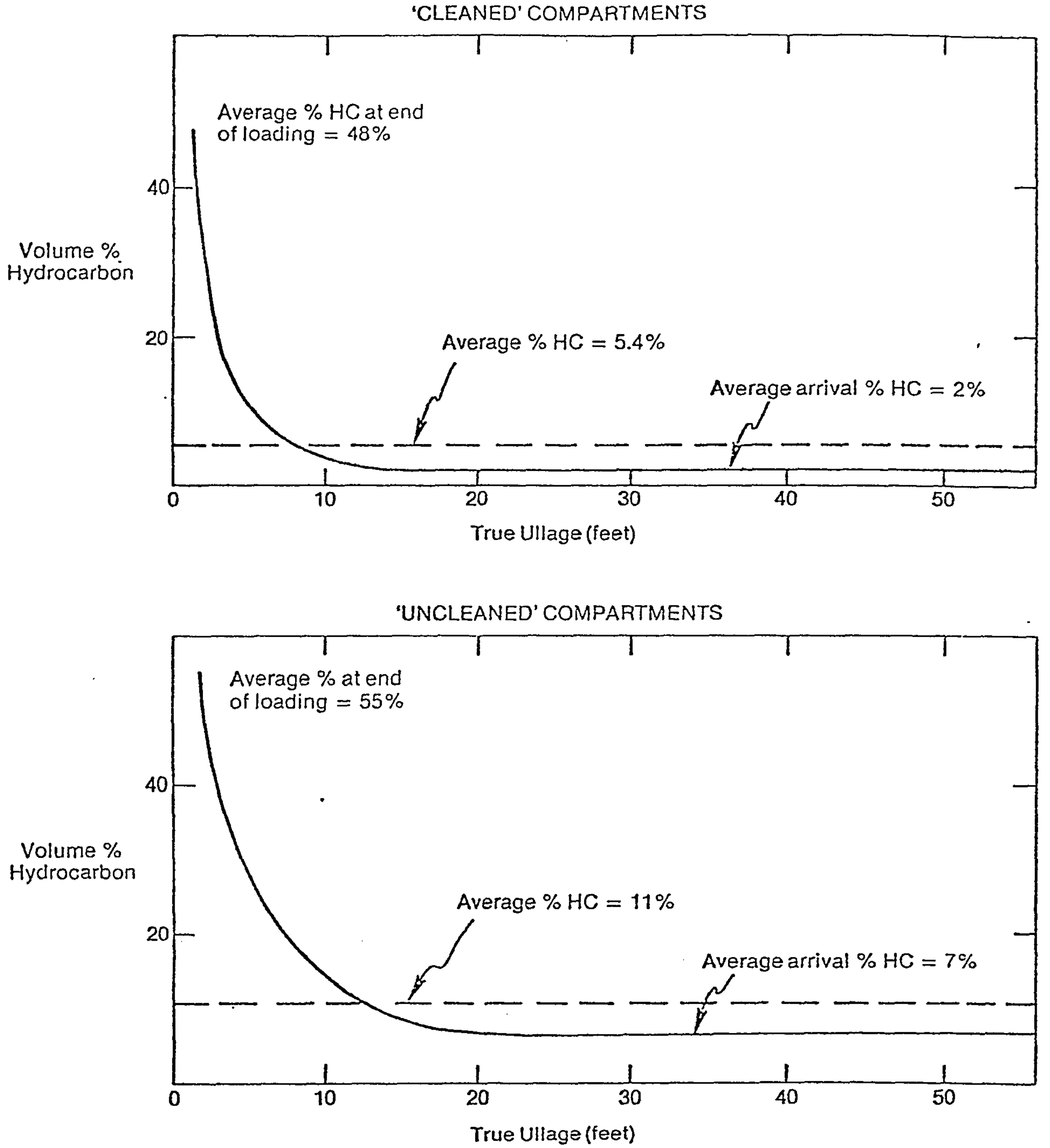

Figure C-1 Typical Ship Emission Profiles the arrival vapor component and the concentration is almost uniform. There is a sharp rise in hydrocarbon vapor concentration just above the liquid surface. This is the generated component. The generated component, also called a "vapor blanket," is attributable 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.

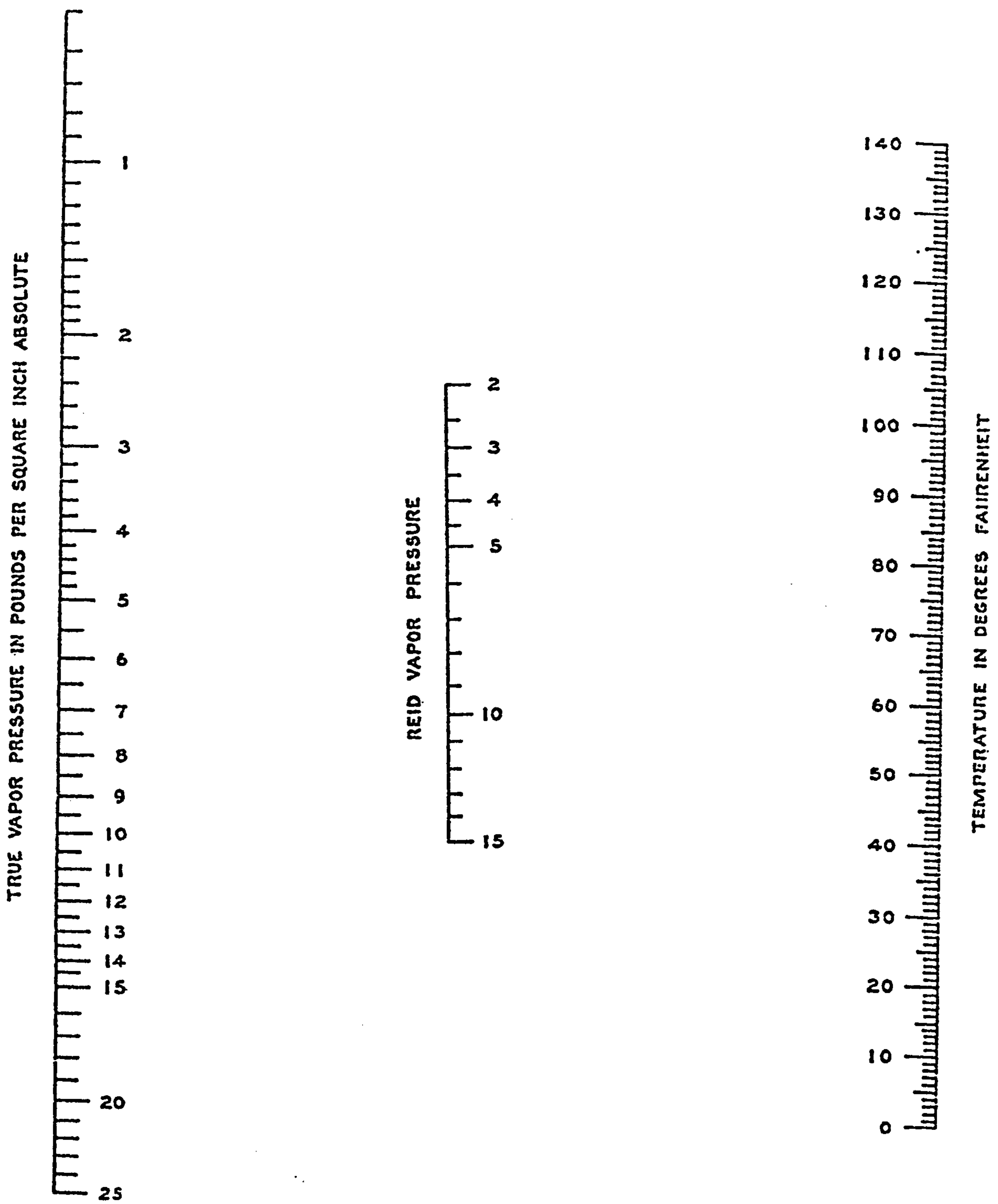

Figure C-2 Vapor Pressures of Crude Oil

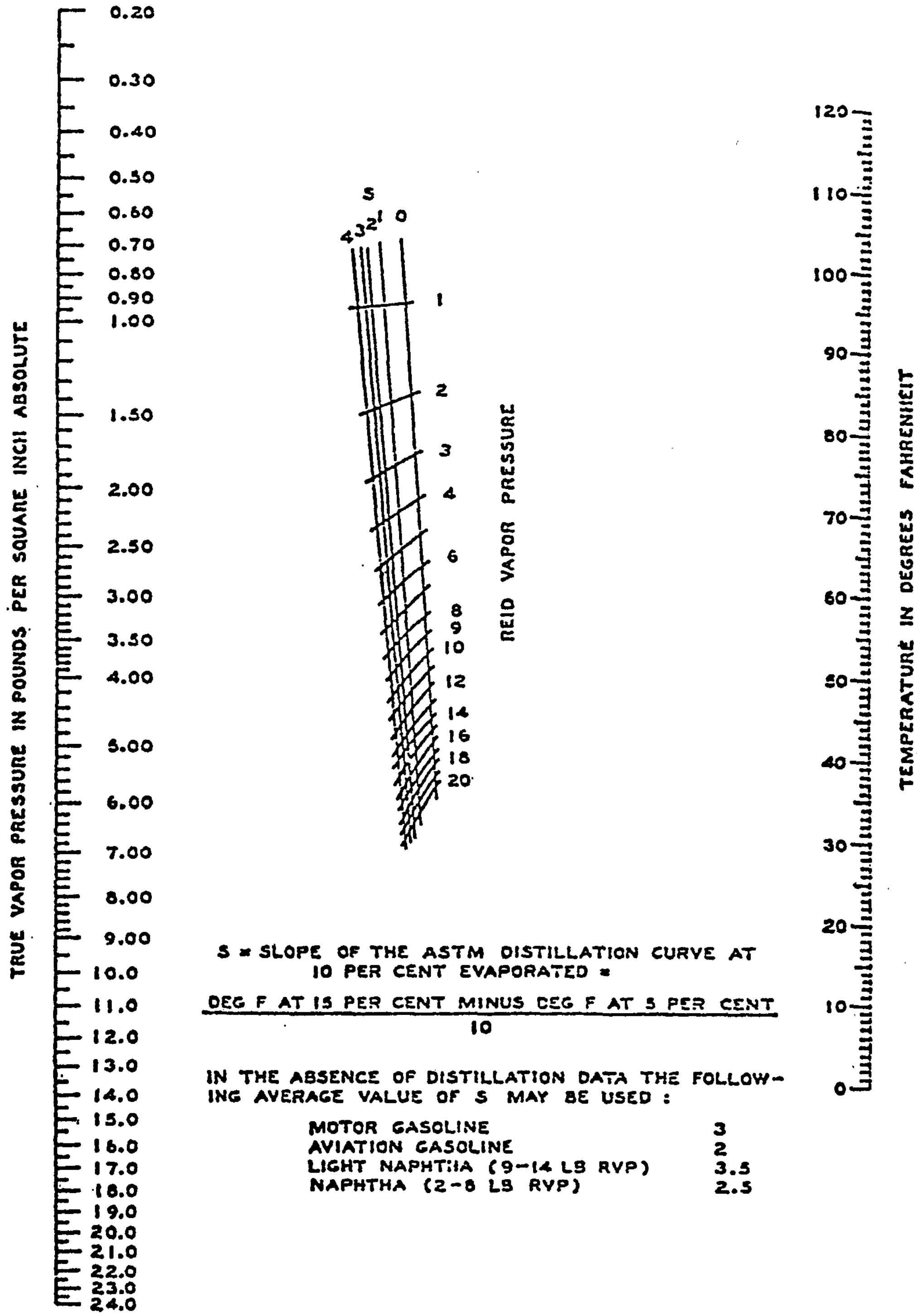

Figure C-3 Vapor Pressures of Gasolines and Finished Petroleum Products

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 C-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 lcean 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:

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

and

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

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 $ft^3/ft^2 \cdot$ 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

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

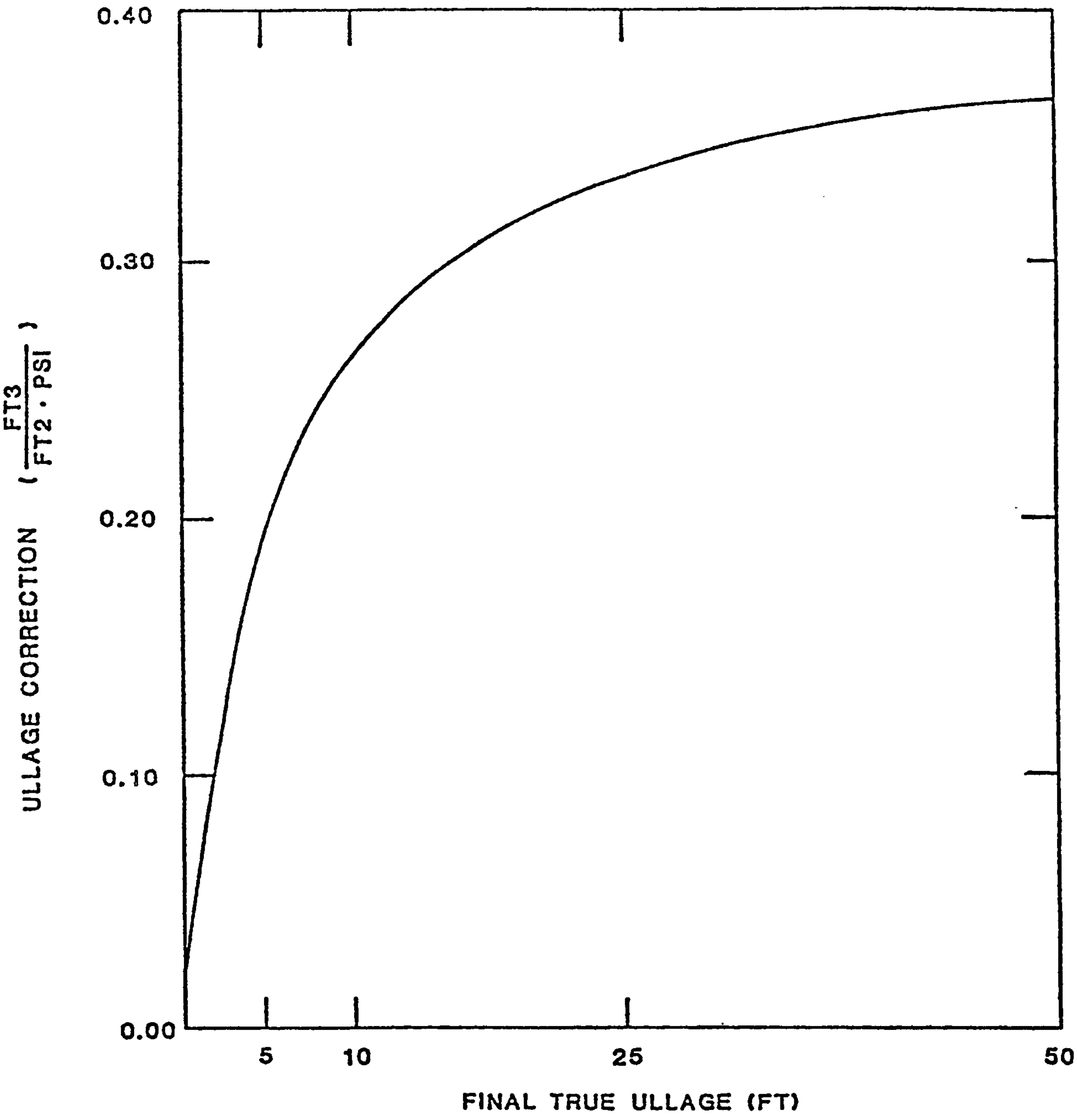

Figure C-4 Hydrocarbon Generation Coefficient, Final Ullage Correction to the EXXON Corporation

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:

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

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 α_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

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

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

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 C-2 Intermolecular 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 C-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)	$\Omega_{\mathscr{D},AB}$ (For mass diffusivity)	$\kappa T/\epsilon$ or $\kappa T/\epsilon_{AB}$	$\Omega_\mu = \Omega_k$ (For viscosity and thermal conductivity)	$\Omega_{\mathscr{D},AB}$ (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 C-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 C-5 Summary of Maximum and Average Hydrocarbon Emission Factors (lb/1000 gallon) for Crude Oil Transport Operation

Vessels	Arrival Conditions[a]	Maximum Emission Factor[b]						Average Emission Factor[c]					
		Previous Cargo						Previous Cargo					
		Gasoline			Crude Oil			Gasoline			Crude Oil		
		70°F	100°F	120°F	70°F	100°F	120°F	70°F	100°F	120°F	70°F	100°F	120°F
Ship Loading													
	Cleaned	--	--	--	0.33	0.45	0.56	--	--	--	0.30	0.38	0.48
	Uncleaned	1.90	2.01	2.12	0.83	0.94	1.05	1.86	1.95	2.04	0.79	0.88	0.97
	Average	--	--	--	0.58	0.70	0.81	--	--	--	0.55	0.63	0.73
Barge Loading													
	Cleaned	--	--	--	0.52	0.65	0.77	--	--	--	0.48	0.57	0.68
	Uncleaned	3.87	3.99	4.12	1.59	1.71	1.84	3.83	3.93	4.03	1.54	1.65	1.75
	Average	--	--	--	1.06	1.18	1.31	--	--	--	1.01	1.11	1.22
Ship Ballasting													
	Cleaned	--	--	--	0.17	0.17	0.17	--	--	--	0.17	0.17	0.17
	Uncleaned	--	--	--	0.66	0.66	0.66	--	--	--	0.66	0.66	0.66
	Average	--	--	--	0.42	0.42	0.42	--	--	--	0.42	0.42	0.42

[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.

[c] Based on RVP = 4.0.

REFERENCES

1. Chevron Research Company, "Hydrocarbon Emissions During Marine Tanker Loading, WOGA Test Program, Interim Report No. 1," November 1976.

2. American Petroleum Institute, "Hydrocarbon Emissions from Marine Vessel Loading of Gasoline," API Bulletin 2514-A, December 1976.

3. Environmental Protection Agency, "Background Information on Hydrocarbon Emissions from Marine Terminal Operations," Volume I and II, EPA-450/3-76-038a,b, November 1976.

4. American Petroleum Institute, "Evaporation Loss from Tank Cars, Tank Trucks, and Marine Vessels," API Bulletin 2514, November 1959.

5. Environmental Protection Agency, "Compilation of Air Pollutant Emission Factors," 2nd edition with supplements, AP-42, Research Triangle Park, N.C., 1973.

6. Mackay, D. and Matsuger, R. S., Canadian Journal of Chemical Engineering 51, 434, 1973.

7. Bird, R. B., et al, Transport Phenomena, John Wiley & Sons, Inc., 1960.

APPENDIX D

OIL TEMPERATURES DURING WITHDRAWAL

APPENDIX D

OIL TEMPERATURES DURING WITHDRAWAL

D.1 INTRODUCTION

The temperature of the oil being handled is an important factor in determining the emission of hydrocarbon vapors from storage tanks, tankers and barges in transit, and during transfers to and from carrier vessels. The oil temperature during oil fill operations will tend to average about 70°F, the average ambient temperature. During storage, however, heat transfer from the salt dome structure to the oil in the cavities could heat the oil to temperatures approaching that of the rock salt. Therefore, the hydrocarbon emissions from this higher temperature oil will be greater during withdrawal than during fill.

To determine the hydrocarbon emission factors during oil withdrawal, estimates must be made of the heat transfer rates during oil movement. The temperature of the storage cavity walls is a critical parameter; temperatures may range from 90° to 100°F at 1000 foot depths to 150°F at 4000 to 5000 foot depths. The oil in storage, which is able to circulate in free convection, will tend to reach the temperature of the warmest portion of the cavity. Heat transfer analyses to estimate the temperature of the oil withdrawn must consider the following: (1) heat exchange from the warm oil to the incoming fresh water flowing through the fill pipe (not applicable to Weeks Island and Cote Blanche Island mine storage caverns); (2) heat loss from buried pipelines during transport to the distribution terminal; and (3) frictional heating of the oil during pipeline transport. Oil temperatures calculated at terminal delivery can then be used to determine oil properties for calculation of hydrocarbon vapor losses during tank storage, tanker transfer, and tanker transit.

The following subsections develop an estimate of the heat transfer rates which may apply to withdrawals from the Weeks Island, Cote Blanche Island, and Bayou Choctaw storage sites. Controlling equations, oil properties, and physical configurations are developed and applied to the conditions of withdrawal at these sites.

D.2 PROPERTIES OF THE OIL AND BRINE

The oil is assumed to be characterized by an average U.S. crude, API 26°.

Density - 316. lbm/barrel, (56.03 lbm/cu.ft.)

Specific heat - 0.45 BTU/lbm°F

Thermal conductivity - 0.08 BTU/hr-ft-°F.

Variation of properties with temperature and pressure can be neglected, except for viscosity. Viscosity values are:

6 centipoise = 14.5 lbm/ft.hr. at 140°F
13 centipoise = 31.5 lbm/ft.hr. at 120°F
19 centipoise = 46.0 lbm/ft.hr. at 100°F
30 centipoise = 72.6 lbm/ft.hr. at 80°F

The brine solution is characterized as 0.1 molal, or 300 ppt salt. The heat capacity and thermal conductivity of the salt in solution may be neglected, so that the thermal properties per unit volume are equivalent to those for water.

Density - 81 lbm/cu.ft.

Thermal conductivity - 0.38 BTU/hr-ft-°F

Specific heat - 0.77 BTU/lbm°F = 62.4 BTU/cu. ft.°F

Viscosity - 0.3 centipoise = 0.73 lbm/ft.hr.

D.3 HEAT EXCHANGE DURING OIL DISPLACEMENT (BAYOU CHOCTAW SITE)

The heat exchange between the oil and displacement water can be described by standard heat transfer equations for heating or cooling of fluids flowing in tubes.

The heating of a fluid during flow between points 1 and 2 along a tube is defined by

$$WC(T_2-T_1) = h\pi DL(\Delta t) \qquad (1)$$
$$= h_L L(\Delta t)$$

where h is the heat transfer coefficient per unit area

h_L is the heat transfer coefficient per unit length

W is the mass flow rate

C is the specific heat

T_2, T_1 are the fluid temperatures at points 1, 2

(Δt) is the average temperature difference between the fluid and tube wall

L is tube length

D is tube diameter or hydraulic diameter.

To simplify the problem, it is noted that the potential rate of heat release or uptake into the water is much more rapid than that for oil; consequently it is assumed that the wall temperature is identical to the temperature of the water in the inner pipe. The heat exchange between oil and water is balanced:

$$W_o C_o (T_{01} - T_{02}) = W_w C_w (T_{w2} - T_{w1}) \quad (2)$$

The average temperature differential between points 1 and 2 is:

$$(\Delta t) = 1/2[(T_{w2} - T_{02}) + (T_{w1} - T_{01})] \quad (3)$$

The heat transfer coefficient of the oil in turbulent flow is given by a well-known Nusselt correlation (Perry, 1963):

$$(Nu) = \frac{hD}{K} = 0.023\ (Re)^{0.8} (Pr)^{1/3} \quad (4)$$

and for flow regimes transitional between turbulent and laminar,

$$(Nu) = \frac{hD}{K} = 0.027\ (Re)^{0.8} (Pr)^{1/3} (\mu/\mu_w)^{.14} \quad (5)$$

where (Nu) is Nusselt number

(Re) is the Reynold's number [$4W/\pi D\mu$]

(Pr) is Prandtl number [$\mu C/K$]

μ_w is fluid viscosity at the wall temperature

μ,C,K are, respectively, the fluid viscosity, specific heat, and thermal conductivity.

The system of four equations with four unknowns (T_{oil}, $T_{water\ at\ exit}$, (Δt), h) is solved iteratively because the viscosity varies enough with temperature to prevent treatment as a constant.

D.4 OIL COOLING IN PIPELINE FLOW

Warm oil flowing in a pipeline in cooler soil will release heat to the soil. Davenport and Conti (1971) give an approximate formula for the heat transfer coefficient per unit length of pipeline, based upon the method of images:

$$h_p = 2\pi K_s / \ln\ (4H/D)$$

where K_s is the thermal conductivity of the soil

H is the burial depth to pipeline centerline

D is the pipe diameter

ln refers to the natural logarithm.

The formula assumes a homogeneous soil. About 10% more heat may be dissipated to the air for shallow-buried lines, and with air and soil near temperature equilibrium. The thermal conductivity of a typical soil (90% sand, with 10% clay) ranges from 0.7 to 1.5 BTU/hr-ft°F (from dry soil at 0.7 to wet soil at 1.5). Thermal conductivity decreases with further water percentage increases until the mixture is sufficiently fluid to permit convective movement of the water around the pipe.

In contrast to the oil-water heat exchange in the fill pipe, where the heat transfer in the pipe wall can be neglected, the pipeline may be coated with insulating materials or concrete. Such coatings will have a thermal resistance per unit length of

$$h_i = \frac{\Pi DK_i}{X_i} \tag{7}$$

where X is the coating thickness and K is the conductivity of the covering material. Typical values for coatings are:

corrosion coating	X_i = 1/2 inch = .042 ft;	K_i = 0.09
concrete	X_i = 3 inches = .25 ft;	K_i = 0.7

Further, the oil heat transfer to the pipe wall, as given in Section D.3, must be included. An approximate value of the heat transfer coefficient, conveniently expressed per unit length of pipeline instead of per unit area, is derived from Perry (1963).

$$h_L = S\Pi\ (VD')^{0.8}/\ \mu^{0.467} \tag{8}$$

where the units are selected to have the following dimensions:

V in ft/sec, D′ in inches, and μ is the viscosity in centipoise.

The reciprocals of the heat transfer coefficients, $R = \frac{1}{h}$, define thermal resistances which are additive. The cooling of the line is then given by (see equation (1)):

$$\frac{T_2 - T_1}{L} = \frac{\Delta t}{WC}\ [\Sigma R]^{-1} = \frac{\Delta t}{WC}\ \left[\frac{1}{h_L} + \frac{1}{h_i} + \frac{1}{h_p}\right]^{-1}$$

D.5 OIL FRICTIONAL HEATING IN PIPELINE FLOW

The frictional heating of the oil is a strong function of fluid velocity; it is generally negligible below 5 ft/sec but significant at 10 feet/sec. The heating may be expressed by:

$$\frac{\Delta T}{L} = \frac{\Pi}{8} e\ f\ r \frac{V^3 D}{WC} \qquad (9)$$

where r is the fluid density,

v is the fluid velocity,

e is a roughness factor (adding 2% to 10% to the friction)

f is the friction factor in the Blasius or Nikuradse form:

$$f = \frac{.316}{(Re)^{.25}}, \text{ for } (Re) < 10^5$$

$$\text{and } f = .0032 + \frac{.221}{(Re)^{.237}}, \text{ for } (Re) > 10^5$$

In calculating the heating in ^oF/mile, conversion factors of 777.6 ft-lbf per BTU and 32.2 lbm ft/sec^2 per lbf are used. The roughness factor varies from 1.02 at (Re) of 50,000, to 1.10 at (Re) of 250,000, and can be obtained from standard piping handbooks. (There is no functional expression for e).

D.6 ESTIMATION OF OIL TEMPERATURE FOR WEEKS ISLAND AND COTE BLANCHE ISLAND MINE STORAGE

D.6.1 Water-Oil Heat Exchange

Oil would be pumped out of the caverns at Weeks Island and Cote Blanche Island, minimizing heat losses. Consequently, it is assumed that oil reaches the surface at a maximum temperature of 100^{o}F.

D.6.2 Pipeline Cooling

The pipeline conditions assumed are cover of 3 feet, moist sandy soil, and 1/2 inch of corrosion wrapping. Concrete sections are ignored over the 67 mile length, although more than half of the line would be protected. Slightly lower heat losses would be realized in these sections.

Maximum flow is 773 MBD in a 36" line. The thermal resistances are:

Soil - H/D = 1.5 , K_s = 1.5

thus: R = .19

Wrapping - $R = \frac{X}{\Pi D K_i}$, K_i = .09, X = .042

D = 3

thus: R = .05

Oil internal thermal resistance R = .0024 at 100°F
The total resistance (ΣR_i) is .242 in wet soil, about 40% greater in dry soil. The cooling per mile, expressed as:

$$\frac{T_2 - T_1}{L} = \frac{\Delta t}{WC} (\Sigma R)^{-1}$$

will be (with ambient temperature at 70°F) 0.14°F for 100°F oil. Cooling rate in dry soil would be about 40% less.

D.6.3 Heating in the Pipeline

With maximum flow at 773 MBD, velocity is 7 feet/second, mass flow is 10.2×10^6 lbm/hr. Then:

	Re	f	e
80°F	59,600	.0202	1.03
100°F	94,100	.0177	1.06

The heating rate is thus 0.09°F per mile at 80°F and 0.08°F per mile at 100°F.

D.6.4 Summary of Thermal Effects for Oil Withdrawn from Weeks Island and Cote Blanche Island

Oil withdrawn from the mine caverns could reach the surface at a temperature as high as 100°F. Net cooling in the pipeline would be about 0.05 to 0.06°F/mile, or about 4° along the total pipeline length. Thus, oil reaching St. James should not exceed 100°F (the temperature used for calculating hydrocarbon emissions from tanks, tanker transfers, and tanker transits during withdrawal).

D.7 ESTIMATION OF OIL TEMPERATURE FOR BAYOU CHOCTAW STORAGE

As oil stored at Bayou Choctaw would also be delivered to the St. James docks during withdrawal, estimation of maximum expected oil temperature is provided as a basis for calculating interactive air quality effects.

D.7.1 Water-Oil Heat Exchange

The fill pipe for each cavern is annular with oil in the outer annulus. The flow rate is about 5600 barrels per hour through an annulus of 143 square inches. Dimensions are ID of 19" and OD of 13-3/8" (hydraulic diameter 0.47 ft.), with a nominal length of 2500 feet. The water flows in a tubing of area 123 square inches and 12-1/2" ID.

Water flow is 2.1×10^6 lbm/hr, at 10.3 ft/sec. (Re) is 3.5×10^6. Oil flow is 1.8×10^6 lbm/hr at 8.9 ft/sec. Reynolds numbers are 11,800; 18,600; 27,200; and 59,000 at 80°F, 100°F, 120°F, and 140°F, respectively.

The worst case assumption of cavern temperatures is 150°F; water intake can be expected to average 70°F. Thus $\Delta t = 40 + 1/2\,(T_{02}-T_{W1})$, where T_{02} and T_{W1} are unknown.

The Nusselt correlation, expressed as a function of average cooling temperature differential gives:

T_2-T_1	Δt	(Nu)	(Pr)	(Re)
5.1°F	10°F	654	82	59,000
9.5°F	20°F	612	100	50,000
12.9°F	30°F	555	120	41,000
16.3°F	40°F	526	160	34,000
17.7°F	50°F	455	177	27,200
20.5°F	60°F	441	180	26,000

The solution of the problem, obtained by matching the oil exit temperature and the wall/oil differential temperature in the equation for (Δt) and the above table, gives

oil - cooled from 150° to 124° at the surface

water - heated from 70° to 80° at the salt dome cavity.

Other solutions, assuming alternate cavern temperatures, are:

- o oil cooled from 140° to 120°; water heated from 70° to 77.5°
- o oil cooled from 130° to 114°; water heated from 70° to 76°
- o oil cooled from 120° to 107°; water heated from 70° to 75°

D.7.2 Pipeline Cooling

The pipeline conditions assumed are cover of 3 feet, moist sandy soil, and 1/2 inch of corrosion wrapping. Concrete sections are ignored over the 39 mile pipeline length, although there may be substantial length of weighted sections. Maximum flow is 577 MBD in a 36" line. The thermal resistances are:

soil: H/D = 1.5; $K_s = 1.5$: therefore, R = .19

wrapping: $R = \frac{x}{\pi D K_i}$ $K_i = 0.09$; x = 0.042; D = 3:

therefore, R = .05

Oil internal thermal resistance at 577,000 barrels per day in the 36" line, with V = 5.3 ft/sec, is:

R = .0032 at 120°F

R = .0038 at 100°F

The total pipeline thermal resistance is thus about .244 in wet soil and 40 percent greater in dry soil. The cooling per mile for 120°F oil would be 0.32°F to an ambient of 70°F and 0.19°F for 100°F oil. Cooling in dry soil would be about 40 percent less.

D.7.3 Heating in the Pipeline

With a flow of 577 MBD, velocity is 5.3 feet per second, mass flow is 7.6×10^6 lbm/hr,

	(Re)	(f)	(e)
80°F	44,400	.0218	1.03
100°F	70,100	.0194	1.05
120°F	102,000	.0176	1.06

Heating is 0.05°F per mile at 80°F; 0.04°F per mile at 100°F and 120°F.

D.7.4 Summary of Thermal Effects for Oil Withdrawn from Bayou Choctaw

The existing cavities at Bayou Choctaw may reach a temperature, estimated from their depth, of 120°F. Heat exchange with incoming water at 70° would reduce this temperature to about 107°F. Net cooling in the 39 mile pipeline would average .16°F per mile, or 6.2°F. Resultant oil temperatures at St. James would be about 100°F.

However, temperatures as high as 140°F to 150°F could occur in one or more cavities. Oil temperature at the surface would then be 120°F to 124°F, with cooling in the line to about 110°F to 115°F at St. James under wet soil conditions and to 115°F to 120°F under dry soil conditions. This latter case could constitute worst case conditions and is used for calculation of hydrocarbon emissions during withdrawal handling of Bayou Choctaw oil.